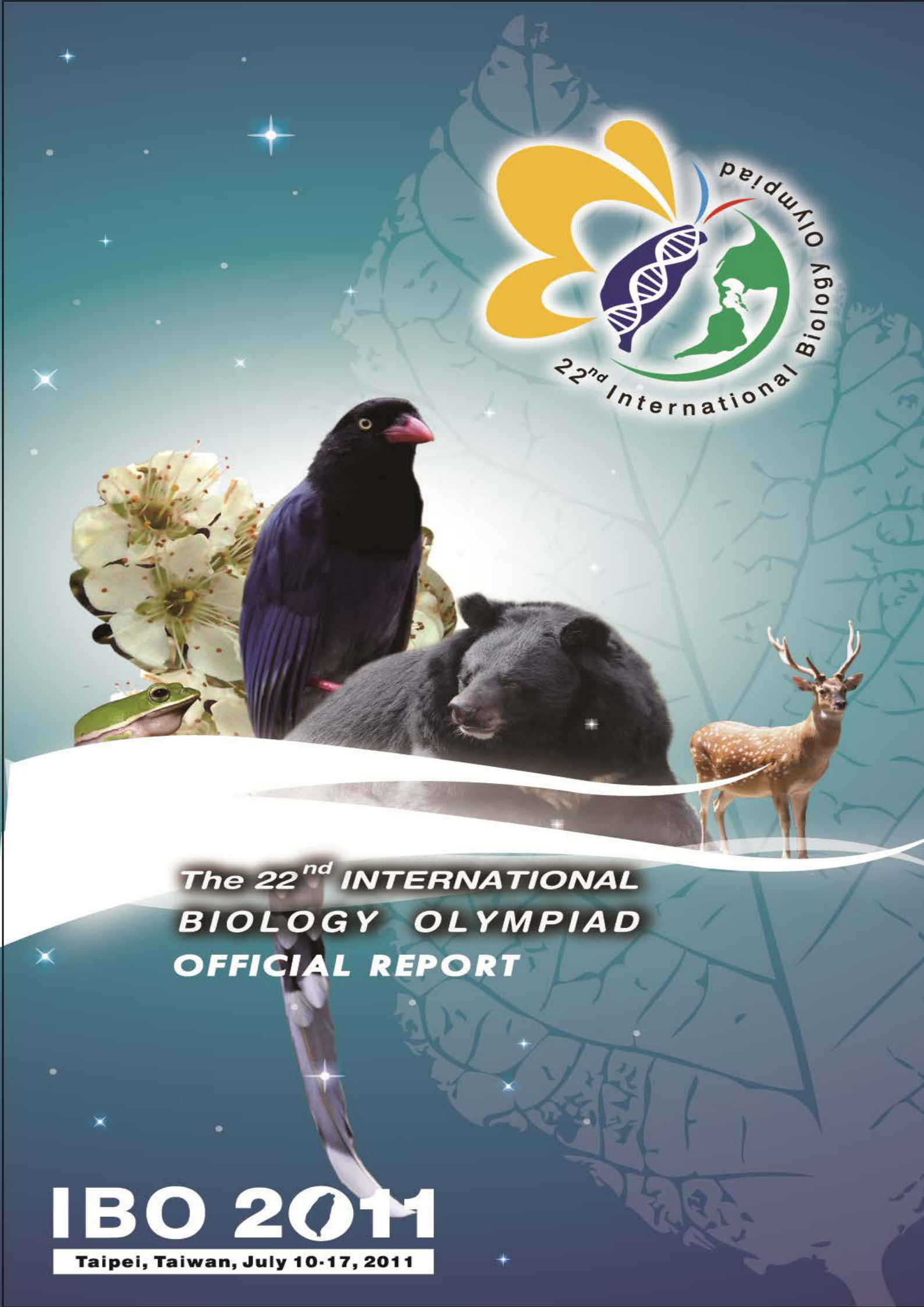

The 22nd INTERNATIONAL BIOLOGY OLYMPIAD OFFICIAL REPORT

IBO 2011

Taipei, Taiwan, July 10-17, 2011

IBO2011 Official Report Contents

A. Outline

Official Name:	The 22nd International Biology Olympiad
Abbreviated Name:	IBO2011 Taipei, Taiwan
Duration:	July 10th to 17th, 2011
Subgroup meeting:	July 6th to 10th, 2011
Venue:	National Taiwan Normal University, Taipei, Taiwan
Participated Countries:	60 (including two observing countries)
Participants:	423
Students:	227
Team Leaders:	113
Observers:	83
Staffs:	148
Senior Staffs:	27
Senior Guides:	9
Jury Staffs:	19
Jury Guides:	13
Student Staffs:	14
Student Guides:	18
Exam Staffs:	44
First Aid:	4
Medals:	139
Gold Medals:	24
Silver Medals:	47
Bronze Medals:	68
Participants' Fee:	$2000 USD Per team (including 4students and 2 leaders)
	$1700 USD Per observer

B. Institutions & Organizations

Host

Ministry of Education

National Science Council

Organizer

National Taiwan Normal University

Department of Life Science

Science Education Center

Sponsor

Lungteng Cultural Co., Ltd.

KangSi Cultural Co., Ltd.

Nan I Book Enterprise Co., Ltd.

Kang Hsuan Educational Publishing Group

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Yehliu Geopark

Major Instruments Co., Ltd.

Tseng Hsiang Life Science Co. Ltd.

Genmall Biotechnology Co., Ltd.

Wego Elementary School

Win Young Corporation

WM Book

C. Science Committee & Organizing Committee

Chairperson of IBO2011

Dr. Kuo-En Chang (President of National Taiwan Normal University)

Organizing Committee

Chairperson

Prof. Yung-Ta Chang (Dept. of Life-Science, National Taiwan Normal University)

Co-chairperson

Prof. Chun-Yen Chang (Science Education Center, National Taiwan Normal University)

Prof. Teng-Chiu Lin (Dept. of Life-Science, National Taiwan Normal University)

Prof. Chih-Wen Sun (Dept. of Life-Science, National Taiwan Normal University)

Dr. Chung-Hsin Wu (Dept. of Life-Science, National Taiwan Normal University)

Dr. John Che-Di Lee (Science Education Center, National Taiwan Normal University)

Lect. Bij-Chyi Hwang (Dept. of Life-Science, National Taiwan Normal University)

Dr. Tsung-Hau Jen (Science Education Center, National Taiwan Normal University)

Dr. Pei-Hua Lo (Science Education Center, National Taiwan Normal University)

Lect. Chi-Mei Lee (Dept. of Life-Science, National Taiwan Normal University)

Science Committee

Chairperson

Prof. Jenn-Che Wang (Dept. of Life-Science, National Taiwan Normal University)

Co-chairperson

Prof. Kwok-Tung Lu (Dept. of Life-Science, National Taiwan Normal University)

Prof. Yu-Chie Wang (Dept. of Life-Science, National Taiwan Normal University)

Prof. Yee-Yung Charng (Agricultural Biotechnology Research Center, Academia Sinica)

Prof. Ling-Long Huang (Institute of Ecology and Evolutionary Biology, National Taiwan University)

Prof. Ming-Hsiun Hsieh (Institute of Plant and Microbial Biology, Academia Sinica)

Prof. Guey-Jen Lee (Dept. of Life-Science, National Taiwan Normal University)

Prof. Hung-Hung Sung (Dept. of Microbiology, Soochow University)

Prof. Hsiu-Mei Hsieh (Dept. of Life-Science, National Taiwan Normal University)

Prof. Guan-Chiun Lee (Dept. of Life-Science, National Taiwan Normal University)

Prof. Shyh-Hwang Chen (Dept. of Life-Science, National Taiwan Normal University)

Prof. Ying Wang (Dept. of Life-Science, National Taiwan Normal University)

Prof. Yu-Feng Hsu (Dept. of Life-Science, National Taiwan Normal University)

Prof. Ling-Ling Lee (Institute of Ecology and Evolutionary Biology, National Taiwan University)

Prof. Chiang-Ting Chien (Graduate Institute of Clinical Medicine, National Taiwan University)

Prof. Li-Yih Lin (Dept. of Life-Science, National Taiwan Normal University)

Prof. Being-Sun Wung (Dept. of Microbiology, Immunology and Biopharmaceuticals, National Chiayi University)

D. Participants

1. Students

Team Name	Name		
Argentina	JAVIER	CARLOS	VILLARRAZA
Argentina	RAMIRO		ARRECHEA ANTELO
Argentina	CRISTIAN	CARLOS	GONZALEZ
Argentina	MATIAS	FRANCISCO	LEDESMA GONZALEZ
Armenia	Vardges		Tserunyan
Armenia	Shushan		Toneyan
Armenia	Lusine		Hovhannisyan
Armenia	Robert		Yeghikyan
Australia	Callum	Thomas	Gray
Australia	Nathan	Howard	Isaacson
Australia	Darcy	Robert	Gray
Australia	Phillip	Timothy	O'Riordan
Azerbaijan	Sadig		Niftullayev
Azerbaijan	Tamerlan		Bayramov
Azerbaijan	Kamran		Kerimov
Azerbaijan	Bakhtiyar		Taghizada
Belarus	ULADZIMIR	VALENTINOVICH	HRYNEVICH
Belarus	VOLHA	YURIEVNA	IVANOVA
Belarus	RAMAN	VALERIEVICH	PIARESKA
Belarus	YULIYA	VALERIEVNA	ZAITSAVA
Belgium	Jan	Hendrik Achiel	Brijs
Belgium	Michel	Philippe Pascal Pirre	Reginster
Belgium	Frédéric	Jean Pierre Francis	Clarembeau
Belgium	Julien	Gerard Charles	Mortier
Brazil	Mattheus José	Medeiros	Fernandes
Brazil	Pablo Ivo	Borges	Ferreira
Brazil	Rafaell	DA SILVA	LIMA
Brazil	PEDRO	BARBOSA	OLIVEIRA
Bulgaria	Petar	Iliyanov	Iliev

Bulgaria	Georgi	Dimitrov	Magaranov
Bulgaria	Elizar	Mariyanov	Tsvetkov
Bulgaria	Mira	Lyudmilova	Nencheva
Canada	Wei	Chan	XIANG
Canada	Jia	Cheng	LUO
Canada	Sean	Alexander	RIDOUT
Canada	Moustafa	Mohamed Saad Atia	ABDALLA
China	Zidong		Zhang
China	Yao		Xiao
China	Kemeng		Wu
China	Jin		Yang
Cyprus	Evdokia		Ttooulou
Cyprus	Elina	Eleni	Tringou
Cyprus	Andreas		Matthaiou
Cyprus	Andreas		Petrou
Czech Republic	Kateřina		Medková
Czech Republic	Karel		Kodejš
Czech Republic	Václav		Nuc
Czech Republic	Lenka		Ćurnová
Denmark	Monica	Aimee Harlund	Oyre
Denmark	Johan	May	Nitschke
Denmark	Liane		Dupont
Denmark	Lea	Lybek	Rueløkke
Estonia	Uku-Laur		Tali
Estonia	Erik		Tamre
Estonia	Anu		Ainsaar
Estonia	Ando		Vaan
Finland	Mikaela	Maria	Mutru
Finland	Joni	Sampsa Olavi	Ollonen
Finland	Laura	Johanna	Poso
Finland	Tinja	Maria Suvi-Tuulia	Toikka
Georgia	Nia		Khachapuridze

Georgia	Bela		Nishnianidze
Georgia	Ana		Gzirishvili
Georgia	Lado		Niauri
Germany	David	Sebastian	Fischer
Germany	Franziska	Maria	Feller
Germany	Tim	Ulf	Hutschenreiter
Germany	Roderich		Römhild
Greece	DAINORA		ČEPAITYTE
Greece	ELENI		TEREZAKI
Greece	GEORGIOS		AGORANOS
Greece	ALEXIOS		VOURVOUKELIS
Hungary	Bálint		REHŌ
Hungary	Marton		SZENTIRMAI
Hungary	Máté		NÁ SZAI
Hungary	Fatime		HAWCHAR
India	Saloni		Kapoor
India	Pritish	Laxmikant	Patil
India	Sanchit		Kumar
India	Twinkle	Tushar	Parekh
Indonesia	Thoriq		Salafi
Indonesia	Husni		Muarif
Indonesia	Marsha	Christanvia	Wibowo
Indonesia	Afandi		Charles
Iran	Ali		Vafaei
Iran	Mehrdad		Goshayeshi avval
Iran	Mahsima		Shabani
Iran	Ahmad		Vafaeian
Italy	ALESSIO		CAPOBIANCO
Italy	DANIELE		CERVETTINI
Italy	MARTINA		CHIRIACO'
Italy	LUCA		BIAVATI
Japan	HIDEAKI		KUME

Japan	TOMOYUKI		MIKAMI
Japan	YUTA		OTSUKA
Japan	HIROKI		MATSUDA
Kazakhstan	Zhassulan		Shaikhygali
Kazakhstan	Yernar		Tursynbay
Kazakhstan	Baizak		Kudaibergenov
Kazakhstan	Altynay		Narmanova
Korea	Seung Min		Kwak
Korea	Yeo Jin		YOO
Korea	Myeong hwan		Son
Korea	Ji Young		SONG
Kuwait	SALEH	HABIB	HAIDAR
Kuwait	SARAH	YOUSEF	ALMAJID
Kuwait	EELAF	AHMAD	HUSAIN
Kuwait	DALAL	SAEED	ALQALLAF
Kyrgyzstan	MYRZABEK		ALIBAEV
Kyrgyzstan	ERBOL		MOLDOZHUNUSOV
Kyrgyzstan	ELDOS		MUKASHOV
Kyrgyzstan	SANZHAR		ISAKUNOV
Latvia	Rūta		Talla
Latvia	Anete		Romanauska
Latvia	Kārlis		Jermacāns
Latvia	Anna		Stikāne
Liechtenstein	Donat		APPERT
Lithuania	Irmantas		Mogila
Lithuania	Emilija		Emma
Lithuania	Gabija		Lazaravičiūtė
Lithuania	Miglė		Mikutėnaitė
Mexico	José de Jesús		Naveja
Mexico	Melissa		Calzada
Mexico	Martín		López
Mexico	Alejandro		Rodríguez

Moldova	Bivol		Sergiu
Moldova	Solovei		Valeria
Moldova	Saragov		Diana
Moldova	Caraiman		Vladlena
Mongolia	Javzanpagma		Tsogbadrakh
Mongolia	Mashbayar		Sukhbat
Mongolia	Munkhzul		Tsogtsaikhan
Mongolia	Dolgormaa		Bataa
Netherlands	Johannes	Cornelis Jacobus	Mertens
Netherlands	Stephen	Robert	Skocpol
Netherlands	Dirk	Christiaan	Jungerius
Netherlands	Frank		Poort
New Zealand	Vicky	Wei-Chi	Tai
New Zealand	Richard	Yu-Cheng	Chou
New Zealand	Benjamin	Yu Hang	Bai
New Zealand	Yujie		Zhou
Nigeria	Opeoluwa	Samuel	Adewale
Nigeria	Goo'sPower	Toyin	Oboli
Nigeria	Ikponmwosa	Jesuferanmi	Igbinigie
Nigeria	Victor	Ojonugwa	Igono
Pakistan	Saneeha		Shahid
Pakistan	Numra	Abdul	Aleem
Pakistan	Urooj	Imdad	Memon
Pakistan	Armaghan-e-Rehman		Mansoor
Poland	SYLWIA	NATALIA	GAJDA
Poland	PRZEMYSŁAW	ANDRZEJ	PĘKALA
Poland	KAROLINA		TROCKA
Poland	ALICJA	MONIKA	KREJNER
Romania	ROXANA	GABRIELA	SANDU
Romania	VICTOR		SERBAN
Romania	MIHAELA	MADALINA	TARTALEA
Romania	TEODORA		GHEORGHE

Russia	Ivan	I.	Istomin
Russia	Tatiana	S.	Filatova
Russia	Anastasia	D.	Tsvetkova
Russia	Mark	R.	Sanevich
Singapore	Chentian		Jin
Singapore	Xinyuan		Hong
Singapore	Zhen Wei, Michael		Sia
Singapore	Javan Tze Han		Lee
Slovak Republic	Jaroslav		Ferenc
Slovak Republic	Mária		Mrázová
Slovak Republic	Alžbeta		Harárová
Slovak Republic	Slavomira		Heželyová
Slovenia	Domen		Kampjut
Slovenia	Rebeka		Jereb
Slovenia	Jure		Črepinšek
Slovenia	Eva		Slapnik
SPAIN	ALVARO		GABALDON BADIOLA
SPAIN	Pablo	Ricardo	Hernández Malmierca
SPAIN	DIANA		ESTELLER GAUXAX
SPAIN	AITOR		LOPEZ GONZALEZ
Sri Lanka	Heennilame Shehan	Umeda	Ratnayake
Sri Lanka	Nimeshika	Chathurangi	Mahaarachchi
Sri Lanka	Hiruni	Kaumadee	Gajanayake
Sri Lanka	Arun		Rajaratnam
Sweden	Johan	Arvid	Hagelberg
Sweden	Isak	Gunnar Ilian	Häggmark
Sweden	Torkel	Enok	Loman
Sweden	Hanna	Lovisa Elvira	Borsiin
Switzerland	Andreas		ZINGG
Switzerland	Jacqueline	Caroline	MOCK

Switzerland	Daniel		BALLMER
Switzerland	Gaétan		Colussi
Taiwan(R.O.C)	Je-Rui		Chang
Taiwan(R.O.C)	Yu-Hung		Tung
Taiwan(R.O.C)	Yu-Min		Lin
Taiwan(R.O.C)	Hsiao-Hung		Lu
Tajikistan	Manizhabonui		Mirzoolimzoda
Tajikistan	Dilnoza		Kamoliddinova
Tajikistan	Farzonai		Muzaffar
Tajikistan	Zilola		Zaripova
Thailand	Natthawut		Adulyanukosol
Thailand	Kanat		Chanthongdee
Thailand	Supassorn		Armornmaneerat
Thailand	Aschariya		Wipattanakitcharoen
Turkey	DENIZ	ARAL	OZBEK
Turkey	IPEK		AKCABELEN
Turkey	IZZET		ALTUN
Turkey	UTKU	GORKEM	ERDOGAN
Turkmenistan	SAZAK		ATAYEV
Turkmenistan	AZADY		PIRHANOV
Turkmenistan	ABDYRAHYM		ATASHEV
Turkmenistan	NEDIR		ATAGELDIYEV
Ukraine	Andriy		Volkov
Ukraine	Alona		Goncharuk
Ukraine	Valeriya		Sapozhnikova
Ukraine	Dariia		Shyriaieva
United Arab Emirates	Abdul Rahman	Yaaqoub M. Aljaberi	Aljaberi
United Arab Emirates	Saif	Yousuf Haj Abdulla Gharib	Alhammadi
United Kingdom	Patrick	Louis Frederick	Perryman-Owens
United Kingdom	Andre	Jean	Zylstra
United Kingdom	Vasanth		Sritharan

United Kingdom	Holly	Anne	Rees
United States of America	Rebecca	Doris	Shi
United States of America	Shulin		Ye
United States of America	Chelsea	Sierra	Voss
United States of America	Charles Huanghong		Du
Vietnam	NGUYEN	TRUNG	KIEN
Vietnam	DANG	THU	TRANG
Vietnam	TRUONG	THI PHUONG	THAO
Vietnam	NGUYEN	THU	TRANG

2. Jury

Team Name	Title	Name		
Argentina	Dr.	HERMINDA	ELMIRA	REINOSO
Argentina	Dr.	MARIA	ISABEL	ORTIZ
Armenia	Prof.	Hripsime		Matevosyan
Armenia	Dr.	Gayane		Ghukasyan
Australia	Prof.	Mary	Colette	Oliver
Australia	Ms.	Patricia	Therese	Illing
Australia	Ms.	Lillian	Corrina	Lesueur
Azerbaijan	Prof.	Adalat		Farajov
Azerbaijan	Mr.	Anar		Majidov
Belarus	Ms.	GALINA	STEPANOVNA	ROMANOVETS
Belarus	Prof.	NATALIA	PAVLOVNA	MAXIMOVA
Belgium	Prof.	LOUIS		DE VOS
Belgium	Mr.	Gerard		COBUT
Belgium	Ms.	Emilie		Etoundi
Belgium	Dr.	Hugo		Vandendries
Belgium	Mr.	Victor		RASQUIN
Brazil	Dr.	Rubens	Akeshi Macedo	Oda
Brazil	Dr.	José Carlos	Pelielo	de Mattos
Bulgaria	Dr.	Albena	Georgieva	Jordanova
Bulgaria	Prof.	Snezhanka	Borisova	Tomova
Canada	Mr.	Robert	James	RODDIE
Canada	Dr.	Sylvie		BARDIN
China	Prof.	Chongren		Xu
China	Prof.	Enshan		Liu
China	Prof.	Xiangjun		Tong
China	Prof.	Liumin		Fan
Cyprus	Ms.	Olga		Charalambous
Cyprus	Ms.	Niki		Rose
Czech Republic	Dr.	Jan		Černý
Czech Republic	Dr.	Antonín		Reiter

Czech Republic	Dr.	Tomas		Soukup
Denmark	Ms.	Neel	Holm	Møller
Denmark	Mr.	Christian	Medom	Madsen
Denmark	Ms.	Vibeke		Birkmann
Denmark	Ms.	Kirsten		Wøldike
Estonia	Mr.	Sulev		Kuuse
Estonia	Dr.	Kalle		Kipper
Estonia	Ms.	Maarja		Soomann
Finland	Ms.	Tiina		Moilanen
Finland	Prof.	Matias		Lommi
Finland	Mr.	Tuomas		Aivelo
Georgia	Dr.	Nana		Barnaveli
Georgia	Dr.	Ekaterine		Bakuradze
Georgia	Dr.	Irina		Modebadze
Germany	Dr.	Eckhard	R.	Lucius
Germany	Mr.	Dennis		Kappei
Germany	Dr.	Christiane		Muehle
Germany	Ms.	Christine		Labahn-Lucius
Germany	Dr.	Alexander		Friedmann
Germany	Dr.	Olga		Waksmann
Greece	Dr.	DIMITRIOS		ARVANITIS
Greece	Dr.	THEODOROS-DIMITRIOS		OREINOS
Hungary	Mr.	Sandor		BAN
Hungary	Ms.	Viktoria		GAL
Hungary	Mr.	Marton		ROZSA
India	Prof.	Anindya		Sinha
India	Prof.	MADAN MOHAN		CHATURVEDI
India	Dr.	Ujwala	Chintamani	Bapat
India	Mr.	Vikrant	Suresh	Ghanekar
Indonesia	Dr.	Sucipto		Hariyanto
Indonesia	Dr.	Maelita	Ramdani	Moeis

Indonesia	Dr.	Ramadhani	Eka	Putra
Indonesia	Dr.	Agus	Dana	Permana
Indonesia	Dr.	Edi		Purwanto
Iran	Ms.	Elaheh		Alavi
Iran	Dr.	Saman		Hosseinkhani
Iran	Dr.	Alireza		Sari
Iran	Mr.	Ahmad		Shahabeddin Parizi
Italy	Prof.	ANNA		PASCUCCI
Italy	Prof.	ISABELLA		MARINI
Japan	Dr.	Masanao		Honda
Japan	Dr.	Junichi		Saito
Japan	Prof.	Ryoichi		Matsuda
Japan	Prof.	Takahiro		Asami
Japan	Prof.	Shinobu		SATO
Japan	Dr.	Ko		Tomikawa
Japan	Dr.	Munetaka		Sugiyama
Japan	Dr.	Masamichi		Yamashita
Japan	Dr.	Noboru		Sasagawa
Japan	Dr.	Rumi		Kondo
Japan	Dr.	Masahiro		Suzuki
Kazakhstan	Dr.	Saken		Sherkhanov
Kazakhstan	Prof.	Amangeldy		Bissenbayev
Kazakhstan	Ms.	Sara		Kudabayeva
Korea	Prof.	Jae Geun		Kim
Korea	Prof.	YOUNG JOON		SHIN
Korea	Prof.	Kil Jae		Lee
Korea	Mr.	BEOB CHAN		KIM
Korea	Prof.	Sung-Ha		Kim
Korea	Prof.	Heui Baik		Kim
Korea	Prof.	Eun Hee		CHO
Korea	Prof.	Hawk Bin		Kwon
Kuwait	Mr.	ABDULHADI	MOHAMMAD	ALHUSANI

Kuwait	Ms.	SAMIA		ALQATTAN
Kuwait	Mr.	RASHED	TAHER	ALSHIMALI
Kyrgyzstan	Prof.	AIGUL		AKHMATOVA
Latvia	Mr.	Janis		Liepins
Latvia	Ms.	Maruta		Kusina
Liechtenstein	Mr.	Michael		JUTZI
Liechtenstein	Mr.	Fabian		EGLI
Lithuania	Mr.	Raimondas		Šiukšta
Lithuania	Dr.	Andrius		Petrašiūnas
Lithuania	Mr.	Julius		Juodakis
Mexico	Dr.	Cristina		Revilla
Mexico	Biologist	Patricia		Ojeda
Moldova	Ms.	Goraş		Mariana
Moldova	Dr.	Leşanu		Mihai
Mongolia	Dr.	Oyungerel		Shagjjav
Mongolia	Dr.	Bayarmaa		Jambalsuren
Mongolia	Ph.D student	Narangarvuu		Dashdondog
Montenegro	MSc	Stana-Sanja		Kaludjerovic
Montenegro	Ms.	Vesna		Lazovic
Netherlands	Drs.	Hans		Morélis
Netherlands	Drs.	Ange		Taminiau
Netherlands	Ms.	Mary	ter	Wal
Netherlands	Drs.	Eva		Deinum
New Zealand	Dr.	Angela	Denise	Sharples
New Zealand	Prof.	Alison	Mary	Campbell
New Zealand	Mr.	Richard	John Kelvin	Hendra
Nigeria	Ms.	Franka	Nneka	Ezekpeazu
Nigeria	Prof.	Jonathan	Ajisafe	Ogidi
Nigeria	Ms.	Oluwafunmilayo	Omolara	Omole
Nigeria	Mr.	Chukwunwike		Ezekpeazu
Nigeria	Mr.	Friday	Nicholas	Olowokere

Nigeria	Ms.	Oluwayemisi	Stellamaris	Adeyemi
Pakistan	Dr.	Zahid		Mukhtar
Pakistan	Dr.	Zafar	Mahmood	Khalid
Poland	Dr.	PIOTR		BEBAS
Poland	Dr.	MAGDA		SOBOLEWSKA-LACKA
Romania	Dr.	ALEXANDRA		SIMON-GRUITA
Romania	Prof.	TRAIAN		SAITAN
Russia	Prof.	Gleb	G.	Shvetsov
Russia	Dr.	Galina	A.	Belyakova
Russia	Prof.	Alexander	M.	Rubtsov
Singapore	Dr.	Ngan Kee		Ng
Singapore	Ms.	Siew Shin		Er
Singapore	Ms.	Tsui Wei		Choong
Singapore	Dr.	Tit Meng		Lim
Singapore	Dr.	Chong Lek		Koh
Singapore	Dr.	Chong Jinn Darren		Yeo
Singapore	Ms.	Ann Nee		Yong
Singapore	Dr.	Shirley		Lim
Slovak Republic	Prof.	Pavol		ELIAS
Slovak Republic	Dr.	Peter		Fedor
Slovak Republic	Dr.	Miroslava		Slaninova
Slovenia	Ms.	Katja		Ota
Slovenia	Mrs.	Tatjana		Durmic
SPAIN	Mr.	José Luis		Barba Gutiérrez
SPAIN	Mr.	Javier		Fernández-Portal Díaz del Río
SPAIN	Mr.	JULIAN		MONTOTO LOUZAO
SPAIN	Ms.	Iosune		Baraibar
Sri Lanka	Prof.	Jayantha	Sisirakumara	Wijeyaratne
Sri Lanka	Prof.	Hiran	Samarasinghe	Amarasekera
Sri Lanka	Prof.	Horadigala	Gamage	Nandadasa

Sweden	Mr.	Ulf		Larsson
Sweden	Mr.	Mats		Carlberg
Sweden	Ms.	Lena		Lundquist
Switzerland	Dr.	Daniel		WEGMANN
Switzerland	Ms.	Noémie		JORDI
Switzerland	Mr.	Mathias		WENGER
Switzerland	Ms.	Irène	Renée	STEINEGGER-MEIER
Taiwan(R.O.C)	Prof.	Jyh-Wei		SHIN
Taiwan(R.O.C)	Dr.	Shu-Chuan		Hsiao
Taiwan(R.O.C)	Ms.	Tsui-Hua		Liu
Taiwan(R.O.C)	Prof.	Shen-Horn		Yen
Taiwan(R.O.C)	Prof.	David		Chao
Taiwan(R.O.C)	Prof.	Kuei-Shu		Tung
Tajikistan	Mr.	Husnu		Yaman
Thailand	Dr.	Poonpipope		Kasemsap
Thailand	Dr.	Teerapong		Buaboocha
Thailand	Dr.	Noppadon		Kitana
Thailand	Dr.	SUPACHITRA		CHADCHAWAN
Thailand	Dr.	Sunadda		Yomyart
Thailand	Dr.	Pitiwong		Tantichodok
Turkey	Prof.	IRFAN		KANDEMIR
Turkey	Prof.	CUMHUR		COKMUS
Turkmenistan	Mr.	ŞEVKİ		AYDIN
Ukraine	Prof.	Nataliia		Skrypnyk
Ukraine	Ms.	Svitlana		Fitsailo
United Arab Emirates	Mr.	khalid	Abdullah	Bin Dawood
United Arab Emirates	Mr.	Ismail		Alhosani
United Kingdom	Dr.	Andrew	John	Treharne
United Kingdom	Mr.	Neil	Thomas	Richards
United Kingdom	Dr.	Bill		Burnett
United States of America	Dr.	Scott		Mills

United States of America	Ms.	Kathy		Frame
Vietnam	Prof.	MAI	SY	TUAN
Vietnam	Prof.	DINH	DOAN	LONG
Vietnam	Dr.	PHAM	VAN	LAP
Vietnam	Mr.	LE	DINH	TUAN
Vietnam	Dr.	NGUYEN	QUANG	HUY
Vietnam	Dr.	TRAN	VAN	KIEN
Vietnam	Dr.	DUONG	MINH	LAM
Vietnam	Ms.	TRAN	THI	HUE
South Africa	Mr.	Naidoo		Sooklachar
South Africa	Mr.	ILHAMI		DEMIRTAS

E. The Decorations of IBO2011

1. Logo

2. Posters


IBO 2011


Welcome to Taiwan
歡迎來到臺灣
2011
July 10-17, 2011


IBO
Taipei, Taiwan
Organizer
Host
Welcome to Taiwan
歡迎來到臺灣
2011
July 10-17, 2011


IBO 2011
22nd International Biology Olympiad


IBO 2011
22nd International Biology Olympiad

3. Souvenirs


IBO 2011


IBO 2011


IBO 2011
IBO 2011


10-17 July2011, Taipei, Taiwan
22nd International Biology Olympiad

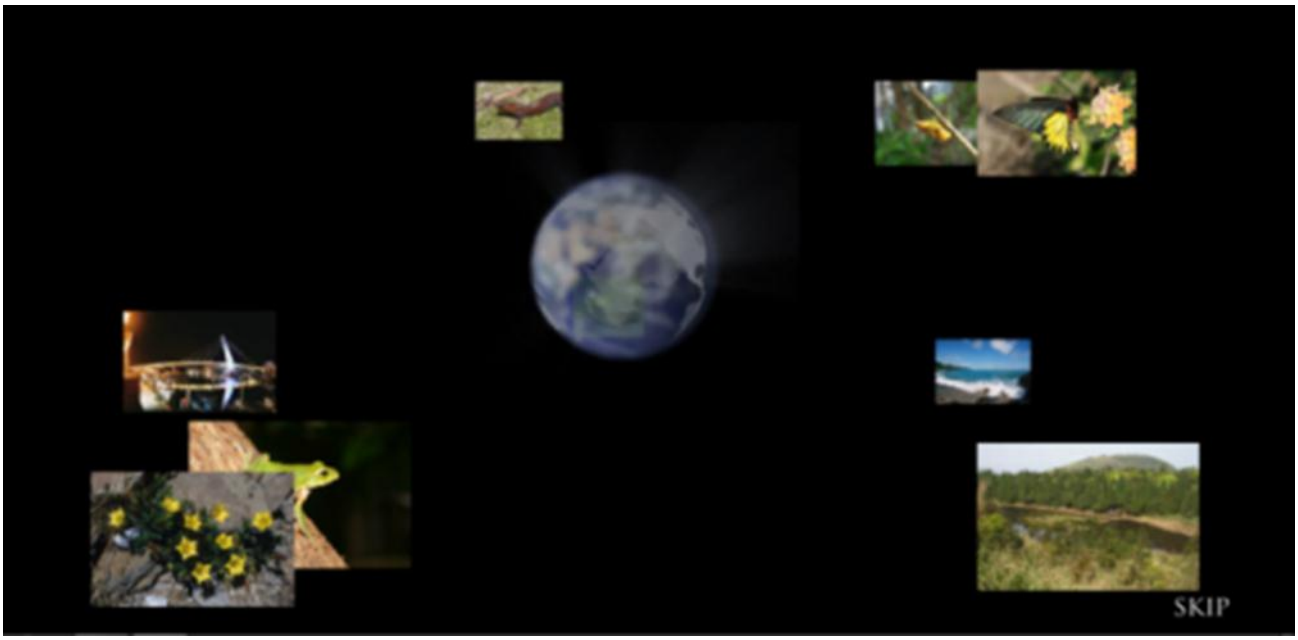

IBO 2011
IBO 2011

4. Medals

5. Certificates

6. IBO2011 Website

a. Welcome page



IBO 2011

22nd International Biology Olympiad

Taipei, Taiwan

SKIP

b. Homepage

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News

2011-08-02 We are back :)
2011-07-04 Pickingup schedule!!
2011-06-24 The training will be held as usual!
2011-06-23 Caution!! Tropical Storm HAIMA & MEARI
2011-06-17 urgent announcement

>more news

Acknowledgement

Dear friends and participants of the International Biology Olympiad,

National Taiwan Normal University is really honored to be commissioned by Ministry of Education and financed by National Science Council of Taiwan, to host the 22nd International Biology Olympiad (IBO) in Taipei, Taiwan. We appreciate all your enthusiasms and participations during July 10th ~ 17th, 2011, and people from all kinds of fields for their cares and supports.

As the Chair Person of organizing committee IBO2011, firstly I would like to show my deeply respects to all the committee members. After 2 years of learning, planning and educational training for the staff team, I present my thankfulness to all the staff crews. Each team did their best to make this event more thoroughly, and they were prepared to adapt different situations. With the beginning of IBO 2011, they stuck to their positions and gave out all their efforts only to hope our guests could feel the completions from their sweats. Applauds at the closing ceremony given to the award winners, moreover, these applauds were dedicated to all the participants, and also encouragements to our staff crews. There were mouthwatering dishes at the farewell banquet, along with the recollections during the event swallowed down to taste the memories.

Organizer & Co-host

Ministry of Education

National Science Council

National Taiwan Normal University

Department of Life Science

Science Education Center

Sponsors

It is the host's responsibility to keep all examinations standardized and thus to ensure that the competition is fair. This has been the spirit of IBO activities since the start. We did our best to meet this goal. As Poon has mentioned, all the participating students are winners. Not only did many of them win medals, but most importantly, all of them got a chance to establish new friendships.

I would like to express my sincere gratitude to our respectable guests from all over the world. We tried our best to introduce Taiwan to you. You got the chance to witness Taiwanese beautiful nature, traditional culture and hospitality of local people. Please, excuse any mistakes that happened during the IBO event. We believe that after a careful revision we can learn from these in order to make improvement in the future.

Reaching for the medals is not the only goal we try to fulfill in our contest. We sincerely hope that all of you gained valuable experience and found new friends. Although IBO 2011 has ended, but let's hope that we will meet again in the near future, with bright smiles on our faces!

Yung-ta Chang

The 22nd International Biology Olympiad Organizing Committee Chair Person

c. Welcome Letter

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2010-11-02 Welcome Letter

Dear friends and participants of the International Biology Olympiad,

We would all agree that the inquisitive spirit of human beings is what urges us on in our exploration of biological science. Each year, the International Biology Olympiad offers us the opportunity to witness the academic efforts of our young elite friends and the passing down of our intellectual legacy. It is the sharing of the passion for biology and “life” that brings us to this distinguished convention.

Taipei, Taiwan, at National Taiwan Normal University. On behalf of our university, I would like to extend my sincere welcome to all of you. Our university, located in the heart of Taipei, has been the leading university in training teachers and scholars in basic and applied research in Taiwan. The pursuit of higher achievements in science and the nurturing of bright minds has always been a core concept in our commitment to education and the academia. The Department of Life Science, formerly named the Department of Biology, was established 50 years ago, and is a highly regarded science institution. We are experienced in holding international competitions and will ensure you the highest standards in academic expertise and fairness, as well as greatness in hospitality.

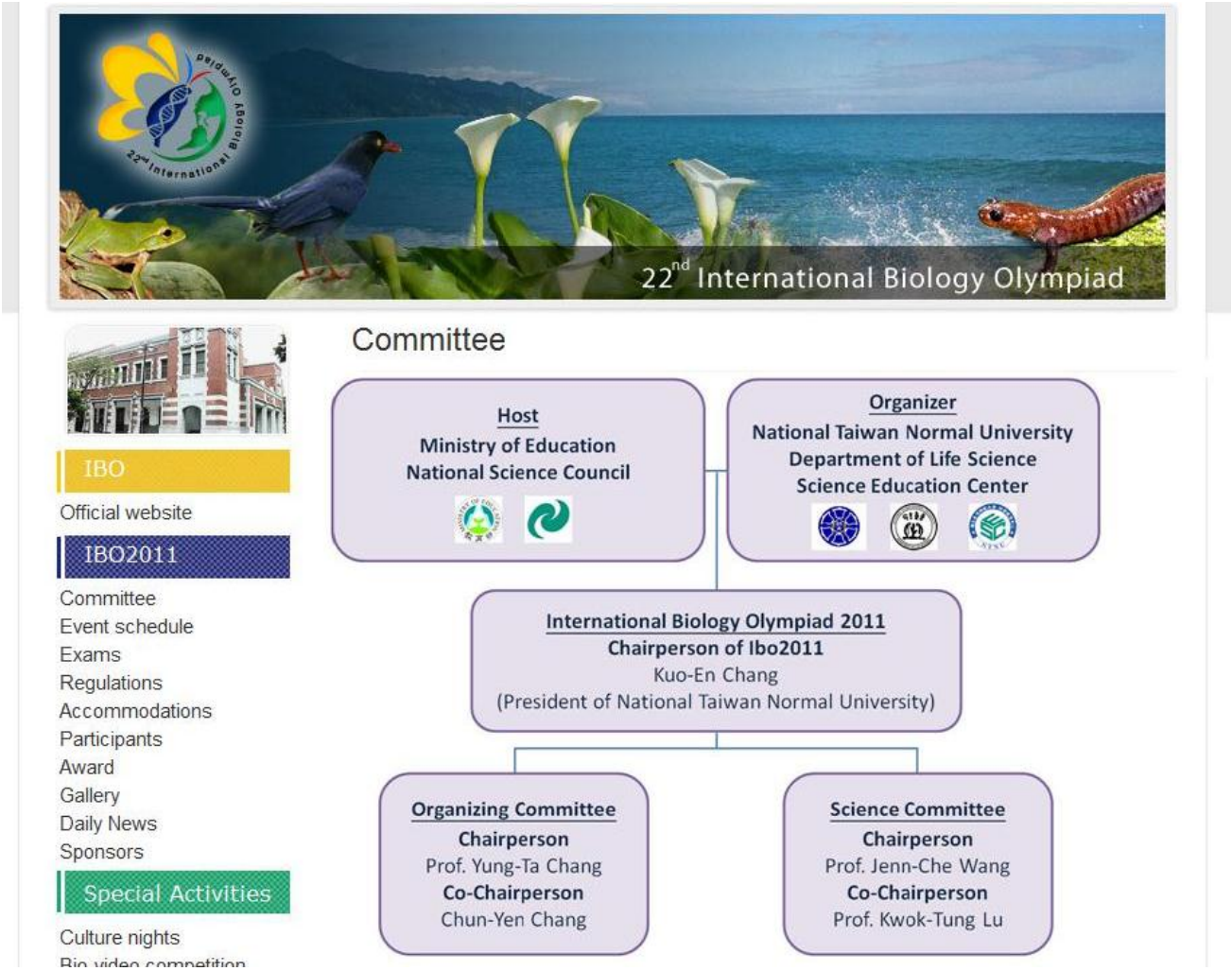
As host of the 2011 International Biology Olympiad, we look forward to seeing you at NationalTaiwanNormalUniversity. Come and enjoy the remarkable sights of Taipei. Wish you all the best in your endeavors.

Kuo-en Chang

The President of National Taiwan Normal University
The 22nd International Biology Olympiad Chair Person

d. Official Website

e. Committee



f. Event Schedule

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Event schedule

2011	Students	Juries & Observers
July 7th(Thu) to July 9th(Sat)	**none**	**Subgroup Meeting** Review The Practical and Theoretical Examinations
July 10th (Sun)	Arrival & Registration	
July 11st (Mon)	Opening Ceremony	
	Taipei 101 Practical Exams Lab Visit Academic Night	**Review & Translation** Practical Exams
July 12nd (Tue)	Practical Exams	**Excursion** Yangmingshan National Park National Palace Museum Taipei 101
	Culture Night	
	Reunion	
July 13rd (Wed)	**Excursion** Center for Traditional Arts Aviation Museum	**Review & Translation** Theoretical Exams
	Culture Night	
July 14th (Thu)	Theoretical Exams	**Excursion** Center for Traditional Arts King Car Education Foundation
	Taipei Friendship Night	
July 15th (Fri)	Excursion Yangmingshan National Park National Palace Museum	Moderation Meeting Coordinators Meeting Medal Presentation Approval Meeting
	Culture Night	NBO Description Explanation
July 16th (Sat)	**Excursion** Dashi Historic Street / Coca-Cola Museum	**Excursion** Yehliu Geopark
	Award Ceremony & Closing Ceremony	
	Farewell Banquet	
July 17th (Sun)	Departure	

g. Exams

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Exams

Exams Subjects

Exams are composed of the following two parts: **Practical** and **Theoretical** parts.

Practical Exams

Practical tests will be divided into the following four sections.

1. **Biochemistry and cell biology**
2. **Plant physiology, anatomy and genetics**
3. **Animal physiology and anatomy**
4. **Ecology and systematics**

Four tests will be held in one day, two in the morning and the other two in the afternoon. Each test will last for 90 minutes (6 hours in total). There is a 30 to 45 minutes break each between the first and last two tests. And there is a one and a half hour lunch break at noon. Participants will manipulatethe experimental materials and equipments following different types of questions, and hand in answer sheets in requested format.

Students will visit the place of practical exams in July 11, 2011.

Theoretical Exams

Theoretical exams, consisting two sections (Part A and Part B), will take place in one day. Part A last for 120 minutes and Part B last for 150 minutes. There is one and a half lunch break between two test sections. The answer format will be made in numerical or symbolic forms in order to avoid the language dependent difficulities.

Field and its allotment of Theoretical exams are as following table:

	Field	Allotment (percentage)
1	Cell biology	20%
2	Plant anatomy and physiology	15%
3	Animal anatomy and physiology	25%
4	Ethology	5%
5	Genetics and evolution	20%
6	Ecology	10%
7	Biosystematics	5%

Results

Practical and theoretical scores will be weighed equally in the final results. The number of gold medals will be limited to approximately 10 % of the number of participants, the number of silver medals will be limited approximately to 20 % of the number of participants and the number of bronze medals will be limited approximately to 30 % of the total number of competitors.

h. Regulations

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Regulations

The IBO Guide Content:

1.What is the IBO ?
2.Organization Rules
3.Guidelines for a new participating country
4.Guidelines for the host country

For full Guide information, please download the Official IBO Guide(22nd revised edition)

i. Accommodations

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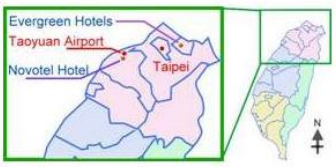
Accommodations

Pick Up

All Participants will be picked up at Taiwan Taoyuan International Airport. There will be shuttle buses going to hotels.



Hotel

Students will stay in Novotel Taipei Taoyuan International Airport located right next to the Taoyuan International Airport .

Juries and **observers** will stay in the Evergreen International Hotels (Keelung).

Notice

If you will arrive in Taiwan before July 10 in 2011, you need to make the accommodation arrangement by yourself. Novotel Hotel is one of your choices. There will be a special price for your stay. Please contact Mr. Nelson Pan: H6701-s17@accor.com

j. Participants

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Team Name
Argentina
Armenia
Australia
Azerbaijan
Belarus
Belgium
Brazil
Bulgaria
Canada
China
Cyprus
Czech Republic
Denmark
Estonia
Finland
Germany
Georgia
Greece
Hungary
India
Indonesia
Iran
Italy
Japan
Kazakhstan
Korea
Kuwait
Kyrgyzstan
Latvia
Liechtenstein
Lithuania
Mexico
Moldova
Mongolia
Netherlands
New Zealand
Nigeria
Pakistan
Poland
Romania
Russia
Singapore
Slovak Republic
Slovenia
Spain
Sri Lanka
Sweden
Switzerland
Chinese Taipei, Taiwan
Tajikistan
Thailand
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Turkmenistan
Ukraine
United Arab Emirates
United Kingdom
United States of America
Vietnam
Observer
Montenegro
South Africa

k. Awards

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Awards of IBO2011

The number of **gold medals** will be limited to approximately **10 %** of the number of participants, the number of **silver medals** will be limited approximately to **20 %** of the number of participants and the number of **bronze medals** will be limited approximately to **30 %** of the total number of competitors. The exact cut will be at the largest gap within three possible cuts going after the limit given by the percentages.

The following file is the final result of IBO2011.

IBO 2011 final result.pdf

Awards of "Lap around" in Opening Ceremony

The most impressive team is "**Liechtenstein**"

The most energetic team is "**Netherlands**"

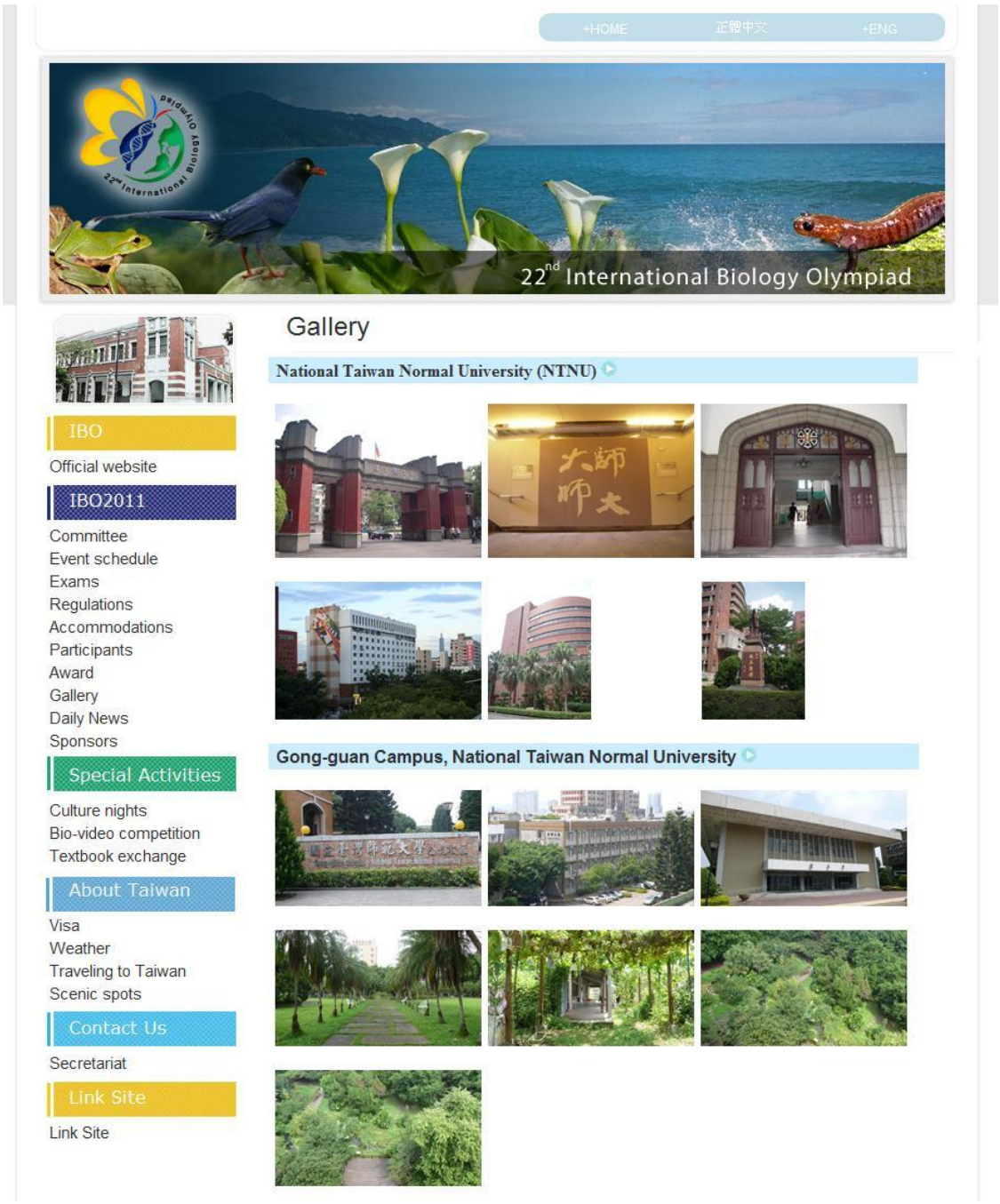
The most friendly team is "**Australia**"

The best dressed team is "**Sri Lanka**"

The most mysterious team is "**Nigeria**"

The best team overall is "**Germany**"

l. Gallery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National Taiwan Normal University (NTNU)
Gong-guan Campus, National Taiwan Normal University

Novotel Taipei Taoyuan International Airport

Evergreen International Hotels(Keelung)

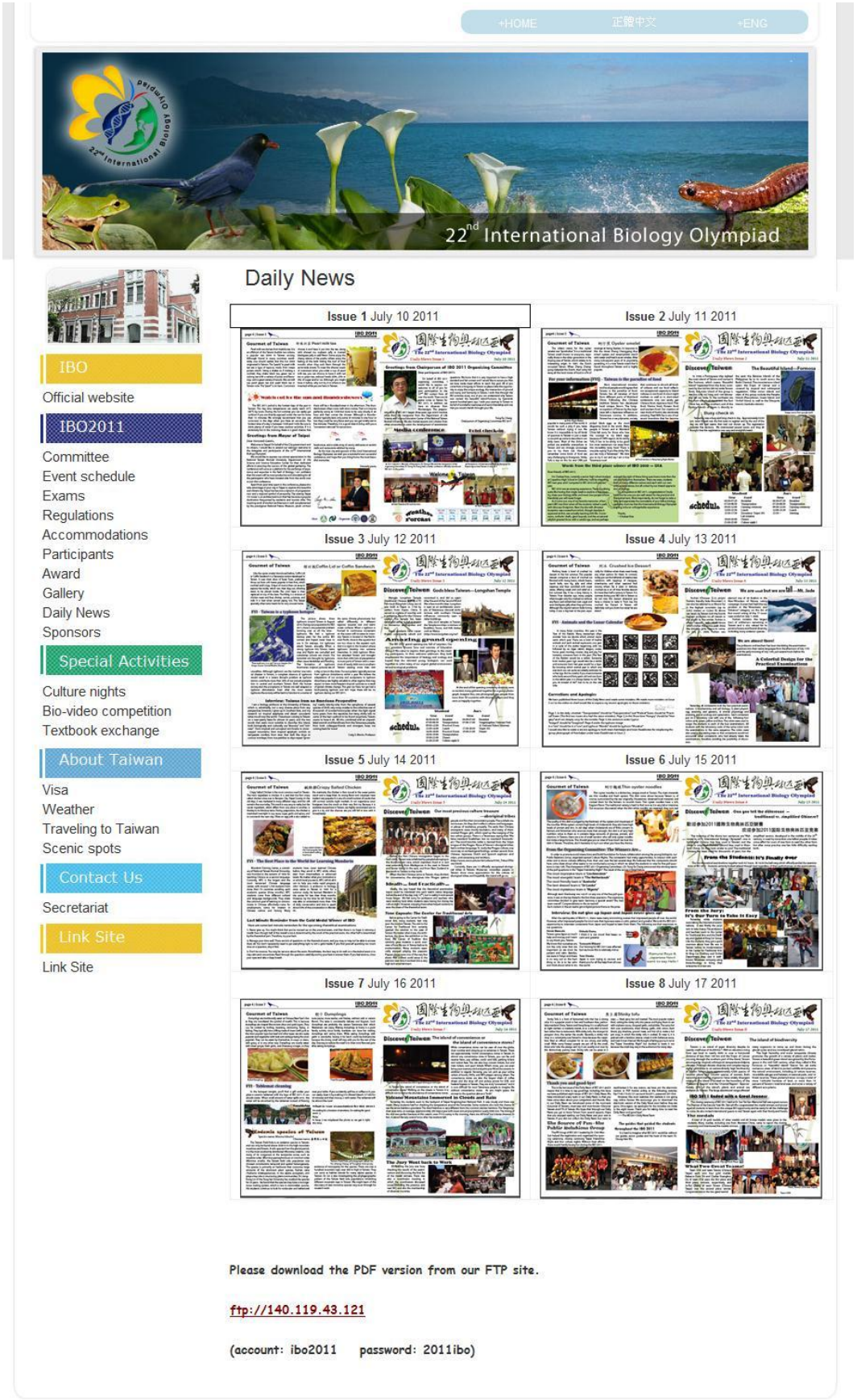
7 Angels

IBO 2011 Signature Banner

Please click the image to download the file.

Event Photo

m. Daily News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Issue 3 July 12 2011
Issue 4 July 13 2011
Issue 5 July 14 2011
Issue 6 July 15 2011
Issue 7 July 16 2011
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Please download the PDF version from our FTP site.
ftp://140.119.43.121
(account: ibo2011 password: 2011ibo)
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n. Sponsors

o. Culture Nights

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Award of "Lap around" in Opening Ceremony		
Item	Team	Name
The most impressive team	Liechtenstein	Donat APPERT
The most energetic team	Netherlands	Johannes Cornelis Jacobus Mertens
		Stephen Robert Skocpol
		Dirk Christiaan Jungerius
		Frank Poort
The most friendly team	Australia	Callum Thomas Gray
		Nathan Howard Isaacson
		Darcy Robert Gray
		Phillip Timothy O'Riordan
The best dressed team	Sri Lanka	Heennilame Shehan Umeda Ratnayake
		Nimeshika Chathurangi Mahaarachchi
		Hiruni Kaumadee Gajanayake
		Arun Rajaratnam
The most mysterious team	Nigeria	Opeoluwa Samuel Adewale
		Goo'sPower Toyin Oboli
		Ikponmwosa Jesuferanmi Igbinigie
		Victor Ojonugwa Igono
The best team overall	Germany	David Sebastian Fischer
		Franziska Maria Feller
		Tim Ulf Hutschenreiter
		Roderich Römhild

p. Bio-video Competition

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Special Activity

Bio-video competition: Are you in love with biology? Or with your pets? Do you talk daily to your houseplants? Do you sleep with your biology books? Do you want to share your passion for biology? Try it out!
You and your team could be awarded in the IBO 2011 closing ceremony in Taiwan. All you have to do is producing a short video on the Internet (on You Tube) about your national team IBO preparation.

Detail information is available in the following files: Bio-video competition

The Bio-video Competition Award : Armenia

q. Textbook Exchange

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Textbook exchange

Special Activity

Biology textbook exchange: Since IBO is specially designed for the students from the secondary school, the Organizing Committee of IBO2011 would like to share different idea of science education in the secondary school with all participating countries. If your country is interested in exchange biology textbooks with us, please inform the secretary of IBO2011, and we will contact you regarding for the details of this textbook exchange event.

Participants of Biology Textbook Exchange
Armenia
Bulgaria
China
Georgia
Germany
Greece
Hungary
Iran
Japan
Pakistan
Poland
Slovenia
Spain
SriLanka
Turkmenistan
Ukraine
UNITED ARAB EMIRATES

r. Visa

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ARGENTINA	ARMENIA	AUSTRALIA	AZERBAIJAN
BELARUS	BELGIUM	BRAZIL	BULGARIA
CANADA	CHINA	CYPRUS	CZECH REPUBLIC
DENMARK	ESTONIA	FINLAND	FRANCE
GEORGIA	GERMANY	GREECE	HUNGARY
INDIA	INDONESIA	IRAN	IRELAND
ITALY	JAPAN	KAZAKHSTAN	KOREA
KUWAIT	KYRGYZSTAN	LATVIA	LITHUANIA
MEXICO	MOLDOVA	MONGOLIA	NETHERLANDS
NEW ZEALAND	NIGERIA	PAKISTAN	POLAND
ROMANIA	RUSSIA	SINGAPORE	SLOVAKIA
SLOVENIA	SOUTH AFRICA	SPAIN	SRI LANKA
SWEDEN	SWITZERLAND	TAJIKISTAN	THAILAND
TURKEY	TURKMENISTAN	UKRAINE	UNITED ARAB EMIRATES
UNITED KINGDOM	USA	UZBEKISTAN	VIETNAM
ARGENTINA	ARMENIA	AUSTRALIA	AZERBAIJAN

For more information please visit the following websites :

The Bureau of consular Affairs, Ministry of Foreign Affairs

http://www.boca.gov.tw/mp.asp?mp=2

NATIONAL IMMIGRATION AGENCY

http://www.immigration.gov.tw/immig_eng/aspcode/main4.asp

s. Weather

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Weather

Current Weather

Mean Temperature

	Month/Year	Mean Temperature
Taipei City	July/2009	30.1°C /86.2°F
	August/2009	29.8°C /85.6°F
	July/2008	29.6°C /85.3°F
	August/2008	29.7°C /85.5°F

Central Weather Bureau of Taiwan

t. Traveling to Taiwan

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Traveling to Taiwan

By air

All Participants could come to Taiwan by air.

Address	No. 9, Hangzhan S. Rd., Dayuan Township, Taoyuan, Taiwan 33758, R.O.C.
Service counter	+886-3-398-2143 (T1 Departure Service Counter) +886-3-398-3274 (T2 Departure Service Counter)
Voice inquiry	+886-3-398-3728
Website	http://www.taoyuan-airport.com/chinese/index.jsp

u. Scenic Spots

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Taiwan

Taiwan is an island laid of the southeastern coast of mainland Asia and situated in East Asia in the Western Pacific Ocean. It's total land area is only about 3,6000 square kilometers; it has a population of 23 million people, and the official language is Mandarin Chinese.

Taiwan's climate is marine tropical, The entire island experiences hot, humid weather in summer. The island of aiwan straddles the Tropic of Cancer, giving it a warm tropical-subtropical climate with plenty rainfall. Covering a wide range of altitudes from high forest-covered mountains to grassy lowlands, Taiwan features an richness of biodiversity.

Taiwan

Attractions

- Night Markets
- Cultural Tour
- Ecotourism

Hot spots

- North Taiwant
- Central Taiwan
- South Taiwan
- Central Taiwan
- Taipei

Popular Tours

Tourism Bureau of Taiwan	http://taiwan.net.tw/
Youth Travel in Taiwan	http://www.youthtravel.tw/
Taipeitravel.net	http://www.taipeitravel.net/

v. Secretariat

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IBO 2011 Secretariat

No. 88, Sec. 4, Tingzhou Rd., Taipei 11677,

Taiwan, R. O. C., IBO Office

Email : secretary@ibo2011.org.tw

Tel : +886-2-7734-6777

Fax : +886-2-2932-7187

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IBO 2007	IBO 2006	IBO 2005
	In Argentina	In China

7. Voting System

Account : *

Password : *

Login

Back to Main

Accept

Not Accept

Reset

Issue 0:

Result:
Agree: 0
Disagree: 0

●: Agree | ●: Disagree

Team Name	Result	Team Name	Result	Team Name	Result	Team Name	Result
Argentina		Germany		Lithuania		Sri Lanka	
Armenia		Georgia		Mexico		Sweden	
Australia		Greece		Moldova		Switzerland	
Azerbaijan		Hungary		Mongolia		Chinese Taipei ,Taiwan	
Belarus		India		Netherlands		Tajikistan	
Belgium		Indonesia		New Zealand		Thailand	
Brazil		Iran		Nigeria		Turkey	
Bulgaria		Italy		Pakistan		Turkmenistan	
Canada		Japan		Poland		Ukraine	
China		Kazakhstan		Romania		United Arab Emirates	
Cyprus		Korea		Russia		United Kingdom	
Czech Republic		Kuwait		Singapore		United States of America	
Denmark		Kyrgyzstan		Slovak Republic		Vietnam	
Estonia		Latvia		Slovenia		Montenegro	
Finland		Liechtenstein		Spain		South Africa	

F. Event Schedule

2011	Students	Juries
July 7-9	none	**Subgroup Meeting** Review the practical and theoretical examinations
July 10 (Sun)	Arrival & Registration	
July 11 (Mon)	Opening Ceremony	
	Taipei 101 Practical & Theoretical Exam Lab Visit	**Review & Translation** Practical Exam
	Academic Night	
July 12 (Tue)	Practical Exam	**Excursion** Yangmingshan National Park, National Palace Museum, Taipei 101
	Reunion	
	Culture Night	
July 13 (Wed)	**Excursion** Center for traditional Arts, Aviation Museum	**Review & Translation** Theoretical Exam
	Culture Night	
July 14 (Thu)	Theoretical Exams	**Excursion** Center for Traditional Arts, King Car Education Foundation
	Taipei Friendship Night	
July 15 (Fri)	**Excursion** Yangmingshan National Park, National Palace Museum	Moderation Meeting Coordinators Meeting Medal Presentation Approval Meeting NBO description explanation
	Culture Night	
July 16 (Sat)	**Excursion** Dashi Historic Street / Coca-Cola Museum	**Excursion** Yehliu Geopark
	Award Ceremony & Closing Ceremony	
	Farewell Banquet	
July 17 (Sun)	Departure	

G. Opening Ceremony

Date: Monday, July 11th 2011

Time: 9:00 AM ~ 12:00 PM

Location: the Auditorium of the National Dr. Sun Yat-Sen Memorial Hall

Agenda:

Time	Event
09:00~09:30	Procession
09:30~10:20	Lap around the venue by the Contestants
10:20~10:27	Introductory Short Film
10:27~10:30	Arrival of the Vice President of Taiwan
10:30~10:35	Address from the Vice President of Taiwan - Mr. Vincent C. Siew
10:35~10:40	Address from the Minister of Education - Dr. Ching-Ji Wu
10:40~10:55	Broadway Performance－Amigos Para Siempre
10:55~11:00	Address from the Chairperson of the IBO2011 - Dr. Kuo-En Chang
11:00~11:05	Address from the Chairperson of IBO Coordinators - Dr. Poonpipope Kasemsap
11:05~11:10	Oath of the Competitors
11:10~11:15	Oath of the Delegation leaders
11:15~11:30	Taiwan Aboriginal Dance – Flying Heart
11:30~11:35	Official Announcement of Opening by IBO2011 Chairperson
11:35~11:40	Report from the Chairperson of the IBO2011 Organizing Committee
11:40~12:00	Group Photo

Addresses

Dr. Ching-Ji Wu, Minister of Education:

Your Excellency, president of IBO, Doctor Kuo-En Chang, President of National Taiwan Normal University, Doctor Chang, distinguished juries, outstanding students, ladies and gentlemen, welcome to Taiwan for the 22nd International Biology Olympiad. On behalf of Ministry of Education, I would like to give a warm welcome to our guests from all over the world. Biology is a science of life which focuses on ranging from the microscope study of genes all the way to the global ecosystem. The life that the biologists have studied includes the lives of our foreign species and the life of our fellow species on the earth. These numbers in millions, most people would agree that life is the most wonderful and amazing thing on earth. What can be more fascinating than exploring the mystery of life? Here in Taiwan, biology science is a key element of our science education. All of our general public universities have biology related departments. Biomedical and biotechnological industries in early years such as genes genetic engineering are considered as leading knowledge. The treatments are growing rapidly as results of our investments in biology education. In addition to biotechnology, we also care about biodiversity and the negative effects of global climate changes on ecosystems. Three years ago, we began to plan the inclusion of ecological engineering into the curriculum of education. This reflects our determination and commitment to protect and manage our ecosystems in a sustainable manner. I believe the experiment of competing and interacting with talented young scientists during IBO 2011 will have major positive influence on your lives. I am sure all of you are excited and eager to take full advantages of opportunities that aware of you. The international friendship you will make can open your windows to the world. Having knowledge of cultures different from our own help us respect and cherish all cultures. The values of the unique experiments offer by the IBO are all far beyond winning an award. Because the IBO provide many things that you can not learn easily in the classroom. It is important for you to bear all of this in mind while competing with others. Therefore, I would like to remind you to use this opportunity to interact with each other, and build a foundation of the future cooperation. By working together, you can make major contributions to solve many global environmental and ecological issues, and bring biology into a new era. Ladies and gentlemen, Taiwan is a beautiful island which we call Formosa. It is well-known for its citizens with hospitality and rich diversity in endemic plants and animals. As well as a wide variety of delicious foods, please take some time to enjoy our hospitality to see our amazing wild lives. Also, please try some of our amazing food while you are here. Once again, welcome to Taiwan. I wish all of you would succeed both in this competition and your future inspiration. Thank you. Welcome to Taiwan again.

Mr. Vincent C. Siew, Vice President of Taiwan:

Doctor Wu, the Minister of Education, Doctor Chang, President of National Normal Taiwan University, Doctor Kasemsap, President of IBO, distinguished guests, ladies and gentlemen, good morning. I am speaking on behalf of the government, and people of the Republic of China in Taiwan. I would like to extend my worm welcome to our guests who have come from 61 different countries, participating in the 22nd International Biology Olympiad in Taiwan. It is an honor and pleasure to host the IBO. It is also an honor to see so many talented young scientists from every single continent

of the world participating in the competition. The field of biology has played a very important role in the human civilization. Thanks to the progress in biology and biotechnology, we are now able to do a very good job of treating many diseases that were once fatal. The average life spans of humans a century ago was less than 45 years. But by 2010, the world average has increased to 62.5 years. For biologists, ecosystems are treasures of knowledge and fascination. The more closely you observe it, the more clearly you come to see the independence between all living things. That is why environmental changes cause the disappearance of species. And disruption in the barrenness of nature can trigger reactions. Human is the dominant species on our planet. The quest to satisfy our desires has had a tremendous impact upon ecosystems throughout the world. The burning of fossil fuels, for example, causes acid rain and global warming while the barren of tropical rain has wired up the entire species. In recent years, we have seen the disappearance of the colonists. The depression of decreasing stocks and increasingly frequent extreme weather events faced by these science and environmental distress, more and more people become more concerned about the future. The biggest single challenge facing to human race today is a question of how to manage our ecosystem in a sustainable manner. In seeking to address this challenge as solid, grasp of science is the most important pull that we have our dispose. The Department of Biology enables us to understand what must be done to maintain a global ecosystem and provides all policy makers and general public with objective sake of standards to form the basis of specific action plan. For students and teachers of biology, this represents a challenge that is reached with its chances of mission. I do believe in your effort will bring positive changes to human society. The students taking parts in this year Olympiad are the best of the best in your respective countries. So the competition in the next few days is going to be very intense. This is surely to be an unforgettable experience for all of you. From apart of taking part in cooperation and competition, I hope that you will also interact on personal effort with other participants because this will be a rare opportunity to make friends with people of similar interests from all around the world. Prices come in limited quantity but you will find acknowledge and the friendship are the most valuable resources that you go through life. For organizers and co-hosts of this week's events have arranged a lot of sightseeing visits for you. I do hope you will find that these activities can enhance your experiences here. Our country only covers 36000 square kilometers, which is 0.025 % of the globe. But Taiwan is one of the most mountainous islands in the world. We have more than 260 peaks of 300 meters or higher. Our mountains provide an incredible diversity of habitats, supporting a species density that is hundreds times to World average. Also, species density is 400 times to average for marine species. So even though Taiwan is small, it is never small among nations in terms of ecology diversity. I would like to thank the organizers, and co-hosts for the hard work they have put in to the preparations for these events. National Taiwan Normal University began planning for IBO two years ago. It has gone for extra miles to make sure that you all feel great when you came here. Let us have a big round of applause to show our appreciation for their work. Thank you. In closing, I hope that our guests will feel the warmest and friendliness of the people of Taiwan. I also hope that you will all meet a lot of Taiwanese new friends while you are here. And you leave intellectually and rich by this experience. Thank you everyone. Thank you.

Dr. Kuo-En Chang, The Chairman for 2011 International Biology Olympiad:

All distinguished guests and all dear participants, ladies and gentlemen, good morning. On behalf of National Taiwan University, I would like to express my welcome to all participants to Taiwan. It is our honor to host the 22nd IBO. This year, we have a total of 58 teams from all over the world with a total more than 300 participants. For the young scientists, your presences prove that you are among the best young biologist in the world. For the senior biologist here, I would like to thank you for training the young scientists and bring them to Taiwan for this important event. National Taiwan University has hosted Physics, Chemistry, Mathematics, Earth science, and Science Olympiads over the last decade. The opportunity of hosting IBO this year compresses our honor of hosting all the major International Olympiads in science. Our university has a long history of commitment of high quality education and research. In our culture, educating students is among the most enjoyable work. In my personal opinion, the opportunity to host the IBO and interact with gifted young scientists from all over the world is even more enjoyable. Biology is an important element in our university. Our biology program was established more than decades ago. Currently, we have more than 30 faculty members in the Department of Life Science. We are proud to say that most of Taiwan high school biology teacher were trained in our university. The local IBO committee have been working hard to ensure you will have a fair competition and to provide a platform to encourage all participants to interact and exchange knowledge. Over the last 7 months, I have witnessed intense training programs for volunteers to assist and host IBO. I know that the committees have arranged several journeys for our participants to see some of the tourist attractions of Taiwan and get to know Taiwanese culture and history. In the next few days, your knowledge of biology will be challenged. You will compete with the best in the field of biology. I hope you are more exciting than nervous. I believe that the competition will bring out the best of you. During your visiting in Taiwan, if you have any questions or need any helps, please don't hesitate to ask our local committees. Our students, faculty members, staffs and I, are more than happy to assist you in every way possible. Thank you, welcome to Taiwan.

Dr. Poonpipope Kasemsap, The Chairperson of IBO Coordinators:

Your excellencies, Mr. Minister of Education, President of National Taiwan Normal University, distinguished guests, organizers, colleagues, and last but not least – competitors!

I would like to say a few words on behalf of all coordinators of this Olympiad.

First of all, welcome you all to this 22nd International Biology Olympiad, 58 countries, some two hundred and twenty seven competitors, to participate in this Olympiad. Although I believe four are on the way, but a special welcome will go to Georgia the new participants.

Where are you? Georgia? All right.

Well, in biology we always, you know, put a great attention to endanger species, so this week, let us, you know, pay more attention to our amigo – Frankenstein.

Dear competitors, I would like to congratulate each and every one of you for your wonderful success in winning national biology Olympiads. It must be very very difficult. But! You know what? All of you are already winners! Hey!

And your outstanding achievements in biology will be recognized and honored here in this great city of Taipei, today and to throughout this week. But your participation, in this truly especial event.

Ladies and gentlemen, biology is a beautiful and valuable subject. Until 10,000 years ago, our ancestors lived as hunter, goatherd. Then, the arrival of agriculture, which is essentially basic, applied and practical Biology, changed everything. Agriculture prompted one of the most critical revolution in history of mankind. When they set to food servers, lead to many other things. The formation of permanent human settlement, the use of middle tools and other inventions, the domestication of animals and plants, agriculture, biology, part of biology, also encouraged more trade and cooperation. And that led to a more complete society. And then, we moved, transited into civilization. So Biology helped us from the very beginning.

Today, biology is still very important. It helps us in every aspects of life from medicine, food security, safety and sustainability, to bio-energy and so on. Biology will be even more vital for our survival in the future. And a greater selection pressure from looming global prices, global change is one of them.

Biology Olympiads aims to challenge and to stimulate gifted students to expand their talents and to promote their career as biologists. We want to challenge you now, with this great competition that you will faith. With the hope that will motivate you to become biologists. So that you could help us, every one of us to faith that a great challenge are coming in the near future.

Well, I'd like to ask you a question, is this Biology Olympiad going to be the biggest challenge in your life so far? Are you ready?(Yes)

Show me your hands! Are you ready? Woo, I'll be scared, I was expecting a louder, stronger, more confidence thrills. Yeah, alright.

Well, it's okay, I would guess some of you may not really think it's going to be the challenge, but rather a crisis. I can accept that. No! Not really, I, let me put this way, I would encourage you to consider this Olympiad as your personal crisis, the biggest one in your life! Providing that you acquire a new trade, very quickly, that new trade could help you to prevail to survive this week. That trade is not actually a trade, it's an understanding, it's called Chinese wisdom toward crisis. See, Chinese has been around for a long time and they, how many of them are in this world? You know, the way they write the world crisis, they use two characters. The first one means danger. The second one would be reminds you of opportunity. In a crisis, beware of danger, but recognized of opportunity. Are there going to be a lot of danger this coming week? Not really. Unless you decide to tears a hydrochloric acid in your practical tomorrow, you know, otherwise you'll be fined. The host are taking care of us really well. But what about opportunities? You think of the most important opportunity in your life, winning medal, but there are a lot more. Other opportunities that and they hope you can recognize it.

Winning medal will be great. Winning medal prize will be great, really. But what about winning biological prize? Win a friend, and it's great that when you win a friend, your friend, your new friend, win too. It's a win-win situation, always. Well, another important IBO goal is to provide excellent opportunity for you, young biologists, to build one friendship that will lead to strong cooperation in your future, career, and it will increase probability for our species to prevail in the future.

Remember, you really have gotten opportunities, use them well, and use them wisely. Make lots of friends, make good friends. Have lots of fun. Let your heart fly. I wish you all great success in this

Olympiad and I have a few words to say to our dear host. 各位朋友，這是一次非常特別的 IBO，非常感謝你們在美麗的台北為我們所做的準備及付出。Have a great week!

Dr. Yung-Ta Chang, The Chairperson of IBO2011 Organizing Committee:

Minister of Education Dr. Wu., Chairperson of IBO Dr. Kasemsap, Chairman of IBO 2011, the President of National Taiwan Normal University, Dr. Chang. All the participants. Ladies and Gentlemen. On behave the organizing committee. I would like to welcome you all again for your participation in IBO 2011. I'm also very glad to be here to make this report. In IBO 2011, there are 60 teams to attend this event, totally 227 competitors and 196 juries and observers. After the contest, we presume that we shall have 23 gold medal winners, 46 silver medals and 69 bronze medal winners. The first arrival is Dr. Hans Morelis from Netherland, he came to Taiwan on the 2nd of July. After his private tour in Hualien, then he worked with all the science committee members and subgroup. This committee already previewed the exam task in three-day subgroup meeting. Every day, they worked more than 12 hours. We believe that their efforts could reduce the suffering of long discussion for all juries and observers. We also very appreciate for their hard works. All of you know that arranging IBO contest really is a very hard and very complicate work. But we already do our best to accommodate you. We hope that we can consider everything previously. If there is any mistakes or problem, please let us know and tolerate us. We wish all of you have a nice journey in Taiwan. So, welcome to Taiwan and also enjoy Taiwanese people's enthusiasm and the contest. Thank you very much!

Rules in the examination rooms

Examination Schedule

Practical examinations 12 July	
Exam. I	9:00 – 10:30
Exam. II	11:00 – 12:30
Exam. III	14:00 – 15:30
Exam. IV	16:00 – 17:30

Theoretical examinations 14 July	
Exam. I	9:30 – 11:30
Exam. II	14:30 – 16:30

Location map

A、B、C、D：Examination room

Ra、Rb、Rc、Rd：Resting area

Group (color of cloth)	9:00-10:30 11:00-12:30 14:00-15:30 16:00-17:30
S1 (pink)	Ra → C → Ra →A →Rb→D →Rb →B →Rb
S2 (green)	Rb → D → Rb →B →Ra →C →Ra →A →Ra
S3 (blue)	Rc → A → Rc →C →Rd →B →Rd →D →Rd
S4 (yellow)	Rd → B → Rd →D →Rc →A →Rc →C →Rc

The procedures for the practical examinations in 12 July

- The contestants wait in the resting rooms
- Contestants find and sit on their assigned seats
- Staff check if the ID number of each contestant matches the number on the table
- The bell rings to begin the examination
- Ten minutes before the examination ends the bell rings
- The bell rings when the time is up (90 minutes) to end the examination
- All contestant stop working on their examination
- Staff collect examination paper
- Wait until the invigilator announces that contestants may leave the room

Important!!!

- Be sure to bring your ruler given to you after this introductory presentation to the examinations

Practical Examinations

- Biochemistry and cell biology
- Plant physiology, anatomy and genetics
- Animal physiology and anatomy
- Ecology and systematics

Theoretical Examinations

Rules in the examination room

- There is a clock on each table.
- When seated please check if your ID number matches the number on the seat and on the examination paper.
- Ten minute the examination ends there will be short bell rings.
- There will be long bell rings when the examination starts and ends.
- When you need to use the toilet or the emergency room please raise your hand and our staff will guide you to the exit of the examination room.

Rules in the examination rooms

- Do not look around while taking the examination and do not talk with others. If you violate the rule a yellow card will be raised to warn you. If you have are warned twice or more the staff will make an official record of your behavior together with you ID.
- When you finish your examination our staff will collect your examination paper. You may not leave you seat before our staff has collected your examination paper.

Situations when a contestant may raise the red card—In practical exams

- Instrument/material problem →replacement right away
- Contest needs → Photograph taking or using shared instrument

Problems of the examination paper →The invigilator or staff will take care of the problems

***If you break the instrument or the materials during the examination, there will be no replacement.

Trial on the equipment

- Today's culture night is an "academic night". You have the chance to get familiar with the timer and pipetman which you will use in the examination tomorrow.
- We will also measure the appropriate size of gloves for your use in the examination. Tomorrow please pick up the right size gloves in the resting room.

I. Examination paper

1. Practical Exams

(1) Before subgroup meeting – test questions

PRACTICAL TEST 1 : BIOCHEMISTRY AND CELL BIOLOGY

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 3 tasks:

  Task I: Protein electrophoresis (35 points)

  Task II: Protein purification (30 points)

  Task III: Protein quantification (35 points)

- Check your **ID number** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please raise your **cardboard.**
- Use **pencils and erasers**. You can use a ruler and a calculator provided.
- Stop answering and put down your pencil **immediately** after the end bell rings.
- After test, please enclose both the answer sheets and test sheets in the provided envelop. Our invigilator will collect it promptly.
- Put the formula on your **Answer Sheet**. With correct formula, you may get part of score even though the answer is wrong.

Good Luck!!

Shared instruments:

Camera, spectrophotometer, printer

Equipments and Materials:

	Equipments:	**Quantity**
1	Power supply	1
2	Electrophoresis tank (with gel and buffer)	1
3	Mini centrifuge	1
4	Micropipettes P20 and P200	1 each
5	80-well microcentrifuge tube rack with 1.5-mL microcentrifuge tubes (×12)	1
6	Wire test tube rack with 15-mL centrifuge tubes (×6) (yellow cap)	1
7	4-way test tube rack	1
8	Plastic droppers in 15-mL centrifuge tubes	2
9	Micropipette tips (for P20 and P200)	1 each
10	Timer	1
11	96-well microplate	1
12	Marker pen & paper label	1 each
13	600-mL beaker for waste disposal	1
14	Scissors	1
15	Double-sticker (attach the result)	1
16	ID number sticker	1

	Materials:	**Quantity**
1	Loading dye (microcentrifuge tube-L) (pink tube with orange label)	1
2	Protein molecular weight marker (microcentrifuge tube-M) (pink tube with orange label)	1
3	Unknown protein samples (microcentrifuge tubes-U1 and U2) (pink tube with orange label)	1

4	Protein sample (microcentrifuge tube-C) (blue tube with blue label)	1
5	Anion exchange chromatography column on 15-mL centrifuge tube	1
6	Anionic buffers A and B (5 mL each in two separated 15-mL centrifuge tubes) (blue cap)	1
7	Coomassie brilliant blue G-250 (CBG) reagent 1 mL in each of six 15-mL centrifuge tubes (A1~A3 & B1~B3, red cap)	1
8	CBG reagent in 50-mL centrifuge tube	1
9	Bovine serum albumin (BSA) concentration standard (0.5 mg/mL) in microcentrifuge tube (green tube with yellow label)	1
10	Enzyme E in two microcentrifuge tubes: concentrations X and Y (green tube with yellow label)	1
11	Distilled water (microcentrifuge tube-ddH_2O) (green tube with yellow label)	1

Task I (35 points)
Protein electrophoresis

Introduction:

Polyacrylamide gel electrophoresis (PAGE) is a common technique for protein study. It can be used to separate different proteins based on their charges or sizes. A type of PAGE is termed SDS-PAGE, in which the negatively charged chemical, SDS, is added during protein electrophoresis. The amount of SDS binds to proteins is proportional to the size of the protein which confers each protein a similar charge-to-mass ratio and renders the intrinsic charge of the protein insignificant. Thus, the major factor that affects the migration of protein is the molecular weight (MW) of the protein during SDS-PAGE. The relative mobility (R_f) of the protein can be calculated as the ratio of the distance migrated by the protein to that migrated by the dye-front. The value of R_f is negatively proportional to the log of its molecular weight.

In the problem set, you will perform the following experiment:

1. An electrophoresis tank has been set up for SDS-PAGE, in which a polyacrylamide gel has been secured on electrode assembly and electrophoresis buffer has been filled. There are 10 wells for sample loading on the top of the gel. To load the sample, please use the P20 micropipette with tip to withdraw protein sample, and carefully place the tip on the top of the well. By injecting slowly the sample will sink to the bottom of the well by gravity (**Figure 1**).
2. To practice, please use the P20 micropipette with tip to withdraw 10 μL of loading dye from microcentrifuge tube L (pink tube with orange label) on rack. Please load the sample into wells 1~3 or 7~10.
3. Each of microcentrifuge tubes M, U1 and U2 (pink tube with orange label) contains 15 μL of protein molecular weigh marker, unknown protein U1 and unknown protein U2, respectively. Please use micropipette P20 to withdraw 10 μL solution from each tube and load the samples into wells 4~6 as shown in **Figure 1**.
4. As soon as finishing sample loading, **Lift the sign**, working staffs will connect the power cord to power supply and set the voltage to 200 V for you. The gel will run for 25 minutes. The timer will be set up by a staff to countdown.
5. After finishing electrophoresis, **Lift a sign**, working staffs will disassemble the electrophoresis set-up and give back your gel. Please wipe clean the surface of gel with tissue papers and **label the gel with your ID number** sticker. Working staffs will take the photo of your gel. Put the photo on the answer sheet using double-sticker (5 points).

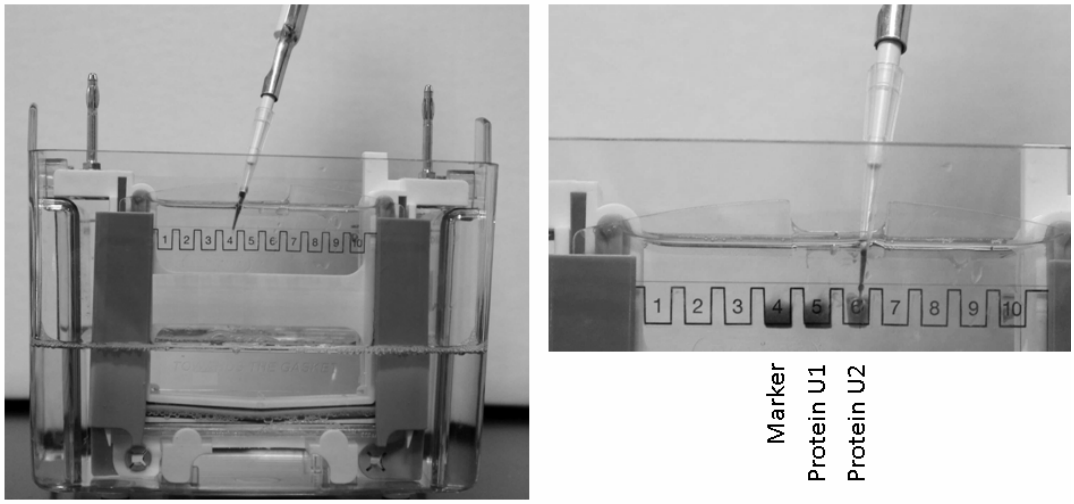


Figure 1

Please answer the following questions:

Q.1.1. (2 points) **Figure 2** shows the photography of a SDS-PAGE gel. The electrophoresis start point and dye-front are indicated. Which side of the gel should be connected to the anode of the power supply? Please mark your answer (X) on the answer sheet.

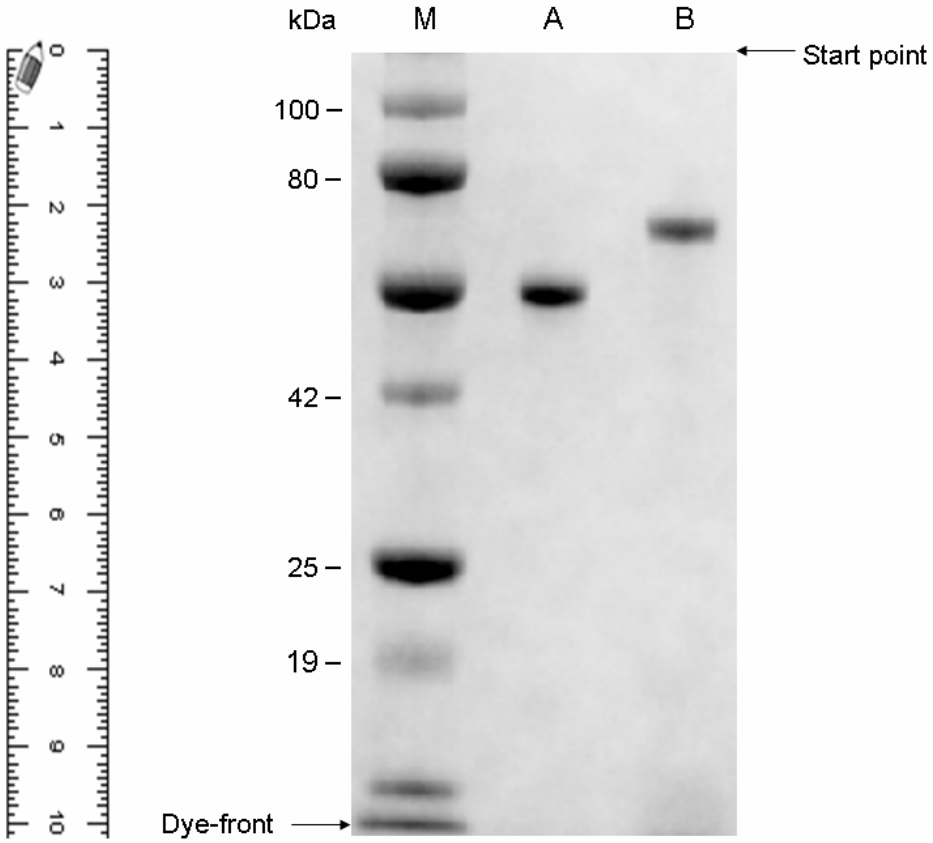


Figure 2

Q.1.2. (8 points) Based on the information provided in **Figure 2**, please make a plot of log MW values of the five marker proteins versus their relative migration-R_f values on the answer sheet (4 points). Estimate the molecular weights of unknown proteins on lanes A and B (4 points). Please write down your answers on the answer sheet.

Q.1.3. (5 points) A larger protein complex is composed of multiple subunits by non-covalent interaction. If the molecular weight of the protein complex is 246 kDa, two protein bands of 57 and 33 kDa were identified after SDS-PAGE. How many 57-kDa and 33-kDa subunits, respectively, are included in the protein complex? Please write down your answers on the answer sheet.

Q.1.4. (5 points) The average molecular weight of amino acids is about 110 daltons. How many amino acids are there in a 33-kDa protein subunit? How many nucleotides of RNA are translated into the protein? Please write down your answers on the answer sheet.

Q.1.5. (5 points) Suppose the average molecular weight of nucleotides of is 330 daltons. Excluding intron and stop codon, what is the mass ratio of DNA encoding the 33-kDa protein to the 33-kDa protein? Please write down your answer on the answer sheet.

Q.1.6. (5 points) Suppose protein P can bind to protein Q (MW = 1000 daltons). The binding can be revealed by gel-mobility shift assay. Now 200 pmol of protein P was mixed with various amounts (0~500 ng) of protein Q. These mixtures were resolved by 10% (w/v) polyacrylamide gel. Gel was stained by Coomassie blue and showed in **Figure 3**. Please calculate the binding molar ratio of proteins P and Q? Please write down your answer on the answer sheet.

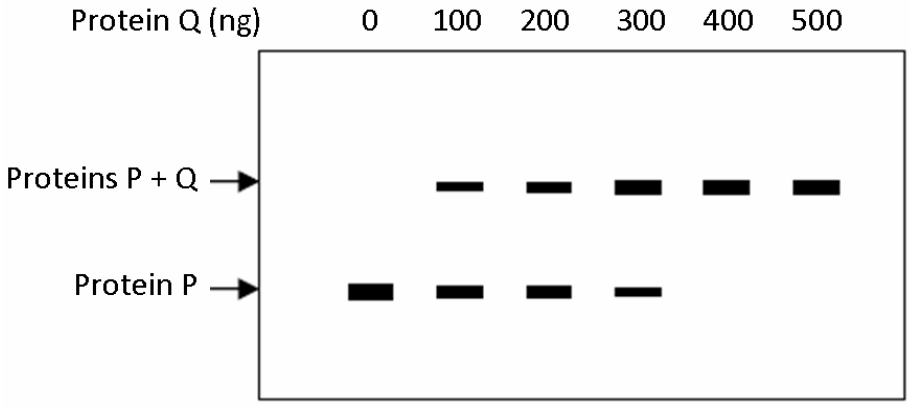


Figure 3

Task II (30 points)
Protein purification

Introduction:

Column chromatography is commonly used for purification of protein. The column is made by packing solid porous material (stationary phase) in a column filled with buffer solution (mobile phase). The protein solution to be separated is loaded on top of the column and allowed to percolate into the solid matrix (stationary phase). A reservoir at the top supplies elution buffer constantly which flows through the matrix and passes out of the column at the bottom (the eluent). Since proteins interact with solid matrix in different degree, individual proteins migrate faster or more slowly through the column depending on their properties. Therefore, one can obtain purified proteins by collecting eluent at different times (**Figure 4**).

Ion-exchange chromatography can be used to separate proteins with different electric charge at a given pH. In anion exchange chromatography, negatively charged proteins bind to positively charged stationary phase. Using solution containing anions to compete with proteins for the adsorption of solid matrix, the bound proteins will be eluted. In practical, proteins are eluted first with buffer containing lower concentration of anion, then with buffer containing higher concentration of anion. Since different charged proteins interact with the stationary phase in different strength, they can be separately eluted by different concentrations of anionic buffers.

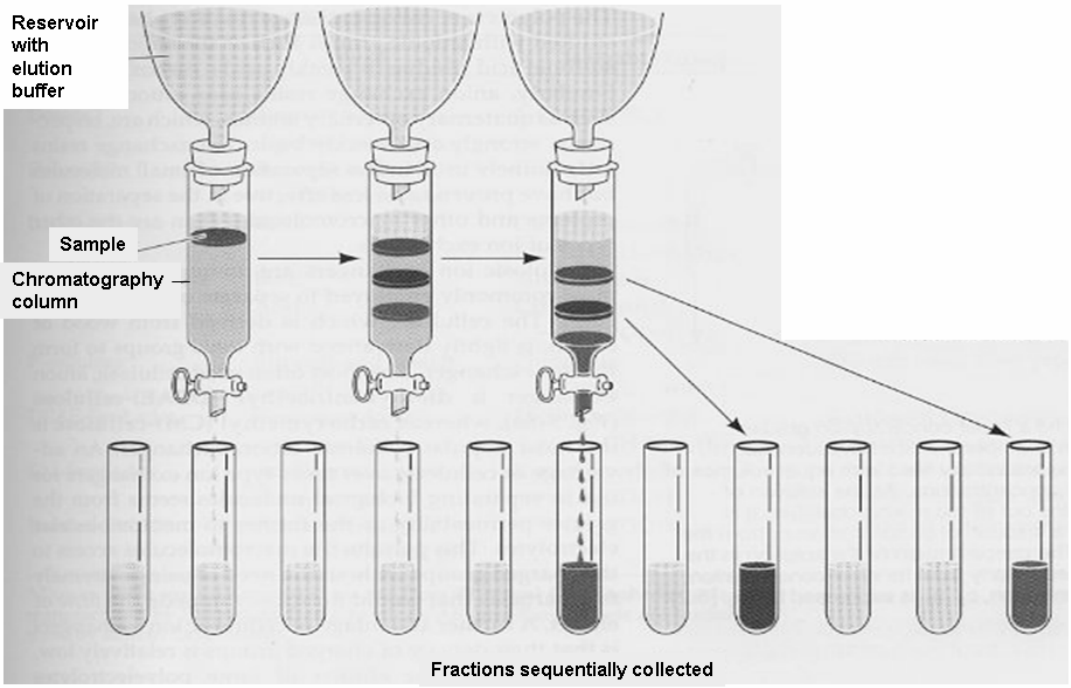


Figure 4

<u>In the problem set, you will perform the following experiment:</u>

1. Label six 15-mL centrifuge tubes (yellow cap) a1~a3 and b1~b3 accordingly, with a marker pen.
2. Take the anion chromatography column (**Figure 5A**), un-plug the tube and allow the solution to be drained by gravity in the same centrifuge tube. Plug the tube intermediately when the liquid surface reaches the top of the disc (**Figure 5A**, white arrow). Please do not over-dry the gel as it may affect protein purification.
3. Withdraw 200 μL of protein solution from microcentrifuge tube C (blue tube with blue label) using a P200 micropipette, apply the sample to the chromatography column slowly by touching the filled pipette tip lightly against the inside wall of the tube (**Figure 5B**).
4. Un-plug the column and allow the protein sample to drain down. Transfer the column to centrifuge tube a1 (yellow cap). Withdraw 3 mL of anion buffer A (blue cap) with a plastic dropper and apply the solution to gel by touching pipette tip against the wall of the tube (**Figure 5C**).
5. Collect ~1 mL eluent in centrifuge tubes a1~a3 (yellow cap) sequentially. It takes about 2~3 minutes for each tube.
6. Allow the contents of the column to drain entirely out then transfer the column to centrifuge tube

b1 (yellow cap). Withdraw 3 mL of anion buffer B (blue cap) with a plastic dropper and apply the solution to gel by touching pipette tip against the wall of the tube (**Figure 5C**).

7. Collect ~1 mL eluent in centrifuge tubes b1~b3 (yellow cap) sequentially. It takes about 2~3 minutes for each tube.
8. Withdraw 50 μL of eluent from tubes a1~a3 & b1~b3 (yellow cap) and transfer to centrifuge tubes A1~A3 & B1~B3 (red cap), respectively. Mix and observe color change. CBG (see introduction in Task III) reagent in tubes A1~A3 & B1~B3 will turn blue when it reacts with the eluted protein.
9. After finishing all the experiments, **Lift the sign**, working staffs will take photo of your experiment results. Please put the photo on your answering sheet using double-sticker. (5 points)

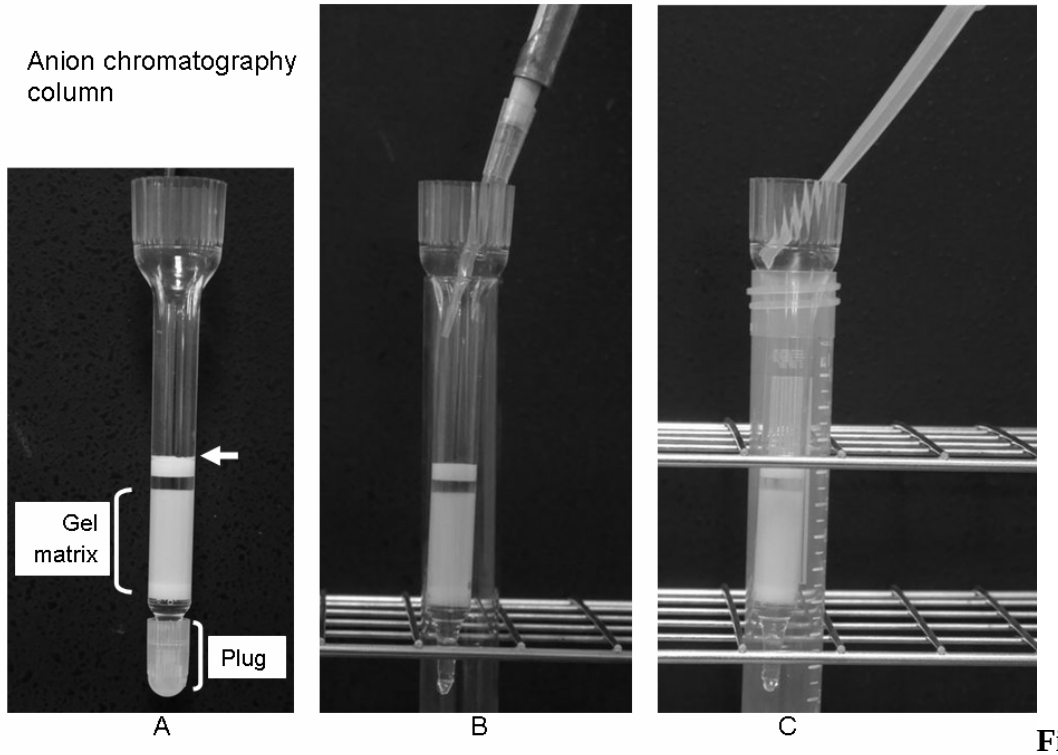


Figure 5

Q.2.1. (2 points) Which of the following buffer (buffer A or buffer B) can be used to elute protein? Please mark your answer (X) on the answer sheet.

Figure 6 shows the purification of enzyme A from bacteria monitored by SDS-PAGE. Total proteins (lane 1) were subjected for purification first using anion-exchange chromatography. During purification the eluent was collected in a series of fractions. The fractions containing activity of enzyme A (lane 2) were further purified using hydrophobic interaction chromatography. The fractions containing enzyme activity (lane 3) were subjected for further purification using gel filtration chromatography to obtain fractions with enzyme activity (lane 4).

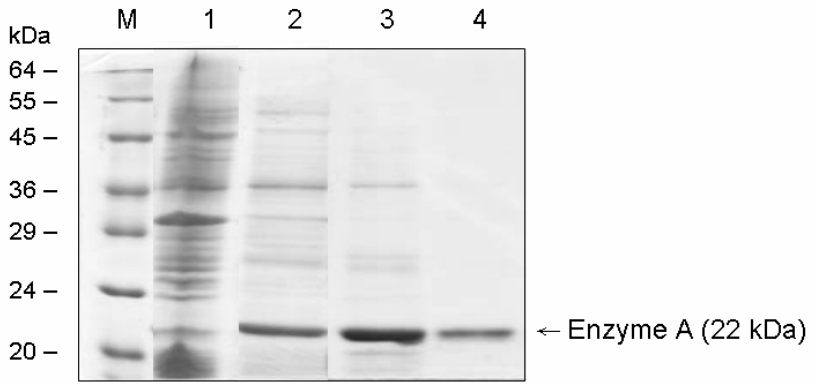


Figure 6

Please answer the following questions accordingly:

Q.2.2. (5 points) Enzyme A is a protein whose surface is evenly distributed with electric charges. If enzyme A can be eluted form anionic exchange chromatography by higher concentration of anionic buffer, what is the property of enzyme A with respect to electric charge? Please mark (X) the answer on the answer sheet.

(A) Higher negative net charges

(B) Higher positive net charges

(C) Lower negative net charges

(D) Lower positive net charges

(E) Zero net charge

Q.2.3. (4 points) Different amino acids differ in the chemical nature of the R group (side chain). **Figure 7** shows four amino acids A, B, C, and D in their prevailing ionic forms at pH 7.2, with the side chain marked in white box. Which of the following amino acids in **Figure 7** would be present more frequently on enzyme A? Please write down your answer on the answer sheet.

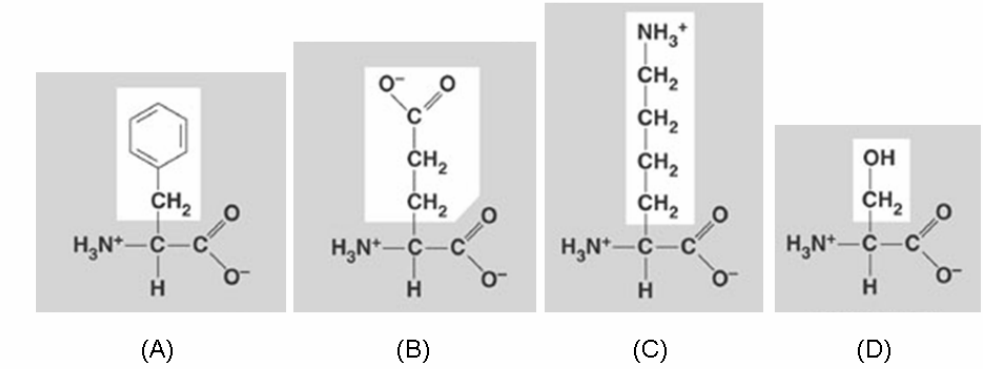


Figure 7

Q.2.4. (5 points) Hydrophobic interaction chromatography can be used to separate proteins based on their hydrophobicity. To perform the chromatography, protein samples were first treated with buffer containing high concentration of salts such as ammonium sulfate $(NH_4)_2SO_4$. The salt ions will hydrate with the water molecules on the protein surface (salvation), which causes the hydrophobic area on the surface of protein to be exposed. When the salt-treated proteins are subjected for chromatography, they will be absorbed on the stationary phase through hydrophobic interactions. The higher the hydrophobicity of the protein has, the stronger the absorption is. As salt concentration can affect the hydrophobic interaction between protein and stationary phase, different proteins can be separately eluted by using different concentrations of salt-containing buffers. If enzyme A is highly hydrophobic, which of the following buffers should be used to separate enzyme A from other proteins by the chromatography? Please mark (X) the answer on the answer sheet.

(A) Low salt buffer

(B) High salt buffer

(C) Buffer without salt

(D) Low salt buffer first then high salt buffer

(E) High salt buffer first then low salt buffer

Q.2.5. (4 points) If enzyme A is highly hydrophobic, which of the amino acids in **Figure 7** would be present more frequently on enzyme A? Please mark (X) the answer on the answer sheet.

Q.2.6. (5 points) Gel filtration chromatography separates proteins based on their sizes. The gel, or stationary phase, consists of cross-linked polymer beads with engineered pores of a particular size. Small proteins enter the pores and are retarded by their more labyrinthine path. Large proteins cannot enter the pores and so take a short path through the column, around the beads. **Table 1** is a list of gels and their fractionation ranges. Suppose both enzyme A (22 kDa) and protein B (44 kDa) are single-subunit proteins, one would like to purify enzyme A from a mixture containing enzyme A and protein B using gel filtration chromatography. Which gel is best suited for the job? Please mark your answer (X) on the answer sheet.

Table 1

Types of stationary phase	Fractionation range (MW, Da)
G-10	<700
G-15	<1500
G-25	1,000-6,000
G-50	1,500-30,000
G-75	3,000-70,000
G-100	4,000-150,000
G-150	5,000-400,000
G-200	5,000-800,000

Task III (35 Points)
Protein quantification

Introduction:

Coomassie Brilliant Blue G-250 (CBG) is a protein staining reagent. It appears in a different color under different pH conditions. It looks reddish brown in acidic solution, whereas it turns blue under neutral or alkaline condition. Since proteins can provide a relative neutral environment, CBG will turn blue with the maximum absorbance at wavelength of 595 nm when binding to protein. The more protein there is in a sample, the more CBG will bind to it, and thus, the higher intensity of blue color will be. In other words, the absorbance of 595 nm is proportional to the amount of protein in a sample. Based on this, one can determine the concentration of protein by measuring the blue intensity of a sample.

