THE 20TH INTERNATIONAL BIOLOGY OLYMPIAD 2009 TSUKUBA JAPAN

July 12-19, 2009

OFFICIAL REPORT

2009 Tsukuba Japan IBO
THE 20th INTERNATIONAL BIOLOGY OLYMPIAD

Contents

Introduction

The 20th International Biology Olympiad (IBO) was held in Tsukuba, Japan from 12th July to 19th July and was attended by 221 students and 210 leaders and observers from 59 countries and regions, including 3 observing countries. It was the largest Olympiad in the IBO's twenty-year history.

The opportunity for Japan to host the 20th IBO came as a surprise at the end of 2006 after the sudden cancelation by the original hosts, Greece. At that time, there was a lengthy discussion on whether to accept or not. The reasons for opposition were simple and reasonable—there was no money, no time and no history. Japan began participating in the IBO just two few years before, in 2005, which meant the organization was too weak to organize the 20th IBO. In addition, there was only two years for preparation including fund-raising. However, Japan ultimately decided to hold the 20th IBO in Japan for the continuity of IBO, for the contribution to the students and biology of the world, and for the development of biology and science education in Japan.

The 20th IBO was hosted by three organizers—IBO2009 Tsukuba Organizing Committee, the University of Tsukuba, and Japan Science Foundation (JSF). The Organizing Committee organized the IBO while JSF was charged with budget management and pre-events. The University of Tsukuba played a large role in the preparation and execution. The University renovated a building to be used as the exam venue, and installed new desks, chairs, labware etc at its own expense. The Executive Committee, volunteer students and staff consisted mostly of the members of the University of Tsukuba.

The 20th IBO faced many serious troubles during the preparation stage, such as the worldwide financial crisis, the so-called Subprime shock and Lehman shock. The pandemic of 2009 H1N1 Flu (Swine flu) was one of the biggest troubles possible to call off the 20th IBO. Fortunately, the flu situation calmed temporarily in June and July in many countries including Japan, so we could commence the 20th IBO. We were also fortunate with the weather during the 20th IBO. Despite being rainy season in Japan, there was no rain during the week. The 20th IBO was a great success, a success that was accomplished by dedicated service and work by all staff and volunteers, in addition to the unreserved cooperation of leaders, observers and students that participated in the 20th IBO.

Outline of the 20th International Biology Olympiad

Honorary President	His Imperial Highness Prince Akishino
Official Name	The 20th International Biology Olympiad
Abbreviated Name	IBO2009 Tsukuba
Duration	July 12th 2009 (Sunday) to July 19th (Sunday), 8 days
Venue	Tsukuba City, Ibaraki-Prefecture, Japan (University of Tsukuba with Tsukuba Science City)
Organizer	IBO2009 Tsukuba Organizing Committee / University of Tsukuba / Japan Science Foundation
Co-Organizer	Ibaraki Prefecture/ Tsukuba City/ Tsukuba Science City Network / Tsukuba Expo'85 Memorial Foundation / National Museum of Nature and Science
Special Sponsor	Japan Science and Technology Agency
Cooperation	Gushinkai Foundation
Official Supporter	The Ministry of Education, Culture, Sports, Science and Technology / Cabinet Office, Government of Japan / The Ministry of Foreign Affairs of Japan / The Ministry of Health, Labour and Welfare / The Ministry of Agriculture, Forestry and Fisheries of Japan / The Ministry of the Economy, Trade and Industry / The Ministry of Environment / Science Council of Japan / The Asahi Shimbun / The Mainichi Newspapers / The Yomiuri Shimbun / Nikkei Inc. / The Sankei Shimbun / The Chunichi Shimbun / Jiji Press, Ltd. / Kyodo News / The Ibaraki Shimbun / Japan Broadcasting Corporation / Ibaraki Broadcasting System / Joyo Newspaper / Joyoliving
Institutional Support	The Japanese Association for the Study of Taste and Smell / Anatomical Science International (ASI) / The Botanical Society of Japan / The Japanese Biochemical Society(JBS) / The Society for Biotechnology, Japan / The Zoological Society of Japan / Japan Society for Bioscience, Biotechnology, and Agrochemistry / The Pharmaceutical Society of Japan / The Japanese Pharmacological Society / The Molecular Biology Society of Japan / Japanese Society for Immunology (JSI) / The Genetics Society of Japan / The Japanese Association of Medical Sciences / Japanese Society for Biological Sciences in Space / Palaeontological Society of Japan / Japan Society for Cell

	Biology Contents / The Japanese Society of Plant Physiologists / The Japanese Society for Neurochemistry / The Japan Neuroscience Society (JNS) / Society of Evolutionary Studies, Japan / Ecological Society of Japan / The Society of Biological Sciences Education of Japan / The Biophysical Society of Japan / The Japanese Society of Phycology / Association of Japanese Agricultural Scientific Societies / The Japanese Society of Developmental Biologists (JSDB) / The Japanese Society for Comparative Physiology and Biochemistry / The Japan Society for Comparative Endocrinology (JSCE) / The Japanese Society of Microbial Ecology (JSME) / The Society for Antibacterial and Antifungal Agents, Japan / The Physiological Society of Japan
Participated Countries	59 (including three observing countries)
Participants	Students 221, Team leaders 110, Observers 104
Staff	Staff 77 (excluding committee members), Assistant Students 84, Volunteer Students 121
Medals	Gold Medals 23, Silver Medals 46, Bronze medals 68
Participants Fee	$2,500 USD per team (for four students and two team leaders) $1,500 USD per observer

Organization

1. Organizing Committee

Chairperson

Hiroo Imura, Professor Emeritus, Kyoto University

Vice Chairperson

Hideo Mohri, Professor Emeritus, University of Tokyo
Osamu Numata, Chair/Executive Committee, Professor, University of Tsukuba
Katsumi Matsuura, Chair/Science Committee, Professor, Tokyo Metropolitan University
Makoto Asashima, Chair, Fund Raising Committee / Professor, University of Tokyo

Adviser

Kiyoshi Kurokawa, Professor, National Graduate Institute for Policy Studies
Etsuhiko Shouyama, Chairman Emeritus, Hitachi Limited.
Katsunosuke Maeda, Chairman Emeritus, Toray Industries, Inc
Fumimaro Takaku, President, Japanese Association of Medical Sciences

Committee Members

Katsuhiro Utada, Chairman, Japan Association of Bioindustries Executives
Hatsuo Aoki, Senior Advisor, Japan Manufacturers Association
Tadashi Hirata, Senior Advisor, Kyowa Hakko Kirin Co., Ltd.
Shinichi Aizawa, President, Japanese Society of Developmental Biologists
Yutaka Hatsumi, President, Japan Association of Biology Education
Sakayu Shimizu, President, Japan Society for Bioscience, Biotechnology, and Agrochemistry
Norio Matsuki, President, The Pharmaceutical Society of Japan
Tetsukazu Yahara, President, Ecological Society of Japan
Kazuyoshi Tsutsui, President, Japan Society for Comparative Endocrinology
Sadao Ishiwa, Professor Emeritus, Ochanomizu University.
Nori Satoh, President, The Zoological Society of Japan
Ryoko Imaichi, President, The Japanese Society of Plant Morphology
Tadaharu Tsumoto, President, Japan Neuroscience Society
Kiyotaka Okada, President, The Molecular Biology Society of Japan
Keiko Nakamura, Director General, JT Biohistory Research Hall

Eisuke Nishida, President, Japan Society for Cell Biology
Kenzo Nakamura, President, The Japanese Society of Plant Physiologists
Mariko Hasegawa, President, The Society of Evolutionary Studies, Japan
Kazuyuki Mikami, President, The Society of Biological Science Education of Japan
Masahiro Sokabe, President, The Biophysical Society of Japan
Hidenori Ichijyo, Councilor, The Japanese Biochemical Society
Shigeo Mori, President, Japanese Society for Biological Sciences in Space
Hiroo Fukuda, President, The Botanical Society of Japan
Nobuhiro Yamada, President, University of Tsukuba
Masaru Hashimoto, Governor, Ibaraki Prefecture
Kenichi Ichihara, Mayor, Tsukuba City
Akira Ono, Senior Vice-President, National Institute of Advanced Industrial Science and Technology
Tadashi Yamaki, Vice-President, National Agriculture and Food Research Organization
Yuichi Obata, Director, RIKEN BioResource Center and Tsukuba Institute RIKEN
Toranosuke Nishino, Chairman, Meikeikai, Alumni Association of Tsukuba University, Corporate Juridical Person
Kenji Tsuboi, Managing Director, Japan Science Foundation