In the problem set, you will perform the following experiment:

1. make BSA concentration standard (**Table 2**), add 0, 2, 4, 6, 8 and 10 μL of 0.5 mg/mL BSA (green color) in A1~A6 wells of a microplate (**Figure 8**). Adjust the total volume of each BSA solution to 10 μL by adding an appropriate volume of H_2O. If this step is incorrect, you can repeat the procedure in wells A7~A12.

2. Make a duplicated BSA concentration standard in B1~B6 wells (or B7~B12) as step 1.

3. Add 200 μL of CBG reagent per well in A1~A6 & B1~B6. Mix and observe the color change.

4. To determine the two concentrations X and Y of enzyme E, add appropriate amount (2~10 μL) of enzyme E (green color) in duplicate to empty wells and bring up the volume to 10 μL with H_2O.

5. Add 200 μL of CBG reagent per well to the diluted enzyme E. Mix and observe the color change.

6. If the color of the enzyme E (unknown concentrations X and Y) is within the color range of BSA standards, **Lift the sign**. Working staffs will accompany you to measure the absorbance of your sample at 595 nm using spectrophotometer. Put your ID number on the print-out data with

marker pen.

7. Return to your work bench, and put the result on answer sheet using double-sticker.

Table 2

Materials	Well of a microplate					
	A1 & B1	**A2 & B2**	**A3 & B3**	**A4 & B4**	**A5 & B5**	**A6 & B6**
0.5 mg/mL BSA (μL)	0	2	4	6	8	10
H_2O (μL)	10	8	6	4	2	0
CBG dye (μL)	200	200	200	200	200	200

	1	2	3	4	5	6	7	8	9	10	11	12
A	A1	A2	A3	A4	A5	A6						
B	B1	B2	B3	B4	B5	B6						
C												
D												
E												
F												
G												
H												

Figure 8

Please answer the following questions:

Q.3.1. (10 points) Plot a standard curve of BSA concentrations (X-axis) versus mean absorbance values of duplicated standard (Y-axis) on the answer sheet.

Q.3.2. (12 points) Please describe how did you prepare dilutions of enzyme E and write down the optical density (OD_{595} nm) on the answer sheet.

Q.3.3. (8 points) Based on the dilution you made, calculate the original concentrations (X and Y) of enzyme E from the standard curve of BSA concentration. The concentrations should be expressed in

units of mg/mL. Please write down your answers on the answer sheet.

Q.3.4. (5 points) Assumed the concentration of total proteins from bacterial culture (lane 1) in **Figure 6** is 1 mg/mL and the activity of enzyme A is 0.5 units in 1-mL protein sample. The concentration of total proteins from gel filtration chromatography (lane 4) is 0.1 mg/mL and the activity of enzyme A is 1 unit in 1-mL protein sample. Please calculate the purification factor (times of purity improvement) of enzyme A. Please write down your answer on the answer sheet.

PRACTICAL TEST 2 : ANIMAL PHYSIOLOGY AND ANATOMY

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: The observation of the sciatic nerve of American bullfrog (40 points)

  Task II: The observation of tissue morphology and the match of their functionality (60points)

- Check your **ID number** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please raise your **cardboard.**
- Use **pencils and erasers**. You can use a ruler and a calculator provided.
- **You must complete part one first.**
- Stop answering and put down your pencil **immediately** after the end bell rings.
- After test, please enclose both the answer sheets and test sheets in the provided envelop. Our invigilator will collect it promptly.
- Put the formula on your **Answer Sheet**. With correct formula, you may get part of score even though the answer is wrong.

Good Luck!!

Equipments and Materials:

For task I: The observation of the sciatic nerve of American bullfrog.

Instruments/materials	Quantity	unit
Bullfrog specimen	1	piece
Dissecting tray	1	piece
Round plastic culture dish	1	piece
Ringer's solution (in wash bottle)	500	ml
Plastic dropper	2	piece
Lay pin	10	piece
Cotton line	2	piece
Electric stimulating device	1	set
Surgery device: scissors (large) scissors (small) forceps	1 1 2	pair pair pair

For task I: The observation of tissue morphology and the match of their functionality

Instruments/materials	Quantity	unit
Dissecting microscope	1	set
Slide specimen	10	slide
Color pictures (numbered 1-9) on 3 sheets of A4 paper	1	set

Task I (36 points)
The observation of the sciatic nerve of American bullfrog.

Introduction:

Sciatic nerve is a branch of sacral plexus. It is the thickest and longest nerve tract in body, extending from vertebral to foot. Sciatic nerve includes the distributed sensory and motor nerves that control most sensory and motor activities of lower extremity. Mediated by sciatic nerve, the sensory signals from lower limb could be transduced into brain. Similarly, the muscle contraction of lower extremity could also be stimulated by the activation of motor nerve in sciatic nerve that is triggered by the action order from brain. It is also known that the sciatic nerve tract is composed of many different types of nerve fibers, and the major distributed never fibers belong to types A, B, and C. The aim of this experiment is to observe and isolate the sciatic nerve from bullfrog.

Experiment Procedure:

Step 1 to 4: (To keep the tissues wet constantly, a small amount of Ringer's solution should be added onto the tissues any time)

1. Carefully check if all the experiment instruments /materials are fully provided. Please raise your hand promptly if you have any problem.
2. Put the bullfrog specimen on the provided dissecting tray.
3. First, you are asked to observe the 10 pairs of spinal nerves extending from the vertebra of the bullfrog carefully. Next, find out the sciatic nerve that is assembled by the 7th, 8th and 9th pairs of spinal nerves. (Fig. 1)
4. Turn on the switch (on/off) on the electric stimulating device. The red light will be lighted up immediately, indicating that the device is in normal function. If the red light is not on, please promptly raise the provided board to notify and get help from invigilator.

5. Simultaneously stimulate the sciatic nerve with the two electric wires that are separately connected to the (+) and (-) electrodes of the electric stimulating device (Fig. 1 indicates the position of sciatic nerve). Observe the response of the hind limb.

Fig. 1. Spinal nerve	Fig. 2. Electric stimulating device	Fig. 3. Sciatic nerve

Q.1.1. (9 points) When you have finished the above five steps, write down the results of your observation on the answer sheets. And, raise the cardboard to notify invigilator for checking the results and recording.

Step 6 to 10: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissues any time)

6. Use a pair of scissors to circularly cut open the skin at the upper part of the **right** thigh of the bullfrog. Starting from the cutting point, completely peel off the skin by hand to remove it from the hind limb. (Fig. 4)
7. Lay the bullfrog on the dissecting tray with its back facing up.
8. Push two lay pins separately into both ends of gastrocnemius and separate it from tibia (shinbone) (Fig. 5).
9. Sciatic nerve locates in the trough surrounded by thigh muscles. Carefully separate the muscles on both sides of the trough and let the light yellow colored sciatic nerve be exposed. Pass through a cotton line underneath the sciatic nerve to label it.
10. Stimulate the cotton line labeled sciatic nerve with the provided electric stimulating device and observe the contracting response of gastrocnemius.

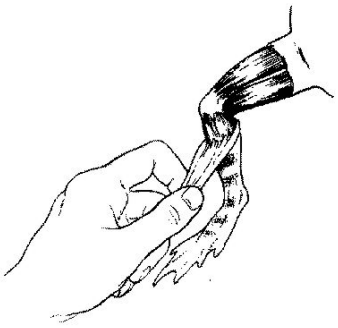


Fig. 4. Demonstration of skin peeling

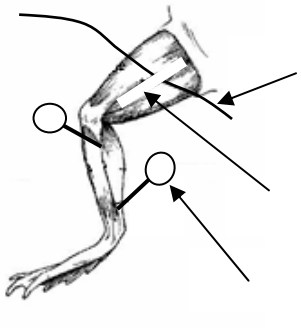


Fig. 5 Labeling sciatic nerve and gastrocnemius

Q.1.2. (9 points) When you have finished the steps 6 to 10, write down the results of your observation on the answer sheets. And, raise the cardboard to notify invigilator for checking the results and recording.

Step 11 to 12: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissues any time)

11. Completely separate and isolate the connected tissue of 「sciatic nerve- gastrocnemius」from the bullfrog specimen and soak this tissue specimen in Ringer's solution in a culture dish. When this is done, it will be as that shown in Fig. 6.
12. Stimulate the sciatic nerve with electric stimulating device and observe the contracting response of gastrocnemius.

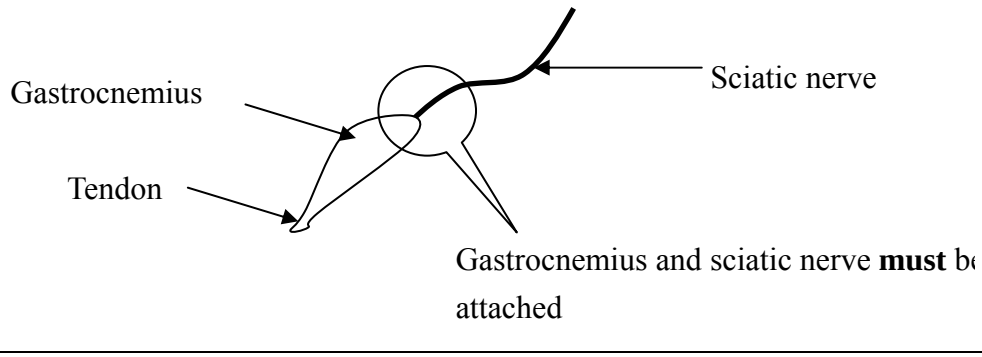


Fig. 6 Isolation of 「sciatic nerve-gastrocnemius」tissue

Q.1.3. (18 points) When you have finished the steps 11-12, write down the results of your observation on the answer sheets. And, raise the cardboard to notify invigilator for checking the results and recording.

Task II (64 points)
Identify tissues based on their morphology and matching their functionality

Introduction:

Human body is an organism built by different hierarchical structures. It starts from a simple chemical level and reaches rather complex system level. Between these two, it also involves the differentiation and development of the cell, tissue, and organ levels of structures. The entire human physiological system is established by the functional coordination among 11 organ systems, which include skin, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems.

Identify the specimens on the slides (40 points)

On slides A ~ J, they are different sliced specimens from vertebrate. Please identify the specimens, based on their characteristic features, by using microscope and answer the questions below:

1. vein	2. artery	3. ganglion	4. motor nerve	5. erythrocyte (frog)
6. erythrocyte (human)	7. ovary	8. testis	9. lung	10. skeletal muscle
11. smooth muscle	12. cardiac muscle	13. kidney	14. cartilage	15. bone
16. pancreas	17. intestine	18. gastric tissue	19. skin	20. rectum

Q.2.1. (40 points) Please match each slide specimen (a ~ j) with its correct name from 20 different tissue/organ names listed in above table. (note: only one correct answer for each specimen). Fill in the correct number in the answer sheets.

Identify the sliced tissue and match their correct functions (24 points)

Fig. 1-9 are the enlarged pictures of parts of different mammalian tissues. Based on their structural features, determine the precise sources of them and answer the questions below.

The functions of 12 organs are listed in the following table. Each specific function is assigned an alphabetic letter (a ~ l)。

symbol	Functional description
a	Producing vitamin D_3
b	Producing erythropoietin
c	Producing urea
d	Producing Surfactant to reduce the surface tension
e	Regulating the homeostasis of the pH of body fluid
f	Helping the vein compression and promoting blood stream back to the heart
g	Digesting proteins
h	Secreting secretin
i	Producing cholecystokinin
j	Producing inhibin
k	Major organ for the storage of calcium and phosphate
l	Producing progesterone

Q.2.2. (24 points) Correctly write down the functional symbols, i.e. the alphabetic letters (a ~ l), on the answer sheets. Match the organ with their functionalities. To be noted that each organ may have more than one function.

PRACTICAL TEST 3 : ECOLOGY AND SYSTEMATICS

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: Reconstruct the phylogenetic tree for giving spiders (60 points)

  Task II: Test of species association in a community (40points)

- Check your **ID number** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please raise your **cardboard.**
- Use **pencils and erasers.** You can use a ruler and a calculator provided.
- **Check the integrity of the spiders in 5 minutes.** If any of the legs is missing, please raise your **cardboard. No replacement of the spiders after 5 minutes.**
- Stop answering and put down your pencil **immediately** after the end bell rings.
- After test, our invigilators will check the integrity of the spiders and fill out the spider checklist at the end of your answer sheet. **Each undamaged spider will get you one bonus point.** Please sign after the check is done.
- Enclose both the answer sheets and test sheets in the provided envelop after the spider check is finished. Our invigilator will collect it promptly.
- Put the formula on your **Answer Sheet**. With correct formula, you may get part of score even though the answer is wrong.

Good Luck!!

Equipments and Materials:

Equipments:

1	Dissecting microscope	1
2	Four sheets of colored pictures and one sheet of black and white picture:	
	Figure (figure 1−3 through 1−12)	4
	Figure (figure 2-1)	1
3	Forceps	2
4	Petri dish	2
5	70% ethanol	1
6	Plastic dropper	1
7	1m quadrat cardboard	1

Materials:

1	Four spider samples in glass bottles (W, X, Y, Z)	1

TASK 1: (60 points)

Reconstruct the phylogenetic tree for giving spiders

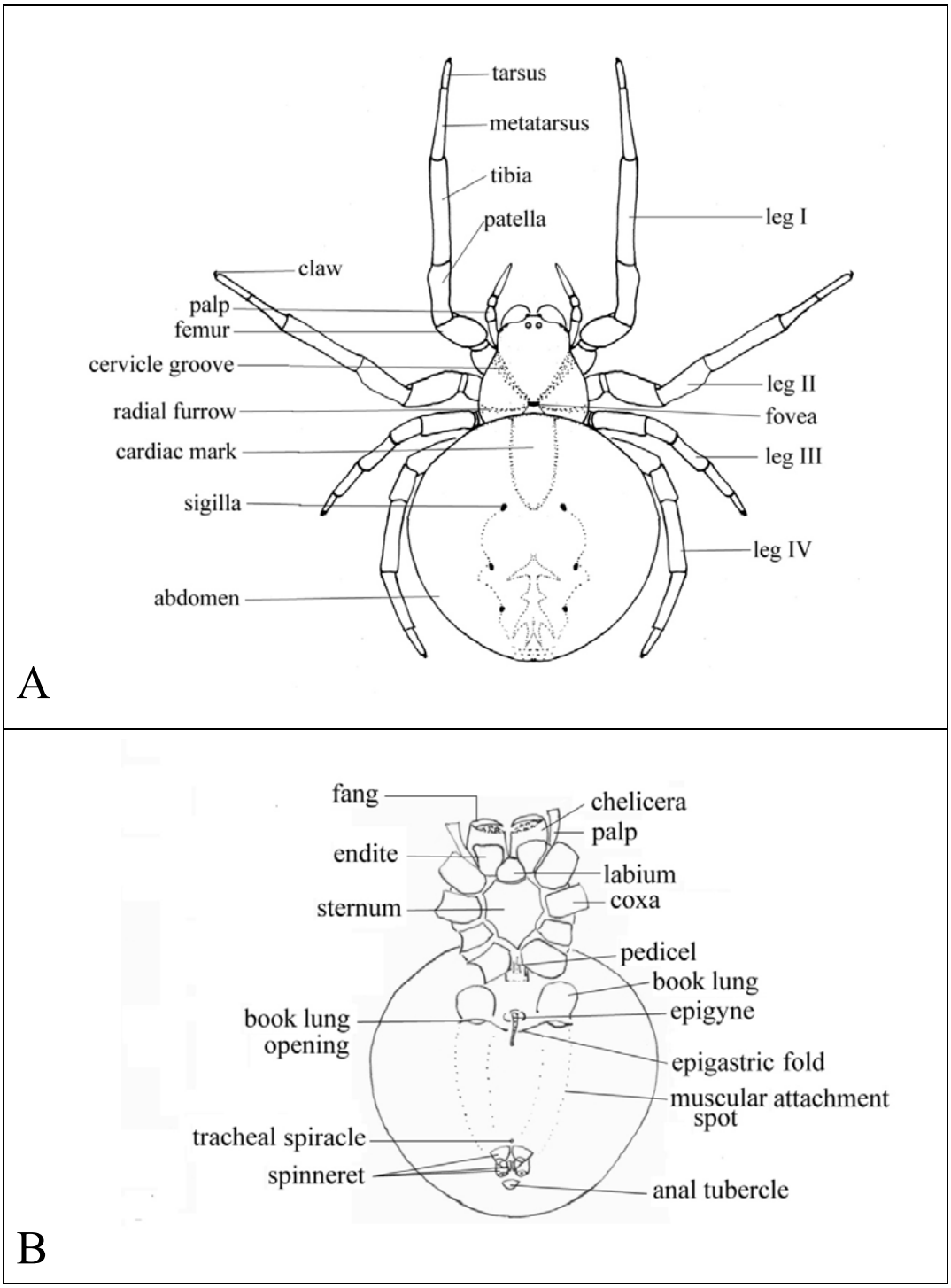


Figure 1-1 External morphology of spider. A. Dorsal view. B. Ventral view.

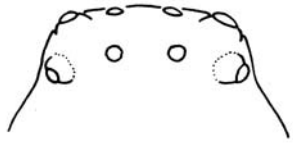
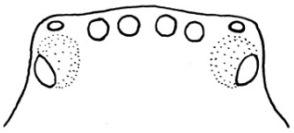
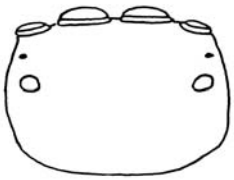
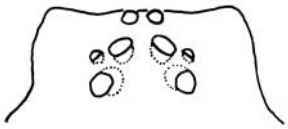
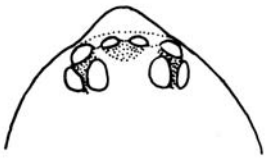
A: two transverse eye rows, with 4 eyes on each eye row	B: two rows, with 6 eyes on the first eye row	C: four rows, with 2 first row eyes smallest and 6 posterior eyes arranged in a hexagonal configuration
		
D: three rows, with the 4 first row eyes much smaller than the others	E: three rows, with the 2 anterior median eyes much larger than the others	F: three rows, with 4 eyes on the second eye row
		
G: eight eyes with one diad (a cluster of 2 eyes) and two triads(a cluster of 3 eyes)	H: six eyes in two triads	I: six eyes in three diads
		

Figure 1-2 Eye arrangements

Legends and Abbreviations of figures 1-3 – 1-12

Figure 1-3 Book lungs. A. Two pairs. B. One pair.

Figure 1-4 Spinnerets. A. Three pairs. B. Two pairs.

Figure 1-5 Cribellum. A. Absent. B. Present.

Figure 1-6 Calamistrum on metatarsus IV. A. Absent. B. Present.

Figure 1-7 Tarsi claw. A. Three pairs. B. Two pairs.

Figure 1-8 Claw tufts. A. Absent. B. Present.

Figure 1-9 Base of anterior spinnerets (AS). A. Widely separated. B. Close or in contact.

Figure 1-10 Grades of legs. A. Prograde. B. Laterigrade.

Figure 1-11 Tibia and metatarsus of legs I and II with series of long spines interspersed with much shorter setae. A. Absent. B. Present.

Figure 1-12 Double-rowed trichobothria on femora IV. A. Absent. B. Present.

1-1 Key to species of some common spiders

There are many living creatures in the world. For an unfamiliar living creature, scientists usually choose a suitable key, the most commonly used tool, to find out its name. A key is using the dichotomous statements (a or b) of diagnosed characters to divide a larger group of taxa into two smaller subgroups (indicates by numbers or taxon names). Beginning with the number 1, choose a more likely statement (a or b) for the specimen and then go to the number shown at the end of the statement, and so on. Go through the key, until a taxon name is shown. A key for some common spiders of the world is given below.

Key to species of some common spiders

1a Two pairs of book lungs (Fig. 1-3A) ……2

1b One pair of book lungs (Fig. 1-3B) …… 3

2a Abdominal tergite present; 3 pair of spinnerets (Fig. 1-4A)…… ***A. aus***

2b Abdominal tergite absent; 2 pair of spinnerets (Fig. 1-4B) ……***M. bus***

3a With a cribellum in front of the spinnerets (Fig. 1-5B), and a calamistrum on metatarsus IV (Fig. 1-6B) ……***Z. cus***

3b Without the cribellum and calamistrum (Figs. 1-5A, 1-6A) ……4

4a With six eyes ……5

4b With eight eyes …… 6

5a six eyes in three diads (Fig. 1-2I) ····· ***S. dus***

5b six eyes in two triads (Figs. 1-2G, H) ·····***P. eus***

6a Tarsi with two claws (Fig. 1-7B), with or without claw tufts ····· 7

6b Tarsi with three claws (Fig. 1-7A), never with claw tufts (Fig. 1-8A) ····· 10

7a Eyes in 3 or 4 rows (Figs. 1-2C, D, E, F) ····· 8

7b Eyes in two rows (Figs. 1-2A, B) ····· 9

8a Eyes arranged in 4-2-2 three rows; with a pair of remarkably large anterior median eyes (AMEs) (Fig. 1-2E)·····***T. fus***

8b Eyes arranged in 2-4-2 three rows (Figs. 1-2F); AMEs not as above ····· ***C. gus***

9a Base of both anterior spinnerets separated from each other or wide apart (Fig. 1-9A); Legs prograde (Fig. 1-10A) ····· ***Z. hus***

9b Bases of both anterior spinnerets in contact (Fig. 1-9B); Legs prograde (Fig. 1-10B) ····· ***T. kus***

10a Eye group hexagonal, eyes arranged in 2-2-2-2 four rows (Fig. 1-2C)····· ***O. lus***

10b Eye group not hexagonal····· 11

11a Eyes in two rows (Figs. 1-2A, B)····· 12

11b Eyes in three rows (Figs. 1-2D, E, F)·····***P. mus***

12a Tibia and metatarsus of legs I and II armed with series of long spines interspersed with much shorter setae (Fig. 1-11B) ·····***M. nus***

12b Legs I and II without such spine arrangement····· 13

13a Femora IV with a proximal cluster of double-rowed trichobothria (Fig. 1-12B) ····· ***L. ous***

13b Femora IV without such trichobothria (Fig. 1-12A)····· ***N. pus***

Now, you have four spider specimens coded W – Z, respectively, as shown on outside of the bottles. Please key out all these spiders and mark some of their characters with aid of figures 1-1 – 1-12. (**Caution!** You may take out the specimen from the bottle for identification. When you do so, you should place a spider in the petridish with some 70% alcohol to examine its characters under the stereomicroscope. Because the spider's body is very fragile, the most ideal way to handle the specimen is gently grasping its legs with forceps to move it in or out from the bottle. Don't break spider's body and its legs. Un-damaged spider will get extra points as bonus. Please handle everything with care! Spiders should be kept in 70% alcohol at any time to prevent desiccation).

Q1.1.1 (4 points for each correct spider; 16 points total) Fill in the correct cell with the exact taxon code in your Answer Sheet. Note: each spider code can only be used once, or the grades of these cells will not be counted.

Q1.1.2 (0.65 points for each cell; 13 points total) If spider shown those characters listed in the left column of the table in your Answer Sheet, please fill in the blank cells with an "X".

1-2 Reconstruct a phylogenetic tree for eight spiders

Data matrix 1-1 represents character entries (a through t) for a group of hypothetical organisms A through H. Based on Data Matrix 1-1, Taxon A is served as the outgroup and the rest 7 species (Taxa B-H) are ingroups. Character state 0 represent the pleisiomorphy (ancestor character) and states 1-6 are apomorphies (derived characters). We may reconstruct a cladogram (cladistic tree) by using the synapomorphies (shared derived characters). Each change represents one step of the evolutionary events (indicated by the character and its statement, e.g., e-5, t-4). The following tree (Figure 1-13) is one of the most parsimonious cladogram that shows all the character changes on the tree. Numbers 1-15 represent 15 steps of the tree.

Data Matrix 1-1

Taxa	Character													
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**m**	**n**	**o**	**p**	**s**	**t**
A	0	0	0	0	0	0	0	0	0	0	0	0	0	-
B	1	1	0	1	5	0	0	1	1	1	0	0	2	-
C	1	1	0	1	6	0	0	0	0	0	0	0	2	-
D	1	1	0	1	3	0	0	0	0	0	0	0	2	-
E	1	1	0	0	1	0	0	0	0	0	0	0	1	3
F	1	1	0	0	1	0	0	0	0	0	1	0	1	4
G	1	1	0	1	4	0	0	1	1	1	0	0	2	-
H	1	1	0	0	1	0	1	1	1	1	0	0	2	-

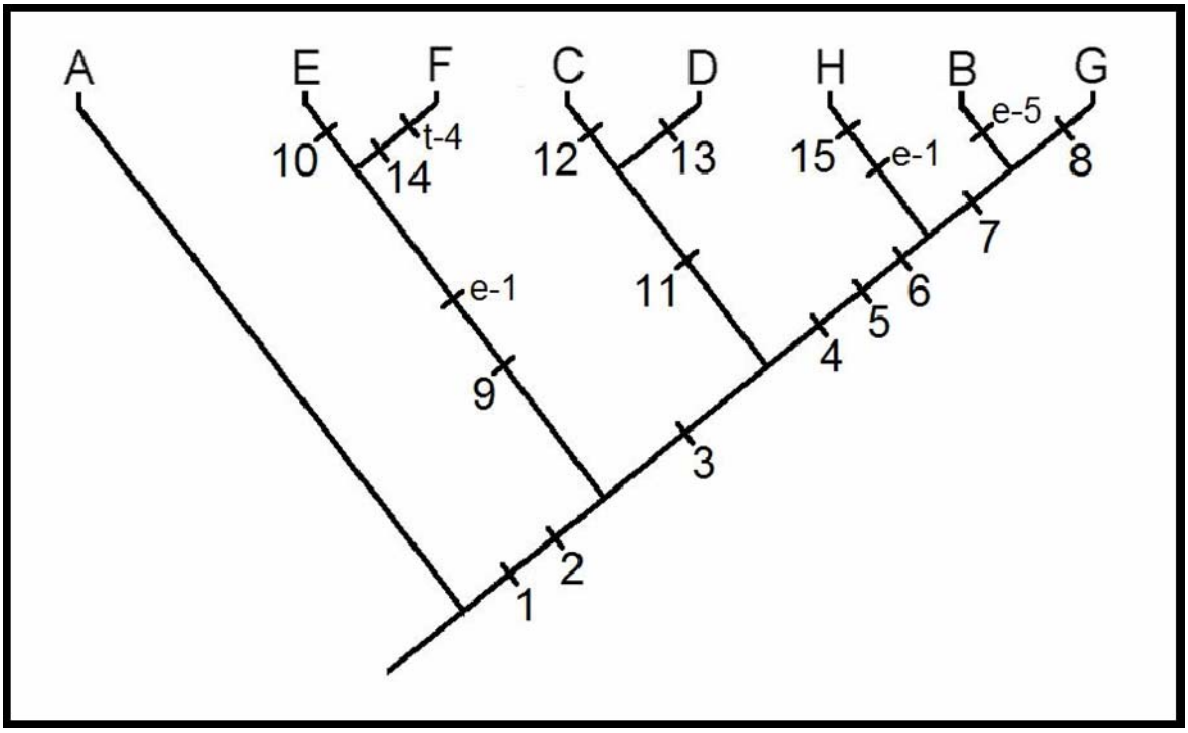


Figure 1-13 The most parsimonious cladogram reconstructed from data matrix 1-1.

Q1.2. (1.2 points for each cell; 18 points total) Fill in the character code and state (e.g., e-1) in the answer sheet for each of the 15 steps.

1-3 Based on the cladogram (figure 1-13), answer following questions:

Q1.3.1. (2 points) How many steps of the cladogram totally?

Q1.3.2. (2 points) Which character(s) is/are homoplasious (i.e., not homologous characters)?

Q1.3.3. (2 points) Which of the following taxa is the sister group of taxon {C, D}?

(A) {E, F} (B) {H, B, G} (C) {F} (D) {H} (E) {B, G}

Q1.3.4. (All answers must be correct, 2 points) Which of the following characters is/are appeared prior to the evolution of character m-1 in the cladogram?

(A) s-1

(B) s-2

(C) a-1

(D) g-1

(E) d-1

Q1.3.5. (1 point for each cell; 5 points total) What kind of grouping of the following taxon belongs to: use code "X" for polyphyletic, "Y" for paraphyletic, or "Z" for monophyletic grouping.

TASK 2: (40 points)
Test of species association in a community

Studying the association between species in a community is one of the study subjects in the community ecology. Many techniques have been developed to fulfill this purpose. One of the simplest ways is to determine the association between two species. The basic idea of community organization is that species tend to be associated in a nonrandom manner. To understand their association conditions we can use a 2x2 contingency table (Table 2-1-0): If a sample contains both species x and y is defined as a type "a" observation. If a sample contains only species y, species x, or no species, then it is defined as a type "b", "c", or "d" observation, respectively.

Table 2-1-0

	Species x		
Species y	present	absent	Total
Present	a	b	a+b
absent	c	d	c+d
Total	a+c	b+d	n

n = a + b + c + d

Probability of obtaining species x P(x) = (a+c)/n

Probability of obtaining species y P(y) = (a+b)/n

Joint probability (JP): the probability of both species x and y are present

JP = P(x)* P(y)

Significant level for Chi-squared statistical test (X^2)

Significant level (α) / df	0.05	0.01
1	3.841	6.635
2	5.991	9.210
3	7.815	11.345

Figure 2-1 is a distribution map of two plant species, Plant-A (○) and Plant-B (●),and a sympatric spider species, Spider (✻), in a hypothetical community. Each square is 0.5 x 0.5 m^2.

2-1-1 Association between Plant-A(○) and Spider(✻): analyzed by quadrat method.

Put a 1-m square quadrat on Figure 2-1 using the following 40 randomly assigned coordinates as the center (i.e., 2 x 2 complete squares) and determine the type of each quadrat.

N-11, S-8, F-10, Q-18, O-16, K-2, L-4, M-17, M-4, H-17

X-2, K-11, T-19, M-8, P-10, G-8, B-19, M-19, S-10, O-12
J-18, D-7, B-17, I-11, B-10, G-13, V-16, C-3, F-5, R-15
L-2, Q-11, R-5, G-11, K-10, T-10, X-9, R-3, O-3, F-16

Q2.1.1. (0.5 points each; 4.5 points total) Write down your results in Table 2-1-1 and complete all the blank cells.

2-1-2 Calculate the expected joint occurrences.

Q2.1.2a. (0.5 points) Calculate P(Plant-A).

Q2.1.2b. (0.5 points) Calculate P(Spider).

Q2.1.2c. (0.5 points) Calculate JP.

Q2.1.2d. (0.5 points) Calculate the expected joint occurrences.

Q2.1.2e. (0.5 points) Two species are more likely positively associated If the expected joint occurrence is smaller than the actual observation, *vice versa*. What kind of the association is between the Plant-A and Spider? [Answer Code: P for positive association, N for negative association.]

2-1-3 A simple Chi-squared statistical test (X^2) with one degree of freedom (df = 1) is calculated as follows:

$$n = a + b + c + d$$

$$X^2 = \frac{n\,(ad-bc)^2}{(a+b)(c+d)(a+c)(b+d)}$$

Q2.1.3. (2 points) Based on Table 2-1-1, Calculate X^2. **(to the fourth decimal place)**

2-1-4 The strength of the association between the two species can be estimated from a coefficient (V) defined as follows:

$$V = \frac{ad-bc}{\sqrt{(a+b)(c+d)(a+c)(b+d)}}$$

The V value varies from -1 (strongly negative association) to +1 (strongly positive association) and it is zero when there is no association.

Q2.1.4a. (2 points) Calculate the V value from Table 2-1-1. **(to the fourth decimal place)**

Q2.1.4b. (2 points) What kind of the association is between the two species? (Mark your answer with "X" in the cell)

2-2 Association between Plant-A(○) and Spider(✻): analyzed by quadrat method.

Put a 2-m square quadrat on Figure 2-1 using the following 40 randomly assigned coordinates as the center (i.e., 4 x 4 complete squares) and determine the type of each quadrat.

N-11, S-8, F-10, Q-18, O-16, L-4, M-17, M-4, G-15, H-17

K-11, T-19, M-8, P-10, G-8, M-19, S-10, O-12, L-8, V-4
J-18, D-7, I-11, G-13, V-16, C-3, F-5, R-15, M-9, P-4
Q-11, R-5, G-11, K-10, T-10, X-9, R-3, O-3, V-10, F-16

Q2.2.1. The results have been done in Table 2-2-1 .

Table 2-2-1

Plant-A(○)	Spider(✻)		Total
	present	absent	
Present	14	16	30
absent	8	2	10
Total	22	18	40

The expect joint occurrence is 16.5.
The Chi-squared statistical test (X^2) with one degree of freedom (df = 1) is calculated as $X^2 = 3.3670$.

Based on Table 2-2-1 answer following questions:

Q2.2.2a. (2 points) What kind of the association is between Plant-A and Spider? [Answer Code: P for positive association, N for negative association]

Q2.2.2b. (2 points) Calculate the V value from Table 2-2-1. **(to the fourth decimal place)**

Q2.2.2c. (2 points) What kind of the association is between the two species? (Mark your answer with "X" in the cell)

2-3 Association between Plant-A (○) and Plant-B(●): analyzed by the nearest neighbor method.

Use a ruler to measure the distances between a Plant-A and all its neighboring plants (Plant-A and/or Plant-B), then determine its nearest neighboring plant species. Go through all individuals of Plant-A and Plant-B.

Q2.3.1. (0.5 points for each cell; 3 points total) Write down your results in Table 2-3-1 and complete all the blank cells.

Q2.3.2a. (2 points) Based on Table 2-3-1 with one degree of freedom (df = 1), calculate X^2.

(to the fourth decimal place)

Q2.3.2b. (2 points) Are these two plant species randomly distributed or segregated? (Mark your answer with "X" in the cell)

2-4 Answer questions:

Q2.4. (2 points each; 14 points total) Tick off (with X) on the answer sheet for each statement whether it is true or false.

1. Both results of association by using 1-m and 2-m square quadrat (sections 2-1 and 2-2) are confirmed by the X^2 test.
2. If two species are segregated, they are negatively associated.
3. The null hypothesis of the X^2 test for the nearest neighbor method is that both Plant-A and Plant-B are randomly distributed.
4. The larger the quadrat size used, the more accuracy the prediction yield.
5. Increasing the sampling efforts of quadrat method might improve the accuracy of the prediction on species association.
6. The results of association tested by quadrat method had not changed according to the species we selected.
7. Using the nearest neighbor method to test species association can prevent the quadrat-sized effect from our results.

PRACTICAL TEST 4 : PLANT ANATOMY, PHYSIOLOGY, AND GENETICS

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: Plant anatomy (50 points)

  Task II: Plant physiology and genetics (50 points)

- Check your **ID number** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please raise your **cardboard.**
- Use **pencils and erasers.** You can use a ruler and a calculator provided.
- Stop answering and put down your pencil **immediately** after the end bell rings.
- After test, please enclose both the answer sheets and test sheets in the provided envelop. Our invigilator will collect it promptly.
- Put the formula on your **Answer Sheet**. With correct formula, you may get part of score even though the answer is wrong.

Good Luck!!

Task 1 (50 points)

Plant Anatomy

Equipments on your bench	**Quantity**
1. Slides	20
2. Cover slips	30
3. Compound microscope (with 4X, 10X, and 40X objective lenses)	1
4. Ocular micrometer (installed within the lens)	1
5. Razor blade	5
6. Plastic droppers	2
7. Petri dish	1
8. Forceps	1
9. Lens paper	1
10. Paper towel	1

Materials	**Quantity**
1. Double distilled water	50 mL/vial
2. 1 N hydrochloric acid (HCl)	5-10 mL/vial
3. Transparent nail polish (in carrier box)	1 vial
4. Four-compartment plastic Petri dish (Containing tissue samples from plant V, W, M, N, P, Q, R, S in each compartment)	2
5. Section slides X, Y, and Z of the root of plant K in slide box K	1 slide each

Part A: Structure of Plant Root (12 points total)

Introduction :

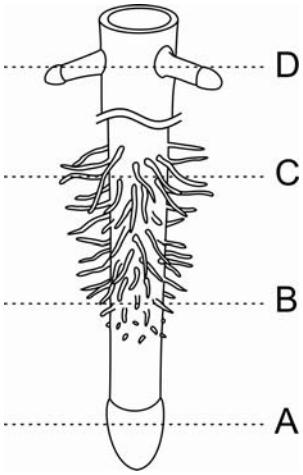


Figure 4 The structure of a typical plant root.tip

There are three slides (X, Y, and Z) that are the transverse sections (located within the circular label on the slides) from different regions of the root of plant K. Please observe these sections under microscope and answer the following questions.

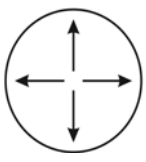
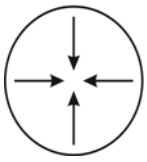
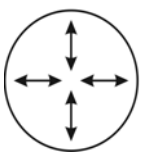
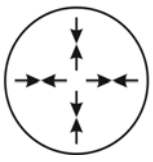
Q1.A.1.（3 points each, 9 points total）

Section X, Y, and Z each corresponds to which part of the root depicted in Figure 3?

	Part A, B, C, or D
Section X	
Section Y	
Section Z	

Q.1.A.2. （3 points, single choice）

According to your observation, what is the maturation direction of primary xylem in the root (tissues mature earlier → tissues mature later)?

(A)  (B)  (C)  (D)  (E) 

Part B: Structure of Plant Stem（4 points total）

Introduction :

Please take stem segments of plant V and W, carefully dissect into transverse sections of proper thickness, and place on slides. Add a drop of water onto the sections and cover with cover slips. Observe under microscope, and answer the following questions.

Q.1.B.（each plant 2 points, 4 points total）

What are the distribution patterns of vascular bundles in the stems of plant V and W?

T (True) or F (False)

Distribution pattern of vascular bundles in the stem	Plant V	Plant W
arranged in a ring		
scattered in ground tissue		
solid vascular cylinder with star-like xylem		
central core of parenchyma cells surrounded by rings of xylem and phloem		

Part C: Structure of Plant Leaf（14 points total）

Introduction :

Please first determine the upper and lower epidermis of the leaves of plant M and N.

Q.1.C.1（8 points）

Observation of stomata of plant M:

Prepare the upper and lower epidermis of the leaves, either by peeling them off with bare hands or by scraping off the undesired parts and leaving only the epidermis. Place these epidermal tissues on the

slides separately, with the epidermal side facing upward. Add a drop of water on each tissue sample and cover with cover slip. Observe under microscope and use the ocular micrometer for measurements, then answer the following questions. One unit of scale length of the micrometer is approximately 30 μm when observing under 4X objective lens.

(a) Measurement of stomatal size on upper epidermis:

i) .Under the 40X objective lens, what is the length of each scale unit of the ocular micrometer? _____ ◦ (include the unit；1 point)

ii) Measure the lengths of 3 guard cells, then average their lengths. _____ (include the unit; 3 points)

(b) Measurement of stomatal density on lower epidermis:

i) .Under 40X objective lens , what is the approximate area of thefield of view ? _____mm^2 ◦ (1 point)

ii) Observe 3 fields of view, and calculate the number of stomata in each. Then work out the average stomatal density._____ (stomatal number /mm^2), (3 points)

Q.1.C.2 （2 points each, 6 points total）

Observation of leaf tissue of plant N:

Dissect out transverse sections of appropriate thickness, add a drop of water, and cover with cover slips. Use the provided transparent nail polish to paint the upper and lower epidermis of leaves. When the nail polish dried, carefully peel off the layers and place on slides , with the epidermal side facing upward. Add a drop of water on each sample, cover with cover slips. Use the appropriate objective lens to observe. Determine the stomatal distribution of the upper and lower epidermis, and deduce the habitat of plant N according to the structure of its leaf tissues. Fill the results of your observation in the table below.

	T (True) or F (False)
Few or no stomata on the upper epidermis	
Many stomata on the lower epidermis	
An aquatic plant	

Part D :

Q.1.D (1 point each, 5 points total)

Determine whether plant K, M**,** N, V, and W are monocot or eudicot**,** and fill in the table below.

Plant	Monocot or Eudicot
K	
M	
N	
V	
W	

Part E: The Calcium Crystals in Plant Cells（15 points）

Introduction :

Some plants have idioblasts that can form polygonal calcium oxalate crystals or calcium carbonate crystals. Use the four plant materials (P, Q, R, S), carefully dissect out transverse or longitudial? sections of appropriate thickness with a clean razor blade, and place the sections on slides. Add a drop of water on each section, and cover with cover slips. Observe under microscope and check for the presence of calcium crystals. If the crystals are present, locate the region of crystal distribution in the tissue, carefully open the cover slip, and add a few drops of HCl. Observe the samples and deduce the types of calcium crystals that are present.

Q.1.E （1.5 points each, 15 points total）

According to your observation, fill in the corresponding letters to the diagram below:

Plants: **P** ; **Q** ; **R** ; **S**

Location of calcium crystals: **A** (in cells of vascular bundles) ; **B** (not in cells of vascular bundles)

Types of calcium crystal: **C** (polygonal calcium oxalate crystal) ; **D** (calcium carbonate crystal)

	Plant	Location of crystals (A or B)	Crystal type (C or D)
No calcium crystals		—	—
Presence of Calcium crystals			

Task 2 (50 points)
Plant Physiology and Genetics

Shared Equipment

ELISA reader

Equipments on your bench

		Quantity
1	1000 – 100 µL Pipetman (use with large filter tips)	1
2	200 – 20 µL Pipetman (use with small filter tips)	1
3	96 well plate	1
4	1.5 mL microtubes (labeled 0 μ M, 25 μ M, 50 μ M, 100 μ M, 200 μ M, 400 μ M)	10
5	Microtube rack / 4-way test tube rack	1 each
6	Waste basket	1
7	Scissors	1
8	Double-sticker (attach the result)	1
9	Marker pen	1

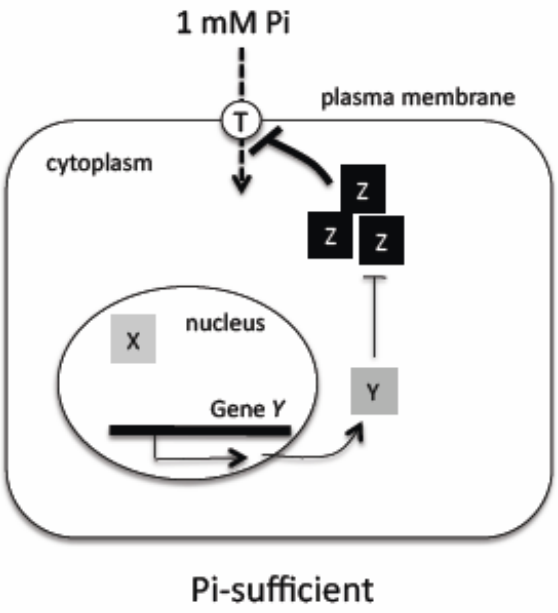
Materials

		Quantity
1	Phosphate detection solution (labeled as “Solution A”)	10 mL/tube
2	400 µM KH_2PO_4 solution (labeled as “Solution B”)	10 mL/tube
3	Double distilled water (labeled as “ddH_2O”)	50 mL/vial
4	6 samples to be tested (allotted in microtubes, labeled as sample #1, #2, #3, #4, #5, & #6)	

Introduction:

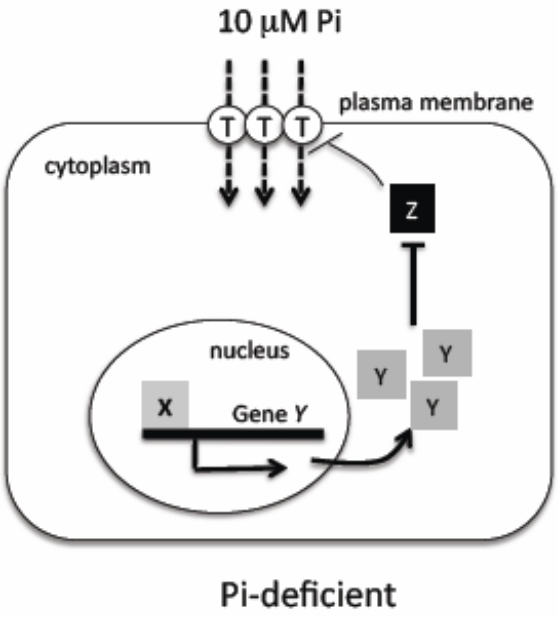
Phosphate is an important plant nutrient that constitutes substances such as cell membranes, nucleic acids, and energy compounds like ATP. When lacking phosphates, plants' growth and development can be dramatically affected. Plants can sense changes in phosphate concentration in the environment and regulate accordingly their gene expressions, and change the activity of phosphate transport proteins on the cell membranes to maintain the homeostasis of phosphate concentration within. Using the model plant *Arabidopsis*, scientists discovered that root cells respond to phosphate-sufficient (Pi-sufficient; e.g. 1mM) or phosphate-deficient (Pi-deficient; e.g. 10μM) condition as depicted below in Figure 1 and 2, respectively:

Figure 1



Pi-sufficient

Figure 2



Pi-deficient

When *Arabidopsis* is in Pi-sufficient condition (Fig. 1), the protein Z regulates the level of the protein T on plasma membrane, which is responsible for the transport of phosphates into the cell, to avoid excessive phosphate absorption that leads to toxicity. On the other hand, when plant is in Pi-deficient condition (Fig. 2), the transcription factor X will enhance the expression of gene *Y* and thus increase the level of protein Y. Protein Y can promote the degradation of protein Z, leading to

the increase of protein T level, and consequently a higher absorption of phosphate. In general, the phosphate level in the shoot of a plant is proportional to the uptake efficiency of phosphate in the root.

The phosphate level in plants will be considerably affected, when the expression of genes encoding T, X, Y, and Z is perturbed by mutation or transgene. Therefore, plant biologists can utilize such mutant or transgenic plants to determine the role and relationship of these genes in the regulatory mechanism of phosphate homeostasis.

There are 6 samples in microtubes, which are extracts from the shoots of five *Arabidopsis* lines (A~E) grown under either Pi-sufficient (1 mM) or Pi-deficient (10 μM) condition (as listed in Table 1). *Arabidopsis* A is wild type and B to E are either knockout (KO; null mutant with complete loss of function of the gene) mutant line or over-expression line corresponding to gene *T*, *X*, *Y*, or *Z*. You will be measuring the phosphate level in each sample and determine their identities based on the principle shown in Fig. 1 and 2. Each sample was extracted and brought to final volume of 10 mL with ddH_2O from 20 seedlings of fresh weight shown in Table 1.

Table 1

Sample No.	Plant	[Pi] in medium	Fresh weight of seedlings (mg)
1	A	1 mM	40.4
2	A	10 μM	17.3
3	B	1 mM	28.0
4	C	1 mM	39.2
5	D	1 mM	30.6
6	E	1 mM	33.8

Please use the provided equipments and solutions to perform the following experiment. Measure the phosphate concentration in each sample and answer the questions below:

Experiment Procedures:

1. Use the 400 μM KH_2PO_4 solution (Solution B), ddH_2O, 1.5 mL microtubes to prepare the following concentrations of phosphate solutions for standard curve: 0, 25, 50, 100, 200, 400 μM. For each concentration, there should be at least 0.5 mL of the diluted standard solution. Use the pipetman to transfer 0.1 mL of each standard solution into the 96 well plate at specified positions (as in Fig. 3). Make 2 replicates for each standard.
2. Transfer 0.1 mL of each seedling extract sample into the 96 well plate at specified positions (as in Fig. 3). Make 2 replicates for each sample.
3. Add 0.1mL of the phosphate detection solution (Solution A) into the wells that contain the standards or the samples. Mix well by pipetting up and down for a few times.
4. Raise your hand after you finish Step 3, and wait for assistants guiding and helping you with measuring the absorbance of the reaction mixtures with ELISA reader at 820 nm.
5. The assistant will print out the data sheet and hand it to you. Please use the graphing paper on the answer sheet to sketch out the standard curve with a ruler. Calculate the phosphate concentrations of samples # 1~6. Write your answers on the answer sheet.
6. Please answer the following questions:

Figure 3 Positions of samples in 96 well plate

			Standards			Samples						
A			0	0		1	1					
B			25	25		2	2					
C			50	50		3	3					
D			100	100		4	4					
E			200	200		5	5					
F			400	400		6	6					
G												
H												
	1	2	3	4	5	6	7	8	9	10	11	12

Q.2.1. (2.5 points for each phosphate concentration measured, 1 point for each nmol/mg of phosphate calculated; 21 points total)

Please fill in the phosphate concentrations of the extracts and the nmol phosphate per mg of seedling fresh weight for sample # 1~6 in the table of answer sheet:

Sample #	Plant	Fresh weight of seedlings (mg)	Average phosphate concentration of extract (μM)	nmol of phosphate per mg of seedling fresh weight (nmol/mg)
1	A	40.4		
2	A	17.3		
3	B	28.0		
4	C	39.2		
5	D	30.6		
6	E	33.8		

Q.2.2. (Multiple answers, 6 points. Points given when all correct answers are selected)

What are the plausible explanations for those plants having higher phosphate content (nmol/mg) than the wild type?

(A) X cannot be activated in this plant, thus leading to an increase in phosphate uptake.

(B) Loss of function of Gene *Y* in this plant causing an increase in phosphate uptake.

(C) Loss of function of Gene *Z* in this plant causing an increase in phosphate uptake.

(D) This plant harbors a transgene that over-expressed gene *Y*, causing the loss of inhibition of protein T, leading to higher activity in phosphate uptake.

(E) Protein T of this plant has a defect, unable to prevent the influx of phosphate, and thus causing an increase in phosphate uptake.

(F) The transcription factor X of this plant has a mutation, and is incapable to bind the promoter of gene *Y*.

Q.2.3. (3.5 points each, 14 points total)

According to the results from the experiment, please fill in the corresponding label (A, B, C, D, or E) of each plant in the right column:

	Plant
Knockout mutant plant of gene *X*	
Knock out mutant plant of gene *Z*	
Plant with defective protein T	
Transgenic plant with gene *Y* over-expression	

Q.2.4. (Single answer, 5 points)

If wild type plant (W), gene *X* knockout mutant (X), and gene *Y* knockout mutant (Y) were all grown in the same Pi-deficient condition, what would be the phosphate level in their shoots, ranking from the lowest to highest?

(A) X < W < Y

(B) Y < W < X

(C) W < X < Y

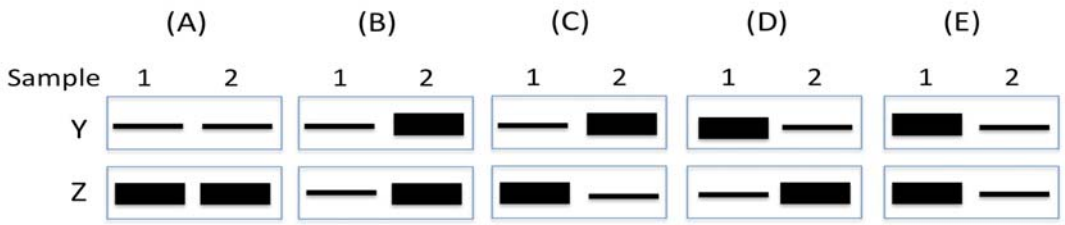
(D) W < Y < X

(E) X < Y < W

(F) Y < X < W

Q.2.5. (Single answer, 4 points)

Which of the followings would most likely be the result of the Western blot analysis of protein Y and Z from the total protein extract of samples # 1 and 2?



(2) After subgroup meeting – test questions

PRACTICAL TEST 1 : BIOCHEMISTRY AND CELL BIOLOGY

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 3 tasks:

  Task I: Protein electrophoresis (35 points)

  Task II: Protein quantification (35 points)

  Task III: Protein purification (30 points)

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Make sure that you have received all the materials listed for each task. If any of the listed items is missing, **raise your sign.**
- Use pen only.
- You should perform the **Tasks I, II, and III** sequentially.
- Stop answering **immediately** after the end bell rings.
- After test, enclose both the **Answer sheets, Question paper, and Data printout** in the provided envelope. Our lab assistants will collect it promptly.
- No paper or materials should be taken out of the laboratory.

Good Luck!!

Shared instruments:

Camera, spectrophotometer, printer

Equipments and Materials:

	Equipments:	**Quantity**
1	Power supply	1
2	Electrophoresis tank (with gel and buffer)	1
3	Micropipettes P20 and P200	1 each
4	80-well microcentrifuge tube rack	1
5	Wire test tube rack with 15-mL centrifuge tubes (×6) (yellow cap)	1
6	4-way test tube rack	1
7	Plastic droppers in 15-mL centrifuge tubes	2
8	Micropipette tips (for P20 and P200)	1 each
9	Timer	1
10	96-well microplate	1
11	Marker pen & paper label	1 each
12	600-mL beaker for waste disposal	1
13	Scissors	1
14	Double-sticker to attach the results	1
15	Student Code sticker	1
16	Tissue paper	1
17	Mini centrifuge (if you need to spin down the samples in the microcentrifuge tubes)	1

	Materials:	**Quantity**
1	Loading dye (microcentrifuge tube-L) (pink tube with orange label)	1
2	Pre-stained protein molecular weight marker (microcentrifuge tube-M) (pink	1

	tube with orange label)	
3	Unknown pre-stained protein samples (microcentrifuge tubes-U1 and U2) (pink tube with orange label)	1
4	CBG reagent in 50-mL centrifuge tube	1
5	Bovine serum albumin (BSA) concentration standard (0.5 mg/mL) in microcentrifuge tube (green tube with yellow label)	1
6	Enzyme E in two microcentrifuge tubes: concentrations X and Y (green tube with yellow label)	1
7	Distilled water (microcentrifuge tube-ddH_2O) (green tube with yellow label)	1
8	Protein sample (microcentrifuge tube-C) (blue tube with blue label)	1
9	Anion exchange chromatography column on 15-mL centrifuge tube	1
10	Anionic buffers A and B (5 mL each in two separated 15-mL centrifuge tubes) (green cap)	1
11	Coomassie brilliant blue G-250 (CBG) reagent 1 mL in each of six 15-mL centrifuge tubes (A1 to A3 & B1 to B3, red cap)	1

Task I (35 points)

Protein electrophoresis

Introduction:

Polyacrylamide gel electrophoresis (PAGE) is a common technique for protein study. It can be used to separate different proteins based on their charges or sizes. A type of PAGE is termed SDS-PAGE, in which the negatively charged chemical, SDS, is added before protein electrophoresis. The amount of SDS that binds to proteins is proportional to the size of the protein which confers each protein a similar charge-to-mass ratio and renders the intrinsic charge of the protein insignificant, at least for this experiment. Thus, the major factor that affects the migration of protein is the molecular weight (MW) of the protein during SDS-PAGE. The relative mobility (R_f) of the

protein can be calculated as the ratio of the distance migrated by the protein to that migrated by the dye-front. The value of R_f is negatively proportional to the log of its molecular weight.

In the problem set, you will perform the following experiment:

1. An electrophoresis tank has been set up for SDS-PAGE, in which a polyacrylamide gel has been secured on electrode assembly and electrophoresis buffer has been filled. There are 10 wells for sample loading on the top of the gel. To load the sample, use the P20 micropipette with tip to withdraw protein sample, and carefully place the tip on the top of the well. By injecting slowly the sample will sink to the bottom of the well by gravity (**Figure 1**).
2. If you need to practice, use the P20 micropipette with tip to withdraw 10 μL of loading dye from microcentrifuge tube L (pink tube with orange label) on rack. Load the dye into wells 1 to 3 or 7 to 10.
3. Each of the microcentrifuge tubes M, U1 and U2 (pink tube with orange label) contains 15 μL of protein molecular weight marker, unknown protein U1 and unknown protein U2, respectively. Use micropipette P20 to withdraw 10 μL solution from each tube and load the samples into wells 4 to 6 as shown in **Figure 1**.
4. As soon as you finish sample loading, **Lift the sign**, lab assistants will connect the power cord to power supply and set the voltage to 200 V for you. The gel will run for 25 minutes. The timer will be set up by an assistant to countdown.
5. After finishing electrophoresis, **Lift the sign**, lab assistants will disassemble the electrophoresis set-up and give back your gel. Wipe clean the surface of gel with tissue papers and **label the gel with your Student Code** sticker. Lab assistants will take the photo of your gel. Put the photo on the answer sheet using double-sticker (5 points).

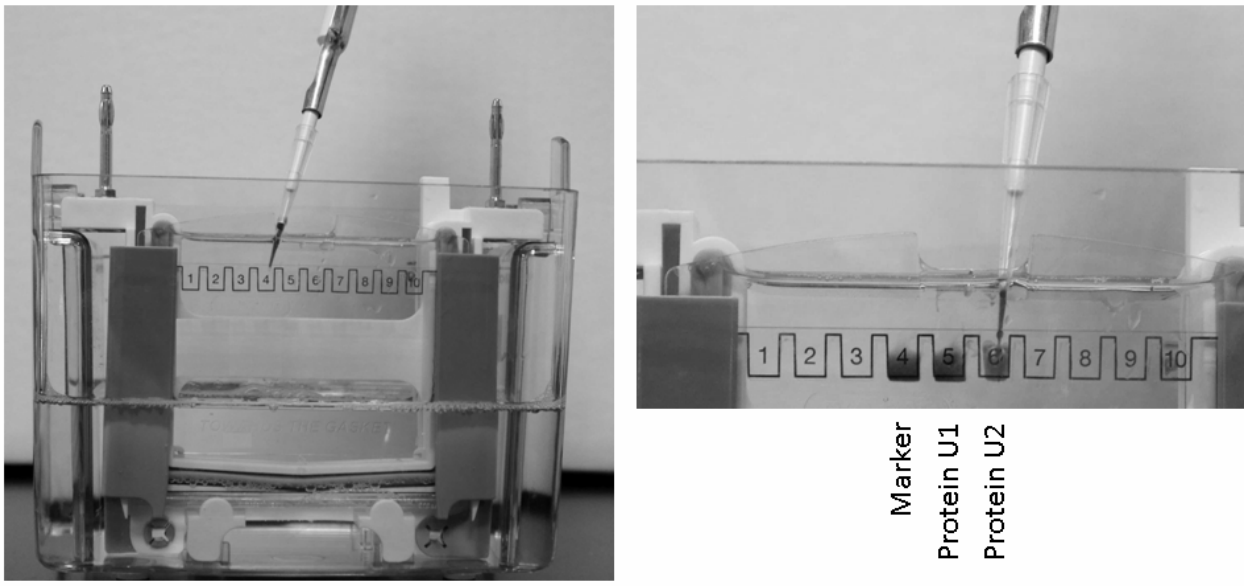


Figure 1

Answer the following questions:

Q.1.1. (2 points) **Figure 2** shows a photograph of a SDS-PAGE gel. The electrophoresis start point and dye-front are indicated. Which side of the gel should be connected to the anode (+ charge) of the power supply? Mark your answer (X) on the answer sheet.

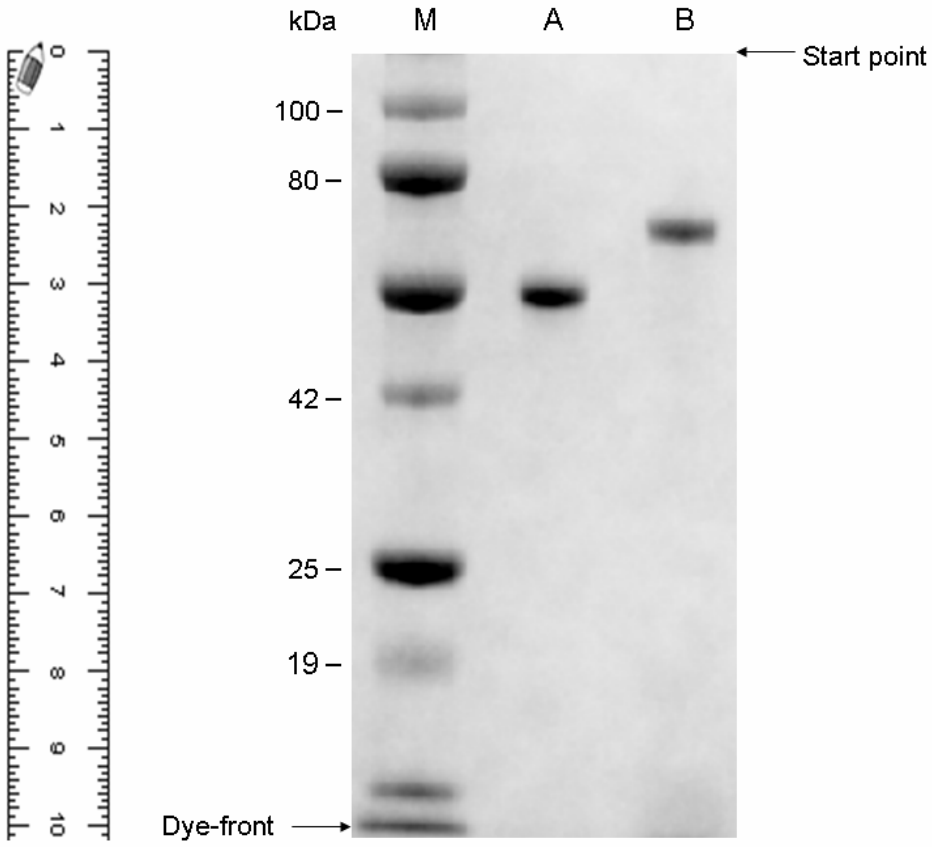


Figure 2

Q.1.2. (8 points) Based on the information provided in **Figure 2**, make a plot of log molecular weight values of the five marker proteins versus their relative migration-R_f values on the answer sheet (4 points). Use the graph to estimate the molecular weights of unknown proteins on lanes A and B (4 points). Write down your answers on the answer sheet.

Q.1.3. (5 points) A protein complex of molecular weight 246 kDa is composed of multiple subunits bound by non-covalent interaction. Two protein bands of 57 and 33 kDa were identified after SDS-PAGE. How many 57-kDa and 33-kDa subunits, respectively, are included in the protein complex? Write down your answers on the answer sheet.

Q.1.4. (5 points) The average molecular weight of amino acids is about 110 daltons. How many amino acids are there in the 33-kDa protein subunit? How many nucleotides of RNA are translated into the protein? Write down your answers on the answer sheet.

Q.1.5. (5 points) Suppose the average molecular weight of nucleotides is 330 daltons. Excluding intron and stop codon, what is the mass ratio of dsDNA encoding the 33-kDa protein to the 33-kDa protein? Write down your answer on the answer sheet.

Q.1.6. (5 points) Suppose a protein P can bind to a protein Q (MW = 1000 daltons). The binding can be revealed by gel-mobility shift assay. Now 200 pmol of protein P were mixed with various amounts (0 to 500 ng) of protein Q. These mixtures were resolved by 10% (w/v) polyacrylamide gel. Gel was stained by Coomassie blue and is shown in **Figure 3**. Calculate the binding molar ratio of proteins P and Q? Write down your answer on the answer sheet.

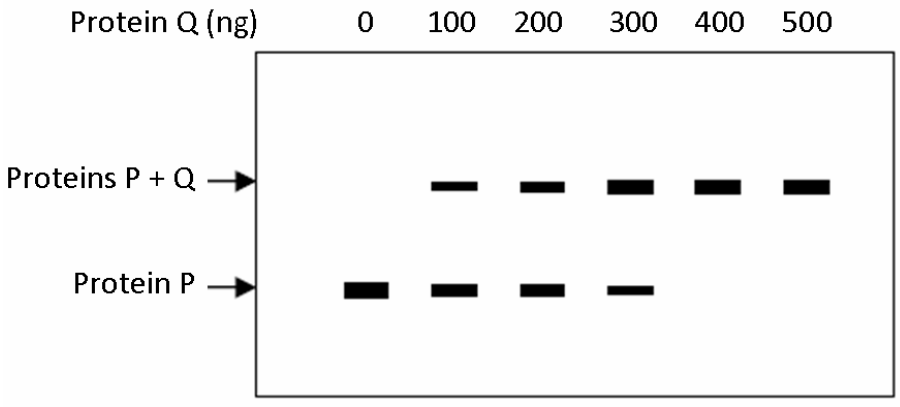


Figure 3

Task II (35 Points)

Protein quantification

Introduction:

Coomassie Brilliant Blue G-250 (CBG) is a protein staining reagent. It appears in a different color under different pH conditions. It looks reddish brown in acidic solution, whereas it turns blue under neutral or alkaline condition. Since proteins can provide a relative neutral environment, CBG will turn blue with the maximum absorbance at a wavelength of 595 nm when binding to protein. The more protein there is in a sample, the more CBG will bind to it, and thus, the higher intensity of blue color will be. In other words, the absorbance at 595 nm is proportional to the amount of protein in a sample. Based on this, one can determine the concentration of protein by measuring the blue intensity of a sample.

In the problem set, you will perform the following experiment:

1. To make BSA concentration standards (**Table 1**), add 0, 2, 4, 6, 8 and 10 μL of 0.5 mg/mL BSA (green color) in A1 to A6 wells of a microplate (**Figure 4**). Make duplicated BSA concentration standards in B1 to B6 wells. If this step is incorrect, you can repeat the procedure in wells A7 to A12 and/or B7 to B12. Adjust the total volume of each BSA solution to 10 μL by adding an appropriate volume of H_2O (**Table 1**).

2. Add 200 μL of CBG reagent per well in A1 to A6 & B1 to B6. Mix and observe the color change.

3. To determine the two concentrations X and Y of enzyme E, add various amounts (2, 4, 6, 8 and 10 μL) of enzyme E (green color) in duplicate to empty wells and bring up the volume to 10 μL with H_2O.

4. Add 200 μL of CBG reagent per well to the diluted enzyme E. Mix and observe the color change.

5. **Lift the sign**, lab assistants will accompany you to measure the absorbance values of your samples at 595 nm using spectrophotometer. Put your Student Code on the print-out data with marker pen.

6. Return to your work bench, and put the result on the answer sheet using double-sticker.

Table 1

Materials	Well of a microplate					
	A1 & B1	**A2 & B2**	**A3 & B3**	**A4 & B4**	**A5 & B5**	**A6 & B6**
0.5 mg/mL BSA (μL)	0	2	4	6	8	10
H_2O (μL)	10	8	6	4	2	0
Diluted BSA concentration (mg/mL)	0					

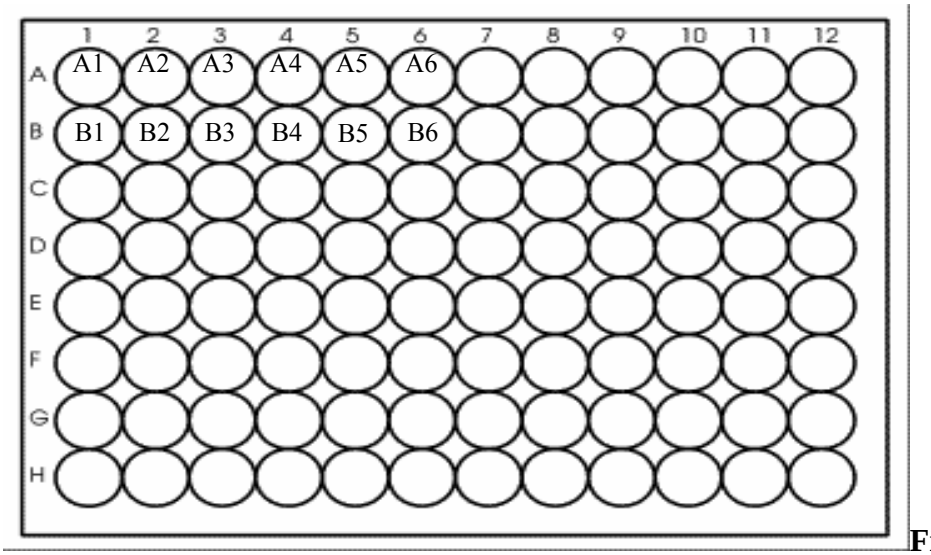


Figure 4

Answer the following questions:

Q.2.1. (10 points) Calculate the concentrations of BSA in each sample (10 μL) and fill in the blanks in the table on the answer sheet (Q1.1. 5points). Use these values to plot a standard curve of BSA concentrations (X-axis) versus mean absorbance values of duplicated standards (Y-axis) on the answer sheet (Q.2.1.2. 5points).

Q.2.2. (12 points) Choose the best sample solution within the range of BSA standard curve and fill in the table on the answer sheet.

Q.2.3. (8 points) Based on the best sample solution you chose, calculate the original concentrations (X and Y) of enzyme E from the standard curve of BSA concentration. The concentrations should be expressed in units of mg/mL. Write down your answers on the answer sheet.

Q.2.4. (5 points) Assume that the concentration of total proteins in the original solution is 1 mg/mL and the activity of enzyme A is 0.5 units in 1-mL protein sample. The concentration of total proteins after purification is 0.1 mg/mL and the activity of enzyme A is 1 unit in 1-mL protein sample. Calculate the purification factor (times of purity improvement) of enzyme A. Write down your answer on the answer sheet.

Task III (30 points)

Protein purification

Introduction:

Column chromatography is commonly used for purification of proteins. The column is made by packing solid porous material (stationary phase) in a column filled with buffer solution (mobile phase). The protein solution to be separated is loaded on top of the column and allowed to percolate into the solid matrix (stationary phase). A reservoir at the top supplies elution buffer constantly which flows through the matrix and passes out of the column at the bottom (the eluent). Since proteins interact with solid matrix in different degree, individual proteins migrate faster or more slowly through the column depending on their properties. Therefore, one can obtain purified proteins by collecting eluent at different times (**Figure 5**).

Ion-exchange chromatography can be used to separate proteins with different electric charge at a given pH. In anion exchange chromatography, negatively charged proteins bind to positively charged stationary phase. Using solution containing anions to compete with proteins for the adsorption of solid matrix, the bound proteins will be eluted. In practical, proteins are eluted first with buffer containing lower concentration of anion, then with buffer containing higher concentration of anion. Since different charged proteins interact with the stationary phase in different strength, they can be separately eluted by different concentrations of anionic buffers.

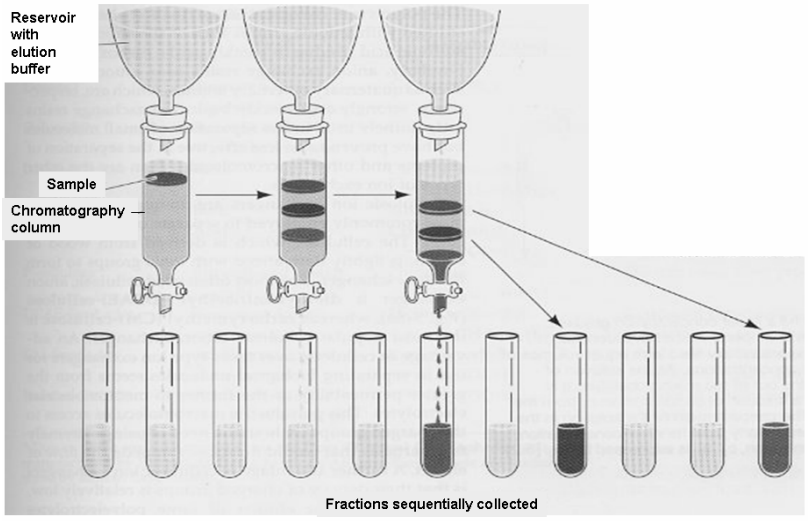


Figure 5

In the problem set, you will perform the following experiment (5 points):

1. Label six 15-mL centrifuge tubes (yellow cap) a1 to a3 and b1 to b3 accordingly, with a marker pen.
2. Take the anion chromatography column (**Figure 6A**), un-plug the tube and allow the solution to be drained by gravity in the same centrifuge tube. Plug the tube intermediately when the liquid surface reaches the top of the disc (**Figure 6A**, white arrow). Do not over-dry the gel as it may affect protein purification.
3. Withdraw 200 μL of protein solution from microcentrifuge tube C (blue tube with blue label) using a P200 micropipette, apply the sample to the chromatography column slowly by touching the filled pipette tip lightly against the inside wall of the tube (**Figure 6B**).
4. Un-plug the column and allow the protein sample to drain out, then transfer the column to centrifuge tube a1 (yellow cap). Withdraw 3 mL of anion buffer A (blue cap) with a plastic dropper and apply the solution to gel by touching pipette tip against the wall of the tube (**Figure 6C**).
5. Collect ~1 mL eluent in centrifuge tubes a1 to a3 (yellow cap) sequentially. It takes about 2 to 3 minutes for each tube.
6. Allow the contents of the column to drain entirely out then transfer the column to centrifuge tube b1 (yellow cap). Withdraw 3 mL of anion buffer B (blue cap) with a plastic dropper and apply the solution to gel by touching pipette tip against the wall of the tube (**Figure 6C**).
7. Collect ~1 mL eluent in centrifuge tubes b1 to b3 (yellow cap) sequentially. It takes about 2 to 3 minutes for each tube.
8. Withdraw 50 μL of eluent from tubes a1 to a3 & b1 to b3 (yellow cap) and transfer to centrifuge tubes A1 to A3 & B1 to B3 (red cap), respectively. Mix and observe color change. CBG (see introduction in Task II) reagent in tubes A1 to A3 & B1 to B3 will turn blue when it reacts with the eluted protein.
9. After finishing all the experiments, **Lift the sign**, lab assistants will take photo of your experiment

results.

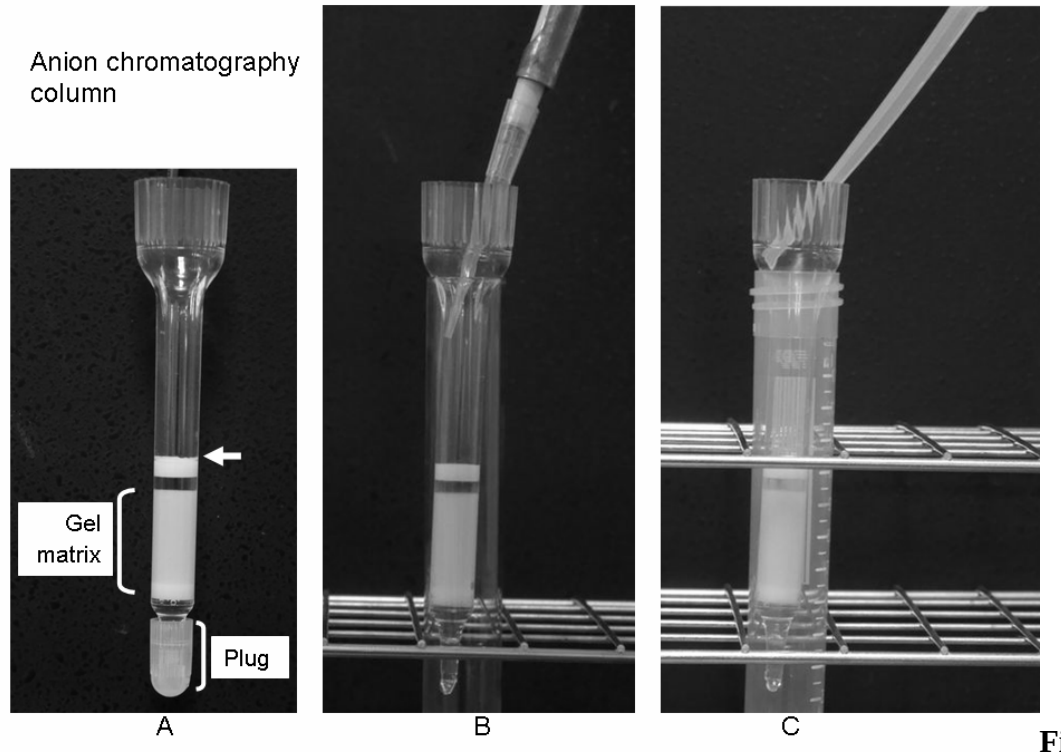


Figure 6

Q.3.1. (7 points) Mark the deepest color change (X) on the answer sheet (Q.3.1.1. 5 points). Which of the following buffers (buffer A or buffer B) can be used to elute the protein? Mark your answer (X) on the answer sheet (Q.3.1.2. 2 points).

Q.3.2. (5 points) Enzyme A is a protein whose surface is evenly distributed with electric charges. If enzyme A can be eluted from anionic exchange chromatography by high concentration of anionic buffer, what is the property of enzyme A with respect to electric charge? Mark (X) the answer on the answer sheet.

(A) High negative net charges

(B) Low negative net charges

(C) Zero net charge

(D) Low positive net charges

(E) High positive net charges

Q.3.3. (4 points) Different amino acids differ in the chemical nature of the R group (side chain). **Figure 7** shows four amino acids A, B, C, and D in their prevailing ionic forms at pH 7.2, with the side chain marked in white box. Which of the following amino acids in **Figure 7** would be present more frequently on enzyme A? Write down your answer (X) on the answer sheet.

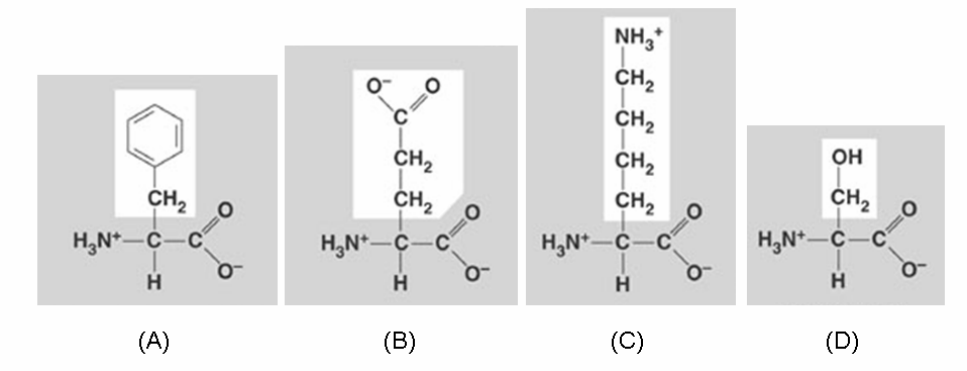


Figure 7

Q.3.4. (5 points) Hydrophobic interaction chromatography can be used to separate proteins based on their hydrophobicity. To perform the chromatography, protein samples were first treated with buffer containing high concentration of salts such as ammonium sulfate $(NH_4)_2SO_4$, which will remove water molecules from the protein surface. This causes the hydrophobic area on the surface of the protein to be exposed. When the salt-treated proteins are subjected for chromatography, they will be absorbed on the stationary phase through hydrophobic interactions. The higher the hydrophobicity of the protein, the stronger the absorption. As salt concentration can affect the hydrophobic interaction between the protein and the stationary phase, different proteins can be separately eluted by using different concentrations of salt-containing buffers. If enzyme A is highly hydrophobic, which of the following buffers should be used to separate enzyme A from other proteins by chromatography? Mark (X) the answer on the answer sheet.

(A) Low-salt buffer

(B) High-salt buffer

(C) Buffer without salt

(D) Low-salt buffer first then high-salt buffer

(E) High-salt buffer first then low-salt buffer

Q.3.5. (4 points) If enzyme A is highly hydrophobic, which of the amino acids in **Figure 7** would be present more frequently on enzyme A? Mark (X) the answer on the answer sheet.

Q.3.6. (5 points) Gel filtration chromatography separates proteins based on their sizes. The gel, or stationary phase, consists of cross-linked polymer beads with engineered pores of a particular size. Small proteins enter the pores and are retarded by their more labyrinthine path. Large proteins cannot enter the pores and so take a short path through the column, around the beads. **Table 2** is a list of gels and their fractionation ranges. Suppose both enzyme A (22 kDa) and protein B (44 kDa) are single-subunit proteins. One would like to purify enzyme A from a mixture containing enzyme A and protein B using gel filtration chromatography. Which gel is best suited for the job? Mark your answer (X) on the answer sheet.

Table 2

Types of stationary phase	Fractionation range (MW, Da)
G-10	<700
G-15	<1500
G-25	1,000-6,000
G-50	1,500-30,000
G-75	3,000-70,000
G-100	4,000-150,000
G-150	5,000-400,000
G-200	5,000-800,000

PRACTICAL TEST 2 : ANIMAL PHYSIOLOGY AND ANATOMY

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: The observation of the sciatic nerve of American bullfrog (58 points)

  Task II: The observation of tissue morphology and the match of their functionality (42 points)

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Make sure that you have received all the materials listed for each task. If any of the listed items is missing, **raise your sign.**
- **You must complete task I first.**
- Stop answering and put down your pen **immediately** after the end bell rings.
- After test, enclose both the **Answer sheets and Question paper** test sheets in the provided envelope. Our Lab assistants will collect it promptly.
- No paper or materials should be taken out from the laboratory.

Good Luck!!

Equipment and Materials:

For task I: The observation of the sciatic nerve of American bullfrog.

Instruments/materials	Quantity	unit
Bullfrog specimen	1	piece
Dissecting tray	1	piece
Round plastic petri dish	1	piece
Ringer's solution (in wash bottle)	500	mL
Pin	10	pieces
Cotton line	2	pieces
Electric stimulating device	1	set
Dissecting equipment : scissors (large)	1	pair
scissors (small)	1	pair
fine forceps	2	pairs

For task II: The observation of tissue morphology and the match of their functionality

Instruments/materials	Quantity	unit
Microscope	1	set
Slice specimen (marked A to J)	10	slides
Color pictures (numbered 1 to 9) on 3 sheets of A4 paper	1	set

Task I (58 points)

The observation of the sciatic nerve of American bullfrog.

Introduction:

The sciatic nerve is a branch of the sacral plexus. It is the thickest and longest nerve tract in the body, extending from the vertebral column to the foot. The sciatic nerve includes the distributed sensory and motor nerves that control most sensory and motor activities of the lower extremities. Mediated by the sciatic nerve, sensory signals from the lower limbs are transmitted to the brain. Similarly, muscle contraction of the lower extremities can be stimulated by nerve impulses from the brain. The aim of this experiment is to observe and isolate the sciatic nerve from the bullfrog.

Experiment Procedure:

Step 1 to 4: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissue anytime. Do not allow the tissues to dry out.)

1. Carefully check if all the experiment instruments/materials are fully provided. Raise your sign if you have any problem.
2. Put the bullfrog specimen on the provided dissecting tray.
3. First, carefully observe the 10 pairs of spinal nerves extending from the vertebra of the bullfrog. Next, locate the sciatic nerve that is assembled by pairs of spinal nerves VII, VIII and IX (as shown in Fig. 1).
4. Turn on the switch (on/off) on the electric stimulating device. The red light will be lighted up immediately, indicating that the device is functioning.
5. Simultaneously stimulate the sciatic nerve with the two electric wires that are separately connected to the (+) and (-) electrodes of the electric stimulating device. Fig. 3 indicates the

position of sciatic nerve emerging form the spinal cord. Observe the contracting response of the hind limb.

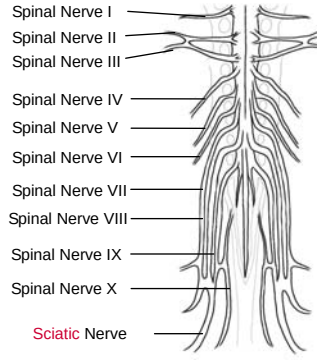


Fig. 1. Spinal nerve

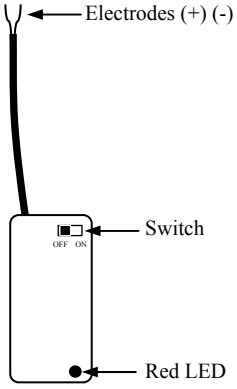


Fig. 2. Electric stimulating device

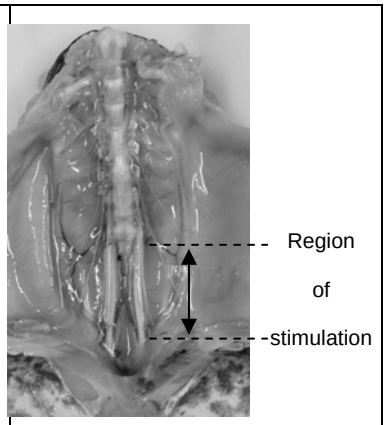


Fig. 3. Sciatic nerve

Q.1.1. (9 points) When you have finished the above five steps, raise the sign to notify the Lab assistant to videotape the contraction.

Step 6 to 10: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissues any time)

6. Use a pair of scissors to circularly cut open the skin at the upper part of **one** thigh of the bullfrog. Starting from the cutting point, completely peel off the skin by hand to remove it from the hind limb (Fig. 4).

7. Lay the bullfrog on the dissecting tray with its back facing up.

8. Push two pins separately into both ends of gastrocnemius and separate it from tibia (shinbone) (Fig. 5).

9. The sciatic nerve is located in the trough surrounded by thigh muscles. Carefully separate the muscles on both sides of the trough and let the light yellow colored sciatic nerve be exposed. Pass through a cotton line underneath the sciatic nerve to label it.

10. Stimulate the cotton line-labeled sciatic nerve with the provided electric stimulating device and

observe the contracting response of gastrocnemius.

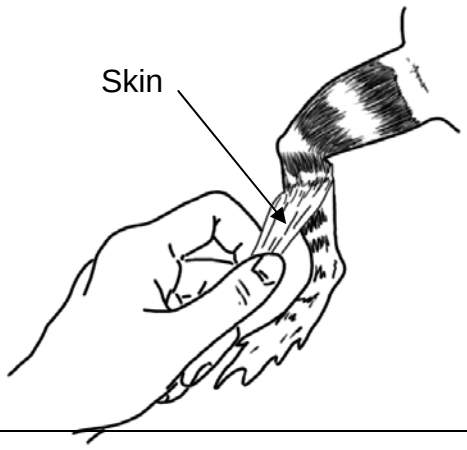


Fig. 4. Demonstration of skin peeling

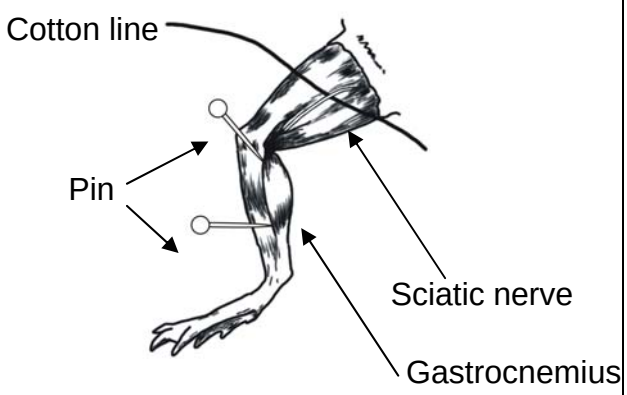


Fig. 5 Sciatic nerve and gastrocnemius

Q.1.2. (9 points) When you have finished the steps 6 to 10, raise the sign to notify the Lab assistant to videotape the contraction.

Step 11 to 12: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissues any time)

11. Completely separate and isolate the connected tissue of 「sciatic nerve - gastrocnemius」from the bullfrog specimen and place it in a petri dish, as shown in Fig. 6.
12. Stimulate the sciatic nerve with the electric stimulating device and observe the contracting response of the gastrocnemius.

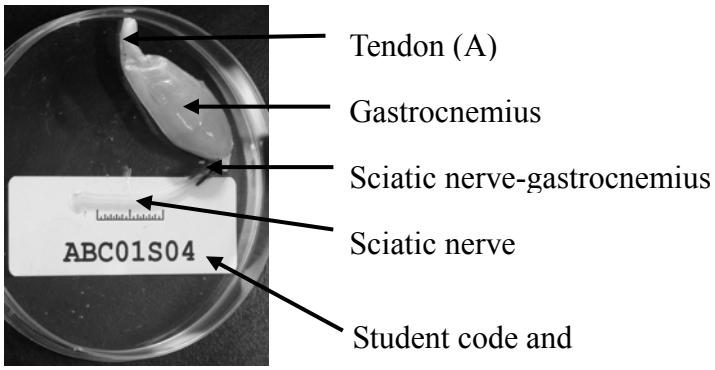


Fig. 6 Isolation of 「sciatic nerve-gastrocnemius」tissue

Q.1.3. (40 points) When you have finished steps 11-12, write down the results of your observation on the answer sheets. Then, raise the sign to notify the Lab assistant for checking the results and videotape the contraction.

Task II (42 points)

Identify tissues based on their morphology and match their functionality

Introduction:

The vertebrate physiological system is established by the functional coordination of 11 organ systems, which include the skin, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems.

Identify the specimens on the slides (30 points)

Slides A to J are tissue sections from vertebrates. Identify the tissues, based on their characteristic features, using microscope.

1. Vein	2. Artery	3. Ganglion	4. Neuron	5. Erythrocyte（frog）
6. Erythrocyte（human）	7. Ovary	8. Testis	9. Lung	10. Skeletal muscle
11. Smooth muscle	12. Cardiac muscle	13. Kidney	14. Cartilage	15. Bone
16. Pancreas	17. Intestine	18. Gastric tissue	19. Skin	20. Rectum

Q.2.1. (30 points) Match each slide specimen (A to J) with its correct name from 20 different tissue/organ names listed in above table. (Note: only one correct answer for each specimen). Fill in the correct number in the answer sheets.

Identify the sliced tissue and match their correct functions (12 points)

Fig. 1-9 are the enlarged pictures of parts of different mammalian tissues. Based on their structural features, determine the precise sources of them and answer the questions below.

The functions of 11 organs are listed in the following table. Each specific function is assigned an alphabetic letter (A to L)。

symbol	Functional description
A	Producing vitamin D_3
B	Producing erythropoietin
C	Producing urea
D	Producing Surfactant to reduce the surface tension
E	Regulating the homeostasis of the pH of body fluid
F	Helping the vein compression and promoting blood stream back to the heart
G	Digesting proteins
H	Secreting secretin
I	Producing inhibin
J	Major organ for the storage of calcium and phosphate
K	Producing progesterone

Q.2.2. (12 points) Correctly write down the functional symbols, i.e. the alphabetic letters (A to K), on the answer sheets. Match the organ with their functionalities. Note: some organs may have more than one function (1 point will be deducted for each incorrect answer and minimum score will not be less than zero).

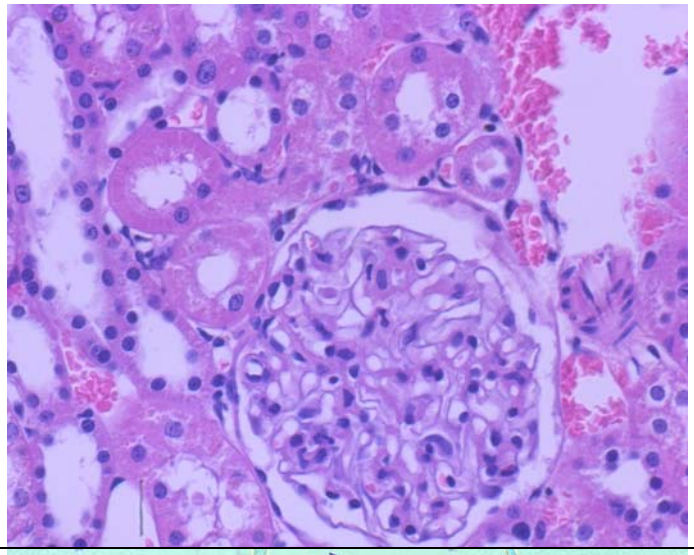
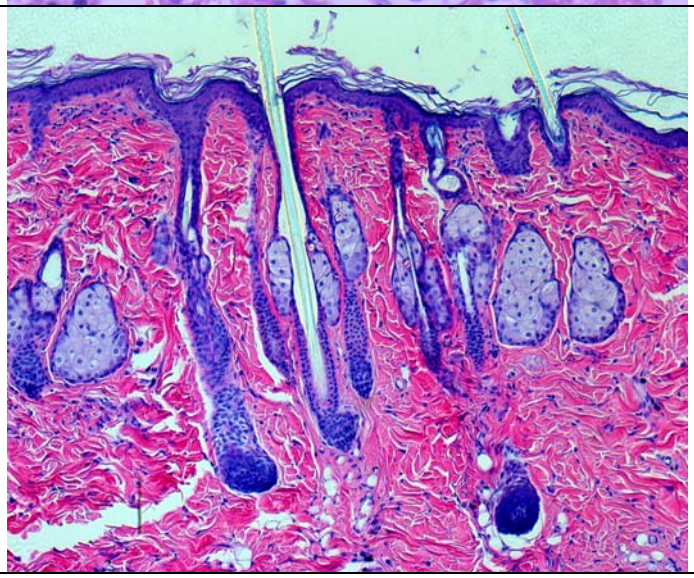
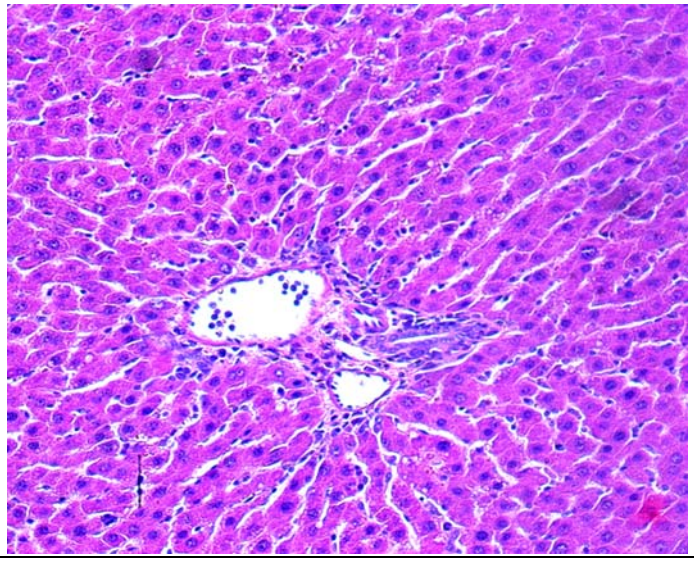
Fig 1.	 H&E stain (400 X)
Fig 2.	 H&E stain (100 X)
Fig 3.	 H&E stain (200 X)

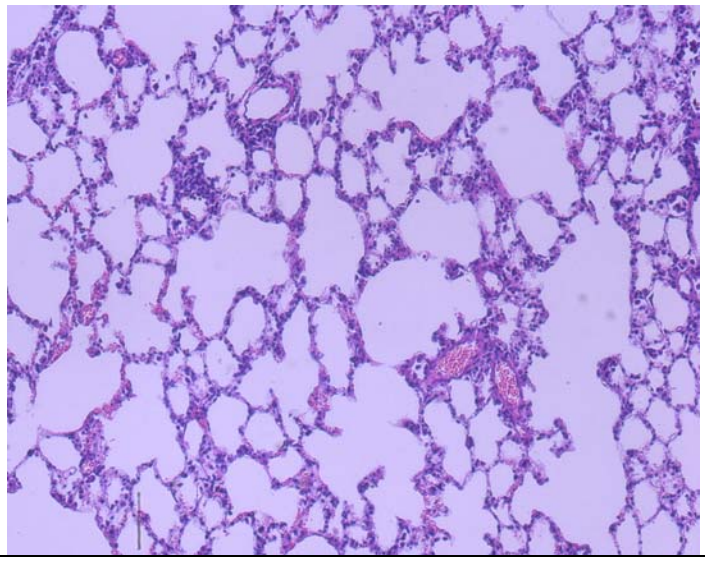
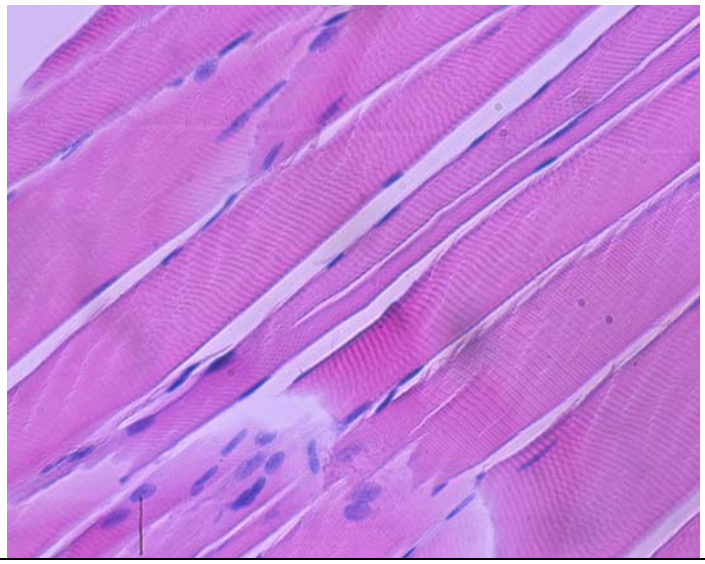
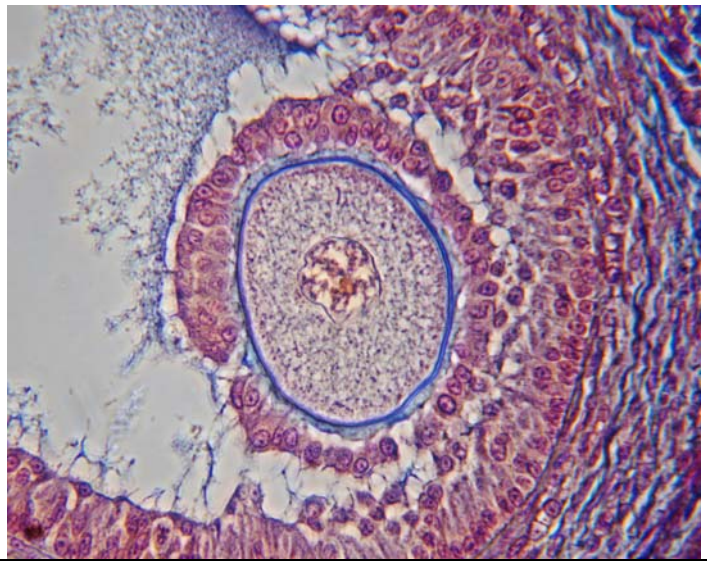
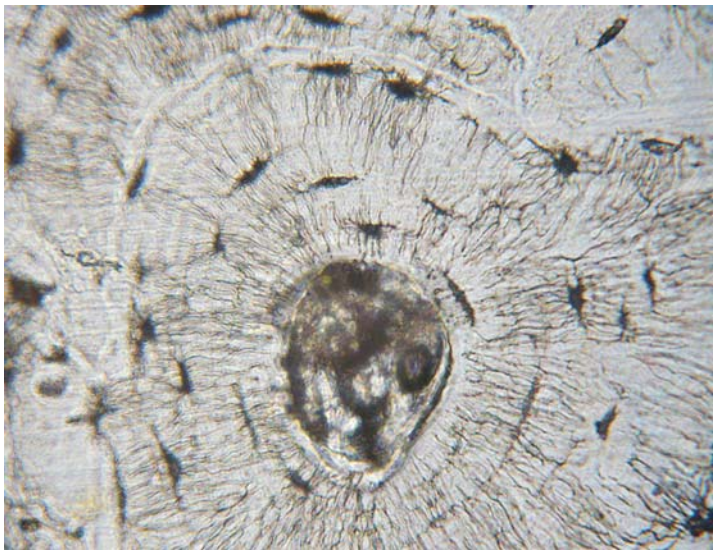
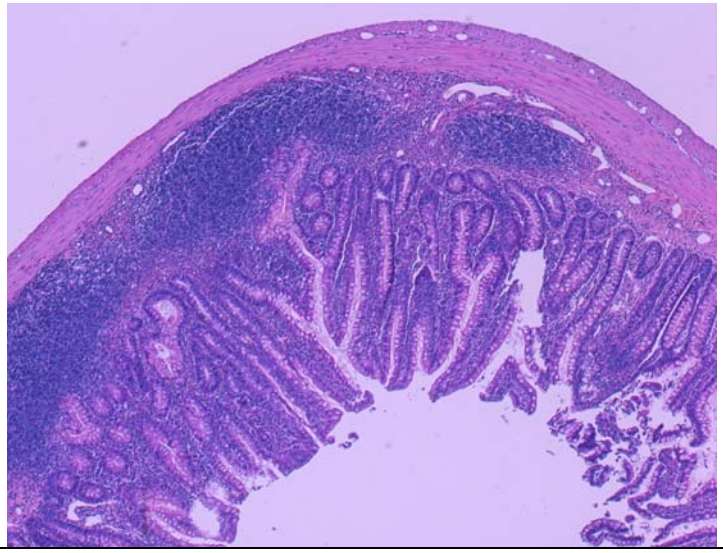
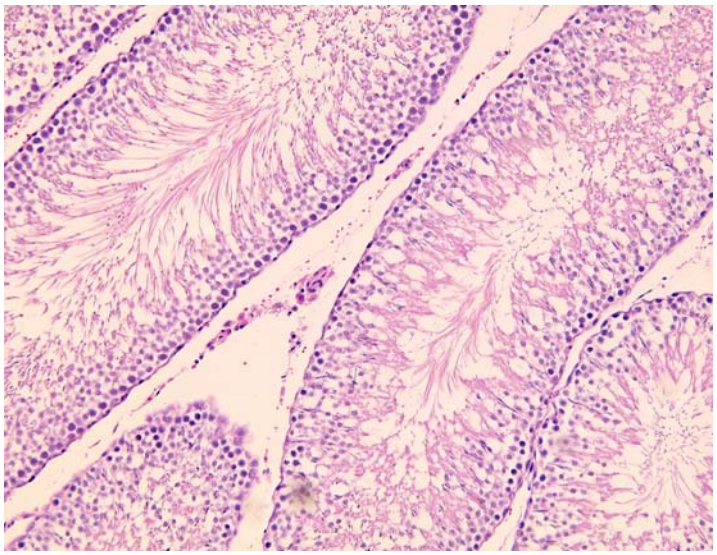
Fig 4.	 H&E stain (200 X)
Fig 5.	 H&E stain (200 X)
Fig 6.	 H&E stain (40 X)

Fig 7.	 (200 x)
Fig 8.	 H&E stain (100 X)
Fig 9.	 H&E stain (200 X)

PRACTICAL TEST 3 : ECOLOGY AND SYSTEMATICS

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: Reconstruct the phylogenetic tree for the given spiders (60 points)

  Task II: Test of species association in a community (40 points)

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please **raise your sign.**
- Use **pen only.** You can use a ruler and a calculator provided.
- **Check the condition of the spiders in 5 minutes.** If any of the legs is missing, please raise your **sign. No replacement of the spiders is possible after 5 minutes.**
- Stop answering and put down your pen **immediately** after the end bell rings.
- After test, our lab assistants will check the condition of the spiders and fill out the spider checklist at the end of your answer sheet. **Each undamaged spider in the original vial will get you one bonus point.** Please sign after the check is done.
- Enclose both the **Answer Sheets** and **Question Paper** in the provided envelope after the spider check is finished. Our invigilator will collect it promptly.

Good Luck!!