2. Fund Raising Committee

Chairperson

Makoto Asashima, Professor, University of Tokyo

Committee Members

Kouichi Ikeda, Chairman, CEO, Asahi Breweries, Ltd
Hatsuo Aoki, Counselor, Astellas Pharma Inc.
Katsuhiro Utada, Chairman, Japan Association of Bioindustries Executives
Haruo Naito, President, CEO, Eisai Co.,Ltd.
Tatsuo Higuchi, President, Representative Director, Otsuka Holdings Co.,Ltd.
Yuzaburo Mogi, Chairman, CEO, Kikkoman Corporation
Tadashi Hirata, Counselor Emeritus, Kyowa Hakko Kirin Co., Ltd.
Koichiro Aramaki, President, CEO, Kirin Holdings Co., Ltd
Nobutada Saji, President, Suntory Holdings Limited
Motozo Shiono, President, Shionogi & Co., Ltd.
Shoji Uehara, President Emeritus, Taisho Pharmaceutical Co., Ltd.

Kiyoshi Morita, Chairman, Corporate Officer, Daiichi Sankyo Co., Ltd.
Yasuo Okamoto, Adviser, Dainippon Sumitomo Pharma Co., Ltd.
Kunio Takeda, President, Takeda Pharmaceutical Co., Ltd.
Natsuki Hayama, President, Representative Director, Mitsubishi Tanabe Pharma Corporation
Osamu Nagayama, President, Chugai Pharmaceutical Co. Ltd.
Takashi Wachi, Representative Director, Chairman, Terumo Corporation
Shoichiro Toyoda, Chairman Emeritus, Toyota Motor Corporation
Katsunosuke Maeda, Chairman Emeritus, Toray Industries,Inc.
Etsuhiko Shoyama, Chair, Hitachi, Ltd.
Ichiro Kitasato, Supreme Advisor, Meiji Seika Kaisha, Ltd.
Akinori Suzuki, President, Association of Japanese Agricultural Scientific Societies
Kimura Hiromichi, Professor, University of Tokyo
Yoshihiro Hayashi, Professor, University of Tokyo
Shoichi Shogenji, Professor, University of Tokyo
Hideo Mohri, Professor Emeritus, University of Tokyo
Hiroshi Kamada, Professor, University of Tsukuba
Masahiko Ikeuchi, Professor, University of Tokyo
Ryoichi Matsuda, Associate Professor, University of Tokyo
Makoto Yoshizaki, Professor, Toho University
Hiroshi Hosoya, Professor, Hiroshima University
Jyunichi Saito, Teacher, Tokyo Gakugei University Senior High School

3. Science Committee

Chairperson
Katsumi Matsuura, Professor, Tokyo Metropolitan University

Committee Members
Theoretical Exam sub committee
Katsumi Matsuura, Professor, Tokyo Metropolitan University
Masakazu Shimada, Professor, University of Tokyo
Fumio Tajima, Professor, University of Tokyo
Sadao Yasugi, Professor, Kyoto Sangyo University
Munetaka Sugiyama, Associate Professor, University of Tokyo
Hiroshi Wada, Professor, University of Tsukuba
Masayuki Okutani, Teacher, Tokyo Metropolitan Koishikawa Secondary

Education School
Yoko Nagayama, Teacher, Friends School
Keiko Suzuki, Teacher, Hosei University Girls' High School

Practical Exam sub committee
Shinobu Satoh, Professor, University of Tsukuba
Kazuo Watanabe, Professor, University of Tsukuba
Rhuichiro Machida, Associate Professor, University of Tsukuba
Koji Nomura, Associate Professor, University of Tsukuba
Tomohiko Kuwabara, Associate Professor, University of Tsukuba
Katsuo Furukubo-Tokunaga, Associate Professor, University of Tsukuba
Kyoichi Sawamura, Lecturer, University of Tsukuba
Kentaro Nakano, Lecturer, University of Tsukuba

4. Executive Committee

(Staff were members of the University of Tsukuba unless otherwise stated)

Chairperson: Osamu Numata
Vice Chairperson: Shinobu Satoh, Koji Nakamura

Financial and General Affairs sub committee
Chairperson: Yoshihiro Shiraiwa
Financial Affairs: Iwane Suzuki, Hisashi Satoh
General Affairs: Koji Iwamoto, Katsutsugu Tando, Yukiko Tsurumi, Akiho Yamauchi, Etsuko Kounosu, Akemi Ishitsuka
Registration and communication: Yachiyo Tobita, Yukiko Tsurumi, Jennifer Manyweathers, Yoko Ogasawara