Equipments and Materials:

Equipments:

1	Dissecting microscope	1
2	Four sheets of colored pictures and one sheet of black and white picture:	
	Figures (figure 1−3 to 1−12)	4
	Figure (figure 2-1)	1
3	Forceps	2
4	Petri dish	2
5	70% ethanol	1
6	Plastic dropper	1
7	1-m quadrat cardboard	1

Materials:

1	Four spider samples in glass vials (W, X, Y, Z)	1

TASK I: (60 points)

Reconstruct the phylogenetic tree for the given spiders

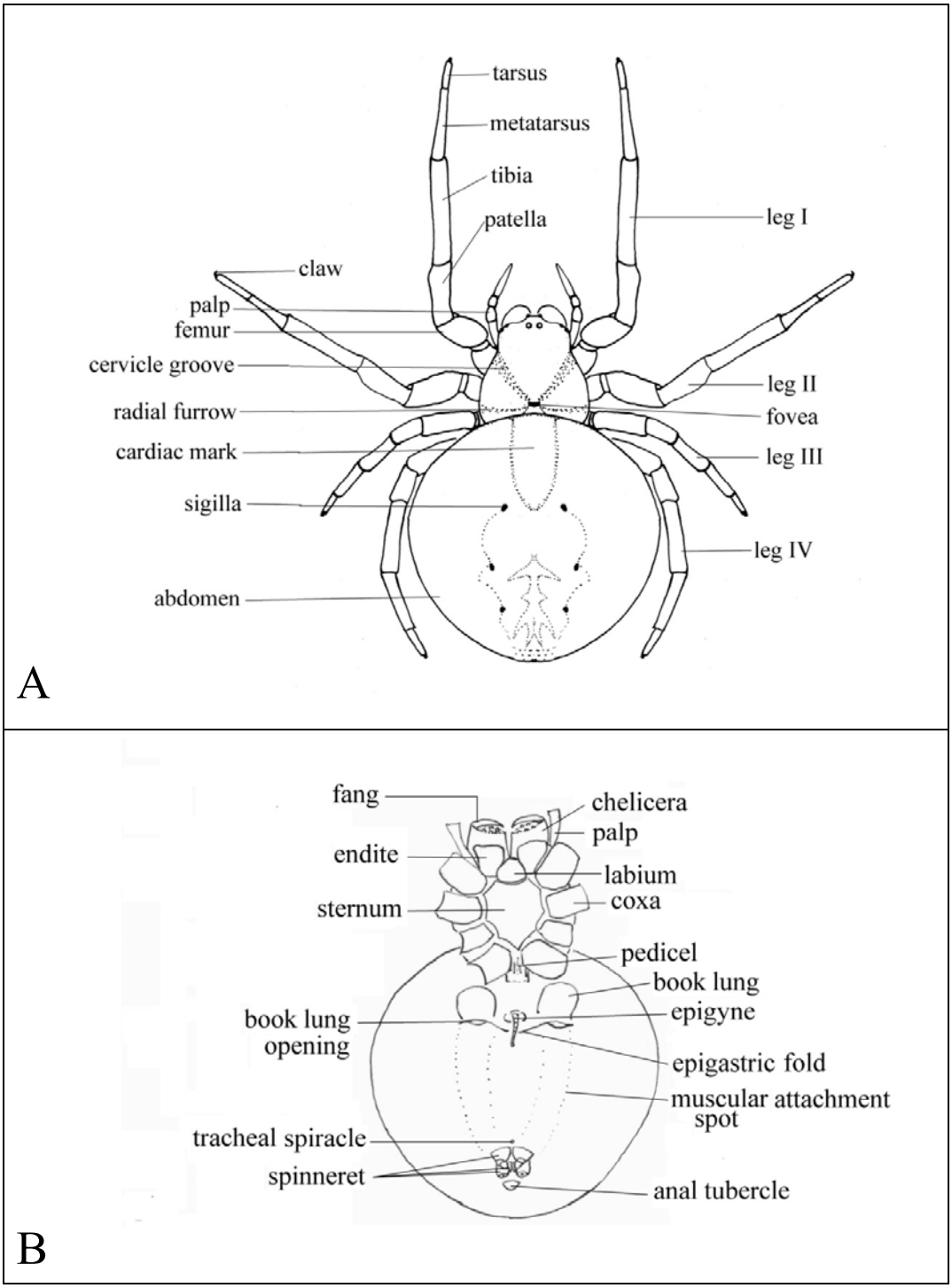


Figure 1-1 External morphology of spider. A. Dorsal view. B. Ventral view.

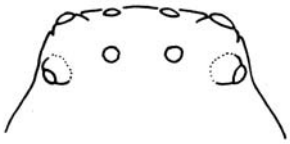
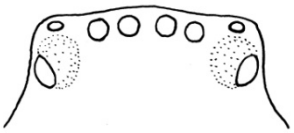
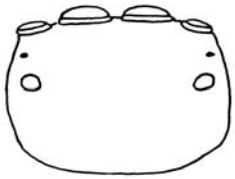
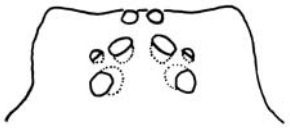
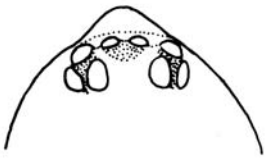
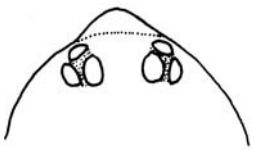
A: two transverse eye rows, with 4 eyes on each eye row 	B: two rows, with 6 eyes on the first eye row 	C: four rows, with 2 first row eyes smallest and 6 posterior eyes arranged in a hexagonal configuration 
D: three rows, with the 4 first row eyes much smaller than the others 	E: three rows, with the 2 anterior median eyes much larger than the others 	F: three rows, with 4 eyes on the second eye row 
G: eight eyes with one diad (a cluster of 2 eyes) and two triads (a cluster of 3 eyes) 	H: six eyes in two triads 	I: six eyes in three diads 

Figure 1-2 Eye arrangements

Legends and Abbreviations of figures 1-3 to 1-12

Figure 1-3 Book lungs. A. Two pairs. B. One pair.

Figure 1-4 Spinnerets. A. Three pairs. B. Two pairs.

Figure 1-5 Cribellum. A. Absent. B. Present.

Figure 1-6 Calamistrum on metatarsus IV. A. Absent. B. Present.

Figure 1-7 Tarsi claw. A. Three pairs. B. Two pairs.

Figure 1-8 Claw tufts. A. Absent. B. Present.

Figure 1-9 Base of anterior spinnerets (AS). A. Widely separated. B. Close or in contact.

Figure 1-10 Grades of legs. A. Prograde. B. Laterigrade.

Figure 1-11 Tibia and metatarsus of legs I and II with series of long spines interspersed with much shorter setae. A. Absent. B. Present.

Figure 1-12 Double-rowed trichobothria on femora IV. A. Absent. B. Present.

1-1 Key to species of some common spiders

There are many living creatures in the world. For unfamiliar creatures, scientists usually choose a suitable key, the most commonly used tool, to find out its name. A key uses the dichotomous statements (a or b) of diagnosed characters to divide a larger group of taxa into two smaller subgroups (indicated by numbers or taxon names). Beginning with the number 1, choose a more likely statement (a or b) for the specimen and then go to the number shown at the end of the statement, and so on. Go through the key, until a taxon name is shown. A key for some common spiders of the world is given below.

Key to species of some common spiders

1a Two pairs of book lungs (Fig. 1-3A) ……2

1b One pair of book lungs (Fig. 1-3B) …… 3

2a Abdominal tergite present; 3 pair of spinnerets (Fig. 1-4A)…… ***A. aus***

2b Abdominal tergite absent; 2 pair of spinnerets (Fig. 1-4B) ……***M. bus***

3a With a cribellum in front of the spinnerets (Fig. 1-5B), and a calamistrum on metatarsus IV (Fig. 1-6B) ……***Z. cus***

3b Without the cribellum and calamistrum (Figs. 1-5A, 1-6A) ……4

4a With six eyes ……5

4b With eight eyes …… 6

5a six eyes in three diads (Fig. 1-2I) …… ***S. dus***

5b six eyes in two triads (Figs. 1-2G, H) ……***P. eus***

6a Tarsi with two claws (Fig. 1-7B), with or without claw tufts …… 7

6b Tarsi with three claws (Fig. 1-7A), never with claw tufts (Fig. 1-8A) …… 10

7a Eyes in three or four rows (Figs. 1-2C, D, E, F) …… 8

7b Eyes in two rows (Figs. 1-2A, B) …… 9

8a Eyes arranged in 4-2-2 three rows; with a pair of remarkably large anterior median eyes (AMEs) (Fig. 1-2E)……***T. fus***

8b Eyes arranged in 2-4-2 three rows (Figs. 1-2F); AMEs not as above …… ***C. gus***

9a Base of both anterior spinnerets separated from each other or wide apart (Fig. 1-9A); Legs prograde (Fig. 1-10A) …… ***Z. hus***

9b Bases of both anterior spinnerets in contact (Fig. 1-9B); Legs prograde (Fig. 1-10B) …… ***T. kus***

10a Eye group hexagonal, eyes arranged in 2-2-2-2 four rows (Fig. 1-2C)…… ***O. lus***

10b Eye group not hexagonal…… 11

11a Eyes in two rows (Figs. 1-2A, B)…… 12

11b Eyes in three rows (Figs. 1-2D, E, F)……***P. mus***

12a Tibia and metatarsus of legs I and II armed with series of long spines interspersed with much shorter setae (Fig. 1-11B) ……***M. nus***

12b Legs I and II without such spine arrangement…… 13

13a Femora IV with a proximal cluster of double-rowed trichobothria (Fig. 1-12B) …… ***L. ous***

13b Femora IV without such trichobothria (Fig. 1-12A)…… ***N. pus***

Now, you have four spider specimens coded W to Z, respectively, as shown on outside of the vials. Please key out all these spiders and mark some of their characters with aid of figures 1-1 to 1-12. (**Caution!** You may take out the specimen from the vials for identification. When you do so, you should place a spider in the petridish with some 70% alcohol to examine its characters under the stereomicroscope. Because the spider's body is very fragile, the most ideal way to handle the specimen is gently grasping its legs with forceps to move it in or out from the vial. Don't break spider's body and its legs. Undamaged spiders in their original vials will get extra points as bonus. Please handle everything with care! Spiders should be kept in 70% alcohol at any time to prevent desiccation).

Q1.1.1 (4 points for each correct spider; 16 points total) Fill in the correct cell with the exact taxon code in your Answer Sheet. Note: each spider code can only be used once, or the grades of these cells will not be counted.

Q1.1.2 (0.65 points for each cell; 13 points total) If a spider has the characters listed in the left column of the table in your Answer Sheet, indicate with a "＋" and if the character is absent, indicate with a "－". **(Penalty of 0.2 points for each wrong answer, minimum 0 point)**

1-2 Reconstruct a phylogenetic tree for eight spiders

Data matrix 1-1 represents character entries (a to t) for a group of hypothetical organisms A to H.

Based on Data Matrix 1-1, Taxon A serves as the outgroup and the rest 7 species (Taxa B to H) are ingroups. Character state 0 represents the pleisiomorphy (ancestor character) and states 1-6 are apomorphies (derived characters). We may reconstruct a cladogram (cladistic tree) by using the synapomorphies (shared derived characters). Each change represents one step of the evolutionary events (indicated by the character and its statement, e.g., e-5, t-4). The following tree (Figure 1-13) is one of the most parsimonious cladogram that shows all the character changes on the tree. Numbers 1 to 15 represent 15 steps of the tree.

Data Matrix 1-1

Taxa	Character													
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**m**	**n**	**o**	**p**	**s**	**t**
A	0	0	0	0	0	0	0	0	0	0	0	0	0	-
B	1	1	0	1	5	0	0	1	1	1	0	0	2	-
C	1	1	0	1	6	0	0	0	0	0	0	0	2	-
D	1	1	0	1	3	0	0	0	0	0	0	0	2	-
E	1	1	0	0	1	0	0	0	0	0	0	0	1	3
F	1	1	0	0	1	0	0	0	0	0	1	0	1	4
G	1	1	0	1	4	0	0	1	1	1	0	0	2	-
H	1	1	0	0	1	0	1	1	1	1	0	0	2	-

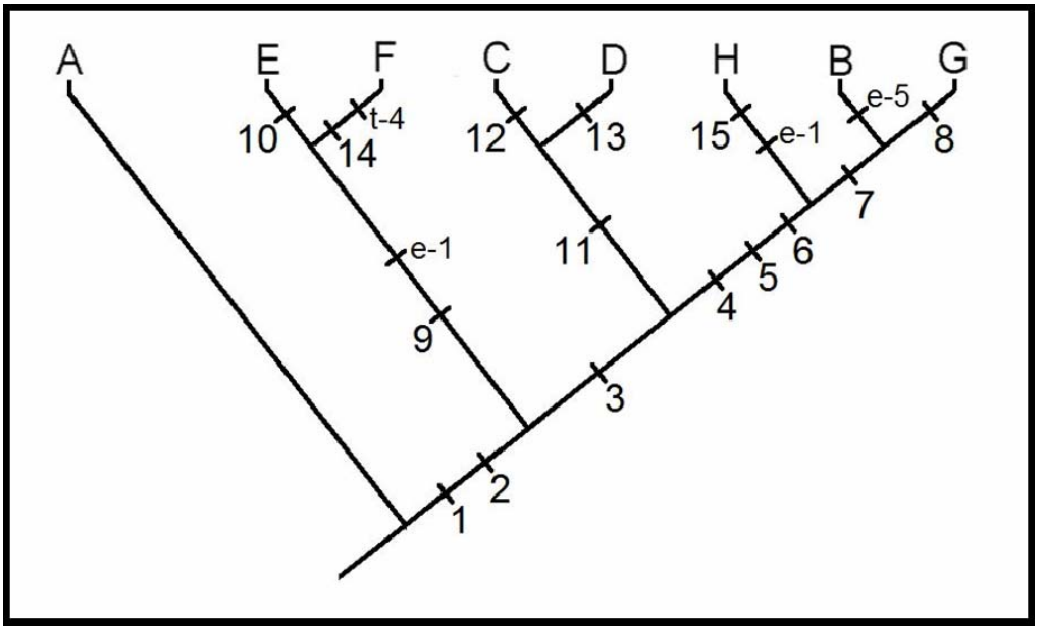


Figure 1-13 The most parsimonious cladogram reconstructed from data matrix 1-1.

Q1.2. (1.2 points for each cell; 18 points total) Fill in the character code and state (e.g., e-1) in the answer sheet for each of the 15 steps.

1-3 Based on the cladogram (figure 1-13), answer following questions:

Q1.3.1. (2 points) How many steps of the cladogram are there in total?

Q1.3.2. (2 points) Besides character e-1, which character is homoplasious (i.e., not homologous characters)?

Q1.3.3. (2 points) Which of the following taxon is the sister group of taxon {C, D}?

(A) {E, F} (B) {H, B, G} (C) {F} (D) {H} (E) {B, G}

Q1.3.4. (Each correct answer will get 0.4 points, 2 points total) Mark with an "X" in the "True" cell in the Answer Sheet if the characters given below appeared prior to the evolution of character m-1 in the cladogram, otherwise in the "False" cell.

Character
s-1
s-2
a-1
g-1
d-1

Q1.3.5. (1 point for each cell; 5 points total) To what kind of grouping do the following taxa belong? Use code "I" for polyphyletic, "II" for paraphyletic, or "III" for monophyletic grouping.

Taxon
{H}
{B, C, G, H}
{C, D, E, F}
{B, G, H}
{B, E, G}

TASK II: (40 points)

Test of species association in a community

The basic idea of community organization is that species tend to be associated in a nonrandom manner. One way to understand their association conditions is to use a 2 × 2 contingency table (Table 2-1-0): If a sample contains both species x and y, it is defined as type "a". If a sample contains only species y, species x, or no species, then it is defined as type "b", "c", or "d" respectively.

Table 2-1-0

	Species x		
Species y	Present	Absent	Total
Present	a	b	a+b
Absent	c	d	c+d
Total	a+c	b+d	n

$n = a + b + c + d$

Probability of obtaining species x $P(x) = (a+c)/n$

Probability of obtaining species y $P(y) = (a+b)/n$

Joint probability (JP): the probability of both species x and y are present

$JP = P(x) \times P(y)$

Significant level for Chi-squared statistical test (χ^2)

Significant level (α) / df	0.05	0.01
1	3.841	6.635
2	5.991	9.210
3	7.815	11.345

Figure 2-1 is a distribution map of two plant species, Plant-A (○) and Plant-B (●), and a sympatric spider species, Spider (✻), in a hypothetical community. Each square is 0.5×0.5 m^2.

2-1 Association between Plant-A (○) and Spider (✻): analyzed by quadrat method.

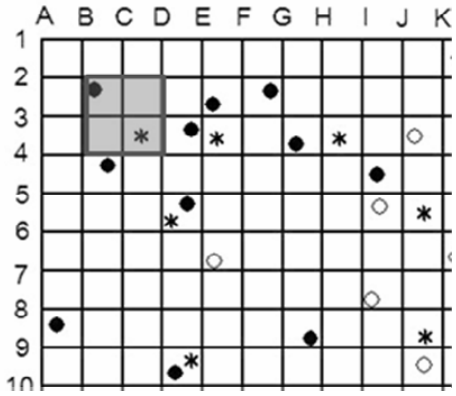
Put a 1-m square quadrat on Figure 2-1 using the following 40 randomly assigned coordinates as the center (i.e., 2 × 2 complete squares) and determine the type of each quadrat.

N-11, S-8, F-10, Q-18, O-16, K-2, L-4, M-17, M-4, H-17

X-2, K-11, T-19, M-8, P-10, G-8, B-19, M-19, S-10, O-12

J-18, D-7, B-17, I-11, B-10, G-13, V-16, C-3, F-5, R-15

L-2, Q-11, R-5, G-11, K-10, T-10, X-9, R-3, O-3, F-16



C-3 for example:

Q2.1.1. (1 point each; 9 points total) Write down your results in Table 2-1-1 and complete all the blank cells.

Answer the following in your Answer Sheet:

Q2.1.2a. (0.6 points) Calculate P (Plant-A).

Q2.1.2b. (0.6 points) Calculate P (Spider).

Q2.1.2c. (0.6 points) Calculate JP (Plant-A and Spider)

Q2.1.2d. (0.6 points) Calculate the expected joint occurrences.

Q2.1.2e. (0.6 points) Two species are more likely to be positively associated if the actual observation of the joint occurrence is greater than the expected one, and negatively associated if the actual observation is smaller than the expected one. What kind of association exists between the Plant-A and Spider? [Answer Code: P for positive association, N for negative association.]

2-1-3 A simple Chi-squared statistical test (χ^2) with one degree of freedom (df = 1) is calculated as follows:

$$n = a + b + c + d$$

$$\chi^2 = \frac{n\,(ad-bc)^2}{(a+b)(c+d)(a+c)(b+d)}$$

Q2.1.3. (2 points) Based on Table 2-1-1, Calculate χ^2**. (to the fourth decimal place)**

2-1-4 The strength of the association between the two species can be estimated from a coefficient (V) defined as follows:

$$V = \frac{ad - bc}{\sqrt{(a+b)(c+d)(a+c)(b+d)}}$$

The V value varies from -1 (strongly negative association) to +1 (strongly positive association) and it is zero when there is no association.

Q2.1.4a. (2 points) Calculate the V value from Table 2-1-1. **(to the fourth decimal place)**

Q2.1.4b. (2 points) What kind of the association exists between the two species? (Mark your answer with an "X" in the cell)

2-2 The following table shows data using 40 randomly placed 2-m square quadrats.

Table 2-2-1

	Spider (✻)		
Plant-A(○)	Present	Aabsent	Total
Present	14	16	30
Absent	8	2	10
Total	22	18	40

The expected joint occurrence is 16.5.

The Chi-squared statistical test (χ^2) with one degree of freedom (df = 1) is calculated as χ^2 = 3.3670.

V = -0.2901

Based on Table 2-2-1 answer following questions:

Q2.2.1a. (2 points) What kind of the association exists between Plant-A and Spider? [Answer Code: P for positive association, N for negative association]

Q2.2.1b. (2 points) What kind of the association exists between the two species? (Mark your answer with "X" in the cell)

2.2.2. (6 points total) Answer questions: Mark with an "X" on the answer sheet for each statement whether it is true or false.

Q2.2.2a. (2 points) Both tests of association using 1-m and 2-m square quadrats (sections 2-1 and 2-2) allowed us to reject the null hypothesis of random distribution.

Q2.2.2b. (2 points) The larger the quadrat size used, the more accurate the results.

Q2.2.2c. (2 points) Increasing the sampling efforts in the quadrat method might improve the accuracy of the results of species association.

2-3 Association between Plant-A (○) and Plant-B (●): analyzed by the nearest neighbor method.

Tally up the frequencies of the nearest neighbor of each plant systematically for all individuals. Fill in the totals in the table printed in the Answer Sheet.

Q2.3.1. (0.5 points for each cell; 3 points total) Write down your results in Table 2-3-1 and complete all the blank cells.

Q2.3.2a. (2 points) Based on Table 2-3-1 with one degree of freedom (df = 1), calculate χ^2.

(to the fourth decimal place)

Q2.3.2b. (3 points) Are these two plant species randomly distributed, associated or segregated? (Mark your answer with an "X" in the cell)

2-4 Answer questions: Mark with an "X" on the Answer Sheet for each statement whether it is true or false. **(4 points total)**

Q2.4.1. (2 points) The null hypothesis of the χ^2 test for the nearest neighbor method is that both Plant-A and Plant-B are randomly distributed.

Q2.4.2. (2 points) Using the nearest neighbor method to test species association can avoid the quadrat-size effect.

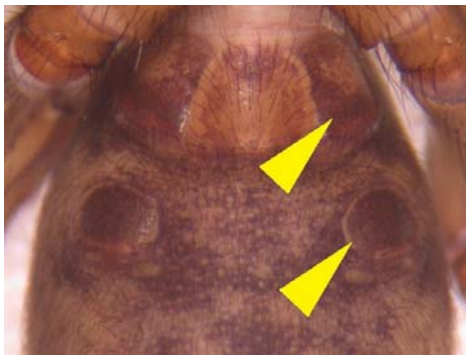
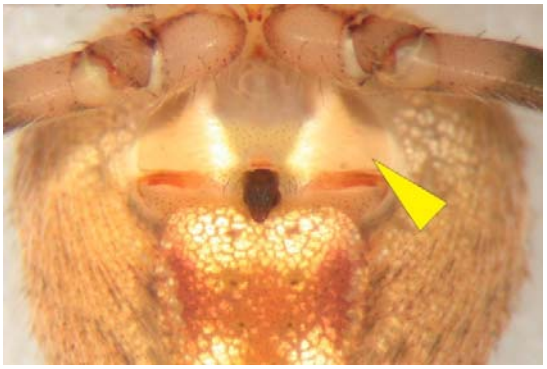
A: two pairs	B: one pair
	

Figure 1-3 Book lungs

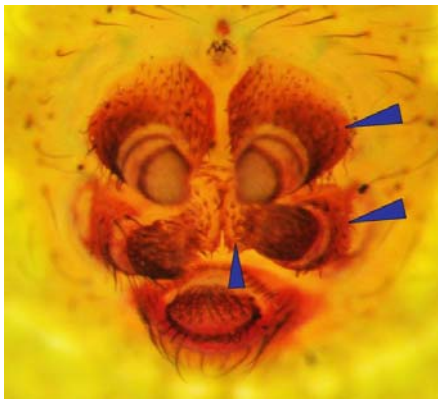
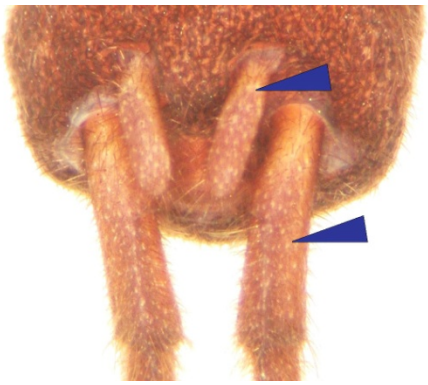
A: three pairs	B: two pairs
	

Figure 1-4 Spinnerets

A: absent	B: present
	

Figure 1-5 Cribellum

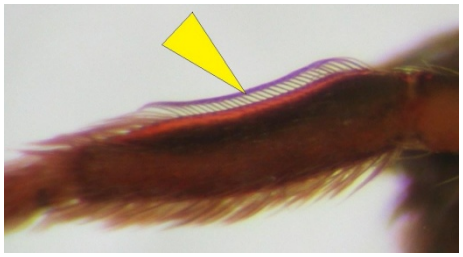
A: absent	B: present
	

Figure 1-6 Calamistrum on metatarsus IV

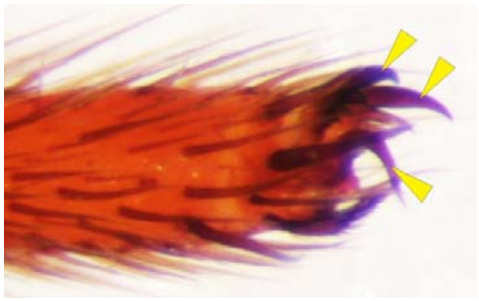
A: three claws	B: two claws
	

Figure 1-7 Tarsi claws

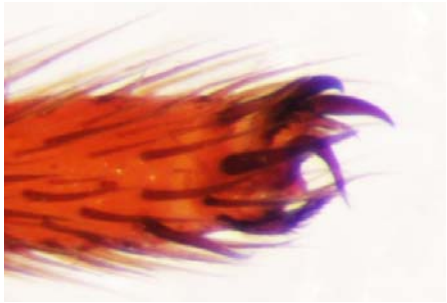
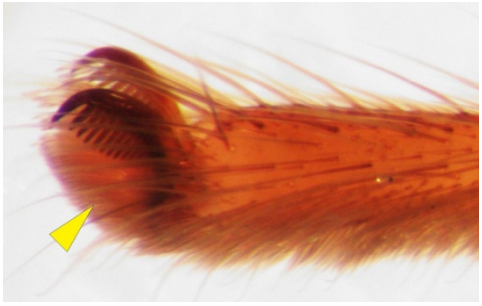
A: absent	B: present
	

Figure 1-8 Claw tufts

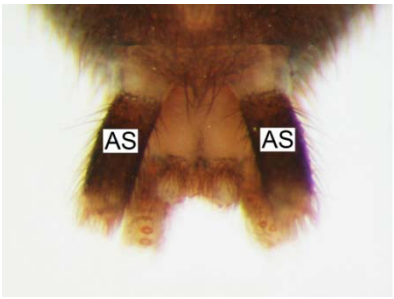
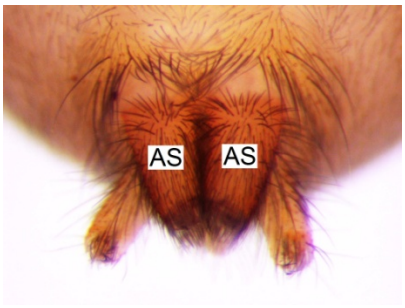
A: widely separated	B: close or in contact
	

Figure 1-9 Base of anterior spinnerets (AS)

A : prograde	B: laterigrade
	

Figure 1-10 Grades of Legs

A: absent	B: present
	

Figure 1-11 Tibia and metatarsus of legs I and II with series of long spines interspersed with much shorter setae.

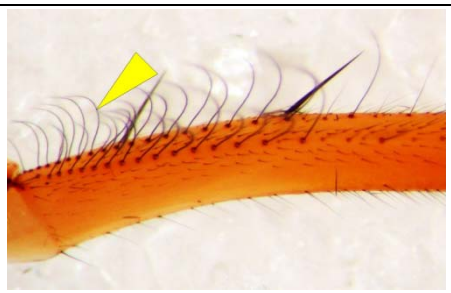
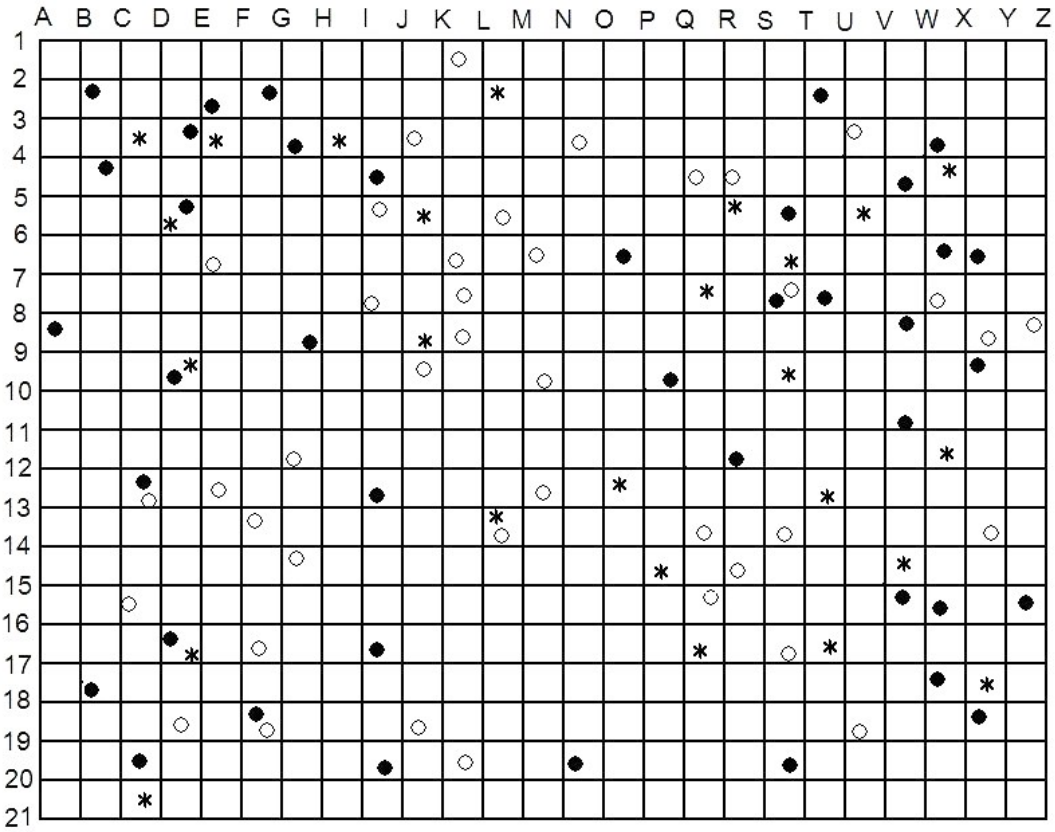
A: absent	B: present
	

Figure 1-12 Double-rowed trichobothria on femora IV


A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

PRACTICAL TEST 4 : PLANT ANATOMY, PHYSIOLOGY, AND GENETICS

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: Plant anatomy (**60 points**)

  Task II: Plant physiology and genetics (**40 points**)

- Check your **Student Code** on the **Answer Sheet and Template paper** before starting the test.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Make sure that you have received all the materials listed for each task. If any of the listed items is missing, **lift the sign.**
- Ensure that you organize the sequence of your tasks efficiently.
- Stop answering **immediately** after the end bell rings.
- After test, enclose the **Answer sheets**, **Question paper**, **Data printout**, and the **Template paper** in the provided envelop. Our lab assistant will collect it promptly.
- No paper or materials should be taken out of the laboratory.

Good Luck!!

Task I (60 points)

Plant Anatomy

Equipments:	**Quantity**
1. Slides (in carrier box)	20
2. Cover slips (in carrier box)	30
3. Compound microscope (with 4X, 10X, and 40X objective lenses)	1
4. Ocular micrometer (installed within the lens)	1
5. Single sided razor blade (in carrier box)	5
6. Petri dish (in carrier box)	1
7. Forceps (in carrier box)	1
8. Kimwipes	1
9. Paper towel	1
10 Waste basket	1

Materials:	**Quantity**
1. Double distilled water (labeled as "ddH_2O" in carrier box)	20 mL/vial
2. 1 N hydrochloric acid (HCl) (in carrier box)	5-10 mL/vial
3. Transparent nail polish (in carrier box)	1 vial
4. Section slides X, Y, and Z of the root of plant K in slide box K	1 slide each
5. Four-compartment plastic petri dish (Containing tissue samples from plants V, W, M, N, P, Q, R, S in each compartment)	2 petri dishes
6. Template paper (with student code) for placing the slides with sections you made and for documenting	1 sheet

Part A: Structure of Plant Root (5 points total)

Introduction :

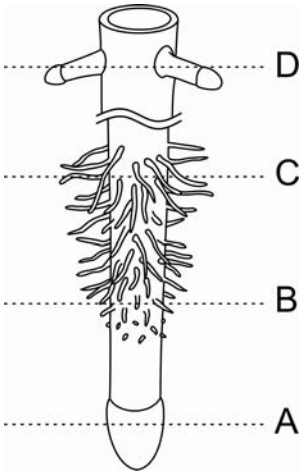


Figure 1 The structure of a typical plant root tip

There are three slides (X, Y, and Z) that are the transverse sections (located within the circular label on the slides) from different regions of the root of plant K. Observe these sections under microscope and answer the following questions.

Q1.A.1.（1 point each, 3 points total）

Section X, Y, and Z each corresponds to which part of the root depicted in Figure 1. Check [X] the correct answers on the answer sheet.

Q.1.A.2. （single answer, 2 points）

What is the direction of maturation of primary xylem in the root (tissues mature earlier → tissues mature later)? Check [X] the correct answers on the answer sheet.

Part B: Structure of Plant Stem（6 points total）

Introduction :

Carefully prepare transverse sections of proper thickness from the stem segments of plants V and W and place them on separate slides. Add a drop of water onto the sections and cover with cover slips. Observe under the microscope, and answer the following questions. When you finish this part, place

your slides with the sections on the template paper.

Q.1.B.（3 points for each plant, points are given when all correct answers are selected; 6 points total）

What are the distribution patterns of vascular bundles in the stems of plant V and W? Check [X] the correct answers on the answer sheet.

Part C: Structure of Plant Leaf（14 points total）

Introduction :

First determine the upper and lower epidermis of the leaves of plants M and N. Answer the following questions. When you finish this part, place your slides with the sections on the template paper.

Q.1.C.1（8 points）

Observation of stomata of plant M:

Prepare the upper and lower epidermis strips of the leaves, either by peeling them off with bare hands or by scraping off the undesired parts and leaving only the epidermis. Place these epidermal tissues on separate slides, with the epidermal side facing upward. Add a drop of water on each tissue sample and cover with cover slip. Observe under the microscope and use the ocular micrometer for measurements. One smallest unit of scale length of the micrometer is approximately 30 μm when observing under 4X objective lens. Answer the following questions in the answer sheet.

(a) Measurement of stomatal size on upper epidermis:

i) Under the 40X objective lens, what is the length of each smallest scale unit of the ocular micrometer? (1 point)

ii) Measure the lengths of 3 guard cells, then average their lengths. (3 points)

(b) Measurement of stomatal density on lower epidermis:

i) Under 40X objective lens , what is the approximate area of the field of view ? (1 point)

ii) Observe 3 fields of view, and calculate the number of stomata in each. Then work out the average stomatal density. (3 points)

Q.1.C.2 （6 points, points are given when all correct answers are selected）

Observation of leaf tissue of plant N:

Use the provided transparent nail polish to paint the upper and lower epidermis of leaves. When the nail polish has dried, carefully peel off the layers and place on separate slides, with the epidermal side facing upward. Add a drop of water on each sample, cover with cover slips. Use the appropriate objective lens to observe. Determine the stomatal distribution of the upper and lower epidermis, and deduce the habitat of plant N. Check [X] the correct answers on the answer sheet.

Part D : Monocot or Dicot of Plants (5 points)

Q.1.D (1 point each, 5 points total)

Determine whether plants K, V**,** W, M, and N are monocot or dicot. Check [X] the correct answers on the answer sheet.

Part E: Calcium Crystals in Plant Cells（20 points）

Introduction :

Some plants have idioblasts that can form polygonal calcium oxalate crystals or calcium carbonate crystals. Use the four plant materials (P, Q, R, S), carefully prepare transverse sections of appropriate thickness with a clean razor blade, and place the sections on separate slides. Add a drop of water on each section, and cover with cover slips. Observe under the microscope and check for the presence of crystals. If the crystals are present, locate the region of crystal distribution in the tissue (most crystals present in or absent from the cells of vascular bundles), carefully open the cover slip, remove the excess water around the sections, and add a few drops of HCl. Add cover slips again and

observe the samples under the microscope and deduce the types of crystals that are present. When you finish this part, place your slides with sections on the template paper.

Q.1.E （6 points for each plant with the presence of crystals, points are given when all correct answers are selected ; 2 points for the plant with the absence of crystals; 20 points total）

According to your observation, fill in the corresponding letters in the table in the answer sheet.

Plants: P, Q, R, S

Location of crystals: **A** (most crystals present in cells of vascular bundles)

B (crystals absent from the cells of vascular bundles)

Crystal type: **C** (polygonal calcium oxalate crystal) ; **D** (calcium carbonate crystal)

Documentation **(10 points total)**

When you finish all the parts (A to E) of Task I, **lift the sign** and the lab assistant will take a photo of the template paper with slides (1 point for each slide present).

Task II (40 points)

Plant Physiology and Genetics

Shared Equipment

ELISA reader

Equipments:	**Quantity**
1. Micropipettes P200 and P1000	1 each
2. 96-well microplate	1
3. 1.5 mL microcentrifuge tubes (for preparation of standard solutions, use those labeled 0 μM, 25 μM 50 μM, 100 μM, 200 μM, 400 μM)	12 (6 extra unlabeled)
4. 80-well microcentrifuge tube rack / 4-way test tube rack	1 each
5. Vortex	1
6. Marker pen	1

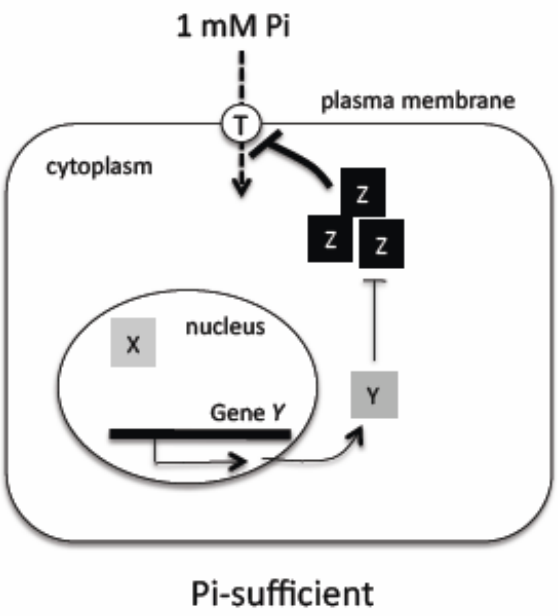
Materials:	**Quantity**
1. Phosphate detection solution (labeled as "Solution A")	10 mL/tube
2. 400 μM KH_2PO_4 solution (labeled as "Solution B")	10 mL/tube
3. Double distilled water (labeled as "ddH_2O")	50 mL/vial
4. 6 samples to be tested (allotted in microcentrifuge tubes, labeled as sample #1, #2, #3, #4, #5, & #6)	

Introduction:

Phosphate is an important plant nutrient that constitutes substances such as cell membranes, nucleic acids, and energy compounds like ATP. When lacking phosphates, plants' growth and development can be dramatically affected. Plants can sense changes in phosphate concentration in the environment and accordingly regulate their gene expressions, changing the activity of phosphate transport proteins on the cell membranes to maintain the homeostasis of phosphate concentration within. Using the model plant *Arabidopsis*, scientists discovered that root cells respond to

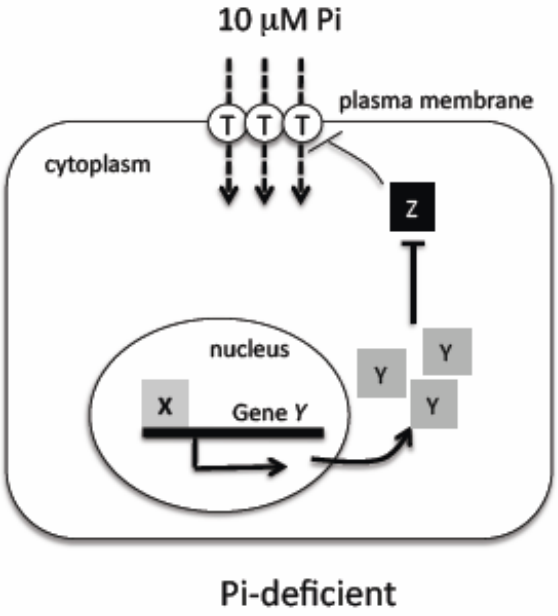
phosphate-sufficient (Pi-sufficient; e.g. 1mM) or phosphate-deficient (Pi-deficient; e.g. 10μM) condition as depicted below in Figure 2 and 3, respectively:

Figure 2



Pi-sufficient

Figure 3



Pi-deficient

When *Arabidopsis* is in Pi-sufficient condition (Figure 2), the protein Z negatively regulates the level of the protein T on plasma membrane, which is responsible for the transport of phosphate into the cell, to avoid excessive phosphate absorption that leads to toxicity. On the other hand, when plant is in Pi-deficient condition (Figure 3), the transcription factor X will enhance the expression of gene *Y* and thus increase the level of protein Y. Protein Y can promote the degradation of protein Z, leading to the increase of protein T level, and consequently a higher absorption of phosphate. In general, the phosphate level in the shoot of a plant is proportional to the uptake efficiency of phosphate in the root.

The phosphate level in plants will be considerably affected when the expression of genes encoding T, X, Y, and Z is perturbed by mutation or transgene. Therefore, plant biologists can utilize such mutant or transgenic plants to determine the role and relationship of these genes in the regulatory mechanism of phosphate homeostasis.

There are 6 samples in microcentrifuge tubes, which are extracts from the shoots of five *Arabidopsis* lines (A to E) grown under either Pi-sufficient (1 mM) or Pi-deficient (10 μM) condition (as listed in Table 1). *Arabidopsis* A is wild type and B to E are either knockout (KO; null mutant with complete loss of function of the gene) mutant line or over-expression line corresponding to gene *T*, *X*, *Y*, or *Z*. You will be measuring the phosphate level in each sample and determine their identities based on the principle shown in Fig. 2 and 3. Each sample is derived from 20 seedlings of fresh weight shown in Table 1 and brought to final volume of 10 mL with ddH_2O .

Table 1

Sample No.	Plant	[Pi] in medium	Fresh weight of seedlings (mg)
1	A	1 mM	40.4
2	A	10 μM	17.3
3	B	1 mM	28.0
4	C	1 mM	39.2
5	D	1 mM	30.6
6	E	1 mM	33.8

Use the provided equipments and solutions to measure the phosphate concentration in each sample according to the experimental procedures.

Experimental Procedures:

1. Use the 400 μM KH_2PO_4 solution (Solution B), ddH_2O, and pre-labeled 1.5 mL microcentrifuge tubes to prepare the following concentrations of phosphate solutions for standard curve: 0, 25, 50, 100, 200, 400 μM. Use vortex to mix solutions thoroughly. For each concentration, there should be at least 0.5 mL. Use the P200 micropipette to transfer 0.1 mL of each standard solution into the 96-well microplate at specified positions (as in Figure 4, make 2 replicates for each standard).

Figure 4 Positions of standards and samples in 96-well microplate

			Standards			Samples			Standards			
A			0		#1	#1		0				
B			25		#2	#2		25				
C			50		#3	#3		50				
D			100		#4	#4		100				
E			200		#5	#5		200				
F			400		#6	#6		400				
G												
H												
	1	2	3	4	5	6	7	8	9	10	11	12

2. Transfer 0.1 mL of each sample into the 96-well microplate at specified positions (as in Figure 4, make 2 replicates for each sample).
3. Add 0.1 mL of the phosphate detection solution (Solution A) into the wells that contain the standards and the samples. Mix by gently tapping the side of the plate.
4. **Lift the sign** after you finish Step 3, and wait for lab assistants to guide and help you with measuring the absorbance of the reaction mixtures with ELISA reader at 820 nm.
5. The lab assistant will print out the data for you. **Put your student code on the print-out**.
6. Answer the following questions:

Q.2.1. (18 points total)

Calculate the mean values of the absorbance for each sample and standard. Use the graphing paper on the answer sheet to plot a standard curve. **(0.5 point for each standard point correctly plotted)** Determine the phosphate concentrations of the samples in μM and the nmol phosphate per mg of seedling fresh weight for sample # 1 to # 6. Fill in your results in the table of answer sheet. **(2 points for each phosphate concentration measured, 0.5 point for each nmol/mg of phosphate calculated)**

Q.2.2. (Multiple answers, 4 points. Points given when all correct answers are selected)

For each of the following statements, determine whether they are true or false explanations for those plants having higher phosphate content (nmol/mg) than the wild type. Check [X] the correct answers on the answer sheet.

(A) X cannot be activated in this plant, thus leading to an increase in phosphate uptake.

(B) Loss-of- function of Gene *Y* in this plant causing an increase in phosphate uptake.

(C) Loss-of-function of Gene *Z* in this plant causing an increase in phosphate uptake.

(D) This plant harbors a transgene that over-expressed gene *Y*, causing the loss of inhibition of protein T, leading to higher activity in phosphate uptake.

(E) Protein T of this plant has a defect, unable to prevent the influx of phosphate, and thus causing an increase in phosphate uptake.

(F) The transcription factor X of this plant has a mutation, and is incapable to bind the promoter of gene *Y.*

Q.2.3. (2.5 points each, 10 points total)

According to the results from the experiment, assign the corresponding plant (B, C, D, or E) to the correct description on the answer sheet.

Q.2.4. (Single answer, 4 points)

If wild type plant (W), gene *X* knockout mutant (X), and gene *Y* knockout mutant (Y) were all grown in the same Pi-deficient condition, what would be the phosphate level in their shoots (rank from the lowest to highest)? Check [X] the correct answer on the answer sheet.

(A) X < W < Y

(B) Y < W < X

(C) W < X < Y

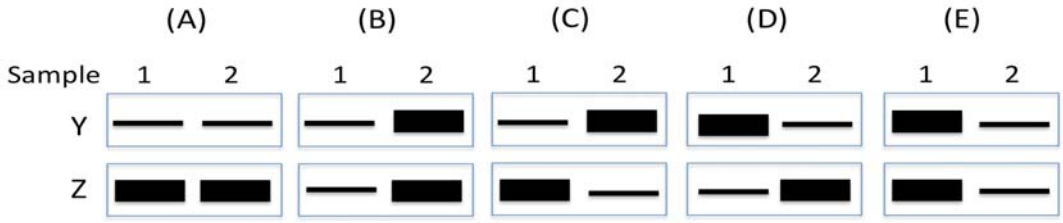
(D) W < Y < X

(E) X < Y < W

(F) Y < X < W

Q.2.5. (Single answer, 4 points)

Which of the following would be the most likely result of the Western blot analysis of protein Y and Z from the total protein extract of samples # 1 and # 2? Check [X] the correct answer on the answer sheet.



Template paper for Task I (1 point for each slide present, 10 points total)

Part	Plant	
Part B	Plant V	Plant W
Part C	Plant M (upper epidermis)	Plant M (lower epidermis)
	Plant N (upper epidermis)	Plant N (lower epidermis)
Part E	Plant P	
	Plant Q	
	Plant R	
	Plant S	

(3) Final – test questions

PRACTICAL TEST 1 : BIOCHEMISTRY AND CELL BIOLOGY

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 3 tasks:

  Task I: Protein electrophoresis (35 points)

  Task II: Protein quantification (30 points)

  Task III: Protein purification (35 points)
- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Make sure that you have received all the materials listed for each task. If any of the listed items is missing, **raise your sign.**
- Use a pen only.
- You should organize your work efficiently but ensure that you complete task II early enough to obtain the spectrophotometer readings to answer the questions that follow.
- Stop answering **immediately** after the end bell rings.
- After test, enclose both the **Answer sheets, Question paper, and Data printout** in the provided envelope. Our lab assistants will collect it promptly.
- No paper or materials should be taken out of the laboratory.

Good Luck!!

Shared instruments:

Camera, spectrophotometer, printer

Equipments and Materials:

	Equipments:	**Quantity**
1	Power supply	1
2	Electrophoresis tank (with gel and buffer)	1
3	Micropipettes P20 and P200	1 each
4	80-well microcentrifuge tube rack	1
5	Wire test tube rack with 15-mL centrifuge tubes (×6) (yellow cap)	1
6	4-way test tube rack	1
7	Plastic droppers in 15-mL centrifuge tubes	2
8	Micropipette tips (for P20 and P200)	1 each
9	Timer	1
10	96-well microplate	1
11	Marker pen & paper label	1 each
12	600-mL beaker for waste disposal	1
13	Scissors and ruler	1 each
14	Double-sticker to attach the results	1
15	Student Code sticker	1
16	Tissue paper	1
17	Mini centrifuge (if you need to spin down the samples in the microcentrifuge tubes)	1

	Materials:	**Quantity**
1	Loading dye (microcentrifuge tube-L) (pink tube with orange label)	1
2	Pre-stained protein molecular weight marker (microcentrifuge tube-M) (pink tube with orange label)	1
3	Unknown pre-stained protein samples (microcentrifuge tubes-U1 and U2) (pink tube with orange label)	1
4	CBG reagent in 50-mL centrifuge tube	1

5	Bovine serum albumin (BSA) concentration standard (0.5 mg/mL) in microcentrifuge tube (green tube with yellow label)	1
6	Enzyme E in two microcentrifuge tubes: concentrations X and Y (green tube with yellow label)	1
7	Distilled water (microcentrifuge tube-ddH_2O) (green tube with yellow label)	1
8	Protein sample (microcentrifuge tube-C) (blue tube with blue label)	1
9	Anion exchange chromatography column on 15-mL centrifuge tube	1
10	Anionic buffers A and B (5 mL each in two separated 15-mL centrifuge tubes) (green cap)	1
11	Coomassie brilliant blue G-250 (CBG) reagent 1 mL in each of six 15-mL centrifuge tubes (A1 to A3 & B1 to B3, red cap)	1

Task I (35 points)

Protein electrophoresis

Introduction:

Polyacrylamide gel electrophoresis (PAGE) is a common technique for protein study. It can be used to separate different proteins based on their charges or sizes. A type of PAGE is termed SDS-PAGE, in which the negatively charged chemical, SDS, is added before protein electrophoresis. The amount of SDS that binds to proteins is proportional to the size of the protein which confers each protein a similar charge-to-mass ratio and renders the intrinsic charge of the protein insignificant, at least for this experiment. Thus, the major factor that affects the migration of protein is the molecular weight (MW) of the protein during SDS-PAGE. The relative mobility (R_f) of the protein can be calculated as the ratio of the distance migrated by the protein to that migrated by the dye-front. The value of R_f is inversely proportional to the log of its molecular weight.

In the problem set, you will perform the following experiment:

1. An electrophoresis tank has been set up for SDS-PAGE, in which a polyacrylamide gel has been secured on electrode assembly and electrophoresis buffer has been filled. There are 10 wells for sample loading on the top of the gel. To load the sample, use the P20 micropipette with tip to

withdraw protein sample, and carefully place the tip on the top of the well. By injecting slowly the sample will sink to the bottom of the well by gravity (**Figure 1**).

2. If you need to practice, use the P20 micropipette with tip to withdraw 10 μL of loading dye from microcentrifuge tube L (pink tube with orange label) on rack. Load the dye into wells 1 to 3 or 7 to 10.
3. Each of the microcentrifuge tubes M, U1 and U2 (pink tube with orange label) contains 15 μL of protein molecular weight marker, unknown protein U1 and unknown protein U2, respectively. Use micropipette P20 to withdraw 10 μL solution from each tube and load the samples into wells 4 to 6 as shown in **Figure 1**.
4. As soon as you finish sample loading, **Lift the sign**, lab assistants will connect the power cord to power supply and set the voltage to 200 V for you. The gel will run for 25 minutes. The timer will be set up by an assistant to countdown.
5. After finishing electrophoresis, **Lift the sign**, lab assistants will disassemble the electrophoresis set-up and give back your gel. Wipe clean the surface of gel with tissue papers and **label the gel with your Student Code** sticker. Lab assistants will take the photo of your gel. Put the photo on the answer sheet using double-sticker (5 points).

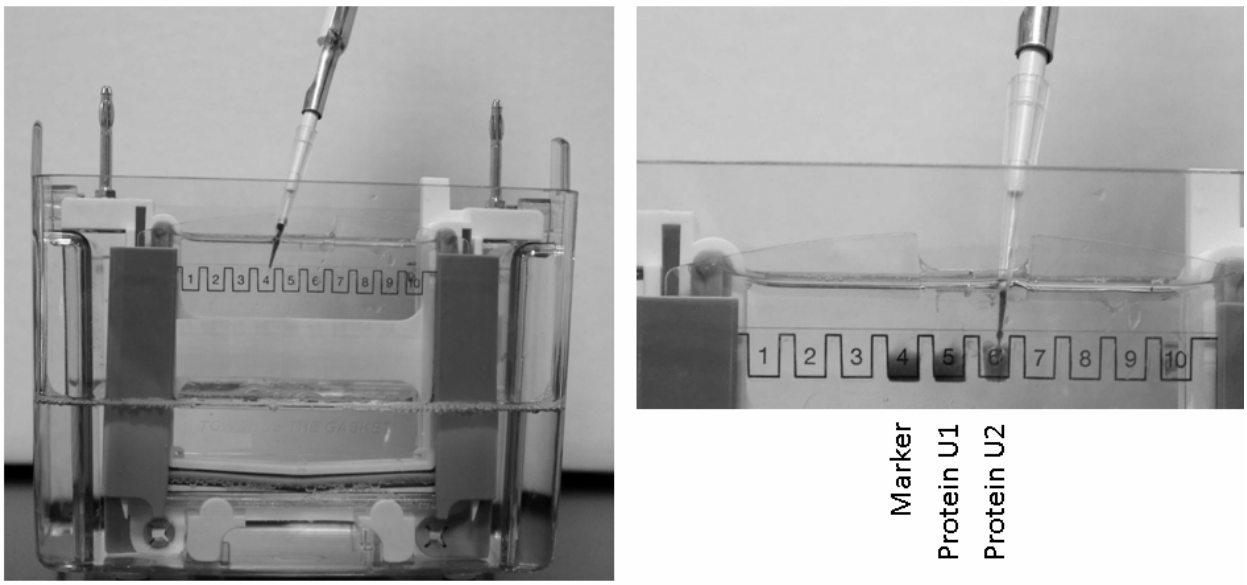


Figure 1

Answer the following questions:

Q.1.1. (2 points) **Figure 2** shows a photograph of a SDS-PAGE gel. The electrophoresis start point and dye-front are indicated. Which side of the gel should be connected to the anode (+ charge) of the power supply? Mark your answer (X) on the answer sheet.

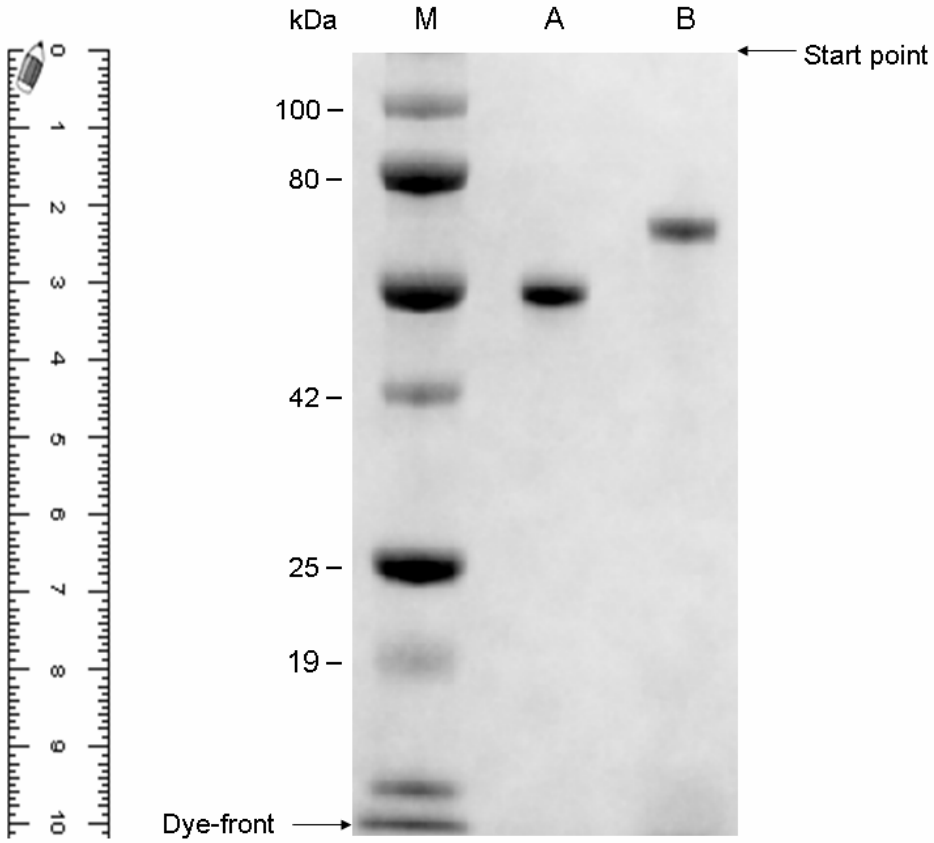


Figure 2

Q.1.2. (8 points) Based on the information provided in **Figure 2**, plot a graph of molecular weight values on graph paper provided of the five marker proteins versus their relative migration-R_f values on the answer sheet (4 points). Use the graph to estimate the molecular weights of unknown proteins on lanes A and B (4 points). Write down your answers on the answer sheet.

Q.1.3. (5 points) A protein complex of molecular weight 246 kDa is composed of multiple subunits bound by non-covalent interaction. Two protein bands of 57 and 33 kDa were identified after SDS-PAGE. How many 57-kDa and 33-kDa subunits, respectively, are included in the protein complex? Write down your answers on the answer sheet.

Q.1.4. (5 points) The average molecular weight of amino acid residues is about 110 daltons. How many amino acids are there in the 33-kDa protein subunit? How many nucleotides of RNA are translated into the protein? Write down your answers on the answer sheet.

Q.1.5. (5 points) Suppose the average molecular weight of nucleotides is 330 daltons. Excluding intron and stop codon, what is the mass ratio of dsDNA encoding the 33-kDa protein to the 33-kDa protein? Write down your answer on the answer sheet.

Q.1.6. (5 points) Suppose a protein P can bind to a protein Q (MW = 1000 daltons). The binding can be revealed by gel-mobility shift assay. Now 200 pmol of protein P were mixed with various amounts (0 to 500 ng) of protein Q. These mixtures were resolved by 10% (w/v) polyacrylamide gel. Gel was stained by Coomassie blue and is shown in **Figure 3**. Calculate the binding molar ratio of proteins P and Q? Write down your answer on the answer sheet.

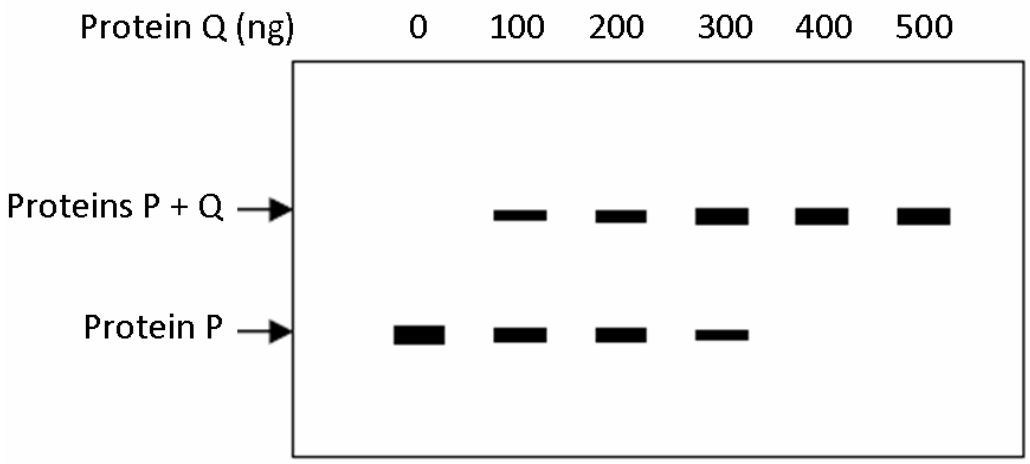


Figure 3

Task II (30 Points)

Protein quantification

Introduction:

Coomassie Brilliant Blue G-250 (CBG) is a protein staining reagent. It appears in a different color under different pH conditions. It looks reddish brown in acidic solution, whereas it turns blue under neutral or alkaline condition. Since proteins can provide a relative neutral environment, CBG will turn blue with the maximum absorbance at a wavelength of 595 nm when binding to protein. The more protein there is in a sample, the more CBG will bind to it, and thus, the higher intensity of blue color will be. In other words, the absorbance at 595 nm is proportional to the amount of protein in a sample. Based on this, one can determine the concentration of protein by measuring the blue intensity of a sample.

In the problem set, you will perform the following experiment:

1. To make BSA concentration standards (**Table 1**), add 0, 2, 4, 6, 8 and 10 μL of 0.5 mg/mL BSA (green color) in A1 to A6 wells of a microplate (**Figure 4**). Make duplicated BSA concentration standards in B1 to B6 wells. If this step is incorrect, you can repeat the procedure in wells A7 to A12 and/or B7 to B12. Adjust the total volume of each BSA solution to 10 μL by adding an appropriate volume of H_2O (**Table 1**).

2. Add 200 μL of CBG reagent per well in A1 to A6 & B1 to B6. Mix and observe the color change.

3. To determine the two concentrations X and Y of enzyme E, add various amounts (2, 4, 6, 8 and 10 μL) of enzyme E (green color) in duplicate to empty wells and bring up the volume to 10 μL with H_2O.

4. Add 200 μL of CBG reagent per well to the diluted enzyme E. Mix and observe the color change.

5. **Lift the sign**, lab assistants will accompany you to measure the absorbance values of your samples at 595 nm using spectrophotometer. Put your Student Code on the print-out data with

marker pen.

6. Return to your work bench, and put the result on the answer sheet using double-sticker.

Table 1

Materials	Well of a microplate					
	A1 & B1	**A2 & B2**	**A3 & B3**	**A4 & B4**	**A5 & B5**	**A6 & B6**
0.5 mg/mL BSA (μL)	0	2	4	6	8	10
H_2O (μL)	10	8	6	4	2	0
Diluted BSA concentration (mg/mL)	0					

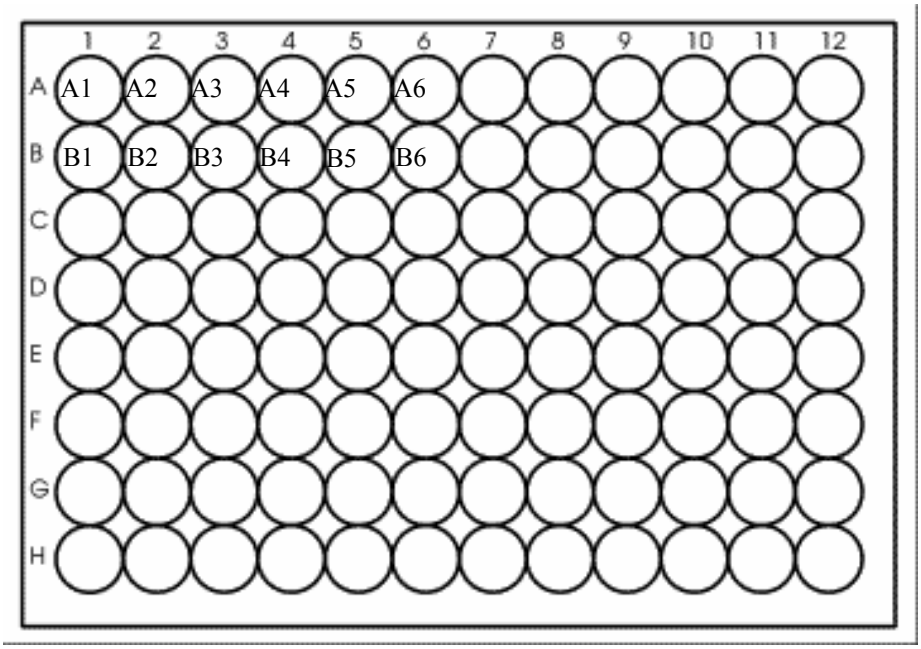


Figure 4

Answer the following questions:

Q.2.1. (10 points) Calculate the concentrations of BSA in each sample (10 μL) and fill in the blanks in the table on the answer sheet (Q2.1.1. 5points). Use these values to plot a standard curve of BSA concentrations (X-axis) versus mean absorbance values of duplicated standards (Y-axis) on the answer sheet (Q.2.1.2. 5points).

Q.2.2. (12 points) Choose the best sample solution of diluted solutions X and Y within the range of BSA standard curve and fill in the table on the answer sheet.

Q.2.3. (8 points) Based on the best sample solution you chose, calculate the original concentrations (X and Y) of enzyme E from the standard curve of BSA concentration. The concentrations should be expressed in units of mg/mL. Write down your answers on the answer sheet.

Task III (35 points)

Protein purification

Introduction:

Column chromatography is commonly used for purification of proteins. The column is made by packing solid porous material (stationary phase) in a column filled with buffer solution (mobile phase). The protein solution to be separated is loaded on top of the column and allowed to percolate into the solid matrix (stationary phase). A reservoir at the top supplies elution buffer constantly which flows through the matrix and passes out of the column at the bottom (the eluent). Since proteins interact with solid matrix in different degree, individual proteins migrate faster or more slowly through the column depending on their properties. Therefore, one can obtain purified proteins by collecting eluent at different times (**Figure 5**).

Ion-exchange chromatography can be used to separate proteins with different electric charge at a given pH. In anion exchange chromatography, negatively charged proteins bind to positively charged stationary phase. Using solution containing anions to compete with proteins for the adsorption of solid matrix, the bound proteins will be eluted. In practical, proteins are eluted first with buffer containing lower concentration of anion, then with buffer containing higher concentration of anion. Since different charged proteins interact with the stationary phase in different strength, they can be separately eluted by different concentrations of anionic buffers.

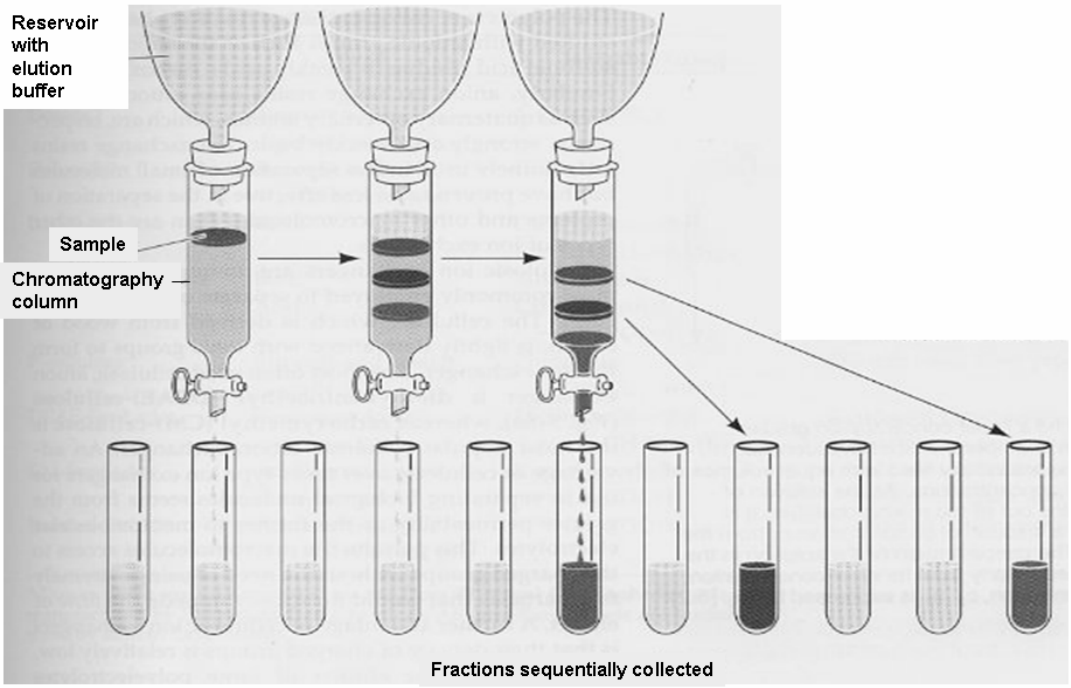


Figure 5

<u>In the problem set, you will perform the following experiment (5 points):</u>

1. Label six 15-mL centrifuge tubes (yellow cap) a1 to a3 and b1 to b3 accordingly, with a marker pen.
2. Take the anion chromatography column (**Figure 6A**), un-plug the tube and allow the solution to be drained by gravity in the same centrifuge tube. Plug the tube intermediately when the liquid surface reaches the top of the disc (**Figure 6A**, white arrow). Do not over-dry the gel as it may affect protein purification.
3. Withdraw 200 μL of protein solution from microcentrifuge tube C (blue tube with blue label) using a P200 micropipette, apply the sample to the chromatography column slowly by touching the filled pipette tip lightly against the inside wall of the tube (**Figure 6B**).
4. Un-plug the column and allow the protein sample to drain out, then transfer the column to centrifuge tube a1 (yellow cap). Withdraw 3 mL of anion buffer A (green cap) with a plastic dropper and apply the solution to gel by touching pipette tip against the wall of the tube (**Figure 6C**).
5. Collect ~1 mL eluent in centrifuge tubes a1 to a3 (yellow cap) sequentially. It takes about 2 to 3

minutes for each tube.

6. Allow the contents of the column to **drain entirely out** then transfer the column to centrifuge tube b1 (yellow cap). Withdraw 3 mL of anion buffer B (green cap) with a plastic dropper and apply the solution to gel by touching pipette tip against the wall of the tube (**Figure 6C**).
7. Collect ~1 mL eluent in centrifuge tubes b1 to b3 (yellow cap) sequentially. It takes about 2 to 3 minutes for each tube.
8. Withdraw 50 μL of eluent from tubes a1 to a3 & b1 to b3 (yellow cap) and transfer to centrifuge tubes A1 to A3 & B1 to B3 (red cap), respectively. Mix and observe color change. CBG (see introduction in Task II) reagent in tubes A1 to A3 & B1 to B3 will turn blue when it reacts with the eluted protein.
9. After finishing all the experiments, **Lift the sign**, lab assistants will take photo of your experiment results and put a stamp mark on your answer sheet. Without the stamp mark, you will not be evaluated for Q.3.1.1. and Q.3.1.2.

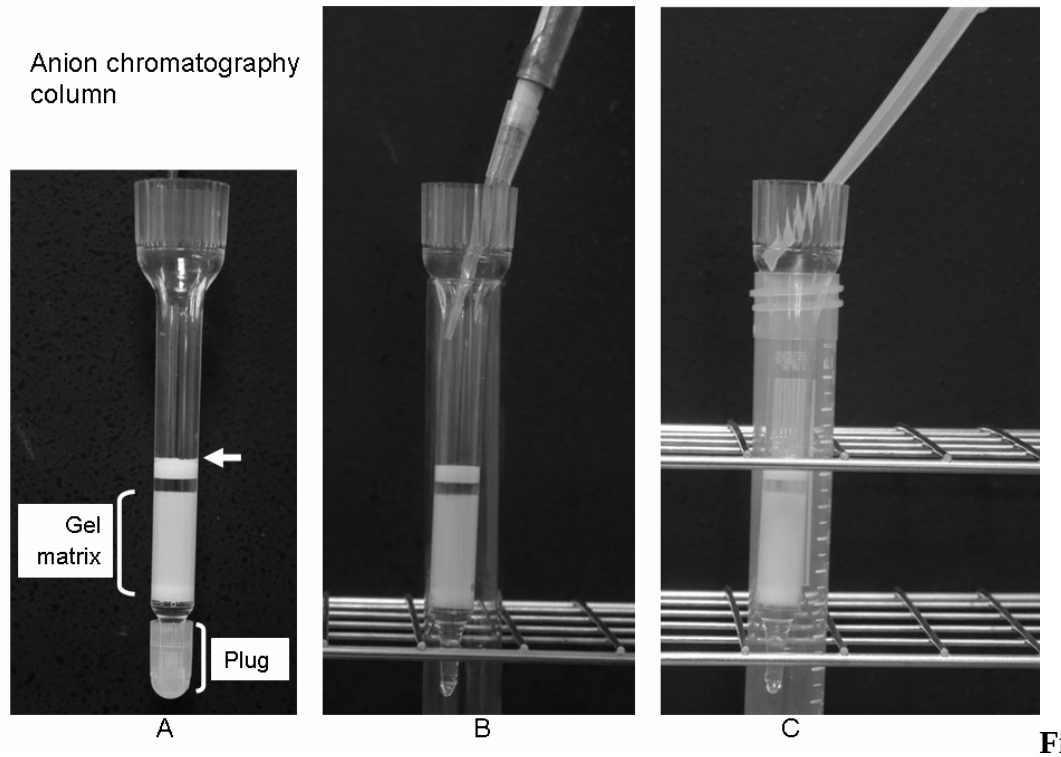


Figure 6

Q.3.1. (7 points) Mark the deepest color change (X) on the answer sheet (Q.3.1.1. 5 points). Which of the following buffers (buffer A or buffer B) can be used to elute the protein? Mark your answer (X) on the answer sheet (Q.3.1.2. 2 points).

Q.3.2. (5 points) Enzyme A is a protein whose surface is evenly distributed with electric charges. If enzyme A can be eluted from anionic exchange chromatography by high concentration of anionic buffer, what is the property of enzyme A with respect to electric charge? Mark (X) the answer on the answer sheet.

(A) High negative net charges

(B) Low negative net charges

(C) Zero net charge

(D) Low positive net charges

(E) High positive net charges

Q.3.3. (4 points) Different amino acids differ in the chemical nature of the R group (side chain). **Figure 7** shows four amino acids A, B, C, and D in their prevailing ionic forms at pH 7.2, with the side chain marked in white box. Which of the following amino acids in **Figure 7** would be present more frequently on enzyme A? Write down your answer (X) on the answer sheet.

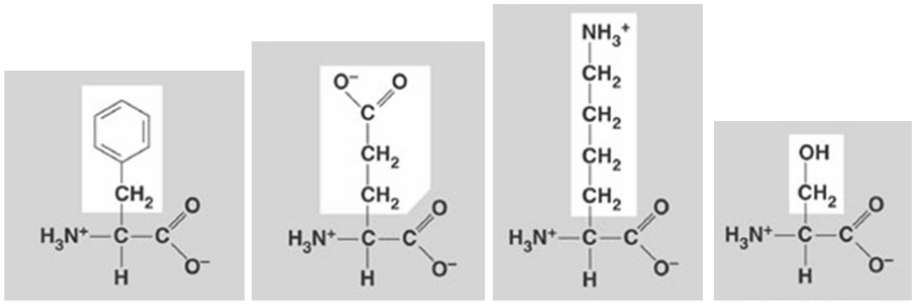


Figure 7

Q.3.4. (5 points) Hydrophobic interaction chromatography can be used to separate proteins based on their hydrophobicity. To perform the chromatography, protein samples were first treated with buffer containing high concentration of salts such as ammonium sulfate $(NH_4)_2SO_4$, which will remove water molecules from the protein surface. This causes the hydrophobic area on the surface

of the protein to be exposed. When the salt-treated proteins are subjected for chromatography, they will be absorbed on the stationary phase through hydrophobic interactions. The higher the hydrophobicity of the protein, the stronger the absorption. As salt concentration can affect the hydrophobic interaction between the protein and the stationary phase, different proteins can be separately eluted by using different concentrations of salt-containing buffers. If enzyme A is highly hydrophobic, which of the following buffers should be used to separate enzyme A from other proteins by chromatography? Mark (X) the answer on the answer sheet.

(A) Low-salt buffer

(B) High-salt buffer

(C) Buffer without salt

(D) Low-salt buffer first then high-salt buffer

(E) High-salt buffer first then low-salt buffer

Q.3.5. (4 points) If enzyme A is highly hydrophobic, which of the amino acids in **Figure 7** would be present more frequently on enzyme A? Mark (X) the answer on the answer sheet.

Q.3.6. (5 points) Gel filtration chromatography separates proteins based on their sizes. The gel, or stationary phase, consists of cross-linked polymer beads with engineered pores of a particular size. Small proteins enter the pores and are retarded by their more labyrinthine path. Large proteins cannot enter the pores and so take a short path through the column, around the beads. **Table 2** is a list of gels and their fractionation ranges. Suppose both enzyme A (22 kDa) and protein B (44 kDa) are single-subunit proteins. One would like to purify enzyme A from a mixture containing enzyme A and protein B using gel filtration chromatography. Which gel is best suited for the job? Mark your answer (X) on the answer sheet.

Table 2

Types of stationary phase	Fractionation range (MW, Da)
G-10	<700
G-15	<1500
G-25	1,000-6,000
G-50	1,500-30,000
G-75	3,000-70,000
G-100	4,000-150,000
G-150	5,000-400,000
G-200	5,000-800,000

Q.3.7. (5 points) Assume that the concentration of total proteins in the original solution is 1 mg/mL and the activity of enzyme A is 0.5 units in 1-mL protein sample. The concentration of total proteins after purification is 0.1 mg/mL and the activity of enzyme A is 1 unit in 1-mL protein sample. Calculate the purification factor (times of purity improvement) of enzyme A. Write down your answer on the answer sheet.

PRACTICAL TEST 2 : ANIMAL PHYSIOLOGY AND ANATOMY

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: The observation of the sciatic nerve of American bullfrog (58 points)

  Task II: The observation of tissue morphology and the match of their functionality (42 points)

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Make sure that you have received all the materials listed for each task. If any of the listed items is missing, **raise your sign.**
- **Use pen only.**
- **You must complete task I first.**
- Stop answering and put down your pen **immediately** after the end bell rings.
- After test, enclose both the **Answer sheets and Question paper** test sheets in the provided envelope. Our Lab assistants will collect it promptly.
- No paper or materials should be taken out from the laboratory.

Good Luck!!

Equipment and Materials:

For task I: The observation of the sciatic nerve of American bullfrog.

Instruments/materials	Quantity	unit
Bullfrog specimen	1	piece
Dissecting tray (containing a cooler)	1	piece
Round plastic petri dish	1	piece
Ringer's solution (in wash bottle)	500	mL
Pin (in a glass bottle)	10	pieces
Cotton line (in a glass bottle)	2	pieces
Electric stimulating device	1	set
Wet paper	1	set
Plastic glove	1	pair
Dissecting equipment : scissors (large)	1	pair
scissors (small)	1	pair
fine forceps	2	pairs

For task II: The observation of tissue morphology and the match of their functionality

Instruments/materials	Quantity	unit
Microscope	1	set
Tissue section (marked A to J)	10	slides
Color pictures (numbered 1 to 9) on 3 sheets of A4 paper	1	set

Task I (57 points)

The observation of the sciatic nerve of American bullfrog.

Introduction:

The sciatic nerve is a branch of the sacral plexus. It is the thickest and longest nerve tract in the body, extending from the vertebral column to the foot. The sciatic nerve includes the distributed sensory and motor nerves that control most sensory and motor activities of the lower extremities. Mediated by the sciatic nerve, sensory signals from the lower limbs are transmitted to the brain. Similarly, muscle contraction of the lower extremities can be stimulated by nerve impulses from the brain. The aim of this experiment is to observe and isolate the sciatic nerve from the bullfrog.

Experiment Procedure:

Step 1 to 5: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissue anytime. Do not allow the tissues to dry out.)

1. Carefully check if all the experiment instruments/materials are fully provided. Raise your sign if you have any problem.
2. Put the bullfrog specimen on the provided dissecting tray.
3. First, carefully observe the 10 pairs of spinal nerves extending from the vertebra of the bullfrog. Next, locate the sciatic nerve that is assembled by pairs of spinal nerves VII, VIII and IX (as shown in Fig. 1).
4. Turn on the switch (on/off) on the electric stimulating device. The red light will be lighted up immediately, indicating that the device is functioning.
5. Simultaneously stimulate the sciatic nerve with the two electric wires that are separately connected to the (+) and (-) electrodes of the electric stimulating device. Fig. 3 indicates the position of sciatic nerve emerging form the spinal cord. Observe the contracting response of the

hind limb.

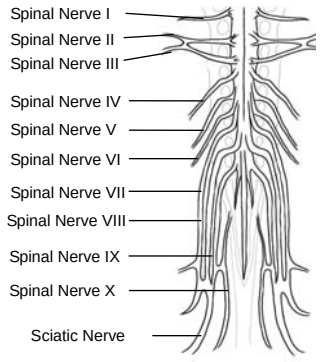


Fig. 1. Spinal nerve

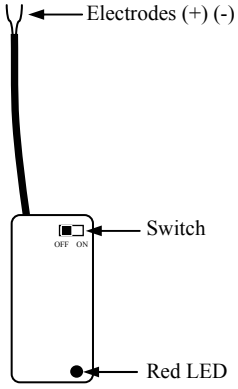


Fig. 2. Electric stimulating device

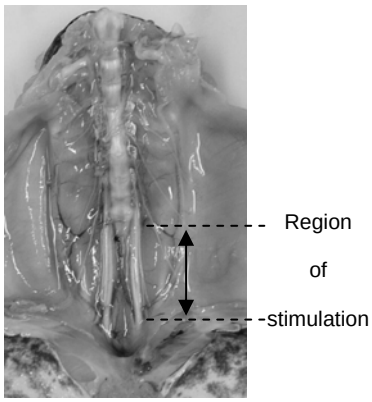


Fig. 3. Sciatic nerve

Q.1.1. (9 points) When you have finished the above five steps, **lift the sign** to notify the Lab assistant to videotape the contraction.

Step 6 to 10: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissues any time)

6. Use a pair of scissors to circularly cut open the skin at the upper part of **one** thigh of the bullfrog. Starting from the cutting point, completely peel off the skin by hand to remove it from the hind limb (Fig. 4). It may be necessary to cut some connections between the skin and underlying tissues.

7. Lay the bullfrog on the dissecting tray with its back facing up.

8. Push two pins separately into both ends of gastrocnemius and separate it from tibiofibula (shinbone) (Fig. 5).

9. The sciatic nerve is located in the trough surrounded by thigh muscles. Carefully separate the muscles on both sides of the trough and let the light yellow colored sciatic nerve be exposed.

Pass through a cotton line underneath the sciatic nerve to label it.

10. Stimulate the cotton line-labeled sciatic nerve with the provided electric stimulating device and observe the contracting response of gastrocnemius.

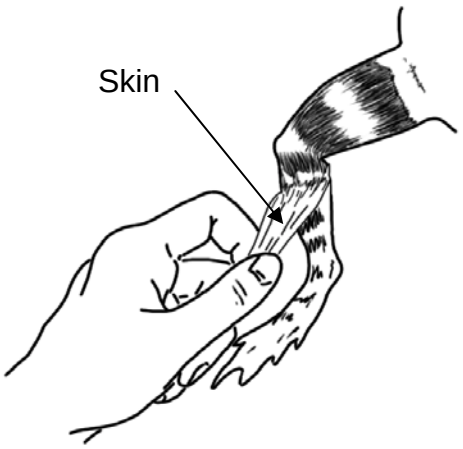


Fig. 4. Demonstration of skin peeling

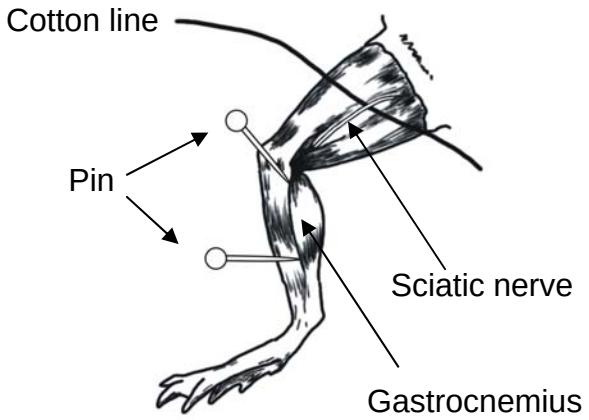


Fig. 5 Sciatic nerve and gastrocnemius

Q.1.2. (8 points) When you have finished the steps 6 to 10, **lift the sign** to notify the Lab assistant to videotape the contraction.

Step 11 to 12: (To keep the tissues wet, a small amount of Ringer's solution may be added onto the tissues any time)

11. Completely separate and isolate the intact sciatic nerve-gastrocnemius muscle preparation from the bullfrog specimen and place it in a petri dish, as shown in Fig. 6. (Sciatic nerve must be at least 2 cm long).
12. Stimulate the sciatic nerve with the electric stimulating device and observe the contracting response of the gastrocnemius.

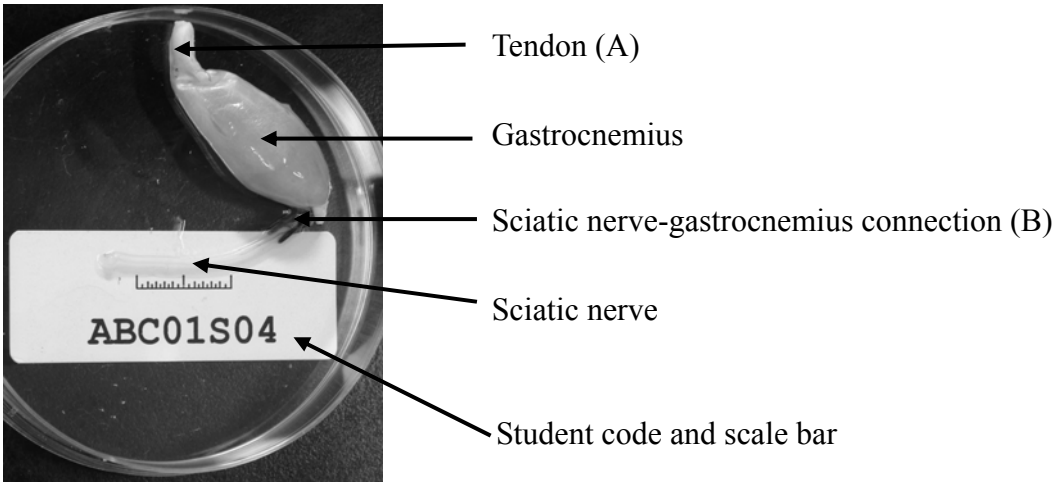


Fig. 6 Isolation of 「sciatic nerve-gastrocnemius」tissue

Q.1.3. (40 points) When you have finished steps 11-12, ~~write down the results of your observation on the answer sheets. Then,~~ **lift the sign** to notify the Lab assistant for checking the results and videotape the contraction.

Task II (43 points)

Identify tissues based on their morphology and match their functionality

Introduction:

The vertebrate physiological system is established by the functional coordination of 11 organ systems, which include the skin, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems.

Identify the specimens on the slides (30 points)

Slides A to J are tissue sections from vertebrates. Identify the tissues or cell types, based on their characteristic features, using microscope.

1. Vein	2. Artery	3. Ganglion	4. Neuron	5. Blood（frog）
6. Blood （human）	7. Ovary	8. Testis	9. Lung	10. Skeletal muscle
11. Smooth muscle	12. Cardiac muscle	13. Kidney	14. Cartilage	15. Bone
16. Pancreas	17. Intestine	18. Gastric tissue	19. Skin	20. Rectum

Q.2.1. (30 points) Match each slide specimen (A to J) with its correct name from 20 different tissue/organ names listed in above table. (Note: only one correct answer for each specimen). Fill in the correct number in the answer sheets.

Identify the sliced tissue and match their correct functions (13 points)

Fig. 1-9 are the enlarged pictures of parts of different mammalian tissues. Based on their structural features, identify the tissue ~~determine the precise sources of them~~ and answer the questions below. The functions of 11 organs are listed in the following table. Each specific function is assigned an alphabetic letter (A to K).

Symbol	Functional description
A	Producing vitamin D_3
B	Producing erythropoietin
C	Producing urea
D	Producing Surfactant to reduce the surface tension
E	Regulating the homeostasis of the pH of body fluid
F	Helping the vein compression and promoting blood stream back to the heart
G	Digesting proteins
H	Producing secretin
I	Producing inhibin
J	Major organ for the storage of calcium and phosphate
K	Producing progesterone

Q.2.2. (13 points) Correctly write down the functional symbols, i.e. the alphabetic letters (A to K), on the answer sheets. Match the organ with their functionalities. **Note**: some organs may have more than one function (1 point will be deducted for each incorrect answer and minimum score will not be less than zero).

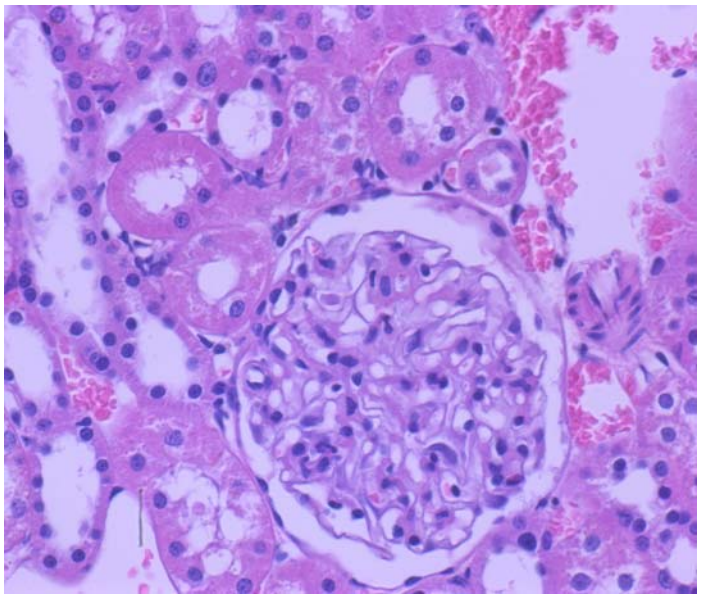
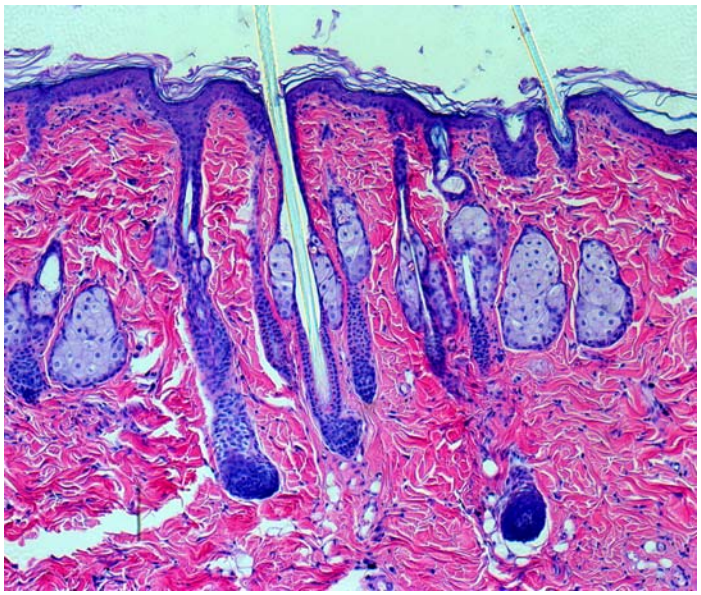
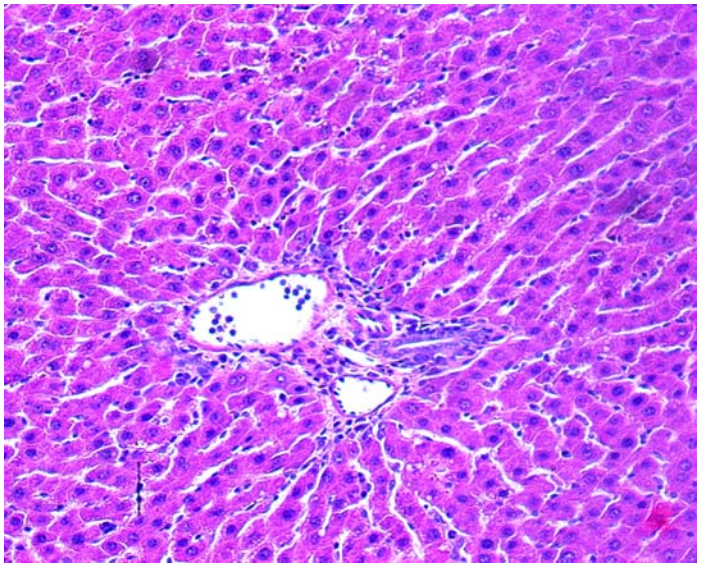
Fig 1.	 H&E stain (400 X)
Fig 2.	 H&E stain (100 X)
Fig 3.	 H&E stain (200 X)

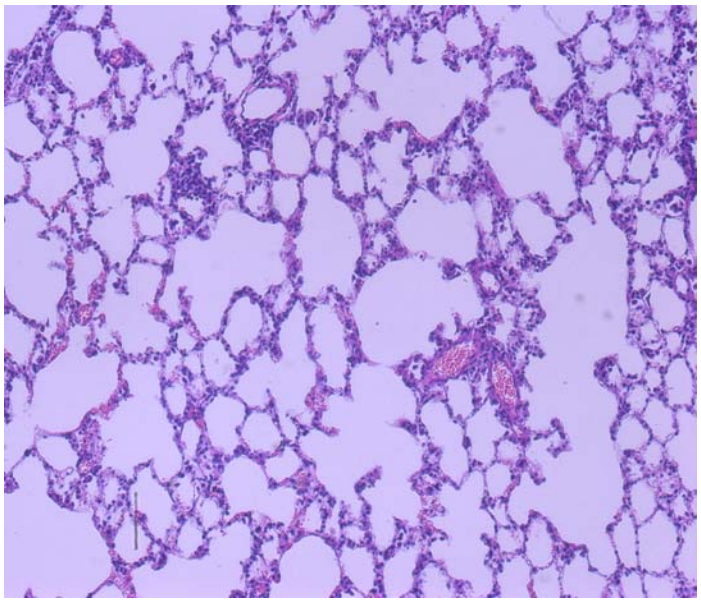
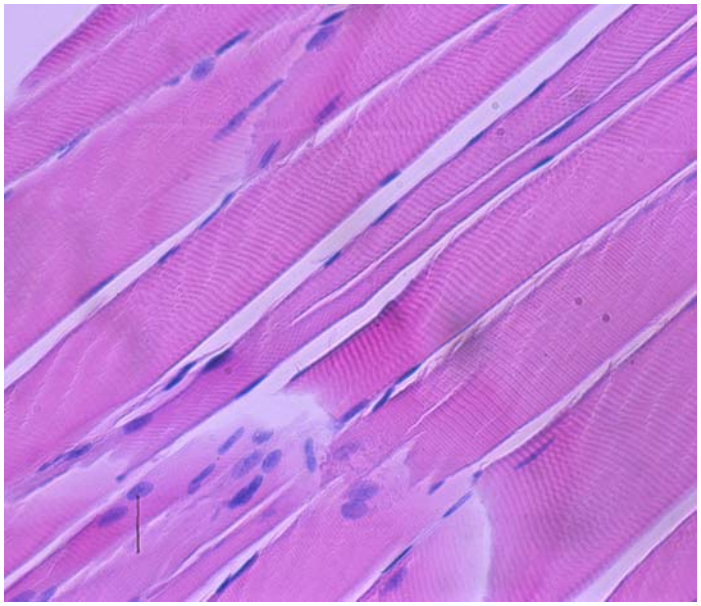
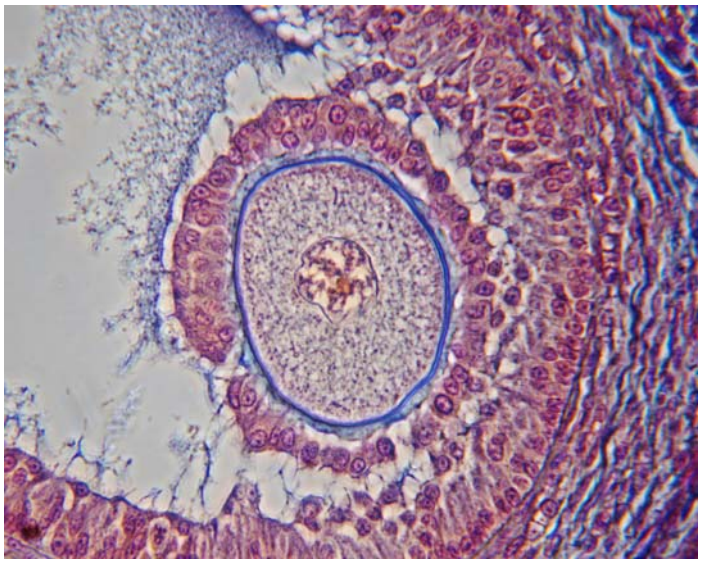
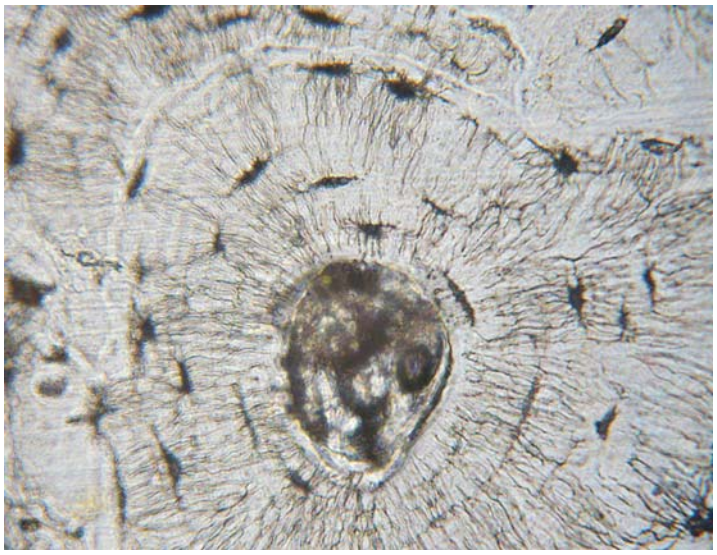
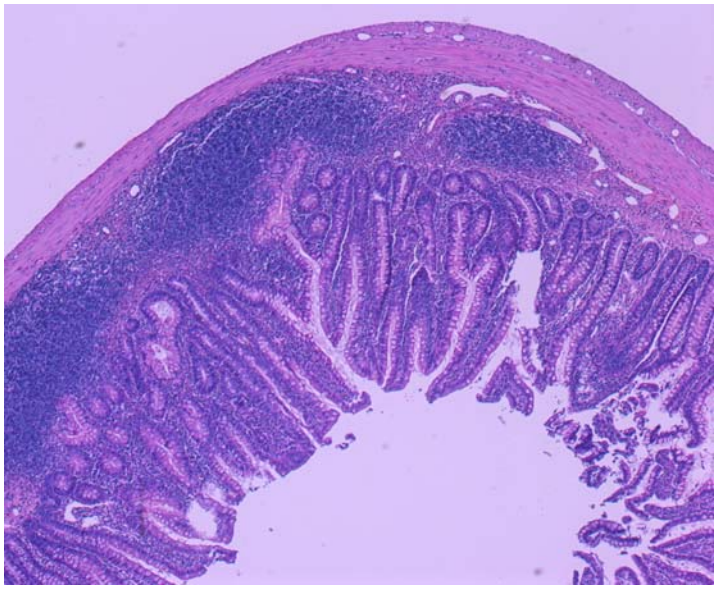
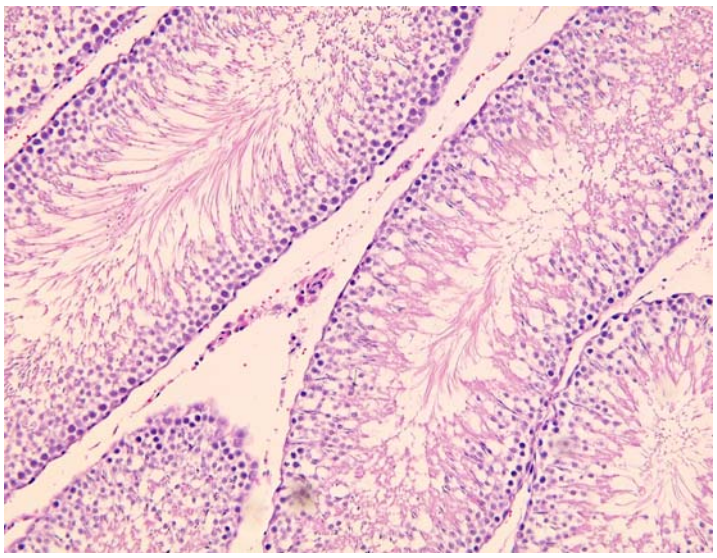
Fig 4.	 H&E stain (200 X)
Fig 5.	 H&E stain (200 X)
Fig 6.	 H&E stain (40 X)

Fig 7.	 (200 x)
Fig 8.	 H&E stain (100 X)
Fig 9.	 H&E stain (200 X)

PRACTICAL TEST 3 : ECOLOGY AND SYSTEMATICS

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: Reconstruct the phylogenetic tree for the given spiders (60 points)

  Task II: Test of species association in a community (40 points)

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- Write down your results and answers in the **Answer Sheet. Answers written in the Question Paper will not be evaluated.**
- Please make sure that you have received all the materials listed for each task. If any of the listed items is missing, please **raise your sign.**
- Use **pen only.** You can use a ruler and a calculator provided.
- **Check the condition of the spiders in the first 5 minutes.** If any of the legs is missing, please **raise your sign. No replacement of the spiders is possible after 5 minutes.**
- Stop answering and put down your pen **immediately** after the end bell rings.
- After test, our lab assistants will check the condition of the spiders and fill out the spider checklist at the end of your answer sheet. **Each undamaged spider in the original vial will get you one bonus point.** Please put down the **Student Code** after the check is done.
- Enclose both the **Answer Sheets** and **Question Paper** in the provided envelope after the spider check is finished. Our Lab Assistants will collect it promptly.

Good Luck!!

Equipments and Materials:

Equipments:

1	Dissecting microscope	1
2	Four sheets of colored pictures and one sheet of black and white picture: Figures (figure 1−3 to 1−12) Figure (figure 2-1)	 4 1
3	Forceps	2
4	Petri dish	2
5	70% ethanol	1
6	Plastic dropper	1
7	1-m quadrat cardboard (represented by a small cardboard in the zip lock bag)	1

Materials:

1	Four spider samples in glass vials (W, X, Y, Z)	1

TASK I: (60 points)

Reconstruct the phylogenetic tree for the given spiders

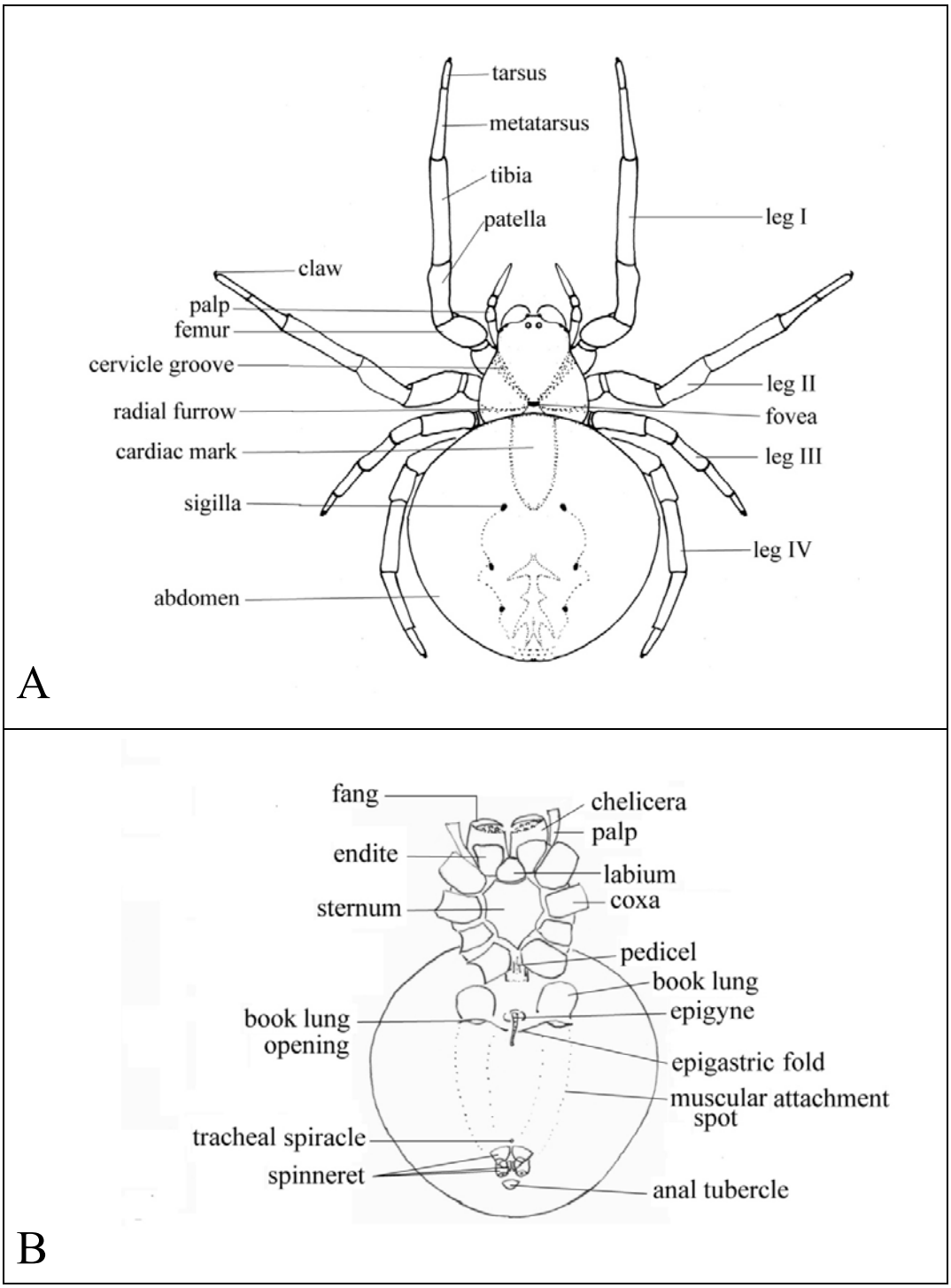


Figure 1-1 External morphology of spider. A. Dorsal view. B. Ventral view.

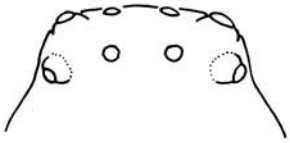
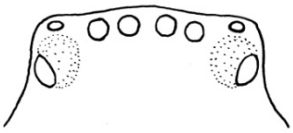
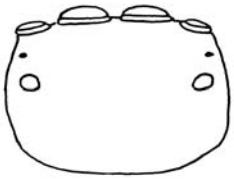
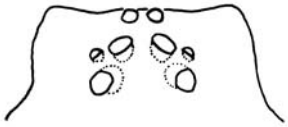
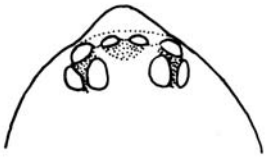
A: two transverse eye rows, with 4 eyes on each eye row 	B: two rows, with 6 eyes on the first eye row 	C: four rows, with 2 first row eyes smallest and 6 posterior eyes arranged in a hexagonal configuration 
D: three rows, with the 4 first row eyes much smaller than the others 	E: three rows, with the 2 anterior median eyes much larger than the others 	F: three rows, with 4 eyes on the second eye row 
G: eight eyes with one diad (a cluster of 2 eyes) and two triads (a cluster of 3 eyes) 	H: six eyes in two triads 	I: six eyes in three diads 

Figure 1-2 Eye arrangements (A key is provided on page 7-9)

Legends and Abbreviations of figures 1-3 to 1-12

Figure 1-3 Book lungs. A. Two pairs. B. One pair.

Figure 1-4 Spinnerets. A. Three pairs. B. Two pairs.

Figure 1-5 Cribellum. A. Absent. B. Present.

Figure 1-6 Calamistrum on metatarsus IV. A. Absent. B. Present.

Figure 1-7 Tarsi claw. A. Three claws. B. Two claws.

Figure 1-8 Claw tufts. A. Absent. B. Present.

Figure 1-9 Base of anterior spinnerets (AS). A. Widely separated. B. Close or in contact.

Figure 1-10 Grades of legs. A. Prograde. B. Laterigrade.

Figure 1-11 Tibia and metatarsus of legs I and II with series of long spines interspersed with much shorter setae. A. Absent. B. Present.

Figure 1-12 Double-rowed trichobothria on femora IV. A. Absent. B. Present.

1-1 Key to species of some common spiders

There are many living creatures in the world. For unfamiliar creatures, scientists usually choose a suitable key, the most commonly used tool, to find out its name. A key uses the dichotomous statements (a or b) of diagnosed characters to divide a larger group of taxa into two smaller subgroups (indicated by numbers or taxon names). Beginning with the number 1, choose a more likely statement (a or b) for the specimen and then go to the number shown at the end of the statement, and so on. Go through the key, until a taxon name is shown. A key for some common spiders of the world is given below.

Key to species of some common spiders

1a Two pairs of book lungs (Fig. 1-3A) ……2

1b One pair of book lungs (Fig. 1-3B) …… 3

2a Three pairs of spinnerets (Fig. 1-4A)……***A. aus***

2b Two pairs of spinnerets (Fig. 1-4B) ……***M. bus***

3a With a cribellum in front of the spinnerets (Fig. 1-5B), and a calamistrum on metatarsus IV (Fig. 1-6B) ……***Z. cus***

3b Without the cribellum and calamistrum (Figs. 1-5A, 1-6A) ……4

4a With six eyes ……5

4b With eight eyes ····· 6

5a six eyes in three diads (Fig. 1-2I) ····· ***S. dus***

5b six eyes in two triads (Fig. 1-2H) ····· ***P. eus***

6a Tarsi with two claws (Fig. 1-7B), with or without claw tufts ····· 7

6b Tarsi with three claws (Fig. 1-7A), never with claw tufts (Fig. 1-8A) ····· 10

7a Eyes in three or four rows (Figs. 1-2C, D, E, F) ·····8

7b Eyes in two rows (Figs. 1-2A, B) ····· 9

8a Eyes arranged in 4-2-2 three rows; with a pair of remarkably large anterior median eyes (AMEs) (Fig. 1-2E)·····***T. fus***

8b Eyes arranged in 2-4-2 three rows (Figs. 1-2F); AMEs not as above ····· ***C. gus***

9a Base of both anterior spinnerets separated from each other or wide apart (Fig. 1-9A); Legs prograde (Fig. 1-10A) ····· ***Z. hus***

9b Bases of both anterior spinnerets in contact (Fig. 1-9B); Legs laterigrade (Fig. 1-10B) ····· ***T. kus***

10a Eye group hexagonal, eyes arranged in 2-2-2-2 four rows (Fig. 1-2C)····· ***O. lus***

10b Eye group not hexagonal····· 11

11a Eyes in two rows (Figs. 1-2A, B)····· 12

11b Eyes in three rows (Figs. 1-2D, E, F)·····***P. mus***

12a Tibia and metatarsus of legs I and II armed with series of long spines interspersed with much shorter setae (Fig. 1-11B) ·····***M. nus***

12b Legs I and II without such spine arrangement····· 13

13a Femora IV with a proximal cluster of double-rowed trichobothria (Fig. 1-12B) ····· ***L. ous***

13b Femora IV without such trichobothria (Fig. 1-12A)····· ***N. pus***

Now, you have four spider specimens coded W to Z, respectively, as shown on outside of the vials. Please key out all these spiders and mark some of their characters with aid of figures 1-1 to 1-12. (**Caution!** You may take out the specimen from the vials for identification. When you do so, you should place a spider in the petridish with some 70% alcohol to examine its characters under the stereomicroscope. Because the spider's body is very fragile, the most ideal way to handle the specimen is gently grasping its legs with forceps to move it in or out from the vial. Don't break spider's body and its legs. Undamaged spiders in their original vials will get extra points as bonus. Please handle everything with care! Spiders should be kept in 70% alcohol at any time to prevent desiccation).

Q1.1.1 (4 points for each correct spider; 16 points total) Match each spider code with the correct taxon name respectively in your **Answer Sheet**.
Note: each spider code can only be used once, or the grades of these cells will not be counted.

Q1.1.2 (0.65 points for each cell; 13 points total) If a spider has the characters listed in the left column of the table in your **Answer Sheet**, indicate with a "＋" and if the character is absent, indicate with a "－". (Penalty of 0.2 points for each wrong answer, minimum 0 point)

1-2 Reconstruct a phylogenetic tree for eight spiders

Data matrix 1-1 represents character entries (a to t) for a group of hypothetical organisms A to H. Based on Data Matrix 1-1, Taxon A serves as the outgroup and the rest 7 species (Taxa B to H) are ingroups. Character state 0 represents the pleisiomorphy (ancestor character) and states 1-6 are apomorphies (derived characters). "-" represents missing character. We may reconstruct a cladogram (cladistic tree) by using the synapomorphies (shared derived characters). Each change represents one step of the evolutionary events (indicated by the character and its state, e.g., e-5, t-4). The following tree (Figure 1-13) is the only resulting most parsimonious cladogram that shows all the character changes on the tree. Numbers 1 to 15 represent 15 steps of the tree.

Data Matrix 1-1

Taxa	Character													
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**m**	**n**	**o**	**p**	**s**	**t**
A	0	0	0	0	0	0	0	0	0	0	0	0	0	-
B	1	1	0	1	5	0	0	1	1	1	0	0	2	-
C	1	1	0	1	6	0	0	0	0	0	0	0	2	-
D	1	1	0	1	3	0	0	0	0	0	0	0	2	-
E	1	1	0	0	1	0	0	0	0	0	0	0	1	3
F	1	1	0	0	1	0	0	0	0	0	1	0	1	4
G	1	1	0	1	4	0	0	1	1	1	0	0	2	-
H	1	1	0	0	1	0	1	1	1	1	0	0	2	-

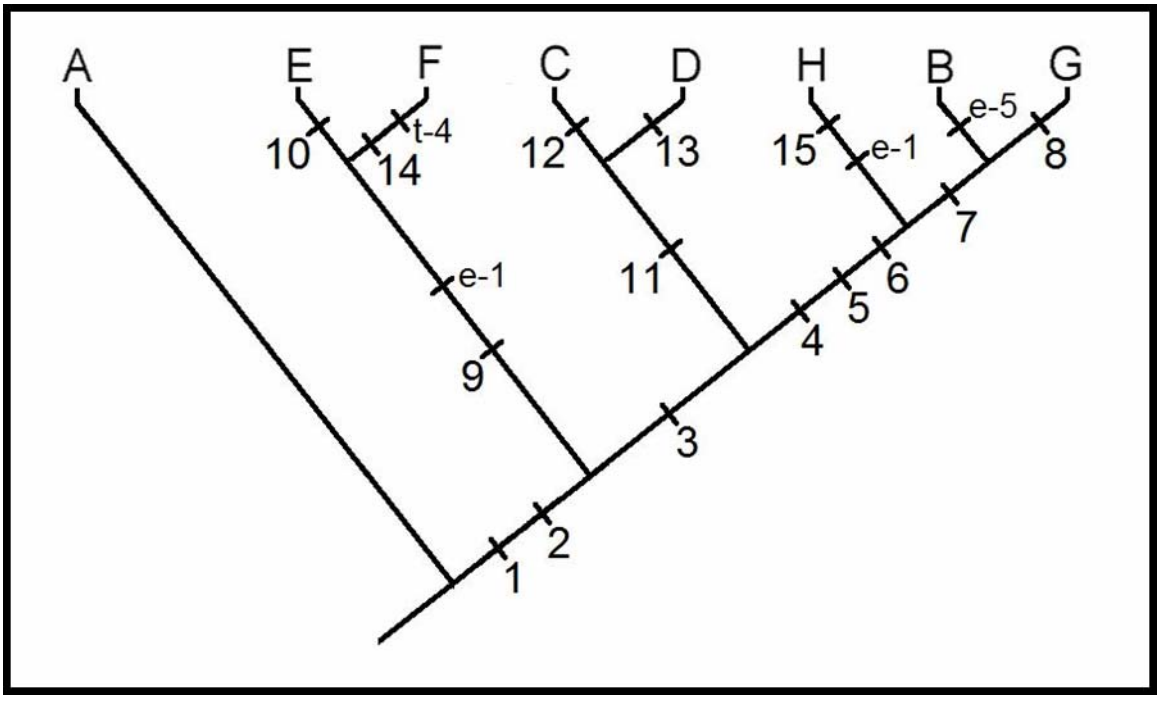


Figure 1-13 The most parsimonious cladogram reconstructed from data matrix 1-1.

Q1.2. (1.2 points for each cell; 18 points total) Fill in the character code and state (e.g., e-1) in the answer sheet for each of the 15 steps.

1-3 Based on the cladogram (figure 1-13), answer following questions:

Q1.3.1. (2 points) How many steps of the cladogram are there in total?

Q1.3.2. (2 points) Besides character e-1, which character is homoplasious (i.e., not homologous character)?

Q1.3.3. (2 points) Which of the following taxon is the sister group of taxon {C, D}?

(A) {E, F} (B) {H, B, G} (C) {F} (D) {H} (E) {B, G}

Q1.3.4. (Each correct answer will get 0.4 points, 2 points total) Mark with an "X" in the "True" cell in the **Answer Sheet** if the characters given below appeared prior to the evolution of character m-1 in the cladogram, otherwise in the "False" cell.

Character
s-1
s-2
a-1
g-1
d-1

Q1.3.5. (1 point for each cell; 5 points total) To what kind of grouping do the following taxa belong? Use code "I" for polyphyletic, "II" for paraphyletic, or "III" for monophyletic grouping.

Taxon
{H}
{B, C, G, H}
{C, D, E, F}
{B, G, H}
{B, E, G}

TASK II: (40 points)

Test of species association in a community

The basic idea of community organization is that species tend to be associated in a nonrandom manner. One way to understand their association conditions is to use a 2 × 2 contingency table (Table 2-1-0): If a sample contains both species x and y, it is defined as type “a”. If a sample contains only species y, species x, or no species, then it is defined as type “b”, “c”, or “d” respectively.

Table 2-1-0

	Species x		
Species y	Present	Absent	Total
Present	a	b	a+b
Absent	c	d	c+d
Total	a+c	b+d	n

$n = a + b + c + d$

Probability of obtaining species x $P(x) = (a+c)/n$

Probability of obtaining species y $P(y) = (a+b)/n$

Joint probability (JP): the probability of both species x and y are present

$JP = P(x) \times P(y)$

Expected joint occurrences $= n \times JP$

Significance level for Chi-squared statistical test (χ^2)

Significance level (α) / df	0.05	0.01
1	3.841	6.635
2	5.991	9.210
3	7.815	11.345

Figure 2-1 (The figure on a separate paper on your table) is a distribution map of two plant species, Plant-A (○) and Plant-B (●), and a sympatric spider species, Spider (✻), in a hypothetical community. Each square is 0.5 × 0.5 m^2.

2-1 Association between Plant-A (○) and Spider (✻): analyzed by quadrat method.

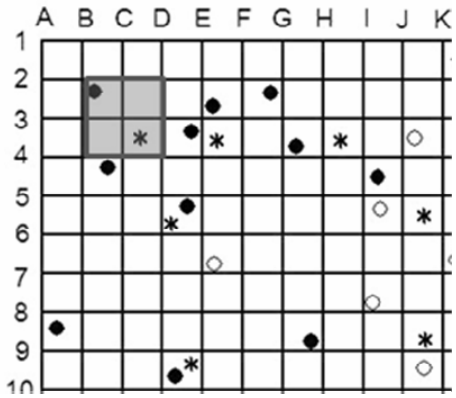
Put a 1-m square quadrat on Figure 2-1 using the following 40 randomly assigned coordinates as the center (i.e., 2 × 2 complete squares) and determine the type of each quadrat.

N-11, S-8, F-10, Q-18, O-16, K-2, L-4, M-17, M-4, H-17

X-2, K-11, T-19, M-8, P-10, G-8, B-19, M-19, S-10, O-12

J-18, D-7, B-17, I-11, B-10, G-13, V-16, C-3, F-5, R-15

L-2, Q-11, R-5, G-11, K-10, T-10, X-9, R-3, O-3, F-16



C-3 for example:

Q2.1.1. (1 point each; 9 points total) Write down your results in Table 2-1-1 and complete all the blank cells.

Answer the following in your Answer Sheet:

Q2.1.2a. (0.6 points) Calculate P (Plant-A).

Q2.1.2b. (0.6 points) Calculate P (Spider).

Q2.1.2c. (0.6 points) Calculate JP (Plant-A and Spider)

Q2.1.2d. (0.6 points) Calculate the expected joint occurrences.

Q2.1.2e. (0.6 points) Two species are more likely to be positively associated if the actual observation of the joint occurrence is greater than the expected one, and negatively associated if the actual observation is smaller than the expected one. According to the expected joint occurrence, what can be hypothesized about the kind of the association between Plant-A and Spider? [Answer Code: P for positive association, N for negative association.]

2-1-3 A simple Chi-squared statistical test (χ^2) with one degree of freedom (df = 1) is calculated as follows:

$$n = a + b + c + d$$

$$\chi^2 = \frac{n\,(ad-bc)^2}{(a+b)(c+d)(a+c)(b+d)}$$

Q2.1.3. (2 points) Based on Table 2-1-1, Calculate χ^2**. (to the fourth decimal place)**

2-1-4 The strength of the association between the two species can be estimated from a coefficient (V) defined as follows:

$$V = \frac{ad - bc}{\sqrt{(a+b)(c+d)(a+c)(b+d)}}$$

The V value varies from -1 (strongly negative association) to +1 (strongly positive association) and it is zero when there is no association.

Q2.1.4a. (2 points) Calculate the V value from Table 2-1-1. **(to the fourth decimal place)**

Q2.1.4b. (2 points) According to the V value, what can be hypothesized about the strength of the association between the two species? (Mark your answer with an "X" in the cell on the **Answer Sheet**)

2-2 The following table shows data using 40 randomly placed 2-m square quadrats.

Table 2-2-1

Plant-A (○)	Spider (∗)		Total
	Present	Absent	
Present	14	16	30
Absent	8	2	10
Total	22	18	40

The expected joint occurrence is 16.5.

The Chi-squared statistical test (χ^2) with one degree of freedom (df = 1) is calculated as $\chi^2 = 3.3670$.

V = -0.2901

Based on Table 2-2-1 answer following questions:

Q2.2.1a. (2 points) According to the expected joint occurrence, what can be hypothesized about the kind of the association between Plant-A and Spider? [Answer Code: P for positive association, N for negative association]

Q2.2.1b. (2 points) According to the V value, what can be hypothesized about the strength of the association between the two species? (Mark your answer with an "X" in the cell on the **Answer Sheet**)

2.2.2. (6 points total) Mark with an "X" on the **Answer Sheet** for each statement whether it is true or false.

Q2.2.2a. (2 points) Both tests of association using 1-m and 2-m square quadrats (sections 2-1 and 2-2) allowed us to reject the null hypothesis of random distribution.

Q2.2.2b. (2 points) The larger the quadrat size used, the more accurate the results.

Q2.2.2c. (2 points) Increasing the sampling efforts in the quadrat method should improve the accuracy of the results of species association.

2-3 Association between Plant-A (○) and Plant-B (●): analyzed by the nearest neighbor method.

Tally up the frequencies of the nearest neighbor of each plant systematically for all individuals. Fill in the totals in the table printed in the Answer Sheet.

Q2.3.1. (0.5 points for each cell; 3 points total) Write down your results in Table 2-3-1 and complete all the blank cells.

Q2.3.2a. (2 points) Based on Table 2-3-1 with one degree of freedom (df = 1), calculate χ^2.

(to the fourth decimal place)

Q2.3.2b. (3 points) Are these two plant species randomly distributed, associated or segregated? (Mark your answer with an "X" in the cell)

2-4 Mark with an "X" on the **Answer Sheet** for each statement whether it is true or false. **(4 points total)**

Q2.4.1. (2 points) The null hypothesis of the χ^2 test for the nearest neighbor method is that both Plant-A and Plant-B are randomly distributed.

Q2.4.2. (2 points) Using the nearest neighbor method to test species association can avoid the quadrat-size effect.

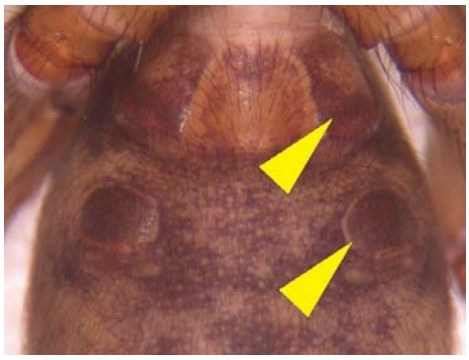
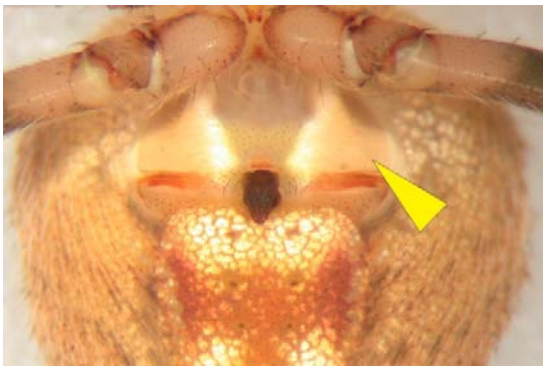
A: two pairs	B: one pair
	

Figure 1-3 Book lungs

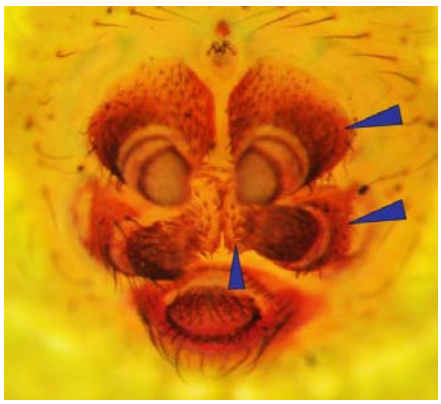
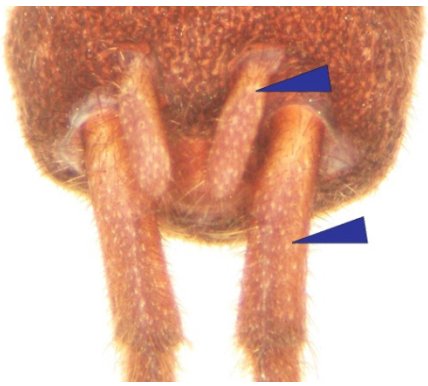
A: three pairs	B: two pairs
	

Figure 1-4 Spinnerets

A: absent	B: present
	

Figure 1-5 Cribellum

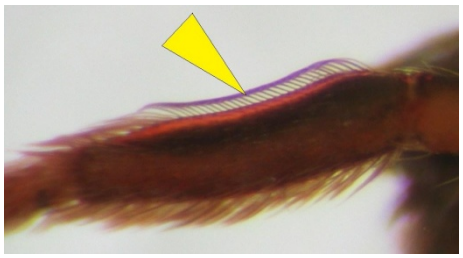
A: absent	B: present
	

Figure 1-6 Calamistrum on metatarsus IV

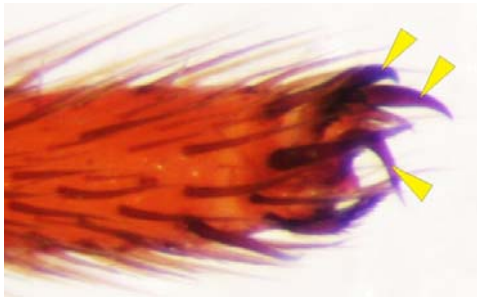
A: three claws	B: two claws
	

Figure 1-7 Tarsi claws

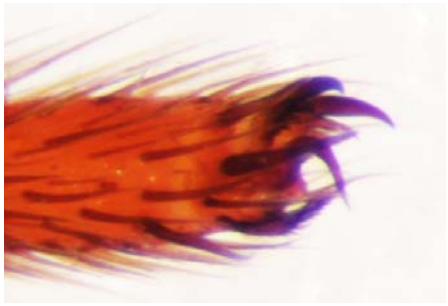
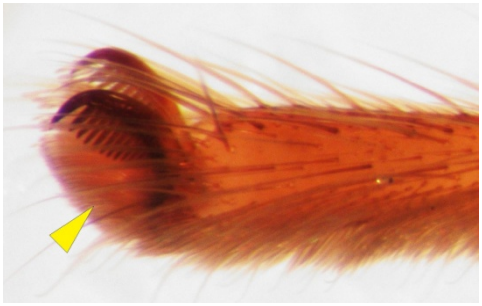
A: absent	B: present
	

Figure 1-8 Claw tufts

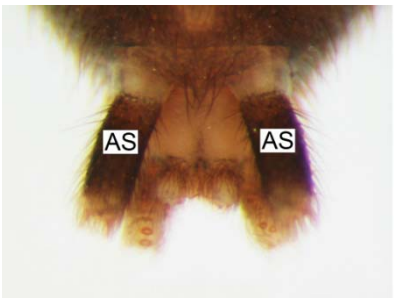
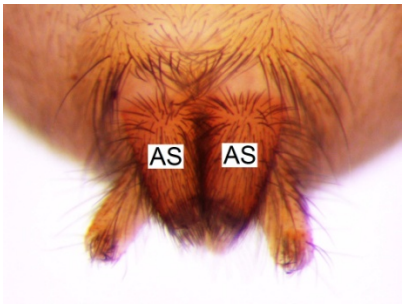
A: widely separated	B: close or in contact
	

Figure 1-9 Base of anterior spinnerets (AS)

A : prograde	B: laterigrade
	

Figure 1-10 Grades of Legs

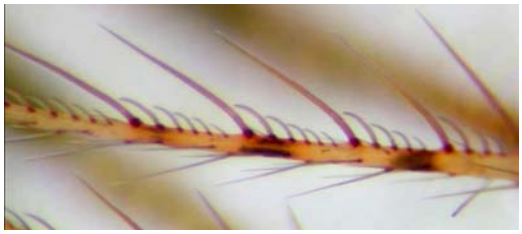
A: absent	B: present
	

Figure 1-11 Tibia and metatarsus of legs I and II with series of long spines interspersed with much shorter setae.

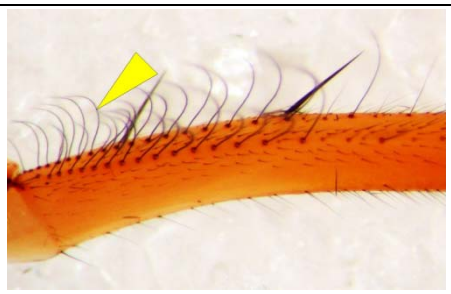
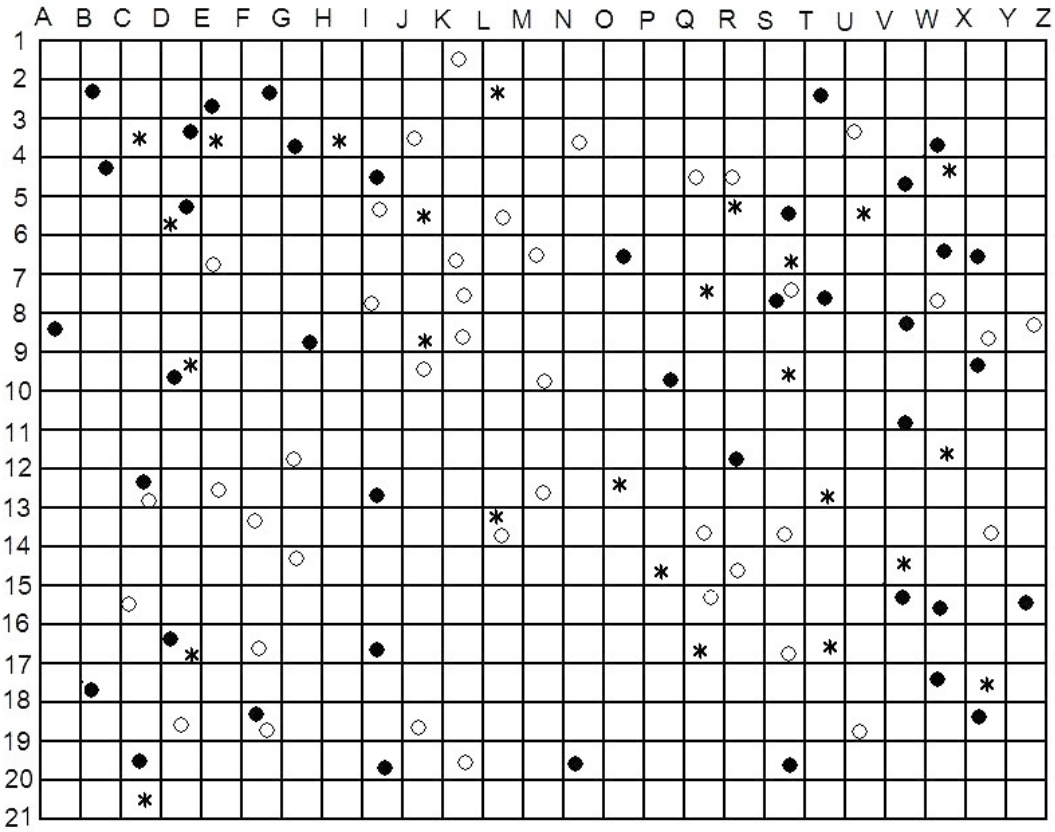
A: absent	B: present
	

Figure 1-12 Double-rowed trichobothria on femora IV


A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

PRACTICAL TEST 4 : PLANT ANATOMY, PHYSIOLOGY, AND GENETICS

Total Points: 100 Duration: 90 minutes

Dear Participants,

- In this test, you have been given the following 2 tasks:

  Task I: Plant anatomy (**60 points**)

  Task II: Plant physiology and genetics (**40 points**)

- Check your **Student Code** on the **Answer Sheet** and **Template paper** before starting the test.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Make sure that you have received all the materials listed for each task. If any of the listed items is missing, **lift the sign.**
- Ensure that you organize the sequence of your tasks efficiently.
- Stop answering **immediately** after the end bell rings.
- After test, enclose the **Answer sheets**, **Question paper**, **Data printout**, and the **Template paper (without slides)** in the provided envelop. Our lab assistant will collect it promptly.
- No paper or materials should be taken out of the laboratory.

Good Luck!!

Task I (60 points)

Plant Anatomy

Equipments:	**Quantity**
1. Slides (in carrier box)	20
2. Cover slips (in carrier box)	30
3. Compound microscope (with 4X, 10X, and 40X objective lenses)	1
4. Ocular micrometer (installed within the lens)	1
5. Single sided razor blade (in carrier box)	5
6. Petri dish (in carrier box)	1
7. Forceps (in carrier box)	1
8. Marker pen	1
9. Kimwipes	1
10. Paper towel	1
11. Waste basket	1

Materials:	**Quantity**
1. Double distilled water (labeled as "ddH_2O" in carrier box)	20 mL/vial
2. 1 N hydrochloric acid (HCl) (in carrier box)	5-10 mL/vial
3. Transparent nail polish (in carrier box)	1 vial
4. Section slides X, Y, and Z of the root of plant K in slide box K	1 slide each
5. Four-compartment plastic petri dish (Containing tissue samples from plants V, W, M, N, P, Q, R, S in each compartment)	2 petri dishes
6. Template paper (with student code) for placing the slides with sections you made and for documenting	1 sheet

Part A: Structure of Plant Root (10 points total)

Introduction :

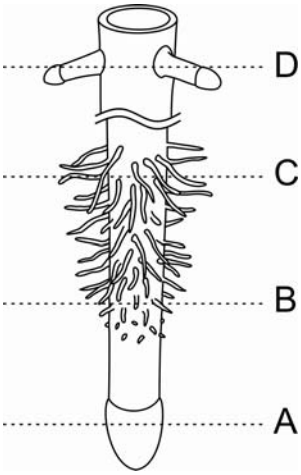


Figure 1 The structure of a typical plant root tip

There are three slides (X, Y, and Z) that are the transverse sections (located within the circular label on the slides) from different regions of the root of plant K. You need to determine whether plant K is monocot or dicot to answer questions later. Observe these sections under microscope and answer the following questions.

Q1.A.1.（2 point each, 6 points total）

Section X, Y, and Z each corresponds to which part of the root depicted in Figure 1. Check [X] the correct answers on the answer sheet.

Q.1.A.2. （single answer, 4 points）

What is the direction of maturation of primary xylem in the root (tissues mature earlier → tissues mature later)? Check [X] the correct answers on the answer sheet.

Part B: Structure of Plant Stem（6 points total）

Introduction :

Carefully prepare transverse sections of proper thickness from the stem segments of plants V and W and place them on separate slides. Add a drop of water onto the sections and cover with cover slips.

Observe under the microscope, and answer the following questions. You need to determine whether plants V and W are monocot or dicot to answer questions later. **When you finish this part, place your slides with the sections on the template paper, lift the sign and the lab assistant will mark with stamp in the boxes with slides.**

Q.1.B.（3 points for each plant, points are given when all correct answers are selected; 6 points total）

What are the distribution patterns of vascular bundles in the stems of plants V and W? Check [X] the correct answers on the answer sheet.

Part C: Structure of Plant Leaf（14 points total）

Introduction :

First determine the upper and lower epidermis of the leaves of plants M and N. Answer the following questions. You need to determine whether plants M and N are monocot or dicot to answer questions later. **When you finish this part, place your slides with the sections on the template paper, lift the sign and the lab assistant will mark with stamp in the boxes with slides.**

.

Q.1.C.1（8 points）

Observation of stomata of plant M:

Prepare the upper and lower epidermis strips of the leaves, either by peeling them off with bare hands or by scraping off the undesired parts and leaving only the epidermis. Place these epidermal tissues on separate slides, with the epidermal side facing upward. Add a drop of water on each tissue sample and cover with cover slip. Observe under the microscope and use the ocular micrometer for measurements. One smallest unit of scale length of the micrometer is approximately 30 μm when observing under 4X objective lens. Answer the following questions in the answer sheet.

(a) Measurement of stomatal size on upper epidermis:

i) Under the 40X objective lens, what is the length of each smallest scale unit of the ocular micrometer? (1 point)

ii) Measure the lengths of 3 guard cells, then average their lengths. (3 points)

(b) Measurement of stomatal density on lower epidermis:

i) Under 40X objective lens, what is the approximate area of the field of view? (1 point)

ii) Observe 3 fields of view, and calculate the number of stomata in each. Then work out the average stomatal density. (3 points)

Q.1.C.2 （6 points, points are given when all correct answers are selected）

Observation of leaf tissue of plant N:

Use the provided transparent nail polish to paint the upper and lower epidermis of leaves. When the nail polish has dried, carefully peel off the layers and place on separate slides, with the epidermal side facing upward. Add a drop of water on each sample, cover with cover slips. Use the appropriate objective lens to observe. Determine the stomatal distribution of the upper and lower epidermis, and deduce the habitat of plant N. Check [X] the correct answers on the answer sheet.

Part D: Monocot or Dicot Plants (5 points)

Q.1.D (1 point each, 5 points total)

Determine whether plants K, V**,** W, M, and N are monocot or dicot. Check [X] the correct answers on the answer sheet.

Part E: Calcium Crystals in Plant Cells（20 points）

Introduction :

Some plants have idioblasts that can form polygonal calcium oxalate crystals or calcium carbonate crystals. Use the four plant materials (P, Q, R, S), carefully prepare transverse sections of appropriate thickness with a clean razor blade, and place the sections on separate slides. Add a drop of water on each section, and cover with cover slips. Observe under the microscope and check for the presence of crystals. If the crystals are present, locate the region of crystal distribution in the tissue (most crystals present in or absent from the cells of vascular bundles), carefully open the cover slip, remove the excess water around the sections, and add a few drops of HCl. Add cover slips again and observe the samples under the microscope and deduce the types of crystals that are present. **When you finish this part, place your slides with sections on the template paper, lift the sign and the lab assistant will mark with stamp in the boxes with slides.**

.

Q.1.E （6 points for each plant with the presence of crystals, points are given when all correct answers are selected ; 2 points for the plant with the absence of crystals; 20 points total）

According to your observation, fill in the corresponding letters in the table in the answer sheet.

Plants: P, Q, R, S

Location of crystals: **A** (most crystals present in cells of vascular bundles)

B (crystals absent from the cells of vascular bundles)

Crystal type: **C** (polygonal calcium oxalate crystal) ; **D** (calcium carbonate crystal)

Documentation

When you finish all the parts (A to E) of Task I, double check whether you have collected all the stamps for this Task. If not, lift the sign and the lab assistant will check your template sheet. (0.5 point for each slide present, 5 points total).

Task II (40 points)

Plant Physiology and Genetics

Shared Equipment

ELISA reader

Equipments:

		Quantity
1.	Micropipettes P200 and P1000	1 each
2.	Micropipettes tips for P200 and P1000	1 box each
3.	96-well microplate	1
4.	1.5 mL microcentrifuge tubes (for preparation of standard solutions, use those labeled 0 μM, 25 μM 50 μM, 100 μM, 200 μM, 400 μM)	12 (6 extra unlabeled)
5.	80-well microcentrifuge tube rack / 4-way test tube rack	1 each
6.	Vortex mixer	1
7.	Marker pen	1

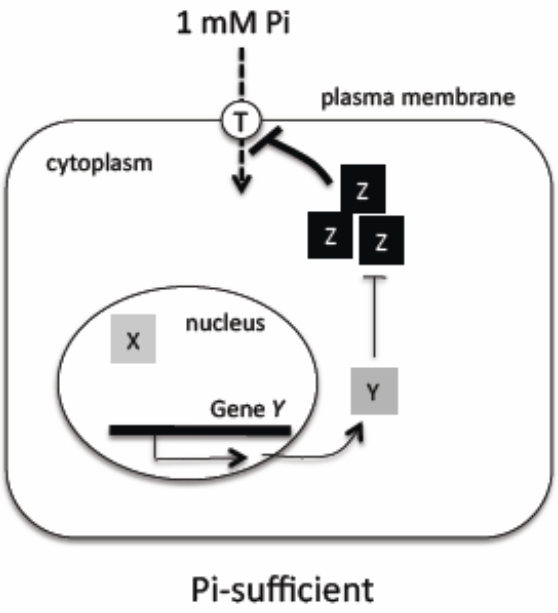
Materials:

		Quantity
1.	Phosphate detection solution (labeled as “Solution A”)	10 mL/tube
2.	400 μM KH_2PO_4 solution (labeled as “Solution B”)	10 mL/tube
3.	Double distilled water (labeled as “ddH_2O”)	50 mL/vial
4.	6 samples to be tested (allotted in microcentrifuge tubes, labeled as samples #1, #2, #3, #4, #5, & #6)	

Introduction:

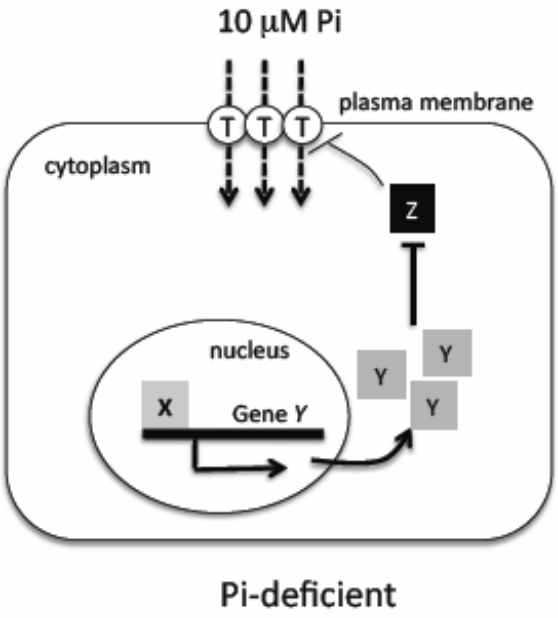
Phosphate is an important plant nutrient that constitutes substances such as cell membranes, nucleic acids, and energy compounds like ATP. When lacking phosphates, plants' growth and development can be dramatically affected. Plants can sense changes in phosphate concentration in the environment and accordingly regulate their gene expressions, changing the activity of phosphate transport proteins on the cell membranes to maintain the homeostasis of phosphate concentration within. Using the model plant *Arabidopsis*, scientists discovered that root cells respond to phosphate-sufficient (Pi-sufficient; e.g. 1mM) or phosphate-deficient (Pi-deficient; e.g. 10μM) condition as depicted below in Figures 2 and 3, respectively:

Figure 1



Pi-sufficient

Figure 2



Pi-deficient

When *Arabidopsis* is in Pi-sufficient condition (Figure 2), the protein Z negatively regulates the level of the protein T on plasma membrane, which is responsible for the transport of phosphate into the cell, to avoid excessive phosphate absorption that leads to toxicity. On the other hand, when plant is in Pi-deficient condition (Figure 3), the transcription factor X will enhance the expression of gene *Y* and thus increase the level of protein Y. Protein Y can promote the degradation of protein Z, leading to the increase of protein T level, and consequently a higher absorption of phosphate. In

general, the phosphate level in the shoot of a plant is proportional to the uptake efficiency of phosphate in the root.

The phosphate level in plants will be considerably affected when the expression of genes encoding T, X, Y, and Z is perturbed by mutation or transgene. Therefore, plant biologists can utilize such mutant or transgenic plants to determine the role and relationship of these genes in the regulatory mechanism of phosphate homeostasis.

There are 6 samples in microcentrifuge tubes, which are extracts from the shoots of five *Arabidopsis* lines (A to E) grown under either Pi-sufficient (1 mM) or Pi-deficient (10 μM) condition (as listed in Table 1). *Arabidopsis* A is wild type and B to E are either knockout (KO; null mutant with complete loss of function of the gene) mutant line or over-expression line corresponding to gene *T*, *X*, *Y*, or *Z*. You will be measuring the phosphate level in each sample and determine the identities of the samples based on the principles shown in Fig. 2 and 3. Each sample is derived from 20 seedlings of fresh weight shown in Table 1 and brought to final volume of 10 mL with ddH_2O .

Table 1

Sample No.	Plant	[Pi] in medium	Fresh weight of seedlings (mg)
1	A	1 mM	40.4
2	A	10 μM	17.3
3	B	1 mM	28.0
4	C	1 mM	39.2
5	D	1 mM	30.6
6	E	1 mM	33.8

Use the provided equipments and solutions to measure the phosphate concentration in each sample according to the experimental procedures

Experimental Procedures:

1. Use the 400 μM KH_2PO_4 solution (Solution B), ddH_2O, and pre-labeled 1.5 mL microcentrifuge tubes to prepare the following concentrations of phosphate solutions for standard curve: 0, 25, 50, 100, 200, 400 μM. Use vortex mixer to mix solutions thoroughly. For each concentration, there should be at least 0.5 mL. Use the P200 micropipette with fresh tips to transfer 0.1 mL of each standard solution into the 96-well microplate at specified positions (as in Figure 4, make 2 replicates for each standard).

Figure 4 Positions of standards and samples in 96-well microplate

			Standards			Samples			Standards				
A			0		#1	#1		0					
B			25		#2	#2		25					
C			50		#3	#3		50					
D			100		#4	#4		100					
E			200		#5	#5		200					
F			400		#6	#6		400					
G													
H													
	1	2	3	4	5	6	7	8	9	10	11	12	

2. Transfer 0.1 mL of each sample into the 96-well microplate at specified positions (as in Figure 4, make 2 replicates for each sample).
3. Add 0.1 mL of the phosphate detection solution (Solution A) into the wells that contain the standards and the samples. Mix by gently tapping the side of the plate.
4. **Lift the sign** after you finish Step 3, and wait for lab assistants to guide and help you with measuring the absorbance of the reaction mixtures with ELISA reader at 820 nm.
5. The lab assistant will print out the data for you. **Put your student code on the print-out**.
6. Answer the following questions:

Q.2.1. (18 points total)

Calculate the mean values of the absorbance for each sample and standard. Use the graph paper on the answer sheet to plot a standard curve. **(0.5 point for each standard point correctly plotted)**

Determine the phosphate concentrations of the samples in μM and the nmol phosphate per mg of seedling fresh weight for sample # 1 to # 6. Fill in your results in the table of answer sheet. **(2 points for each phosphate concentration measured, 0.5 point for each nmol/mg of phosphate calculated)**

Q.2.2. (Multiple answers, 4 points. Points given when all correct answers are selected)

For each of the following statements, determine whether they are true or false explanations for those plants having higher phosphate content (nmol/mg) than the wild type. Check [X] the correct answers on the answer sheet.

(A) X cannot be activated in the plant, thus leading to an increase in phosphate uptake.

(B) Loss-of- function of Gene *Y* in the plant causing an increase in phosphate uptake.

(C) Loss-of-function of Gene *Z* in the plant causing an increase in phosphate uptake.

(D) The plant harbors a transgene over-expressed gene *Y*, causing the loss of inhibition of protein T, leading to higher activity in phosphate uptake.

(E) Protein T of the plant has a defect, and it is unable to transport phosphate efficiently.

(F) The transcription factor X of the plant has a mutation, and is incapable to bind the promoter of gene *Y.*

Q.2.3. (2.5 points each, 10 points total)

According to the results from the experiment, assign the corresponding plant (B, C, D, or E) to the correct description on the answer sheet.

Q.2.4. (Single answer, 4 points)

If wild type plant (W), gene *X* knockout mutant (X), and gene *Y* knockout mutant (Y) were all grown in the same Pi-deficient condition, what would be the phosphate level in their shoots (rank from the lowest to highest)? Check [X] the correct answer on the answer sheet.

(A) X < W < Y

(B) Y < W < X

(C) W < X < Y

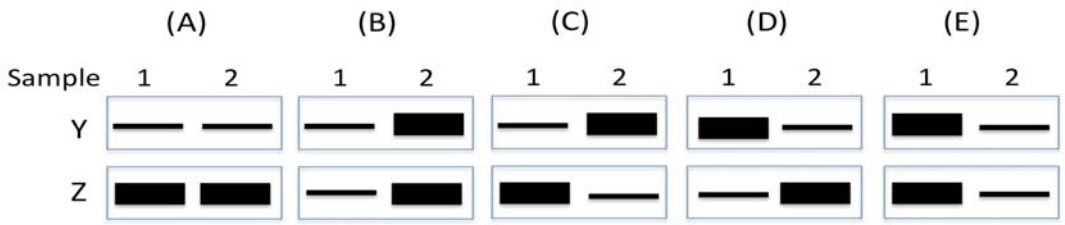
(D) W < Y < X

(E) X < Y < W

(F) Y < X < W

Q.2.5. (Single answer, 4 points)

Western blot is a technique to detect specific protein level with the use of antibody. Which of the following would be the most likely result of the Western blot analysis of protein Y and Z from the total protein extracts of samples # 1 and # 2? Check [X] the correct answer on the answer sheet.



Template paper for Task I (0.5 point for each slide present, 5 points total).

Part	Plant	
Part B	Plant V	Plant W
Part C	Plant M (upper epidermis)	Plant M (lower epidermis)
	Plant N (upper epidermis)	Plant N (lower epidermis)
Part E	Plant P	
	Plant Q	
	Plant R	
	Plant S	

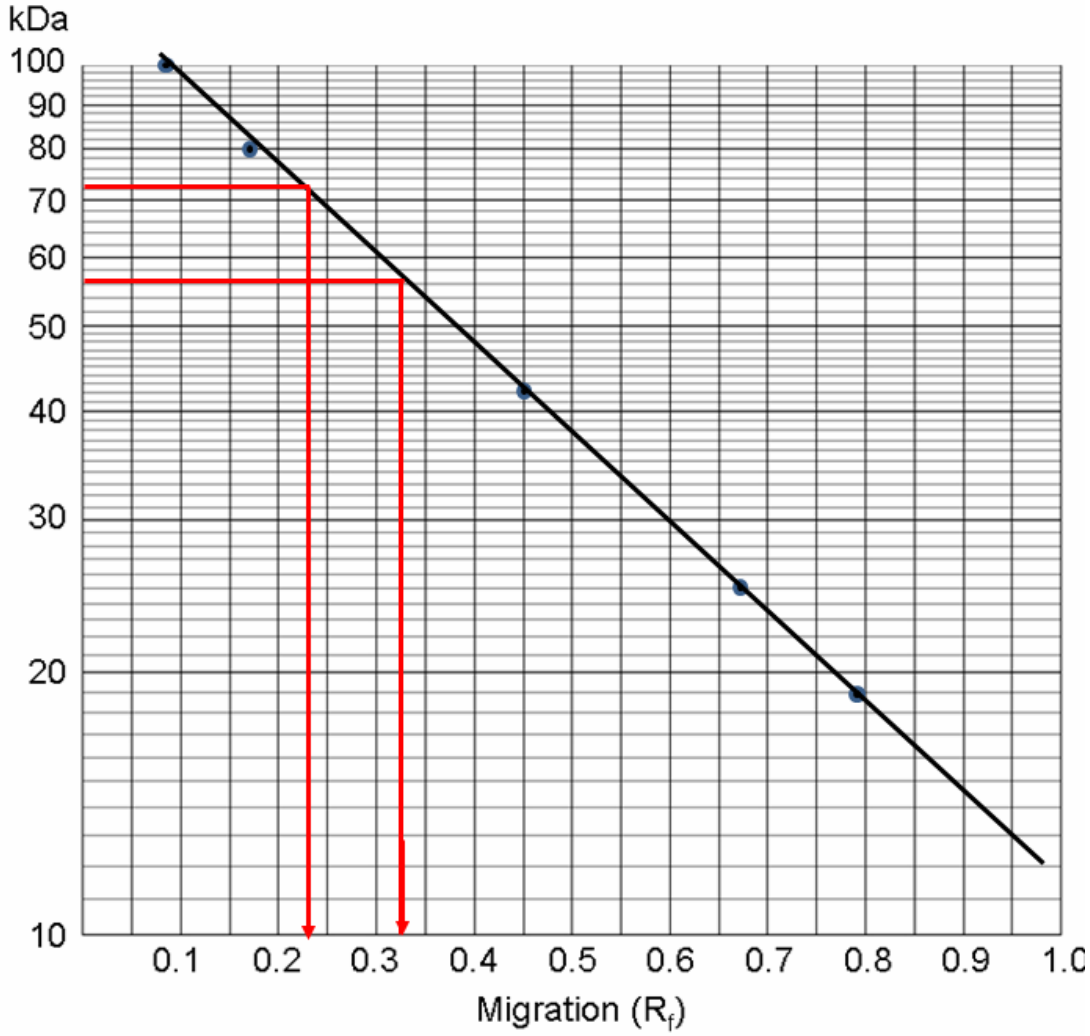
(4) Answer key

PRACTICAL TEST 1 : BIOCHEMISTRY AND CELL BIOLOGY

Q.1.1. (2 points)

Anode (+ charge)	Start point	Dye-front
		X

Q.1.2. (4+4 points)



Protein	Lane A	Lane B
Molecular weight (kDa)	**56 (53-59)**	**72 (68-76)**

Q.1.3. (5 points)

	57 kDa	33 kDa
Number	**2**	**4**

Q.1.4. (5 points)

	Amino acid	Nucleotide
Number	**300**	**900**

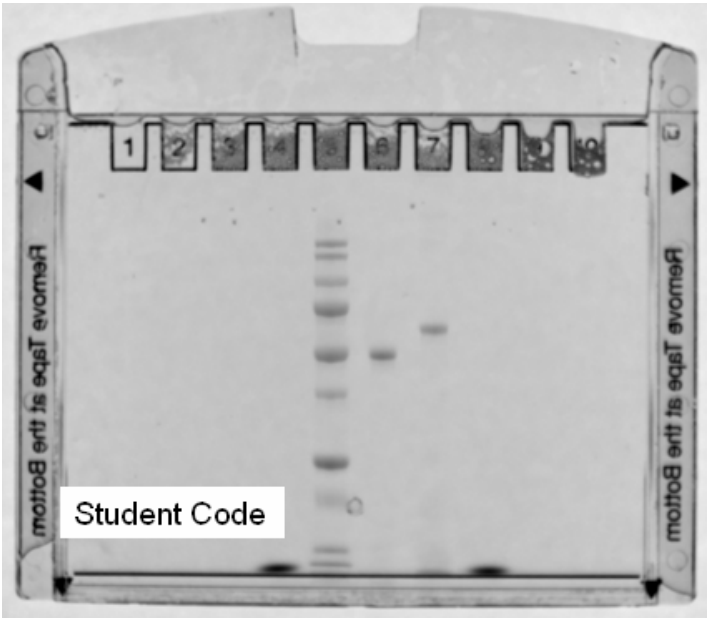
Q.1.5. (5 points)

DNA	:	Protein
18	**:**	**1**

Q.1.6. (5 points)

P : Q = **1 : 2**

Task I photo - protein electrophoresis (5 points)



Task II result sheet - Protein quantification

BSA

X

Y

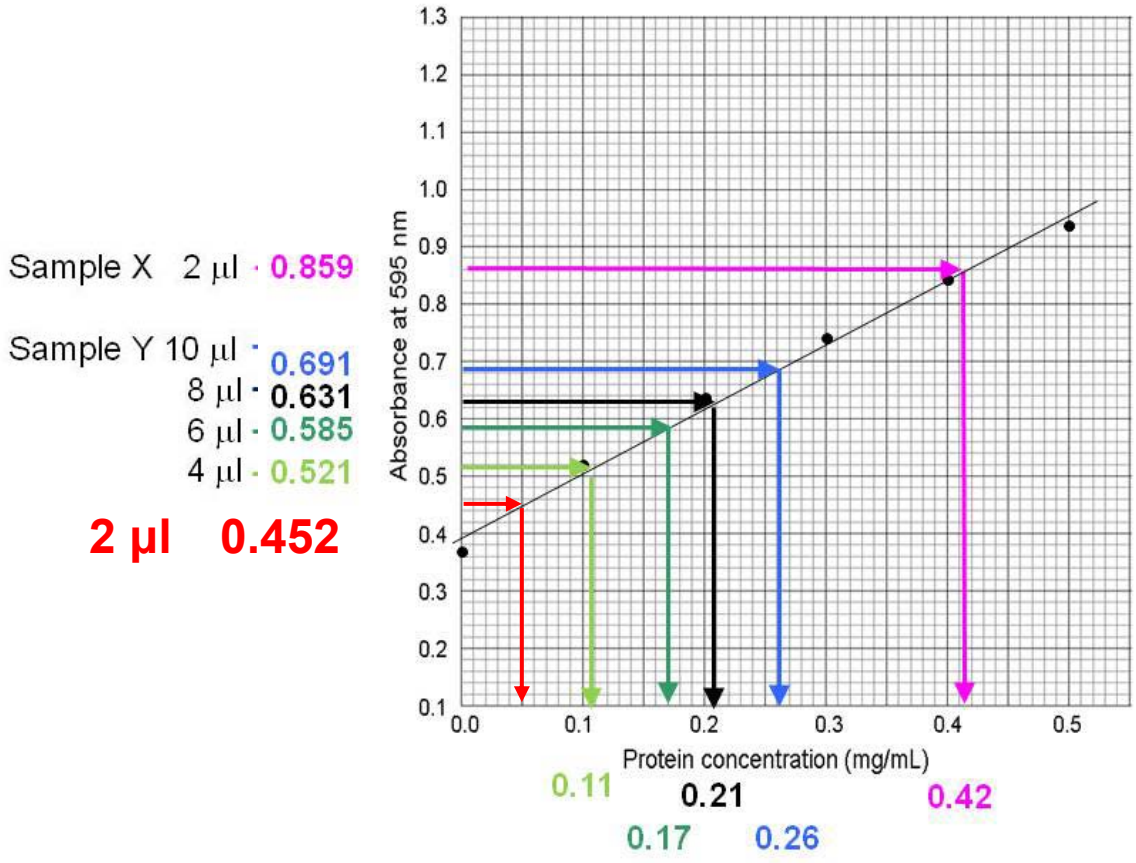
Absorbances Filter 1: 595nm

	1	2	3	4	5	6	7	8	9	10	11	12
A	0.369	0.503	0.635	0.729	0.813	0.935	0.045	0.045	0.044	0.044	0.044	0.045
B	0.371	0.539	0.634	0.746	0.825	0.929	0.045	0.045	0.044	0.044	0.044	0.044
C	0.044	0.045	0.044	0.045	0.045	0.044	0.045	0.044	0.044	0.044	0.044	0.044
D	0.062	0.885	1.121	1.299	1.371	1.412	0.045	0.044	0.044	0.044	0.044	0.044
E	0.044	0.833	1.130	1.236	1.314	1.430	0.044	0.044	0.044	0.045	0.044	0.044
F	0.044	0.044	0.044	0.044	0.044	0.044	0.045	0.044	0.044	0.044	0.044	0.044
G	0.044	0.445	0.524	0.584	0.634	0.689	0.045	0.045	0.044	0.044	0.044	0.044
H	0.045	0.459	0.517	0.587	0.628	0.693	0.044	0.044	0.044	0.044	0.045	0.044

Q.2.1.1. (5 points)

Materials	Well of a microplate					
	A1 & B1	A2 & B2	A3 & B3	A4 & B4	A5 & B5	A6 & B6
0.5 mg/mL BSA (µL)	0	2	4	6	8	10
H_2O (µL)	10	8	6	4	2	0
Diluted BSA concentration (mg/mL)	0	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**

Q.2.1.2. (5 points) Standard curve for BSA



Q.2.2. (12 points)

	Solution X					Solution Y				
Sample volume (µL)	**2**	4	6	8	10	2	**4**	**6**	**8**	**10**
H_2O (µL)	**8**	6	4	2	0	8	**6**	**4**	**2**	**0**
Optical density - OD_{595} nm	**0.859**					**0.452**	**0.521**	**0.586**	**0.631**	**0.691**

out of range

Q.2.3. (8 points)

Concentration of X (mg/mL)	Concentration of Y (mg/mL)
2.0 (1.6-2.4)	**0.26 (0.21-0.31)**

Q.3.1.1. (5 points)

Tube	A1	A2	A3	B1	B2	B3
Color change				**X**		

Q.3.1.2. (2 points)

Buffer	A	B
		X

Q.3.2. (5 points)

A	B	C	D	E
X				

Q.3.3. (4 points)

A	B	C	D
	X		

Q.3.4. (5 points)

A	B	C	D	E
				X

Q.3.5. (4 points)

A	B	C	D
X			

Q.3.6. (5 points)

G-10	G-15	G-25	G-50	G-75	G-100	G-150	G-200
			X				

Q.3.7. (5 points)

20

PRACTICAL TEST 2 : ANIMAL PHYSIOLOGY AND ANATOMY

Q.1.1. (9 points) When you have finished the above five steps, **lift the sign** to notify the Lab assistant to videotape the contraction.

The 1st checkpoint	Points	Lab assistant signature
Leg limb muscle contraction	0 or 9	

Q.1.2. (8 points) When you have finished the steps 6 to 10, **lift the sign** to notify the Lab assistant to videotape the contraction.

The 2nd checkpoint	Points	Lab assistant signature
Indicate the sciatic nerve correctly (nerve must be intact)	0 or 4	
Gastrocnemius contraction	0 or 4	

Q.1.3. (40 points) When you have finished the steps 11-12, **lift the sign** to notify the Lab assistant for checking the results and videotape the contraction.

The 3rd checkpoint	Points	Lab assistant signature
Isolation of "sciatic nerve" (must be more than 2 cm)	0 or 15	
Isolation of "gastrocnemius" (must be intact; including A and B parts)	0 or 15	
Contraction of the isolated sciatic nerve-gastrocnemius tissue.	0 or 10	

Q.2.1. (30 points) Match each tissue section (A to J) with its correct name from 20 different tissue/organ names listed in above table. (Note: only one correct answer for each specimen). Fill in the correct number in the answer sheets.

Slide specimen	Answers（3 points each）
A.	**4**
B.	**9**
C.	**15**
D.	**10**
E.	**14**
F.	**11**
G.	**18**
H.	**5**
I.	**12**
J.	**17**

Q.2.2. (13 points) **Correctly write down the functional symbols, i.e. the alphabetic letters (A to K), on the answer sheets.** Match the organ with their functionalities. Note: some organs may have more than one function (1 point will be deducted for each incorrect answer, minimum score will not be less than zero).

Figure	Functional symbol
1.	**B,E**
2.	**A**
3.	**C**
4.	**D,E**
5.	**F**
6.	**I ,K**
7.	**J**
8.	**G,H**
9.	**I**

PRACTICAL TEST 3 : ECOLOGY AND SYSTEMATICS

Q.1.1.1. (4 points for each correct spider; 16 points total)

Note: each spider code can only be used once, or the grades of these cells will not be counted.

Taxon name	Spider code
A. aus	
C. gus	
L. ous	**Z**
M. bus	
N. pus	**Y**
O. lus	**W**
P. eus	

Taxon name	Spider code
P. mus	**X**
P. nus	
S. dus	
T. fus	
T. kus	
Z. cus	
Z. hus	

Q.1.1.2. (0.65 points for each right answer cell; 13 points total)

(Penalty of 0.2 point for each wrong answer, minimum 0 point)

Spider Code / **Character**	**W**	**X**	**Y**	**Z**
Eyes in two rows	—	—	+	+
Tarsi with three claws	+	+	+	+
Bases of both anterior spinnerets in contact	+	+	+	+
Calamistrum present on metatarsus IV	—	—	—	—
A cluster of double-rowed trichobothria present on femora IV	—	—	—	+

Please put all spider specimens back to the original vials.

Up to 4 points bonus will be granted to students who keep the intact specimens.

Q1.2. (1.2 points for each cell; 18 points total)

1	2	3	4	5
a-1 or b-1	**b-1 or a-1**	**s-2**	**h-1 or m-1 or n-1**	**h-1 or m-1 or n-1**

6	7	8	9	10
h-1 or m-1 or n-1	**d-1**	**e-4**	**s-1**	**t-3**

11	12	13	14	15
d-1	**e-6**	**e-3**	**o-1**	**g-1**

Q1.3.1.	Q1.3.2.	Q1.3.3.
19	**d-1**	**B**

(2 points for each cell)

Q1.3.4. (Each correct answer will get 0.4 points, 2 points total)

Character	True	False
s-1		**X**
s-2	**X**	
a-1	**X**	
g-1		**X**
d-1		**X**

Q1.3.5. (1 point for each cell; 5 points total)

Taxon	Kind of grouping
{H}	**III**
{B, C, G, H}	**II**
{C, D, E, F}	**II**
{B, G, H}	**III**
{B, E, G}	**I**

Q2.1.1. (1 point each; 9 points total)

Table 2-1-1

Plant-A(○)	Spider (＊)		Total
	Present	Absent	
Present	**2**	**10**	**12**
absent	**4**	**24**	**28**
Total	**6**	**34**	**40**

Q2.1.2a.	Q2.1.2b.	Q2.1.2c.	Q2.1.2d.	Q2.1.2e.
0.3	**0.15**	**0.045**	**1.8**	**P**

(0.6 points for each cell)

Q2.1.3.(2 points)

0.0373

Q2.1.4a. (2 points)

0.0306

Q2.1.4b. (2 points)

Association V value	Strong — -1=V≦-0.6	Moderate — -0.6＜V≦-0.2	None -0.2＜V＜0.2	Moderate + 0.2≦V＜0.6	Strong + 0.6≦V=1
			X		

Q2.2.1a. (2 points)

N

Q2.2.1b. (2 points)

Association V value	Strong — -1=V≦-0.6＜	Moderate — -0.6＜V≦-0.2	None -0.2＜V＜0.2	Moderate + 0.2≦V＜0.6	Strong + 0.6≦V=1
		X			

	Q2.2.2a. (2 points)	Q2.2.2b. (2 points)	Q2.2.2c. (2 points)
True			**X**
False	**X**	**X**	

Q2.3.1. (0.5 points for each cell; 3 points total)

Table 2-3-1

Species	Species of nearest neighbor		Total
	Plant-A (○)	Plant-B (●)	
Plant-A (○)	**24**	**16**	**40**
Plant-B (●)	**21**	**19**	**40**
Total	**45**	**35**	**80**

Q2.3.2a. (2 points)

0.4571

Q2.3.2b. (3 points)

randomly distributed	X
associated	
segregated	

	Q2.4.1 (2 points)	Q2.4.2 (2 points)
True	**X**	**X**
False		

Check list of the spider condition in their original vials

(**Filled out by the LAB ASSISTANTS after test**)

Taxon	W	X	Y	Z
Damaged				
Undamaged				

Signed by Inspector:_____Student Code:_____

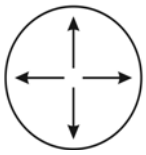
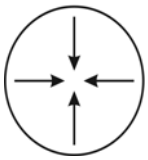
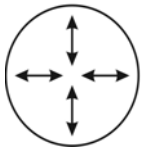
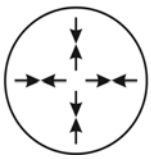
(Without Student Code written here, the 4 bonus points will not be awarded)

PRACTICAL TEST 4 : PLANT ANATOMY, PHYSIOLOGY, AND GENETICS

Q1.A.1.（2 point each, 6 points total）Check [X] the correct answers

	Part A	Part B	Part C	Part D
Section X		**X**		
Section Y	**X**			
Section Z			**X**	

Q.1.A.2. （Single answer, 4 points）Check [X] the correct answers

				
	X			

Q.1.B.（3 points for each plant, points are given when all correct answers are selected; 6 points total）

Check [X] the correct answers

Distribution pattern of vascular bundles in the stem	Plant V	Plant W
arranged in a ring	**X**	
scattered in ground tissue		**X**
solid vascular cylinder with star-like xylem		
central core of parenchyma cells surrounded by rings of xylem and phloem		

Q.1.C.1（8 points）

Fill in the correct answers

(a)

i) 3 μm. (1 point)

ii) 40 μm (± 10) μm. (3 points)

(b)

i) 0.25 (± 0.05) mm^2. (1 point)

ii) 130 (± 50) (stomatal number /mm^2). (3 points)

Q.1.C.2 （6 points, points are given when all correct answers are selected）

Check [X] the correct answers

	True	False
Few or no stomata on the upper epidermis	**X**	
Many stomata on the lower epidermis	**X**	
An aquatic plant		**X**

Q.1.D (1 point each, 5 points total)

Check [X] the correct answers

Plant	Monocot	Dicot
K		**X**
V		**X**
W	**X**	
M	**X**	
N		**X**

Q.1.E （6 points for each plant with the presence of crystals, points are given when all correct answers are selected ; 2 points for the plant with the absence of crystals; 20 points total）

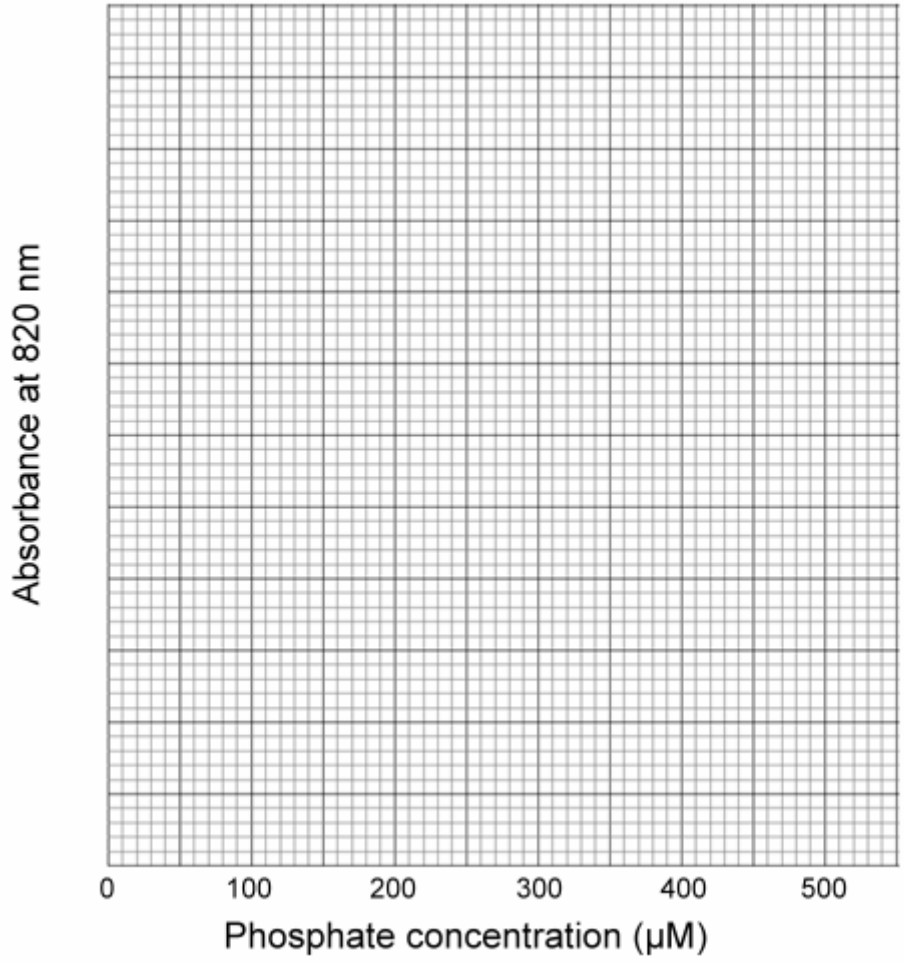
Fill in the corresponding letters

	Plant (P, Q, R, or S)	Location of crystals (A or B)	Crystal type (C or D)
Presence of crystals	**P**	**B**	**D**
	Q	**B**	**D**
	S	**B**	**C**
Absence of crystals	**R**		

Documentation **(0.5 point for each slide present, 5 points total).**

Q.2.1. (18 points total)

(0.5 point for each standard point correctly plotted)



(2 points for each phosphate concentration measured, 0.5 point for each nmol/mg of phosphate calculated)

Sample #	Plant	Fresh weight of seedlings (mg)	Average phosphate concentration of extract (μM)	nmol of phosphate per mg of seedling fresh weight (nmol/mg)
1	A	40.4	**160 ± 10%**	**39.6 ± 10%**
2	A	17.3	**33 ± 10%**	**19.0 ± 10%**
3	B	28.0	**75 ± 10%**	**26.8 ± 10%**
4	C	39.2	**150 ± 10%**	**38.3 ± 10%**
5	D	30.6	**380 ± 10%**	**124.2 ± 10%**
6	E	33.8	**300 ± 10%**	**88.8 ± 10%**

Q.2.2. (Multiple answers, 4 points. Points given when all correct answers are selected) Check [X] the correct answers

	(A)	(B)	(C)	(D)	(E)	(F)
True			**X**	**X**		
False	**X**	**X**			**X**	**X**

Q.2.3. (2.5 points each, 10 points total) Check [X] the correct answers

	B	C	D	E
Knockout mutant plant of gene *X*		**X**		
Knock out mutant plant of gene *Z*			**X**	
Plant with defective protein T	**X**			
Transgenic plant with gene *Y* over-expression				**X**

Q.2.4. (Single answer, 4 points) Check [X] the correct answers

(A)	(B)	(C)	(D)	(E)	(F)
					X

Q.2.5. (Single answer, 4 points) Check [X] the correct answers

(A)	(B)	(C)	(D)	(E)
		X		

2. Theoretical Exams

(1) Before subgroup meeting – test questions

THEORETICAL TEST : PART A

Total Points: 60 Duration: 120 minutes

Dear Participants,

- Check your **ID number** on the **Answer Sheet** before starting the test.
- The questions in Part A have **only one** correct answer. Fill your answer in the Answer Sheet. The **marks, characters** to answer questions vary depending on questions. Mark the correct answer with "X" on the Answer Sheet clearly, as shown below.

No.	**A**	**B**	**C**	**D**	**E**	**F**
A0	**X**					

- Use **pencils and erasers**. You can use a ruler and a calculator provided.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal points of Part A is 60 (1 point each for each question).
- Stop answering and put down your pencil IMMEDIATELY after the end bell rings.

:

Good Luck!!

Cell Biology

A1. Endorphin is a natural analgesic secreted by pituitary gland. Upon binding to its receptor on the brain cells, endorphin can relieve pain and create a sense of euphoria. Morphine is extracted from opium, the latex produced from the seed pods of *Papaver somniferum*. Morphine can achieve similar pain relief effects by binding to the endorphin receptor. However, morphine is considered to be a drug because it causes addiction. Why both endorphin and morphine can bind to the endorphin receptors on the brain cells?

(A) Sizes of both molecules are similar.

(B) Molecular weights of both molecules are similar.

(C) Both are isomers.

(D) Shapes of both molecules are similar.

(E) Net charges of both molecules are identical.

A2. Most biological macromolecules are made by the polymerization of small principal components. For instance, nucleic acid is a polymer of nucleotide. The major structural polysaccharide of insect exoskeleton is also a polymer. Which of the following statements regarding this kind of polysaccharide is **incorrect**?

(A) It is made by polymerization of glucose.

(B) It contains C, H, O and N atoms.

(C) Its structure is similar to that of cellulose.

(D) It can be used to produce chitosan and glucosamine in industry.

(E) This polymer can also been found on the cell wall of fungi.

A3. In some cells synthesis of isoleucine from threonine is catalyzed by sequential actions of five enzymes a, b, c, d and e which produce 4 intermediates A, B, C, D, and the end product isoleucine, respectively. What will happen when isoleucine is overproduced and there is an ample supply of threonine in cells?

(A) Isoleucine associates with threonine to inhibit the activity of enzyme a.

(B) Isoleucine associates with intermediate D to inhibit the activity of enzyme e.

(C) Isoleucine binds to enzyme a and inhibits its activity.

(D) Isoleucine binds to enzyme e and inhibits its activity.

(E) Threonine is converted into isoleucine continuously through 5 enzymes.

A4. In some prokaryotic organisms, SO_4^{2-} is used as the final electron receptor at the end of electron transport chain during cellular respiration. Which of the following statements regarding this cellular respiration in these prokaryotic organisms is **incorrect**?

(A) It is an anaerobic respiration.

(B) The reception of electron by SO_4^{2-} is accompanied by the production of H_2O.

(C) Operation of the electron transport chain builds up a proton motive force.

(D) ATP can be produced.

(E) Production of ATP is correlated with the mobility of H^+.

A5. Penicillin can inhibit the synthesis of bacterial cell wall. At which stage penicillin inhibits the growth of bacteria?

(A) Lag phase (B) Log phase

(C) Stationary phase (D) Before division

(E) All phases of the growth

A6. Which structural or physiological feature of bacteria can be used as a target for developing drugs to kill bacteria effectively but with no harm on human cells?

(A) Glycolysis

(B) Components of plasma membrane

(C) Components of ribosome

(D) Components of electron transport chain in aerobic respiration

(E) Oxygen requirement

A7. Histones are small basic proteins that assemble with DNA molecules to form chromosomes. There are five histones, including H1, H2A, H2B, H3 and H4, in eukaryotic cells. Which of the

following structural features of chromosome is associated with Histone H1?

(A) Telomere

(B) Nucleosome fiber (10-nm fiber)

(C) 30-nm fiber

(D) Looped domains

(E) Centromere

A8. DNA is a double helix molecule containing four different types of nitrogen bases. Which of the following statements regarding the replication and chemical composition of DNA is correct?

(A) Base sequences of both strands are the same.

(B) The amount of purine is equal to that of pyrimidine in a doubled strand DNA.

(C) Both strands are synthesized continuously in 5'→3' direction.

(D) The first base of the newly synthesized DNA is catalyzed by DNA polymerase.

(E) The proofreading activity of DNA polymerase is proceeded in 5'→3' direction.

A9. Scott has compared DNA and the corresponding RNA and protein sequences of many human genes. What conclusion will be drawn from the sequence comparison?

(A) Numbers of exons are always more than those of introns.

(B) The translation start codon is located within the first exon.

(C) The translation stop codon is located within the last exon.

(D) The G nucleotide of RNA capping is the first nucleotide transcribed from DNA.

(E) The polyA tail is transcribed from the polydT of DNA.

A10. Jenny conducts DNA synthesis and transcription reactions in two separated test tubes. Which of the following substances is needed to add into both reactions?

(A) ATP (B) DNA template

(C) RNA primer (D) DNA polymerase

(E) DNA ligase

A11. The Nobel Prize in Physiology or Medicine 2009 was awarded jointly to Elizabeth H.

Blackburn, Carol W. Greider and Jack W. Szostak. They discovered that chromosomes are protected by telomeres and the enzyme telomerase is highly correlated with aging and cancer in animals. Which of the following statements regarding telomere and telomerase is correct?

(A) Telomerase is a DNA exonuclease.

(B) Telomerase is an RNA polymerase.

(C) Embryonic cells possess longer telomere and higher telomerase activity.

(D) Telomere is longer and telomerase is inactive in cancer cells.

(E) Telomere is longer and telomerase is highly activated in somatic cells.

A12. *Eco*RI restriction enzyme is a DNA endonuclease that can recognize the sequence GAATTC. It was first discovered in *E. coli*, therefore it was named *Eco*RI. To produce a large quantity of the endonuclease, the DNA fragment encoded the gene was subcloned into an expression plasmid and the resultant recombinant plasmid was transformed into *E. coli* cells to produce recombinant enzyme for molecular biology study. Why the host DNA is not cleaved by recombinant *Eco*RI?

(A) The host DNA does not contain *Eco*RI cleavage sites.

(B) *Eco*RI is secreted out of the host cells.

(C) The environmental factors such as temperature and pH value inhibit *Eco*RI activity.

(D) The *E. coli* host produces inhibitors to block *Eco*RI activity.

(E) The *Eco*RI cleavage sites within host DNA are modified.

Plant anatomy and physiology

A13. Hypersensitive response is one of the plant defense responses. Pathogen strains **a** to **d** each produce a distinct range of effectors. One of the effectors, Avr, recognized by a specific receptor protein encoded by the resistance (R) gene in the host plant is present in strains **b** and **c**. The host plants **B** and **D** are producing the R protein. Which plant(s) will likely develop a hypersensitive response after the host plants **A** to **D** are infected by pathogens **a** to **d** (**a**Æ **A**, **b**Æ **B**, **c**Æ **C**, **d**Æ **D**), respectively?

(A) **A** only (B) **B** only (C) **C** only (D) **D** only (E) **B** and **C** (F) **B** and **D**

A14. Which of the following statements about leaf senescence is **incorrect**?

(A) An aging leaf produces less and less auxin.

(B) The breakdown of chlorophyll allows other pigments to become more noticeable.

(C) At the molecular level, leaf senescence requires new gene expression.

(D) Cells close to the veins need to remain active to retrieve nutrients from the senescent leaves.

(E) Leaf senescence is associated with abscission, which is stimulated by abscisic acid.

A15. Basidiomycetes, including mushrooms, puffballs and shelf fungi, are important decomposers of wood and other plant material. Which of the following statements about mushroom-forming basidiomycetes is **incorrect**?

(A) Basidiomycetes usually have a long-lived, dikaryotic (n+n) mycelium.

(B) Haploid (n) mycelia may have different mating types.

(C) Two haploid (n) mycelia of different mating types may undergo plasmogamy to form a dikaryotic (n+n) mycelium.

(D) The dikaryotic (n+n) mycelium may develop into basidiocarps (mushrooms) in response to environmental stimuli.

(E) Basidiospores (n) are produced through asexual reproduction.

A16. Which of the following statements about cellulose and the production of cellulosic ethanol is

incorrect?

(A) Cellulose, starch, and glycogen are composed entirely of glucose monomers.

(B) Enzymes that digest starch cannot digest cellulose.

(C) Cellulose is a branched β glucose polymer, which can be digested by some prokaryotes in the rumen of a cow.

(D) Cellulosic ethanol is chemically identical to the ethanol produced from sugar or starch crops.

(E) Lignin is one of the main barriers that prevent cell wall hydrolysis enzymes from accessing cellulose.

A17. Which of the following statements about red algae is correct?

(A) Most red algae are unicellular.

(B) Red algae, such as kelps, are the largest and most complex algae.

(C) Red algae are reddish because they have a photosynthetic accessory pigment phycoerythrin.

(D) Red algae have diverse life cycles including flagellated stages.

(E) Red algae are evolutionarily closer to brown algae than to green algae.

A18. It has been estimated that around 124 million children are vitamin A deficient, causing about 500,000 children to go blind each year. To help children who suffer from vitamin A deficiency, scientists have developed a variety of rice (*Oryza sativa* L.), Golden Rice, through genetic engineering. The original Golden Rice was produced using the japonica variety Taipei 309, which is genetically enriched in

(A) auxin (B) starch (C) β-carotene

(D) iron (E) anthocyanins

A19. Abscisic acid (ABA) is one of the important growth regulators of plants. It often antagonizes the functions of hormones that promote growth. Plant biologists have been interested in elucidating the signaling pathway of ABA by genetic approaches. They screened for the

model plant *Arabidopsis thaliana* mutants that respond abnormally to ABA treatment to identify the involving components of the pathway. One type of the mutant phenotypes is ABA-insensitive (*abi*). Which of the following phenotypes are likely to be observed in the *abi* mutants?

(1) Seeds germinate at the presence of exogenous ABA.

(2) Seeds become dormant at the presence of exogenous ABA.

(3) Stomata do not close in response to drought.

(4) More tolerant to drought than the wild-type plants.

(5) Leaf does not abscise when it becomes senescent.

(6) Leaf is prematurely abscised even when greenish.

(A) (1), (3) (B) (2), (3) (C) (2), (5) (D) (2), (4), (5)

(E) (1), (3), (6) (F) (2), (4), (6)

A20. Ethylene is a hormone that influences plant's growth and development. It is known that treatment with 10 ppm of 1-methylcyclopropene (MCP) can block the signal transduction of ethylene. If plant tissues were treated with or without 10 ppm MCP, which of the following phenotypes could be observed in MCP-treated tissues?

(A) Shorter hypocotyl in etiolated mung bean seedling

(B) Increased degradation of chlorophyll in detached leaves

(C) Increased synthesis of ethylene in banana fruits

(D) Inhibition of the ripening of tomato fruits

(E) Induction of the senescence of carnation cut flowers

A21. During the leaf development of water lily, the sclereid-initials first grow and elongate along the palisade mesophyll cells or the intercellular space between them. After elongation, they gradually produce calcium oxalate crystals between the cell membrane and cell wall, and then form the secondary cell wall. What is the correct order of the following components?

(A) plasma membrane, primary cell wall, calcium oxalate crystals, secondary cell wall, middle

lamella

(B) plasma membrane, primary cell wall, calcium oxalate crystals, middle lamella, secondary cell wall

(C) plasma membrane, secondary cell wall, primary cell wall, calcium oxalate crystals , middle lamella

(D) plasma membrane, secondary cell wall, calcium oxalate crystals, primary cell wall, middle lamella

(E) plasma membrane, middle lamella, primary cell wall, calcium oxalate crystals, secondary cell wall

A22. Photropin is an important photoreceptor in plants. Which of the following descriptions of phototropin is **incorrect**?

(A) Phototropin is also known as cryptochrome

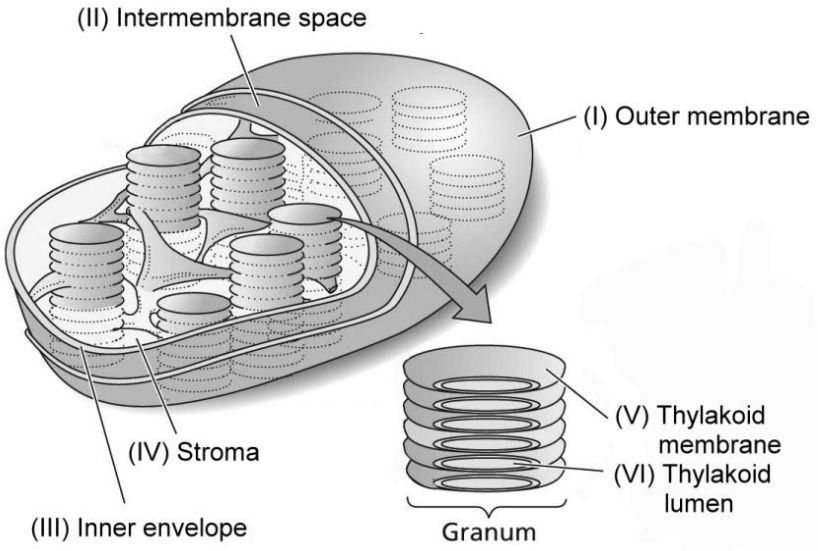
(B) Phototropin is a protein conjugated with nonpolypeptide chromophore

(C) Phototropin absorbs blue light

(D) Phototropin is a protein kinase

(E) Phototropin is involved in the phototropic response of oat coleoptiles

A23. The following figure portrays the structure of chloroplast in plant cells:



According to the figure above, please match the part of chloroplast (labeled as I, II, III, IV, V, or VI) where the photosynthesis-related event occurs: (0.5% each)

Photosynthesis-related event	Part of chloroplast
Accumulation of NADPH	
Biosynthesis of 3-phosphoglycerate	
Light absorption of chlorophyll	
Reaction of ribulose-1,5-bisphosphate and O_2	
Starch biosynthesis	
Water splitting reaction	

Animal anatomy and physiology

A24. Which of the following is the only vertebrate in which blood flows directly from respiratory organs to body tissues without returning to the heart first?

(A) cartilaginous fish (B) amphibians

(C) mammals (D) reptiles

(E) birds

A25. How does the hemocyanin of arthropods differ from the hemoglobin of mammals?

(A) The oxygen dissociation curve of hemocyanin is not a S-shape

(B) Hemocyanin carries considerably more carbon dioxide

(C) Hemocyanin is a single chain respiratory pigment

(D) Hemocyanin is a protein coupled with magnesium

(E) Hemocyanin is a protein coupled with copper

A26. A shark is more likely to survive for an extended period of food deprivation than is a dolphin with equivalent size because

(A) the shark maintains a higher basal metabolic rate

(B) the shark expends more energy/kg body weight than the dolphin

(C) the shark invests much less energy in temperature regulation

(D) the shark metabolizes its stored energy more readily than the dolphin does.

(E) the shark has a better insulation on its body surface

A27. Which of the following descriptions of human digestive system is correct?

(A) Absorptive cells of the gastrointestinal tract are located within the mucosa.

(B) Parasympathetic antagonists would stimulate gastrointestinal motility.

(C) Inhibiting the activities of parietal cells would stimulate protein digestion.

(D) Sympathetic nerve fibers would cause the release of HCl from parietal cells

(E) Mutation of the gene encoding cholecystokinin would hinder the secretion of pancreatic bicarbonate.

A28. Which of the following statements is correct?

(A) Vasopressin stimulates the contraction of uterus and the release of oxytocin.

(B) Vasopressin is synthesized in the posterior pituitary.

(C) The release of oxytocin is stimulated by hypothalamic releasing factors.

(D) Oxytocin and vasopressin are the same hormone.

(E) Oxytocin is synthesized in the hypothalamus.

A29. Which of the following events will result in an excitatory postsynaptic potential?

a. increasing sodium influx.

b. blocking potassium out-flux.

c. increasing calcium influx.

d. closing a chloride channel.

(A). a (B) a & b (C) a & d (D) a, b & c (E) a, b, c & d.

A30. Which of the following is the correct effect of hyperthyroidism (hypersecretion of thyroid hormone) on Thyrotropin-releasing hormone (TRH), thyroid-stimulating hormone (TSH), and Thyroid hormones T3 and T4?

↑: increase ↓: decrease —: remains unchange

	TRH	TSH	T3	T4
A	↑	↑	—	↑
B	↑	↑	↑	—
C	↓	↓	↑	↑
D	↓	↓	↓	↓
E	↓	↑	↑	↑

A31. Which of following receptors/molecules are required for the activation of Helper T cells trigged by antigen presenting cells.

1. CD8

2. CD4

3. Class I MHC molecule

4. Class II MHC molecule

5. T cell receptor

(A) 1, 3 and 5 (B) 2, 4 and 5 (C) 3, 4 and 5

(D) 2 and 4 (E) 1 and 3

A32. An intact cardiac cycle includes three parts of contractile and relaxed phases: a. ventricle systole; b. atrial systole; c. atrial and ventricular diastole. Find the correct sequential events occur in one intact cardiac cycle.

(A) a→b→c (B) a→c→b (C) b→a→c

(D) c→a→b (E) c→b→a

A33. Which of the following statements correctly describes the kidney function in concentrating urine in vertebrates?

(A) Countercurrent multiplier system occurs in the proximal tubule that concentrates urine by NaCl reabsorption.

(B) Countercurrent multiplier system occurs in the loop of Henle that concentrates urine by urea reabsorption.

(C) Countercurrent multiplier system occurs in the loop of Henle that concentrates urine by NaCl reabsorption.

(D) Countercurrent exchange occurs in the collecting duct via aquaporin mediated NaCl reabsorption.

(E) Countercurrent exchange occurs in the collecting duct via aquaporin mediated urea reabsorption.

A34. When people quickly lose blood, such as that happens in a car accident, which of following situations will **NOT** occur

(A) Stroke volume increases; cardiac output increases

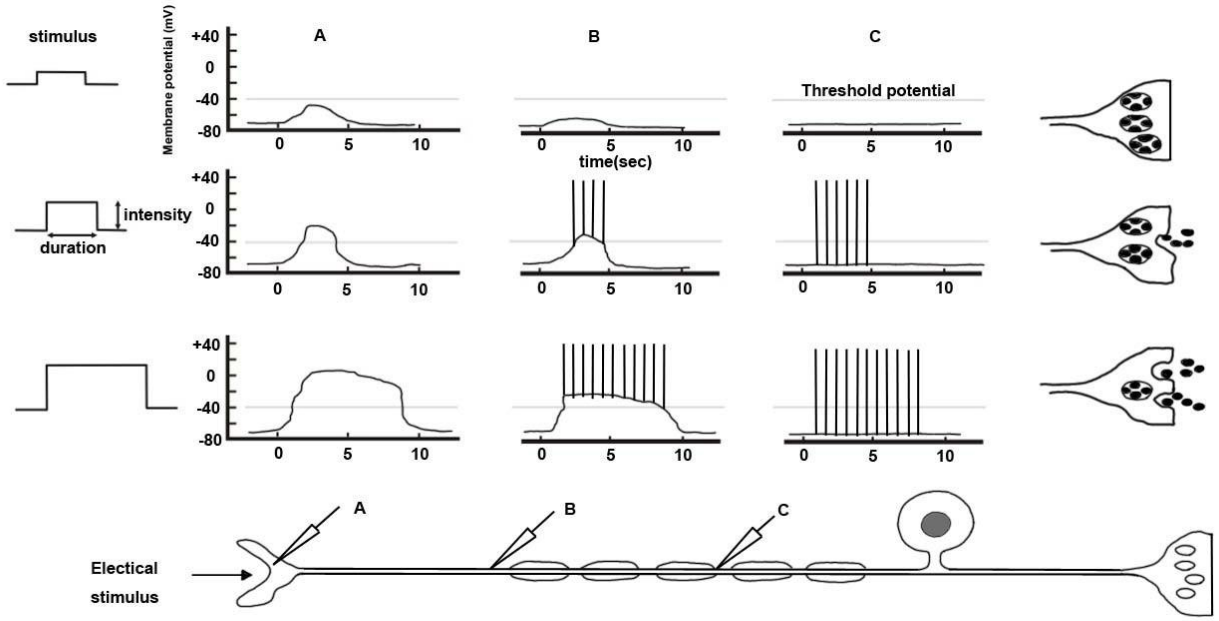
(B) Blood volume decreases but interstitial fluid increases

(C) Increase in the resistance of blood vessel

(D) Decrease of sodium concentration in urine

(E) Decrease in the proportion of red blood cells in blood.

A35. The following figure illustrates the membrane potential changes measured at three different sites (ABC) along a sensory neuron and the release of neurotransmitters from the axon termini when the depolarizing electrical stimuli with varied intensities were applied to the dendrite. Based on the information provided in the above figure, choose the correct statements in the following box.

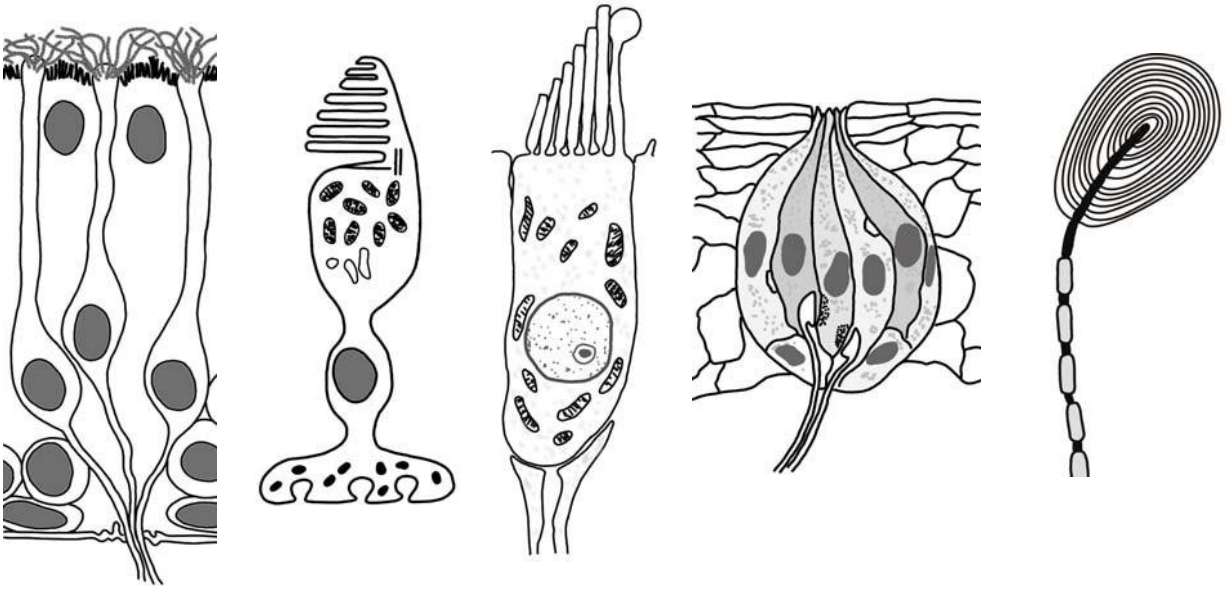


1. The membrane potential changes evoked at A site would be proportional to the intensity of the electrical stimuli applied to the dendrite.
2. An action potential would be generated at B site only when the intensity of the applied current stimulus causes the membrane potential to be higher than the threshold potential.
3. The frequency of the action potentials at B site is independent of the intensity of the applied current stimulus at A.
4. The quantity of the neurotransmitters released from the axon termini is unlikely to depend on the frequency of the action potential at C site.

(A) 1 and 2 (B) 1 and 3 (C) 2 and 3

(D) 3 and 4 (E) 1, 2, and 3

A36. The perception of the message from the environmental changes is carried out by specialized sensory cells. Their structural composition is in a strict accordance to their functions. Please analyze the following pictures and answer the question below:



1 **2** **3** **4** **5**

Which one of above receptors will be activated by a stimulation and trigger the opening of a potassium channel?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

A37. The symbiotic microbes that help animal to digest cellulose may **NOT** be found in

(A). the crop of some herbivorous birds

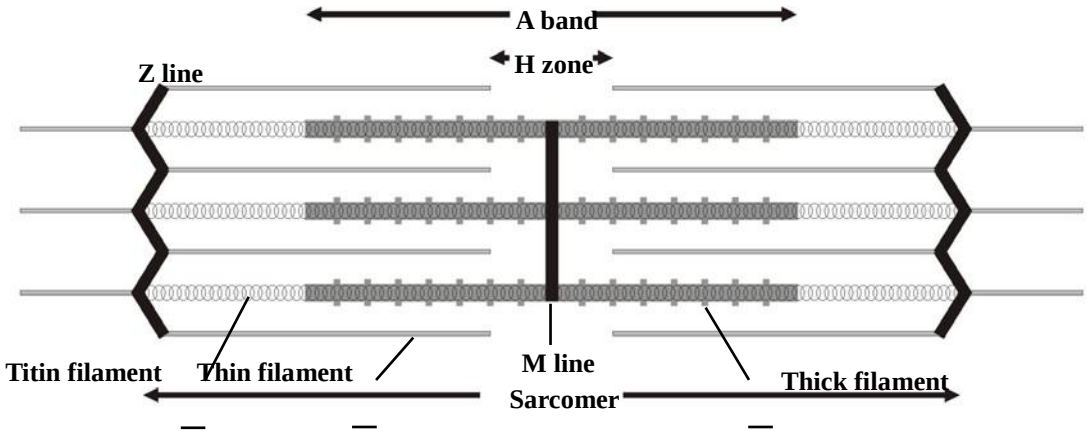
(B) the cecum of horses

(C) the large intestine and cecum of rabbits

(D) the small intestine of koala

(E) the stomach of cattle

A38. The following diagram indicates the basic structure of a sarcomere.



Choose and fill in the appropriate answering code shown below to each statement in the following table. The statements are about a muscle fiber undergoing an isotonic contraction.

Answering code:

01. Correct.

02. Incorrect.

Statement	Code
a. M lines remain the same distance apart	
b. Z lines move closer to the ends of the A bands	
c. A bands become shorter	
d. I bands become wider	
e. M lines move closer to the end of the A band	

Ethology

A39. There are three types of chemical substances that organisms emit to mediate interspecific interactions: kairomone, allomone, and synomone. Kairomone benefits individuals of another species which receives it but is disadvantageous to the emitter. Allomone benefits the emitter, and does not benefit or harm the receiver. Synomone benefits both the emitter and receiver. A plant species emits a volatile essential oil that attracts a phytophagous beetle to feed and lay eggs on its leaves. At the same time, it also attracts a parasitoid wasp, and helps this parasitic natural enemy of the beetles to locate the beetle larvae within which they can lay their own eggs. Which of the following descriptions of the role that this essential oil plays is correct?

(A) It acts as a synomone between the plant and the beetle, and an allomone between the plant and the parasitoid wasp.

(B) It acts as a kairomone between the plant and the parasitoid wasp, and a synomone between the beetle and the parasitoid wasp.

(C) It acts as a kairomone between the plant and the beetle, and a synomone between the plant and the parasitoid wasp.

(D) It acts as a kairomone between the plant and the beetle, and an allomone between the beetle and the parasitoid wasp.

(E) It acts as a kairomone between the plant and the parasitoid wasp, as well as between the beetle and the parasitoid wasp.

A40. In terms of the benefits and harms received by each of the two parties interacting, which of the following pairs of biological interactions are most similar to each other?

(A) Clownfish and sea anemones; dodders and apple trees.

(B) Sea stars and bivalves; locusts and grasshoppers.

(C) Lichens and maples; mistletoes and oaks.

(D) Caterpillars and parasitic wasps; food plants and caterpillars.

(E) HIV virus and human; mushrooms and rotten woods.

A41. Which of the following descriptions about Batesian Mimicry is **<u>NOT correct</u>**?

(A) The imitating organism is similar to the imitated in morphology or coloration.

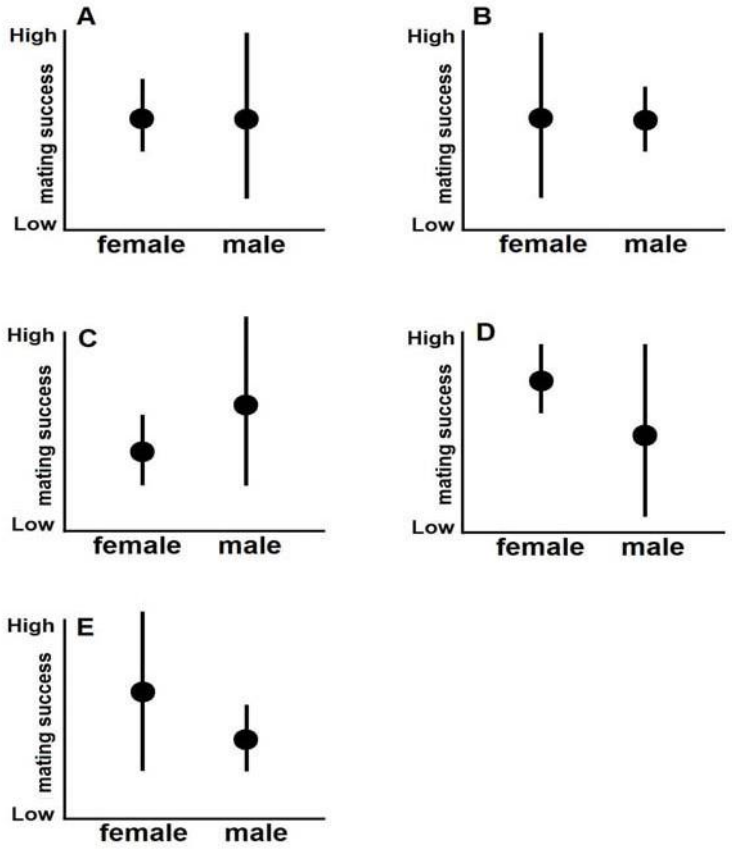
(B) The imitating organism is active during the same time of the day or night as the imitated.

(C) The imitating organism lives in the same habitat as the imitated.

(D) The imitating organism outnumbers the imitated.

(E) The imitating organism is not poisonous, but the imitated is.

A42. A hypothetical insect species employs the polygynous mating system, in which the males are capable of mating multiply, but the females mate only once. The adults of this species occur in the fall when matings take place. All adults of this species die off soon after the mating season. The sex ratio of this species is 1:1. The below shows the comparison of the mating success, defined as the number of mating in a given season, for both male and female in this species. Which one of the graphs below (A - E) best describes the mean and variance of both male and female in this species? Solid dots represent means, and lines denote the ranges of variance.



Genetic and evolution

A43. Johnson has subcloned a cDNA fragment from an animal into an expression plasmid. The recombinant plasmid was transformed into bacteria to produce recombinant protein. If the expressed protein has no function, what is the major factor that affects the function of the expressed protein directly?

(A) Differences in the codon usages between animals and bacteria

(B) Differences in the protein modification between animals and bacteria

(C) Components of bacterial culture media

(D) Modulators of gene transcription

(E) Secretion signal of protein

A44. Austria geneticist Mendel discovered that segregation of genes on non-homologous chromosomes is independent of each other in his garden pea hybridization experiments. Four alleles A, B, C and D are located on four non-homologous chromosomes. Which of the following genotypes will have the highest chance to produce dominant trait in all four loci when it mates with organism with genotype AaBbCcDd?

(A) aabbccdd (B)

AaBbCcDd (C)

AaBBccDd (D)

AaBBCCdd (E)

aaBBCCdd

A45. An X-linked allele determines the coat color of cats with orange being dominant and black being recessive. Which of the following statements regarding the inheritance of orange/black mosaic cat is correct?

(A) Half of male cats are mosaic.

(B) Mosaic phenotype is a consequence of gene interaction.

(C) Mosaic phenotype is correlated with genomic imprinting.

(D) Mosaic phenotype is resulted from X chromosome random inactivation.

(E) The offspring from mating of orange male and black female are mosaic.

Questions 46 and 47 are a **problem set**

A46. On a remote island, Dr. Yeh discovered a new plant species, which can produce either white or purple flowers. This species is self incompatible and requires insects for fertilization. Genetic experiments showed that the white-flower phenotype is recessive to the purple-flower phenotype. Statistical analysis revealed that 91% of these plants produce purple flowers. If one is to randomly select two purple-flower plants and cross them, then what is the approximate probability that their offspring will produce white flowers?

(A) 0.05 (B) 0.10 (C) 0.16 (D) 0.20 (E) 0.30

A47. Dr. Yeh made the above-mentioned homozygous purple-flower plants self compatible by transgenic approach. He then treated the seeds of the transgenic plants with chemical mutagen to produce a mutant population. Two recessive mutants, *wf1* and *wf2*, produced white flowers were selected. Dr. Yeh crossed *wf1* and *wf2* with non-transgenic white-flower plants (*pf*) and obtained the following results: *wf1* x *pf* produced F2 offspring with only white flowers, and *wf2* x *pf* produced F2 offspring with purple and white flowers in a ratio of 9:7. According to these data, which of the statements below is **incorrect**?

(A) *wf1* and *pf* are unable to complement each other.

(B) *wf2* and *pf* are able to complement each other. (C)

wf1 and *pf* are in the same locus.

(D) *wf2* and *pf* are not in the same locus

(E) The F1 offspring from crossing *wf1* and *wf2* will all produce white flowers

A48. A scientist unearthed a plant fossil. Which of the following structures in the fossil allows him to claim this plant as an early angiosperm?

(A) seed (B) pollen (C) stoma

(D) vascular bundle (E) ovary

Ecology

A49. Biogeography researchers found that continental islands tend to have a species composition similar to the mainland, but a lower degree of species differentiation comparing to oceanic islands. If one compares the biome of an oceanic island (X) to a continental island (Y), assuming the two have approximately the same area, and are located in the same latitudinal range, which of the following descriptions is correct?

(A) The proportion of endemic species: X<Y, and total number of species: X>Y.

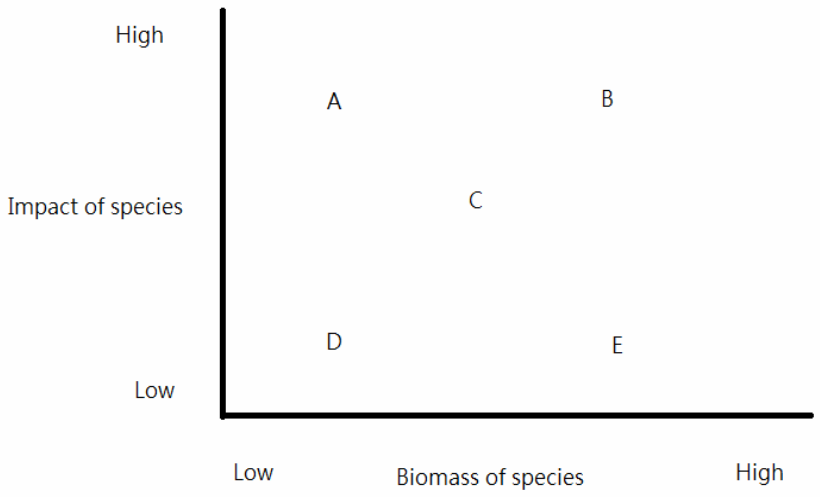
(B) The proportion of endemic species: X>Y, and total number of species: X>Y.

(C) The proportion of endemic species: X>Y, and total number of species: X<Y.

(D) The proportion of endemic species: X<Y, and total number of species: X<Y.

(E) The proportion of endemic species: X=Y, and total number of species: X<Y.

A50. In the figure below, A to E denotes five different species in an ecosystem. Which of the species is most likely to be a keystone species?



(A) A

(B) B

(C) C

(D) D

(E) E

A51. Which of the following statements about predicted consequences of climate change is **not correct**?

(A) Global average temperature will increase.

(B) The frequency of extreme weather events will increase.

(C) There will be a loss of biodiversity.

(D) Sea level will rise due to ice melting at the North Pole.

(E) Arid lands will expand.

A52. Which is of the followings does NOT describe a process driven by density-dependent population regulation?

(A) A wild fire kills tens of thousands of rodents in the grassland.

(B) Wine produced through fermentation by yeasts contains less than 13% of alcohol.

(C) More people are likely to be infected by a TB patient who sneezes or coughs in public in densely populated cities than in rural areas.