Implementation sub committee
Chairperson: Hiroaki Iwai
Arrangement of Student Accommodation: Masayoshi Tokita, Yosuke Degawa, Yasunori Sasakura
Arrangement of Food: Kazuto Nakada
Arrangement of City Transport: Akitsugu Satoh
Arrangement of Airport transfer: Yachiyo Tobita
Arrangement of Students Volunteers: Hiroaki Iwai, Chikahumi Chiba
Arrangement of Special Lecture: Takeo Usui

Arrangement of Examination Venue: Humiaki Maruo
Arrangement of Amity Programs: Humiaki Maruo, Chikahumi Chiba, Yoshimi Ojima
Arrangement of Tsukuba Night: Iwane Suzuki, Hidekazu Kuwayama
Arrangement of Reception Desk: Yoshiteru Hashimoto, Jun Hurukawa
Arrangement of Sign: Shin-Ichi Miyamura
Arrangement of IBO Materials: Iwane Suzuki, Koji Iwamoto
Arrangement of Medical Care: Keiji Tanimoto, Masato Shibuya, Osamu Matsuzaki
Arrangement of Excursions: Akira Kikuchi, Takeo Hama, Toshiyuki Tanaka
Arrangement of Recoding: Kazuichi Sakamoto, Yuji Inagaki, Koji Iwamoto
Arrangement of Daily News: Ken-Ichiro Ishida, Takeshi Nakayama, Mattew Wood

Ceremony sub committee
Chairperson: Koji Nakamura
Member: Iwane Suzuki, Chikahumi Chiba, Ken-Ichiro Ishida, Koji Iwamoto

Public Relations sub committee
Chairperson Osamu Numata
Vice Chair: Ken-Ichiro Ishida
Arrangement of Pre-Events: Osamu Numata
Arrangement of Website: Ken-Ichiro Ishida

Practical Exam sub committee
Chairperson: Shinobu Satoh
Arrangement of Exam Room: Humiaki Maruo, Kazunori Ohami, Muneo Michikawa, Nanae Abe
Arrangement of Student Guidance: Hiroaki Iwai, Humiaki Maruo, Shin-Ichi Miyamura, Chikahumi Chiba
Arrangement of Liaison and Coordination: Hiroshi Wada
Arrangement of Inspectors Care: Mamoru Watanabe, Kazuharu Ohashi, Tomoki Chiba, Hideko Urushihara
Arrangement of Separate Room Exam: Yoichi Kaino, Yuichi Yamaoka
Advisor: Yuichi Nakazato (Junior and Senior High School at Komaba, University of Tsukuba), Katsumi Matsuura (Tokyo Metropolitan University), Munetaka Sugiyama (University of Tokyo)

Theoretical Exam sub committee
Chairperson: Hiroshi Wada
Arrangement of Exam Room: Kei Nakatani, Kazuharu Ohashi, Mamoru Watanabe,

Yoshimi Ojima
Arrangement of Inspectors Care: Tomoki Chiba, Hideko Urushihara
Arrangement of Separate Room Exam: Yoichi Kaino, Yuichi Yamaoka

Jury meeting sub committee
Chairperson: Katsumi Matsuura
Arrangement of Jury Meeting Room: Tsuyoshi Mizoguchi, Mitsuru Hirota, Shinobu Satoh
Arrangement of Jury Meeting Progression: Kazuo Watanabe, Jennifer Manyweathers
Arrangement of Sub Jury Meeting: Koji Iwamoto

5. SCIBO (Students' community for IBO, the volunteers)

(Staff were members of the University of Tsukuba unless otherwise stated)

Leader
Sora Enya, Keiko Fujita, Ai Ichikawa, Takayuki Murata, Syouichi Ishikawa, Michika Fukushi

Sub-Leader
Kentaro Honda, Yurina Suzuki, Daiki Adachi, Yuta Shimizu, Makoto Doiguchi, Mari Fujita, Marika Akiyama, Yasuhumi Komagata, Wataru Nagatomo, Reiko Wada, Koumei morino, Yuka Kunugise