(D) Trout switches diet from one insect species to another when it becomes less abundant.

(E) Surplus gannets that could not obtain a nesting ground do not breed.

A53. A male guppy (*Poecilia reticulata*) with large, bright spots on the body is more likely to attract females, which increases his opportunity to reproduce. In the meantime, he is also more easily detected by the natural enemy, which increases his predation risk. Consider male guppies from three different rivers: X, Y and Z, males from X have the largest spots, males from Y have the intermediate-sized spots, and males from Z have the smallest spots. Which of the following descriptions about the guppies in the three rivers is correct?

(A) The density of male guppies in X is higher than the other rivers.

(B) The density of male guppies in Z is higher than the other rivers.

(C) The density of natural enemy of guppies in X is higher than the other rivers.

(D) The density of natural enemy of guppies in Z is higher than the other rivers.

(E) The density of female guppies in X is higher than the other rivers.

A54. Species M had been introduced multiple times to an ecosystem outside its native distribution, but could not establish itself. However, the final one introduction was eventually successful, and led to a rapid and wide-spread expansion of species M in the ecosystem. Which of the followings is the most plausible explanation for why species M was not natively distributed in this ecosystem?

(A) There are too many competitors of species M in the ecosystem.

(B) There are too many predators of species M in the ecosystem. (C)
Species M is not able to disperse to the ecosystem on it own.

(D) The abiotic environment in the ecosystem is not suitable for the growth of species M.

(E) The ecosystem is frequently under disturbance, which creates an unfavorable condition for species M to sustain.

A55. Which are some of the characteristics of early-successional species?

(1) rapid reproduction, (2) fast growth, (3) long lifespan, (4) strong defense against natural enemies or predators, (5) strong dispersal ability.

(A) 1, 2, 3, 4, 5

(B) 2, 3, 5

(C) 1, 3, 4

(D) 1, 2, 5

(E) 2, 5

A56. large proportion of angiosperms are pollinated by animals. Assign the following flower descriptions (I–V) to the most likely pollinator (a–e).

I. Flower white, open during night, intensive fragrant, nectar hidden in long, tight tubes. II. Flower often with ultraviolet coloring pattern, open during daytime, pleasant fragrant.

III. Flower large and coarse, bright red, open during daytime, no fragrance but large amounts of nectar

IV. Flower large and coarse, far opened, open during night, intensive fragrant, large amounts of nectar

V. Flower reddish brown, no nectar, smell of rotten flesh

a. bats b.

birds c.

bees d.

flies

e. moths

Which of the following statement is correct?

(A) Ia, IIb, IIIc, IVe, Vd

(B) Ib, IIc, IIId, IVa, Ve

(C) Id, IIe, IIIa, IVb, Vc

(D) Ie, IIc, IIIb, IVa, Vd

(E) Ie, IId, IIIc, IVb, Va

Biosystematics

[Questions 57-59] The following table shows the main characteristics of 8 different animals (taxa 1-8). A "+" sign indicates that the animal possesses such characteristic, and a "blank" indicates that the animal does not possess such characteristic:

Characteristics	**Taxon**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Amnion			+	+	+			
Limbs with fingers	+		+		+			
Mammary glands					+			
Lateral line system	+	+				+		
Cycloid scale		+						
Sternum	+		+		+			
Semicircle canals	+	+	+	+	+	+	+	
Ventral nerve cords								+

Please answer questions A57—A59 using the information in the table above.

A57. Which of the following taxa most likely belongs to the same Class as "Taxon 4"?

(A) Taxon 1

(B) Taxon 2

(C) Taxon 3

(D) Taxon 5

(E) Taxon 6

A58. "Taxon 8" <u>is least likely</u> to be which of the following organisms?

(A) Earthworm

(B) Grasshopper

(C) Lobster

(D) Sea star

(E) Spider

A59. “Taxon 1” is most likely to be which of the following organisms?

(A) Shark

(B) Eel

(C) Sea lion

(D) Turtle

(E) Frog

A60. According to the hierarchical classification, wheat and potato belong to which of the same taxa?

(A) Kingdom, phylum

(B) Kingdom, phylum, class

(C) Kingdom, phylum, class, order

(D) Kingdom, phylum, class, order, family

(E) Kingdom, phylum, class, order, family, genus

THEORETICAL TEST : PART B

Total Points: 120 Duration: 150 minutes

Dear Participants,

- Check your **ID number** on the **Answer Sheet** before starting the test.
- The questions in Part B may have **more than one** correct answer. Fill your answer in the Answer Sheet. The **marks, numbers, or characters** to answer question in Part B vary depending on questions. Mark the correct answers with "X" on the Answer Sheet clearly, as shown below.

No.	A	B	C	D	E	F
A0	X		X			

- Use **pencils and erasers**. You can use a ruler and a calculator provided.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal points of Part A is 120 (3 points for eachquestion)
- **All answers must be correct** in each question. Then you will get the points.
- Stop answering and put down your pencil IMMEDIATELY after the end bell rings.

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Good Luck!!

Cell biology

Problem set: **Figure 1** depicts the cross-section of a certain cell surface structure observed by electron microscope. Answer questions 1 and 2.

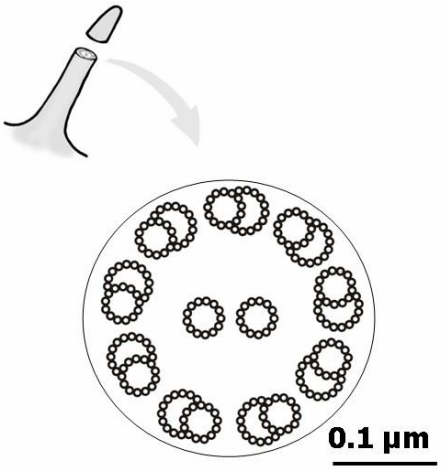


Figure 1. Cross section of an extension structure on cell surface, as viewed with an electron microscope.

B1. Which of the following cells possess(es) the structure feature?

(A) *Paramecium*

(B) *Escherichia coli*

(C) Human sperm cell

(D) Tracheid of gymnosperm

(E) Sieve tube element of angiosperm

(F) Human windpipe cell

(G) Human intestinal epithelial cell

B2. What are the function and the major chemical composition of the structure?

(A) Attachment; cellulose

(B) Locomotion; protein

(C) Transportation; cellulose

(D) Secretion; mucin

(E) Absorption; protein

B3. Exotoxin produced by some pathogens can cause human diseases. One type of exotoxins

consists of two polypeptides subunit A and B. Subunit B can bind to surface receptors on the target cells and causes the transport of the subunit A or associated molecules across the plasma membrane into the cell. Once the subunit A entering cell, it inhibits protein synthesis and destroys the cells. Which of the following statements regarding exotoxin is/are correct?

(A) Subunit A alone can cause disease.

(B) Subunit B alone can bind to target cells.

(C) Subunit A may carry other molecules to kill target cells.

(D) Subunit B may carry other molecules and assist these molecules to enter target cells.

(E) After conjugated with antibody against breast cancer cells, subunit A can kill breast cancer cells.

Problem set: Some leucocytes can ingest invaded pathogens by phagocytosis. The digestive enzymes that kill pathogen only function in acidic conditions. Please answer questions 4 and 5.

B4. Based on the information provided in the following table, complete the synthesis process of digestive enzymes during phagocytosis:

① Replication	⑤ Endothelium reticulum
② Translation	⑥ Vesicle
③ Transcription	⑦ Lysosome
④ Mitochondrion	⑧ Golgi apparatus

(1) mRNA-ribosome complex is transferred to ___a___ to continue ___b___.

(2) Synthesized enzymes enter ___c___ and ___d___ for modification.

(3) The modified enzymes are stored in ___e___.

(A) a: ④ b: ① c: ⑥ d: ⑦ e: ④

(B) a: ⑦ b: ② c: ⑦ d: ⑧ e: ⑤

(C) a: ⑧ b: ③ c: ⑥ d: ⑧ e: ⑥

(D) a: ⑤ b: ② c: ⑤ d: ⑧ e: ⑦

(E) a: ⑥ b: ① c: ⑤ d: ⑦ e: ⑧

B5. Tom isolated phagocytes from a blood sample. He cultured these phagocytes in test tube for a period of time. To observe phagocytosis, *E. coli* was co-cultured with phagocytes. What will be the consequence if antacid is added to the culture?

(A) Phagocytes can ingest and kill *E. coli*.

(B) Ingestion of *E. coli* by phagocytes is inhibited.

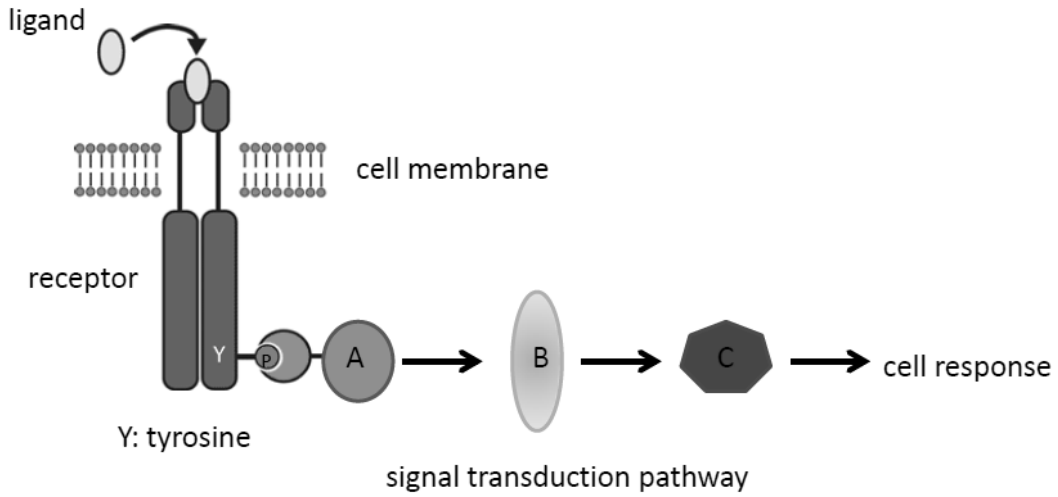
(C) *E. coli* is viable in phagolysosome.

(D) Digestive enzymes in phagolysosome are inactive.

(E) Phagolysosomes are formed.

(F) Phagocytes can secrete ingested debris out of cells.

Problem set: Jessica is dissecting a signal transduction pathway (depicted in the following figure) that leads to oncogenesis in cancer cells, in hope that she can find the inhibitors to block the signaling pathway and use them as chemotherapy drugs for cancer treatment. Please answer questions 8-10.



B6. Components of signal transduction, including A, B and C, usually are activated through phosphorylation or dephosphorylation reaction. What are the mechanisms by which proteins A , B and C are phosphorylated or dephosphorylated?

(A) Receptor may contain enzyme domain which can exert phosphorylation/dephosphorylation reaction.

(B) Enzymes that participated in phosphorylation/dephosphorylation reaction may exist in cytoplasm.

(C) Proteins A, B and C may contain enzyme domain which can exert phosphorylation/dephosphorylation reaction.

(D) Phosphorylation or dephosphorylation may not be mediated through enzymatic reaction.

(E) Phosphate group is transferred from receptor to protein A.

(F) The phosphate group is usually provided by ATP.

B7. Which of the following experiment can prove that the signal transduction pathway is B→C, but not C→B?

(A) Adding an A antagonist will activate B.

(B) Adding an A agonist will activate C.

(C) Adding a B agonist will activate C.

(D) Adding a B antagonist will activate C.

(E) Increasing the expression level of B will generate more active C molecules.

(F) Cell response can be observed when B antagonist and active C molecules are added to the cell.

B8. If this is a highly activated signal transduction pathway in cancer cells, which of the following processes the signaling pathway involve(s)?

(A) Inhibiting cell division

(B) Inhibiting cell differentiation

(C) Hypermethylation of some tumor suppressor genes

(D) Activating the transcription of oncogene

(E) Arresting cell cycle at S phase

(F) Inhibiting the expression of some DNA repair genes

Plant anatomy and physiology

B9 Which of the following statements about the processes of nitrogen assimilation by plants are correct?

(A) NO_3^- is made available to plants by nitrifying bacteria in the soil.

(B) NO_3^- absorbed by plants has to be reduced to NH_4^+ before been incorporated into organic nitrogen compounds.

(C) *Rhizobium* bacteria growing in the roots of legumes can reduce N_2 to NO_3^- by the enzyme complex nitrogenase.

(D) Leghemoglobin can deliver O_2 to nitrogenase in some root nodules.

(E) Nitrogen-fixing *Rhizobium* bacteria cannot fix N_2 in their free state.

B10. A pollen grain typically contains a tube cell and a generative cell. During germination, pollen tube forms, and the generative cell divides into two sperms. Guided by chemical attractants (such as GABA) produced by the synergids, the tip of pollen tube enter the ovule. Then double fertilization occurs in the embryo sac, forming zygote and endosperm initial. Which of the following statements are correct?

(A) Tube cell, sperm, and synergid are haploid, while generative cell and zygote are diploid.

(B) A gradient in GABA content is formed from the stigma (low) to the ovary (high).

(C) The two sperms fertilize two eggs, but only one forms the zygote.

(D) Two sperms fertilize the egg, forming a triploid zygote.

(E) One sperm fertilizes the egg, while another sperm fuses with the polar nuclei.

(F) One zygote and one endosperm initial are formed.

(G) Pollen grain is male gametophyte, while embryo sac is female gametophyte.

B11. Mary divided 30 pots of plant X of similar condition into 10 plants per group, with each group being treated with different types of light regime. After a month, the flowering phenotypes of each group are shown in the table below:

Treatment	Light regime		Flowering result
(I)	12 hr	12 hr	All 10 pots flowered
(II)	14 hr	10 hr	9 pots flowered, and 1 pot failed to flower
(III)	16 hr	8 hr	All 10 pots fail to flower

Light Darkness

According to the information above, which of the following descriptions of plant X are correct? (multiple answers)

(A) Plant X is a short day plant

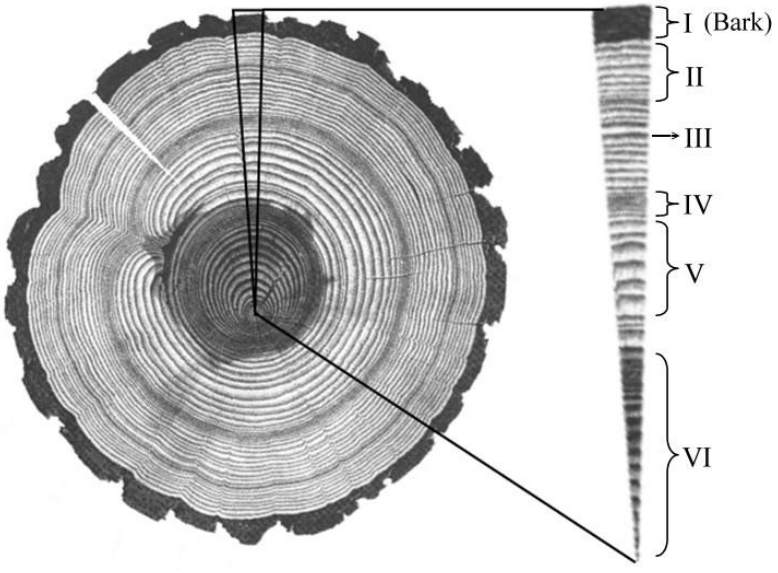
(B) The critical dark-length required by plant X for flowering is less than 10 hours

(C) If group III is given an "one-minute dark treatment" in the middle of the light period, after one month, most plants in this group will flower

(D) If group II is given an "one-minute red light treatment" in the middle of the dark period, most plants in this group will not flower right after one month

(E) If the apical buds of group I plants are removed before giving the light regime treatment, then most plants will not produce florigen required for flowering after giving light regime treatment.

B12. The figure below is the transverse section and a partial enlarged view of the trunk of a eudicot wood.



According to the figure, which of the following statement is correct? (multiple answers)

(A) Region I includes the phloem and periderm

(B) Region II contains primary xylem

(C) Region III corresponds to the growth of xylem in a year

(D) Region IV belongs to secondary xylem

(E) Region V includes both early wood and late wood

(F) The cells in region VI cannot transport nutrients, but still can transport water

B13 Which of the following structures do not exist in the cell of higher plant when it is in late anaphase of mitosis?

(A) cell wall (B) mitochondria (C) cell plate

(D) nuclear membrane (E) centriole (F) chromosome

B14. In plant cells, protein translation can take place in which of the following organelles?

(A) nucleus (B) mitochondrion (C) chloroplast

(D) vacuole (E) peroxisome (F) Golgi apparatus

Animal anatomy and physiology

B15. Which of the following would be considered as a portal vessel system?

(A) he vessels connecting arterioles and venules

(B) a series of vessels allowing the return of blood to heart in an animal with an open circulatory system

(C) the vessels connecting intestine and liver

(D) the vessels connecting two networks of capillaries

(E) the vessels connecting hypothalamus and pituitary gland

B16. "Countercurrent exchange" is an important physiological mechanism in animals. Which of the following descriptions about "countercurrect exchange" are correct?

(A) In mammal kidneys it helps to maximize water reabsorption

(B) In mammal kidneys it helps to maximize urine concentration

(C) In fish gills it helps to maximize gas exchange

(D) In fish gills it helps to maximize salt exchange

(E) In tuna muscles it helps to maximize thermal exchange

(F) In tuna muscles it helps to maximize gas exchange

B17. Which of the following descriptions of mammalian respiration are correct?

(A) Hypocapnia would induce an increase in the pH of arterial blood

(B) Increasing body temperature would decrease the affinity of hemoglobin for oxygen

(C) The percentage of arterial oxygen saturation is greatly affected by exercise

(D) When some tissues produce more CO_2 through the increase in metabolic activities, less O_2 would be supplied to those tissues.

(E) A decreased affinity for oxygen shifts the oxygen dissociation curve to the right

Problem set: In the following figure, the structure of fish gills and the direction of water flow in the ventilation are illustrated. Answer the questions B18-19.

B18. Which of the following statements are correct?

(A) Vessel A carries oxygenated blood (B)

Vessel B carries deoxygenated blood (C)

Vessel A is an arteriole

(D) Vessel B is a venule

(E) Structure C is the site for gas exchange

B19. Scientists found a kind of epithelial cell (X cell) in the structure of D. By which fish can maintain body fluid osmolarity. Consequently, X cells are supposed to

(A) absorb salt actively in freshwater fish

(B) excrete salt actively in seawater fish

(C) excrete water actively in freshwater fish

(D) absorb water actively in seawater fish (E)

be rich in mitochondria

B20. Which of the following statements about thermo-adaption in animals are correct?

(A) Blue-fin tuna is able to raise their core temperature. Therefore, it is an endothermic animal

(B) Some icefish are able to survive in the freezing ice-laden water and maintain a very stable body temperature. Therefore, icefish are homeothermic animals.

(C) Shivering can help mammals to generate heat, and it is regulated by hypothalamus.

(D) Brown adipose tissues help mammals to generate heat by supplying energy to skeletal muscles.

(E) Brown adipose cells are rich in mitochondria for heat generation.

B21. ADH is a peptide hormone released by hypothalamus. To the colleting duct of kidney, the hormone will

(A) promote an increase in the reabsorption of water

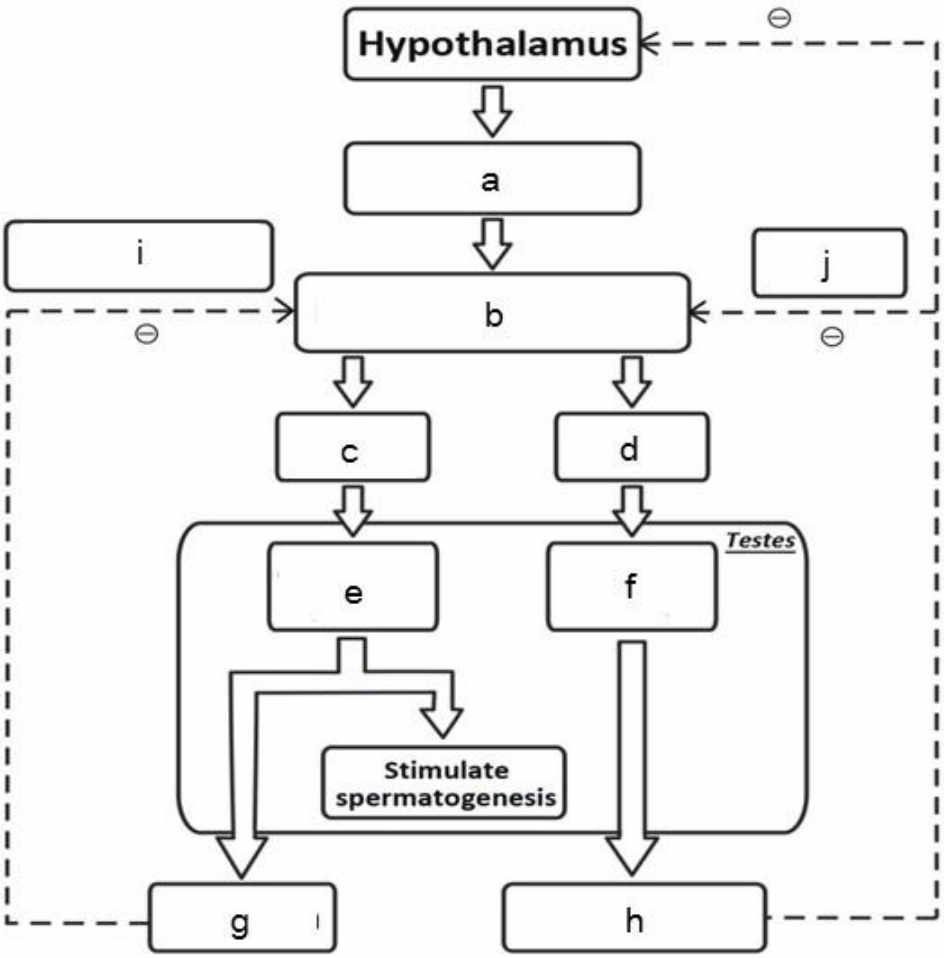
(B) increase the second messenger cAMP

(C) increase the second messenger cGMP.

(D) increase aquaporin mRNA level

(E) decrease the blood osmolarity

B22. The following figure partly illustrates the cross interactions among hypothalamus, pituitary gland, and male gonads. The symbols "(-)" indicate negative feedback inhibitions. As shown in the table below, some hormones, cells, or tissues are tried to match to the terms in this figure (a-j). Actually, some of them are mismatched. Please complete the table by using the answering code shown below.



Answering code: 01. Correct. 02. Incorrect.

	Structure/hormone	Answering code
a	Gonadotropin	
b	Posterior pituitary	
c	FSH	
d	LH	
e	Leydig cells	
f	Sertoli cells	
g	Inhibin	
h	Testosterone	
i	FSH and LH	
j	LH	

B23. There are many different types of blood cells involved in immune response. Please match the functions or properties listed below (A-G) with the types of blood cells indicated in the following table.

A. The most abundant circulating white blood cells.

B. Release enzymes and cytokines in response to antigen or injury.

C. Punching holes in larvae of parasitic worms

D. Alert the immune system to the presence of antigen

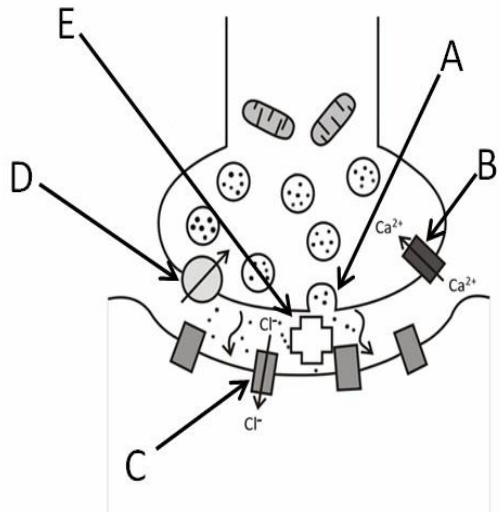
E. Destroy the mutated body cells

F. Mature forms of phagocytic monocytes in blood

G. Increase capillary permeability.

Blood cells	Fill your answer
1. Neutrophils	
2. Basophils	
3. Eosinophils	
4. Dendritic cells	

B24. A~ E in the following diagram represents the five major steps of synaptic transmission.



A. Release of neurotransmitter.

B. Activation of presynaptic calcium channel. C. Activation of postsynaptic chloride channel.

D. Re-uptake of neurotransmitter.

E. Degradation of neurotransmitter.

Which of the above steps is/are missing in the synaptic transmission of acetylcholine, glutamate, and nitric oxide (NO)?

Neurotransmitter	Missing step(s)
Acetylcholine	
Glutamate	
Nitric oxide	

Ethology

B25. There are two types of bird hatchings: precocial and altricial. In general, precocial birds are covered with feathers when they hatch, and can find their own food with help and instructions from their mothers. In contrast, altricial hatchlings require feeding and caring for from the parents. Based on this, which of the following statements are correct?

(A) Precocial hatchlings usually take longer to hatch than altricial hatchlings.

(B) Altricial hatchlings usually develop imprinting earlier than precocial hatchlings.

(C) Parents invest more in precocial hatchlings than in altricial hatchlings during nestling period.

(D) For a group of young birds that hatch at the same time, altricial hatchlings tend to develop the ability to fly earlier than precocial hatchlings.

(E) Parents of precocial and altricial hatchlings have the same level of investment in reproduction during the breeding season.

Genetics and evolution

B26 The population size of a dragonfly in a pond was estimated to be 50,000 during a survey. Their sex ratio is 1:1. Each female lays approximately 400 eggs. A second survey of the next generation revealed that the population size is still 50,000 and the sex ratio is still 1:1. What is the average survival rate (surviving to adult stage) of the eggs?

(A) 0.2%

(B) 0.25%

(C) 0.5%

(D) 1%

(E) 5%

B27. Generation of new species can increase the biodiversity. Which of the following conditions could speed up the evolution of new species?

(A) Crossing over

(B) Gene duplication

(C) Gamete random fertilization

(D) Parthenogenesis

(E) Independent assortment of chromosome

(F) Separation of pair of homologous chromosomes

B28. The black, brown and white coat colors of mice are determined by the interaction of B/b and C alleles. B and b alleles control the synthesis of black and brown pigments, respectively. In the presence of C allele, black and brown pigments are deposited on furs. In a crossing between BbCc and bbCc, which of the following statements are correct?

(A) The coat colors of parental mice are black and brown respectively.

(B) The ratio of black and brown in offspring is 1:1.

(C) 3/4 of the offspring are black.

(D)1/4 of the offspring are brown.

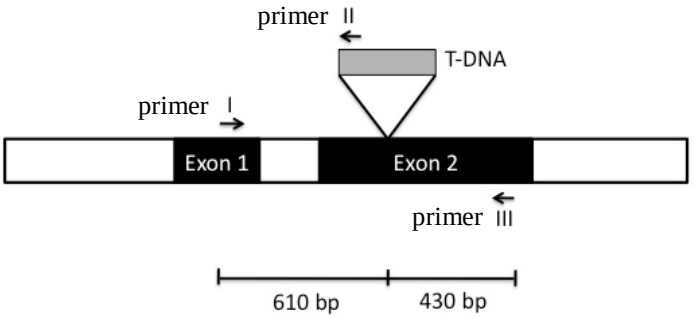
(E) 1/4 of the offspring are white.

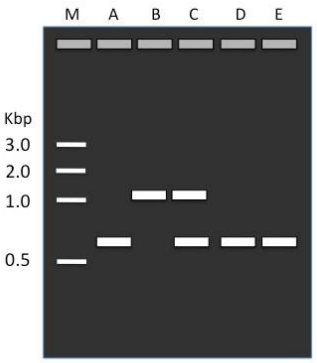
(F) C/c gene is epistatic to B/b gene.

(G) Alleles C and B/b are co-dominant.

Questions B29 to B31 are a <u>problem set</u>

Dr. Chen was investigating the function of gene *X* in rice by using a mutant with a T-DNA inserted in the exon 2 as diagrammed below. The size of the T-DNA is approximately 5 kilo base pairs (Kbp). She used PCR analysis for genotyping of five individual plants (A, B, C, D, E) with primers I, II, and III as indicated in the diagram. The gel on the right shows the PCR result. The DNA molecular size markers are shown in lane M. Lane A-E are the PCR products from leaf samples of the plant A-E, respectively. It is known that the polymerase being used is unable to effectively amplify DNA fragments above 5 Kbp.





Based on the above information, answer questions B29 ~ B31 :

B29. Which pair of primers (I+II; I+III; II+III) amplified the DNA band in lane B?

B30. Which plant(s) (A, B, C, D, or E) is/are homozygous mutant(s)?

B31. Which plant(s) (A, B, C, D, or E) is/are the F1 offspring of homozygous mutant crossed to the wild type?

B32. It is believed that "land plans" are evolved from charophytes. Which of the following statements support this hypothesis?

(A) Both are multicellular organisms

(B) Both have alternation of generation in life cycles

(C) Both have male gametes with whiplash flagella for movement

(D) Both contain chlorophyll a and chlorophyll b

(E) Both have peroxisomes that contain photorespiration related enzymes

(F) Both can form phragmoplasts during cytokinesis

(G) Both contain cellulosic cell walls

(H) Both have the cellulose synthase arranged on the plasma membrane in a rosette pattern

Ecology

B33. Biologists found that the threshold temperature for development of a mosquito species is 15℃. They also found that the product of (1) the number of days it takes to complete development, and (2) the difference between the temperature during development and threshold temperature, is a constant. That is, the result of multiplying (1) and (2) is a constant. It is known that this mosquito requires 15 days to complete development at 30℃, and given that there was an unusually warm May in India this year with an average temperature of 40℃, how many days it should take this mosquito to complete development this May in India?

(A) 7 days

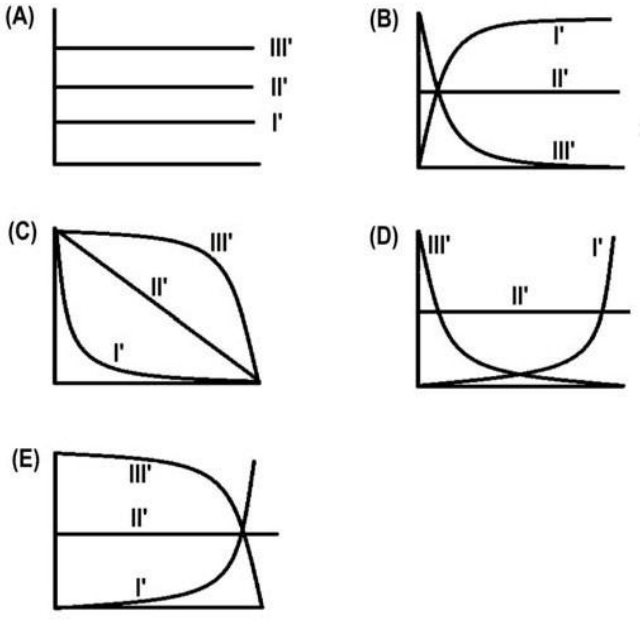
(B) 9 days

(C) 10 days

(D) 12 days

(E) 15 days

B34. Assuming human, birds, and fish respectively have Type I, II, and III survival curves (the vertical axis is survival rate, and horizontal axis is time), which of the following figures most accurately describes mortality curves (obtained by replacing survival rate with mortality rate) for these three groups of organisms (Type I', II' and III')?



B35. A man was bit by a flying creature on a trip. There was a red sore around the bite, followed by symptoms such as fever, headache, muscle and joint pain, and lymph node enlargement. The doctor found a unicellular organism with only one flagellum and a large mitochondrion in his blood, lymph fluid, and cerebrospinal fluid, and determined that this organism was the pathogen that caused the disease, which was probably connected to the bite from the flying creature. Which of the following descriptions about the pathogen are correct?

(A) It is transmitted by insects.

(B) It is widely distributed in Asia and Africa.

(C) It is a type of *Plasmodium*, a protist that causes malaria.

(D) It damages red blood cells and causes anemia.

(E) It is classified under the same Phylum as *Euglena*.

B36. When comparing closely-related bird species, mortality of breeding individuals appears to be higher for species in temperate regions than in tropical regions. Therefore, predation risks to parents themselves, their young and eggs are given different priorities for species in different regions. In an experiment where specimen of three different predators (crows, owls, and hawks) were placed at close distances to the nests during the day in the breeding period, which of the following responses from the parents can be expected? Note that crows are predators of the young and eggs, owls are nocturnal predators, and hawks are diurnal predators of adult birds.

(A) The owl specimen is more strongly avoided by the parents than the hawk specimen.

(B) With the crow specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperate species.

(C) With the hawk specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperature species.

(D) With the hawk specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a greater degree than parents of temperature species.

(E) The degree to which the parents reduce their frequency of returning to the nests and feeding the young when predator specimen is present is not affected by the type of predators or the latitudes in which the species is distributed.

B37. Which of the followings <u>are not</u> results of competition?

(A) Beak depth of Galápagos finches increased following several consecutive years of drought.

(B) Poisonous cuckoo bees and yellow jackets look alike, which reduces their predation risks.

(C) Large numbers of the Emperor Penguins form an orderly huddle formation during the hatching period.

(D) There are lower numbers of species during climax than intermediate successional stages. (E) A big island has more lizard species than a small island with similar environmental conditions.

B38. Some fungi form symbiotic associations with the roots of vascular plants, which are called mycorrhizae. In such associations, mycorrhizae help plants to absorb water, phosphate salt and other mineral nutrients. Depending on whether the fungus colonizes the roots extracellularly or intracellularly, mycorrhizae can be grouped into ectomycorrhizae or arbuscular mycorrhizae. Which of the following descriptions of mycorrhizae are correct?

(A) Seedlings with mycorrhizae grow more rapidly than seedlings without mycorrhizae in low-phosphorus soils.

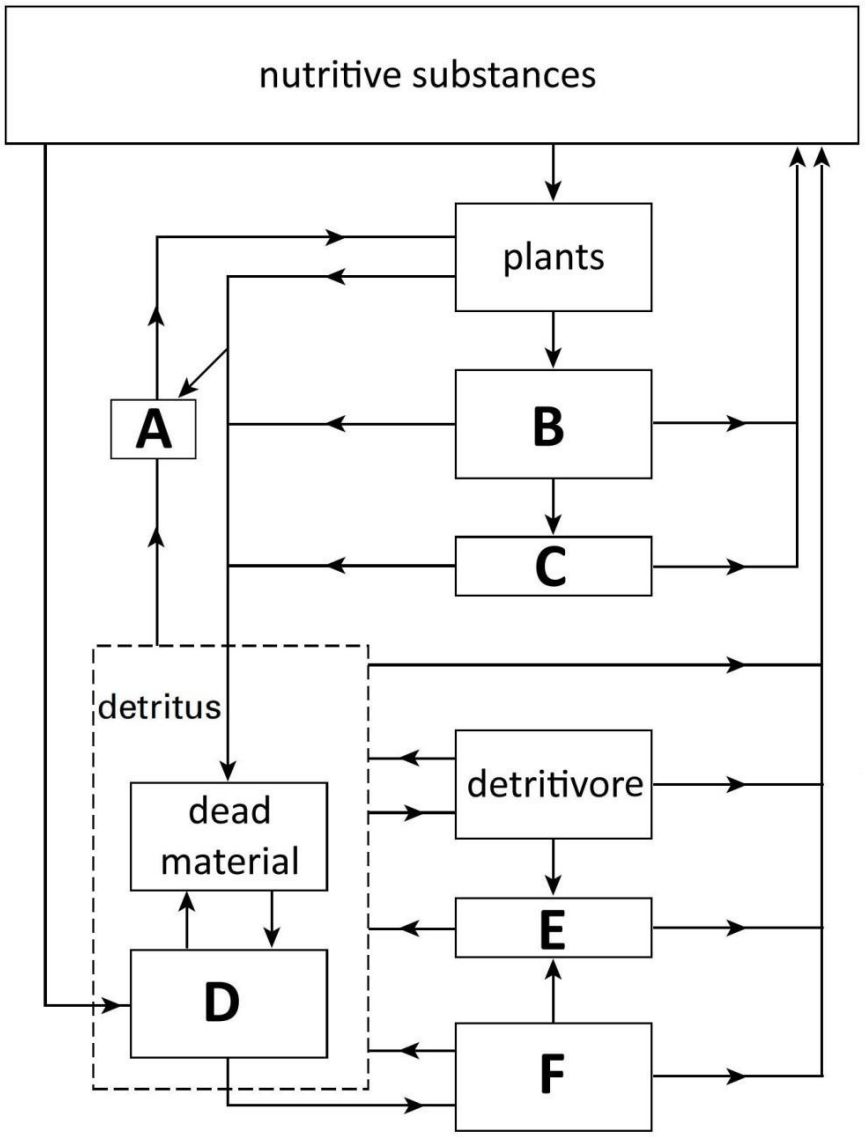
(B) Hyphae of arbuscular mycorrhizae can penetrate the cortical cells of the roots and cell membranes to form symbiotic associations intracellularly.

(C) Hyphae of ectomycorrhizae can penetrate the cortical cells of the roots, and form hyphal sheaths around the roots.

(D) Mycorrhizae have similar functions as root hairs of plants, and therefore, plants with mycorrhizae have less-developed root hairs.

(E) Each mycorrhiza forms symbiotic associations with the roots of specific plants.

B39. The figure below shows a nutrient cycle and organisms involved in this cycle. Six groups are indicated A up to F.



Which of the following descriptions are correct?

(A) C and F are carnivores.

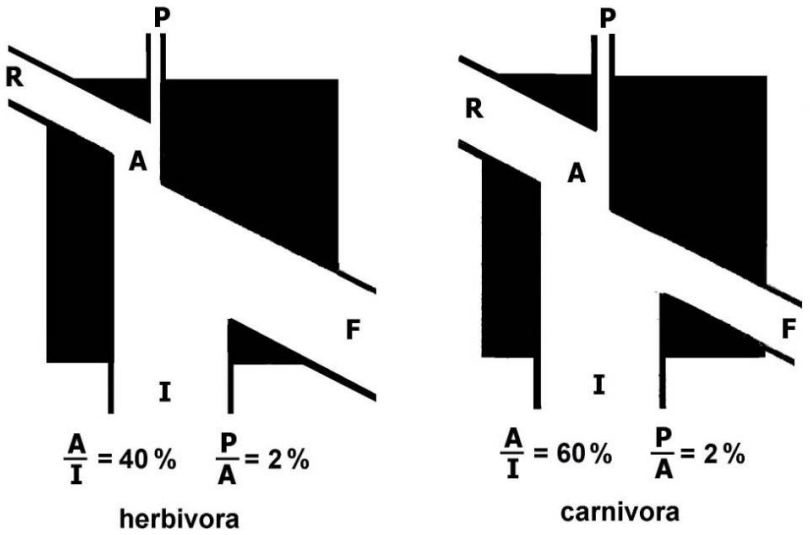
(B) C and E are carnivores.

(C) A and B are herbivores.

(D) D includes bacteria and fungi.

(E) F includes bacterivores and fungivores.

B40. The figure below shows a scheme of the assimilation efficiency (A/I) and production efficiency (P/A) of two groups of mammals in a meadow ecosystem.



A = energy intake in blood after digestion
F = loss of energy through excretion
I = take in of energy present in eaten organic compounds
P = production
R = loss of energy by dissimilation

Suppose I = 100 J

Which of the following descriptions are correct?

(A) Digestion of plant materials costs relatively less energy than digestion of animal materials.

(B) Plant materials that are reabsorbed have less organic contents than animal materials that are reabsorbed.

(C) R ranges between 40 and 60 J in carnivores.

(D) R ranges between 40 and 60 J in herbivores.

(E) R is lower in Bull frogs than in mammals.

Biosystematics

(2) After subgroup meeting – test questions

THEORETICAL TEST : PART A

Total Points: 116 Duration: 120 minutes

Dear Participants,

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- The questions in Part A have **only one** correct answer. Fill your answer in the Answer Sheet. Mark the correct answer with "X" on the Answer Sheet clearly, as shown below.

No.	A	B	C	D	E	F
A0	X					

- You can use a ruler and a calculator provided.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal point of Part A is 116 (2 points each for each question).
- Stop answering and put down your pen IMMEDIATELY after the end bell rings.

:

Good Luck!!

I. Cell Biology

A1. Endorphin is a natural analgesic secreted by the pituitary gland. Upon binding to its receptor in brain cells, endorphin can relieve pain and create a sense of euphoria. Morphine can achieve similar pain relief effects by binding to the endorphin receptor. Why do both endorphin and morphine bind to the endorphin receptors in brain cells?

(A) Sizes of both molecules are similar.

(B) Molecular weights of both molecules are similar.

(C) Both are isomers.

(D) Shapes of both molecules are similar.

(E) Net charges of both molecules are identical.

A2. Most biological macromolecules are made by the polymerization of small principal components. The major structural polysaccharide of the insect exoskeleton is a polymer. Which of the following statements regarding this kind of polysaccharide is **NOT correct**?

(A) It is made by polymerization of glucose.

(B) It contains C, H, O and N atoms.

(C) Its structure is similar to that of cellulose.

(D) It can be used to produce chitosan and glucosamine in industry.

(E) This polymer can also been found in the cell wall of fungi.

A3. In some cells, synthesis of isoleucine from threonine is catalyzed by the sequential action of five enzymes a, b, c, d and e which produce 4 intermediates A, B, C, D, and the end product isoleucine, respectively. What is most likely to happen when isoleucine is overproduced and there is an ample supply of threonine in cells?

(A) Isoleucine associates with threonine to inhibit the activity of enzyme a.

(B) Isoleucine associates with intermediate D to inhibit the activity of enzyme e.

(C) Isoleucine binds to enzyme a and inhibits its activity.

(D) Isoleucine binds to enzyme e and inhibits its activity.

(E) Threonine is converted into isoleucine continuously through the 5 enzymes.

A4. In some prokaryotic organisms, SO_4^{2-} is used as the final electron receptor at the end of electron transport chain during cellular respiration. Which of the following statements regarding cellular respiration in these prokaryotic organisms is **NOT correct**?

(A) It is anaerobic respiration.

(B) The reception of electron by SO_4^{2-} is accompanied by the production of H_2O.

(C) Operation of the electron transport chain builds up a proton motive force.

(D) ATP can be produced.

(E) Production of ATP is correlated with the mobility of H^+.

A5. Three stages in bacteria growth are:

I. Lag phase

II. Log phase

III. Stationary phase

In which phase or phases can penicillin inhibit the synthesis of the bacterial cell wall?

(A) Only I

(B) Only II

(C) Only III

(D) Only I and II

(E) Only I and III

(F) I, II and III

A6. Which structural or physiological feature of bacteria can be used as a target for developing drugs to kill bacteria effectively but with no harm to human cells?

(A) Glycolysis

(B) Components of plasma membrane

(C) Components of ribosome

(D) Components of the electron transport chain in aerobic respiration

(E) Requirement of oxygen

A7. Histones are small basic proteins that assemble with DNA molecules to form chromosomes. There are five histones, including H1, H2A, H2B, H3 and H4, in eukaryotic cells. Which of the following structural features of chromosomes is associated with Histone H1?

(A) Telomere

(B) Nucleosome fiber (10-nm fiber)

(C) 30-nm fiber

(D) Looped domains

(E) Centromere

A8. DNA is a double helix molecule containing four different types of nitrogen bases. Which of the following statements regarding both the replication and chemical composition of DNA is correct?

(A) Base sequences of both strands are the same.

(B) The amount of purine is equal to that of pyrimidine in a double-stranded DNA.

(C) Both strands are synthesized continuously in 5'→3' direction.

(D) The first base of the newly synthesized DNA is catalyzed by DNA polymerase.

(E) The proof-reading activity of DNA polymerase proceeds in the 5'→3' direction.

A9. Mister Spiderman has compared the DNA, the corresponding RNA and protein sequences of many human genes. What conclusion can be drawn from the sequence comparison?

(A) The number of exons is always more than that of introns.

(B) The translation start codon is located within the first exon.

(C) The translation stop codon is located within the last exon.

(D) The G nucleotide of RNA capping is the first nucleotide transcribed from DNA.

(E) The polyA tail is transcribed from the polydT of DNA.

A10. Miss Ling-Ling conducts DNA synthesis and transcription reactions in two separate test tubes. Which of the following substances needs to be added to both reactions?

(A) ATP

(B) DNA template

(C) RNA primer

(D) DNA polymerase

(E) DNA ligase

A11. The Nobel Prize in Physiology or Medicine 2009 was awarded jointly to Blackburn, Greider and Szostak for the discovery that chromosomes are protected by telomeres and the enzyme telomerase is highly correlated with aging and cancer in animals. Which of the following statements regarding telomere and telomerase is correct?

(A) Telomerase is a DNA exonuclease.

(B) Telomerase is an RNA polymerase.

(C) Embryonic cells possess long telomeres and high telomerase activity.

(D) Telomeres are longer and telomerase is inactive in cancer cells.

(E) Telomeres are longer and telomerase is highly active in somatic cells.

A12. *Eco*RI restriction enzyme is a DNA endonuclease that can recognize the sequence GAATTC. It was first discovered in *E. coli*, therefore it was named *Eco*RI. To produce a large quantity of the endonuclease, the DNA fragment encoding the gene was subcloned into an expression plasmid and the resultant recombinant plasmid was transformed into *E. coli* cells to produce recombinant enzyme for a study. Why is the host DNA not cleaved by the recombinant *Eco*RI?

(A) The host DNA does not contain *Eco*RI cleavage sites.

(B) *Eco*RI is secreted out of the host cells.

(C) Environmental factors such as temperature and pH value inhibit *Eco*RI activity.

(D) The *E. coli* host produces inhibitors to block *Eco*RI activity.

(E) The *Eco*RI cleavage sites within the host DNA are modified.

II. Plant anatomy and physiology

A13. Hypersensitive response is one of the plant defense responses to pathogens. Each of four pathogen strains, **a** to **d,** produce a distinct range of effectors. One of the effectors, Avr, recognized by a specific receptor protein encoded by the resistance (R) gene in the host plant is present in strains **b** and **c**. Host plants **B** and **D** produce the R protein. Which plant(s) are likely to develop a hypersensitive response after the host plants **A** to **D** are infected by pathogens **a** to **d** (**a**Æ **A**, **b**Æ **B**, **c**Æ **C**, **d**Æ **D**), respectively?

(A) **A** only

(B) **B** only

(C) **C** only

(D) **D** only

(E) **B** and **C**

(F) **B** and **D**

A14. Plant movement occurs when plant organs change their spatial distribution after being exposed to stimuli, and may be caused either by differential growth or by differential turgor change among cells within the organs. Which of the following plant movements uses a mechanism distinct from the others?

(A) The gravitropic movement of corn roots

(B) The closure of soybean leaflets during night time

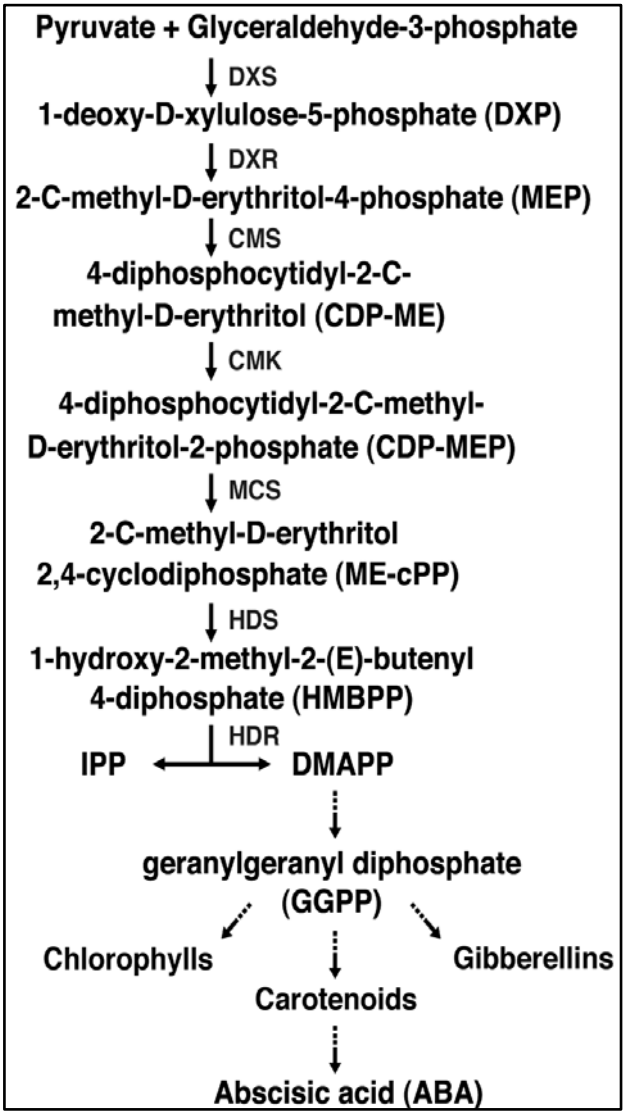
(C) The tentrils of cucumber moving along the trellis

(D) The phototropic movement of mungbean seedlings

(E) The downward bending of the tomato leaves after flooding treatment

Questions 15 and 16 are a **problem set**

A15. In the model plant Arabidopsis, the DXS, DXR, CMS, CMK, MCS, HDS and HDR enzymes are involved in the methyl erythritol phosphate (MEP) pathway of isopentenyl diphosphate (IPP) and dimethylallyl diphosphate (DMAPP) biosynthesis. The Arabidopsis *white devil* albino mutant is impaired in the enzyme HDS. Assuming Arabidopsis can efficiently take up the intermediate metabolites of the MEP pathway, the *white devil* albino mutant will grow and turn green if given which of the following compound?



(A) MEP

(B) CDP-ME

(C) CDP-MEP

(D) ME-cPP

(E)HMBPP

A16. The plant MEP pathway is located in which of the following organelle?

(A) nucleus

(B) vacuole

(C) chloroplast

(D) mitochondrion

(E) endoplasmic reticulum

A17. Dennis dissected a plant leaf and found bundle sheath cells full of starch granules. Which of the

following characteristics can be observed in this plant?

I. Stomata open at night

II. Presence of PEP carboxylase in mesophylls

III. Presence of Rubisco in bundle sheath cells

IV. High photorespiration rate on hot summer days

V. Light reaction and carbon fixation occur in different cell types

VI. Carbon assimilation rate is saturated in the early morning on summer days

(A) Only I, III (B)

Only II, IV (C)

Only II, IV, V

(D) Only II, III, V

(E) Only II, III, V, VI

(F) Only II, IV, V, VI

A18. It has been estimated that around 124 million children are vitamin A deficient, causing about 500,000 children to go blind each year. To help children who suffer from vitamin A deficiency, scientists have developed a variety of rice (*Oryza sativa* L.), Golden Rice, through genetic engineering. The original Golden Rice was produced using the japonica variety Taipei 309, which is genetically enriched in

(A) auxin

(B) starch

(C) β-carotene

(D) iron

(E) anthocyanins

A19. Abscisic acid (ABA) is one of the important growth regulators of plants. It often antagonizes the functions of hormones that promote growth. Plant biologists have been interested in elucidating the signaling pathway of ABA by genetic approaches. They screened mutants of

the model plant *Arabidopsis thaliana* that respond abnormally to ABA treatment to identify the involving components of the pathway. One type of mutant phenotype is ABA-insensitive (*abi*). Which of the following phenotypes are likely to be observed in the *abi* mutants?

(1) Seeds germinate at the presence of exogenous ABA.

(2) Seeds become dormant at the presence of exogenous ABA.

(3) Stomata do not close in response to drought.

(4) More tolerant to drought than the wild-type plants.

(5) Leaf does not abscise when it becomes senescent.

(6) Leaf is prematurely abscised even when greenish.

(A) Only (1), (3)

(B) Only (2), (3)

(C) Only (2), (5)

(D) Only (2), (4), (5)

(E) Only (1), (3), (6)

(F) Only (2), (4), (6)

A20. Ethylene is a hormone that influences plant's growth and development. It is known that treatment with 10 ppm of 1-methylcyclopropene (MCP) can block the signal transduction of ethylene. If certain plant tissues were treated with 10 ppm MCP, which of the following phenotypes could be observed in MCP-treated tissues?

(A) Shorter hypocotyl in etiolated mung bean seedling

(B) Increased degradation of chlorophyll in detached leaves

(C) Increased synthesis of ethylene in banana fruits

(D) Inhibition of the ripening of tomato fruits

(E) Induction of the senescence of carnation cut flowers

A21. During leaf development in water lily, the sclereid-initials grow and elongate along the palisade mesophyll cells or the intercellular space between them. After elongation they gradually form

calcium oxalate crystals in the cell wall along the cell membrane. Thereafter, they form the secondary cell wall. Four cell wall structures are: (I) primary cell wall; (II) secondary cell wall; (III) middle lamella; (IV) calcium oxalate crystals. What is the final sequence of structures in the mature sclereids of water lily, starting from the plasma membrane as the innermost layer to the outermost layer?

(A) I → IV → II → III

(B) III → IV → I → II

(C) I → IV → II → III

(D) III → I → IV → II

(E) II → IV → I → III

A22. *Agrobacterium tumefaciens*-mediated transformation, a widely used method to transfer foreign genes into the plant genome, has contributed to the considerable successes that plant biotechnology has already achieved. For instance, a gene encoding the coat protein (CP) of papaya ringspot virus (PRSV) was used to generate the virus-resistant transgenic SunUp papaya in Hawaii. The construct used for transformation includes the *CP* gene and a selectable marker gene (*nptII*) conferring kanamycin resistance. Both *CP* and *nptII* genes are driven by a constitutive cauliflower mosaic virus (CaMV) 35S promoter. According to the above information, which of the following statements is **NOT correct**?

(A) The SunUp papaya is resistant to kanamycin.

(B) The SunUp papaya contains some DNA sequences from CaMV.

(C) The SunUp papaya contains some genomic DNA of *Agrobacterium tumefaciens*.

(D) The SunUp papaya contains a portion of the Ti plasmid termed T-DNA.

(E) The SunUp papaya contains the *nptII* gene.

III. Animal anatomy and physiology

A23. Which of the following is the only vertebrate in which blood flows directly from respiratory organs to body tissues without returning to the heart first?

(A) Fish

(B) Amphibians

(C) Mammals

(D) Reptiles

(E) Birds

A24. How does the hemocyanin of arthropods differ from the hemoglobin of mammals?

(A) The oxygen dissociation curve of hemocyanin is not a S-shape

(B) Hemocyanin carries considerably more carbon dioxide

(C) Hemocyanin is a single-chain respiratory pigment

(D) Hemocyanin is a protein coupled with magnesium

(E) Hemocyanin is a protein coupled with copper

A25. A shark is more likely to survive for an extended period of food deprivation than is a dolphin with equivalent size because

(A) The shark maintains a higher basal metabolic rate

(B) The shark expends more energy/kg body weight than the dolphin

(C) The shark invests much less energy in temperature regulation

(D) The shark metabolizes its stored energy more readily than the dolphin does

(E) The shark has a better insulation on its body surface

A26. Increased arteriolar resistance contributes to hypertension. Which one of the following factors contribute to the increased vascular resistance most significantly?

(A) Vessel length (B)

Blood viscosity (C)

Vascular diameter

(D) Total leukocyte counts

(E) Heart rate

A27. A method to estimate an mammal's blood volume uses a specific radioactive isotope of iodine(123I). This isotope, usually produced synthetically, has a half-life time of 13 hours. It decays to 123Te, which is almost perfectly stable. To estimate the blood volume, 10 mL of iodine solution are injected into the animal's vein. The activity of the solution at the injection is 2mSv. A sample of 10 mL of the animal's blood, taken 13 hours after the injection, is 0.0025mSv. The estimate volume of the animal's blood volume is?

(A) 10.0 L

(B) 8.0 L

(C) 4.0 L

(D) 2.5 L

(E) 1.25 L

A28. Which of the following events will result in an excitatory postsynaptic potential?

a. Increasing sodium influx.

b. Blocking potassium out-flux.

c. Increasing calcium influx.

d. Closing a chloride channel.

(A) Only a & b

(B) Only b & c (C)

Only a, c & d (D)

Only b, c & d (E)

a, b, c & d.

A29. Which of the following is the correct effect of hyperthyroidism (hypersecretion of thyroid hormone) on Thyrotropin-releasing hormone (TRH), thyroid-stimulating hormone (TSH), and Thyroid hormones T3 and T4?

↑: increase ↓: decrease —: remains unchanged

	TRH	TSH	T3	T4
A	↑	↑	—	↑
B	↑	↑	↑	—
C	↓	↓	↑	↑
D	↓	↓	↓	↓
E	↓	↑	↑	↑

A30. Which of following receptors/molecules are required for the activation of Helper T cells trigged by antigen-presenting cells.

1. CD8
2. CD4
3. Class I MHC molecule
4. Class II MHC molecule
5. T cell receptor

(A) Only 1, 3 & 5

(B) Only 2, 4 & 5

(C) Only 3, 4 & 5

(D) Only 2 & 4 (E)

Only 1 & 3

A31. Inspect the following table which is revealed to the function of kidneys in vertebrate.

What	1. Urine concentration by NaCl reabsorption 2. Urine concentration by urea reabsorption 3. Aquaporin mediated water reabsorption
How	4. Countercurrent multiplier system 5. Countercurrent exchange
Where	6. Loop of Henle 7. Collecting duct 8. Proximal tubule

Figure out which of the following alternatives show a correct combination.

(A) 1-4-6

(B) 1-4-8

(C) 2-4-6

(D) 2-5-8

(E) 3-5-7

A32. When people lose blood quickly as happens in a car accident, which of the following situations will **NOT** occur

(A) Stroke volume increases; cardiac output increases

(B) Blood volume decreases but interstitial fluid increases

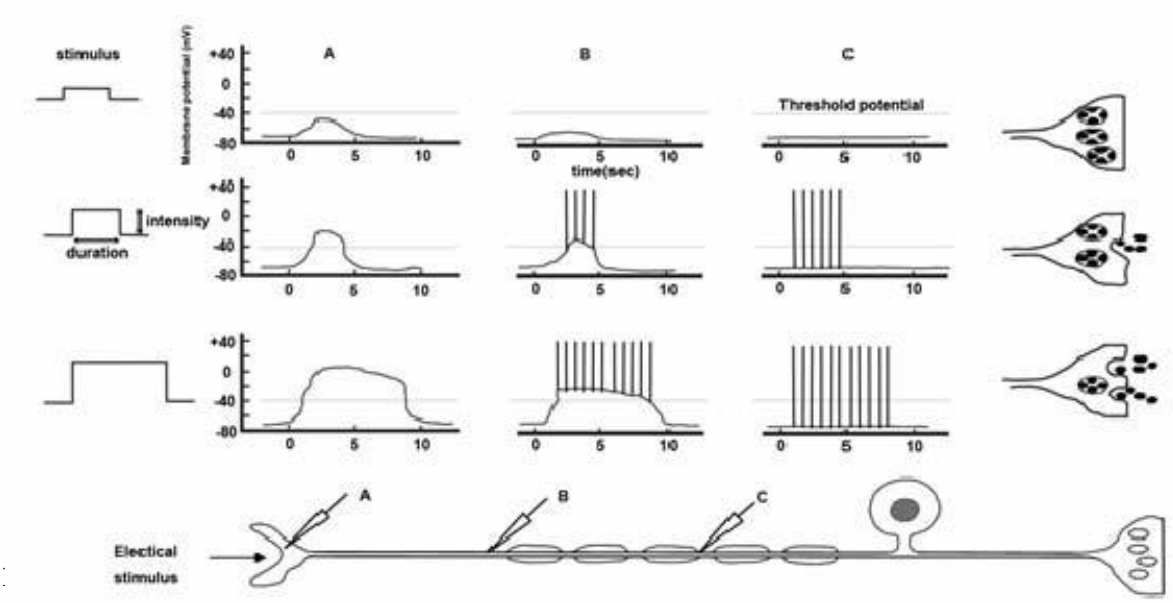
(C) Increase in the resistance of blood vessel

(D) Decrease of sodium concentration in urine

(E) Decrease in the proportion of red blood cells in blood.

A33. The following figure illustrates the membrane potential changes measured at three different sites (A, B, C) along a sensory neuron and the release of neurotransmitters from the axon termini when depolarizing electrical stimuli with varied intensities were applied to the dendrite.

Based on the information provided in the figure below, choose the correct statements in the following box.



intensity of the electrical stimuli applied to the dendrite.

2. An action potential would be recorded at B site only when the intensity of the applied current stimulus causes the membrane potential to be higher than the threshold potential in the axon hillock.
3. The frequency of the action potentials at B site is independent of the intensity of the applied current stimulus at A.
4. The quantity of the neurotransmitters released from the axon termini is unlikely to depend on the frequency of the action potential at C site.

(A) Only 1 and 2

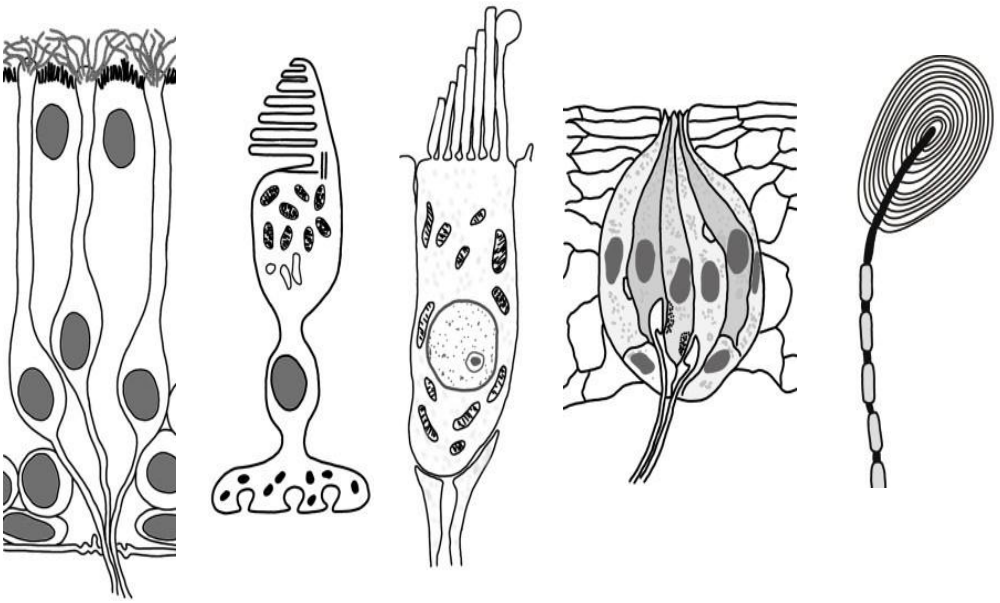
(B) Only 1 and 3

(C) Only 2 and 3

(D) Only 3 and 4

(E) Only 1, 2, and 3

A34. The perception of the messages from the environmental changes is carried out by specialized sensory cells. Their structural composition is in a strict accordance to their functions. Please analyze the following pictures and answer the question below:



1 **2** **3** **4** **5**

Which one of the above receptors in human receptors will be activated by a stimulation and trigger the opening of a potassium channel?

(A) 1

(B) 2

(C) 3

(D) 4

(E) 5

IV. Ethology

A35. There are three types of chemical substances that organisms emit to mediate interspecific interactions: kairomone, allomone, and synomone. Kairomone benefits individuals of another species which receives it but is disadvantageous to the emitter. Allomone benefits the emitter, and does not benefit or harm the receiver. Synomone benefits both the emitter and receiver. A plant species emits a volatile essential oil that attracts a phytophagous beetle to feed and lay eggs on its leaves. At the same time, it also attracts a parasitoid wasp, and helps this parasitic natural enemy of the beetles to locate the beetle larvae within which they can lay their own eggs. Which of the following descriptions of the role that this essential oil plays is correct?

(A) It acts as a synomone between the plant and the beetle, and an allomone between the plant and the parasitoid wasp.

(B) It acts as a kairomone between the plant and the parasitoid wasp, and a synomone between the beetle and the parasitoid wasp.

(C) It acts as a kairomone between the plant and the beetle, and a synomone between the plant and the parasitoid wasp.

(D) It acts as a kairomone between the plant and the beetle, and an allomone between the beetle and the parasitoid wasp.

(E) It acts as a kairomone between the plant and the parasitoid wasp, as well as between the beetle and the parasitoid wasp.

A36. In terms of the benefits and harms received by each of the two parties interacting, which of the following pairs of biological interactions are most similar to each other?

(A) Clownfish and sea anemones; mistletoes and apple trees.

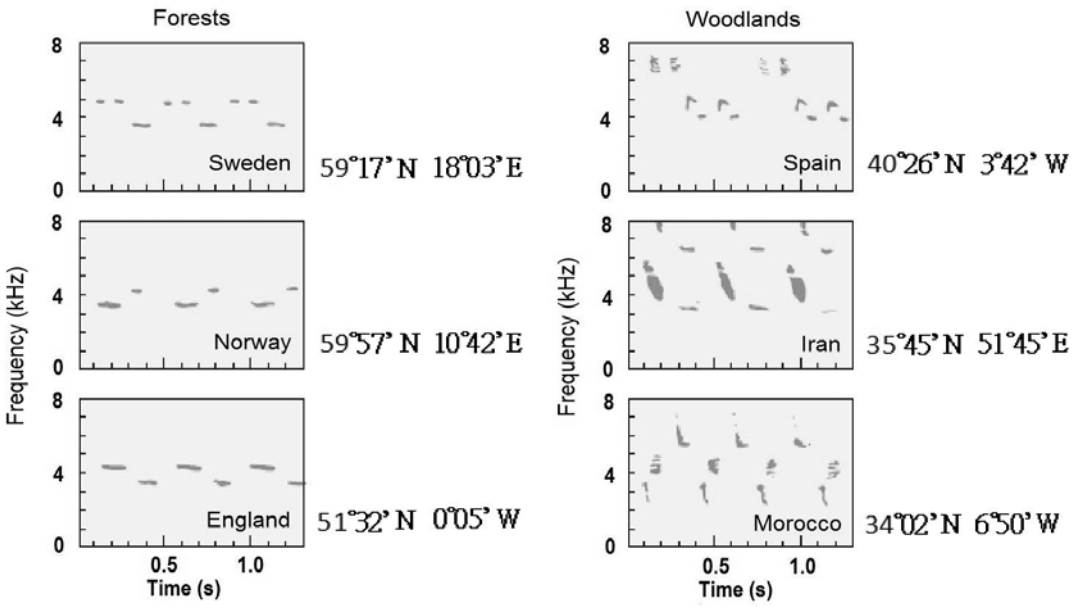
(B) Sea stars and bivalves; locusts and grasshoppers.

(C) Lichens and maples; mistletoes and oaks.

(D) Caterpillars and parasitic wasps; food plants and caterpillars.

(E) HIV virus and human; mushrooms and rotten woods.

A37. Great tits (*Parus major*) inhabiting forests and woodlands (patchy forest) have different song patterns. It is documented that high frequency sounds become less degraded in open habitat than in places with dense vegetation. Consider the following graphs showing song characteristics of great tits from 6 locations. Which of the following statements is correct?



(A) There is less variability in song frequency in low-latitude regions.

(B) Forest inhabitants are more varied in song frequency than woodland inhabitants.

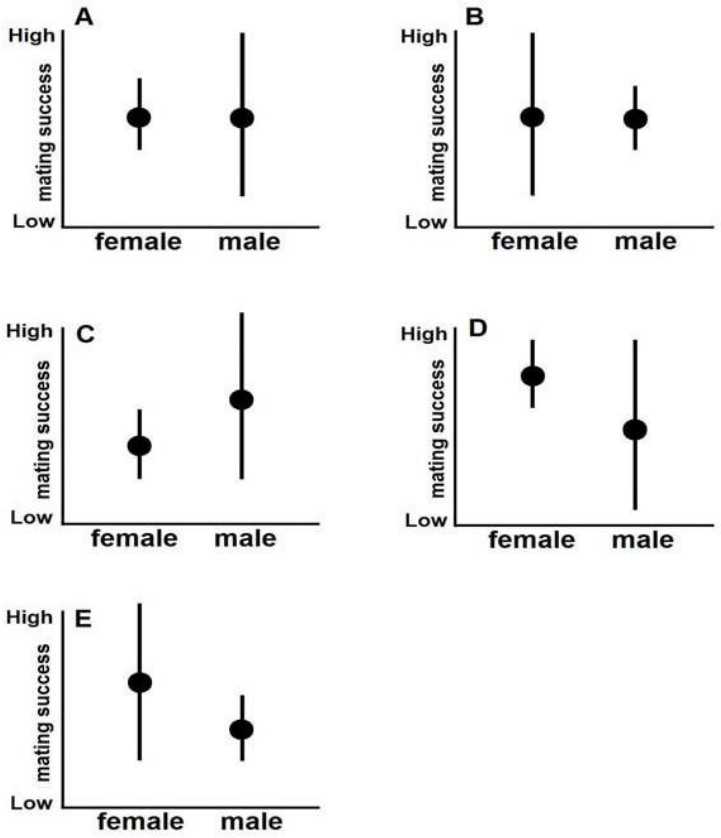
(C) Songs of forest inhabitants have more notes per phrase than those of woodland inhabitants.

(D) The variation of song type has nothing to do with habitat type

(E) If an individual moves from forests to open grassland, the mean frequency of the song is likely to increase**.**

A38. A hypothetical insect species employs the polygynous mating system, in which the males are capable of multiple mating, but the females mate only once. The adults of this species occur in the fall when matings take place. All adults of this species die off soon after the mating season. The sex ratio of this species is 1:1. The below shows the comparison of the mating success, defined as the number of mating in a given season, for both male and female in this species. Which one of the graphs below (A to E) best describes the mean and variance of both male and

female in this species? Solid dots represent means, and lines denote the ranges of variance.



V. Genetics and evolution

A39. Frank has subcloned a cDNA fragment from an animal into an expression plasmid. The recombinant plasmid was transformed into bacteria to produce recombinant protein., What is the major reason that the expressed protein is non-functional ?

(A) Differences in codon usage between animals and bacteria

(B) Differences in protein modification between animals and bacteria

(C) Components of bacterial culture media

(D) Modulators of gene transcription

(E) Secretion signal of proteins

A40. Gregor Mendel discovered that segregation of genes on non-homologous chromosomes is independent of each other in his garden pea hybridization experiments. Four alleles A, B, C and D are located on four non-homologous chromosomes. Which of the following genotypes will have the highest chance to produce the dominant trait in all four loci when it mates with an organism with the genotype AaBbCcDd?

(A) aabbccdd (B)

AaBbCcDd (C)

AaBBccDd (D)

AaBBCCdd (E)

aaBBCCdd

A41. An X-linked allele determines the coat color of cats with orange being dominant and black being recessive. Which of the following statements regarding the inheritance pattern of orange/black mosaic cats is correct?

(A) Half of all male cats are mosaic.

(B) The mosaic phenotype is a consequence of gene interaction.

(C) The mosaic phenotype is correlated with genomic imprinting.

(D) The mosaic phenotype results from random X-chromosomal inactivation.

(E) The offspring from matings of orange males and black females are mosaic.

Questions 42 and 43 are a **problem set**

A42. On a remote island, Dr. Yeh discovered a new plant species, which can produce either white or blue flowers. This species is self fertilized or cross pollinated by insects. Genetic experiments showed that the white-flower phenotype is recessive to the blue-flower phenotype. Statistical analysis revealed that 91% of these plants on the island produce blue flowers. If one is to randomly select two blue-flower plants and cross them, then what is the approximate probability that their F1 offspring will produce white flowers?

(A) 0.09 (B) 0.21 (C) 0.42 (D) 0.49 (E) 0.91

A43. Dr. Yeh treated the seeds of the above-mentioned homozygous blue-flower plants with chemical mutagen to produce a mutant population. Three recessive mutants, *wf1, wf2,* and *wf3,* produced white flowers were selected. He crossed the mutants and obtained the following results: *wf1* x *wf3* produced F2 offspring with only white flowers, and *wf2* x *wf3* produced F2 offspring with blue and white flowers in a ratio of 9:7. According to these data, which of the statements below is **NOT correct**?

(A) *wf1* and *wf3* are unable to complement each other.

(B) *wf2* and *wf3* are able to complement each other. (C)

wf1 and *wf3* are in the same locus.

(D) *wf2* and *wf3* are not in the same locus

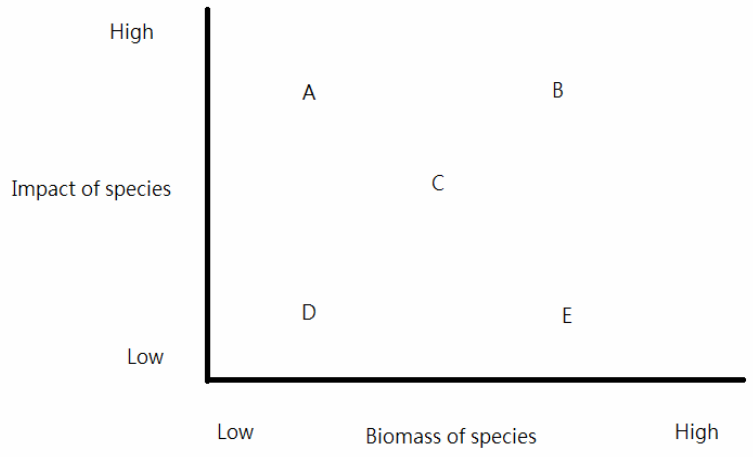
(E) The F1 offspring from crossing *wf1* and *wf2* will all produce white flowers

VI. Ecology

A44. Biogeography researchers found that continental islands tend to have a species composition similar to the mainland, but a lower degree of species differentiation comparing to oceanic islands. If one compares the biome of an oceanic island (X) to a continental island (Y), assuming the two have approximately the same area, and are located in the same latitudinal range, which of the following descriptions is correct?

	Proportion of endemic species	Total number of species
A	X<Y	X>Y
B	X>Y	X>Y
C	X>Y	X<Y
D	X<Y	X<Y
E	X=Y	X<Y

A45. In the figure below, A to E denote five different species in an ecosystem. Which of the species is most likely to be a keystone species?



A46. A group of students would like to know how the discharge of waste water from a factory might influence water quality of a river. The picture shows 7 potential sampling locations (① to ⑦) in relation to the locations of the factory and the river. Which locations are essential to be included in the sampling in order to draw valid conclusions about the pollution of the river by

the factory?

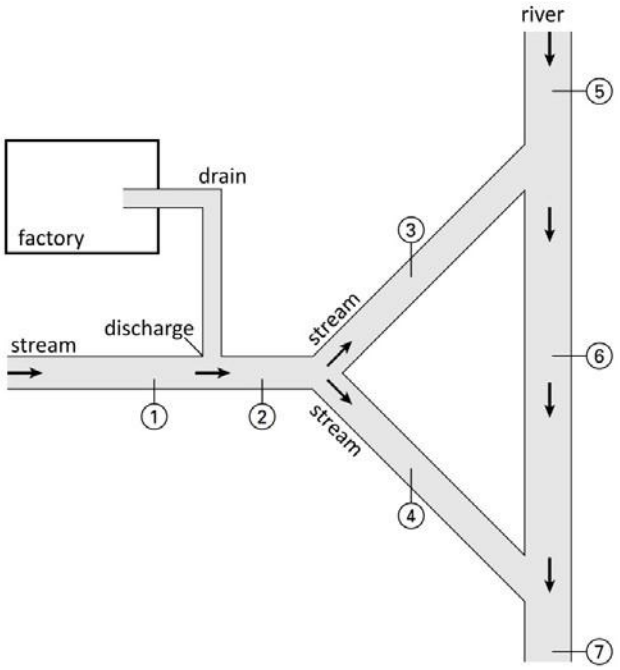
(A) Locations 1, 2, 4, 7

(B) Locations 1, 3, 4, 7

(C) Locations 1, 2, 5, 7

(D) Locations 2, 3, 4, 6

(E) Locations 2, 5, 6, 7



A47. Biogeography researchers have long recognized that terrestrial biomes on islands are often associated with dispersal and colonizing ability of different organisms. Based on dispersal and colonizing ability of the following groups of organisms, which one <u>is least likely</u> to occur on an oceanic, tropical island with a large area, numerous mountains, a dense vegetation cover, and a high level of biodiversity?

(A) Insects

(B) Birds

(C) Ferns

(D) Amphibians

(E) Reptiles

A48. A male guppy (*Poecilia reticulata*) with large, bright spots on the body is more likely to attract females, which increases his opportunity to reproduce. In the meantime, he is also more easily detected by the natural enemy, which increases his predation risk. Consider male guppies from three different rivers: X, Y and Z, males from X have the largest spots, males from Y have the intermediate-sized spots, and males from Z have the smallest spots. Which of the following descriptions about the guppies in the three rivers is correct?

The density of

(A) male guppies in X is higher than in the other rivers.

(B) male guppies in Z is higher than in the other rivers.

(C) natural enemy of guppies in X is higher than in the other rivers.

(D) natural enemy of guppies in Z is higher than the other rivers. (E)

female guppies in X is higher than the other rivers.

A49. Species M had been introduced multiple times to an ecosystem outside its native distribution, but could not establish itself. Although no parameter in ecosystem changed between the different attempts, the final one introduction was eventually successful, and led to a rapid and wide-spread expansion of species M in the ecosystem. Which of the followings is the most plausible explanation for why species M was not natively distributed in this ecosystem?

(A) There are too many competitors of species M in the ecosystem.
(B) There are too many predators of species M in the ecosystem.
(C) Species M is not able to disperse to the ecosystem on it own.
(D) The abiotic environment in the ecosystem is not suitable for the growth of species M.
(E) The ecosystem is frequently under disturbance, which creates an unfavorable condition for species M to sustain.

A50. A large forest is cleared. The land is rapidly colonized by species with which of the following characteristics?

(1) long lifespan, (2) rapid reproduction, (3) fast growth, (4) strong dispersal ability, (5) strong defense against natural enemies or predators.

(A) Only 1, 2, 3
(B) Only 1, 2, 5
(C) Only 1, 4, 5
(D) Only 2, 3, 4
(E) Only 3, 4, 5

A51. A large proportion of angiosperms are pollinated by animals. Assign the following flower descriptions (I to V) to the most likely pollinator (a to e).

I. Flower white, open during night, intensive fragrant, nectar hidden in long, tight tubes. II.

Flower often with ultraviolet coloring pattern, open during daytime, pleasant fragrant.

III. Flower large and coarse, bright red, open during daytime, no fragrance but large amounts of nectar

IV. Flower large and coarse, far opened, open during night, intensive fragrant, large amounts of nectar

V. Flower reddish brown, no nectar, smell of rotten flesh

a. bats

b. birds

c. bees

d. flies

e. moths

Which of the following statement is correct?

(A) Ia, IIb, IIIc, IVe, Vd

(B) Ib, IIc, IIId, IVa, Ve

(C) Id, IIe, IIIa, IVb, Vc

(D) Ie, IIc, IIIb, IVa, Vd

(E) Ie, IId, IIIc, IVb, Va

A52. It has been demonstrated that house roaches show less threat to human health than mosquitos in terms of serving as disease vectors. Which feature possessed by roaches given below may explain this observation?

(A) piercing mouthpart, injecting saliva into the tissue which it feeds upon

(B) chewing mouthpart, swallowing food without saliva

(C) mouthpart sponge-like, secreting saliva upon the food they feed on (D)

microhabitats they prefer much more cleaner than those by mosquitos (E)

by natural they are anthropophobia

VII. Biosystematics

[Questions 53-55] The following table shows the main characteristics of 8 different animals (taxa 1 to 8). A "+" sign indicates that the animal possesses such characteristic, and a "blank" indicates that the animal does not possess such characteristic:

Characteristic	**Taxon**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Amnion			+	+	+			
Limbs with fingers	+		+		+			
Mammary glands					+			
Lateral line system	+	+				+		
Cycloid scales		+						
Sternum	+		+		+			
Semicircle canals	+	+	+	+	+	+	+	
Ventral nerve cords								+

Please answer questions A53 to 55using the information in the table above.

A53. Which of the following taxa most likely belongs to the same Class as "Taxon 4"?

(A) Taxon 1

(B) Taxon 2

(C) Taxon 3

(D) Taxon 5

(E) Taxon 6

A54. "Taxon 8" <u>is least likely</u> to be which of the following organisms?

(A) Earthworm

(B) Grasshopper

(C) Lobster

(D) Sea star

(E) Spider

A55. "Taxon 1" is most likely to be which of the following organisms?

(A) Shark

(B) Eel

(C) Sea lion

(D) Turtle

(E) Frog

A56. Table A is a data matrix for characters of four kinds of animals. The number entries denote shared characters if the same values (0 or 1) are given, not shared if different values (0 and 1) are given.

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Animal A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Animal B	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0
Animal C	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
Animal D	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0

If relationship among organisms can be inferred from the degree of similarity, and the degree of similarity is defined as a coefficient S:

S = quantity of shared characters/(quantity of shared characters + different charcters)

According to the data matrix given by Table A, which animal is the most closely related to animal A, and which one is to C? Please give your animal in the format of (the animal most closely related to A, the animal most closely related to C).

(A) (B, A)

(B) (B, B)

(C) (C, B)

(D) (C, A)

(E) (D, A)

A57. Mary bought rice, potatoes, tomatoes, kelp, pine nuts, mushrooms, dates, bird nest fern, bananas, and corn cobs from the supermarket. Based on hierarchical classification, how many different phyla do these items belong to?

(A) 4

(B) 5

(C) 6

(D) 7

(E) 8

A58. A scientist unearthed four plant fossils (I to IV) with some prominent structures intact. These are listed in the following table:

Structure / Fossil #	Spore	Ovary	Embryo	Pollen	Xylem	Ovule
I			ʒ		ʒ	
II			ʒ	ʒ	ʒ	ʒ
III		ʒ		ʒ	ʒ	ʒ
IV	ʒ		ʒ			

According to this table, which sequence below correctly represents the order of evolution of these plants?

(A) I→II→III→IV

(B) II→III→IV→I

(C) III→IV→I→II

(D) IV→I→II→III

(E) II→I→IV→III

(F) III→I→IV→II

THEORETICAL TEST : PART B

Total Points: 120 Duration: 150 minutes

Dear Participants,

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- The questions in Part B **may have more than one** correct answer. Fill your answers in the Answer Sheet. The **marks, numbers, or characters** to answer questions in Part B vary depending on questions. Mark the correct answers with "◯" and incorrect answers with "—" on the Answer Sheet clearly, as shown below.

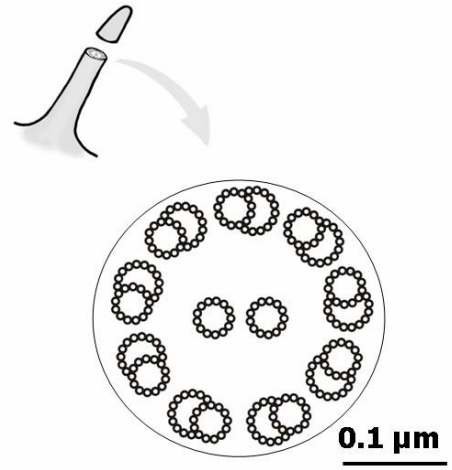
No.	A	B	C	D	E	F
B0.	◯	—	◯	—	—	—

- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal points of Part B is 120 (3 points for each question)
- **All answers must be correct** in each question. Then you will get the points.
- Stop answering and put down your pencil IMMEDIATELY after the end bell rings.

Good Luck!!

I. Cell biology

Problem set: **Figure 1** depicts the cross-section of a certain cell surface structure observed by electron microscope. Answer questions 1 and 2.



B1. Which of the following possess the above structure?

(A) *Paramecium*

(B) *Escherichia coli*

(C) Tracheid of gymnosperm

(D) Sieve tube element of angiosperm

(E) Human tracheal cell

(F) Human intestinal epithelial cell

B2. What is/are the functions and what is the major chemical composition of the structure?

Function options:

(A) Attachment

(B) Locomotion

(C) Transportation

(D) Secretion (E)

Absorption

Composition options:

(P) Cellulose

(Q) Protein

(R) Mucin (S)

Lipid

(T) Nucleic acid

B3. Some pathogens produce exotoxins that can cause human diseases. One type of exotoxins consists of two polypeptides, subunits A and B. Subunit B can bind to surface receptors on the target cells and cause the transport of the subunit A or associated molecules across the plasma membrane into the cell. Once the subunit A enters the cell, it inhibits protein synthesis and destroys the cells. Which of the following statements regarding exotoxins is/are correct?

(A) Subunit A alone can cause disease.

(B) Subunit B alone can bind to target cells.

(C) Subunit A may carry other molecules to kill target cells.

(D) Subunit B may carry other molecules and assist these molecules to enter target cells.

(E) When conjugated with an antibody against breast cancer cells, subunit A can kill breast cancer cells.

Problem set: Some leucocytes can ingest invaded pathogens by phagocytosis. Digestive enzymes that kill pathogens only function in acidic conditions. Please answer questions 4 and 5.

B4. Based on the information provided in the following table, complete the synthesis process of digestive enzymes during phagocytosis:

① Replication	⑤ Endoplasmic reticulum
② Translation	⑥ Vesicle
③ Transcription	⑦ Lysosome
④ Mitochondrion	⑧ Golgi apparatus

(1) mRNA-ribosome complex is transferred to ___a___ to continue ___b___.

(2) Synthesized enzymes enter ___c___ and ___d___ for modification.

(3) The modified enzymes are stored in ___e___.

(A) a: ④ b: ① c: ⑥ d: ⑦ e: ④

(B) a: ⑦ b: ② c: ⑦ d: ⑧ e: ⑤

(C) a: ⑧ b: ③ c: ⑥ d: ⑧ e: ⑥

(D) a: ⑤ b: ② c: ⑤ d: ⑧ e: ⑦

(E) a: ⑥ b: ① c: ⑤ d: ⑦ e: ⑧

B5. Tom isolated phagocytes from a blood sample. He cultured these phagocytes in a test tube for a period of time. To observe phagocytosis, *E. coli* was co-cultured with phagocytes. What will be the consequence if an antacid is added to the culture?

(A) Phagocytes can ingest and kill *E. coli*.

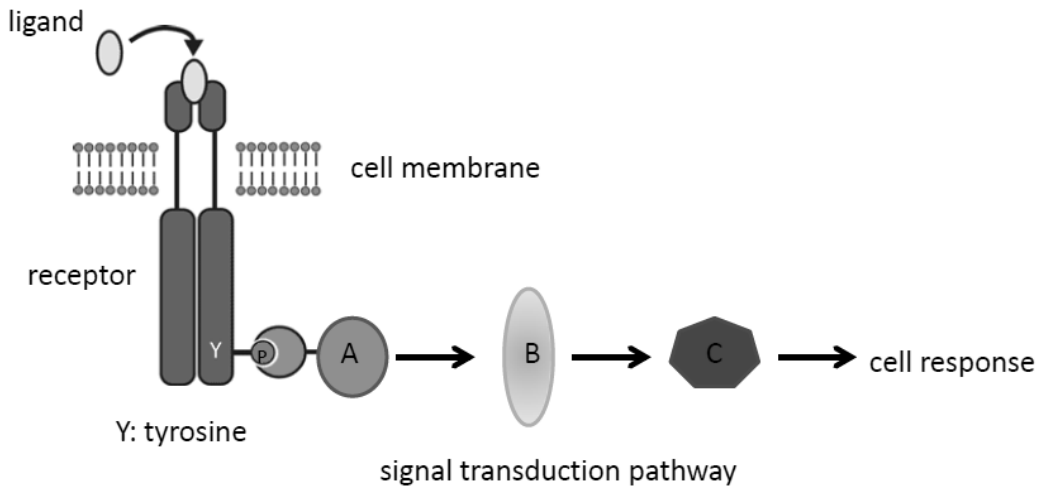
(B) Ingestion of *E. coli* by phagocytes is inhibited.

(C) *E. coli* is viable in phagolysosome.

(D) If phagolysosomes are formed, the digestive enzymes in them are inactive.

(E) Phagocytes can secrete ingested debris out of the cells.

Problem set: Jessica is dissecting a signal transduction pathway (depicted in the following figure) that leads to oncogenesis in cancer cells, in the hope that she can find inhibitors to block the signaling pathway and use them as chemotherapy drugs for cancer treatment. Please answer questions B6-B8.



B6. Components of signal transduction, including A, B and C, usually are activated through phosphorylation or dephosphorylation reactions. What are the mechanisms by which proteins A , B and C are phosphorylated or dephosphorylated?

(A) Receptors may contain enzyme domains which can catalyse phosphorylation/dephosphorylation reactions.

(B) Enzymes that participate in phosphorylation/dephosphorylation reactions may exist in the cytoplasm.

(C) Proteins A, B and C may contain enzyme domains which can catalyse phosphorylation/dephosphorylation reactions.

(D) Phosphorylation or dephosphorylation may not be mediated through enzymatic reactions.

(E) A phosphate group is transferred from the receptor to protein A.

(F) The phosphate group can only be provided by H_3PO_4.

B7. Which of the following experiment can prove that the signal transduction pathway is B→C, but not C→B?

(A) Adding an A antagonist will activate B.

(B) Adding an A agonist will activate C.

(C) Adding a B agonist will activate C.

(D) Adding a B antagonist will activate C.

(E) Increasing the expression level of B will generate more active C molecules.

(F) Cell response can be observed when B antagonist and active C molecules are added to the cell.

B8. If this is a highly activated signal transduction pathway in cancer cells, which of the following processes does the signaling pathway involve?

(A) Inhibiting cell division

(B) Inhibiting cell differentiation

(C) Hypomethylation of some tumor suppressor genes

(D) Activating the transcription of an oncogene

(E) Arresting the cell cycle at S phase

(F) Inhibiting the expression of some DNA repair genes

B9. In protein synthesis, there are 64 codons, 61 codons specify the 20 amino acids and the other 3 for termination "STOP" (**Table**). The following sequence of amino acids occurred in the structure of a polypeptide found in a wild-type organism:

Ser-Arg-Ile-Leu-Ala-Ala-Lys-Tyr. Which of the following may generate the mutant amino acid sequence Ser-Arg-Ile-Trp-Arg-Gln-Lys-Tyr?

Second letter of codon

First letter of codon (5' end)	U		C		A		G	
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys
	UUA	Leu	UCA	Ser	UAA	Stop	UGA	Stop
	UUG	Leu	UCG	Ser	UAG	Stop	UGG	Trp
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg
	AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly

(A) 1 nucleotide mutation

(B) 1 nucleotide insertion

(C) 1 nucleotide deletion

(D) 2 nucleotide mutation

(E) 2 nucleotide insertion

(F) 3 nucleotide mutation

II. Plant anatomy and physiology

B10. At the time of pollination, the living pollen grain typically consists of only the tube cell and the generative cell. During the germination of pollen grain, a pollen tube is produced and the nucleus of generative cell divides and forms two sperms. Directed by a chemical attractant (such as GABA) produced by the synergids, the tip of pollen tube enter the ovule through the micropyle. Then in the embryo sac, double fertilization occurs by the two sperms. Which of the followings are correct as concerning the pollination and double fertilization?

(A) Tube cell, sperm, and synergid are haploid, while generative cell and zygote are diploid. (B) During the pollination, a gradient in GABA content is formed from the stigma (low) to the ovary (high).

(C) The two sperms fertilize two eggs, but only one forming zygote.

(D) After fertilization, one zygote and one endosperm initial are formed.

(E) Germinated pollen grain is male gametophyte, while embryo sac is female gametophyte.

B11. Mary divided 30 pots of plant X of similar condition into 10 plants per group, with each group being treated with different types of light regime. After a month, the flowering phenotypes of each group are shown in the table below:

Treatment	Light regime		Flowering result
(I)	12 hr	12 hr	All 10 pots flowered
(II)	14 hr	10 hr	9 pots flowered, and 1 pot failed to flower
(III)	16 hr	8 hr	All 10 pots fail to flower
	Light	Darkness	

According to the information above, which of the following descriptions of plant X are correct?

(A) Plant X is a short day plant

(B) The critical dark-length required by plant X for flowering is less than 10 hours

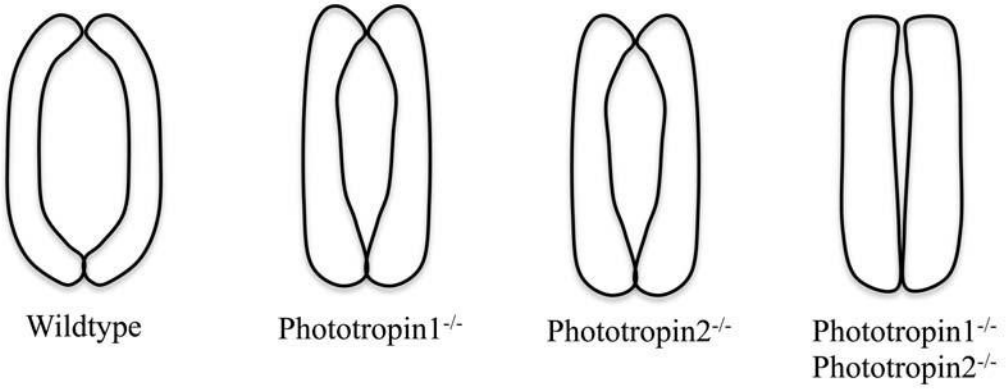
(C) If group III is given an “one-minute dark treatment” in the middle of the light period, after one month, most plants in this group will flower

(D) If group II is given an "one-minute red light treatment" in the middle of the dark period, most plants in this group will not flower right after one month

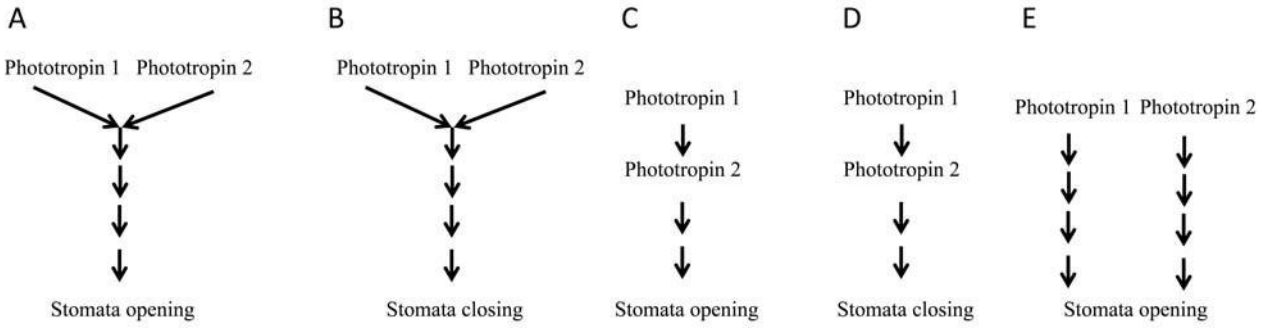
(E) If the apical buds of group I plants are removed before giving the light regime treatment, then most plants will not produce florigen required for flowering after giving light regime treatment.

B12 and B13 are a problem set

Dr. Wang carried out experiments with the model organism *Arabidopsis thatliana*, and identified the two proteins Phototropin 1 and Phototropin 2 as regulators of stomata opening. His experimental results are depicted in the following figure, illustrating the stomata of plants during the day.



B12. Which of the following pathways potentially depicts the relationship of Phototropin 1 and Phototropin 2 on a molecular level?



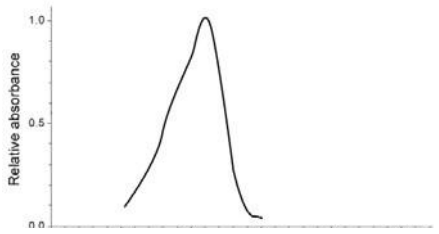
B13. Which of the following processes could be regulated and/or mediated by Phototropin 1 and 2?

(A). K^+ ion efflux (B). K^+ ion influx (C). Na^+ ion influx

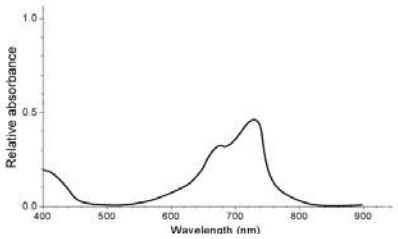
(D). H_2O efflux (E). H^+-ATPase activity (F). Blue light sensing

B14. Phytochromes exist in two isoforms, Pr and Pfr. In darkness, they are synthesized as Pr form, then turned into Pfr form after absorbing red light (most effective at 666 nm). When irradiated with far red light, Pfr transforms back to Pr. According to the description above, which of the following are likely to be the absorption spectra of phytochrome?

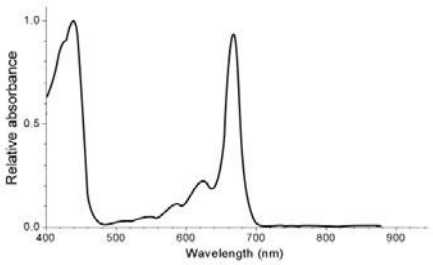
(A)



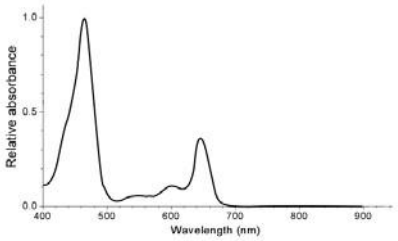
(B)



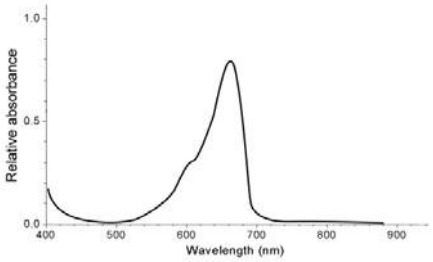
(C)



(D)



(E)



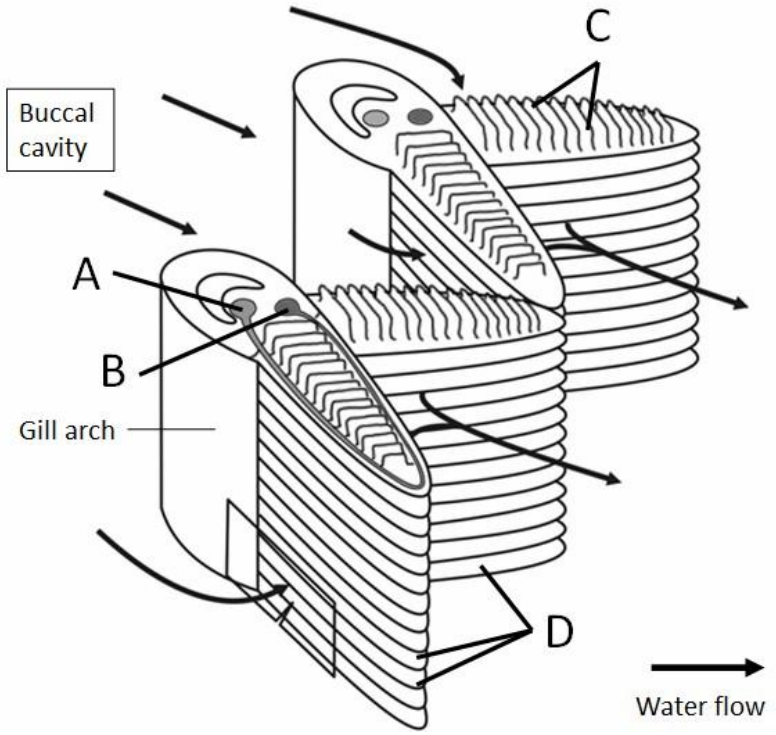
B15. The *AGAMOUS* (*AG*) gene is involved in flower development. Plant mutants without a functional *AG* would produce flowers with only sepals and petals. A scientist generated a transgenic plant harboring a green fluorescence protein (GFP) gene driven by the *AG* promoter in a wild type background that produces normal flowers. In which of the following flower parts, you are likely to observe strong GFP fluorescent signals?

(A) Receptacle (B) Sepal (C) Petal (D) Stamen (E) Carpel

III. Animal anatomy and physiology

B16 to B18 are a problem set

B16. In the following figure, the structure of fish gills and the direction of water flow in the ventilation are illustrated. Answer the questions.



Which of the following statements are correct?

(A) Vessel A carries oxygenated blood

(B) Vessel B carries deoxygenated blood

(C) Vessel A is an arteriole

(D) Vessel B is a venule

(E) Vessel A and B are portal vessels

B17. During evolution, the gas exchange in gills has become more effective by

(A) A decrease in the thickness of the structure C

(B) A decrease in the number of cell layers in structure C

(C) An increase in the metabolic rate of the structure C (D)

An increase in the cell volume of the structure C

(E) An increase in the surface area of the structure C

B18. Scientists found a kind of epithelial cell (X cell) in the structure of D with which fish can maintain body fluid osmolarity. Consequently, X cells are supposed to

(A) Absorb salt actively in freshwater fish

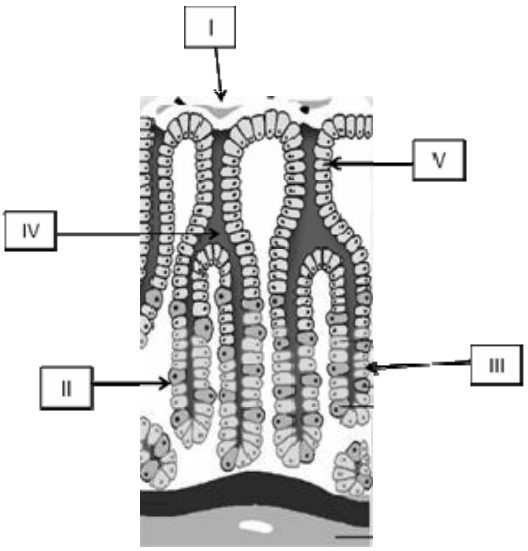
(B) Excrete salt actively in seawater fish

(C) Excrete water actively in freshwater fish

(D) Absorb water actively in seawater fish (E)

be rich in mitochondria

B19. The following image represents a gastric fold from the interior surface of the stomach. The different structures are indicated by roman numerals:



The list below describes the function for each structure.

a. Secretes hydrochloric acid

b. Secretes mucus which lubricates and protects the cells that cover the stomach.

c. Contains a series of ridges or deep pits which lead to the glands

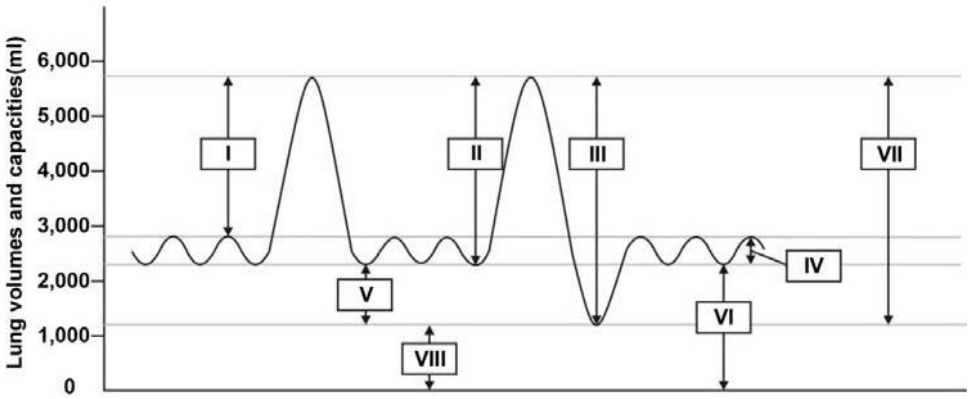
d. Secretes pepsinogen

e. Contains three different types of cells that secrete the components of gastric acid.

Please indicate the correct set of answers relating structure with corresponding function.

Function code	Structure code (I ~ V)
a.	
b.	
c.	
d.	
e.	

B20. The graph below depicts the different pulmonary volumes and capacities:



Below, you will find two charts, please correlate with each other and with the graph above:

1. Tidal volume (TV)

2. Residual volume (RV)

3. Vital capacity (VC)

4. Inspiratory capacity (IC)

5. Expiratory Reserve volume (ERV)

6. Total lung capacity (TLC)

7. Inspiratory reserve volume (IRV)

8. Functional residual capacity (FRC)

a. The maximum volume of air inhaled in a normal inspiration. It comprises tidal volume and inspiratory reserve.

b. The maximum amount of air inhaled over de resting level of spontaneous inspiration.

c. The volume of air remaining in lung after a strong forced expiration.

d. The volume of air present in lung alter a maximum inspiration.

e. Total amount of air flowing between inspiration and expiration at maximal rate. It includes tidal volume, inspiratory reserve volume and spontaneous expiration rate.

f. Amount of air in excess of tidal expiration that can be exhaled with maximum effort.

g. The volume of air present in the lungs, at the end of passive expiration. It is the sum of residual volume and expiratory reserve volume

h. The lung volume representing the normal volume of air displaced between normal inspiration and expiration with or without extra effort applied.