Team Guide

Argentina	Joanna Fajardo	Makoto Doiguchi
Armenia	Aki Ushiki	Kyouko Miwa
Australia	Alisa Senifa	
Azerbaijan	Yuko Arai	
Belarus	Yoshiaki Morino	Aya Komada
Belarus	Toshihito Mitsuma	Kensuke Seto
Belgium	Yoshinari Yonehara	Miyako Takayanagi
Brazil	Yumiko Osawa	Yuki Nishimura
Bulgaria	Atsushi Nakamura	Wataru Nagatomo
Canada	Yukina Kato	Saori Yoshida
China	Chen Shu	Wang Xinyi
Cyprus	Soyomi Uchibori	Madoka Moriyama
Czech	Fumika Akizawa	

Denmark	Marika Akiyama	Kouhei Takeda	
Estonia	Keisuke Hattori		
Finland	Ai Takebe		
France	Taiki Adachi	Kanta Kwanabe	
Greece	Nozomi Yoshihara	Hideaki Shoji	
India	Takuya Kondou	Ryuta Sakaguchi	
Indonesia	Honda Kentarou		
Iran	Hanie Bidadi		
Ireland	Kanae Sakai	Aya Miyashita	
Italy	Shingo Yokota	Haruka Sakurai	
Japan	Yurina Suzuki	Naomi Takebe	
Kazakhstan	Yasuhumi Komagata	Yuusuke Takasu	
Korea	Hyojung Jeon		
Kuwait	Akane Kawaguchi	Yuta Mashimo	
Kyrgyzstan	Kazuya Hasegawa	Sakie Haruna	
Latvia	Haruka Sasaki		
Liechtenstein	yuya Iguchi		
Lithuania	Mari Fujita		
Mexico	Yusuke Muraoka	Atsushi Nakajima	
Mongolia	Takuma Mimura	Sawako Yotsuya	
(The)Netherlands	Shiori Doi	Kazuki Katou	
New Zealand	Reiko Wada		
Nigeria	Yuko Numajiri	Asuka Goto	Kensuke Seto
Pakistan	Kanta Kwanabe	Eri Nakagawa	Nagisa Akaboshi
Pakistan	Yu Uchiumi		
Poland	Teruki Satoh	Naomi Takebe	Kensuke Igarashi
Romania	Andrei Dinu-Ionita	Yusuke Fukushima	
Russia	Eriko Ochi	Singo Ogata	
Singapore	Yuka Kunugise		
Slovakia	Kikyo Watanabe	Haruka Goto	
Slovenia	Mugiho Fukuda		
Spain	Masatoshi Yamazaki	Kouhei B. Hayashi	
Sri Lanka	Takuto Takahashi	Hayato Shiba	Saori Yoshida
Sweden	Koki Inoue	Azusa Ota	
Switzerland	Takuya Inamura	Saori Yoshida	
Taiwan	Melody Tsai	Takuro Hasegawa	
Tajikistan	Yuri Tsuboyama		
Thailand	Pitaksaringkarn Weerasak		

Turkey	Hassan Ucharu	
Turkmenistan	Yuta Shimizu	Yu Uchiumi
USA	Kaoru Sone	Kensuke Igarashi
Ukraine	Moe Amemiya	Kashimura Yuko
United Kingdom	Sakuya Fujita	Risa Shigemasa
Vietnam	Kana Kitabayashi	

Team-J (for Daily news)

Yuko Ikegami, Saki Tsukada, Syu Shirato, Yui Miyachi, Kunpei Ito, Shinya Ueda, Ayako Kikuchi, Naoko Shidehara, Miho Shimizu, Jon Hyojon, Kaoru Takeshita, Yuri Matsuoka, Kana Murakami, Nozomi Morita, Yumi Washizawa, Takaaki Abe, Takuo Teramoto, Tomomi Sawada, Yuna Takaya, Takato Honda, Yusuke Kurumazaki

Team-R (for Radio Broadcasting)

Misato Suzuki, Haruka Sano

The 20th International Biology Olympiad

1. Logo, Emblem and Albatross

Logo:

We have clearly shown the key words of the 20th International Biology Olympiad: "IBO", "2009", "Tsukuba", and "Japan". Also, it uses a five-petaled cherry blossom and a circle in the shape of the Japanese flag to illustrate the host country. The five letters of "Japan" colored in Olympic colors shows that this meeting is a science Olympiad, and the double helix of DNA strands shows that it is an Olympiad of biological sciences.

Emblem:

Its circular shape shows friendship and peace, and also the hope to establish international exchange and friendship between participants from all over the world. Moreover, the circle stands for the Japanese flag, a five-petaled cherry blossom and the white silhouette of Mount Tsukuba shows the host country Japan and Tsukuba. The basic color stands for "Ibaraki blue", wide sky and the vast Kasumigaura Lake of Ibaraki.

Albatross

The bird in the emblem is an albatross (*Pheobastria albatrus*). The population of this species dropped sharply by overhunting and thus its habit is limited to Torishima and Senkaku islands today. However, the number have restored to 2500 as a result of conservation activities contacted mainly by Japanese researchers. This albatross is included in the emblem of the 20th International Biology Olympiad because it is recovering from the verge of extinction. This is in the spirit of the International Biology Olympiad which hopes for enrichment in education and the environment of the Earth. The bird's migration over borders gives us an image of international exchange.

2. Participants

Teams:

1. Argentina
2. Armenia
3. Australia
4. Azerbaijan
5. Belarus
6. Belgium
7. Brazil
8. Bulgaria
9. Canada
10. China
11. Chinese Taipei
12. Cyprus
13. Czech Republic
14. Denmark
15. Estonia
16. Finland
17. France
18. Germany
19. Greece
20. India
21. Indonesia
22. Iran
23. Ireland
24. Italy
25. Japan
26. Kazakhstan
27. Korea
28. Kuwait
29. Kyrgyzstan
30. Latvia
31. Liechtenstein
32. Lithuania
33. Mexico
34. Mongolia
35. (The) Netherlands
36. New Zealand
37. Nigeria
38. Pakistan
39. Poland
40. Romania
41. Russia
42. Singapore
43. Slovak Republic
44. Slovenia
45. Spain
46. Sri Lanka
47. Sweden
48. Switzerland
49. Tajikistan
50. Thailand
51. Turkey
52. Turkmenistan
53. Ukraine
54. United Kingdom
55. United States of America (USA)
56. Vietnam

Observing Countries:

1. Hungary
2. Saudi Arabia
3. United Arab Emirates (UAE)

Students:

Argentina
Martin Facundo Bresnal
Matias Roberto Landino
Santiago Sosa
Sebastian Vishnopolska

Armenia
Varsik Avanesyan
Anna Gevorgyan
Armen Nazaryan
Arpine Torosyan

Australia
Thomas Brereton
Mel Chen
Kristijan Jovanoski
James Nicolas Woodmansey

Azerbaijan
Artoghrul Alishbayli
Nihat Aliyev
Azad Alizada
Resad Cobanli

Belarus
Natallia Siarheeuna Bukhtarevich
Anton Alexandrovich Kavaleuski
Dzmitry Sergeevich Kuzmin
Andrei Yurjevich Sukhareuski

Belgium
Charlotte Callewaert
Jeanne Fourmentin
Nicolas Lepers
Samuel Vandewaeter

Brazil
Rainne Andre Siqueira
Nasser Camara Magalhaes
Daniel Patrocinio Zen
Pedro Sabino Gomes Neto

Bulgaria
Maria Svetomirova Atanasova
Delyan Tsvetanov Georgiev
Andrey Svetlinov Ivanov
Gergana Venkova Velikova

Canada
Aaron Joseph Hakim
Geoffrey James Osgood
Clinton Jia Wang
Fan Zhu

China
Siyang Hao
Rong Huang
Zhengda Li
Chenyu Zhang

Chinese Taipei
Ruei-Je Chang
Yu-Chi Kuo
I-Chun Lee
Po- Fan Wu

Cyprus
Michalis Georgiou
Ioanna Kyprianou
Andreas Petrides
Souzana Eirini Xyda

Czech Republic
Jana Faltynkova
Michael Mikat
Tereza Nedvedova
Jan Smycka

Denmark
Ellen L. Freese
Bolette Mose Jakobsen
Camilla Verner Klejs
Malte Thodberg

Estonia
Mark Gimbutas
Madis Hurt
Uku-Laur Tali
Eero Vaher

Finland
Lassi Ilmari Helanti
Jaakko Tapani Hyypia
Justus Mutanen
Mikko Johannes Tiusanen

France
Mireille Carrere
Mathis Funk
Marine Leve
Mircea Sofonea

Germany
Dave Hartig
Ilia Kats
Jan Krieghoff
Marcel Kuckelkorn

Greece
Anastasia - Paraskevi Aliferi
Sofia - Grigoria Athanasopoulou
Sofia - Ifigeneia Chrysoglou
Margarita Papatheodoridi