	I	II	III	IV	V	VI	VII	VIII
Letter								
Number								

B21. Which of the following statements about thermo-adaption in animals are correct?

(A) Blue-fin tuna is able to raise their core temperature. Therefore, it is an endothermic animal.

(B) Some icefish are able to survive in the freezing ice-laden water and maintain a very stable body temperature. Therefore, icefish are homeothermic animals.

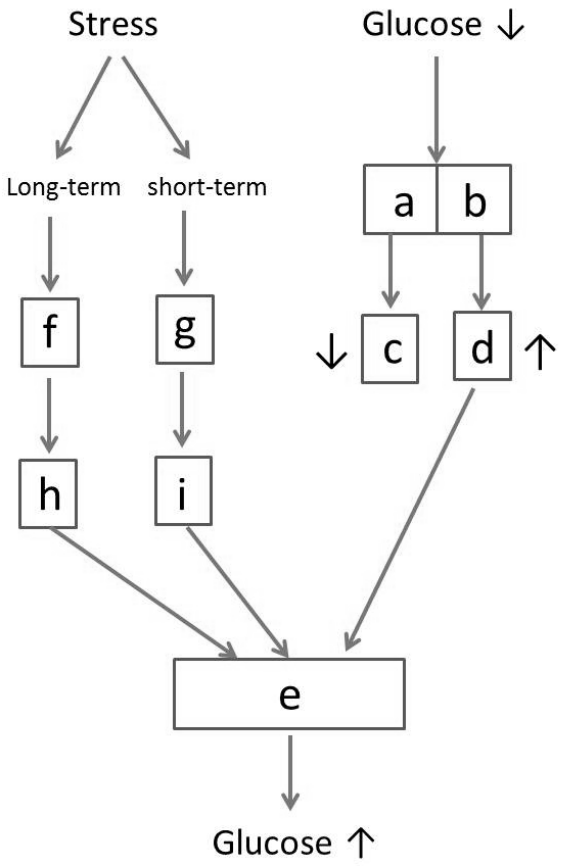
(C) Shivering can help mammals to generate heat, and it is regulated by hypothalamus in mammals.

(D) Brown adipose tissues help mammals to generate heat by supplying energy to skeletal muscles.

(E) Brown adipose cells are rich in mitochondria for heat generation.

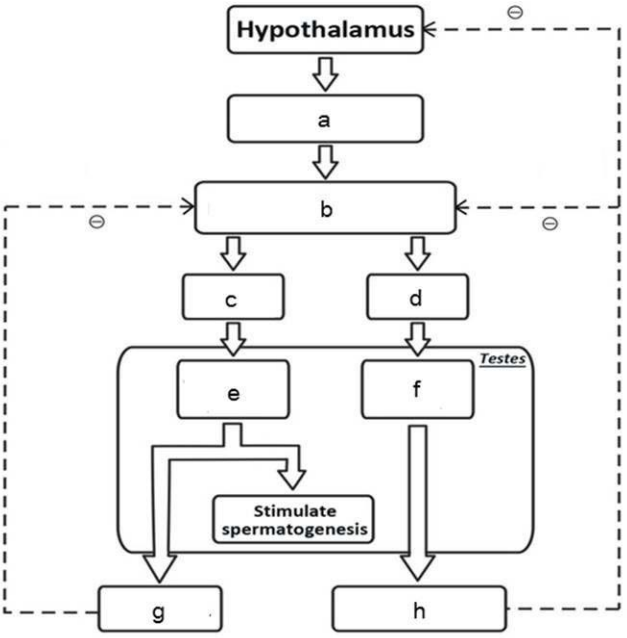
B22. Maintenance of the blood glucose level is important for normal physiological function. It is modulated by both neural and endocrine systems. The diagram below shows two different situations resulting from physiological stress or low blood glucose level. Complete the table in the answer sheet by using appropriate letters shown below.

Structure/hormone	Answer
α cells of the pancreatic islets	
Insulin	
Liver	
Adrenal medulla	
Cortisol	



B23 and B24 are a problem set

B23. Normal spermatognesis and androgen secretion are delicately regulated by hormones in males. The occurrence of infertility in the male could be resulted from the disturbance of hormonal regulation. The following figure partly illustrates the cross interactions among hypothalamus, pituitary gland, and male gonads. The symbols "(-)" indicate negative feedback inhibitions. As shown in the table below, some hormones, cells, or tissues are tried to match to the terms in this figure (a to h).



Structure/hormone	Answer
Sertoli cells	
Anterior pituitary	
Gonadotropin releasing hormone	
FSH	
Inhibin	

B24. The application of available and suitable hormonal therapy to the male patients with gonad failure is very important. Consider how the following case may be improved by a hormonal treatment.

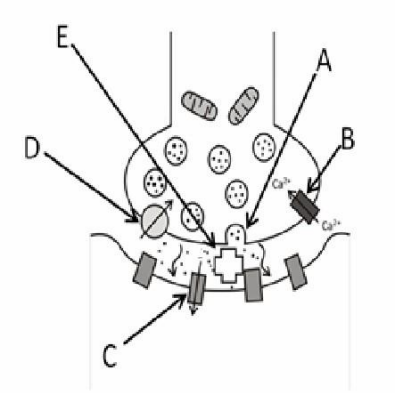
Patient A suffered from testicular cancer and had both testis removed.

According to the figure of Q22, select the most appropriate letter to patient A.

Patient	Answer
A	

B25 and B26 are a problem set

B25. A to E in the diagram below represents the five major steps of synaptic transmission.



A. Release of neurotransmitter.

B. Activation of presynaptic calcium channel.

C. Activation of postsynaptic sodium channel.

D. Re-uptake of neurotransmitter.

Scientists study drug effects on synaptic transmission by using electrophysiological recording. Briefly the postsynaptic current will be recorded and used to determine the possible mechanism which may account for the drug effects. Figure 1 is the typical tract of postsynaptic current before drug administration. Match the figure number with the correct drug effects below

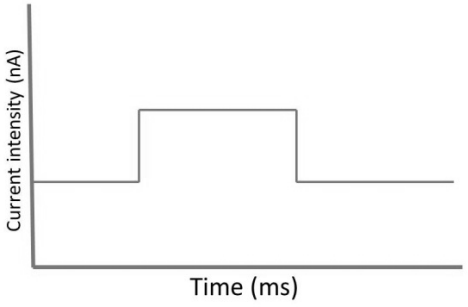
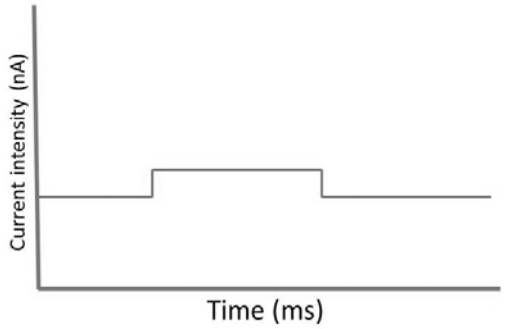


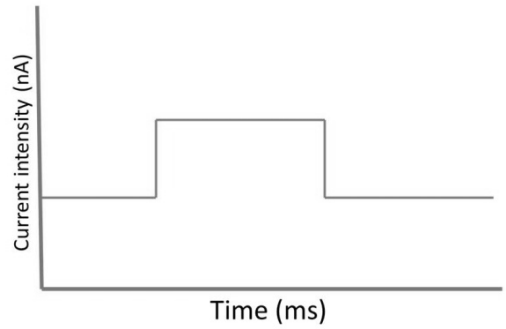
Figure-1

Mechanism	Figure number
Blocking of step A	
Facilitation of step B	
Blocking of step C	
Facilitation of step D	
Blocking of step E	

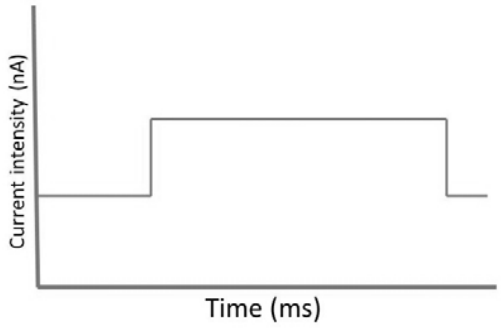
(I)



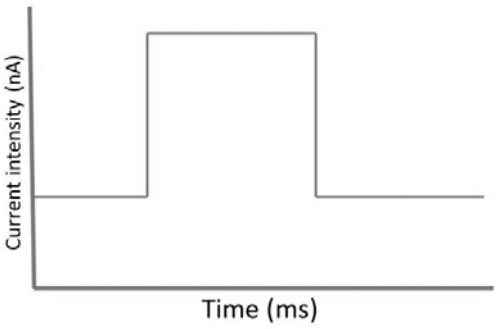
(II)



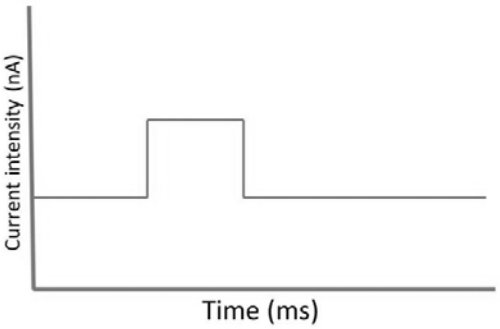
(III)



(IV)



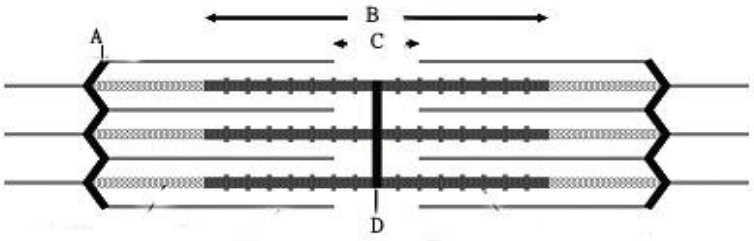
(V)



B26. Epilepsy is a common neurological condition. Patients suffer convulsions which result from hyperactivity of certain cerebral areas. Symptoms can be reduced by using antiepileptic drugs. If the receptor activated in the above figure was a chloride channel instead of a sodium channel, which of the following mechanism(s) may form the basis for an antiepileptic drug?

Mechanism	Answer
Blocking of step A	
Facilitation of step B	
Blocking of step C	
Facilitation of step D	
Blocking of step E	

B27. The following diagram indicates the basic structure of a sarcomere.



Choose and fill in the appropriate answering code shown below to each statement in the following table. The statements are about a muscle fiber undergoing an isotonic contraction.

Statement	Answer
a. D remain the same distance apart	
b. A move closer to the ends of the B	
c. C become shorter	
d. B become wider	
e. D lines move closer to the end of the B	

IV. Ethology

B28. There are two types of bird hatchlings: precocial and altricial. In general, precocial birds are covered with feathers when they hatch, and can find their own food with help and instructions from their mothers. In contrast, altricial hatchlings require feeding and caring for from the parents. Based on this, which of the following statements are correct?

(A) Precocial hatchlings usually take longer to hatch than altricial hatchlings.

(B) Altricial hatchlings usually develop imprinting earlier than precocial hatchlings.

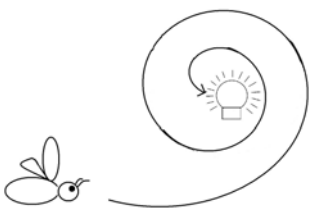
(C) Parents invest more in precocial hatchlings than in altricial hatchlings during nestling period.

(D) For a group of young birds that hatch at the same time, altricial hatchlings tend to develop the ability to fly earlier than precocial hatchlings.

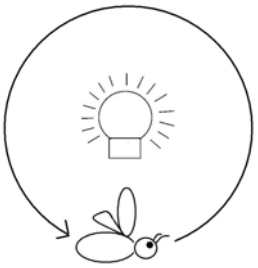
(E) Parents of precocial and altricial hatchlings have the same level of investment in reproduction during the breeding season.

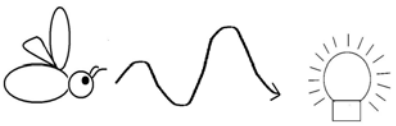
B29. An entomologist found that a species of cockroach use the dramatic change of light intensity at dusk (given as 6:00 pm) to reset its biological clock. He also found out that the circadian (daily) rhythm is 25 hrs. If a student cages a cockroach of this species into a dark box at 6:00 pm, at what time the cockroach will be active after 12 days? Fill in the time in the given space, then circle "am" or "pm" in the Answer Sheet.

B30. A biologist discovered that a species of moth is capable of flying in a straight line at night because it keeps a constant angle (80°) between its body axis and the direction of moon light using photoreceptors as a tool. If the moth encounters a bright light in a dark night, what kind of flight path of the moth one will expect to see in relation with the light source?

(A)	(D)
	

(B) 

(E) 

(C) 

B31. A researcher monitored 10 pairs of adult birds during the breeding season. For each of the pairs, he recorded body lengths of the male and female, and their nesting date (Table 1).

Table 1. The body lengths of the males and females, and the nesting dates for the 10 pairs of birds (A to J)

	A	B	C	D	E	F	G	H	I	J
Female body length (cm)	26.4	27.8	25.1	25.0	27.0	28.1	25.5	25.9	28.3	27.4
Male body length (cm)	28.3	28.4	28.9	29.0	27.9	30.2	29.6	27.4	29.7	30.5
Nesting date	5/6	5/3	5/4	4/28	5/1	4/27	4/29	5/2	5/1	4/26

Based on the data in Table 1, the mean body length is 26.65 cm for the females, and 28.99 cm for the males. In comparison with the mean body length of 26.10 cm in females and 27.60 cm in males in the total adult (breeders + non-breeders) population (N=30) of the study area, which of the following statements are correct?

(A) All males in this species are larger than females.

(B) Females tend to pair with males that are larger than themselves.

(C) Male body lengths do not affect female mate choices.

(D) Nesting dates are linked to male body lengths.

(E) The chance of breeding of this species is most likely affected by the body size.

V. Genetics and Evolution

B32. The black, brown and white coat colors of mice are determined by the interaction of B/b and C alleles. B and b alleles control the synthesis of black and brown pigments, respectively. In the presence of the C allele, black and brown pigments are deposited in the fur. In a crossing between BbCc and bbCc, which of the following statements are correct?

(A) The coat colors of parental mice are black and brown respectively.

(B) The ratio of black and brown offspring is 1:1.

(C) 3/4 of the offspring are black.

(D)1/4 of the offspring are brown.

(E) 1/4 of the offspring are white.

(F) Alleles C and B/b are co-dominant.

B33. Fur of Guinea pigs can have different colors (black and white). Hairs can be rough and smooth. Alleles Q and q are coding for color, alleles R and r for type of hair. A number of cavias with exactly the same genotype (parents group) are allowed to mate and the result is a big F1 offspring. Most of these have a black rough fur. A small number has white smooth fur. Besides about the same number of offspring is white and rough, or black and smooth.

B33.1. Using the given letters, indicate the genotype of the guinea pigs in the parents group: _____.

B33.2. If 1024 F1 offspring were born, how many of them are black and smooth? _____.

B33.3. Guinea pigs often have a fur spot pattern. According to a simplified model spot pattern is determined by one gene with two alleles: G and g. If G is present the guinea pig is spotted. Students investigate the population Guinea pigs in a territory and find out that 84 % was spotted. Presuming this population is in (Hardy Weinberg) equilibrium. Calculate the

frequency of G. Give your answer in one decimal. _____.

B33.4. At one day all unspotted guinea pigs are caught and transported to another territory. What will be the number of unspotted guinea pigs in the next generation? Give your answer as a percentage without decimals. _____.

B34. It is believed that "land plants" are evolved from charophytes. Which of the following statements support this hypothesis?

(A) Both have alternation of generation in life cycles

(B) Both contain chlorophyll a and chlorophyll b

(C) Both have peroxisomes that contain photorespiration related enzymes

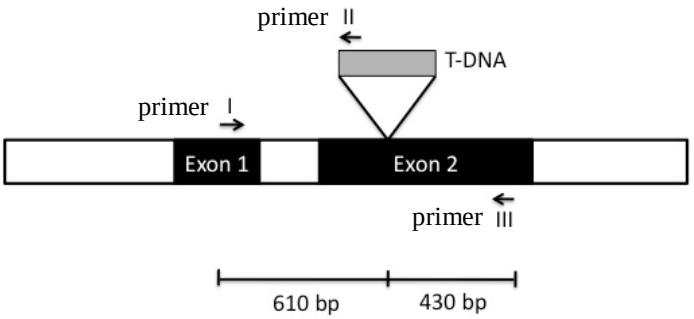
(D) Both can form phragmoplasts during cytokinesis

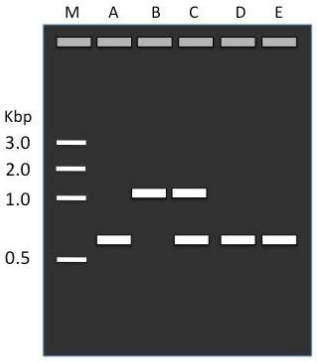
(E) Both contain cellulosic cell walls

(F) Both have the cellulose synthase arranged on the plasma membrane in a rosette pattern

Questions B35a-B35c are a <u>problem set</u>

Dr. Chen was investigating the function of gene *X* in rice by using a mutant with a T-DNA inserted in the exon 2 as diagrammed below. The size of the T-DNA is approximately 5 kilo base pairs (Kbp). She used PCR analysis for genotyping of five individual plants (A, B, C, D, E) with primers I, II, and III as indicated in the diagram. The gel on the right shows the PCR result. The DNA molecular size markers are shown in lane M. Lane A-E are the PCR products from leaf samples of the plant A-E, respectively. It is known that the polymerase being used is unable to effectively amplify DNA fragments above 5 Kbp.





Based on the above information, answer questions B34a-B34b :

B35a. Which pair of primers (I+II, I+III, or II+III) amplified the DNA band in lane B?

B35b. Which plant(s) (A, B, C, D, or E) is/are homozygous mutant(s)?

B35c. Which plant(s) (A, B, C, D, or E) is/are the F1 offspring of homozygous mutant crossed to the wild type?

B36. Doctor Lin isolated a rice mutant with a late flowering time phenotype. The mutant allele responsible for this phenotype was identified by map-based cloning technique and named LFT^m. When Doctor Lin sequenced the whole LFT^m gene, including the promoter region, she could not find any difference in the nucleotide sequence as compared to the wild-type allele. Which of the following phenomena are likely to be responsible for this observation?

(A) The mRNA level of *LFT* in the mutant is the same as that in the wild-type at the same developmental stage

(B) The LFT protein found in the wild type plants cannot be detected or is lower in the mutant

(C) The DNA methylation patterns on *LFT* are altered in the mutant

(D) The levels of histone proteins are dramatically altered in the mutant

(E) Introducing the cloned LFT^m into the wild-type plant generates a transgenic plant with late flowering phenotype

VI. Ecology

B37. The population size of a dragonfly in a pond was estimated to be 50,000 during a survey. Their sex ratio is 1:1. Each female lays approximately 400 eggs. A second survey of the next generation revealed that the population size is still 50,000 and the sex ratio is still 1:1. What is the average survival rate (surviving to adult stage) of the eggs?

(A) 0.2%

(B) 0.25%

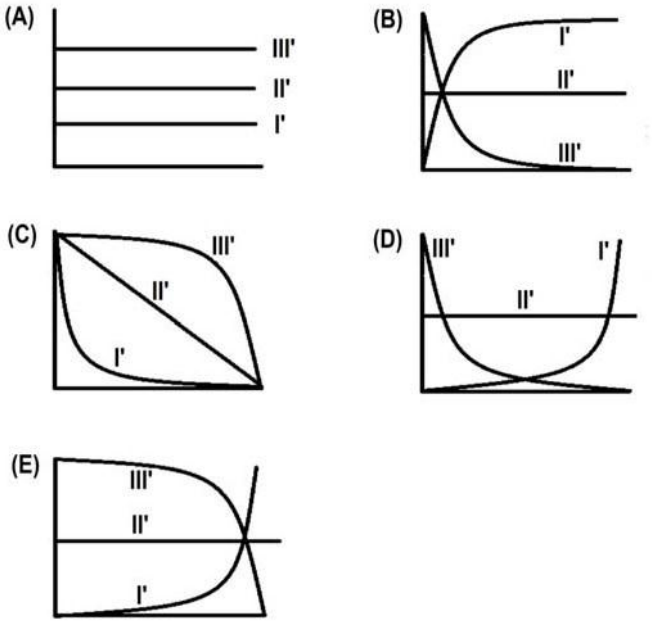
(C) 0.5%

(D) 1%

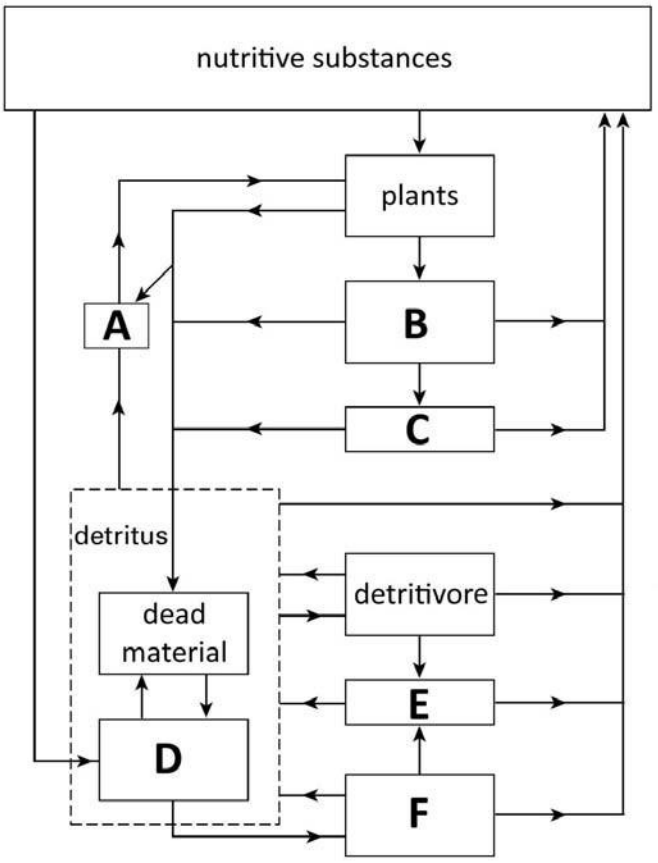
(E) 5%

B38. Biologists found that the threshold temperature for development of a mosquito species is 15℃. They also found that the product of (1) the number of days it takes to complete development, and (2) the difference between the temperature during development and threshold temperature, is a constant. That is, the result of multiplying (1) and (2) is a constant. It is known that this mosquito requires 15 days to complete development at 30℃, and given that there was an unusually warm May in India this year with an average temperature of 40℃, how many days it should take this mosquito to complete development this May in India?

B39. Assuming human, birds, and fish respectively have Type I, II, and III survival curves (the vertical axis is survival rate, and horizontal axis is time), which of the following figures most accurately describes mortality curves (obtained by replacing survival rate with mortality rate) for these three groups of organisms (Type I', II' and III')?



B40. The figure below shows a nutrient cycle, and the six groups of organisms (A to F) involved in this cycle.



Which of the following descriptions are correct?

(A) C and F are carnivores.

(B) C and E are carnivores.

(C) A and B are herbivores.

(D) D includes bacteria and fungi.

(E) F includes bacterivores and fungivores.

B41. When comparing closely-related bird species, mortality of breeding individuals appears to be higher for species in temperate regions than in tropical regions. Therefore, predation risks to parents themselves, their young and eggs are given different priorities for species in different regions. In an experiment where specimen of three different predators (crows, owls, and hawks) were placed at close distances to the nests during the day in the breeding period, which of the following responses from the parents can be expected? Note that crows are predators of the young and eggs, owls are nocturnal predators, and hawks are diurnal predators of adult birds.

(A) The owl specimen is more strongly avoided by the parents than the hawk specimen.

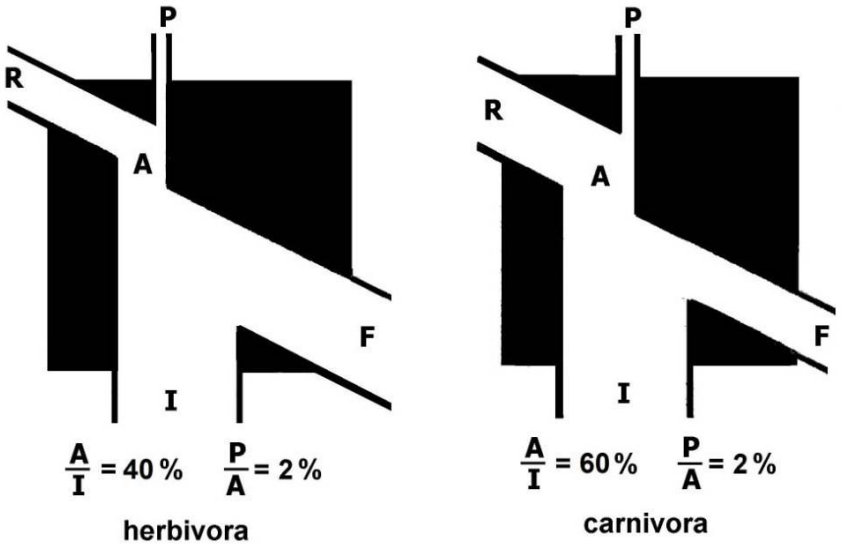
(B) With the crow specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperate species.

(C) With the hawk specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperature species.

(D) With the hawk specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a greater degree than parents of temperature species.

(E) The degree to which the parents reduce their frequency of returning to the nests and feeding the young when predator specimen is present is not affected by the type of predators or the latitudes in which the species is distributed.

B42. The figure below shows a scheme of the assimilation efficiency (A/I) and production efficiency (P/A) of two groups of mammals in a meadow ecosystem.



A = energy intake in blood after digestion
F = loss of energy through excretion
I = take in of energy present in eaten organic compounds
P = production
R = loss of energy by dissimilation

Suppose I = 100 J

Which of the following descriptions are correct?

(A) Digestion of plant materials costs relatively less energy than digestion of animal materials.

(B) Plant materials that are reabsorbed have less organic contents than animal materials that are reabsorbed.

(C) R ranges between 40 and 60 J in carnivores.

(D) R ranges between 40 and 60 J in herbivores.

(E) R is lower in Bull frogs than in mammals.

B43. Some fungi form symbiotic associations with the roots of vascular plants, which are called mycorrhizae. In such associations, mycorrhizae help plants to absorb water, phosphate salt and other mineral nutrients. Depending on whether the fungus colonizes the roots extracellularly or intracellularly, mycorrhizae can be grouped into ectomycorrhizae or arbuscular mycorrhizae.

Which of the following descriptions of mycorrhizae are correct?

(A) Seedlings with mycorrhizae grow more rapidly than seedlings without mycorrhizae in low-phosphorus soils.

(B) Hyphae of arbuscular mycorrhizae can penetrate the cortical cells of the roots and cell membranes to form symbiotic associations intracellularly.

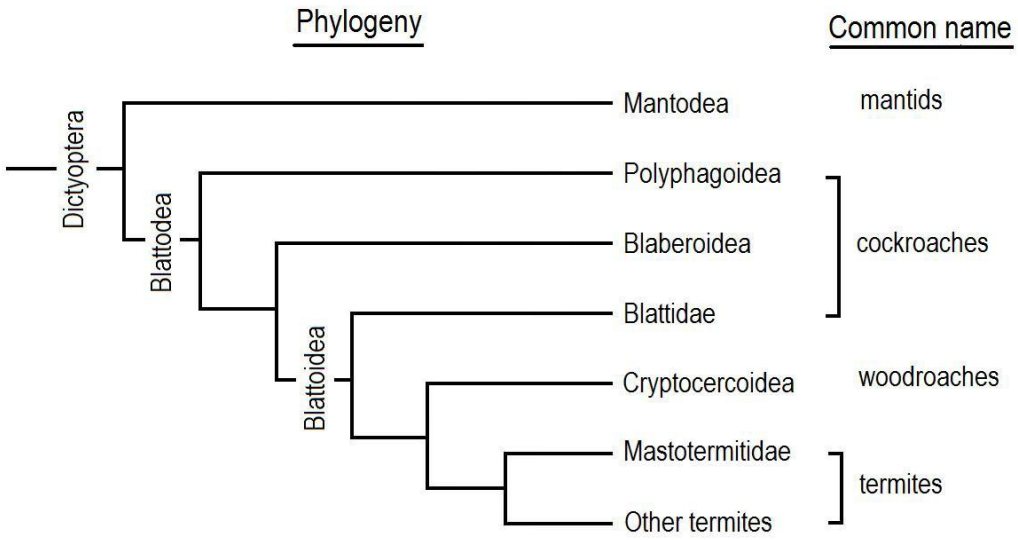
(C) Hyphae of ectomycorrhizae can penetrate the cortical cells of the roots, and form hyphal sheaths around the roots.

(D) Mycorrhizae have similar functions as root hairs of plants, and therefore, plants with mycorrhizae have less-developed root hairs.

(E) Each mycorrhiza forms symbiotic associations with the roots of specific plants.

VII. Biosystematics

B44. Eggleton et al (2007) studied the phylogeny of Dictyoptera, as shown below. According to the proposed phylogeny, determine whether the following statements are true (T) or false (F).



(A) Mantids' sister group is cockroaches.

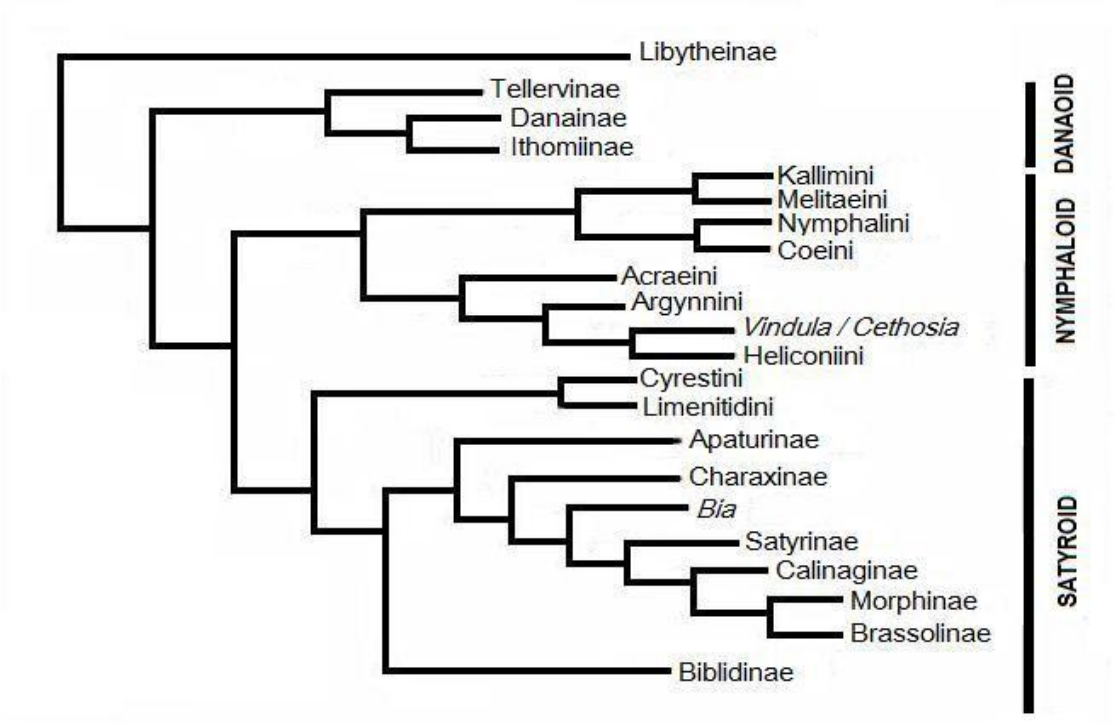
(B) Cockroaches form a paraphyletic group.

(C) Termites should be viewed as highly modified cockroaches.

(D) Mantids should be viewed as highly modified cockroaches.

(E) Termites evolved from mantids.

B45a. Systematic positions of some butterflies such as satyrids (ringlets, etc.), nymphalids (frush foots, etc), danaids (milkweed butterflies, etc.) were controversial. Some researchers regarded them as distinct families, the others disagreed. Recent studies supported the view to pool them into a single family. Below is a phylogeny of these butterflies reconstructed by Freitas & Brown (2004). Answer the following questions based on this phylogeny.



Determine whether the following statements are true (T) or false (F).

(A) Danaid butterflies may still be a distinct family according to Freitas & Brown's phylogeny. (B) Although Calinaginae butterflies resemble danaid butterflies in appearance, they should be classified as Nymphaloid butterflies.

(C) Satyrinae and Brassolinae were considered distinct families, but Apaturinae was always placed in Nymphalidae. If we want to keep Apaturinae in Nymphalidae, both Satyrinae and Brassolinae should be lumped into Nymphalidae.

(D) Danaid butterflies may be considered as the ancestors of Nymphaloid + Satyroid.

B45b. According to the phylogeny diagram above, fill in the blanks.

If Libytheinae is treated as the outgroup on the phylogeny, and 5 major groups (clades) are recognized for the ingroup. The maximum number of lineages of such a major group shown on THE PHYLOGENY is (A) , minimum number is (B)

(2) Final – test questions

THEORETICAL TEST : PART A

Total Points: 116 Duration: 120 minutes

Dear Participants,

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- The questions in Part A have **only one** correct answer. Fill your answer in the **Answer Sheet**.

  Mark the correct answer with "X" on the **Answer Sheet** clearly, as shown below.

No.	**A**	**B**	**C**	**D**	**E**	**F**
A0	**X**					

- You can use the ruler and the calculator provided.
- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal point of Part A is 116 (2 point each for each question).
- Stop answering and put down your pen IMMEDIATELY after the end bell rings.

Good Luck!!

I. Cell Biology

A1. Endorphin is a natural analgesic secreted by the pituitary gland and other brain cells. Upon binding to its receptor in brain cells, endorphin can relieve pain and create a sense of euphoria. Morphine can achieve similar pain relief effects by binding to the endorphin receptor. Why do both endorphin and morphine bind to the endorphin receptors in brain cells?

(A) Sizes of both molecules are similar.

(B) Molecular weights of both molecules are similar.

(C) Both are isomers.

(D) Shapes of both molecules are similar.

(E) Net charges of both molecules are identical.

A2. Most biological macromolecules are made by the polymerization of small principal components. The major structural polysaccharide of the insect exoskeleton is a polymer. Which of the following statements regarding this kind of polysaccharide is **NOT correct**?

(A) It is made by polymerization of glucose.

(B) It contains C, H, O and N atoms.

(C) Its structure is similar to that of cellulose.

(D) It can be used to produce glucosamine in industry.

(E) This polymer can also been found in the cell wall of fungi.

A3. In some cells, synthesis of isoleucine from threonine is catalyzed by the sequential action of five enzymes **a, b, c, d** and **e**, which produce 4 intermediates A, B, C and D, and the end product isoleucine, respectively. What is most likely to happen when isoleucine is overproduced and there is an ample supply of threonine in cells?

(A) Isoleucine associates with threonine to inhibit the activity of enzyme a.

(B) Isoleucine associates with intermediate D to inhibit the activity of enzyme e.

(C) Isoleucine binds to enzyme a and inhibits its activity.

(D) Isoleucine binds to enzyme e and inhibits its activity.

(E) Threonine is converted into isoleucine continuously through the 5 enzymes.

A4. In some prokaryotic organisms, SO_4^{2-} is used as the final electron receptor at the end of electron transport chain during cellular respiration. Which of the following statements regarding cellular respiration in these prokaryotic organisms is **NOT correct**?

(A) It is anaerobic respiration.

(B) The reception of electron by SO_4^{2-} is accompanied by the production of H_2O.

(C) Operation of the electron transport chain builds up a proton motive force.

(D) ATP is produced.

(E) Production of ATP is correlated with the mobility of H^+.

A5. Three stages in the growth of a bacterial culture are:

I. lag phase

II. log phase

III. stationary phase

In which phase or phases can penicillin inhibit the synthesis of the bacterial cell wall ?

(A) only I

(B) only II

(C) only III

(D) I and II

(E) I and III

(F) I, II and III

A6. Which structural or physiological feature of bacteria is commonly used as a drug target to kill bacteria effectively but with very little harm to human cells?

(A) Glycolysis

(B) Components of plasma membrane

(C) Components of ribosome

(D) Components of the electron transport chain in aerobic respiration

(E) Requirement of oxygen

A7. Histones are small basic proteins that assemble with DNA molecules to form chromosomes. There are five histones, including H1, H2A, H2B, H3 and H4, in eukaryotic cells. The formation of which of the following structural feature of chromosomes is driven by Histone H1?

(A) Telomere

(B) Nucleosome fiber (10-nm fiber)

(C) 30-nm fiber

(D) Looped domains

(E) Centromere

A8. DNA is a double helix molecule containing four different types of nitrogen bases. Which of the following statements regarding both the replication and chemical composition of DNA is correct?

(A) Base sequences of both strands are the same.

(B) The amount of purine is equal to that of pyrimidine in a double-stranded DNA.

(C) Both strands are synthesized continuously in 5'→3' direction.

(D) The first base of the newly synthesized nucleic acid is catalyzed by DNA polymerase.

(E) The proof-reading activity of DNA polymerase proceeds in the 5'→3' direction.

A9. Spiderman has compared the DNA, the corresponding RNA and protein sequences of many human genes. What conclusion can be drawn from the sequence comparison?

(A) The number of exons is always more than that of introns.

(B) The translation start codon is located within the first exon.

(C) The translation stop codon is located within the last exon.

(D) The G nucleotide of RNA capping is the first nucleotide transcribed from DNA.

(E) The polyA tail is transcribed from the poly-dT of DNA.

A10. Ling-Ling conducts DNA amplification and transcription reactions in two separate test tubes.

Which of the following substances needs to be added to both reactions?

(A) ATP

(B) DNA template

(C) RNA primer

(D) DNA polymerase

(E) DNA ligase

A11. The Nobel Prize in Physiology or Medicine 2009 was awarded jointly to Blackburn, Greider and Szostak for the discovery that chromosomes are protected by telomeres and the enzyme telomerase is highly correlated with aging and cancer in animals. Which of the following statements regarding telomere and telomerase is correct?

(A) Telomerase is a DNA exonuclease.

(B) Telomerase is an RNA polymerase.

(C) Embryonic cells possess long telomeres and high telomerase activity.

(D) Telomeres are longer and telomerase is inactive in cancer cells.

(E) Telomeres are longer and telomerase is highly active in somatic cells.

A12. *Eco*RI restriction enzyme is a DNA endonuclease that can recognize the sequence GAATTC. It was first discovered in *Escherichia coli*, therefore it was named *Eco*RI. To produce a large quantity of the endonuclease, the DNA fragment encoding the gene was subcloned into an expression plasmid and the resultant recombinant plasmid was transformed into *E. coli* cells to produce recombinant enzyme for a study. Why is the host DNA not cleaved by the recombinant *Eco*RI?

(A) The host DNA does not contain *Eco*RI cleavage sites.

(B) *Eco*RI is secreted out of the host cells.

(C) Environmental factors such as temperature and pH value inhibit *Eco*RI activity.

(D) The *E. coli* host produces inhibitors to block *Eco*RI activity.

(E) The *Eco*RI cleavage sites within the host DNA are modified.

II. Plant anatomy and physiology

A13. Hypersensitive response is one of the plant defense responses to pathogens. Each of four pathogen strains, **a** to **d,** produce a distinct range of effectors. One of the effectors, Avr, recognized by a specific receptor protein encoded by the resistance (R) gene in the host plant is present in strains **b** and **c**. Host plants **B** and **D** produce the R protein. Which plant(s) are likely to develop a hypersensitive response after the host plants **A** to **D** are infected by pathogens **a** to **d** (**a**Æ **A**, **b**Æ **B**, **c**Æ **C**, **d**Æ **D**), respectively?

(A) **A** only

(B) **B** only

(C) **C** only

(D) **D** only

(E) **B** and **C**

(F) **B** and **D**

A14. Plant movement occurs when plant organs change their spatial distribution after being exposed to stimuli, and may be caused either by differential growth or by differential turgor change among cells within the organs. Which of the following plant movements uses a mechanism distinct from the others?

(A) The gravitropic movement of corn roots

(B) The closure of soybean leaflets during night time

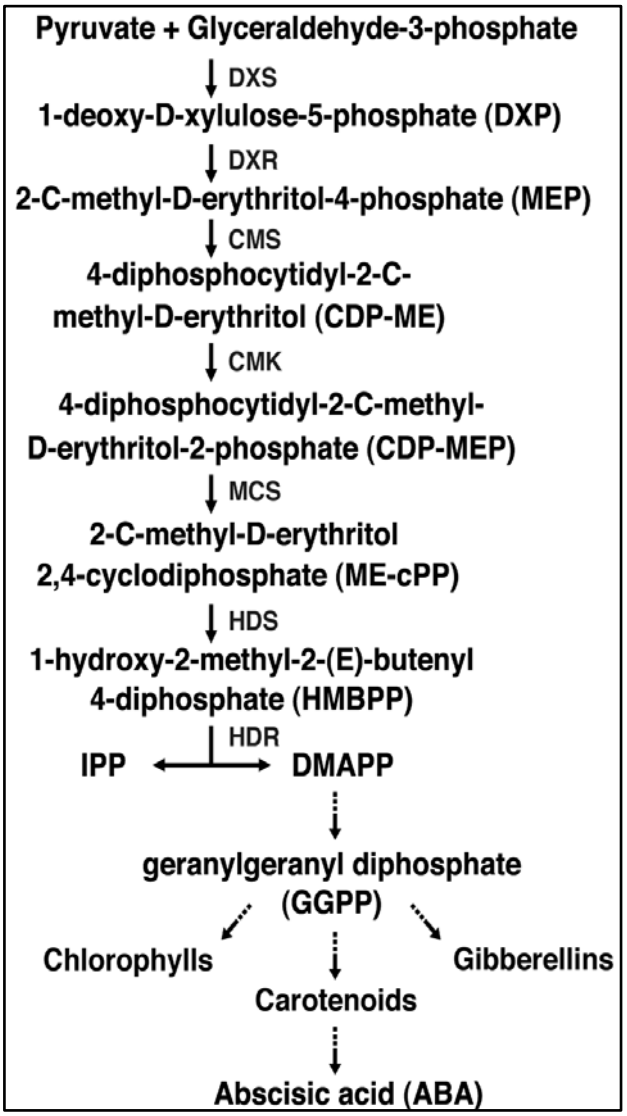
(C) The tendrils of cucumber moving along the trellis

(D) The phototropic movement of mungbean seedlings

(E) The downward bending of the tomato leaves after flooding treatment

Questions 15 and 16 are a **problem set**

A15. In the model plant Arabidopsis, the DXS, DXR, CMS, CMK, MCS, HDS and HDR enzymes are involved in the methyl erythritol phosphate (MEP) pathway of isopentenyl diphosphate (IPP) and dimethylallyl diphosphate (DMAPP) biosynthesis. The Arabidopsis *white devil* albino mutant is impaired in the enzyme HDS. Assuming Arabidopsis can efficiently take up the intermediate metabolites of the MEP pathway, the *white devil* albino mutant will grow and turn green if given which of the following compound?



(A) MEP

(B) CDP-ME

(C) CDP-MEP

(D) ME-cPP (E)

HMBPP

A16. The plant MEP pathway is located in which of the following organelle?

(A) nucleus

(B) vacuole

(C) chloroplast

(D) mitochondrion

(E) endoplasmic reticulum

A17. Dennis dissected a plant leaf and found bundle sheath cells full of starch granules. Which of the following characteristics can be observed in this plant?

I. Stomata open at night

II. Presence of PEP carboxylase in mesophylls

III. Presence of Rubisco in bundle sheath cells

IV. High photorespiration rate on hot summer days

V. Carbon fixation can occur in both mesophyll and bundle sheath cells

VI. Carbon assimilation rate is saturated in the early morning on summer days

(A) Only I, IV

(B) Only II, IV, V

(C) Only II, IV, VI

(D) Only II, III, V

(E) Only II, III, V, VI

(F) Only II, IV, V, VI

A18. It has been estimated that around 124 million children are vitamin A deficient, causing about 500,000 children to go blind each year. To help children who suffer from vitamin A deficiency, scientists have developed a variety of rice (*Oryza sativa* L.), Golden Rice, through genetic engineering. The original Golden Rice was produced using the japonica variety Taipei 309, which is genetically enriched in

(A) auxin

(B) starch

(C) β-carotene

(D) iron

(E) anthocyanins

A19. Abscisic acid (ABA) is one of the important growth regulators of plants. It often antagonizes the functions of hormones that promote growth. Plant biologists have been interested in elucidating the signaling pathway of ABA by genetic approaches. They screened mutants of the model plant *Arabidopsis thaliana* that respond abnormally to ABA treatment to identify the involving components of the pathway. One type of mutant phenotype is ABA-insensitive (*abi*). Which of the following phenotypes are likely to be observed in the *abi* mutants?

(1) Seeds germinate at the presence of exogenous ABA.

(2) Seeds become dormant at the presence of exogenous ABA.

(3) Stomata do not close in response to drought.

(4) More tolerant to drought than the wild-type plants.

(5) Leaf does not abscise when it becomes senescent.

(6) Leaf is prematurely abscised even when greenish.

(A) Only (1), (3)

(B) Only (2), (3)

(C) Only (2), (5)

(D) Only (2), (4), (5)

(E) Only (1), (3), (6)

(F) Only (2), (4), (6)

A20. Ethylene is a hormone that influences plant's growth and development. It is known that treatment with 10 ppm of 1-methylcyclopropene (MCP) can block the signal transduction of ethylene. If certain plant tissues were treated with 10 ppm MCP, which of the following phenotypes could be observed in MCP-treated tissues?

(A) Shorter hypocotyl in etiolated mung bean seedling

(B) Increased degradation of chlorophyll in detached leaves

(C) Increased synthesis of ethylene in banana fruits

(D) Inhibition of the ripening of tomato fruits

(E) Induction of the senescence of carnation cut flowers

A21. During leaf development in water lily, the sclereid-initials grow and elongate along the palisade mesophyll cells or the intercellular space between them. After elongation they gradually form calcium oxalate crystals in the cell wall along the cell membrane. Thereafter, they form the secondary cell wall. Four cell wall structures are: (I) primary cell wall; (II) secondary cell wall; (III) middle lamella; (IV) calcium oxalate crystals. What is the final sequence of structures in the mature sclereids of water lily, starting from the plasma membrane as the innermost layer to the outermost layer?

(A) I → IV → II → III

(B) III → IV → I → II

(C) I → II→ IV→ III

(D) III → I → IV → II

(E) II → IV → I → III

A22. *Agrobacterium tumefaciens*-mediated transformation, a widely used method to transfer foreign genes into the plant genome, has contributed to the considerable successes that plant biotechnology has already achieved. For instance, a gene encoding the coat protein (CP) of papaya ringspot virus (PRSV) was used to generate the virus-resistant transgenic SunUp papaya in Hawaii. The construct used for transformation includes the *CP* gene and a selectable marker gene (*nptII*) conferring kanamycin resistance. Both *CP* and *nptII* genes are driven by a constitutive cauliflower mosaic virus (CaMV) 35S promoter. According to the above information, which of the following statements is **NOT correct**?

(A) The SunUp papaya is resistant to kanamycin.

(B) The SunUp papaya contains some DNA sequences from CaMV.

(C) The SunUp papaya contains some chromosomal DNA of *Agrobacterium tumefaciens.*

(D) The SunUp papaya contains a portion of the Ti plasmid termed T-DNA.

(E) The SunUp papaya contains the *nptII* gene.

III. Animal anatomy and physiology

A23. Which of the following is the only vertebrate in which blood flows directly from respiratory organs to body tissues without returning to the heart first?

(A) Fish

(B) Amphibians

(C) Mammals

(D) Reptiles

(E) Birds

A24. How does the hemocyanin of arthropods differ from the hemoglobin of mammals?

(A) The oxygen dissociation curve of hemocyanin is not a S-shape

(B) Hemocyanin carries considerably more carbon dioxide

(C) Hemocyanin is a single-chain respiratory pigment

(D) Hemocyanin is a protein coupled with magnesium

(E) Hemocyanin is a protein coupled with copper

A25. A shark is more likely to survive for an extended period of food deprivation than is a dolphin with equivalent size because

(A) The shark maintains a higher basal metabolic rate

(B) The shark expends more energy/kg body weight than the dolphin

(C) The shark invests much less energy in temperature regulation

(D) The shark metabolizes its stored energy more readily than the dolphin does

(E) The shark has a better insulation on its body surface

A26. Increased arteriolar resistance contributes to hypertension. Which one of the following factors contribute to the increased vascular resistance most significantly?

(A) Vessel length (B)

Blood viscosity (C)

Vascular diameter

(D) Total leukocyte counts

(E) Heart rate

A27. A method to estimate a mammal's blood volume uses a specific radioactive isotope of iodine (^{123}I). This isotope, usually produced synthetically, has a half-life time of 13 hours. It decays to ^{123}Te, which is almost perfectly stable. To estimate the blood volume, 10 mL of iodine solution are injected into the animal's vein. The activity of the solution at the injection is 2mSv. A sample of 10 mL of the animal's blood, taken 13 hours after the injection, is 0.0025mSv. The estimate volume of the animal's blood volume is?

(A) 10.0 L

(B) 8.0 L

(C) 4.0 L

(D) 2.5 L

(E) 1.25 L

A28. Which of the following events will result in an excitatory postsynaptic potential?

a. Increasing sodium influx.

b. Blocking potassium out-flux.

c. Increasing calcium influx.

d. Closing a chloride channel.

(A) Only a & b

(B) Only b & c (C)

Only a, c & d (D)

Only b, c & d (E)

a, b, c & d.

A29. Compared to a healthy individual what are the levels of the following hormones in an individual with primary hyperthyroidism (hypersecretion of thyroid hormone)?

Thyrotropin-releasing hormone (TRH), thyroid-stimulating hormone (TSH), Thyroid

hormones T3 and T4

↑: increase ↓: decrease —: remains unchanged

	TRH	TSH	T3	T4
A	↑	↑	—	↑
B	↑	↑	↑	—
C	↓	↓	↑	↑
D	↓	↓	↓	↓
E	↓	↑	↑	↑

A30. Which of following receptors/molecules are required for the activation of Helper T cells trigged by antigen-presenting cells.

1. CD8

2. CD4

3. Class I MHC molecule

4. Class II MHC molecule

5. T cell receptor

(A) Only 1, 3 & 5

(B) Only 2, 4 & 5

(C) Only 3, 4 & 5

(D) Only 2 & 4 (E)

Only 1 & 3

A31. Inspect the following table which is revealed to the function of kidneys in vertebrate.

What	1. Urine concentration by NaCl reabsorption 2. Urine concentration by urea reabsorption 3. Aquaporin mediated water reabsorption
How	4. Countercurrent multiplier system 5. Countercurrent exchange
Where	6. Loop of Henle 7. Collecting duct 8. Proximal tubule

Figure out which of the following alternatives show a correct combination.

(A) 1-4-6

(B) 1-4-8

(C) 2-4-6

(D) 2-5-8

(E) 3-5-7

A32. When people lose blood quickly as happens in a car accident and his/her physiological parameters are monitored right away, which of the following situations will **NOT** occur

(A) Decrease of sodium concentration in urine

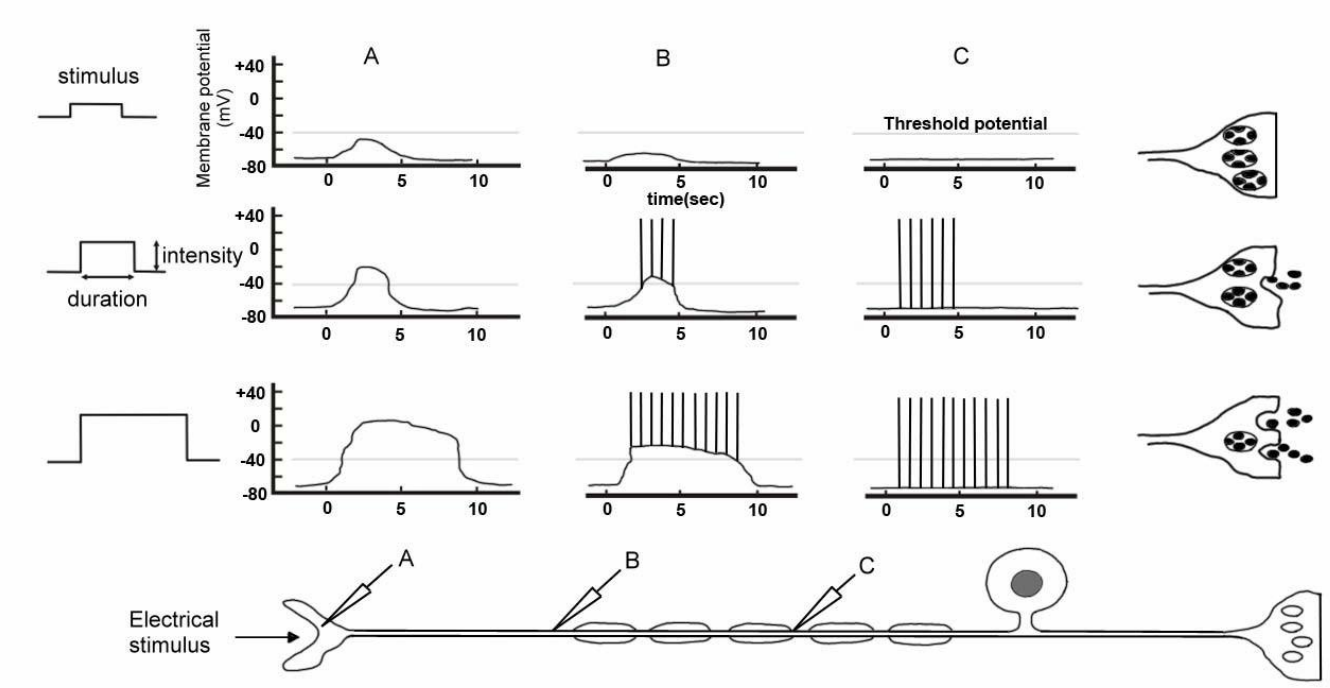
(B) Blood volume decreases but interstitial fluid increases

(C) Increase in the resistance of blood vessel

(D) Stroke volume increases; cardiac output increases

(E) Decrease in the proportion of red blood cells in blood.

A33. The following figure illustrates the membrane potential changes measured at three different sites (A, B, C) along a sensory neuron and the release of neurotransmitters from the axon termini when depolarizing electrical stimuli with varied intensities were applied to the dendrite. Based on the information provided in the figure below, choose the correct statements in the following list.



1. The membrane potential changes evoked at A site would be proportional to the intensity of the electrical stimuli applied to the dendrite.
2. An action potential would be recorded at B site only when the intensity of the applied current stimulus causes the membrane potential to be higher than the threshold potential in the axon hillock.
3. The frequency of the action potentials at B site is dependent on the duration of the applied current stimulus at A.
4. The quantity of the neurotransmitters released from the axon termini is unlikely to depend on the frequency of the action potential at C site.

(A) Only 1 and 2

(B) Only 1 and 3

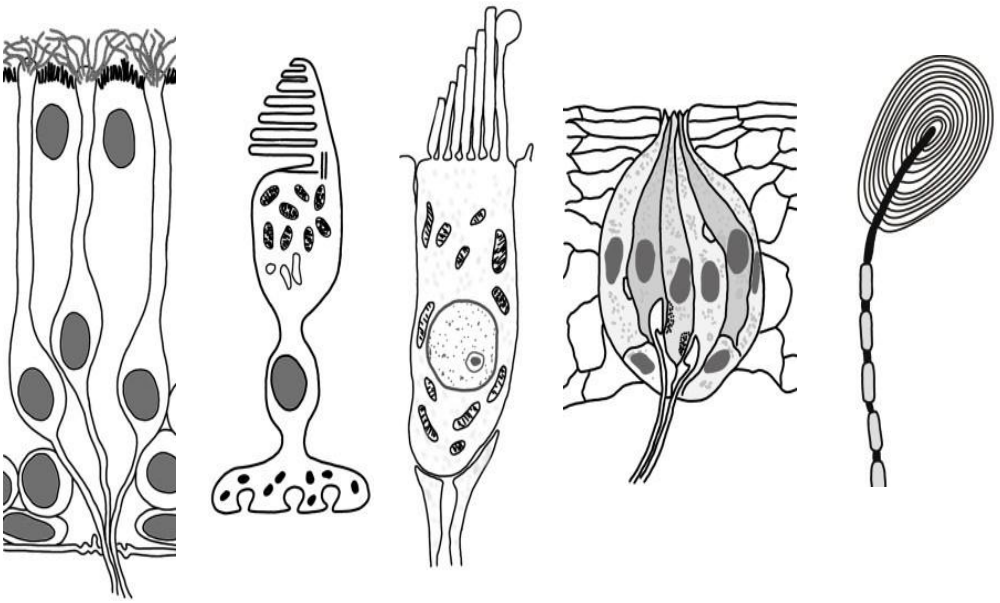
(C) Only 2 and 3

(D) Only 3 and 4

(E) Only 1, 2, and 3

A34. The perception of the messages from the environmental changes is carried out by specialized sensory cells. Their structural composition is in a strict accordance to their functions.

Which of the following receptors in human receptors will be activated by a stimulation and consequently close a Na^+ channel leading to hyperpolarization?



A **B** **C** **D** **E**

IV. Ethology

A35. There are three types of chemical substances that organisms emit to mediate interspecific interactions: kairomone, allomone, and synomone. The roles of these chemicals can be classified as the table given below.

Participant / Chemical	Emitter	Receiver
Kairomone	Disadvantage	Benefit
Allomone	Benefit	No benefit/harm
Synomone	Benefit	Benefit

A plant species emits a volatile essential oil that attracts a phytophagous beetle to feed and lay eggs on its leaves. At the same time, it also attracts a parasitoid wasp, and helps this parasitic natural enemy of the beetles to locate the beetle larvae within which they can lay their own eggs. Which of the following descriptions regarding to this essential oil is correct? This essential oil acts as a

(A) Synomone between the plant and the beetle, allomone between the plant and the parasitoid wasp.

(B) Kairomone between the plant and the parasitoid wasp, synomone between the beetle and the parasitoid wasp.

(C) Kairomone between the plant and the beetle, synomone between the plant and the parasitoid wasp.

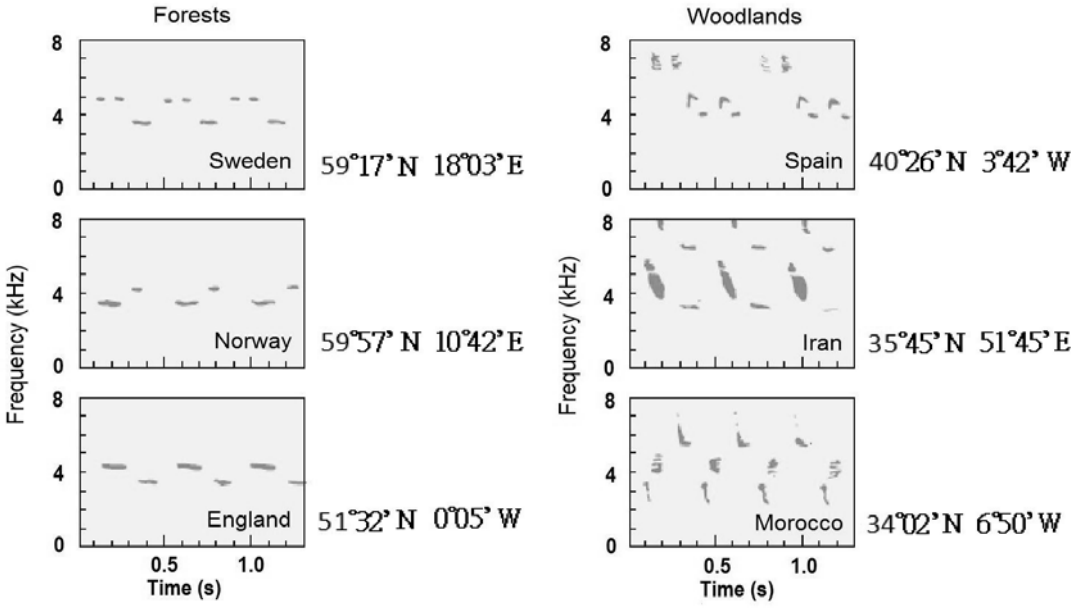
(D) Kairomone between the plant and the beetle, allomone between the beetle and the parasitoid wasp.

(E) Kairomone between the plant and the parasitoid wasp, also kairomone between the beetle and the parasitoid wasp.

A36. In terms of the benefits and harm received by each of the two parties interacting, which of the following pairs of biological interactions are most similar to each other?

Pairs		
A	Clownfish and sea anemones	Mistletoes and apple trees
B	Sea stars and bivalves	Locusts and grasshoppers
C	Lichens and maples	Mistletoes and oaks
D	Caterpillars and parasitic wasps	Food plants and caterpillars
E	HIV virus and human	Mushrooms and rotten woods

A37. Great tit birds (*Parus major*) inhabiting forests (dense vegetation) and woodlands (patchy vegetation) have different song patterns. It is documented that high frequency sounds become less degraded in open habitat than in places with dense vegetation. Consider the following graphs showing song characteristics of great tits from 6 locations. Which of the following statements is correct?



(A) There is less variability in song frequency in low-latitude regions.

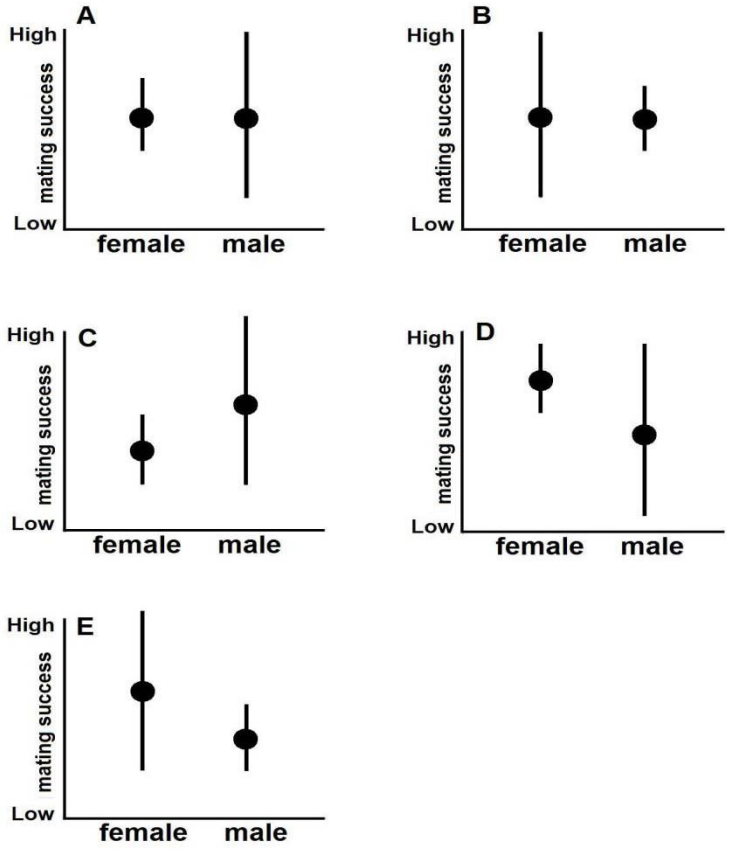
(B) Forest inhabitants are more varied in song frequency than woodland inhabitants.

(C) Songs of forest inhabitants have more notes per phrase than those of woodland inhabitants.

(D) The variation of song type has nothing to do with habitat type

(E) If an individual moves from forests to open grassland, the variation of the song among its descendents is likely to increase**.**

A38. A hypothetical insect species employs the polygynous mating system, in which the males are capable of multiple mating with many females, but the females mate only once. Mating season is autumn. All adults of this species die off soon after the mating season. The sex ratio of this species is 1:1. The mating success, defined as the number of mating in a given season is compared, for both male and female in this species. Which one of the graphs below (A to E) best describes the mean and variance of the mating success for both male and female in this species? Solid dots represent mean of mating success, and lines denote the ranges of variance.



V. Genetics and evolution

A39. Frank has subcloned a cDNA fragment from an animal into an expression plasmid. The recombinant plasmid was transformed into bacteria to produce recombinant protein., What is the main reason that the expressed protein is non-functional ?

(A) Differences in codon usage between animals and bacteria

(B) Differences in protein processing between animals and bacteria

(C) Components of bacterial culture media

(D) Modulators of gene transcription

(E) Secretion signal of proteins

A40. Gregor Mendel discovered that segregation of genes on non-homologous chromosomes is independent of each other in his garden pea hybridization experiments. Four genes A, B, C and D are located on four non-homologous chromosomes. Which of the following genotypes will have the highest chance to produce the dominant trait in all four loci when it mates with an organism with the genotype AaBbCcDd?

(A) aabbccdd (B)

AaBbCcDd (C)

AaBBccDd (D)

AaBBCCdd (E)

aaBBCCdd

A41. An X-linked allele determines the coat color of cats with orange being dominant and black being recessive. Which of the following statements regarding the inheritance pattern of orange/black mosaic cats is correct?

(A) Half of all male cats are mosaic.

(B) The mosaic phenotype is a consequence of gene interaction.

(C) The mosaic phenotype is correlated with genetic recombination.

(D) The mosaic phenotype results from random X-chromosomal inactivation.

(E) The offspring from matings of orange males and black females are mosaic.

Questions 42 and 43 are a **problem set**

A42. On a remote island, Dr. Yeh discovered a new plant species, which can produce either white or blue flowers. This species is mainly cross-pollinated by insects. Genetic experiments showed that the white-flower phenotype is recessive to the blue-flower phenotype. Statistical analysis revealed that 91% of these plants on the island produce blue flowers. If one is to randomly select two blue-flower plants and cross them, then what is the approximate probability that they are capable of producing white-flowered F1 offspring?

(A) 0.09 (B) 0.21 (C) 0.42 (D) 0.49 (E) 0.91

A43. Dr. Yeh treated the seeds of the above-mentioned homozygous blue-flower plants with chemical mutagen to produce a mutant population. Three recessive mutants, *wf1, wf2,* and *wf3,* produced white flowers were selected. He crossed the mutants and obtained the following results: *wf1* x *wf3* produced F2 offspring with only white flowers, and *wf2* x *wf3* produced F2 offspring with blue and white flowers in a ratio of 9:7. According to these data, which of the statements below is **NOT correct**?

(A) *wf1* and *wf3* are unable to complement each other.

(B) *wf2* and *wf3* are able to complement each other. (C)

wf1 and *wf3* are in the same locus.

(D) *wf2* and *wf3* are not in the same locus.

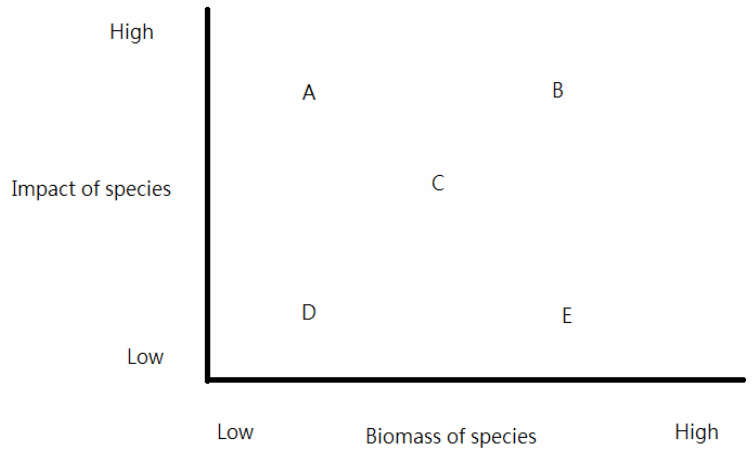
(E) The F1 offspring from crossing *wf1* and *wf2* will all produce white flowers

VI. Ecology

A44. Biogeography researchers found that continental islands tend to have a species composition similar to that of the mainland, but a lower degree of species differentiation compared to oceanic islands. If one compares the biome of an oceanic island (X) to that of a continental island (Y), assuming the two have approximately the same area, and are located in the same latitudinal range, which of the following descriptions is correct?

	Proportion of endemic species	Total number of species
A	X<Y	X>Y
B	X>Y	X>Y
C	X>Y	X<Y
D	X<Y	X<Y
E	X=Y	X<Y

A45. In the figure below, A to E denote five different species in an ecosystem. Which of the species is most likely to be a keystone species?



A46. A group of students would like to know how the discharge of waste water from a factory might influence water quality of a river. The picture shows 7 potential sampling locations (① to ⑦) in relation to the locations of the factory and the river. Which locations are essential to be included in the sampling in order to draw valid conclusions about the pollution of the river by

the factory?

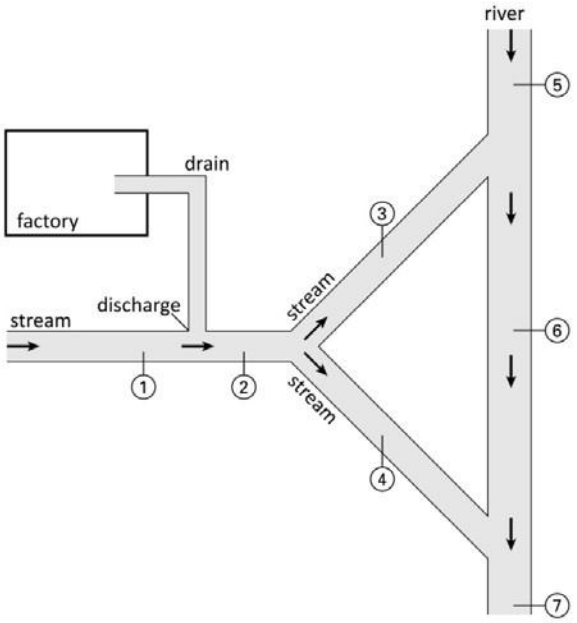
(A) Locations 1, 2, 4, 7

(B) Locations 1, 3, 4, 7

(C) Locations 1, 2, 5, 7

(D) Locations 2, 3, 4, 6

(E) Locations 2, 5, 6, 7



A47. Biogeography researchers have long recognized that terrestrial biomes on islands are often associated with dispersal and colonizing ability of different organisms. Based on dispersal and colonizing ability of the following groups of organisms, which one <u>is least likely</u> to occur on an oceanic, tropical island with a large area, numerous mountains, a dense vegetation cover, and a high level of biodiversity?

(A) Insects

(B) Birds

(C) Ferns

(D) Amphibians

(E) Reptiles

A48. A male guppy (*Poecilia reticulata*) with large, bright spots on the body is more likely to attract females, which increases his opportunity to reproduce. In the meantime, he is also more easily detected by the natural enemy, which increases his predation risk. Consider male guppies from three different rivers: X, Y and Z, males from X have the largest spots, males from Y have the intermediate-sized spots, and males from Z have the smallest spots. Which of the following descriptions about the guppies in the three rivers is correct?

The density of

(A) male guppies in X is higher than in the other rivers.

(B) male guppies in Z is higher than in the other rivers.

(C) natural predator of guppies in X is higher than in the other rivers.

(D) natural predator of guppies in Z is higher than the other rivers. (E)

female guppies in X is higher than the other rivers.

A49. Species M had been introduced multiple times (few individuals or small population) to an ecosystem outside its native distribution, but could not establish itself. Although no parameter in ecosystem changed between the different attempts, the final one introduction was eventually successful, and led to a rapid and wide-spread expansion of species M in the ecosystem. Which of the followings is the most plausible explanation for why species M was not natively distributed in this ecosystem?

(A) There are too many competitors of species M in the ecosystem.

(B) There are too many predators of species M in the ecosystem. (C)

Species M is not able to disperse to the ecosystem on it own.

(D) The abiotic environment in the ecosystem is not suitable for the growth of species M.

(E) The ecosystem is frequently under disturbance, which creates an unfavorable condition for species M to sustain.

A50. A large forest is cleared. The land is rapidly colonized by species with which of the following characteristics?

(1) long lifespan, (2) rapid reproduction, (3) fast growth, (4) strong dispersal ability, (5) strong defense against natural enemies or predators.

(A) Only 1, 2, 3

(B) Only 1, 2, 5

(C) Only 1, 4, 5

(D) Only 2, 3, 4

(E) Only 3, 4, 5

A51. A large proportion of angiosperms are pollinated by animals. Assign the following flower descriptions (I to V) to the most likely pollinator (a to e).

I. Flower white, open during night, intensive fragrant, nectar hidden in long, tight tubes. II.

Flower often with ultraviolet coloring pattern, open during daytime, pleasant fragrant.

III. Flower large and coarse, bright red, open during daytime, no fragrance but large amounts of nectar

IV. Flower large and coarse, far opened, open during night, intensive fragrant, large amounts of nectar

V. Flower reddish brown, no nectar, smell of rotten flesh

a. bats

b. birds

c. bees

d. flies

e. moths

Which of the following statement is correct?

(A) I-a, II-b, III-c, IV-e, V-d

(B) I-b, II-c, III-d, IV-a, V-e

(C) I-d, II-e, III-a, IV-b, V-c

(D) I-e, II-c, III-b, IV-a, V-d

(E) I-e, II-d, III-c, IV-b, V-a

A52. It has been demonstrated that house roaches show less threat to human health than mosquitos in terms of serving as disease vectors. Which feature possessed by roaches given below may explain this observation?

(A) piercing mouthpart, injecting saliva into the tissue which it feeds upon

(B) chewing mouthpart, swallowing food without saliva

(C) mouthpart sponge-like, secreting saliva upon the food they feed on (D)

microhabitats they prefer much more cleaner than those by mosquitos (E)

by natural they are anthropophobia

VII. Biosystematics

[Questions 53-55] The following table shows the main characteristics of 8 different animals (taxa 1 to 8). A "+" sign indicates that the animal possesses a characteristic, and a "blank" indicates that the animal does not possess a characteristic:

Characteristic	**Taxon**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Amnion			+	+	+			
Limbs with fingers	+		+		+			
Mammary glands					+			
Lateral line system	+	+				+		
Cycloid scales		+						
Sternum	+		+		+			
Semicircular canals	+	+	+	+	+	+	+	
Ventral nerve cord								+

Please answer questions A53 to 55 using the information in the table above.

A53. Which of the following taxa most likely belongs to the same Class as "Taxon 4"?

(A) Taxon 1

(B) Taxon 2

(C) Taxon 3

(D) Taxon 5

(E) Taxon 6

A54. "Taxon 8" <u>is least likely</u> to be which of the following organisms?

(A) Earthworm

(B) Grasshopper

(C) Lobster

(D) Sea star

(E) Spider

A55. "Taxon 1" is most likely to be which of the following organisms?

(A) Shark

(B) Eel

(C) Sea lion

(D) Turtle

(E) Frog

A56. Table A is a data matrix for characters of four kinds of animals. The entries denote shared characters if animals have the same values (eg. 0,0 or 1,1), or different characters if animals have different values (ie. 0,1).

Table A

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Animal A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Animal B	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0
Animal C	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
Animal D	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0

If relationship among organisms can be inferred from the degree of similarity, and the degree of similarity is defined as a coefficient S:

S = number of shared characters/ (number of shared characters + number of different characters)

According to the data matrix given by Table A, which animal is the most closely related to animal A, and which one is to C? Please give your animal in the format of (the animal most closely related to A, the animal most closely related to C).

(A) (B, A)

(B) (B, B)

(C) (C, B)

(D) (C, A)

(E) (D, A)

A57. Mary bought rice, potatoes, tomatoes, kelp, pine nuts, mushrooms, dates, bird nest fern, bananas, and corn cobs from the supermarket. Based on hierarchical classification, how many different phyla (divisions) do these items belong to?

(A) 4

(B) 5

(C) 6

(D) 7

(E) 8

A58. A scientist unearthed four plant fossils (I to IV) with some prominent structures intact. These are listed in the following table:

Structure / Fossil #	Spore	Ovary	Embryo	Pollen	Xylem	Ovule
I			✓		✓	
II			✓	✓	✓	✓
III		✓		✓	✓	✓
IV	✓		✓			

According to this table, which sequence below correctly represents the order of evolution of these plants?

(A) I→II→III→IV

(B) II→III→IV→I

(C) III→IV→I→II

(D) IV→I→II→III

(E) II→I→IV→III

(F) IV→I→ III→II

THEORETICAL TEST : PART B

Total Points: 147 Duration: 150 minutes

Dear Participants,

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- The questions in Part B **may have more than one** correct answer. Fill your answers in the Answer Sheet. The **marks, numbers, or characters** to answer questions in Part B vary depending on questions. Unless mentioned otherwise, mark the correct answers with "○" and incorrect answers with "—" for multiple choice questions on the Answer Sheet clearly, as shown below.

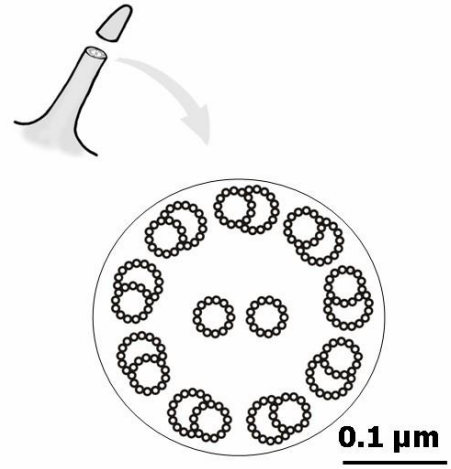
No.	A	B	C	D	E	F
B0.	○	—	○	—	—	—

- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal points of Part B is 147 (3 points for each question)
- **Every cell counts in** each question. Then you will get the points.
- Stop answering and put down your pencil IMMEDIATELY after the end bell rings.

Good Luck!!

I. Cell biology

Problem set: **Figure 1** depicts the cross-section of a certain cell surface structure observed by electron microscope. Answer questions **B1** and **B2**.



B1. Which of the following possess the above structure?

(A) *Paramecium*

(B) *Escherichia coli*

(C) Tracheid of gymnosperm

(D)Human oviduct epithelial cell

(E) Human tracheal epithelial cell

(F) Human intestinal epithelial cell

B2. What is/are the functions and what is/are the major chemical composition of the structure?

Function options:

(A) Attachment

(B) Locomotion

(C) Transportation

(D) Secretion (E)

Absorption

Composition options:

(P) Cellulose

(Q) Protein

(R) Mucin

(S) Lipid

(T) Nucleic acid

B3. Some pathogens produce exotoxins that can cause human diseases. One type of exotoxins consists of two polypeptides, subunits A and B. Subunit B can bind to surface receptors on the target cells and cause the transport of the subunit A or associated molecules across the plasma membrane into the cell. Once the subunit A enters the cell, it inhibits protein synthesis and destroys the cells. Which of the following statements regarding exotoxins is/are correct?

(A) Subunit A alone can cause disease.

(B) Subunit B alone can bind to target cells.

(C) Subunit A may carry other molecules to enter and kill the target cells.

(D) Subunit B may carry other molecules and assist these molecules to enter target cells.

(E) When conjugated with an antibody against breast cancer cells, subunit A may kill breast cancer cells.

Problem set: Some leucocytes can ingest invaded pathogens by phagocytosis. Digestive enzymes that kill pathogens only function in acidic conditions. Please answer questions **B4** and **B5**.

B4. Based on the information provided in the following table, complete the synthesis process of digestive enzymes during phagocytosis:

① Replication	⑤ Endoplasmic reticulum
② Translation	⑥ Vesicle
③ Transcription	⑦ Lysosome
④ Mitochondrion	⑧ Golgi apparatus

(1) mRNA-ribosome complex is transferred to ___A___ to continue ___B___.

(2) Synthesized enzymes enter ___C___ and ___D___ for modification.

(3) The modified enzymes are stored in ___E___.

Fill in the correct numbers on your answer sheet.

B5. Tom isolated phagocytes from a blood sample. He cultured these phagocytes in a test tube for a period of time. To observe phagocytosis, *E. coli* was co-cultured with phagocytes. What will be the consequence if you neutralize acidic pH in lysosomes inhibiting proton pump by a specific inhibitor?

(A) Phagocytes can recognize *E. coli* via toll-like receptor.

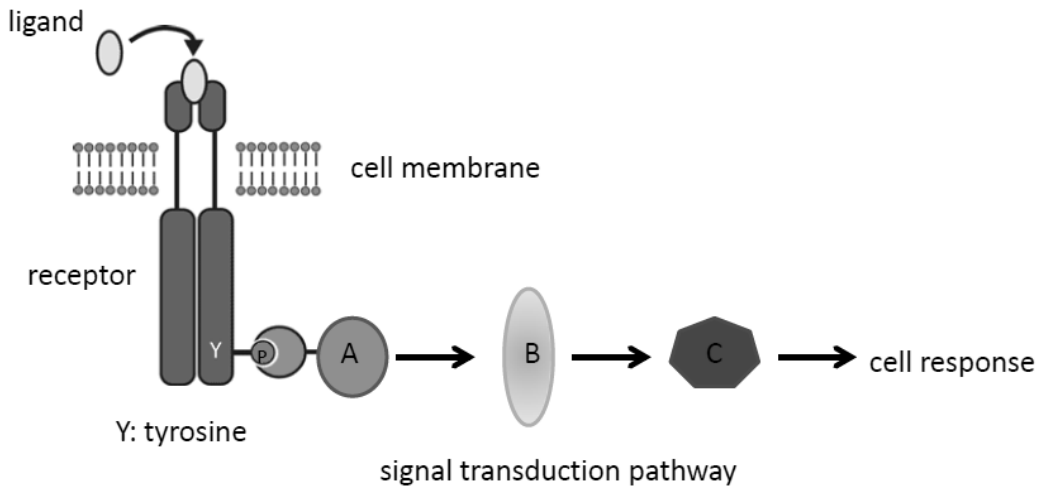
(B) Ingestion of *E. coli* by phagocytes is inhibited.

(C) *E. coli* can survive in phagolysosomes for long periods of time.

(D) If phagolysosomes are formed, the digestive enzymes in them are inactive.

(E) Phagocytes can secrete ingested debris out of the cell.

Problem set: Jessica is dissecting a signal transduction pathway (depicted in the following figure) that leads to oncogenesis in cancer cells, in the hope that she can find inhibitors to block the signaling pathway and use them as chemotherapy drugs for cancer treatment. Please answer **questions B6-B8**.



B6. Components of signal transduction, including A, B and C, usually are activated through phosphorylation or dephosphorylation reactions. What are the mechanisms by which proteins A , B and C are phosphorylated or dephosphorylated?

(A) Receptors may contain enzyme domains which can catalyse phosphorylation/dephosphorylation reactions.

(B) Enzymes that participate in phosphorylation/dephosphorylation reactions may exist in the cytoplasm.

(C) Proteins A, B and C may contain enzyme domains which can catalyse phosphorylation/dephosphorylation reactions.

(D) Phosphorylation or dephosphorylation may not be mediated through enzymatic reactions.

(E) A phosphate group is transferred from the receptor to protein A.

(F) The phosphate group can only be provided by H_3PO_4.

B7. Which of the following experiment can prove that the signal transduction pathway is B→C, but not C→B?

(A) Adding an A antagonist will activate B.

(B) Adding an A agonist will activate C.

(C) Adding a B agonist will activate C.

(D) Adding a B antagonist will activate C.

(E) Increasing the expression level of B will generate more of the active C molecules.

(F) Cell response can be observed when B antagonist and active C molecules are added into the cell.

B8. If this is a highly activated signal transduction pathway in cancer cells, in which of the following processes may the signaling pathway be involved?

(A) Inhibiting cell division

(B) Inhibiting cell differentiation

(C) Hypomethylation of some tumor suppressor genes

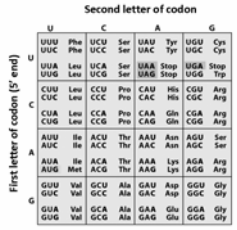
(D) Activating the transcription of an oncogene

(E) Arresting the cell cycle at S phase

(F) Inhibiting the expression of some DNA repair genes

~~**B9(DELETED).** In protein synthesis, there are 64 codons, 61 codons specify the 20 amino acids and the other 3 for termination "STOP" (**Table**). The following sequence of amino acids occurred in the structure of a polypeptide found in a wild-type organism:~~

~~Ser-Arg-Ile-Leu-Ala-Ala-Lys-Tyr. Which of the following may generate the mutant amino acid sequence Ser-Arg-Ile-Trp-Arg-Gln-Lys-Tyr?~~



~~(A) 1 nucleotide mutation~~

~~(B) 1 nucleotide insertion~~

~~(C) 1 nucleotide deletion~~

~~(D) 2 nucleotide mutation~~

~~(E) 2 nucleotide insertion~~

~~(F) 3 nucleotide mutation~~

II. Plant anatomy and physiology

B10. At the time of pollination, the living pollen grain typically consists of only the tube cell and the generative cell. During the germination of pollen grain, a pollen tube is produced and the nucleus of generative cell divides and forms two sperms. Directed by a chemical attractant (such as GABA) produced by the synergids, the tip of pollen tube enter the ovule through the micropyle. Then in the embryo sac, double fertilization occurs by the two sperms. Which of the followings are correct as concerning the pollination and double fertilization?

(A) Tube cell, sperm, and synergid are haploid, while generative cell and zygote are diploid.

(B) During the pollination, a gradient in GABA content is formed from the stigma (low) to the ovary (high).

(C) The two sperms fertilize two eggs, but only one forming zygote.

(D) After fertilization, one zygote and one endosperm initial are formed.

(E) Germinated pollen grain is male gametophyte, while embryo sac is female gametophyte.

B11. Mary divided 30 pots of plant X of similar condition into 10 plants per group, with each group being treated with different types of light regime. After a month, the flowering phenotypes of each group are shown in the table below:

Treatment	Light regime		Flowering result
(I)	12 hr	12 hr	All 10 plants flowered
(II)	14 hr	10 hr	9 plants flowered, and 1 plant failed to flower
(III)	16 hr	8 hr	All 10 plants fail to flower

Light Darkness

According to the information above, which of the following descriptions of plant X are correct?

(A) Plant X is a short day plant

(B) The critical dark-length required by plant X for flowering is less than 10 hours

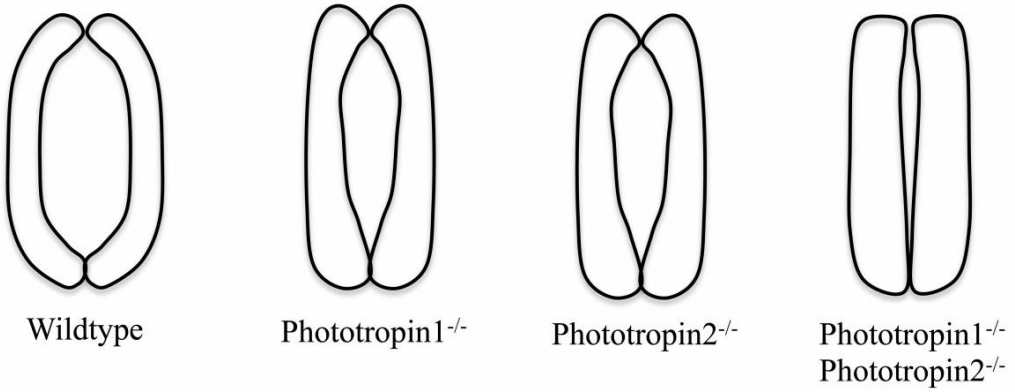
(C) If group III is given an "one-minute dark treatment" in the middle of the light period, after one month, most plants in this group will flower

(D) If group II is given an "one-minute red light treatment" in the middle of the dark period, most plants in this group will not flower right after one month

(E) If the apical buds of group I plants are removed before giving the light regime treatment, then most plants will not produce florigen required for flowering after giving light regime treatment.

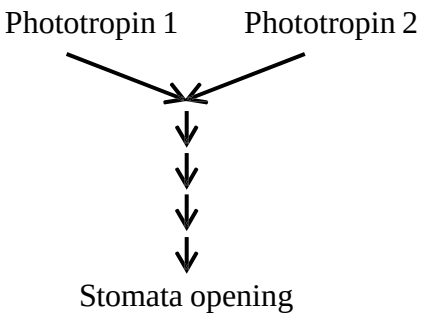
B12 and B13 are a problem set

Dr. Wang carried out experiments with the model organism *Arabidopsis thaliana*, and identified the two proteins Phototropin 1 and Phototropin 2 as regulators of stomata opening. His experimental results are depicted in the following figure, illustrating the stomata of plants during the day.

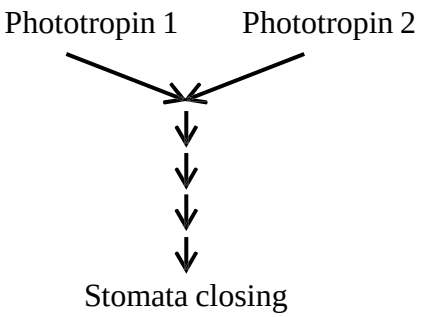


B12. Which of the following pathways potentially depict the relationship of Phototropin 1 and Phototropin 2 on a molecular level?

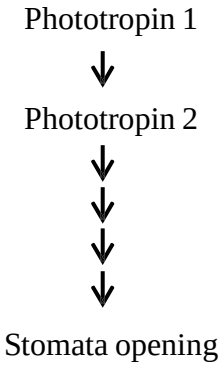
(A)



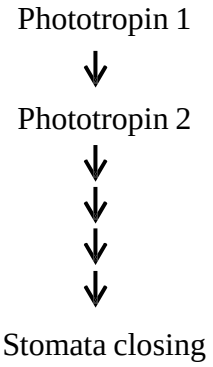
(B)



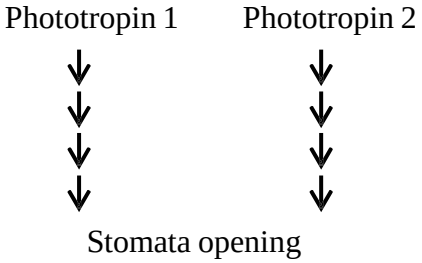
(C)



(D)



(E)



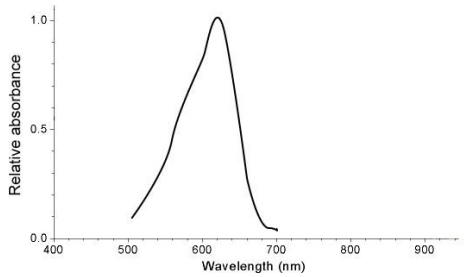
B13. Which of the following processes could be regulated and/or mediated by Phototropin 1 and 2?

(A) K^+ ion efflux (B) K^+ ion influx (C) Na^+ ion influx

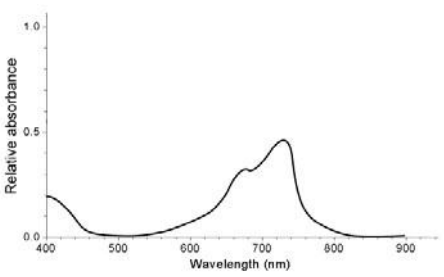
(D) H_2O efflux (E) H^+-ATPase activity (F) Blue light sensing

B14. Phytochromes exist in two isoforms, Pr and Pfr. In darkness, they are synthesized as Pr form, then turned into Pfr form after absorbing red light (most effective at 666 nm). When irradiated with far red light, Pfr transforms back to Pr. According to the description above, which of the following are likely to be the absorption spectra of phytochrome?

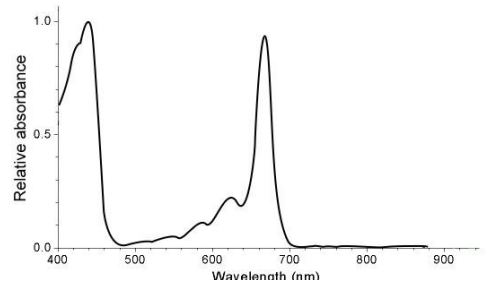
(A)



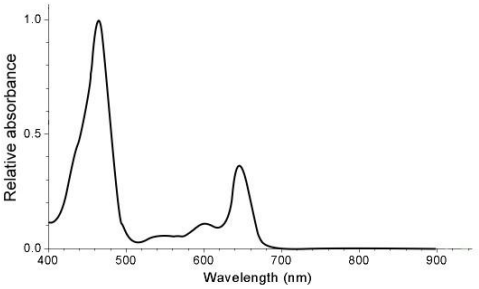
(B)



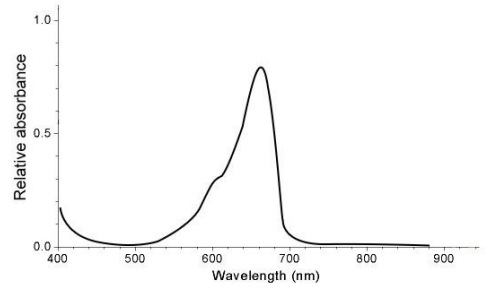
(C)



(D)



(E)



B15. The *AGAMOUS* (*AG*) gene is involved in flower development. Plant mutants without a functional *AG* would produce flowers with only receptacle, sepals and petals. A scientist generated a transgenic plant harboring a green fluorescence protein (GFP) gene driven by the *AG* promoter in a wild type background that produces normal flowers. In which of the following flower parts, you are likely to observe strong GFP fluorescent signals?

(A) Receptacle

(B) Sepal

(C) Petal (D)

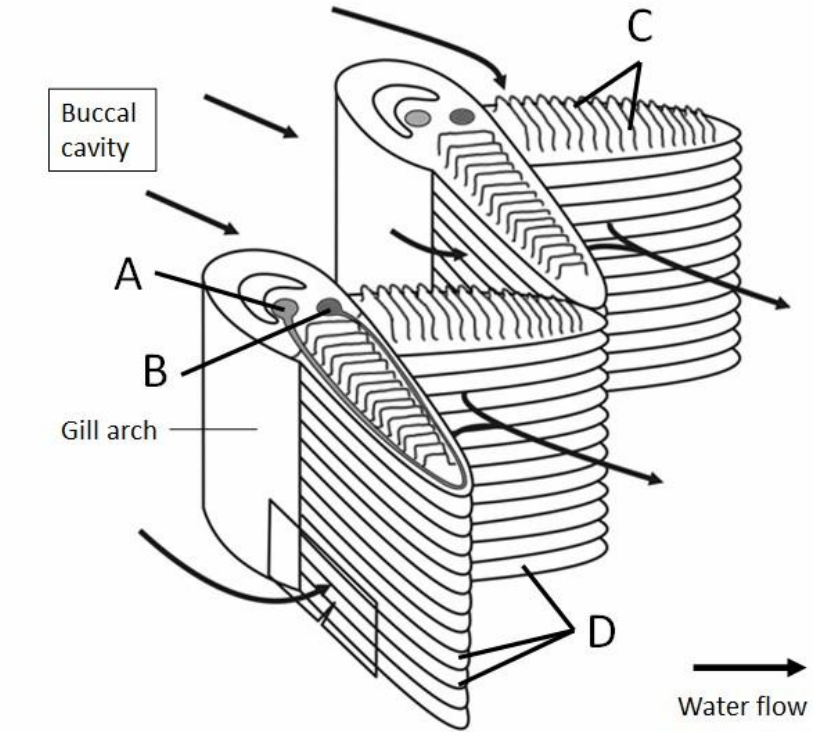
Stamen (E)

Carpel

III. Animal anatomy and physiology

B16 to B18 are a problem set

B16. In the following figure, the structure of fish gills and the direction of water flow in the ventilation are illustrated. Answer the questions.



Which of the following statements are correct?

(A) Vessel A carries oxygenated blood

(B) Vessel B carries deoxygenated blood

(C) Vessel A is an arteriole

(D) Vessel B is a venule

(E) Vessel A and B are portal vessels

B17. During evolution the gas exchange in gills has become more effective by

(A) A decrease in the thickness of the structure C

(B) A decrease in the number of cell layers in structure C

(C) An increase in the metabolic rate of the structure C (D)

An increase in the cell volume of the structure C

(E) An increase in the surface area of the structure C

B18. Scientists found a kind of epithelial cell (X cell) in the structure of D with which fish can maintain body fluid osmolarity. Consequently, X cells are supposed to

(A) absorb salt actively in freshwater fish

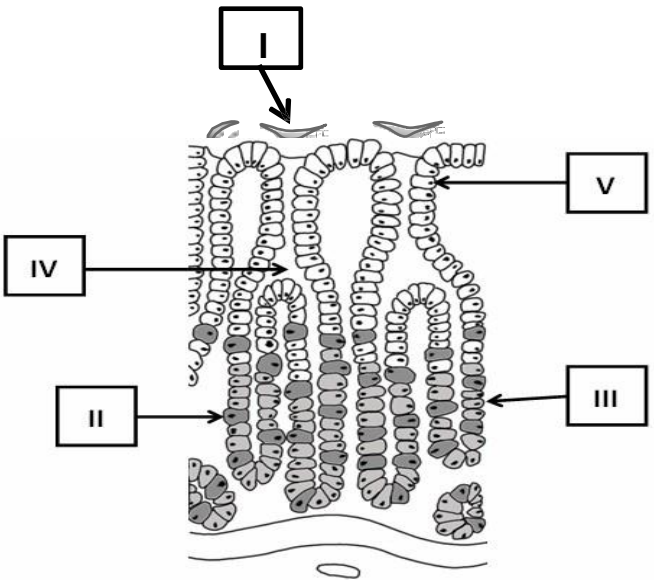
(B) excrete salt actively in seawater fish

(C) excrete water actively in freshwater fish

(D) absorb water actively in seawater fish (E)

be rich in mitochondria

B19. The following image represents a gastric fold from the interior surface of the stomach. The different structures are indicated by roman numerals:



The list below describes the function for each structure.

a. Secretes hydrochloric acid

b. Secretes mucus which lubricates and protects the cells that cover the stomach.

c. Contains a series of ridges or deep pits which lead to the glands

d. Secretes pepsinogen

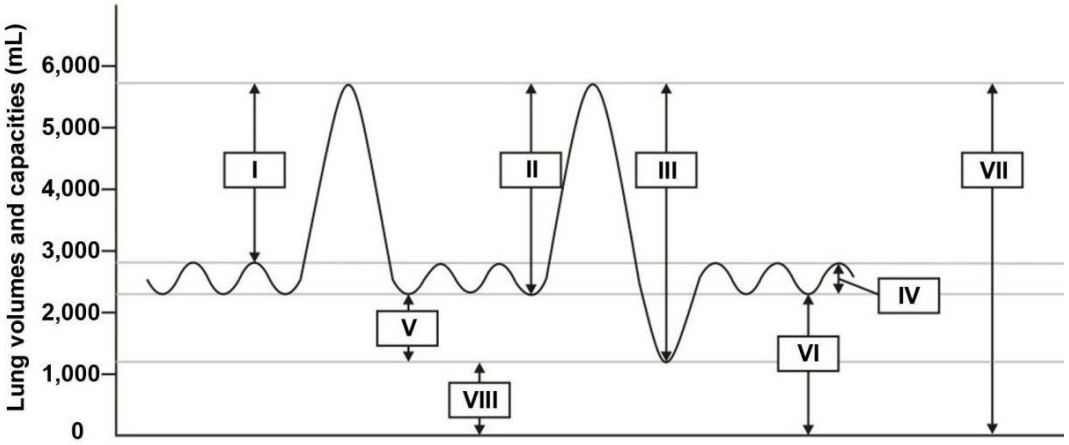
e. Contains three different types of cells that secrete the components of gastric juice.

Please indicate the correct set of answers relating structure with corresponding

function.

Function code	Structure code (I to V)
a.	Do not answer here
b.	
c.	
d.	
e.	

B20. The graph below depicts the different pulmonary volumes and capacities:



Below are two columns, correlate the contents in the 2 columns with the graph above:

1. Tidal volume (TV)	a. The maximum volume of air inhaled in a forced inspiration. It comprises tidal volume and inspiratory reserve.
2. residual volume (RV)	b. The maximum amount of air inhaled over the resting level of spontaneous inspiration.
3. vital capacity (VC)	c. The volume of air remaining in lung after a strong forced expiration.
4. Inspiratory capacity (IC)	d. The volume of air present in lung after a maximum inspiration.
5. Expiratory Reserve volume (ERV)	e. Total amount of air flowing between inspiration and expiration at maximal rate. It includes tidal volume, inspiratory reserve volume and spontaneous expiration rate.
6. Total lung capacity (TLC)	f. Amount of air in excess of tidal expiration that can be exhaled with maximum effort.
7. Inspiratory reserve volume (IRV)	g. The volume of air present in the lungs, at the end of passive expiration. It is the sum of residual volume and expiratory reserve volume
8. Functional residual capacity (FRC)	h. The lung volume representing the normal volume of air displaced between normal inspiration and expiration with or without extra effort applied.

	I	II	III	IV	V	VI	VII	VIII
Letter								
Number								

B21. Which of the following statements about thermo-adaption in animals are correct?

(A) Blue-fin tuna is able to raise their core temperature. Therefore, it is an endothermic animal.

(B) Icefish spend all their life in the freezing ice-laden water and maintain a very stable body temperature. Therefore, icefish are homeothermic animals.

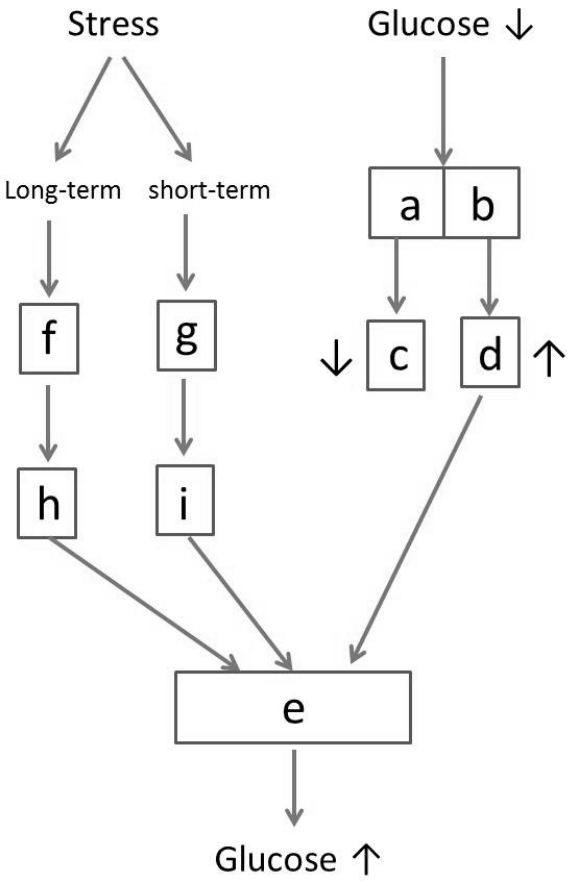
(C) Shivering can help mammals to generate heat, and it is regulated by hypothalamus in mammals.

(D) Brown adipose tissues help mammals to generate heat by supplying energy to skeletal muscles.

(E) Brown adipose cells are rich in mitochondria for heat generation.

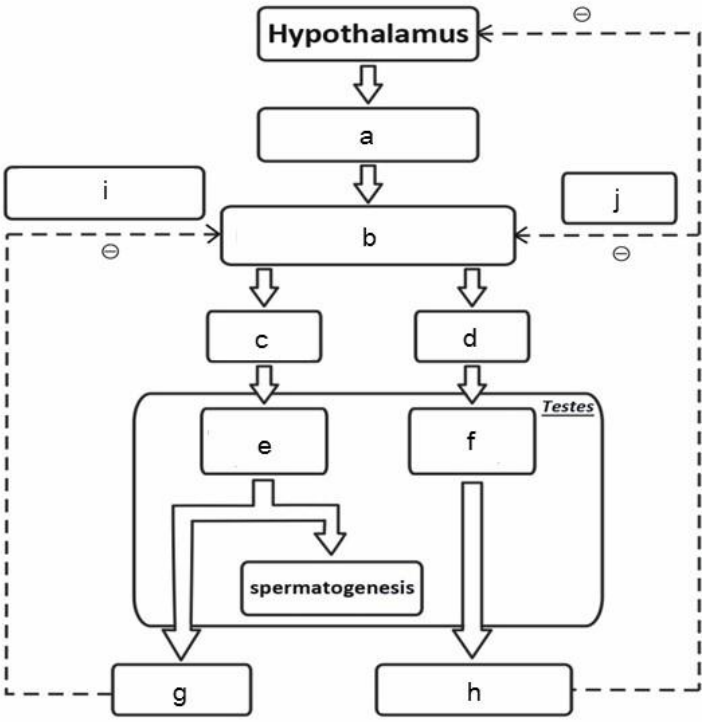
B22. Maintenance of the blood glucose level is important for normal physiological function. It is modulated by both neural and endocrine system. The diagram below shows two different situations resulted from physiological stress or low blood glucose level. Complete the table in the answer sheet by using appropriate letters shown below.

Structure/hormone	Answer
α cells of the pancreatic islets	Do not answer here
Insulin	
Liver	
Adrenal medulla	
Cortisol	



B23 and B24 are a problem set

B23. Normal spermatogenesis and androgen secretion are delicately regulated by hormones in males. The occurrence of infertility in the male could be resulted from the disturbance of hormonal regulation. The following figure partly illustrates the cross interactions among hypothalamus, pituitary gland, and male gonads. The symbols "(-)" indicate negative feedback inhibitions. Insert appropriate symbols (a to h) in the table of the answer sheet.



Structure/hormone	Answering code
Sertoli cells	Do not answer here
Anterior pituitary	
Gonadotropin releasing hormone	
FSH	
Inhibin	

B24. The application of available and suitable hormonal therapy to the male patients with gonad failure is very important. Considering how the following case may be improved by a hormonal treatment.

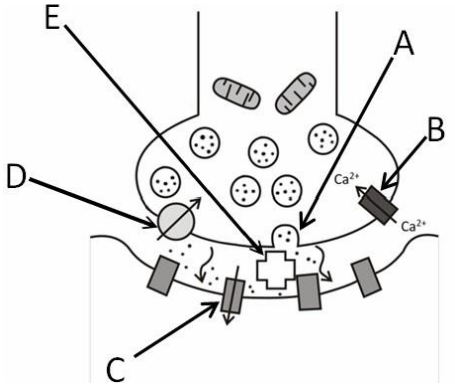
Patient A suffered from testicular cancer and had both testes removed.

With reference to the figure in **B23**, select the most appropriate letter applicable to patient A.

O: Supplement -- : No supplement

a	c	d	e	f	h

B25. A to E in the diagram below represents the five major steps of synaptic transmission.



A. Release of neurotransmitter.
B. Activation of presynaptic calcium channel.
C. Activation of postsynaptic sodium channel.
D. Re-uptake of neurotransmitter.
E. Degradation of neurotransmitter.

Scientists study drug effects on synaptic transmission by using electrophysiological recording. Briefly the postsynaptic current will be recorded and used to determine the possible mechanism which may account for the drug effects. Figure 1 is the typical tract of postsynaptic current before drug administration. Match the figure numbers (I, II, III, IV or V), given at the end with the correct drug effects below. Figures may be used once, more than once or not at all.

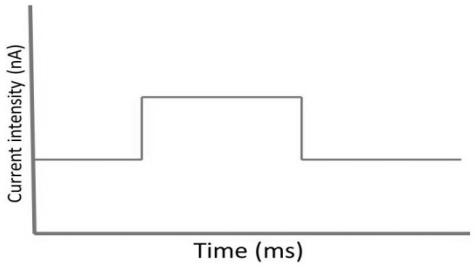
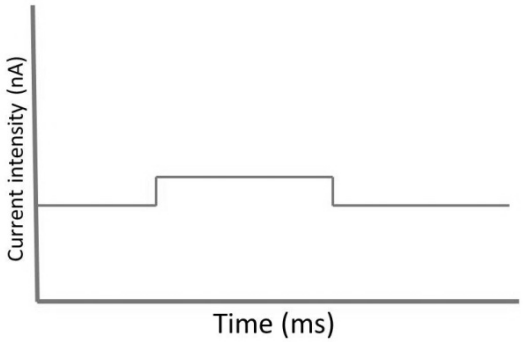


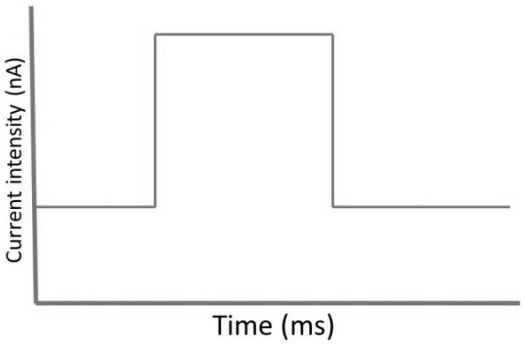
Figure-1

Mechanism	Figure number
Blocking of step A	Do not answer here
Enhancement of step B	
Blocking of step C	
Enhancement of step D	
Blocking of step E	

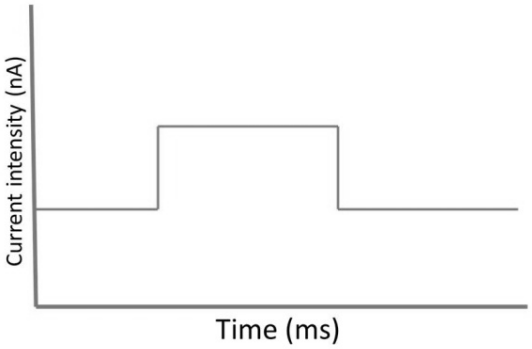
(I)


Current intensity (nA)
Time (ms)

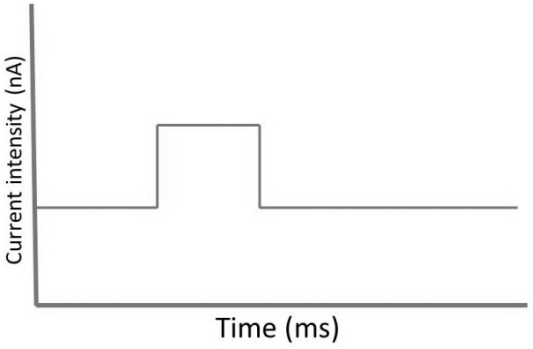
(IV)


Current intensity (nA)
Time (ms)

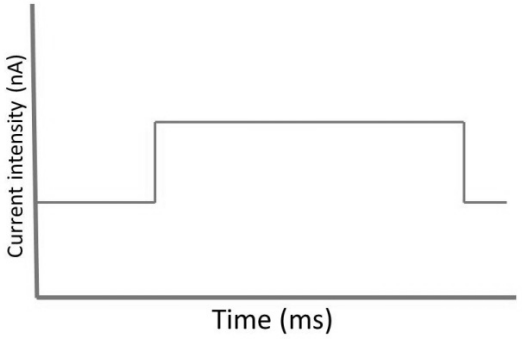
(II)


Current intensity (nA)
Time (ms)

(V)


Current intensity (nA)
Time (ms)

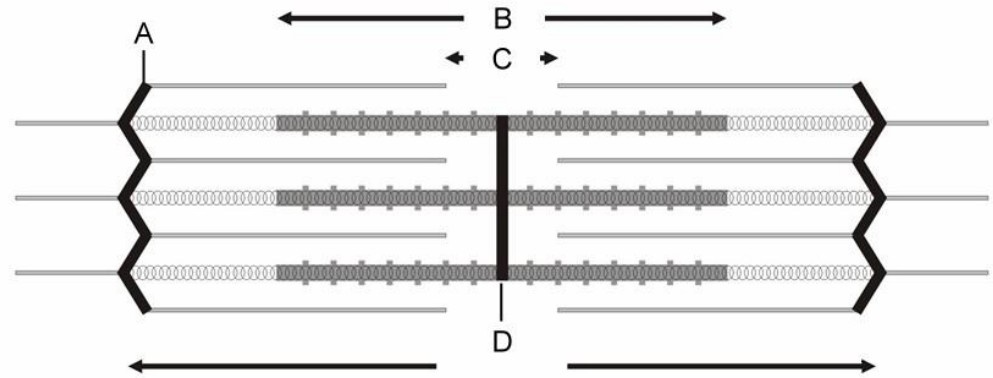
(III)


Current intensity (nA)
Time (ms)

B26. Epilepsy is a common neurological condition. Patients suffer convulsions which result from hyperactivity of certain cerebral areas. Symptoms can be reduced by using antiepileptic drugs. If the receptor activated in the above figure was a chloride channel instead of a sodium channel, which of the following mechanism(s) may form the basis for an antiepileptic drug?

Mechanism	Answer
Blocking of step A	Do not answer here
Enhancement of step B	
Blocking of step C	
Enhancement of step D	
Blocking of step E	

B27. The following diagram indicates the basic structure of a sarcomere.



Mark if the statement correct or incorrect. The statements are about a muscle fiber undergoing an isotonic contraction compared to its relaxed state.

Statement	Answer
a. D bands remain the same distance apart	Do not answer here
b. A move closer to the ends of the B	
c. C become shorter	
d. B become wider	
e. D bands move closer to the end of the B	

IV. Ethology

B28. There are two types of bird hatchlings: precocial and altricial. In general, precocial birds are covered with feathers when they hatch, and can find their own food with the help from their mothers. In contrast, altricial hatchlings require feeding and caring for from the parents. Based on this, which of the following statements are correct?

(A) Precocial hatchlings usually take longer to hatch than altricial hatchlings.

(B) Altricial hatchlings usually develop imprinting earlier than precocial hatchlings.

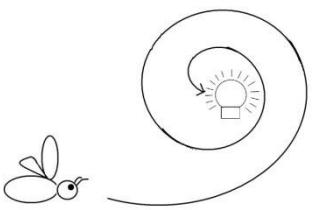
(C) Parents invest more in precocial hatchlings than in altricial hatchlings during nestling period.

(D) For a group of young birds that hatch at the same time, altricial hatchlings tend to develop the ability to move earlier than precocial hatchlings.

(E) Parents of precocial and altricial hatchlings have the same level of investment in reproduction during the breeding season.

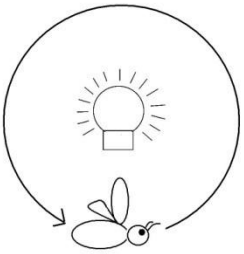
B29. An entomologist found that a species of cockroach uses the dramatic change of light intensity at dusk (given as 18:00) to reset its biological clock. He also found out that the circadian (daily) rhythm is 25 hrs. If a student cages a cockroach of this species into a dark box at 18:00, at what time will the cockroach become active after 12 days? Fill in the time (using the 24hr system, example: 6:00 pm = 18:00) in the given space in the Answer Sheet.

B30. A biologist discovered that a species of moth is capable of flying in a straight line at night because it keeps a constant angle (80°) between its body's longitudinal axis and the direction of moon light using photoreceptors as a tool. If the moth encounters a bright light in a dark night, what kind of flight path one will expect to see in relation to the light source?

(A) 	(D) 

(B)

(E)



(C)

B31. A researcher monitored 10 pairs (A to J) of adult birds during the breeding season. For each of the pairs, he recorded body lengths of the male and female, and their nesting date as shown in the table below.

	A	B	C	D	E	F	G	H	I	J
Female body length (cm)	26.4	27.8	25.1	25.0	27.0	28.1	25.5	25.9	28.3	27.4
Male body length (cm)	28.3	28.4	28.9	29.0	27.9	30.2	29.6	27.4	29.7	30.5
Nesting date (month/date)	5/6	5/3	5/4	4/28	5/1	4/27	4/29	5/2	5/1	4/26

Based on this data, the mean body length is 26.65 cm for the adult females, and 28.99 cm for the adult males. In comparison with the mean body length of 26.10 cm in adult females and 27.60 cm in adult males in the total (breeders + non-breeders) population (N=30) of the study area, which of the following statements are correct?

(A) All males in this species are larger than females.

(B) Females tend to pair with males that are larger than themselves.

(C) Male body lengths do not affect female mate choices.

(D) Nesting dates are linked to male body lengths.

(E) The chances of breeding in this species are most likely affected by the body size.

V. Genetics and Evolution

B32. The black, brown and white coat colors of mice are determined by the interaction of genes *B* and *C*, which are on different autosomes. *B* and *b* alleles control the synthesis of black and brown pigments, respectively. Only in the presence of the dominant *C* allele, black and brown pigments are deposited in the fur. In a crossing between *BbCc* and *bbCc*, which of the following statements are correct?

(A) The coat colors of parental mice are black and brown respectively.

(B) The ratio of black and brown offspring is 1:1.

(C) 3/4 of the offspring are black.

(D) 1/4 of the offspring are brown.

(E) 1/4 of the offspring are white.

(F) Alleles *C* and *B/b* are co-dominant.

B33. Fur of guinea pigs can have different colors (black or white). Hairs can be with different textures (rough or smooth). Alleles *Q* and *q* are coding for color, alleles *R* and *r* for type of hair. There is no linkage between the two genes. A number of guinea pigs with exactly the same genotype (parental group) are allowed to mate and the result in a large number of F1 offspring. Most of these have a black rough fur. A small number has white smooth fur. About the same number of offspring is white and rough, or black and smooth.

B33.1. Using the given letters, indicate the genotype of the guinea pigs in the parental group.

B33.2. If 1024 F1 offspring were born, what is the expected number of the black and smooth?

B33.3. Guinea pigs often have a spotted pattern. According to a simplified model spotted pattern is determined by one gene with two alleles: G and g. If G is present the guinea pig is spotted. Students investigated the population guinea pigs in a territory and found out that 84 % were spotted. Presuming this population is in (Hardy-Weinberg) equilibrium, calculate the frequency of G. Give your answer in one decimal place.

B33.4. In one day all unspotted guinea pigs were removed. What will be the frequency of unspotted guinea pigs appearing in the next generation? Give your answer as a percentage without decimals.

B34. It is believed that "land plants" are evolved from charophytes. Which of the following statements support this hypothesis?

(A) Both have alternation of generation in life cycles

(B) Both contain chlorophyll a and chlorophyll b

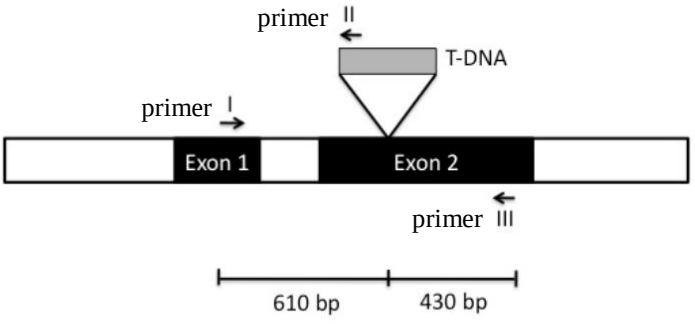
(C) Both have peroxisomes that contain photorespiration-related enzymes

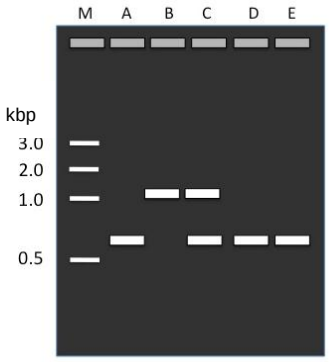
(D) Both can form phragmoplasts during cytokinesis

(E) Both contain cellulose cell walls

Questions B35a-B35c are a <u>problem set</u>

Dr. Chen was investigating the function of gene *X* in rice by using a mutant with a T-DNA inserted in the exon 2 as illustrated below. The size of the T-DNA is approximately 5 kilo base pairs (kbp). She used PCR and gel electrophoresis analyses for genotyping of five individual plants (A, B, C, D, E) with mixture of primers I, II, and III as indicated in the diagram. The gel figure shows the PCR result. The DNA molecular size markers are shown in lane M. Lane A-E are the PCR products from leaf samples of the plant A-E, respectively. It is known that the polymerase being used is unable to effectively amplify DNA fragments above 5 kbp.





Based on the above information, answer questions B35a-B35c:

B35a. Which pair of primers (I+II, I+III, or II+III) amplified the DNA band in lane B? Write down

the correct pair of primers in the answer sheet.

B35b. Which plant(s) (A, B, C, D, or E) is/are homozygous mutant(s)? Write down the correct letter(s) in the answer sheet.

B35c. Which plant(s) (A, B, C, D, or E) is/are the F1 offspring of homozygous mutant crossed with the wild type? Write down the correct letter(s) in the answer sheet.

B36. Doctor Lin isolated a rice mutant with a late flowering time phenotype. The mutant allele responsible for this phenotype was identified by map-based cloning technique and named LFT^m. When Doctor Lin sequenced the whole LFT^m gene, including the promoter region, she could not find any difference in the nucleotide sequence as compared to the wild-type allele. Which of the following phenomena are likely to be responsible for this observation?

(A) The mRNA level of *LFT* in the mutant is the same as that in the wild-type at the same developmental stage

(B) The LFT protein found in the wild type plants cannot be detected or is lower in the mutant

(C) The DNA methylation patterns on *LFT* are altered in the mutant

(D) The levels of histone proteins are dramatically altered in the mutant

(E) Introducing the cloned *LFT* into the wild-type plant generates a *LFT* overexpression transgenic plant with late flowering phenotype

VI. Ecology

B37. The population size of a dragonfly in a pond was estimated to be 50,000 during a survey. Their sex ratio is 1:1. Each female lays approximately 400 eggs. A second survey of the next generation revealed that the population size is still 50,000 and the sex ratio is still 1:1. What is the average survival rate (surviving to adult stage) of the eggs?

(A) 0.2%

(B) 0.25%

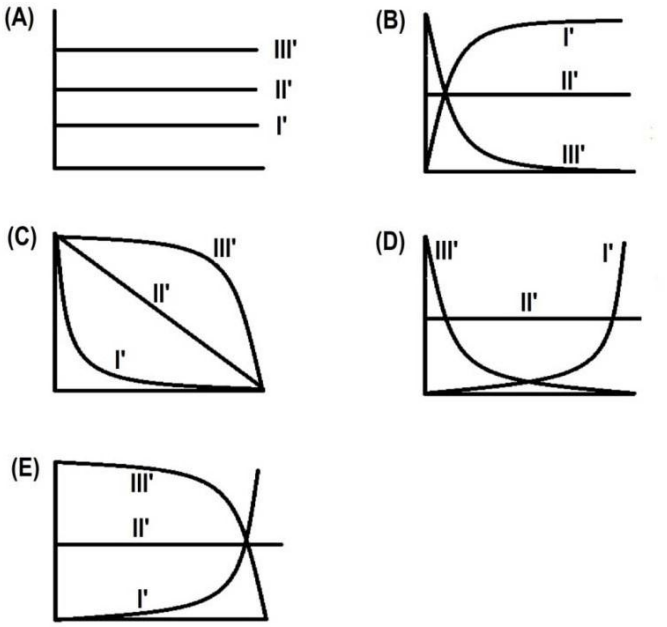
(C) 0.5%

(D) 1%

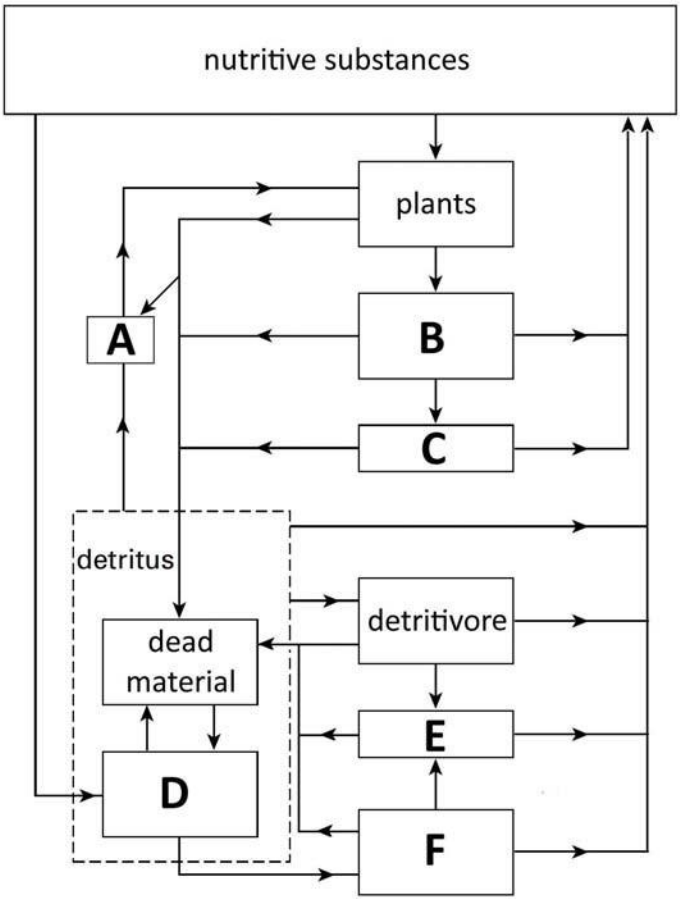
(E) 5%

B38. Biologists found that the threshold temperature for development of a mosquito species is 15℃. They also found that the product of (1) the number of days it takes to complete development, and (2) the difference between the temperature during development and threshold temperature, is a constant. That is, the result of multiplying (1) and (2) is a constant. It is known that this mosquito requires 15 days to complete development at 30℃. Given that May was unusually warm in India this year, with an average temperature of 40℃, how many days should it take this mosquito to complete development this May in India?

B39. Assuming human, a typical bird, and a typical fish species have Type I, II, and III survival curves (the vertical axis is survival rate, and horizontal axis is time) respectively, which of the following figures most accurately describes mortality curves (obtained by replacing survival rate with mortality rate) for these three groups of organisms (Type I', II' and III')?



B40. The figure below shows a nutrient cycle, and the six groups of organisms (A to F) involved in this cycle.



Which of the following descriptions are correct?

(A) C and F are carnivores.

(B) C and E are carnivores.

(C) A and B are herbivores.

(D) D includes bacteria and fungi.

(E) F includes bacterivores and fungivores.

B41. When comparing closely-related bird species, mortality of breeding individuals appears to be higher for species in temperate regions than in tropical regions. Therefore, predation risks to parents themselves, their young and eggs are given different priorities for species in different regions. In an experiment where specimen of three different predators (predator A, predator B, and predator C) were placed at close distances to the nests during the day in the breeding period, which of the following responses from the parents can be expected? Note that predator A are predators of the young and eggs, predator B are nocturnal predators, and predator C are diurnal predators of adult birds.

(A) The predator B specimen is more strongly avoided by the parents than the predator C specimen.

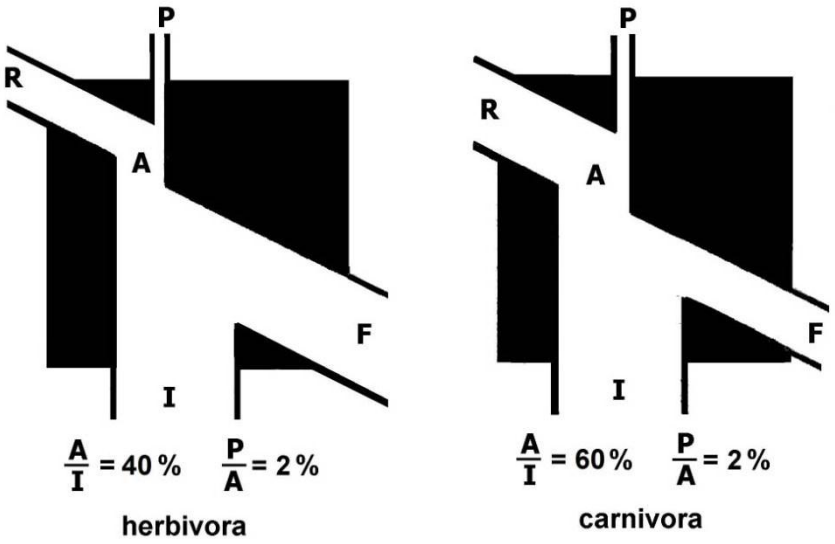
(B) With the predator A specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperate species.

(C) With the predator C specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperate species.

(D) With the predator C specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a greater degree than parents of temperate species.

(E) The degree to which the parents reduce their frequency of returning to the nests and feeding the young when predator specimen is present is not affected by the type of predators or the latitudes in which the species occurs.

B42. The figure below shows a scheme of the assimilation efficiency (A/I) and production efficiency (P/A) of two groups of mammals in a meadow ecosystem.



A = energy intake in blood after digestion
F = loss of energy through excretion and heat
I = energy present in ingested organic compounds
P = production
R = loss of energy through respiration and heat

Suppose I = 100 J

Which of the following descriptions are correct?

(A) Digestion of plant materials costs relatively less energy than digestion of animal materials.

(B) Plant materials that are reabsorbed have less organic contents than animal materials that are reabsorbed.

(C) R ranges between 40 and 60 J in carnivores.

(D) R ranges between 40 and 60 J in herbivores.

(E) R is lower in amphibians than in mammals.

B43. Some fungi form symbiotic associations with the roots of vascular plants, which are called mycorrhizae. In such associations, mycorrhizae help plants to absorb water, phosphate salt and other mineral nutrients. Depending on whether the fungus colonizes the roots extracellularly or intracellularly, mycorrhizae can be grouped into ectomycorrhizae or arbuscular mycorrhizae. Which of the following descriptions of mycorrhizae are correct?

(A) Seedlings with mycorrhizae grow more rapidly than seedlings without mycorrhizae in phosphorus-poor soils.

(B) Hyphae of arbuscular mycorrhizae fungi can penetrate the roots and cell membranes of the cortical cells to form symbiotic associations intracellularly.

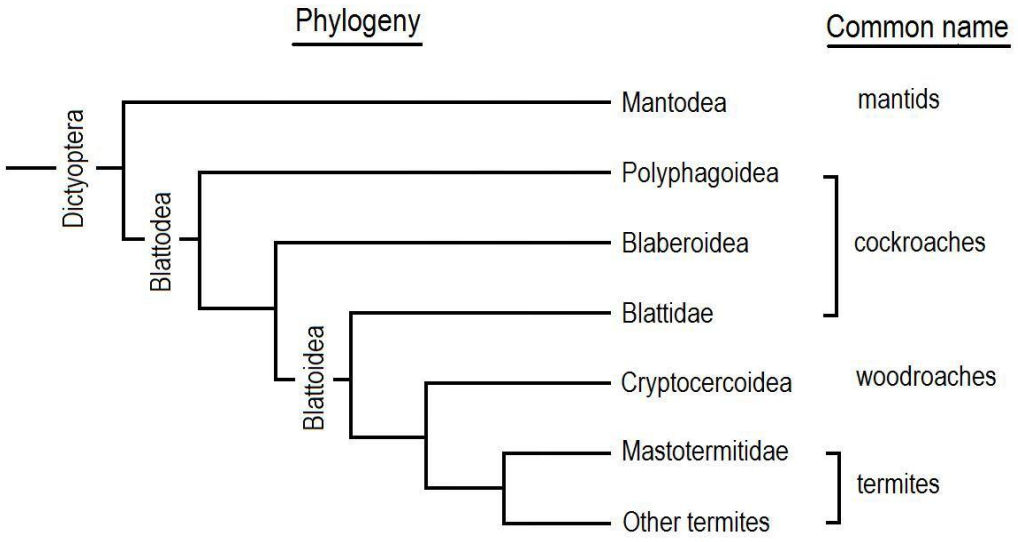
(C) Hyphae of ectomycorrhizae fungi can grow into the cortex of the roots, and form hyphal sheaths around the roots.

(D) Mycorrhizae have similar functions as root hairs of plants, and as a result, plants with both kinds of mycorrhizae have less-developed root hairs.

(E) Each mycorrhiza fungus forms symbiotic associations with the roots of specific plants.

VII. Biosystematics

B44. Eggleton et al (2007) studied the phylogeny of Dictyoptera, as shown below. According to the proposed phylogeny, determine whether the following statements are true (T) or false (F).



(A) Mantids' sister group is cockroaches.

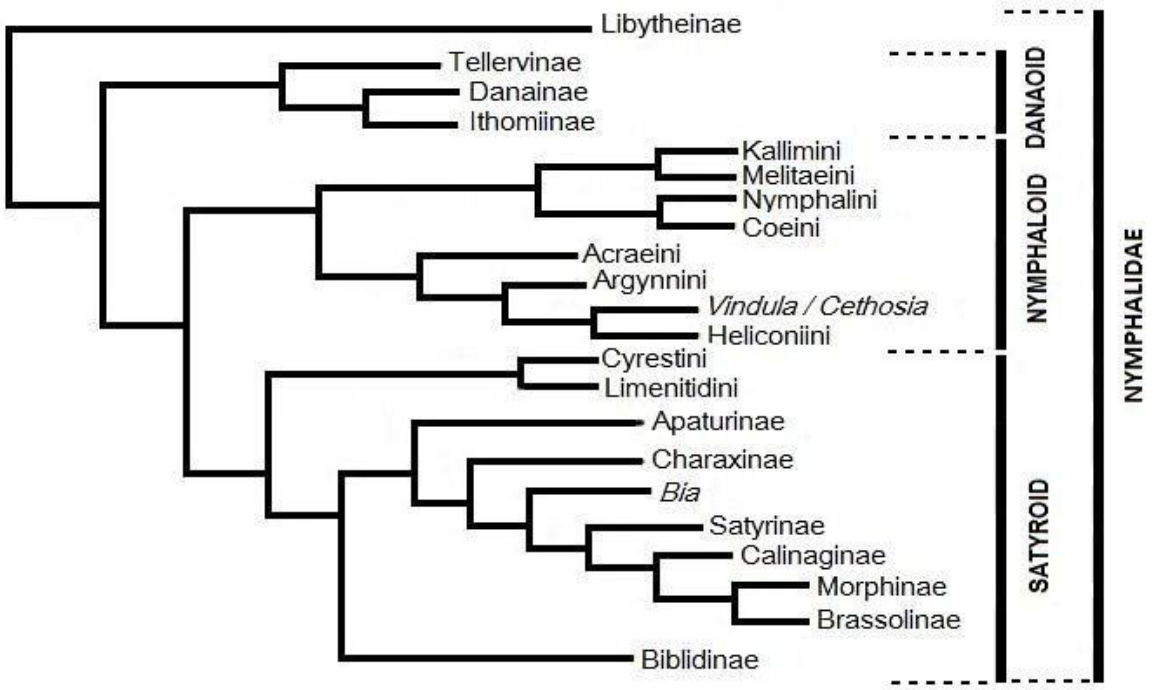
(B) Cockroaches form a paraphyletic group.

(C) Termites should be viewed as highly modified cockroaches.

(D) Mantids should be viewed as highly modified cockroaches.

(E) Termites evolved from mantids.

B45. Systematic positions of some butterflies such as satyrids (ringlets, etc.), nymphalids (frush foots, etc), and danaids (milkweed butterflies, etc.) were controversial. Some researchers regarded them as distinct families, while others disagreed. Recent studies supported the view to pool them into a single family Nymphalidae. Below is a phylogeny of these butterflies reconstructed by Freitas & Brown (2004), who supports this view. Answer the following questions based on this phylogeny.



Determine whether the following statements are true (T) or false (F).

(A) Danaoid butterflies may still be a distinct family according to Freitas & Brown's phylogeny if Nymphalidae is still allowed to divide into several families.

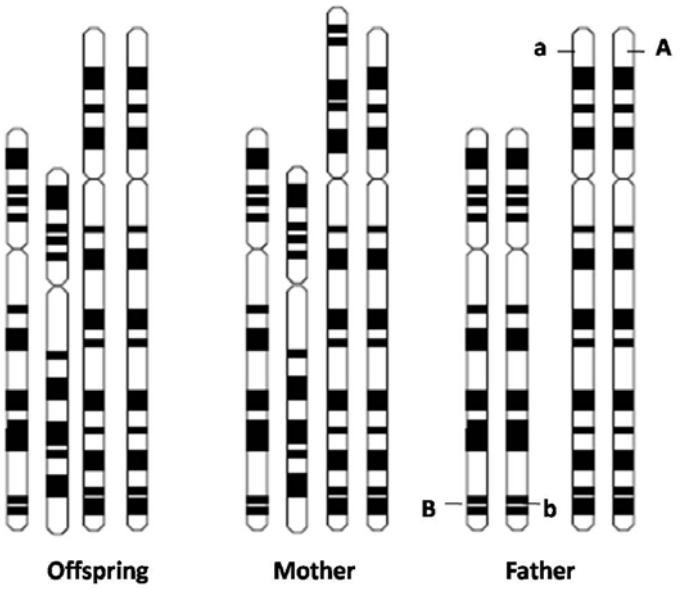
(B) Calinaginae butterflies resemble Danaoid butterflies in appearance, so they should be classified as Danaoid butterflies.

(C) If we want to define the family Nymphalidae to include Apaturinae, Satyrinae and Brassolinae have to be included as well.

(D) Danaoid butterflies may be considered as the ancestors of Nymphaloid + Satyroid.

VII. Genetics and Evolution (Part II)

B46. A hypothetical mammal possesses genes A and B, involved in embryonic development, on chromosomes 6 and 12 of its genome. Alleles A and B are functional whereas alleles a and b are non-functional. A breeding pair has been unable to produce viable offspring experiencing many miscarriages and still births. Karyotype analysis was performed on the breeding pair as well as an offspring that died at birth, showing that a balanced chromosome translocation within the mother's genome is responsible for this outcome. The diagram below shows chromosomes 6 and 12 for each of these individuals, the location of genes A and B are also shown on the father's chromosomes. The father is heterozygous for both gene loci, whilst the mother is homozygous. It is known that overdose or complete absence of the gene product of either gene A or B during development is lethal.



Assuming that no other genes in the affected regions of chromosome 6 and 12 have an effect on development, answer the following questions.

B46.1. Which of the following are possible genotype/s of the offspring shown for A and B?

(A) AAa, b

(B) AAA,Bb

(C) AAA, B

(D) a, BBb

(E) A, BBB

(F) A, BBb

B46.2. What is the probability (as a fraction) that a fertilized zygote produced by these parents will possess three functional copies of allele *B*?

B47. A study has determined that 13.3% of men in a given population are short-sighted for a genetic reason (single gene mutation). 55% of these men also have a short-sighted father.

B47.1. Mark the correct mode of inheritance for the short-sightedness.

(A) autosomal dominant

(B) autosomal recessive

(C) X-chromosomal dominant

(D) X-chromosomal recessive

(E) mitochondrial

B47.2. Based on the conditions of the Hardy-Weinberg equilibrium, what is the frequency of the allele for short-sightedness? Write your answer on the answer sheet.

B48. In *Drosophila* an autosomal transformer allele can be observed. If present, the transformer allele brings about a male appearance if an animal has two X-chromosomes, but such animals are sterile as their testes are underdeveloped. In *Drosophila* the red and white eye color is determined by a gene on an X-chromosome.

A cross is performed between a red eyed *Drosophila* female heterozygous for both loci and a white eyed *Drosophila* male heterozygous for transformer. They produce a large number of offspring. What fraction of their offspring looks like white eyed males?

B49. Two enzymes X and Y form a biochemical pathway that converts substance A into substance C via an intermediate substance B. In order to infer on which human chromosomes genes X_h and Y_h are located, Mr. Lin generated mouse/human hybrid cell lines. These cell lines contain all mouse chromosomes and a few human chromosomes, as shown in Table 1. Prior to the

experiment, a non-sense mutation was induced at the beginning of the mouse gene Y_m. Mr. Lin used specific antibodies to test if human enzyme X_h is produced in each cell line (Table 2). In addition, Mr. Lin added substance A to the cell cultures and, after some time, used colorimetric assays to determine which of the substances A, B or C is present (Table 2). On which human chromosome is Gene Y_h located? Write down the appropriate chromosome number on the answer sheet.

Table 1

	Human Chromosomes							
Cell line	1	2	3	4	5	6	7	8
a	+	-	+	-	+	+	-	-
b	+	+	-	-	-	-	-	+
c	+	+	-	+	+	-	+	+
d	-	+	+	+	-	+	-	+

Table 2

Cell line	Production of X_h	Substance present
a	+	C
b	-	B
c	-	C
d	+	B

B50. Ernst Mayr defined biological species as “groups of actually or potentially interbreeding natural populations that are isolated from other such groups by one or more mechanisms of reproductive isolation”. For which of the following organism couplets is the observation provided sufficient to call them distinct biological species?

(A) Two populations are fixed for competing alleles in the wild. But heterozygous individuals can be produced in laboratory setting.

(B) No mating can be found between Dalmatian and Chihuahua dogs as their body sizes differ dramatically.

(C) Females of two firefly species each only respond to the light signal issued by their conspecific males.

(D) A male and a female moth sample caged in a box failed to mate and lay eggs.

(E) Two individuals of stag beetles with prominent difference in mandible morphology employ the same of sex pheromones.

(4) Answer key

Theoretical Test Part A

NO.	A	B	C	D	E	F	NO.	A	B	C	D	E	F	NO.	A	B	C	D	E	F
A1				**X**			**A21**					**X**		**A41**				**X**		
A2	**X**						**A22**			**X**				**A42**		**X**				
A3			**X**				**A23**	**X**						**A43**					**X**	
A4		**X**					**A24**					**X**		**A44**			**X**			
A5						**X**	**A25**			**X**				**A45**	**X**					
A6			**X**				**A26**			**X**				**A46**			**X**			
A7			**X**				**A27**			**X**				**A47**				**X**		
A8		**X**					**A28**					**X**		**A48**				**X**		
A9	**X**						**A29**			**X**				**A49**			**X**			
A10		**X**					**A30**		**X**					**A50**				**X**		
A11			**X**				**A31**	**X**						**A51**				**X**		
A12					**X**		**A32**				**X**			**A52**		**X**				
A13		**X**					**A33**	**X**						**A53**			**X**			
A14		**X**					**A34**		**X**					**A54**				**X**		
A15					**X**		**A35**			**X**				**A55**					**X**	
A16			**X**				**A36**				**X**			**A56**		**X**				
A17				**X**			**A37**					**X**		**A57**		**X**				
A18			**X**				**A38**	**X**						**A58**				**X**		
A19	**X**						**A39**		**X**											
A20				**X**			**A40**				**X**									

Theoretical Test Part B

(Mark the correct answers with "O" and incorrect answers with "--" on the Answer Sheet clearly. 0.3, 0.5, or 0.6 points per cell, depending on the number of cells for the answer of each question)

NO.	A	B	C	D	E	F	G	P	Q	R	S	T
B1	**O**	**--**	**--**	**O**	**O**	**--**						
B2	**--**	**O**	**O**	**--**	**--**			**--**	**O**	**--**	**O**	**--**
B3	**--**	**O**	**--**	**O**	**O**							

B4 (Fill in the correct set of answers. 0.6 points per cell)

A	B	C	D	E
5	**2**	**5**	**8**	**7**

(Mark the correct answers with "O" and incorrect answers with "--" on the Answer Sheet clearly. 0.5, or 0.6 points per cell, depending on the number of cells for the answer of each question)

No	A	B	C	D	E	F
B5	**O**	**--**	**O**	**O**	**--**	
B6	**O**	**O**	**O**	**--**	**--**	**--**
B7	**--**	**--**	**O**	**--**	**O**	**O**
B8	**--**	**O**	**--**	**O**	**--**	**O**
B9 (deleted)						
B10	**--**	**O**	**--**	**O**	**O**	
B11	**O**	**O**	**--**	**O**	**--**	
B12	**O**	**--**	**--**	**--**	**O**	
B13	**--**	**O**	**--**	**--**	**O**	**O**
B14.	**--**	**O**	**--**	**--**	**O**	
B15	**--**	**--**	**--**	**O**	**O**	
B16	**O**	**O**	**O**	**--**	**--**	
B17	**O**	**O**	**--**	**--**	**O**	

B18	**O**	**O**	**--**	**--**	**O**	

B19 (Fill in the correct set of answers. 0.6 points per cell)

Function code	Structure code (I ~ V)
a.	**II**
b.	**V**
c.	**I**
d.	**III**
e.	**IV**

B20 (Indicate the correct set of answers. 0.375 points for each correct matching)

	I	II	III	IV	V	VI	VII	VIII
Letter	**b**	**a**	**e**	**h**	**f**	**g**	**d**	**c**
Number	**7**	**4**	**3**	**1**	**5**	**8**	**6**	**2**

B21 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points per cell)

A	B	C	D	E
O	**O**	**O**	**--**	**O**

B22 (Fill in the correct answers. 0.6 points per cell)

Structure/hormone	Answer
α cells of the pancreatic islets	**b**
Insulin	**c**
Liver	**e**
Adrenal medulla	**g**
Cortisol	**h**

B23 (Fill in the correct answers. 0.6 points per cell)

Structure/hormone	Answer
Sertoli cells	**e**
Anterior pituitary	**b**
Gonadotropin releasing hormone	**a**
FSH	**c**
Inhibin	**g**

B24 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.5 points per cell)

a	**c**	**d**	**e**	**f**	**h**
--	**--**	**--**	**--**	**--**	**O**

B25 (Fill in the correct answer. 0.6 points per cell)

Mechanism	**Figure number**
Blocking of step A	**I**
Facilitation of step B	**IV**
Blocking of step C	**I**
Facilitation of step D	**V**
Blocking of step E	**III**

B26 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points for each correct matching)

Mechanism	Answer
Blocking of step A	--
Enhancement of step B	O
Blocking of step C	--
Enhancement of step D	--
Blocking of step E	O

B27 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points per cell)

Statement	Answer
a. D remain the same distance apart	--
b. A move closer to the ends of the B	O
c. C become shorter	O
d. B become wider	--
e. D lines move closer to the end of the B	--

B28 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points per cell)

A	B	C	D	E
O	--	--	--	O

B29 (3 points)

6 : 00

(Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points per cell)

No.	A	B	C	D	E	F
B30	--	--	--	O	--	
B31	--	O	--	O	O	
B32	O	O	--	--	O	--

(Fill in the correct answers. 0.75 points per cell)

B33.1.	**QqRr**
B33.2.	**192**
B33.3.	**0.6**
B33.4.	**8%**

B34 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.5 points per cell)

A	B	C	D	E
--	--	**O**	**O**	--

B35a-c. problem set. (Fill in the correct answers. 1 point per question, 3 points total)

B35a I+III

B35b A, D, E

B35c C

(Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points per cell)

No.	A	B	C	D	E
B36	--	**O**	**O**	--	--
B37	--	--	**O**	--	--

B38 (3 points)

9 **days**

(Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.6 points per cell)

No.	A	B	C	D	E
B39	--	--	--	**O**	--
B40	--	**O**	--	**O**	**O**
B41	--	**O**	--	**O**	--
B42	--	--	**O**	--	**O**
B43	**O**	--	**O**	--	**O**

B44 (Indicate true (T) or false (F). 0.6 points for each correct matching)

A	B	C	D	E
F	**T**	**T**	**F**	**F**

B45 (Indicate true (T) or false (F). 0.75 points for each correct matching)

A	B	C	D
T	**F**	**T**	**F**

B46.1 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.25 points per cell)

A	B	C	D	E	F
O	**--**	**O**	**--**	**--**	**--**

B46 .2 (Fill in the correct answer. 1.5 points)

1/8

B47.1 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.3 points per cell)

A	B	C	D	E
O	**--**	**--**	**--**	**--**

B47.2 (Fill in the correct answer, 1.5 points)

0.069

B48 (Fill in the correct answer. 3 points)

5/16

B49 (Fill in the correct answer. 3 points)

Chromosome 5

B50 (Mark the correct answers with" O" and incorrect answers with "--" on the Answer Sheet clearly. 0.5 points per cell)

A	B	C	D	E
--	--	**O**	--	--

J. Subgroup Meeting

Date: 2011.07.07~2011.07.09

Location: Evergreen Laurel Hotel (Keelung) 5F

Member:

Title	Country	Name
Mr.	Australia	Mary Colette Oliver
Mr.	Germany	Dennis Kappei
Dr.	Germany	Alexander Friedmann
Dr.	Germany	Olga Waksmann
Dr.	India	Anindya Sinha
Dr.	Netherland	Hans Morelis
Prof.	Russia	Alexander M. Rubtsov
Dr.	Singapore	Shirley Lim
Dr.	Thailand	Poonpipope Kasemsap

IBO2011 Science Committee

Title	Name
Prof.	Being-Sun Wung
Prof.	Chiang-Ting Chie
Prof.	Guan-Chiun Lee
Prof.	Guey-Jen Lee
Prof.	Hsiu-Mei Hsieh
Prof.	Hung-Hung Sung
Prof.	Jenn-Che Wang (Chairperson)
Prof.	Kwok-Tung Lu (Co-chairperson)
Prof.	Ling-Ling Lee
Prof.	Ling-Long Huang
Prof.	Li-Yih Lin
Prof.	Ming-Hsiun Hsieh
Prof.	Shyh-Hwang Chen
Prof.	Yee-Yung Charng
Prof.	Ying Wang
Prof.	Yu-Chie Wang
Prof.	Yu-Feng Hsu

Daily Schedule:

July 7th

Time	Event
06:00-09:00	Breakfast
09:00-12:00	Subgroup Meeting (Practical Test)
12:00-14:00	Lunch
14:00-18:00	Subgroup Meeting (Practical Test)
18:00-20:00	Welcome Banquet

July 8th

Time	Event
06:00-09:00	Breakfast
09:00-12:00	Subgroup Meeting (Practical Test)
12:00-14:00	Lunch
14:00-17:00	Subgroup Meeting (Theoretical Test)
17:00-19:00	Dinner
19:00-22:00	Subgroup Meeting (Theoretical Test)

July 9th

Time	Event
06:00-09:00	Breakfast
09:00-12:00	Subgroup Meeting (Theoretical Test)
12:00-14:00	Lunch
14:00-17:00	Subgroup Meeting (Theoretical Test)
17:00-19:00	Farewell Banquet
19:00-22:00	Subgroup Meeting (Theoretical Test)

K. Examination Final Score

Raw Score

country	name	Prac 1	Prac 2	Prac 3	Prac 4	Theo A	Theo B
Argentina	JAVIER CARLOS VILLARRAZA	21.5	77	14.1	29	62	82.75
Argentina	RAMIRO ARRECHEA ANTELO	37.5	88	18.9	16.5	50	87.95
Argentina	CRISTIAN CARLOS GONZALEZ	46	64	59.35	50	62	96.9
Argentina	MATIAS FRANCISCO LEDESMA GONZALEZ	19.5	85	14.2	39	58	88.05
Armenia	Vardges Tserunyan	35	59	24.3	28	70	97.825
Armenia	Shushan Toneyan	30	42	14.6	32.5	56	88.25
Armenia	Lusine Hovhannisyan	47	36	41.2	15	78	85.475
Armenia	Robert Yeghikyan	36.5	64	11.45	22	62	92.65
Australia	Callum Thomas Gray	54.5	82	59.5	28.5	68	99.45
Australia	Nathan Howard Isaacson	63	78	39.8	34	66	111.5
Australia	Darcy Robert Gray	68	81	65.9	49	80	109
Australia	Phillip Timothy O'Riordan	62.5	64	67.55	34.5	78	111.325
Azerbaijan	Sadig Niftullayev	16	51	21.55	35	82	100.4
Azerbaijan	Tamerlan Bayramov	21.5	72	8.95	16.5	36	63.15
Azerbaijan	Kamran Kerimov	20	73	22.4	19	46	60.55
Azerbaijan	Bakhtiyar Taghizada	25	57	40.6	34.5	68	89.8
Belgium	Jan Hendrik Achiel Brijs	44	60	41.85	25	56	82.2

Belgium	Michel Philippe Pascal Pirre Reginster	42.5	65	44.4	32	48	74.9
Belgium	Frédéric Jean Pierre Francis Clarembeau	41.5	68	42.25	33.5	70	87.775
Belgium	Julien Gerard Charles Mortier	52	44	44.15	29.5	60	77.35
Belarus	ULADZIMIR VALENTINOVICH HRYNEVICH	39	54	25.4	21	90	107.1
Belarus	VOLHA YURIEVNA IVANOVA	28	73	33.65	38	52	87.8
Belarus	RAMAN VALERIEVICH PIARESKA	42	74	28.9	31	70	92.075
Belarus	YULIYA VALERIEVNA ZAITSAVA	27	31	22.2	26.5	76	78.85
Brazil	Mattheus José Medeiros Fernandes	9.5	59	8.95	21	72	85.975
Brazil	Pablo Ivo Borges Ferreira	22	52	21.55	17	60	68.95
Brazil	Rafaell DA SILVA LIMA	32	59	34.7	46	80	102.575
Brazil	PEDRO BARBOSA OLIVEIRA	31	51	33	28	86	99.55
Bulgaria	Petar Iliyanov Iliev	25	50	30.1	29	76	94.25
Bulgaria	Georgi Dimitrov Magaranov	30	78	30.25	13.5	78	103.65
Bulgaria	Elizar Mariyanov Tsvetkov	43.5	84	28.3	29.5	72	91.65
Bulgaria	Mira Lyudmilova Nencheva	54	83	31.25	34	94	112.375
Canada	Wei Chan XIANG	48	71	61.8	27	72	112.95
Canada	Jia Cheng LUO	39	59	50.3	23.5	64	93.15
Canada	Sean Alexander RIDOUT	59.5	69	61.95	25	92	126.05
Canada	Moustafa Mohamed Saad Atia ABDALLA	53	64	70.1	31	82	106.9
China	Zidong Zhang	93	83	66.95	44	102	116.05

China	Yao Xiao	69	85	67.1	32	102	120.2
China	Kemeng Wu	49	78	65.55	56.5	96	125.6
China	Jin Yang	45	78	57.8	47	86	121.65
Cyprus	Evdokia Ttooulou	23.5	13	23.95	11	48	73.725
Cyprus	Elina Eleni Tringou	36	12	18.35	3	38	70.85
Cyprus	Andreas Matthaiou	23	22	34.6	17.5	44	75.025
Cyprus	Andreas Petrou	32	55	9.4	24	52	68.1
Czech Republic	Kateřina Medková	35.5	56	47.1	32	88	105.5
Czech Republic	Karel Kodejš	53	87	70.7	33	76	96.3
Czech Republic	Václav Nuc	32.5	80	59.05	35	62	99.95
Czech Republic	Lenka Ćurnová	38	80	56.6	37	70	101.725
Denmark	Monica Aimee Harlund Oyre	25.5	59	49.55	34	66	82.3
Denmark	Johan May Nitschke	46.5	67	37.3	43	64	102.1
Denmark	Liane Dupont	44.5	65	33.6	20	64	88.975
Denmark	Lea Lybek Rueløkke	42	53	41.55	35	68	93.25
Spain	ALVARO GABALDON BADIOLA	69	46	49.7	32.5	70	99.3
Spain	Pablo Ricardo Hernández Malmierca	58	61	61.6	38.5	68	95
Spain	DIANA ESTELLER GAUXAX	30.5	66	36.9	32	70	84.35
Spain	AITOR LOPEZ GONZALEZ	63	41	71.25	34	68	90.85
Estonia	Uku-Laur Tali	65	66	64.55	43	88	105.25

Estonia	Erik Tamre	76	59	70.65	39	68	104.7
Estonia	Anu Ainsaar	67	76	42.05	41	82	107.95
Estonia	Ando Vaan	36	64	22.2	22	80	92.7
Finland	Mikaela Maria Mutru	62	72	72	38	72	108.725
Finland	Joni Sampsa Olavi Ollonen	39	56	58.6	20	78	93.525
Finland	Laura Johanna Poso	28.5	49	18.15	20.5	46	78.4
Finland	Tinja Maria Suvi-Tuulia Toikka	66	55	65.8	19.5	70	101.075
United Kingdom	Patrick Louis Frederick Perryman-Owens	49.5	79	61.35	64	82	121.6
United Kingdom	Andre Jean Zylstra	55.5	83	40.15	26	84	106.55
United Kingdom	Vasanth Sritharan	57.5	48	41.3	26	92	104.55
United Kingdom	Holly Anne Rees	51	78	54.85	35.5	80	106.3
Georgia	Nia Khachapuridze	30	42	34.9	15	40	71.675
Georgia	Bela Nishnianidze	25.5	17	15.45	10	44	72.4
Georgia	Ana Gzirishvili	14	62	12.3	17	36	67.25
Georgia	Lado Niauri	10	60	9.85	19	34	68.375
Germany	David Sebastian Fischer	71	76	80.15	35	96	112
Germany	Franziska Maria Feller	69	56	53.55	28	84	100.85
Germany	Tim Ulf Hutschenreiter	52.5	74	59.85	42	80	114.15
Germany	Roderich Römhild	63	47	52.15	40	78	105.75
Greece	DAINORA ČEPAITYTE	24	59	14.25	16	62	75.9

Greece	ELENI TEREZAKI	47	64	28.85	28	72	89.325
Greece	GEORGIOS AGORANOS	30	12	9.2	15.5	58	96.175
Greece	ALEXIOS VOURVOUKELIS	31	53	31.85	18	60	87.2
Hungary	Bálint REHŌ	73	91	61.85	39	72	100.6
Hungary	Marton SZENTIRMAI	56	61	65.35	28.5	96	121.4
Hungary	Máté NÁSZAI	61	92	74.1	51	82	122.65
Hungary	Fatime HAWCHAR	20	92	58.8	36	76	103.05
Indonesia	Thoriq Salafi	64.5	83	46.45	42	82	111.2
Indonesia	Husni Muarif	51.5	79	65.3	27	66	98.025
Indonesia	Marsha Christanvia Wibowo	58	67	73	65	82	111.15
Indonesia	Afandi Charles	54.5	70	43.55	37	90	108.475
India	Saloni Kapoor	49	46	43.75	45.5	90	111.5
India	Pritish Laxmikant Patil	66	76	68.7	31.5	90	105.5
India	Sanchit Kumar	60	72	32.4	54.5	82	118.4
India	Twinkle Tushar Parekh	75	63	66.7	33	98	118.05
Iran	Ali Vafaei	53	53	52.95	30.5	82	104.15
Iran	Mehrdad Goshayeshi avval	57	83	42.4	37	76	107.75
Iran	Mahsima Shabani	62	77	71.8	35	86	128.35
Iran	Ahmad Vafaeian	52	64	54.65	37	86	119.675
Italy	ALESSIO CAPOBIANCO	47	52	78.5	36	82	99.6

Italy	DANIELE CERVETTINI	74.5	85	61.45	33	88	107.6
Italy	MARTINA CHIRIACO'	62	59	66.2	33.5	84	109.65
Italy	LUCA BIAVATI	68	88	50.2	19.5	80	112.025
Japan	HIDEAKI KUME	80	77	81.5	56	94	121.65
Japan	TOMOYUKI MIKAMI	38	81	66.65	22	94	112.875
Japan	YUTA OTSUKA	83	87	68.65	84	94	113.925
Japan	HIROKI MATSUDA	85	73	79.65	52	88	116.325
Kazakhstan	Zhassulan Shaikhygali	62	58	46.6	32	84	116.85
Kazakhstan	Yernar Tursynbay	66.5	69	37.9	14.5	80	106.55
Kazakhstan	Baizak Kudaibergenov	37	41	35.45	17	76	86.4
Kazakhstan	Altynay Narmanova	31	86	7.35	37	84	98.775
Kyrgyzstan	MYRZABEK ALIBAEV	42	78	52.95	12	66	97.9
Kyrgyzstan	ERBOL MOLDOZHUNUSOV	20	25	25.3	31	56	83.05
Kyrgyzstan	ELDOS MUKASHOV	5	28	18.25	17	30	73.3
Kyrgyzstan	SANZHAR ISAKUNOV	21	32	27.95	15.5	70	74.875
Korea	Seung Min Kwak	69	75	79.15	46	106	130.6
Korea	Yeo Jin YOO	82.5	65	45.1	39	100	118.45
Korea	Myeong hwan Son	57	92	72.55	39	104	121.9
Korea	Ji Young SONG	64	73	52.95	31	98	121.6
Kuwait	SALEH HABIB HAIDAR	13	58	15.45	16	24	67

Kuwait	SARAH YOUSEF ALMAJID	14.5	15	18.35	21.5	22	60.9
Kuwait	EELAF AHMAD HUSAIN	16	23	24	21	20	54.9
Kuwait	DALAL SAEED ALQALLAF	2	33	11.9	17	26	57.75
Latvia	Rūta Talla	20	75	21.6	34	56	82.2
Latvia	Anete Romanauska	47	51	37.8	35	74	93.675
Latvia	Kārlis Jermacāns	27	75	20	20	56	80.35
Latvia	Anna Stikāne	53	80	44.25	33	72	94.15
Liechtenstein	Donat APPERT	46	68	22.6	15	64	89.475
Lithuania	Irmantas Mogila	65	79	59.85	40	82	112.2
Lithuania	Emilija Emma	48.5	75	56.65	32	84	106.1
Lithuania	Gabija Lazaravičiūtė	56	28	59.1	31	72	103.35
Lithuania	Miglė Mikutėnaitė	29	90	23.55	32.5	60	91.4
Moldova	Bivol Sergiu	20	23	13.35	23	54	82.4
Moldova	Solovei Valeria	43	52	40.3	10.5	72	84.1
Moldova	Saragov Diana	2	20	18.4	15	36	55.8
Moldova	Caraiman Vladlena	15	22	14.3	9.5	40	50.3
Mexico	José de Jesús Naveja	58	84	61.65	48	90	114.05
Mexico	Melissa Calzada	24.5	80	40.3	21.5	66	88.15
Mexico	Martín López	35.5	84	29.95	21	60	98.325
Mexico	Alejandro Rodríguez	17	75	31	28	56	80.45

Mongolia	Javzanpagma Tsogbadrakh	16.5	54	28.2	28	38	55.45
Mongolia	Mashbayar Sukhbat	25	59	21.55	35	36	64.5
Mongolia	Munkhzul Tsogtsaikhan	30	35	19.25	24	46	70.525
Mongolia	Dolgormaa Bataa	30	67	18.1	23	54	68.925
Netherlands	Johannes Cornelis Jacobus Mertens	54	74	65.65	45.5	70	108.2
Netherlands	Stephen Robert Skocpol	59	49	51.8	28.5	78	98.925
Netherlands	Dirk Christiaan Jungerius	62	46	57.55	32	84	111.85
Netherlands	Frank Poort	41.5	64	36.6	41.5	60	101.975
Nigeria	Opeoluwa Samuel Adewale	20	21	23.95	15.5	58	78.65
Nigeria	Goo'sPower Toyin Oboli	27	24	36.35	12	72	94
Nigeria	Ikponmwosa Jesuferanmi Igbinigie	8	28	8.95	23.5	44	79.6
Nigeria	Victor Ojonugwa Igono	21	12	34.1	14.5	70	84
New Zealand	Vicky Wei-Chi Tai	43	33	58.4	10	76	101.6
New Zealand	Richard Yu-Cheng Chou	78	69	42.2	30	64	99.5
New Zealand	Benjamin Yu Hang Bai	49	69	66	42	78	119.45
New Zealand	Yujie Zhou	82	81	57.7	43.5	100	116.85
Pakistan	Saneeha Shahid	44	62	60.2	13	76	109.1
Pakistan	Numra Abdul Aleem	53	68	44.35	15	76	101.65
Pakistan	Urooj Imdad Memon	45	68	55.95	17	68	105.75
Pakistan	Armaghan-e-Rehman Mansoor	62	51	57	29	90	95.3

Poland	SYLWIA NATALIA GAJDA	60	48	44.95	34.5	94	102.95
Poland	PRZEMYSŁAW ANDRZEJ PĘKALA	50	69	29.2	19	82	100.025
Poland	KAROLINA TROCKA	62	85	59.25	33	98	115.7
Poland	ALICJA MONIKA KREJNER	31	77	23.4	38.5	80	105.35
Romania	ROXANA GABRIELA SANDU	10	82	15.55	33.5	56	95.1
Romania	VICTOR SERBAN	55	98	33.35	40	90	113.95
Romania	MIHAELA MADALINA TARTALEA	53	83	21.4	31	52	94.5
Romania	TEODORA GHEORGHE	51	83	40.5	32.5	86	121.95
Russia	Ivan I. Istomin	58	66	29.65	33	84	107.8
Russia	Tatiana S. Filatova	41	74	46	36	82	111.35
Russia	Anastasia D. Tsvetkova	73	83	65.8	25	104	112.2
Russia	Mark R. Sanevich	70	69	47	21	82	105.175
Singapore	Chentian Jin	87	35	79.35	58	106	124.45
Singapore	Xinyuan Hong	66	56	69.4	38	108	124.8
Singapore	Zhen Wei, Michael Sia	35	78	81	21.5	76	124.95
Singapore	Javan Tze Han Lee	84	80	53	61	102	114.8
Slovenia	Domen Kampjut	53	86	59.4	19	82	104.775
Slovenia	Rebeka Jereb	61.5	70	46.95	19	64	88.4
Slovenia	Jure Črepinšek	33	75	36.6	20	68	85.87
Slovenia	Eva Slapnik	31	66	24.85	29.5	62	91.55

Sri Lanka	Heennilame Shehan Umeda Ratnayake	30	51	31.5	30	64	75.35
Sri Lanka	Nimeshika Chathurangi Mahaarachchi	36	23	14.55	13	58	76.95
Sri Lanka	Hiruni Kaumadee Gajanayake	33	53	35.9	19	78	92.7
Sri Lanka	Arun Rajaratnam	54	84	59.25	38	100	110.7
Switzerland	Andreas ZINGG	41	25	18.75	41	78	93.875
Switzerland	Jacqueline Caroline MOCK	46	72	45.7	44	84	105.15
Switzerland	Daniel BALLMER	42	67	61.35	47.5	80	97.5
Switzerland	Gaétan Colussi	61	84	70.7	56.5	96	117.9
Slovak Republic	Jaroslav Ferenc	33	71	54.45	30.5	72	82.6
Slovak Republic	Mária Mrázová	57	69	10.25	22	78	91.9
Slovak Republic	Alžbeta Harárová	40	34	34	25	76	104.15
Slovak Republic	Slavomira Heželyová	42.5	51	17.9	20	46	77.45
Sweden	Johan Arvid Hagelberg	51	67	44.6	25	68	97.8
Sweden	Isak Gunnar Ilian Häggmark	52.5	61	49.9	42	70	98.275
Sweden	Torkel Enok Loman	57	34	58.2	38	80	104.55
Sweden	Hanna Lovisa Elvira Borsiin	40.5	60	40.9	23.5	62	105.85
Thailand	Natthawut Adulyanukosol	39.5	87	70.8	50	102	118.05
Thailand	Kanat Chanthongdee	66	54	59.95	54	80	111.8
Thailand	Supassorn Armornmaneerat	56	91	70.7	48	92	125.65
Thailand	Aschariya Wipattanakitcharoen	72	89	58.85	49.5	92	111.65

Tajikistan	Manizhabonui Mirzoolimzoda	8	21	20.9	20	32	72.3
Tajikistan	Dilnoza Kamoliddinova	7	53	9.2	11	24	65.1
Tajikistan	Farzonai Muzaffar	22	73	20.4	28.5	66	85.45
Tajikistan	Zilola Zaripova	15	19	13.35	7	42	53.375
Turkmenistan	SAZAK ATAYEV	32	59	50	32	74	111.85
Turkmenistan	AZADY PIRHANOV	51	48	42.7	35	88	99.55
Turkmenistan	ABDYRAHYM ATASHEV	12	56	10.2	11.5	32	65
Turkmenistan	NEDIR ATAGELDIYEV	28	44	38.05	39	82	102.475
Turkey	DENIZ ARAL OZBEK	36	75	22.2	31	96	106.85
Turkey	IPEK AKCABELEN	35	63	55.1	40.5	78	97.3
Turkey	IZZET ALTUN	46	96	40.2	39	86	113.65
Turkey	UTKU GORKEM ERDOGAN	39	63	22.25	30	88	105.05
Chinese Taipei, Taiwan	Je-Rui Chang	44	90	73.2	81	110	130.85
Chinese Taipei, Taiwan	Yu-Hung Tung	74	88	81.8	51.5	102	128.5
Chinese Taipei, Taiwan	Yu-Min Lin	35	85	85.5	57	100	129.675
Chinese Taipei, Taiwan	Hsiao-Hung Lu	79	91	41.2	52	96	124.05
United Arab Emirates	Abdul Rahman Yaaqoub M. Aljaberi Aljaberi	5	61	49.55	28	32	65.225
United Arab Emirates	Saif Yousuf Haj Abdulla Gharib Alhammadi	0	16	26.4	24	26	64.9
Ukraine	Andriy Volkov	54	34	36.9	43.5	90	106.25
Ukraine	Alona Goncharuk	25	72	29.35	31.5	78	80.35

Ukraine	Valeriya Sapozhnikova	52	84	47.25	43	88	111.225
Ukraine	Dariia Shyriaieva	51	85	53.05	44.5	84	103.9
United States of America	Rebecca Doris Shi	86	87	80.6	75	102	127.55
United States of America	Shulin Ye	68	82	67.95	81	98	120.25
United States of America	Chelsea Sierra Voss	90	86	86.3	61.5	96	126.95
United States of America	Charles Huanghong Du	79	87	85.35	57	102	131.45
Vietnam	NGUYEN TRUNG KIEN	37.5	75	32.95	20.5	84	110
Vietnam	DANG THU TRANG	35	33	28.7	13	84	100.625
Vietnam	TRUONG THI PHUONG THAO	48	62	33.9	22	84	106.6
Vietnam	NGUYEN THU TRANG	43	72	25.55	31	86	102.75

T –Score：gold medals:1-24, silver medals:25-71, bronze medals:72-139

country	name	P 1	P 2	P 3	P 4	Pr	Th A	Th B	Th	Final Score	Rank
United States of America	Rebecca Doris Shi	70.8	61.908	68.32	81.381	70.602	65.009	66.357	65.818	136.42	1
Chinese Taipei, Taiwan	Je-Rui Chang	49.63	63.391	64.676	85.735	65.858	69.17	68.192	68.583	134.441	2
United States of America	Charles Huanghong Du	67.272	61.908	70.659	68.321	67.04	65.009	68.525	67.119	134.159	3
United States of America	Chelsea Sierra Voss	72.817	61.413	71.127	71.586	69.236	61.889	66.023	64.37	133.605	4
Chinese Taipei, Taiwan	Yu-Hung Tung	64.752	62.402	68.911	64.33	65.099	65.009	66.885	66.135	131.234	5
Japan	YUTA OTSUKA	69.288	61.908	62.435	87.912	70.386	60.849	58.782	59.609	129.995	6
United States of America	Shulin Ye	61.728	59.436	62.091	85.735	67.247	62.929	62.298	62.551	129.798	7
Korea	Seung Min Kwak	62.232	55.975	67.606	60.339	61.538	67.09	68.053	67.667	129.205	8
Japan	HIDEAKI KUME	67.776	56.964	68.763	67.595	65.274	60.849	63.077	62.186	127.46	9
Chinese Taipei, Taiwan	Yu-Min Lin	45.094	60.919	70.733	68.321	61.267	63.969	67.538	66.111	127.377	10
Singapore	Chentian Jin	71.304	36.197	67.705	69.046	61.063	67.09	64.633	65.616	126.679	11
China	Zidong Zhang	74.329	59.93	61.598	58.888	63.686	65.009	59.963	61.982	125.668	12
Singapore	Javan Tze Han Lee	69.792	58.447	54.729	71.223	63.548	65.009	59.268	61.565	125.112	13
Chinese Taipei, Taiwan	Hsiao-Hung Lu	67.272	63.886	48.918	64.693	61.192	61.889	64.411	63.402	124.594	14
Korea	Myeong hwan Son	56.183	64.38	64.356	55.26	60.045	66.049	63.216	64.349	124.394	15
Thailand	Supassorn Armornmaneerat	55.679	63.886	63.445	61.79	61.2	59.809	65.3	63.104	124.304	16
Switzerland	Gaétan Colussi	58.199	60.425	63.445	67.958	62.507	61.889	60.992	61.351	123.857	17
Japan	HIROKI MATSUDA	70.296	54.986	67.852	64.693	64.457	57.729	60.116	59.161	123.618	18
China	Kemeng Wu	52.151	57.458	60.909	67.958	59.619	61.889	65.273	63.919	123.538	19
Hungary	Máté NÁSZAI	58.199	64.38	65.119	63.967	62.916	54.609	63.633	60.023	122.94	20

New Zealand	Yujie Zhou	68.784	58.941	57.043	58.525	60.823	63.969	60.408	61.833	122.656	21
Singapore	Xinyuan Hong	60.719	46.58	62.805	54.534	56.16	68.13	64.828	66.149	122.308	22
China	Yao Xiao	62.232	60.919	61.672	50.181	58.751	65.009	62.27	63.366	122.117	23
Thailand	Natthawut Adulyanukosol	47.362	61.908	63.494	63.241	59.001	65.009	61.075	62.649	121.65	24
Iran	Mahsima Shabani	58.703	56.964	63.987	52.357	58.003	56.689	66.802	62.757	120.759	25
United Kingdom	Patrick Louis Frederick Perryman-Owens	52.403	57.952	58.841	73.4	60.649	54.609	63.049	59.673	120.322	26
Thailand	Aschariya Wipattanakitcharoen	63.744	62.897	57.61	62.879	61.782	59.809	57.517	58.434	120.216	27
Germany	David Sebastian Fischer	63.24	56.469	68.098	52.357	60.041	61.889	57.711	59.383	119.424	28
Korea	Yeo Jin YOO	69.036	51.03	50.839	55.26	56.541	63.969	61.297	62.366	118.907	29
India	Twinkle Tushar Parekh	65.256	50.041	61.475	50.906	56.92	62.929	61.075	61.817	118.736	30
Russia	Anastasia D. Tsvetkova	64.248	59.93	61.032	45.101	57.578	66.049	57.823	61.113	118.691	31
Mexico	José de Jesús Naveja	56.687	60.425	58.988	61.79	59.473	58.769	58.851	58.818	118.291	32
Poland	KAROLINA TROCKA	58.703	60.919	57.807	50.906	57.084	62.929	59.769	61.033	118.117	33
Indonesia	Marsha Christanvia Wibowo	56.687	52.019	64.578	74.125	61.852	54.609	57.239	56.187	118.039	34
Korea	Ji Young SONG	59.711	54.986	54.704	49.455	54.714	62.929	63.049	63.001	117.715	35
China	Jin Yang	50.134	57.458	57.093	61.065	56.437	56.689	63.077	60.522	116.959	36
Canada	Sean Alexander RIDOUT	57.443	53.008	59.136	45.101	53.672	59.809	65.523	63.237	116.91	37
Sri Lanka	Arun Rajaratnam	54.671	60.425	57.807	54.534	56.859	63.969	56.989	59.781	116.64	38
Australia	Darcy Robert Gray	61.728	58.941	61.081	62.516	61.066	53.569	56.044	55.054	116.12	39
Hungary	Marton SZENTIRMAI	55.679	49.053	60.81	47.641	53.296	61.889	62.938	62.518	115.814	40
Italy	DANIELE CERVETTINI	65.004	60.919	58.89	50.906	58.93	57.729	55.265	56.251	115.181	41
Romania	VICTOR SERBAN	55.175	67.347	45.053	55.985	55.89	58.769	58.796	58.785	114.675	42
Lithuania	Irmantas Mogila	60.215	57.952	58.102	55.985	58.064	54.609	57.823	56.537	114.601	43

India	Sanchit Kumar	57.695	54.491	44.585	66.507	55.819	54.609	61.27	58.605	114.425	44
New Zealand	Benjamin Yu Hang Bai	52.151	53.008	61.131	57.437	55.931	52.529	61.853	58.124	114.055	45
Romania	TEODORA GHEORGHE	53.159	59.93	48.573	50.543	53.051	56.689	63.243	60.622	113.673	46
Thailand	Kanat Chanthongdee	60.719	45.591	58.151	66.144	57.651	53.569	57.6	55.988	113.639	47
Ukraine	Valeriya Sapozhnikova	53.663	60.425	51.897	58.162	56.037	57.729	57.281	57.46	113.497	48
Indonesia	Thoriq Salafi	59.963	59.93	51.503	57.437	57.208	54.609	57.267	56.204	113.412	49
India	Pritish Laxmikant Patil	60.719	56.469	62.46	49.818	57.367	58.769	54.098	55.966	113.333	50
Iran	Ahmad Vafaeian	53.663	50.536	55.541	53.809	53.387	56.689	61.979	59.863	113.25	51
Estonia	Uku-Laur Tali	60.215	51.525	60.416	58.162	57.58	57.729	53.959	55.467	113.047	52
Turkey	IZZET ALTUN	50.638	66.358	48.426	55.26	55.17	56.689	58.629	57.853	113.023	53
Germany	Tim Ulf Hutschenreiter	53.915	55.48	58.102	57.437	56.233	53.569	58.907	56.772	113.005	54
Singapore	Zhen Wei, Michael Sia	45.094	57.458	68.517	42.562	53.408	51.489	64.911	59.542	112.95	55
Japan	TOMOYUKI MIKAMI	46.606	58.941	61.451	42.925	52.481	60.849	58.198	59.258	111.739	56
Bulgaria	Mira Lyudmilova Nencheva	54.671	59.93	44.018	51.632	52.563	60.849	57.92	59.092	111.654	57
Australia	Phillip Timothy O'Riordan	58.955	50.536	61.894	51.995	55.845	52.529	57.336	55.413	111.258	58
Finland	Mikaela Maria Mutru	58.703	54.491	64.085	54.534	57.953	49.409	55.891	53.298	111.251	59
Hungary	Bálint REHŌ	64.248	63.886	59.087	55.26	60.62	49.409	51.373	50.588	111.208	60
Ukraine	Dariia Shyriaieva	53.159	60.919	54.754	59.251	57.02	55.649	53.208	54.185	111.205	61
Estonia	Anu Ainsaar	61.223	56.469	49.337	56.711	55.935	54.609	55.46	55.12	111.055	62
Italy	MARTINA CHIRIACO'	58.703	48.064	61.229	51.269	54.816	55.649	56.405	56.103	110.919	63
Italy	LUCA BIAVATI	61.728	62.402	53.35	41.111	54.648	53.569	57.725	56.063	110.71	64
Kazakhstan	Zhassulan Shaikhygali	58.703	47.569	51.577	50.181	52.008	55.649	60.408	58.504	110.512	65
Netherlands	Johannes Cornelis Jacobus Mertens	54.671	55.48	60.958	59.976	57.771	48.369	55.599	52.707	110.478	66

Indonesia	Afandi Charles	54.923	53.502	50.075	53.809	53.077	58.769	55.752	56.959	110.036	67
Estonia	Erik Tamre	65.76	48.064	63.42	55.26	58.126	47.329	53.653	51.123	109.249	68
Canada	Moustafa Mohamed Saad Atia ABDALLA	54.167	50.536	63.149	49.455	54.327	54.609	54.876	54.769	109.096	69
India	Saloni Kapoor	52.151	41.636	50.174	59.976	50.984	58.769	57.433	57.968	108.952	70
United Kingdom	Holly Anne Rees	53.159	57.458	55.64	52.72	54.744	53.569	54.542	54.153	108.897	71
Netherlands	Dirk Christiaan Jungerius	58.703	41.636	56.969	50.181	51.872	55.649	57.628	56.836	108.709	72
Iran	Mehrdad Goshayeshi avval	56.183	59.93	49.509	53.809	54.858	51.489	55.349	53.805	108.662	73
Lithuania	Emilija Emma	51.899	55.975	56.526	50.181	53.645	55.649	54.431	54.918	108.563	74
Switzerland	Jacqueline Caroline MOCK	50.638	54.491	51.134	58.888	53.788	55.649	53.903	54.601	108.389	75
Russia	Tatiana S. Filatova	48.118	55.48	51.282	53.083	51.991	54.609	57.35	56.254	108.244	76
Slovenia	Domen Kampjut	54.167	61.413	57.88	40.748	53.552	54.609	53.695	54.06	107.612	77
Czech Republic	Karel Kodejš	54.167	61.908	63.445	50.906	57.606	51.489	48.983	49.985	107.592	78
Canada	Wei Chan XIANG	51.646	53.997	59.062	46.553	52.815	49.409	58.24	54.707	107.522	79
United Kingdom	Andre Jean Zylstra	55.427	59.93	48.401	45.827	52.396	55.649	54.681	55.068	107.465	80
Australia	Nathan Howard Isaacson	59.207	57.458	48.229	51.632	54.131	46.289	57.433	52.976	107.107	81
Poland	SYLWIA NATALIA GAJDA	57.695	42.625	50.765	51.995	50.77	60.849	52.68	55.948	106.717	82
Russia	Mark R. Sanevich	62.736	53.008	51.774	42.199	52.429	54.609	53.917	54.194	106.623	83
Germany	Roderich Römhild	59.207	42.13	54.31	55.985	52.908	52.529	54.237	53.554	106.462	84
Switzerland	Daniel BALLMER	48.622	52.019	58.841	61.427	55.227	53.569	49.65	51.218	106.445	85
Italy	ALESSIO CAPOBIANCO	51.142	44.603	67.286	53.083	54.028	54.609	50.817	52.334	106.363	86
Russia	Ivan I. Istomin	56.687	51.525	43.231	50.906	50.587	55.649	55.376	55.485	106.073	87
Germany	Franziska Maria Feller	62.232	46.58	55	47.278	52.772	55.649	51.512	53.167	105.94	88
Hungary	Fatime HAWCHAR	37.533	64.38	57.585	53.083	53.145	51.489	52.735	52.237	105.382	89

Turkey	DENIZ ARAL OZBEK	45.598	55.975	39.562	49.455	47.647	61.889	54.848	57.665	105.312	90
Ukraine	Andriy Volkov	54.671	35.703	46.801	58.525	48.925	58.769	54.515	56.216	105.141	91
Iran	Ali Vafaei	54.167	45.097	54.704	49.092	50.765	54.609	53.347	53.852	104.617	92
United Kingdom	Vasanth Sritharan	56.435	42.625	48.967	45.827	48.464	59.809	53.569	56.065	104.529	93
Sweden	Torkel Enok Loman	56.183	35.703	57.29	54.534	50.927	53.569	53.569	53.569	104.497	94
Pakistan	Armaghan-e-Rehman Mansoor	58.703	44.108	56.699	48.004	51.878	58.769	48.427	52.564	104.442	95
Czech Republic	Lenka Ćurnová	46.606	58.447	56.502	53.809	53.841	48.369	51.999	50.547	104.388	96
Australia	Callum Thomas Gray	54.923	59.436	57.93	47.641	54.982	47.329	50.734	49.372	104.354	97
Czech Republic	Kateřina Medková	45.346	46.58	51.824	50.181	48.483	57.729	54.098	55.55	104.033	98
Kazakhstan	Yernar Tursynbay	60.971	53.008	47.293	37.483	49.689	53.569	54.681	54.236	103.925	99
Turkmenistan	SAZAK ATAYEV	43.582	48.064	53.252	50.181	48.769	50.449	57.628	54.756	103.526	100
Vietnam	NGUYEN TRUNG KIEN	46.354	55.975	44.856	41.836	47.255	55.649	56.599	56.219	103.474	101
Indonesia	Husni Muarif	53.411	57.952	60.786	46.553	54.675	46.289	49.942	48.481	103.156	102
New Zealand	Richard Yu-Cheng Chou	66.768	53.008	49.411	48.729	54.479	45.249	50.762	48.557	103.036	103
Turkmenistan	AZADY PIRHANOV	53.159	42.625	49.657	52.357	49.449	57.729	50.79	53.565	103.015	104
Argentina	CRISTIAN CARLOS GONZALEZ	50.638	50.536	57.856	63.241	55.568	44.209	49.316	47.273	102.841	105
Sweden	Isak Gunnar Ilian Häggmark	53.915	49.053	53.202	57.437	53.402	48.369	50.081	49.396	102.798	106
Vietnam	NGUYEN THU TRANG	49.126	54.491	41.212	49.455	48.571	56.689	52.569	54.217	102.788	107
Spain	Pablo Ricardo Hernández Malmierca	56.687	49.053	58.964	54.897	54.9	47.329	48.26	47.888	102.788	108
Pakistan	Saneeha Shahid	49.63	49.547	58.274	36.394	48.461	51.489	56.099	54.255	102.717	109
Poland	ALICJA MONIKA KREJNER	43.078	56.964	40.153	54.897	48.773	53.569	54.014	53.836	102.609	110
Finland	Tinja Maria Suvi-Tuulia Toikka	60.719	46.086	61.032	41.111	52.237	48.369	51.637	50.33	102.567	111
Turkey	IPEK AKCABELEN	45.094	50.041	55.763	56.348	51.812	52.529	49.539	50.735	102.546	112

Vietnam	TRUONG THI PHUONG THAO	51.646	49.547	45.323	42.925	47.36	55.649	54.709	55.085	102.446	113
Brazil	Rafaell DA SILVA LIMA	43.582	48.064	45.717	60.339	49.425	53.569	52.471	52.91	102.336	114
Latvia	Anna Stikāne	54.167	58.447	50.42	50.906	53.485	49.409	47.787	48.436	101.921	115
Netherlands	Stephen Robert Skocpol	57.191	43.119	54.138	47.641	50.522	52.529	50.442	51.277	101.799	116
Turkey	UTKU GORKEM ERDOGAN	47.11	50.041	39.587	48.729	46.367	57.729	53.847	55.4	101.767	117
Spain	ALVARO GABALDON BADIOLA	62.232	41.636	53.104	50.543	51.879	48.369	50.651	49.738	101.617	118
Denmark	Johan May Nitschke	50.89	52.019	46.998	58.162	52.017	45.249	52.207	49.424	101.441	119
Czech Republic	Václav Nuc	43.834	58.447	57.708	52.357	53.087	44.209	51.012	48.291	101.377	120
Pakistan	Urooj Imdad Memon	50.134	52.514	56.182	39.297	49.532	47.329	54.237	51.474	101.005	121
Pakistan	Numra Abdul Aleem	54.167	52.514	50.469	37.845	48.749	51.489	51.957	51.77	100.519	122
Belarus	ULADZIMIR VALENTINOVICH HRYNEVICH	47.11	45.591	41.138	42.199	44.01	58.769	54.987	56.5	100.51	123
Lithuania	Gabija Lazaravičiūtė	55.679	32.736	57.733	49.455	48.901	49.409	52.902	51.505	100.406	124
Kazakhstan	Altynay Narmanova	43.078	61.413	32.249	53.809	47.637	55.649	50.359	52.475	100.112	125
Spain	AITOR LOPEZ GONZALEZ	59.207	39.164	63.716	51.632	53.43	47.329	45.953	46.503	99.933	126
Poland	PRZEMYSŁAW ANDRZEJ PĘKALA	52.655	53.008	43.009	40.748	47.355	54.609	51.054	52.476	99.831	127
Turkmenistan	NEDIR ATAGELDIYEV	41.565	40.647	47.367	55.26	46.21	54.609	52.416	53.293	99.503	128
Netherlands	Frank Poort	48.37	50.536	46.653	57.074	50.658	43.169	52.138	48.55	99.208	129
Sweden	Johan Arvid Hagelberg	53.159	52.019	50.592	45.101	50.218	47.329	49.817	48.822	99.039	130
Brazil	PEDRO BARBOSA OLIVEIRA	43.078	44.108	44.88	47.278	44.836	56.689	50.79	53.149	97.985	131
Bulgaria	Georgi Dimitrov Magaranov	42.574	57.458	43.526	36.757	45.079	52.529	53.069	52.853	97.932	132
Bulgaria	Elizar Mariyanov Tsvetkov	49.378	60.425	42.566	48.367	50.184	49.409	46.397	47.602	97.786	133
Finland	Joni Sampsa Olavi Ollonen	47.11	46.58	57.487	41.473	48.163	52.529	47.44	49.476	97.638	134
Sweden	Hanna Lovisa Elvira Borsiin	47.866	48.558	48.77	44.013	47.302	44.209	54.292	50.259	97.561	135

Kyrgyzstan	MYRZABEK ALIBAEV	48.622	57.458	54.704	35.669	49.113	46.289	49.872	48.439	97.552	136
Latvia	Anete Romanauska	51.142	44.108	47.244	52.357	48.713	50.449	47.523	48.694	97.407	137
Belarus	RAMAN VALERIEVICH PIARESKA	48.622	55.48	42.861	49.455	49.105	48.369	46.634	47.328	96.432	138
Belgium	Frédéric Jean Pierre Francis Clarembeau	48.37	52.514	49.435	51.269	50.397	48.369	44.243	45.893	96.29	139
Denmark	Lea Lybek Rueløkke	48.622	45.097	49.091	52.357	48.792	47.329	47.287	47.304	96.096	140
Slovak Republic	Alžbeta Harárová	47.614	35.703	45.373	45.101	43.448	51.489	53.347	52.604	96.052	141
Slovenia	Rebeka Jereb	58.451	53.502	51.75	40.748	51.113	45.249	44.59	44.854	95.967	142
New Zealand	Vicky Wei-Chi Tai	49.126	35.208	57.388	34.217	43.985	51.489	51.929	51.753	95.738	143
Azerbaijan	Sadig Niftullayev	35.517	44.108	39.242	52.357	42.806	54.609	51.262	52.601	95.407	144
Slovak Republic	Mária Mrázová	56.183	53.008	33.677	42.925	46.448	52.529	46.536	48.933	95.382	145
Slovak Republic	Jaroslav Ferenc	44.086	53.997	55.443	49.092	50.654	49.409	41.366	44.583	95.238	146
Mexico	Martín López	45.346	60.425	43.378	42.199	47.837	43.169	50.109	47.333	95.17	147
Romania	MIHAELA MADALINA TARTALEA	54.167	59.93	39.168	49.455	50.68	39.009	47.982	44.393	95.073	148
Greece	ELENI TEREZAKI	51.142	50.536	42.837	47.278	47.948	49.409	45.105	46.826	94.775	149
Canada	Jia Cheng LUO	47.11	48.064	53.399	44.013	48.146	45.249	47.231	46.438	94.585	150
Armenia	Vardges Tserunyan	45.094	48.064	40.596	47.278	45.258	48.369	49.831	49.246	94.504	151
Estonia	Ando Vaan	45.598	50.536	39.562	42.925	44.655	53.569	46.981	49.616	94.271	152
Lithuania	Miglė Mikutėnaitė	42.07	63.391	40.227	50.543	49.058	43.169	46.258	45.023	94.08	153
Sri Lanka	Hiruni Kaumadee Gajanayake	44.086	45.097	46.308	40.748	44.06	52.529	46.981	49.2	93.26	154
Azerbaijan	Bakhtiyar Taghizada	40.053	47.075	48.623	51.995	46.936	47.329	45.369	46.153	93.089	155
Bulgaria	Petar Iliyanov Iliev	40.053	43.614	43.452	48.004	43.781	51.489	47.843	49.301	93.082	156
Switzerland	Andreas ZINGG	48.118	31.253	37.863	56.711	43.486	52.529	47.634	49.592	93.079	157
Vietnam	DANG THU TRANG	45.094	35.208	42.763	36.394	39.865	55.649	51.387	53.092	92.957	158

Spain	DIANA ESTELLER GAUXAX	42.826	51.525	46.801	50.181	47.833	48.369	42.339	44.751	92.584	159
Mexico	Melissa Calzada	39.801	58.447	48.475	42.562	47.321	46.289	44.451	45.186	92.508	160
Ukraine	Alona Goncharuk	40.053	54.491	43.083	49.818	46.861	52.529	40.115	45.081	91.942	161
Denmark	Liane Dupont	49.882	51.03	45.176	41.473	46.89	45.249	44.91	45.046	91.936	162
Slovenia	Jure Črepinšek	44.086	55.975	46.653	41.473	47.047	47.329	43.184	44.842	91.889	163
Denmark	Monica Aimee Harlund Oyre	40.305	48.064	53.03	51.632	48.258	46.289	41.199	43.235	91.493	164
Slovenia	Eva Slapnik	43.078	51.525	40.867	48.367	45.959	44.209	46.342	45.489	91.448	165
Belarus	VOLHA YURIEVNA IVANOVA	41.565	54.986	45.2	54.534	49.071	39.009	44.257	42.158	91.229	166
Argentina	MATIAS FRANCISCO LEDESMA GONZALEZ	37.281	60.919	35.622	55.26	47.271	42.129	44.396	43.489	90.76	167
Armenia	Lusine Hovhannisyan	51.142	36.692	48.918	37.845	43.649	52.529	42.964	46.79	90.44	168
Liechtenstein	Donat APPERT	50.638	52.514	39.759	37.845	45.189	45.249	45.188	45.212	90.401	169
Romania	ROXANA GABRIELA SANDU	32.493	59.436	36.287	51.269	44.871	41.089	48.316	45.425	90.296	170
Kazakhstan	Baizak Kudaibergenov	46.102	39.164	46.087	39.297	42.662	51.489	43.479	46.683	89.345	171
Moldova	Solovei Valeria	49.126	44.603	48.475	34.58	44.196	49.409	42.2	45.083	89.279	172
Belgium	Jan Hendrik Achiel Brijs	49.63	48.558	49.238	45.101	48.132	41.089	41.143	41.122	89.254	173
Armenia	Robert Yeghikyan	45.85	50.536	34.268	42.925	43.395	44.209	46.953	45.856	89.25	174
Tajikistan	Farzonai Muzaffar	38.541	54.986	38.676	47.641	44.961	46.289	42.95	44.286	89.247	175
Belgium	Julien Gerard Charles Mortier	53.663	40.647	50.371	48.367	48.262	43.169	38.447	40.336	88.598	176
Argentina	RAMIRO ARRECHEA ANTELO	46.354	62.402	37.937	38.934	46.407	37.969	44.34	41.792	88.198	177
Argentina	JAVIER CARLOS VILLARRAZA	38.289	56.964	35.573	48.004	44.707	44.209	41.449	42.553	87.26	178
Latvia	Rūta Talla	37.533	55.975	39.266	51.632	46.101	41.089	41.143	41.122	87.223	179
Belgium	Michel Philippe Pascal Pirre Reginster	48.874	51.03	50.494	50.181	50.145	36.929	37.085	37.022	87.167	180
Nigeria	Goo'sPower Toyin Oboli	41.061	30.758	46.53	35.669	38.505	49.409	47.704	48.386	86.89	181

Greece	ALEXIOS VOURVOUKELIS	43.078	45.097	44.314	40.022	43.128	43.169	43.923	43.621	86.749	182
Mexico	Alejandro Rodríguez	36.021	55.975	43.895	47.278	45.792	41.089	40.17	40.538	86.33	183
Sri Lanka	Heennilame Shehan Umeda Ratnayake	42.574	44.108	44.142	48.729	44.888	45.249	37.335	40.501	85.389	184
Armenia	Shushan Toneyan	42.574	39.658	35.819	50.543	42.149	41.089	44.507	43.14	85.288	185
Latvia	Kārlis Jermacāns	41.061	55.975	38.479	41.473	44.247	41.089	40.115	40.504	84.751	186
Brazil	Mattheus José Medeiros Fernandes	32.241	48.064	33.037	42.199	38.885	49.409	43.242	45.709	84.594	187
Belarus	YULIYA VALERIEVNA ZAITSAVA	41.061	34.219	39.562	46.19	40.258	51.489	39.281	44.164	84.422	188
Kyrgyzstan	ERBOL MOLDOZHUNUSOV	37.533	31.253	41.088	49.455	39.832	41.089	41.616	41.405	81.237	189
Nigeria	Victor Ojonugwa Igono	38.037	24.825	45.422	37.483	36.442	48.369	42.144	44.634	81.076	190
Greece	GEORGIOS AGORANOS	42.574	24.825	33.16	38.208	34.692	42.129	48.913	46.199	80.891	191
Greece	DAINORA ČEPAITYTE	39.549	48.064	35.647	38.571	40.458	44.209	37.641	40.268	80.726	192
Slovak Republic	Slavomira Heželyová	48.874	44.108	37.444	41.473	42.975	35.889	38.503	37.457	80.432	193
Mongolia	Dolgormaa Bataa	42.574	52.019	37.543	43.65	43.946	40.049	33.763	36.277	80.224	194
Kyrgyzstan	SANZHAR ISAKUNOV	38.037	34.714	42.393	38.208	38.338	48.369	37.071	41.59	79.928	195
Finland	Laura Johanna Poso	41.817	43.119	37.568	41.836	41.085	35.889	39.031	37.774	78.859	196
Brazil	Pablo Ivo Borges Ferreira	38.541	44.603	39.242	39.297	40.421	43.169	33.777	37.534	77.954	197
Moldova	Bivol Sergiu	37.533	30.264	35.204	43.65	36.663	40.049	41.255	40.772	77.435	198
Cyprus	Andreas Petrou	43.582	46.086	33.259	44.376	41.826	39.009	33.304	35.586	77.412	199
Sri Lanka	Nimeshika Chathurangi Mahaarachchi	45.598	30.264	35.795	36.394	37.013	42.129	38.225	39.786	76.799	200
Nigeria	Opeoluwa Samuel Adewale	37.533	29.275	40.424	38.208	36.36	42.129	39.17	40.353	76.713	201
Mongolia	Mashbayar Sukhbat	40.053	48.064	39.242	52.357	44.929	30.688	31.303	31.057	75.986	202
Georgia	Nia Khachapuridze	42.574	39.658	45.816	37.845	41.473	32.768	35.292	34.282	75.756	203
Mongolia	Munkhzul Tsogtsaikhan	42.574	36.197	38.109	44.376	40.314	35.889	34.652	35.147	75.461	204

United Arab Emirates	Abdul Rahman Yaaqoub M. Aljaberi Aljaberi	29.972	49.053	53.03	47.278	44.833	28.608	31.706	30.467	75.3	205
Azerbaijan	Kamran Kerimov	37.533	54.986	39.66	40.748	43.232	35.889	29.107	31.819	75.051	206
Cyprus	Andreas Matthaiou	39.045	29.769	45.668	39.659	38.536	34.849	37.154	36.232	74.768	207
Nigeria	Ikponmwosa Jesuferanmi Igbinigie	31.484	32.736	33.037	44.013	35.318	34.849	39.698	37.758	73.076	208
Azerbaijan	Tamerlan Bayramov	38.289	54.491	33.037	38.934	41.188	30.688	30.552	30.607	71.795	209
Cyprus	Evdokia Ttooulou	39.297	25.32	40.424	34.943	34.996	36.929	36.432	36.63	71.626	210
Georgia	Ana Gzirishvili	34.509	49.547	34.687	39.297	39.51	30.688	32.832	31.974	71.484	211
Mongolia	Javzanpagma Tsogbadrakh	35.769	45.591	42.517	47.278	42.789	31.728	26.271	28.454	71.243	212
Georgia	Lado Niauri	32.493	48.558	33.48	40.748	38.82	29.648	33.457	31.934	70.753	213
Georgia	Bela Nishnianidze	40.305	27.297	36.238	34.217	34.514	34.849	35.695	35.356	69.871	214
Kuwait	SALEH HABIB HAIDAR	34.005	47.569	36.238	38.571	39.096	24.448	32.693	29.395	68.491	215
Tajikistan	Manizhabonui Mirzoolimzoda	31.484	29.275	38.922	41.473	35.289	28.608	35.639	32.827	68.116	216
Cyprus	Elina Eleni Tringou	45.598	24.825	37.666	29.138	34.307	31.728	34.833	33.591	67.898	217
Turkmenistan	ABDYRAHYM ATASHEV	33.501	46.58	33.653	35.306	37.26	28.608	31.581	30.392	67.652	218
Kyrgyzstan	ELDOS MUKASHOV	29.972	32.736	37.617	39.297	34.905	27.568	36.195	32.744	67.65	219
Tajikistan	Dilnoza Kamoliddinova	30.98	45.097	33.16	34.943	36.045	24.448	31.636	28.761	64.806	220
United Arab Emirates	Saif Yousuf Haj Abdulla Gharib Alhammadi	27.452	26.803	41.63	44.376	35.065	25.488	31.525	29.11	64.176	221
Kuwait	SARAH YOUSEF ALMAJID	34.761	26.308	37.666	42.562	35.324	23.408	29.301	26.944	62.268	222
Kuwait	EELAF AHMAD HUSAIN	35.517	30.264	40.448	42.199	37.107	22.368	25.965	24.526	61.633	223
Moldova	Saragov Diana	28.46	28.781	37.691	37.845	33.194	30.688	26.466	28.155	61.349	224
Tajikistan	Zilola Zaripova	35.013	28.286	35.204	32.041	32.636	33.808	25.118	28.594	61.23	225
Kuwait	DALAL SAEED ALQALLAF	28.46	35.208	34.49	39.297	34.364	25.488	27.55	26.725	61.089	226
Moldova	Caraiman Vladlena	35.013	29.769	35.672	33.855	33.577	32.768	23.408	27.152	60.729	227

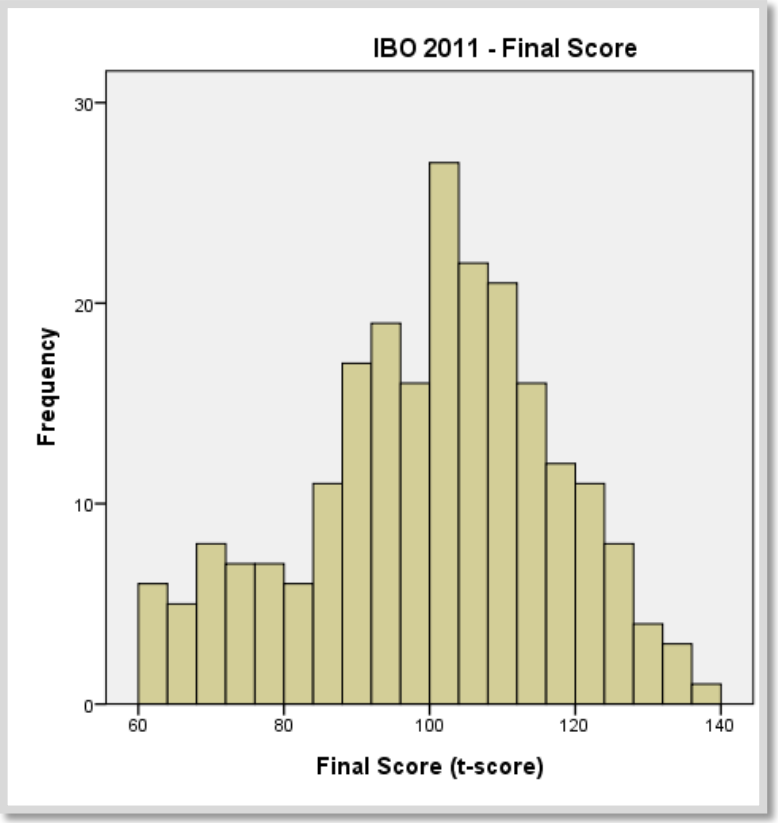
Analysis of Test Results

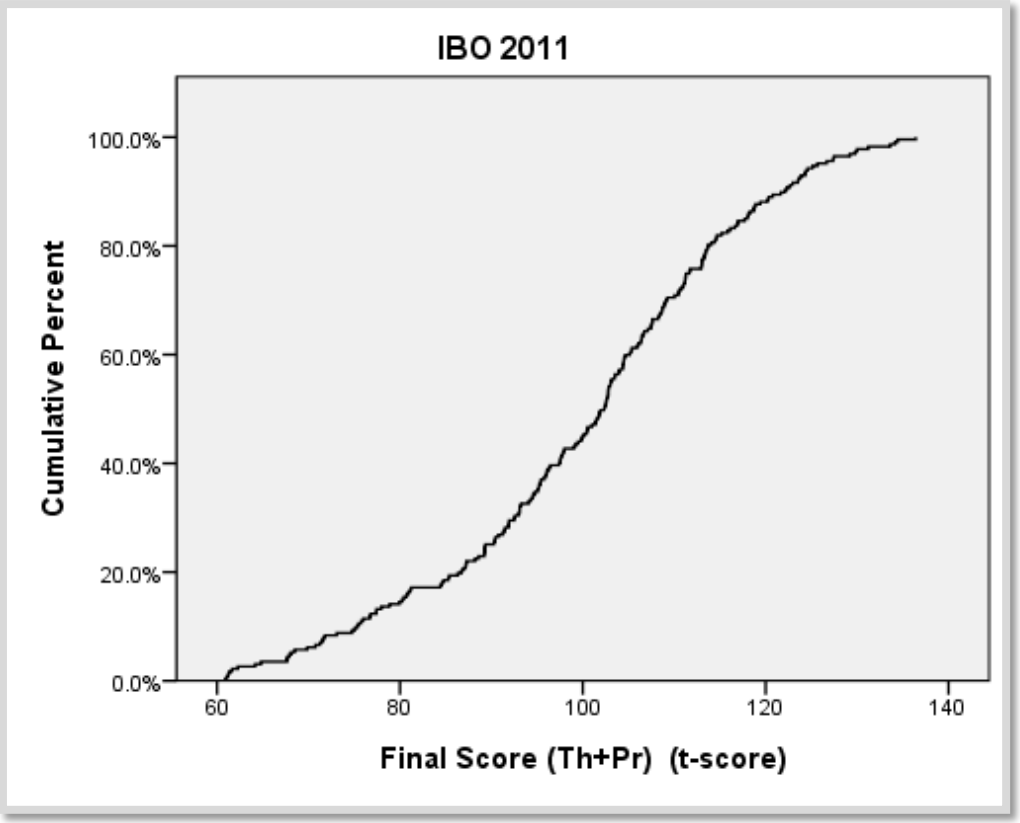
1. Consolidated Table of Points (Raw scores)

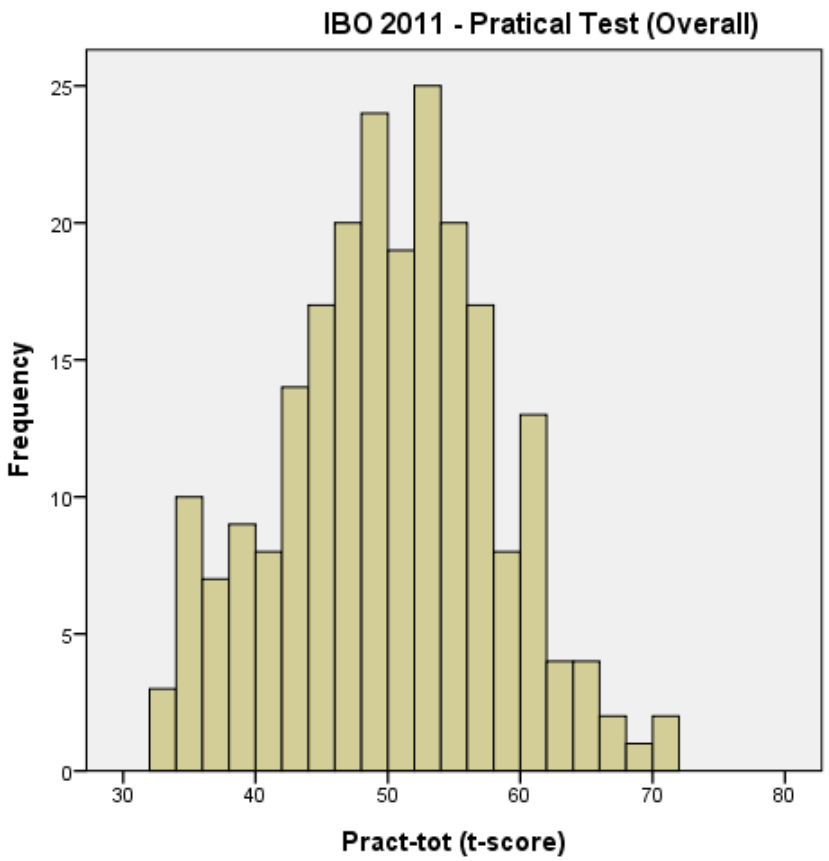
	Th part A	Th part B	Th Total	P1	P2	P3	P4	Pr Total
max possible	116	147	263	100	100	100	100	400
Maximum Obtained points	110.0	131.5	240.9	93.0	98.0	86.3	84.0	328.6
max (%)	**94.8**	**89.4**	**91.6**	**93.0**	**98.0**	**86.3**	**84.0**	**82.2**
Minimum Obtained points	20.0	50.3	74.9	0.0	12.0	7.4	3.0	54.4
min (%)	**17.2**	**34.2**	**28.5**	**0.0**	**12.0**	**7.4**	**3.0**	**13.6**
Mean	**73.1**	**98.1**	**171.3**	**44.7**	**62.9**	**43.4**	**31.8**	**182.8**
Diff. (%)	**63**	**67**	**65**	**45**	**63**	**43**	**32**	**46**
SD	**19.2**	**18.0**	**36.1**	**19.8**	**20.2**	**20.3**	**13.8**	**59.8**
SD (%)	**17**	**12**	**14**	**20**	**20**	**20**	**14**	**15**
DI (%)=sd/xm	**26**	**18**	**21**	**44**	**32**	**47**	**43**	**33**

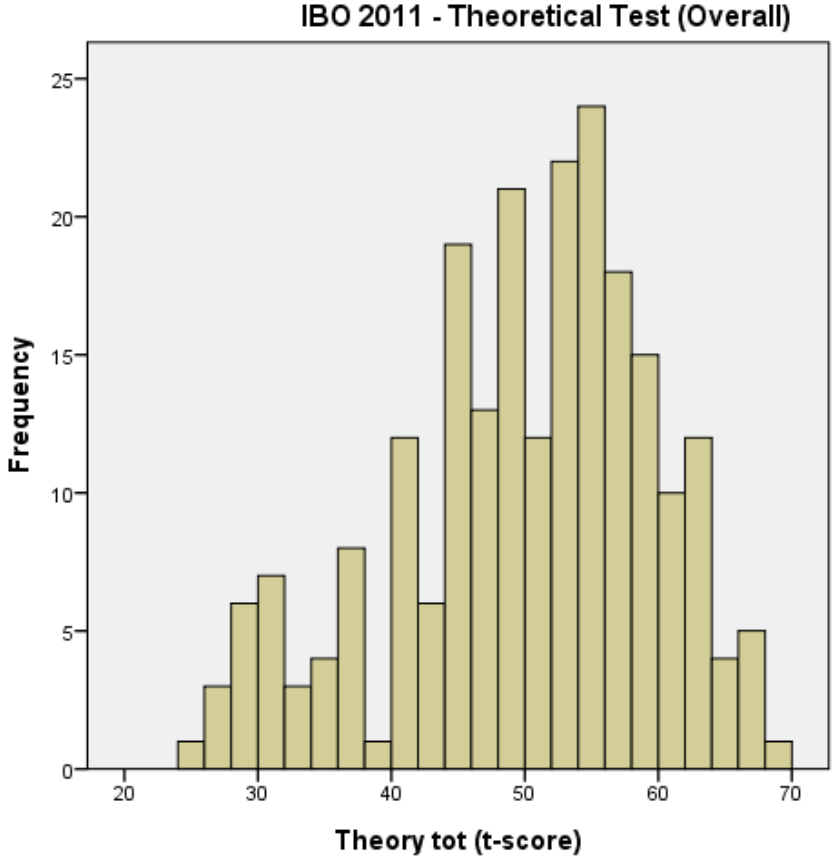
2. Frequency Distribution of Scores

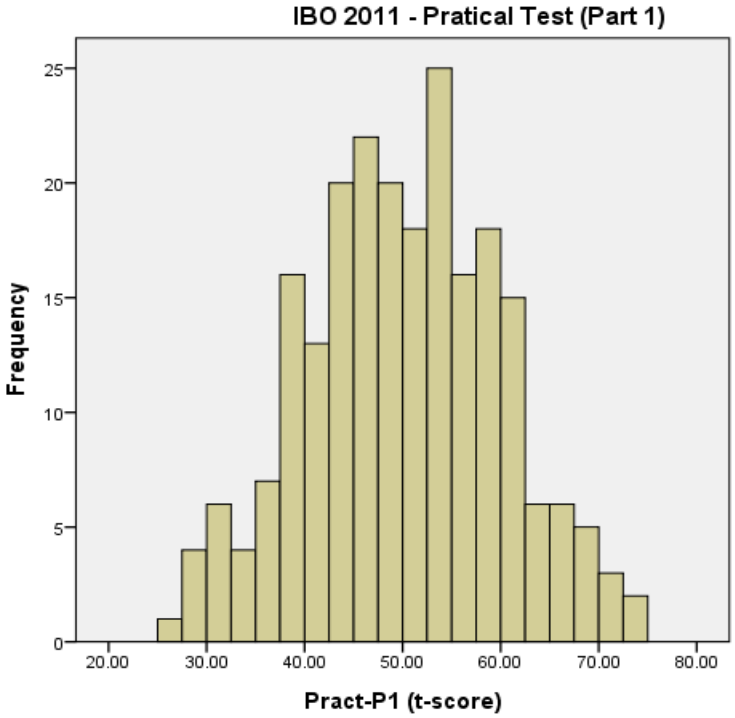
Total

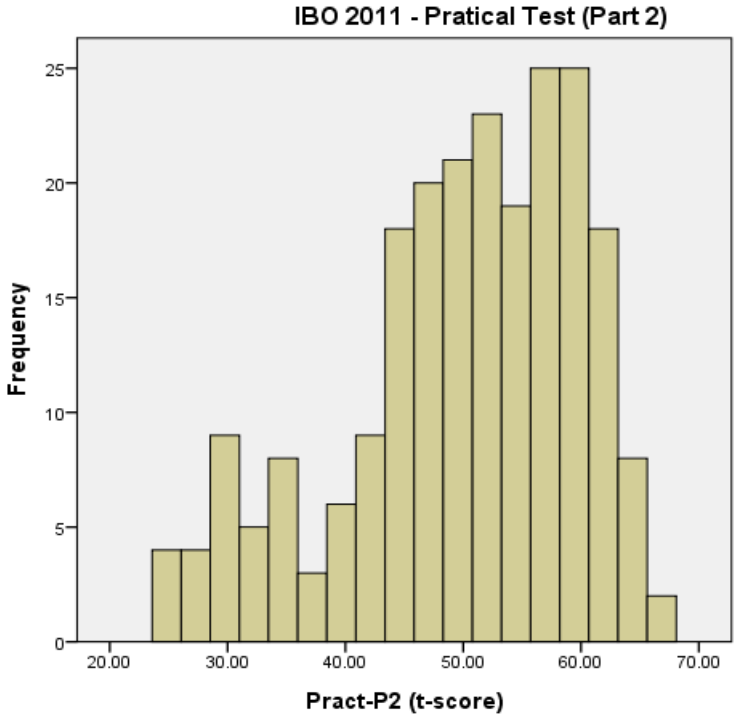


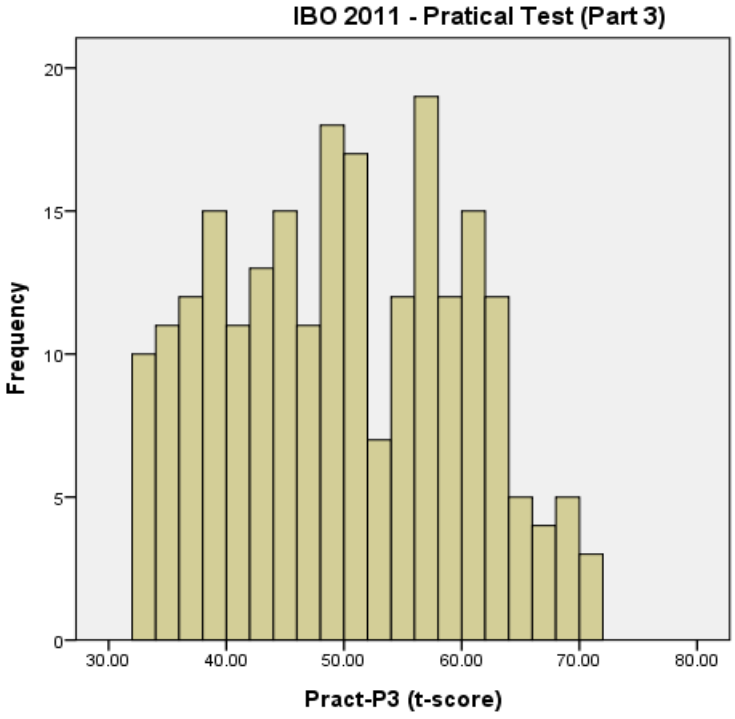


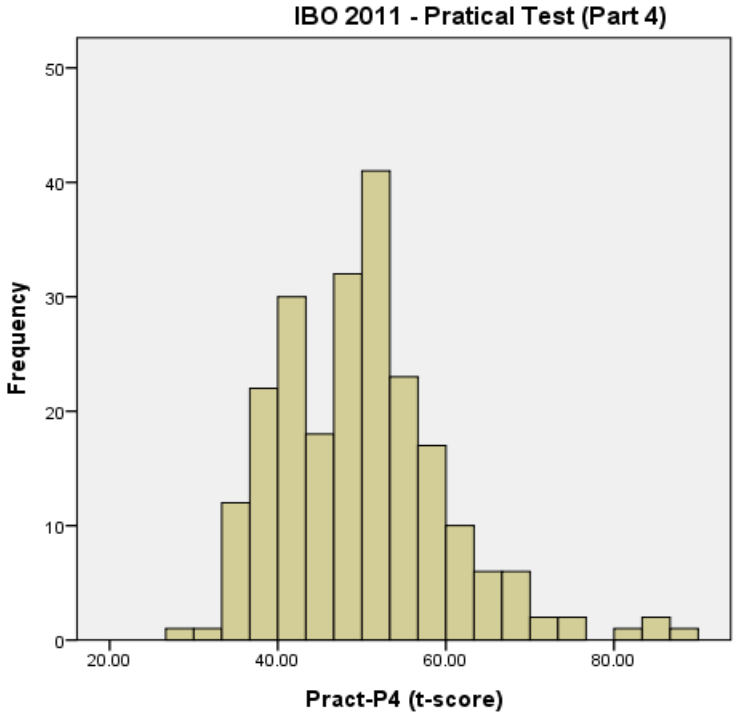

IBO 2011 - Pratical Test (Overall)
Frequency
Pract-tot (t-score)
0
5
10
15
20
25
30
40
50
60
70
80

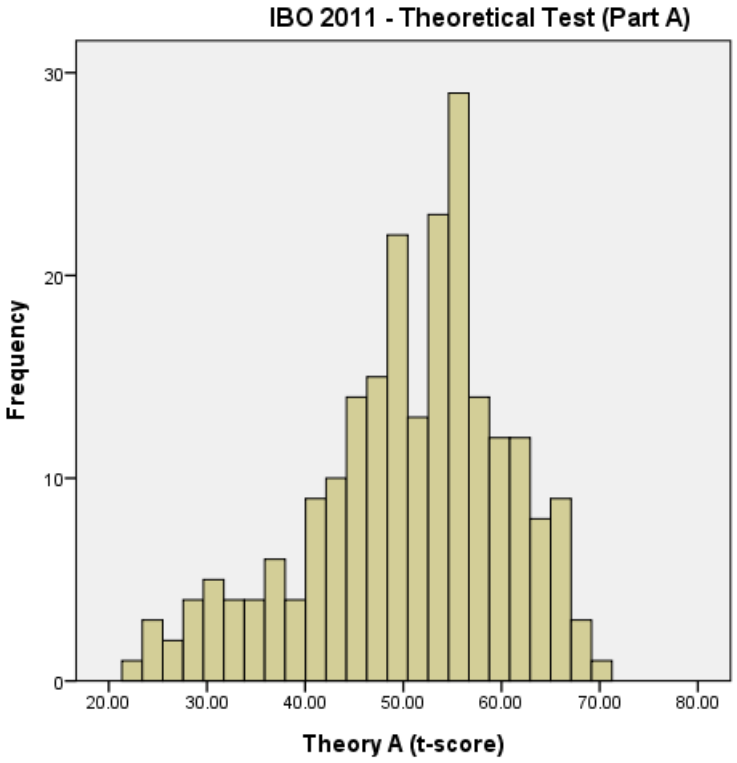

IBO 2011 - Theoretical Test (Overall)
Frequency
Theory tot (t-score)
0
5
10
15
20
25
20
30
40
50
60
70

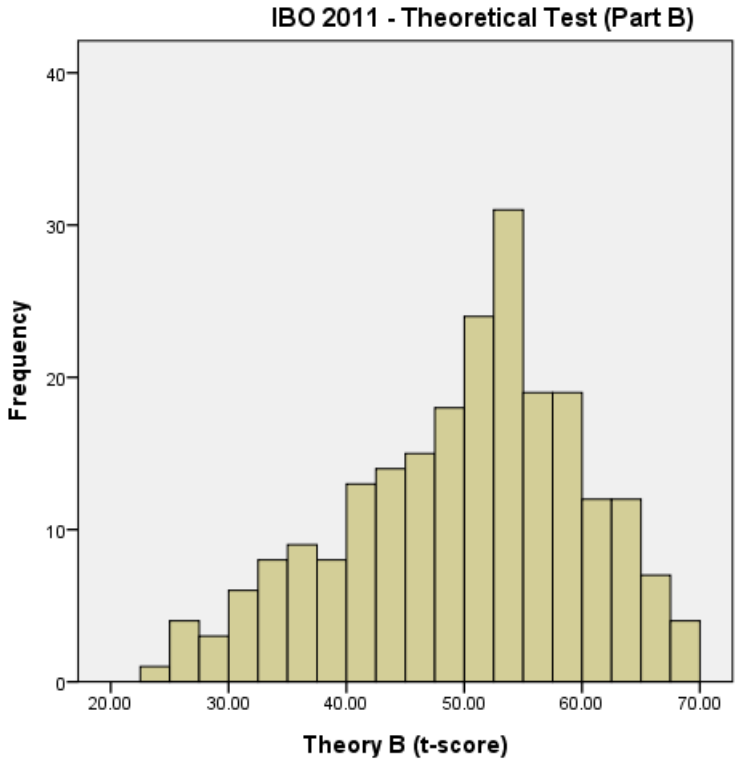

IBO 2011 - Pratical Test (Part 1)
Frequency
Pract-P1 (t-score)


IBO 2011 - Pratical Test (Part 2)
Frequency
Pract-P2 (t-score)


IBO 2011 - Pratical Test (Part 3)
Frequency
Pract-P3 (t-score)

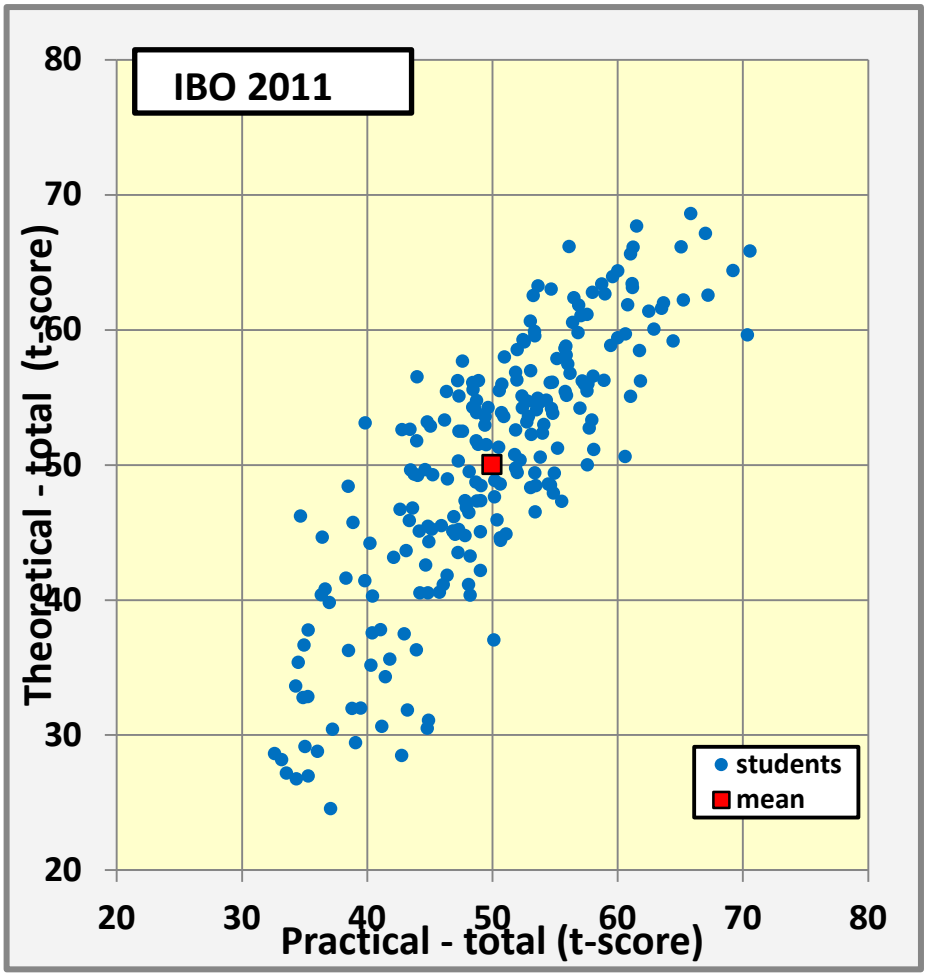

IBO 2011 - Pratical Test (Part 4)
Frequency
Pract-P4 (t-score)

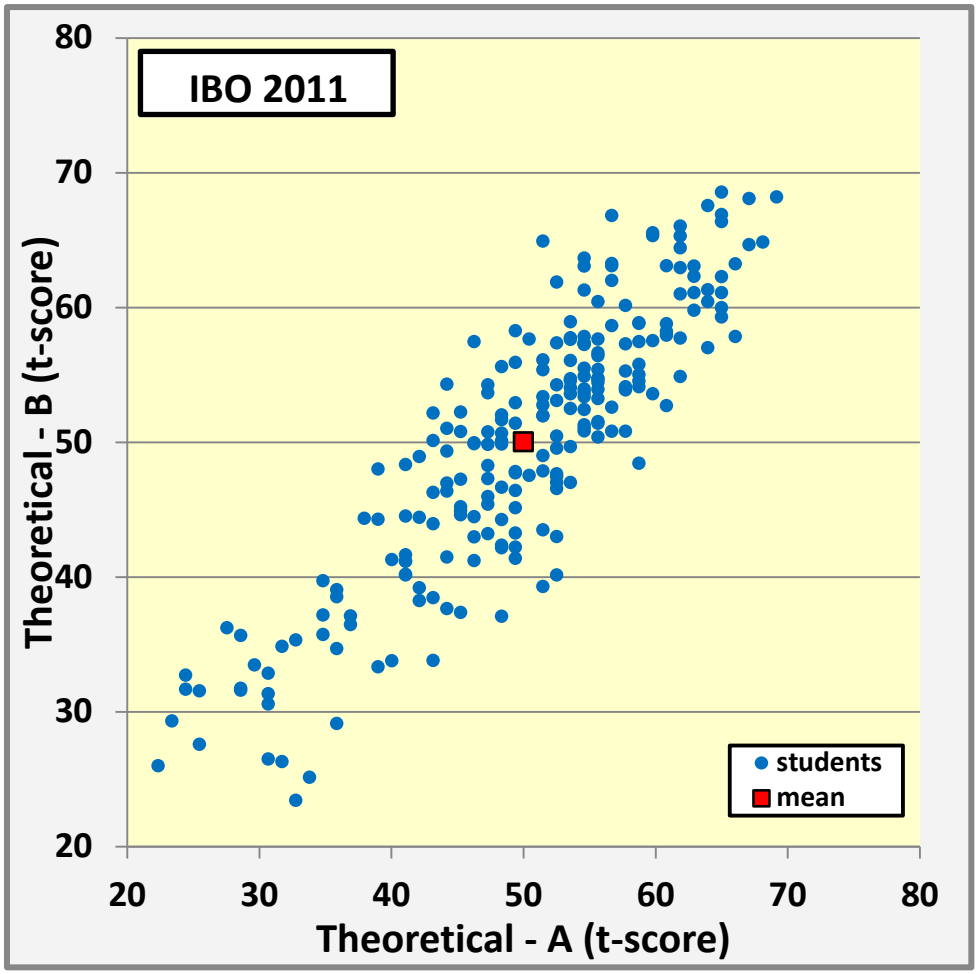

IBO 2011 - Theoretical Test (Part A)
Frequency
30
20
10
0
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Theory A (t-score)

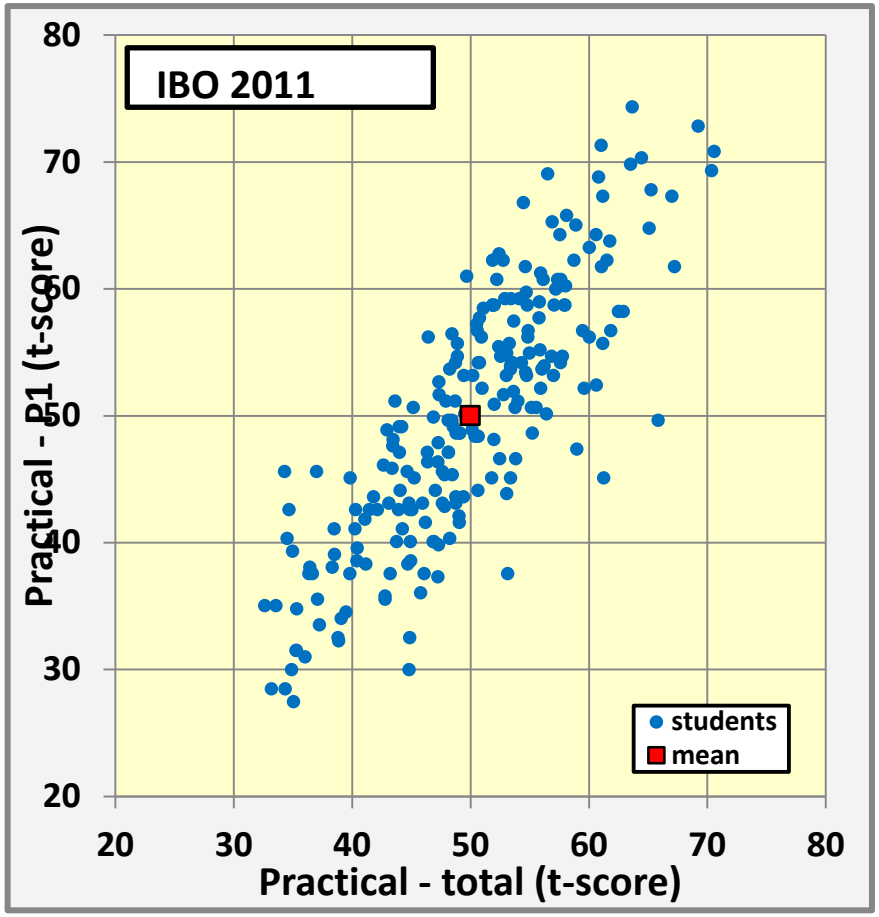

IBO 2011 - Theoretical Test (Part B)
Frequency
40
30
20
10
0
20.00
30.00
40.00
50.00
60.00
70.00
Theory B (t-score)

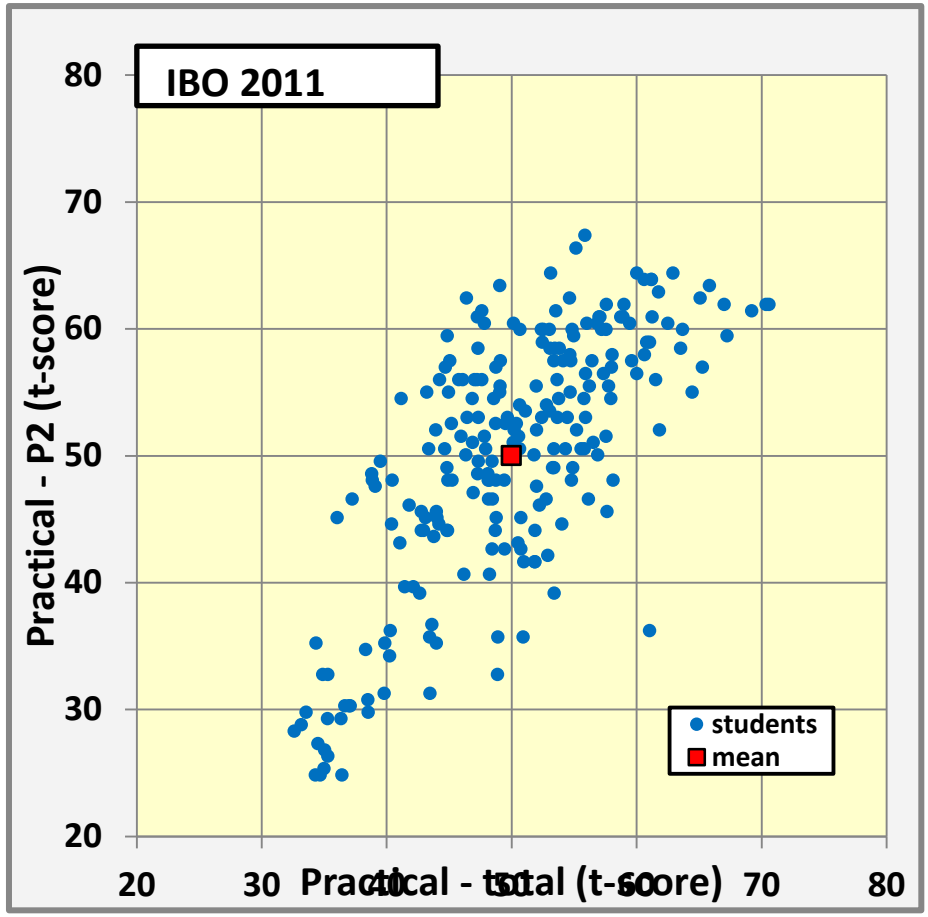
3. Correlation Coefficient

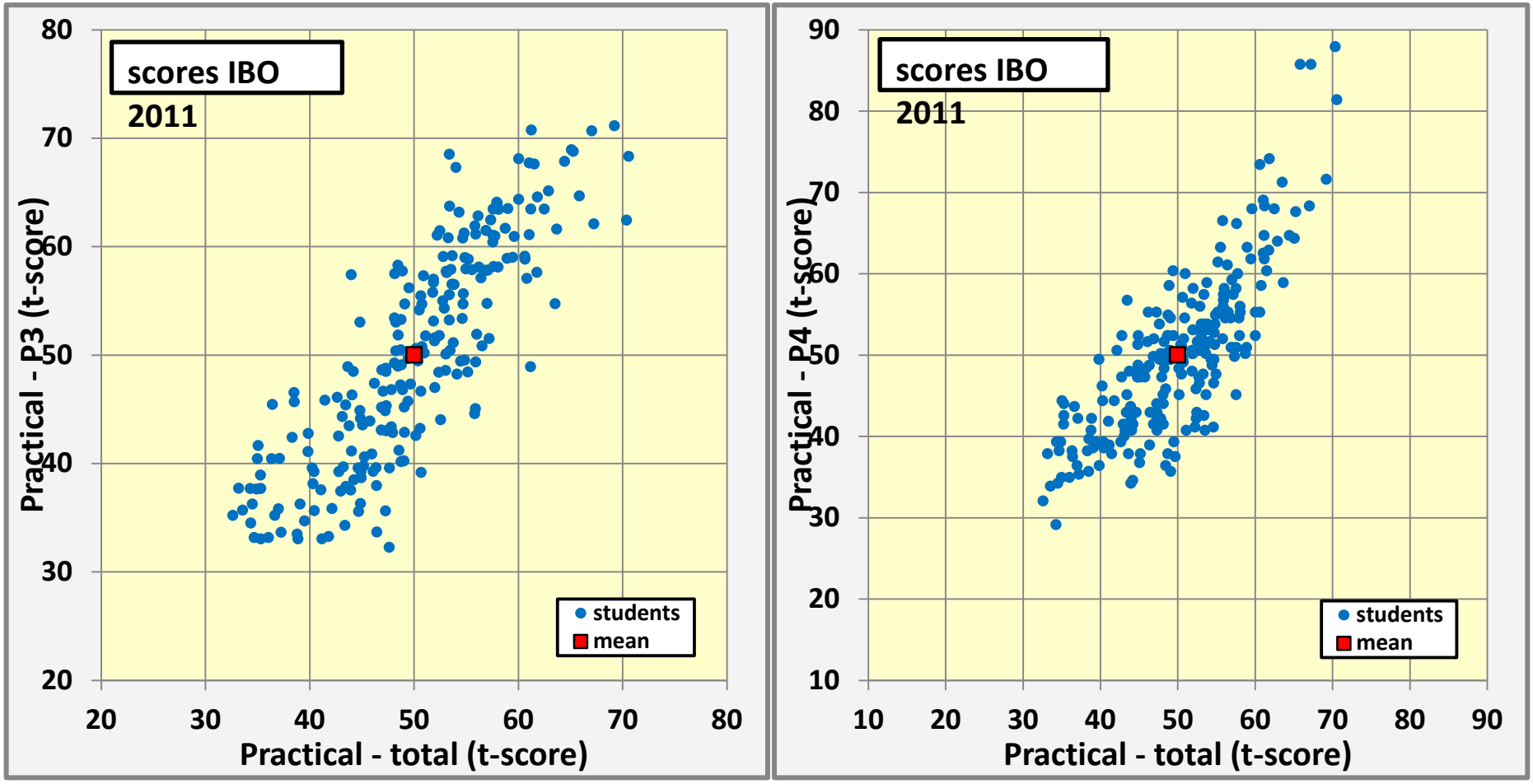
	Theoretical (A)	Theoretical (B)		
Theoretical - Total	0.96	0.98		
Theoretical (A)		0.88		
	Practical P1	Practical P2	Practical P3	Practical P4
Practical - Total	0.85	0.74	0.85	0.77
	Theoretical - Total	Practical - Total		
Final	0.96	0.95		
Theoretical - Total		0.82		


IBO 2011
Theoretical - total (t-score)
Practical - total (t-score)
20
30
40
50
60
70
80
students
mean


IBO 2011
Theoretical - B (t-score)
Theoretical - A (t-score)
20
30
40
50
60
70
80
students
mean


IBO 2011
Practical - P1 (t-score)
Practical - total (t-score)
20
30
40
50
60
70
80
students
mean


IBO 2011
Practical - P2 (t-score)
Practical - total (t-score)
20
30
40
50
60
70
80
students
mean


scores IBO
2011
Practical - P3 (t-score)
Practical - total (t-score)
students
mean
scores IBO
2011
Practical - P4 (t-score)
Practical - total (t-score)
students
mean

L. The Analysis of Difficulty Index and Discriminating Power of Each Theoretical Test Question

To assess the IBO2011 tasks objectively, we compute both Difficulty Index (**P** value) and Discriminating Power (**D** value) from the test result.

P value and **D** value are calculated by first calculating for both the upper group $\mathbf{P_H}$ (Top 27%) and lower group $\mathbf{P_L}$ (Bottom 27%) students the percentage who answered each item correctly.

The formulas are listed below:

$$\mathbf{P}\text{ value} = (P_H + P_L) / 2$$
$$\mathbf{D}\text{ value} = P_H - P_L$$

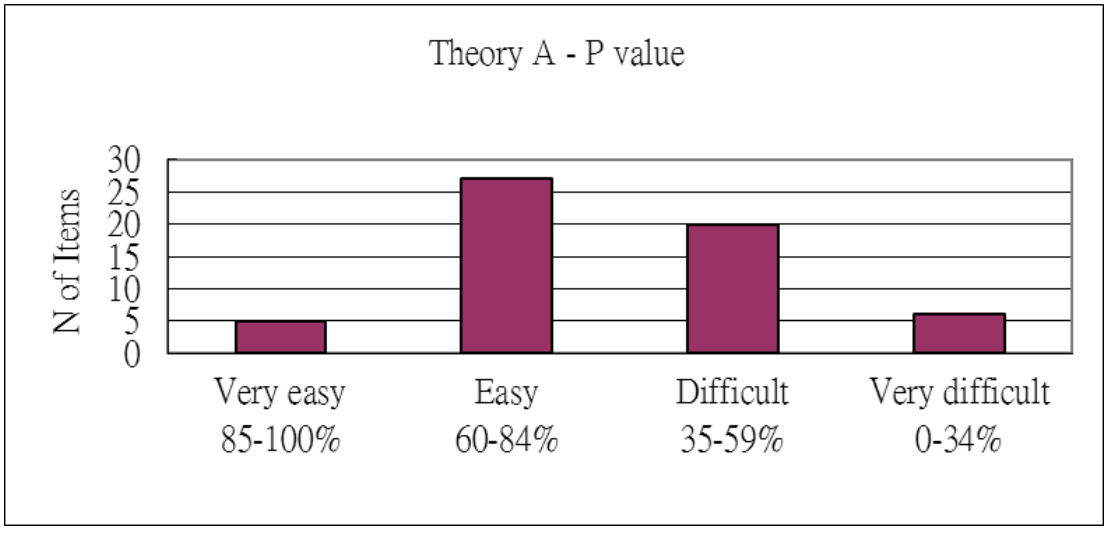
Four levels of Difficulty Index (**P** value) are as follows: (1) Very easy (85-100%), (2) Easy (60-84%), (3) Difficult (35-59%) and (4) Very difficult (0-34%).

Four levels of Discriminating Power (**D** value) are as follows: (1) Excellent (> 40%), (2) Good (30-39%), (3) Fair (10-29%), and (4) Poor (< 9%).

Based on the required knowledge and skills, in conjunction with the results of P value and D value, we included our own analysis for each item.

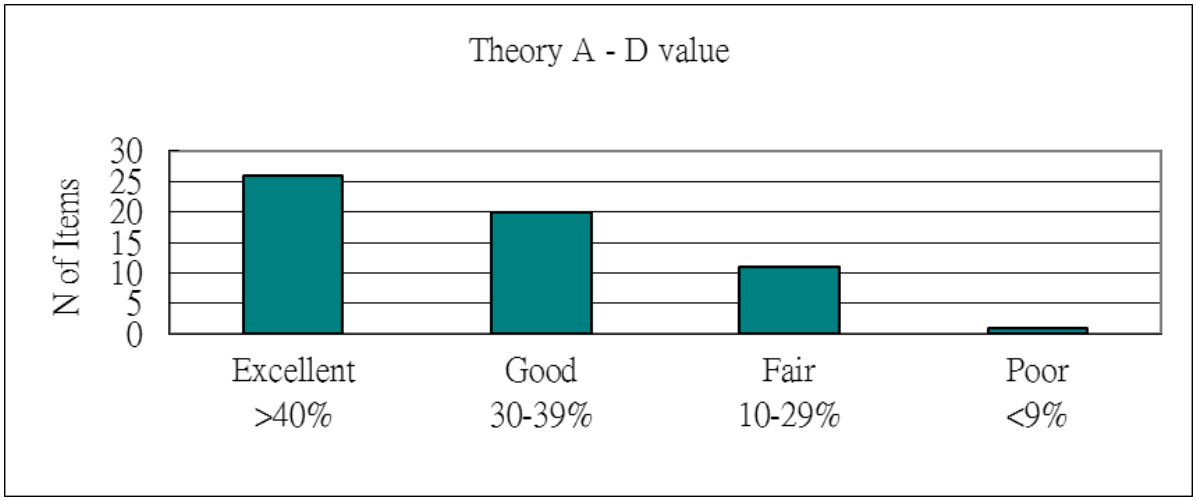
Theoretical A- P value

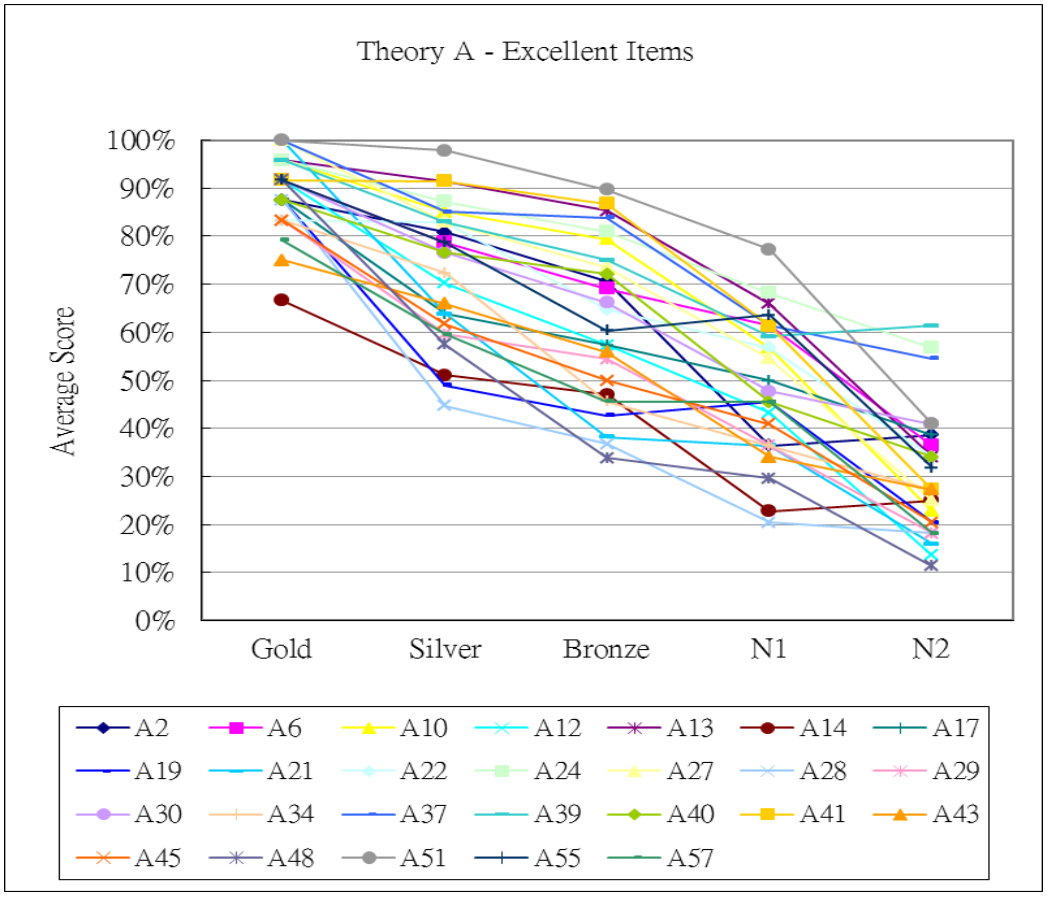
P value	Very easy 85-100%	Easy 60-84%	Difficult 35-59%	Very difficult 0-34%	Total
N of Items	5	27	20	6	58

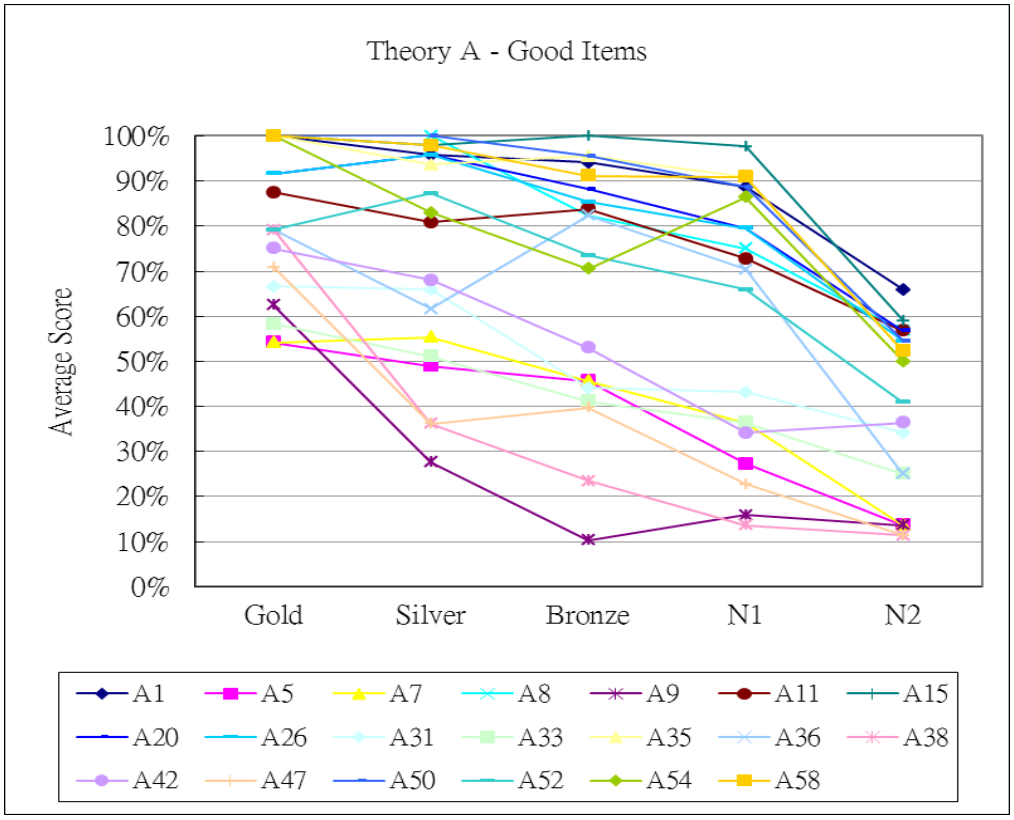


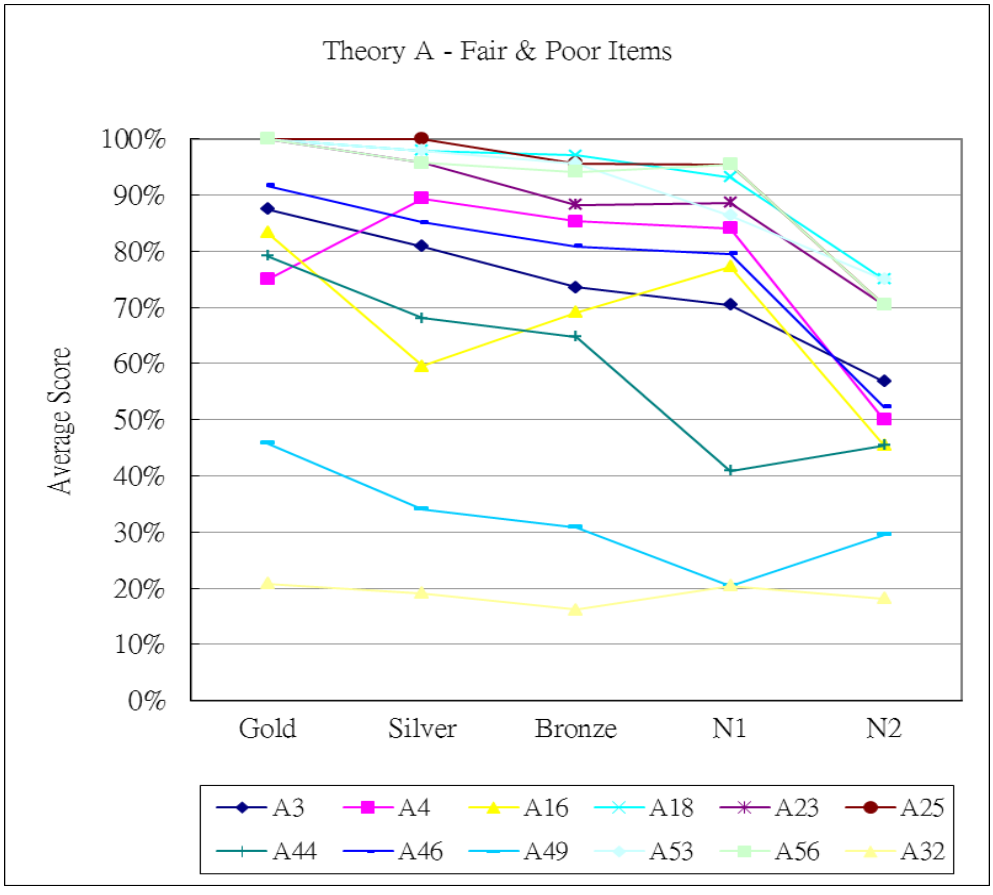
Theoretical A- D value

D value	Excellent >40%	Good 30-39%	Fair 10-29%	Poor <9%	Total
N of Items	26	20	11	1	58



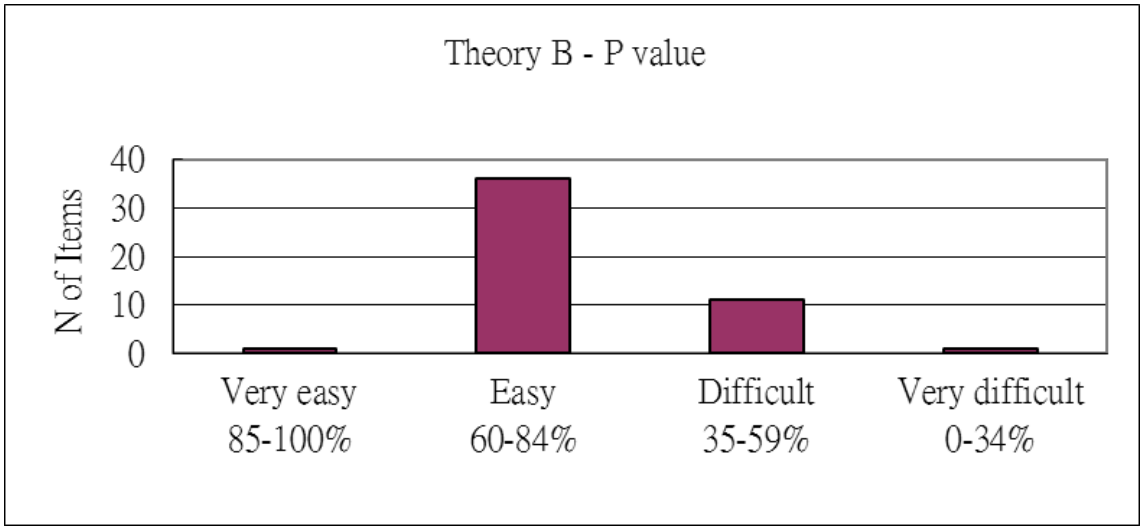



Theory A - Good Items
Average Score
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Gold
Silver
Bronze
N1
N2
A1
A5
A7
A8
A9
A11
A15
A20
A26
A31
A33
A35
A36
A38
A42
A47
A50
A52
A54
A58


Theory A - Fair & Poor Items
Average Score
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Gold
Silver
Bronze
N1
N2
A3
A4
A16
A18
A23
A25
A44
A46
A49
A53
A56
A32

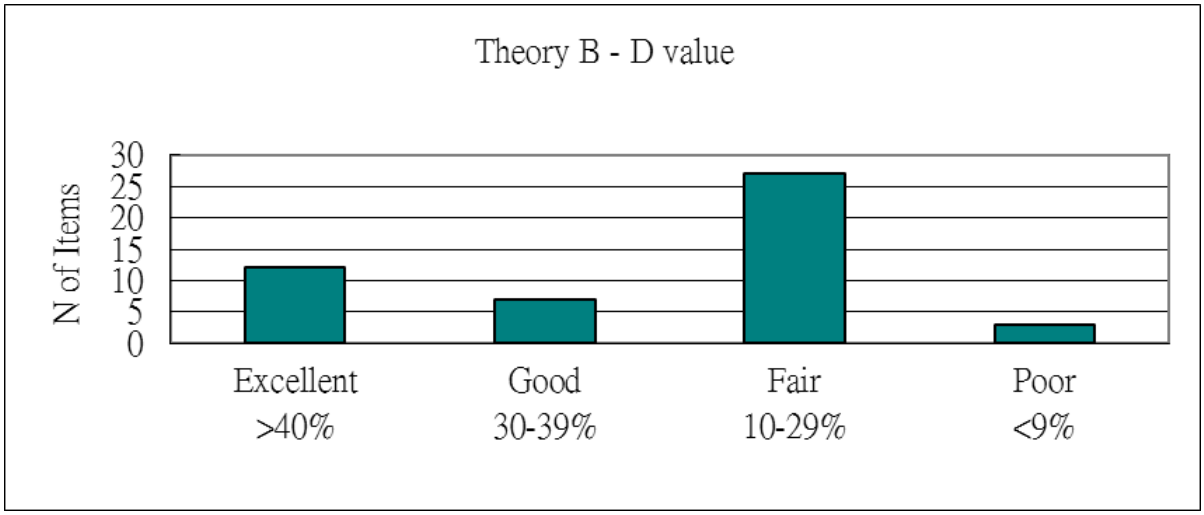
Theoretical B- P value

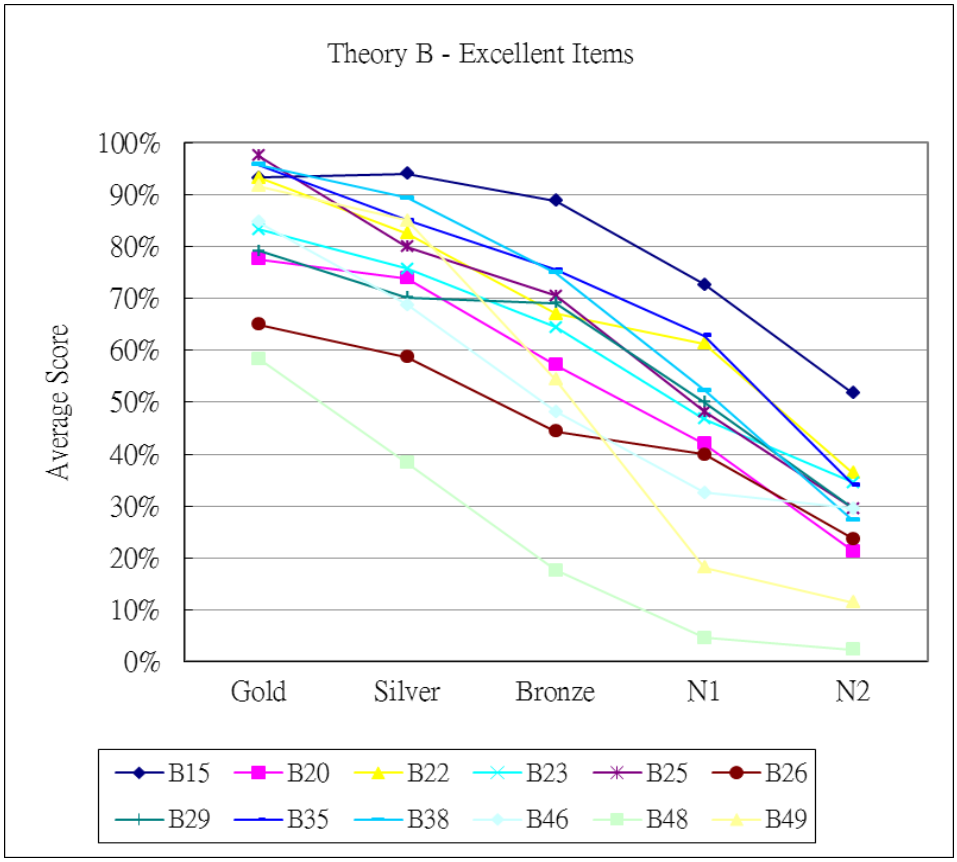
P value	Very easy 85-100%	Easy 60-84%	Difficult 35-59%	Very difficult 0-34%	Total
N of Items	1	36	11	1	49

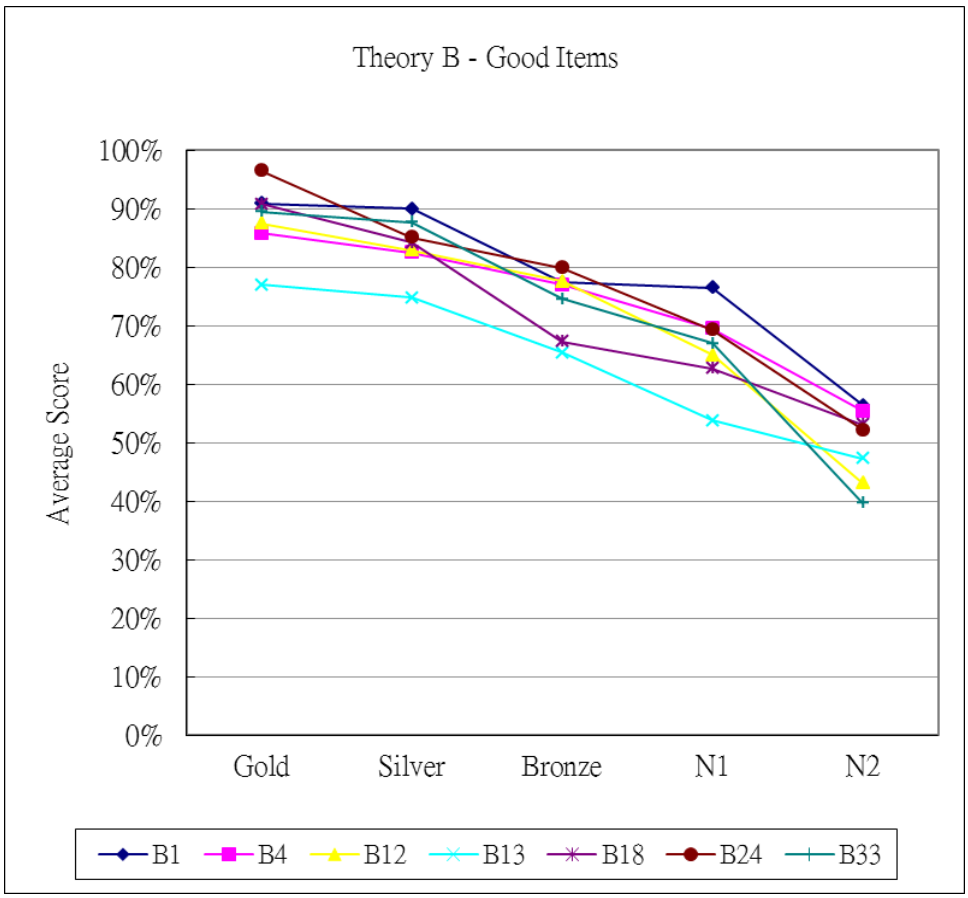


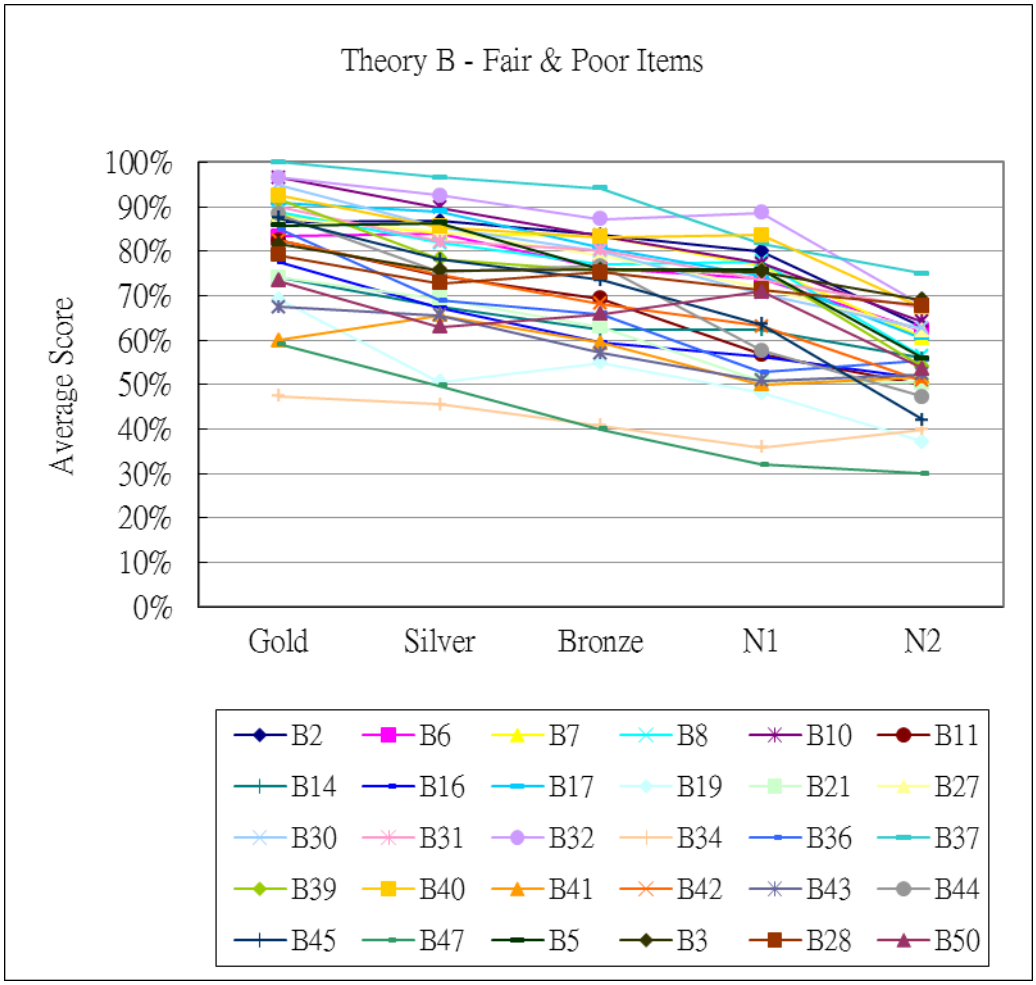
Theoretical B- D value

D value	Excellent >40%	Good 30-39%	Fair 10-29%	Poor <9%	Total
N of Items	12	7	27	3	49




Theory B - Excellent Items
Average Score
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Gold
Silver
Bronze
N1
N2
B15
B20
B22
B23
B25
B26
B29
B35
B38
B46
B48
B49


Theory B - Good Items
Average Score
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Gold
Silver
Bronze
N1
N2
B1
B4
B12
B13
B18
B24
B33


Theory B - Fair & Poor Items
Average Score
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Gold
Silver
Bronze
N1
N2
B2
B6
B7
B8
B10
B11
B14
B16
B17
B19
B21
B27
B30
B31
B32
B34
B36
B37
B39
B40
B41
B42
B43
B44
B45
B47
B5
B3
B28
B50

I. Cell Biology

A1	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Structure and function of proteins	
	Solution	Understand the morphological correlation in the interaction of ligands and receptors.	
	Analysis	Combination of basic knowledge and logic thinking is needed.	

A2	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Biochemical composition of polysaccharides	
	Solution	Apply basic knowledge to the biochemical composition of insect exoskeleton.	
	Analysis	Combination of knowledge and careful thinking is needed.	

A3	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Feedback inhibition in amino acid synthesis	
	Solution	Understand the regulation mechanism of nutrition production.	
	Analysis	Combination of basic knowledge and logic thinking is needed. Descriptions may be confusing to some students.	

A4	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Electron transport chain in cellular respiration	
	Solution	Combine the understanding of electron transport chain and anaerobic respiration.	
	Analysis	Combination of deep understanding and logic thinking is needed. Descriptions may be confusing to some students.	

A5	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ■ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Bacteria growth and antibiotics	
	Solution	Understand the working mechanism of penicillin.	
	Analysis	Combination of deep understanding and logic thinking is needed.	

A6	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Comparison between prokaryotes and eukaryote	
	Solution	Judge the difference between prokaryotes and eukaryote and understanding the working mechanism of antibiotics.	
	Analysis	Combination of basic knowledge and logic thinking is needed.	

A7	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Chromosomal structure	
	Solution	Understand the roles of different histone proteins and their function in the chromosome structure.	
	Analysis	Combination of knowledge and careful thinking is needed.	

A8	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	DNA structure and replication	
	Solution	Understand the structure of double strand DNA and the theory of DNA replication.	
	Analysis	Combination of basic knowledge and logic thinking is needed.	

A9	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ■ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Transcription and translation	
	Solution	Judge the structural difference between DNA and mRNA and understand the concepts of posttranscriptional modification.	
	Analysis	Combination of knowledge and careful thinking is needed.	

A10	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	DNA replication and transcription	
	Solution	Apply the knowledge to DNA replication and transcription.	
	Analysis	Combination of knowledge and careful thinking is needed.	

A11	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Telomere and telomerase	
	Solution	Understand the function of telomerase on telomere and the diseases related to this concept.	
	Analysis	Combination of knowledge and careful thinking is needed.	

A12	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Restriction enzyme	
	Solution	Understand the production of restriction enzymes in bacteria.	
	Analysis	Combination of deep understanding and careful thinking is needed.	

II. Plant anatomy and physiology

A13	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Hypersensitive response	
	Solution	Understand HR response and find the appropriate plant with HR response.	
	Analysis	Combination of knowledge and reasoning is needed.	

A14	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Plant movement	
	Solution	Understand the mechanisms of plant movements and judge the distinct one.	
	Analysis	Combination of knowledge and reasoning is needed.	

A15	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Plant hormone	
	Solution	Read the biosynthetic pathway of plant hormone and can make an appropriate inference.	
	Analysis	Combination of pathway reading and reasoning is needed.	

A16	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Plant hormone	
	Solution	Read the biosynthetic pathway of plant hormone and can make an appropriate inference.	
	Analysis	Easy and knowledge-based.	

A17	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Photosynthesis	
	Solution	Deduce it is a C4 plant and know its photosynthetic characteristics.	
	Analysis	Combination of knowledge and inference is needed.	

A18	**P Values**	■ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Genetic manipulation of plant	
	Solution	Knowing the manipulated gene of Golden Rice.	
	Analysis	Too easy.	

A19	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Plant hormone	
	Solution	Understand ABA functions and can reason the characteristics of mutant plant.	
	Analysis	Combination of knowledge and reasoning is needed.	

A20	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Plant hormone	
	Solution	Understand ethylene functions and can infer the results of blocking its functions in plant.	
	Analysis	Combination of knowledge and inference is needed.	

A21	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Leaf development	
	Solution	Understand the scientific description of leaf development process and deduce the correct structural arrangement.	
	Analysis	Combination of basic knowledge and accurate understanding the scientific description is needed.	

A22	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Genetic manipulation of plant	
	Solution	Understand the description of gene manipulation process of plant and judge the incorrect statement.	
	Analysis	Combination of basic knowledge and accurate understanding the scientific description is needed.	

III. Animal anatomy and physiology

A23	**P Values**	■ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Cardiovascular system	
	Solution	Understand the circulation system among different species and determine which statement is correct.	
	Analysis	Question is knowledge based.	

A24	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Cardiovascular system	
	Solution	Discriminate the structural and functional difference between hemocyanin and hemoglobin.	
	Analysis	Accurate understanding of the knowledge is required.	

A25	**P Values**	■ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Metabolism and homeostasis	
	Solution	To chose the correct statement based on the combine knowledge between metabolism rate and temperature regulation.	
	Analysis	Since the correct answer is too obvious. Competitor may jump to the correct answer without further consideration.	

A26	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Cardiovascular system	
	Solution	To determine the most important factor this has significant contribution on vascular resistance.	
	Analysis	Question is knowledge based.	

A27	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Cardiovascular system	
	Solution	Understand the principle of radio-isotope experiment and based on the provided information to estimate the blood volume.	
	Analysis	Experimental results knowledge and thinking is required.	

A28	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Neural system	
	Solution	To justify the effect of different ions on excitatory synaptic potential.	
	Analysis	A little bit difficult for the competitor, Accurate understanding the knowledge is required, but someone may remember as it is.	

A29	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Endocrine system	
	Solution	Consider the possible outcome of hyperthyroidism on the releasing of TRH, TSH, T3 and T4.	
	Analysis	A little bit difficult to the competitor, combination of knowledge and logic thinking are required.	

A30	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Immune system	
	Solution	To determine the correct receptors/molecules which responsible to the activation of Helper-T cells trigged by antigen presenting cells.	
	Analysis	Accurate understanding of the knowledge is required, but someone may remember as it is.	

A31	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Kidney function	
	Solution	To determine the correct combination between structure and function regard to the urine concentration and water reabsorption.	
	Analysis	A little bit difficult to the competitor. Question is knowledge based, accurate understanding of the knowledge is required	

A32	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ■ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ■ Poor Under 9 %
	Subject	Cardiovascular system	
	Solution	Consider the possible outcome of hemorrhage and related feedback mechanisms.	
	Analysis	This question is too difficult for the competitor. Poor D value is obtained. Competitor may simply answer the question by guessing.	

A33	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Neural system	
	Solution	Diagrams and charts were provided. Competitors were asked to determine the possible results of different manipulations.	
	Analysis	Accurate understanding of knowledge, graph reading skill and logical thinking is required.	

A34	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Sensory system	
	Solution	To identify the receptors based on their key feature. In addition, to determine which one is activated by a stimulation and consequently close a sodium channel leading to hyperpolarization.	
	Analysis	A little bit difficult to the competitor. Basic knowledge regard to the key feature of different sensory receptors is required, but someone may remember as it is.	

IV. Ethology

A35	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Communication and interspecific relationship	
	Solution	Understand the meaning of chemicals and the relationships between emitter and receiver.	
	Analysis	Application of basic knowledge and comparison in different situation are needed.	

A36	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Interspecific interactions and foraging behavior	
	Solution	Understand the most similar biological interaction pairs for the given two parties.	
	Analysis	Accurate understanding and combination of wide range of knowledge are needed.	

A37	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Sound patterns of bird communication	
	Solution	Understand the relatedness of sound frequency with its inhabiting forests.	
	Analysis	Combination of knowledge, picture/description reading, and logical thinking is needed.	

A38	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ■ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Mating system	
	Solution	Estimate the mating success with basic knowledge and from given information.	
	Analysis	Accurate understanding figures, descriptions reading and combination of wide range of knowledge are needed.	

V. Genetics and evolution

A39	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Protein translation and modification			
	Solution	Judge the differences in protein processing between animals and bacteria.			
	Analysis	Knowledge of protein translation and modification are needed.			

A40	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Tetrahybrid genetic cross			
	Solution	Calculate phenotype frequency in a cross of four pairs of traits.			
	Analysis	Knowledge of simple mathematical rules and calculation are needed.			

A41	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	X-linkage and X inactivation			
	Solution	Judge the random X-chromosomal inactivation.			
	Analysis	Knowledge and logical thinking are needed.			

A42	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	☐ Fair	10 – 29 %
		■ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Population genetics			
	Solution	Understand the basic principle of population genetics and perform a simple calculation.			
	Analysis	Combination of basic knowledge and accurate calculation is needed.			

A43	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Population genetics			
	Solution	Understand genetic principles and perform scientific calculation.			
	Analysis	Combination of basic knowledge and accurate calculation is needed.			

VI. Ecology

A44	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Species richness and dispersion	
	Solution	Predict and compare the species richness and species endemism between continental island and oceanic island.	
	Analysis	Combination of knowledge and logical thinking is needed, the subject may be too specific to the students.	

A45	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Community dynamics and structure	
	Solution	Answer with knowledge of keystone species.	
	Analysis	Combination of knowledge, figure reading, and logical thinking is needed, but the concept may be too complicated.	

A46	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Pollution and environmental conservation	
	Solution	Answer with knowledge of the sampling techniques to detect water quality.	
	Analysis	It is good basic question but similar questions may be familiar to the students.	

A47	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ■ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Population structure and dispersion	
	Solution	Answer with combined knowledge of particular taxa and their dispersal ability.	
	Analysis	Combination of wide range of knowledge is needed..	

A48	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Interspecific interactions	
	Solution	Correctly estimate population density in correlated with the natural predators.	
	Analysis	Combination of knowledge, reading, and logical thinking is needed.	

A49	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ■ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Interspecific interactions	
	Solution	Answer an important factor affecting the species dispersal.	
	Analysis	Too difficult. Combination of research result reading, knowledge, and logical thinking is needed.	

A50	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Community dynamics, succession, and interspecific interactions	
	Solution	Answer the major characteristics of the colonizer in a secondary succession ecology.	
	Analysis	Combination of knowledge and thinking is needed.	

A51	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Interspecific interactions of flower and its pollinator	
	Solution	Match flower with its pollinator based on flower characteristics and the nature of pollinator.	
	Analysis	Accurate understanding of basic knowledge is needed.	

A52	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Unitary and modular organisms	
	Solution	Correlate the mouth parts and feeding behavior with the possibility of disease transmission.	
	Analysis	Combination of basic knowledge and logical thinking is needed.	

VII. Biosystematics

A53	**P Values**	■ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Characteristics of animals	
	Solution	Answer accurate understanding the characteristics of all major groups of the vertebrates.	
	Analysis	A little too easy. Knowledge biased, and similar questions may be familiar to the students.	

A54	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Animal structures	
	Solution	Match organisms to the characteristics shown on the table.	
	Analysis	Combination of wide knowledge of the subject is needed.	

A55	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Animal structures	
	Solution	Match organisms to the characteristics shown on the table.	
	Analysis	Combination of wide knowledge of the subject is needed.	

A56	**P Values**	■ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Comparison of animal structures	
	Solution	Predict the most closely related animals by calculating the degree of similarity.	
	Analysis	Too easy. Similar questions are familiar to the students and they are trained.	

A57	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Classification of organisms	
	Solution	Be aware of biological classification knowledge and judge the correct phylum (division) number.	
	Analysis	Combination of basic knowledge and accurate calculation is needed.	

A58	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Plant evolution and classification characters	
	Solution	Relate the phylogenetic tree of green plants with important characters evolved.	
	Analysis	Combination of basic knowledge and reasoning is needed.	

I. Cell Biology

B1	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐Excellent Above 40 % ■Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Cytoskeleton and function of different cells	
	Solution	Understand the structure of microtubules and their presence in different cells.	
	Analysis	Combination of understanding basic concept and graph reading is needed.	

B2	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Function and composition of cytoskeleton	
	Solution	Understand the function of microtubules and their composition.	
	Analysis	Options may be too easy.	

B3	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ■ Poor Under 9 %
	Subject	Interaction of exotoxins and receptors	
	Solution	Answer with text reading and logic thinking related to the interaction between ligand and receptor and their further effect.	
	Analysis	Options may be too easy.	

B4	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐Excellent Above 40 % ■Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Enzyme synthesis in translation and post-translational modification	
	Solution	Understand the cell localization of translation of RNA and post-translational modification of proteins.	
	Analysis	Combination of basic knowledge and careful thinking is needed.	

B5	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Function of cellular organelles	
	Solution	Understand the working condition of lysozyme.	
	Analysis	Options may be too easy.	

B6	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Signal transduction	
	Solution	Understand the phosphorylation and dephosphorylation of components of signal pathway.	
	Analysis	Options may be too easy.	

B7	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Signal transduction	
	Solution	Graph reading and understand the upstream-downstream logic of signal pathway.	
	Analysis	Options may be too easy.	

B8	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Cancer and gene activation	
	Solution	Understand the correlation between cancer and signal transduction and cell cycle.	
	Analysis	Options may be too easy.	

II. Plant anatomy and physiology

B10	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Pollination and double fertilization	
	Solution	Understand the sexual reproduction process of angiosperms.	
	Analysis	Combination of basic knowledge and reasoning is needed.	

B11	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Photoperiodism	
	Solution	Analyze the experimental data and judge the critical day-length required by plant X for flowering.	
	Analysis	Combination of figure reading and reasoning is needed.	

B12	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Regulation of stomatal opening	
	Solution	Correlate Arabidopsis genotypes with stomatal phenotypes, followed by reasoning the plausible regulatory pathways by phototropins.	
	Analysis	Combination of data analysis and reasoning is needed.	

B13	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Regulation of stomatal opening	
	Solution	Reason the possible working mechanisms exerting by phototropins	
	Analysis	Combination of basic knowledge and reasoning is needed.	

B14	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Phytochrome	
	Solution	Match appropriate graphs with the absorption spectra of phytochrome isoforms.	
	Analysis	Combination of figure reading and reasoning is needed.	

B15	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Flower development			
	Solution	Understand the function of *AG* gene and reason the correct answers accordingly.			
	Analysis	Combination of scientific reading and reasoning is needed.			

III. Animal anatomy and physiology

B16	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Respiratory system			
	Solution	Based on the given diagram. To determine the structure and its function during ventilation.			
	Analysis	Similar diagram had been widely used in text books. Competitor may remember the answer as it is.			

B17	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Respiratory system			
	Solution	To identify structure-C based on the given diagram. Logical thinking is required to determine the possible effect of each statement on gas exchange in gill.			
	Analysis	Accurate understanding of the knowledge is required, but someone may remember as it is.			

B18	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	☐ Fair	10 – 29 %
		■ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Respiratory system			
	Solution	To identify structure-D based on the given diagram. Logical thinking is required to determine the possible function of X cells.			
	Analysis	Combination of knowledge and logic thinking are required.			

B19	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Gastrointestinal system.			
	Solution	Identify the structures based on the given diagram and match each structure with its correct function.			
	Analysis	Competitor may be unable to identify the structure and simply answer the question by guessing.			

B20	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Respiratory system			
	Solution	Based on the given graph, to match the different pulmonary volumes/capacity with its definition.			
	Analysis	This question is knowledge based.			

B21	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Metabolism and thermal regulation	
	Solution	Based on the definition of homeothermic and endothermic animals to determine the correct statements.	
	Analysis	This question is knowledge based.	

B22	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Neural system and endocrine system	
	Solution	Fill the correct structure/endocrine to the column based on the knowledge of blood glucose homeostasis.	
	Analysis	Accurate knowledge of blood glucose homeostasis is required.	

B23	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Endocrine system	
	Solution	Fill the correct structure/endocrine to the column based on the combine knowledge of spermatogenesis and gonad hormones.	
	Analysis	Accurate knowledge and logical thinking are required.	

B24	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Endocrine system	
	Solution	Based on the given condition, to estimate the possible outcome of different hormonal treatment on male patients suffering by gonad failure.	
	Analysis	Accurate knowledge and logical thinking are required.	

B25	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Neural system	
	Solution	Identify different steps illustrated in the diagram. Determine the possible outcome of different manipulation effects on postsynaptic current.	
	Analysis	Accurate knowledge of synaptic transmission and logical thinking are needed.	

B26	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Neural system			
	Solution	Identify different steps illustrated in the diagram. Determine which manipulations may have antiepileptic effect.			
	Analysis	Accurate knowledge of synaptic transmission and logical thinking are needed.			

B27	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Structure of skeletal muscle			
	Solution	Justify which statements are correct description for the change of muscle fibrils during muscle contraction.			
	Analysis	An easy question with fair D-value, this question is knowledge based.			

IV. Ethology

B28	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐Excellent Above 40 % ☐Good 30–39 %	☐Fair 10 – 29 % ■Poor Under 9 %
	Subject	Parental care of bird hatchlings	
	Solution	Answer with knowledge of bird reproductive behavior.	
	Analysis	A little too easy. Combination of knowledge, simple thinking, and reading is needed. Similar questions are familiar to the students and they are well trained.	

B29	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Biorhythms of a cockroach	
	Solution	Calculate and estimate the active time based on the circadian rhythm.	
	Analysis	Combination of knowledge, reading and logical thinking is needed.	

B30	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Innate behavior of moths.	
	Solution	Answer with the knowledge of subject.	
	Analysis	A little too easy. Combination of simple thinking and reading is needed, but the case is too familiar to the students.	

B31	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐Excellent Above 40 % ☐Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Mating system and biorhythms of birds	
	Solution	Consider possible experiments and expected results on mating pairs of birds.	
	Analysis	Combination of knowledge, phenomena, and logical thinking is needed.	

V. Genetics and evolution

B32	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Gene interaction and modified dihybrid ratio	
	Solution	cc genotype masks the expression of the *B* and *b* alleles.	
	Analysis	Knowledge of epistasis and combination of two gene pairs are needed.	

B33	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ■ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Allele frequency under Hardy-Weinberg equilibrium	
	Solution	Find a general formula of an allele frequency applying particular cases with related knowledge.	
	Analysis	Understanding of the concept and thinking with formulas are needed.	

B34	**P Values**	☐ Very Easy 85 – 100 % ☐ Easy 60 – 84 %	■ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Evolution of land plants	
	Solution	Correlate the characteristics of charophytes and land plants.	
	Analysis	A knowledge-based question.	

B35	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	■ Excellent Above 40 % ☐ Good 30–39 %	☐ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Gene analysis	
	Solution	Understand the provided scientific diagram and experimental data and judge the correct answers accordingly.	
	Analysis	Combination of figure reading, basic knowledge, and logical thinking is needed.	

B36	**P Values**	☐ Very Easy 85 – 100 % ■ Easy 60 – 84 %	☐ Difficult 35 – 59 % ☐ Very Difficult 0 – 34 %
	D Values	☐ Excellent Above 40 % ☐ Good 30–39 %	■ Fair 10 – 29 % ☐ Poor Under 9 %
	Subject	Gene expression and regulation	
	Solution	Understand the mechanisms of gene expression and regulation and deduce the correct answers.	
	Analysis	Combination of basic knowledge and reasoning is needed.	

VI. Ecology

B37	**P Values**	■ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Survival rate of population dynamics			
	Solution	Calculate and estimate the survival rate between generations.			
	Analysis	Too easy. Simple calculating after reading is needed, and the case is too familiar to the students.			

B38	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Logistic growth and Unitary organisms			
	Solution	Calculate the total hours' time needed for the development of mosquito embryos and expected its hatching time.			
	Analysis	Combination of accurate understanding of knowledge, reading, and logical thinking is needed.			

B39	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Exponential and logistic growth of population dynamics			
	Solution	Accurately understand the meaning of graphs and knowledge of the subject.			
	Analysis	Combination of knowledge, accurate reading, and logical thinking is needed. The case may be too familiar to the students and well trained.			

B40	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Food web and trophic levels of ecosystem			
	Solution	Understand the roles of organism in each food chain of a food web.			
	Analysis	Combination of graph reading and knowledge is needed. Knowledge biased.			

B41	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Competition and predation of interspecific interactions			
	Solution	Deduce expected results as described from the description of experiments.			
	Analysis	Too difficult. Combination of knowledge, reading, and thinking is needed. The experiment may be too complicated to most students.			

B42	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Energy flow of ecosystem			
	Solution	Understand different usages of energy intake from the previous trophic level.			
	Analysis	Combination of figure reading and calculating is needed. Similar questions are familiar to the students and they are well trained.			

B43	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Root symbiotic fungi structure and function			
	Solution	Compare the differences between two major kinds of root symbiotic fungi.			
	Analysis	Knowledge biased. Required knowledge may be too specific for the students.			

VII. Biosystematics

B44	**P Values**	☐ Very Easy ■ Easy	85 – 100 % 60 – 84 %	☐ Difficult ☐ Very Difficult	35 – 59 % 0 – 34 %
	D Values	☐ Excellent ☐ Good	Above 40 % 30–39 %	■ Fair ☐ Poor	10 – 29 % Under 9 %
	Subject	Phylogeny of Dictyoptera in Insects			
	Solution	Answer based on the accurate understanding of a phylogenetic tree.			
	Analysis	Combination of figure reading, knowledge, and logical thinking is needed. Similar questions are familiar to the students and they are well trained.			

B45	**P Values**	☐ Very Easy ■ Easy	85 – 100 % 60 – 84 %	☐ Difficult ☐ Very Difficult	35 – 59 % 0 – 34 %
	D Values	☐ Excellent ☐ Good	Above 40 % 30–39 %	■ Fair ☐ Poor	10 – 29 % Under 9 %
	Subject	Phylogeny of Nymphalidae in Insects			
	Solution	Answer based on the accurate understanding of a phylogenetic tree.			
	Analysis	Combination of figure reading, knowledge, and logical thinking is needed. Similar questions are familiar to the students and they are well trained.			

VII. Genetics and Evolution (Part II)

B46	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Chromosome mutation			
	Solution	Judge the chromosome translocation and calculate the probability of a particular genotype.			
	Analysis	Knowledge of chromosome translocation and thinking with formulas are needed.			

B47	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	■ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Autosomal dominant trait inheritance and Hardy-Weinberg equilibrium			
	Solution	Judge the mode of inheritance and find a general formula of an allele frequency calculation for this case.			
	Analysis	Knowledge of autosomal dominant trait inheritance and thinking with formulas are needed.			

B48	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	■ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Dihybrid genetic cross and gene interaction			
	Solution	Judge the mode of inheritance and find a general formula of phenotype frequency calculation for this case.			
	Analysis	Knowledge of genetic cross and gene interaction are needed.			

B49	**P Values**	☐ Very Easy	85 – 100 %	■ Difficult	35 – 59 %
		☐ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	■ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	☐ Poor	Under 9 %
	Subject	Synteny test			
	Solution	Correlate the presence or absence of chromosome with the presence or absence of gene product.			
	Analysis	Knowledge of somatic cell hybridization and synteny test are needed.			

B50	**P Values**	☐ Very Easy	85 – 100 %	☐ Difficult	35 – 59 %
		■ Easy	60 – 84 %	☐ Very Difficult	0 – 34 %
	D Values	☐ Excellent	Above 40 %	☐ Fair	10 – 29 %
		☐ Good	30–39 %	■ Poor	Under 9 %
	Subject	Definition of biological species			
	Solution	Judge the correct answer based on the concept of biological species.			
	Analysis	Can be solved by simple thinking.			

M. Random Translation Check

IBO2011 sampled teams using systematic sampling from countries belonging to the gold and silver medals. There were 31 teams belonging to the gold and silver medals and we would like to select 10~11 samples. 31/10≒3 Every 3rd team was chosen after a random starting point between 1 and 3. 1 was our random starting point, so Australia, China, Germany, Indonesia, Japan, Lithuania, New Zealand, Russia, Switzerland, Turkey, USA were chosen. There were English, Mandarin, German, Indonesian, Japanese, Lithuanian, Russian, French, and Turkish.

The following pages are IBO2011 translation check lists

IBO2011 Check list

Country (team)_____Language_____

Checker_____

● Theoretical Exam A

A1 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A2 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A3 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A4 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A5 Ans:F

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A6 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A7 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A8 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A9 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A10 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A11 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A12 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A13 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A14 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A15 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A16 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A17 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A18 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A19 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A20 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A21 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A22 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A23 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A24 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A25 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A26 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A27 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A28 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A29 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A30 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A31 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A32 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A33 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A34 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A35 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A36 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A37 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A38 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A39 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

A40 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A41 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A42 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A43 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A44 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A45 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A46 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A47 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A48 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A49 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A50 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

A51 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A52 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A53 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A54 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A55 Ans:E

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A56 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A57 Ans:B

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

A58 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

● Theoretical Exam B

B1 Ans:ADE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B2 Ans:BCQS

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B3 Ans:BDE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to

all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

B4(1) Ans:5,2

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

B4(2) Ans:5,8

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

B4(3) Ans:7

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

B5 Ans:ACD

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

B6 Ans:ABC

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B7 Ans:CEF

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B8 Ans:BD

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B10 Ans:BDE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B11 Ans:ABD

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B12 Ans:AE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B13 Ans:BEF

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B14 Ans:BE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B15 Ans:DE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can

potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

B16 Ans:ABC

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

B17 Ans:ABE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
□ Yes □ No, the sentence "_____" is not.
Exact translation:_____

B18 Ans:ABE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B19 Ans: Ⅱ, Ⅴ, Ⅰ, Ⅲ, Ⅳ

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B20 Ans:b7,a4,e3,h1,f5,g8,d6,c2

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B21 Ans:ABCE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B22 Ans:b,c,e,g,h

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B23 Ans:e,b,a,c,g

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B24 Ans:h

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B25 Ans: Ⅰ,Ⅳ, Ⅰ, Ⅴ, Ⅲ

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B26 Ans:BE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B27 Ans:bc

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B28 Ans:AE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B29 Ans:06:00

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B30 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B31 Ans:BDE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B32 Ans:ABE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to

all the **options** in the question?

□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?

□ Yes □ No, the sentence "_____" is not.

Exact translation:_____

B33

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

B33.1 Ans:QqRr

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

B33.2 Ans:192

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

B33.3 Ans:0.6

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

B33.4 Ans:8%

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

B34 Ans:CD

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?

□ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B35

5. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B35a Ans: Ⅰ＋Ⅲ

6. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B35b Ans:ADE

7. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B35c Ans:C

8. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B36 Ans:BC

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B37 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B38 Ans:9

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B39 Ans:D

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B40 Ans:BDE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B41 Ans:BD

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B42 Ans:CE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question? □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated? □ Yes □ No, the sentence "_____" is not. Exact translation:_____

B43 Ans:ACE

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers? □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?

□ Yes, there is _____ as a hint. □ No

4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B44 Ans:BC

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B45 Ans:AC

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B46

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B46.1 Ans:AC

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B46.2 Ans:1/8

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B47

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B47.1 Ans:A

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

B47.2 Ans:0.069

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B48 Ans:5/16

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B49 Ans:5

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No

B50 Ans:C

1. Are there any symbols, spaces, misspellings or redundancies in the **question and figure** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
2. Are there any symbols, spaces, misspellings or redundancies in the **options** that can potentially be hints to correct answers?
   □ Yes, there is _____ as a hint. □ No
3. Are there any pictures and font styles, including size and format, which may suggest hints to all the **options** in the question?
   □ Yes, there is _____ as a hint. □ No
4. Are all the **options** correctly and clearly translated?
   □ Yes □ No, the sentence "_____" is not.
   Exact translation:_____

Signature: _____

IBO2011 Check list

Country (team)_____ Language_____

Checker_____

- **Practical exam 1-biochemistry and cell biology**

Task I

5. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
6. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.
Exact translation:_____

Q.1.4.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.5.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.6.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task II

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task III

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.1.(1.2)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.4.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.5.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.6.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.
Exact translation:_____

Q.3.7.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

- **Practical answer sheet 1-biochemistry and cell biology**

Q.1.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.4.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.5.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.6.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.1..

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.2..

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.
Exact translation:_____

Q.2.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.1.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.1.2

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.4.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.5.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.6.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.3.7.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

- **Practical Exam 2- animal physiology and anatomy**

Task I

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task II

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

- **Practical answer sheet 2- animal physiology and anatomy**

Q.1.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.3.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.2.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.2.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

- **Practical Exam 3- ecology and systematics**

Task I

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.1.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.1.2

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.2

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.3

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.4

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.5

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task II

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.
Exact translation:_____

Q.2.1.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.2(a-e)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.3

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.4(a.b)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.2.1(a.b)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.2.2(a.b.c)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3.2(a.b)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.4.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.4.2

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

- **Practical Answer sheet 3- ecology and systematics**

Q.1.1.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.1.2

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.3.1 Q.1.3.2 Q.1.3.3

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.4

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.3.5

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.2(a-e)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.3

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that

can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.

Exact translation:_____

Q.2.1.4(a)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.

Exact translation:_____

Q.2.1.4(b)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.

Exact translation:_____

Q.2.2.1(a)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.

Exact translation:_____

Q.2.2.1(b)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.

Exact translation:_____

Q.2.2.2(a.b.c)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3.1

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3.2(a)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q. 2.3.2(b)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.4.(1.2)

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.
Exact translation:_____

- **Practical Exam 4- plant anatomy, physiology, and genetics**

Task I

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task I Part A

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.A.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.A.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task I Part B

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.B.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task I Part C

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.C.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.C.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?

☐ Yes ☐ No, the sentence "_____" is not.
Exact translation:_____

Task I Part D

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.D.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task I Part E

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.E.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Task II

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?

☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.4.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.5.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

● Practical Answer sheet 4- plant anatomy, physiology, and genetics

Q.1.A.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.A.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.B.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated? ☐ Yes ☐ No, the sentence "_____" is not. Exact translation:_____

Q.1.C.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers? ☐ Yes, there is _____ as a hint. ☐ No

2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.C.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.D.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.1.E.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.1.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.2.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.3

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.4.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Q.2.5.

1. Are there any symbols, spaces, misspellings or redundancies in the sentence and figure that can potentially be hints to correct answers?
   ☐ Yes, there is _____ as a hint. ☐ No
2. Are all the questions correctly and clearly translated?
   ☐ Yes ☐ No, the sentence "_____" is not.
   Exact translation:_____

Signature: _____

N. Taipei Friendship Night

Date: Thursday, July 14th 2011

Time: 5:30 PM ~ 10:30 PM

Location: the Jhongjheng Hall of National Taiwan Normal University

Agenda:

Time	Event
17:30~21:30	Experiencing Taiwanese Snacks and Traditional Culture
18:30~	Traditional Lion and Drum Dance by Wego Private Elementary School
19:00~19:30	Orchestra Performance by Kang Chiao Bilingual High School
19:30~20:00	Award of “Lap around" in Opening Ceremony The most impressive team is “Liechtenstein” The most energetic team is “Netherlands” The most friendly team is “Australia” The best dressed team is “Sri Lanka” The most mysterious team is “Nigeria” The best team overall is “Germany”
20:00~21:00	Traditional Drama – Madame White Snake: Flooding of the Golden Mountain Temple
21:00-22:30	Dance Party

O. Culture Nights

a. Academic night

Date: Monday, July 11st 2011

Time: 6:30 PM ~ 11:00 PM

Location: Banqueting hall in Novotel Taipei Taoyuan International Airport

Agenda:

Time	Events
06:30~06:50	Introduction
06:50~09:00	Equipment (for practical exams) tryout
09:00~11:00	Different languages classes

b. Culture Night I

Date: Monday, July 12nd 2011

Time: 6:30 PM ~ 11:30 PM

Location: Banqueting hall in Novotel Taipei Taoyuan International Airport

Agenda:

Time	Events		
7:30~9:30	Performance	Order	Country
		1	(NA)
		2	Georgia
		3	Slovenia
		4	Germany
		5	Sweden
		6	Australia、Poland
		7	Ukraine
		8	Sri Lanka
09:30~09:40	Video－Taiwan will touch your heart		
09:40~09:55	Awards		
10:00~10:30	PR Group Dance		
10:30~11:30	Game 1－Human Bingo		

c. Culture Night Ⅱ

Date: Monday, July 13st 2011

Time: 6:30 PM ~ 10:30 PM

Location: Banqueting hall in Novotel Taipei Taoyuan International Airport

Agenda:

<table>
<tr><td>Time</td><td colspan="3">Events</td></tr>
<tr><td rowspan="11">7:00~8:30</td><td rowspan="11">Performance</td><td>Order</td><td>Country</td></tr>
<tr><td>1</td><td>Mexico</td></tr>
<tr><td>2</td><td>Armenia</td></tr>
<tr><td>3</td><td>Finland</td></tr>
<tr><td>4</td><td>Azerbaijan</td></tr>
<tr><td>5</td><td>Romania</td></tr>
<tr><td>6</td><td>Greece</td></tr>
<tr><td>7</td><td>Spain, Italy, Argentina</td></tr>
<tr><td>8</td><td>Indonesia</td></tr>
<tr><td>9</td><td>Russia</td></tr>
<tr><td>10</td><td>Sweden</td></tr>
<tr><td>8:30~9:00</td><td colspan="3">Award</td></tr>
<tr><td>9:00~9:30</td><td colspan="3">Game 1－Cell division</td></tr>
<tr><td>9:30~10:00</td><td colspan="3">Game 2－Support the frontline</td></tr>
<tr><td>10:00~10:25</td><td colspan="3">Game 3－Charades</td></tr>
<tr><td>10:25~10:30</td><td colspan="3">Awards</td></tr>
</table>

d. Culture Night Ⅲ

Date: Monday, July 15th 2011

Time: 6:30 PM ~ 11:00 PM

Location: Banqueting hall in Novotel Taipei Taoyuan International Airport

Agenda:

<table>
<tr><td>Time</td><td colspan="3">Events</td></tr>
<tr><td rowspan="12">7:30~8:30</td><td rowspan="12">Performances</td><td>Order</td><td>Country</td></tr>
<tr><td>1</td><td>Thailand</td></tr>
<tr><td>2</td><td>United Arab Emirates</td></tr>
<tr><td>3</td><td>Vietnam</td></tr>
<tr><td>4</td><td>China</td></tr>
<tr><td>5</td><td>Latvia</td></tr>
<tr><td>6</td><td>Hungary</td></tr>
<tr><td>7</td><td>Netherlands</td></tr>
<tr><td>8</td><td>Japan</td></tr>
<tr><td>9</td><td>Cyprus</td></tr>
<tr><td>10</td><td>Belarus</td></tr>
<tr><td>11</td><td>Taiwan</td></tr>
<tr><td>8:30~8:40</td><td colspan="3">Awards
Cultural Night Evaluation</td></tr>
<tr><td>8:40~9:10</td><td colspan="3">Clearance</td></tr>
<tr><td>9:10~10:20</td><td colspan="3">Game1: Monopoly of Taiwan Traveling</td></tr>
<tr><td>10:20~10:40</td><td colspan="3">PR Group dance & Monopoly Evaluation</td></tr>
<tr><td>10:40~11:00</td><td colspan="3">Awards</td></tr>
</table>

P. Award & Closing Ceremony

Date: Saturday, July 16th 2011

Time: 2:00 PM ~ 5:00 PM

Location: the Auditorium of the National Dr. Sun Yat-Sen Memorial Hall

Agenda:

Time	Event
14:00~14:30	Procession
14:30~14:35	Award for early departure team - Turkmenistan
14:35~14:50	Performance - Diabolo Saga and Human Pyramid
14:50~14:55	Address from the Minister of the National Science Council - Mr. Lou-Chuang Lee
14:55~15:10	Address from the Chairman of IBO Coordinators - Dr. Poonpipope Kasemsap
15:10~15:15	Video Competition Award Award Presenter: Steering Committee Member of IBO Coordinator Center - Mr. Gerard Cobut
15:15-15:51	Bronze Medal Award
15:51-16:15	Silver Medal Award
16:15-16:27	Gold Medal Award
16:27~16:32	Address from the Premier of the Executive Yuan - Mr. Den-Yih Wu
16:32~16:37	Address from the Head of IBO Coordinator Center One of funders in IBO1990 - Dr. Tomas Soukup
16:37~16:42	Address from the Chairperson of IBO2011 Organization Committee - Prof. Yung-Ta Chang
16:42~16:47	IBO2011- IBO2012 Hand-Over Ceremony
16:47~16:50	Address from the Representative of IBO2012 - Dr. Shirley Lim
16:50~17:00	Performance - Vital Spark

Addresses

Primer Den-Yih Wu, Executive Yuan:

Dr. Poonpipope Kasemsap, Chairman of IBO Coordinators Mr. Chen, Vice Chair of the National Science Council; Mr. Chen, Deputy Chief of the Ministry of Education, and Mr. Chang, President of National Taiwan Normal University. All the special guests, ladies, and gentlemen. Good afternoon.

I am much honored to be invited and participate in the closing ceremony of the 22nd International Biology Olympiad competition.

First, I would like to represent our government to show genuine gratitude and respect to all the staffs, experts, and scholars from all over the world who had planned and carried out this event in the past few days. Also, I would like to congratulate the outstanding groups and competitors who had won the prizes. You proved your abilities and outshone others among the 227 competitors from 58 countries. I am also very proud for that the four Taiwanese contestants all received gold medals, ranking Taiwan as number two among the 58 countries only next to the United States. Biology is a fascinating subject. It is also a lively technology. Therefore, our government has already included bio-technology into Taiwan's six prospecting industries that we are improving with full efforts.

We estimated our country's output value of bio-technology will grow from 2008's 150.6 billion to 260 billion in 2013. This is the goal that we will definitely spare no effort in achieving it. I also heard that, besides participating in the theoretical and practical exams, the IBO committee arranged the trips for contestants so that you could visit Yangmingshan National Park, National Palace Museum, Yilan National Center for Traditional Arts, and Yehliu Geopark.

This was a very well-planned schedule for that it allowed you to explore Taiwan's geographic scenes and the beauty of cultures and arts, fostering cross-boundary mutual understanding and friendship.

All good things must come to an end. But I hope this one week International Biology Competition can make all the participants' hearts overflow with joyful memories.

Wish all the representative teams have delightful trips home. And I hope that you could share what you've experienced here in Taiwan with your countrymen. Tell all your families and friends that Taiwan, the Republic of China, will be welcoming and anticipating all of your friends and beloved ones to visit here someday. Finally, I wish all of our guests here good health and good luck. Thank you.

Dr. Lou-Chuang Lee, Minister of the National Science Council:

President of International Olympiad, Dr. Kasemsap; President of Taiwan National University, Professor Chang; ladies and gentlemen, on behalf of the National Science Council, I would like to congratulate you all at this very moment.

It is our honor to co-host this ever-growing international event with the Ministry of Education.

The National Science Council regards the promotion of science and technology its highest priority and provides funding to support research in science and technology. The scientific career can be a

long and solitary one, but at the same time, it is full of surprise and joy. Sometimes, an answer to a question that we are working on seems nowhere to be found.
However, the major discovery often comes just when we feel helpless and hopeless. I would like to encourage you that in major leading science, especially in biomedical science, we are improving the lives of humankind. Collaborating with gifted friends and working in interdisciplinary topics can easily lead to important discoveries. I must congratulate you again, because you've already have interacted with so many outstanding young biologists around the world at this early stage of your career. There's no doubt then, in the next decades, many of you will be the leading scientists that bring us a new era of biology. Although the Olympiad will end today, I believe that the friendships you have made during this exciting international event will last for a lifetime.
I sincerely hope that the global alliances that you are building here in Taiwan will set the foundation for a bright future and better tomorrow. Thank you very much!

Dr. Poonpipope Kasemsap, The Chairman of IBO Coordinators:

I cannot tell you how excited I'm. It's really great pleasure to be here.
Your excellency, the Minister of National Science Council, and dear friends. How many new friends have you made so far this week? A lot of friends? That seems strange to make friends with your fellow competitors. No, not at all. See, a friendship found on competition is much better than a competition found on friendship. For those of you who have made a number of good friends this week, you are the master of a very important secret of all time. A man needs to be ready for his opportunities when it comes. For those of you who have not found many opportunities to make new friends, may I encourage you that you need not to wait for opportunity to come to you, a wise man will create more opportunities, then he finds one. Learning how to make new friends and how to create opportunity, to build strong friendship, is really a secret for human survival, because it leads to more cooperation. Charles Darwin once said long time ago, in the long history of mankind, those who learned to collaborate and improvised most effectively have prevailed. And we are the only human species have prevailed so far. The stronger ones, the stronger human species have not survived even though they are bigger, stronger, so rather stronger man not be survivor. Friendship is so important is his view, that Charles Darwin declare a man's friendship is one of the best measures of his worth. So you still have some time tonight and tomorrow to make more friends.
Well, I'd like to give some reflections on some IBO activities. Great varieties of excursions have been provided this year from National Palace Museum, very beautiful art crafts; National Center for Traditional Arts, Yangminshan, and Geo-Park, but I think the highlight of this year, cannot be any other place else, but the Taipei 101. The very high one, the high building, have you been there? Well, with all this extracurricular activities, you did very well in your test, indeed. And jury did very well, you know, their brains still function after after 24 hours of work, until six or seven in the morning. And the most important thing I would like to share with you is that Ling-Ling that just came to me inform that, the integrity, the Olympiad spirits, is really high, we are really doing the right things. A

number of countries came to the local experts and tell them that these extra points that you know, need to be taken out of your exam. So, sorry to say that, but because it's the error, you know they are being very honest and we recognize all for that.

In our life, we only want, we only take things at really serve, that's the spirit of Olympiads too. What about practical test on Tuesday? Do you like the spider? Come on, say yes! Yes, alright. Do you notice that one eye of a spider looks like one hundred eyes when your hands are shaking. I think the high light of this year practical was really the frog. You believe it, alright. Let me tell you a secret, we have many secrets, you know, in this Olympiad. While you are checking on frogs' nerve, we were checking on your nerve rather nervously indeed in the very beginning. Several jury member in the jury room expected that a lots number of competitors would have fainted. They call for ambulances and more beds available so that you know we be prepared in advance. The expected value number of causalities was estimated that to be very high. But the end, you know the result, nobody fainted, I don't know if the jury member fainted or not when they looked at the frog. But again, we did not even need to do CHI Square test on that, because you know zero means zero. If you really check that we accept the null hypothesis?

Well, no problem at all. The unexpected result, the failure, has never been a stop sign for us, but they are our guidelines, always are our guidelines. We'll move on. Further investigation required, I went around and did a small survey, very interesting of persuasion comes, from the Dennis team. Where are you Dennis team? Stand up, please. Move around you all, alright, great, you can sit down now. You see they have three lovely young ladies and one handsome young man, they are well prepared, the frog was nothing for them, not for the jury. In this year camp, there they sectile on their trunk, the trunks, and they skim the trunk. Three of them also went to last year's camp, and there they sectile on the snakes, snakes, you believe that? You don't seems surprise at all. Wow! Did you skim the snake too? Alright, so guys you know you saw them stand up and they are pretty, I know you want to, to recognize your opportunity. I warned you beware of the danger, on the outside, the phenotypes may look like cat walk angels, but inside, it's really Charlie's Angeles type. Dear host, you successfully organized a wonderful and memorable Olympiad. Thank you very much.

Wait wait wait wait, all of you, I still have twenty minutes to go, please. Thank you, thank you. Wow, the best things are write here, fifteen more pages.

This 22nd Olympiad is a great success because of your hard work, your dedication, and truly solid perfection. May I be allowed to present the token of appreciation to members of the organizers. The Chairperson of IBO 2011, Dr. Kuo-en Chang, the President of National Taiwan Normal University, please come up to the stage. And I like to call five more members of the organizers: Dr. Yung-ta Chang, Dr. Jen-che Wang, Dr. Teng-Chiu Lin please come up the stage, Dr. Chung-Hsin Wu, Dr. Chih-Wen Sun, please come.

Well, at this time, the International Biology Olympiad recognize the outstanding commitment and involvement from our members and juries, Miss Galina Romanovets and Dr. Natalia Maximova from Belarus, please come up on the stage. Belarus joined IBO since 1992 and hosted IBO in 2003 and it

was a great success with several innovations. High percentage of reasoning questions, high reliability tests, the use of the PCs that works for jury session for the first time, extra day for social activities and so on. And they have been with us for a long long time.

And last but not least, someone very special, she has helped us for a long long time, to translate English to Russian, and Russian back to English. Many many years, we in debt to her. Miss Olga Waksmann, where are you? Olga, come!

Dear friends, this International Biology Olympiad last only a few days, in fact, it will end tomorrow. But the ending will bring a new beginning, of your exciting journey to bright future. You are now well known for your success. For those of you who will get gold, silver, bronze medals, congratulations in advance. Hey.

And for many of you who would not win a medal this time, remember, the award shall lies in a struggle, not in the prize. You'll be very successful in the future I'm sure. But for everyone, your career, your life, is a voyage with a purpose, and a purpose must be shouted. A person who starts out going nowhere, usually gets there – nowhere. You will reach your goal, not by chance, but by choice. You are young, you are bright, and you came acquire our need skills and knowledge to be successful in the future. But remember, the seed of knowledge is in your head, but a wisdom is in your heart. I have no doubt that you'll become a man of success, many successes. But I truly wish you'll become a man of value, a man of value makes his personal success become meaningful and valuable to others, especially the ones less privilege and get less access, or no access to the results you have enjoyed. To me, Biologies are most beautiful and valuable. Thank you all for this great memory, we meet again in Singapore.

Dr. Tomas Soukup, The Head of IBO Coordinator Center:

Distinguished guests, dear friends, let me allow to say a few words, although I think that more things here are already set by the competitors themselves. As a member of IBO, I would like once again to thank to Taiwan Government, to Normal University and Science Council, authorities, to my colleagues in jury who worked hard, to competitors who competed in a fair way, and certainly to all the organizers. I would like to thank all the organizers personally, but it's not possible. So I'll ask the main organizer, Professor Yung-ta, Chang, to give my thanks to all of them, so my thanks to him. Probably for most of you it's not surprising that the names in this part of the word means, or have their own meaning. So Yung-ta could be translated always achieving. Always achieving the goal that he gives himself, so it was a very good choice when the main organizer was Professor Yung-ta, Chang. It means the man who can always achieve the goal that he has. Also, Yung could also be translated as a forever, and I think also this meaning is important for us because we'll remember this wonderful IBO forever. So, in his names are two secrets of the success of this IBO, and I would like to ask Professor Yung-ta Chang to come here because it's a already tradition that before the ceremony or our silver cup goes to the next organizer, the organizer of the present IBO will receive from us a smaller but a gold cup. Professor Yung-ta Chang, please, can you come to me?

Dr. Yung-Ta Chang, The Chairperson of IBO2011 Organizing Committee:

The Depute of Minister of Education Dr. Chen, Chairperson of National Science Council Dr. Lee, Chairperson of IBO Dr. Kamsansap, Chairperson of IBO 2011, the president of NTNU, Dr. Chang, All participants, Ladies and Gentlemen:

Till now, the IBO2011 goes smoothly, on behalf of the organizing committee, it is my honor to appear our appreciation to:

Science committee member for their efforts in exam tasks development, thank you very much,

Science subgroup meeting members, also thanks for your efforts for reducing to suffer the long discussion in Jury meeting. All volunteers, student and jury guides, student and jury staffs, and exam staffs. Also my co-workers, the organizing committee members, Prof Chung-Hsin Wu, Bij-Chyi Hwang, Chih-Wen Sun, Teng-Chiu Lin, Chi-Mei Lee from Dept. of Life Science NTNU and Researcher Pei-Hua Lo, Tsung-Hau Jen, John Che-Di Lee, thanks for all your hard works.

The full time assistants Irene Tao, in this month for the arrangement of this event she responded more than thousands E-mails or phone calls. Chia-hua Hsieh, Li-Wen Chao and Hsin Chien Cheng

I also would like to appear my appreciation to Poon and Tomas for their guidance in our organizing process. Thank you, Poon and Tomas.

As you know, 3 years ago, NTNU were authorized to host and organize IBO2011, not because it is easy but because it is hard. As you know, right the season is the season of Typhoon in Taiwan. We run till now in the normal Schedule, actually, we organized more than 10 schedules for IBO2011 in case we need to change the schedule if Typhoon visits us. Fortunately, till now we just need to run the normal schedule, I think this is also why my government authorized National Taiwan Normal University to host and organize this event.

To keep the exam standardized and competition fair is our responsibility; it is also the spirit of IBO games. We are not allowed to let any students receive the medals and results reluctantly. But we also believe after this contest, no one is considered the underdog. I wish all you will be successful in your carrier development in the near future. And wish all of you have a nice trip in your post-tour or in your flying home, thank you very much.

Q. Textbook Exchange

We deeply appreciate the kindness of the following countries.

Country	TEXTBOOK EXCHANGE	Amount
Armenia	V	3
Bulgaria	V	1
China	V	6
Georgia	V	3
Germany	V	5
Greece	V	5
Hungary	V	2
Iran	V	4
Japan	V	25
Pakistan	V	2
Poland	V	5
Russia	V	5
Slovenia	V	3
Spain	V	4
Sri Lanka		9
Turkmenistan	V	6
Ukraine	V	16
UNITED ARAB EMIRATES	V	2

IBO2011 wish all of you always keep smile like the lovely 7 Angels.