India
Usnish Adhikari
Amit Gupta
Vidhi Hathi
Chetan Srinath

Indonesia
Danang Crysnanto
Anugerah Erlaut
Irfan Haris
Elbert Wijaya

Iran
Arya Haj Mirzaian
Arad Iranmehr
Fatemeh Kashani
Fatemeh Moghadas

Ireland
Francis Samuel Duffy
Roxanne Angelika Lau
Aoife McCarthy
Piers Martin Murphy

Italy
Michele Candrina
Gianmarco Messa
Lorenzo Pallini
Pier Luigi Susini

Japan
Atsuhito Nakayama
Ryota Otsuki
Mai Yamakawa
Ayako Yanaka

Kazakhstan
Nazym Nurlanovna Bashkenova
Ruslan Vladimirovich Kalizhan
Talap Kossybakov
Roman Langolf

Korea
Inji Chang
Na Ye Choi
Woo Jin Jeon
Soo Jin Kim

Kuwait
Abdulrazaq Alawadhi
Suaad Soud Alfaraj
Aishah Mohammad Alsaleh
Hussain Ali Dashti

Kyrgyzstan
Damirbek Abibillaev
Kuban Duishenbekov
Emil Semetei Uulu
Askhatbek Temirkulov

Latvia
Adrija Kalvisa
Juris Kibilds
Zigmunds Orlovskis
Gunda Zvigule

Liechtenstein
Sebastian Haelg

Lithuania
Milda Jakutaviciute
Julius Juodakis
Justas Lavisius
Kotryna Vaidziulyte

Mexico
Jorge Ivan Aguirre
Aaron Ramirez
Miguel Angel Ramos
Janssel Reyes

Mongolia
Myagmarsuren Bat-Erdene
Khongorzul Mungunkhuyag
Bayanbaatar Munkhsaikhan
Ariundalai Tsogbadrakh

(The) Netherlands
Leonie Van Steijn
Danique Van Vliet
Philip Will
Jelle Zijlstra

New Zealand
Max Biggs
Sophia Louise Frentz
Geoffrey Vincent Hoggins
Jiangyuan (Jenny) Liu

Nigeria
Mohammed Idris
Aduramo Abigail Lasode
Edidiong Victor Udoyen
Chiedozie Ugwoke

Pakistan
Saima Hanif
Tayyaba Maqbool Malik
Mahym Mansoor
Raheel Sufian Siddiqui

Poland
Michal Piotr Banacki
Tomasz Jakub Klaus
Pawel Przemyslaw Stepniewski
Lukasz Truszkowski

Romania
Lucian Craciun
Adina -Ioana Dinu
Mihaela Georgescu
Mirela Diana Ilie

Russia
Alexey A. Agapov
Larisa A. Akulkina
Anastasia O. Maslova
Georgy A. Nosov

Singapore
Qi Yan Ang
Yangzi Dong
Wei Han Tan
Chengxiang Yuan

Slovak Republic
Katarina Dlugosova
Samuel Genzor
Kristina Kicova
Veronika Nogellova

Slovenia
Vida Set
Tina Subic
Nina Turk
Nejc Umek

Spain
Elena Collado Lledo
Kevin Doello Gonzalez
Alvaro Lafuente Romero
Pablo Rivera Perez De Rada

Sri Lanka
Sameera Erandaka Ariyarathna
Sameera Gamlath Gamlath Ralalage
Dehiwala Pathirannehelage Udari Tankana Samarasiri
Mirihanage Dona Maheshi Sandunika Wijiayabanbara

Sweden
Yahia Al-Jebari
Lena Margareta Kallsten
Martin Alexander Norlin
Erik Olof Johannes Wannerberg

Switzerland
Linus Meier
Martin Michel
Claudia Simonett
Stefanie Tanner

Tajikistan
Khurshedi Davronzod
Hilola Hakimova
Timur Khabibullin
Azam Kozizoda

Thailand
Virapat Kieuvongngam
Phun-Phai Somkearti
Nuntanuj Vutthikraivit
Jatuporn Wanichanont

Turkey
Enes Karabacak
Osman Aykan Kargin
Alime Gokce Kocaarslan
Sukru Sogut

Turkmenistan
Shohrat Allayev
Rustam Esanov
Farhat Rahimov
Orazdurdy Rahimov

Ukraine
Artem Komissarov
Sergii Kostrikov
Anastasiya Kravets'
Olga Povorozniuk

United Kingdom
Sarah Gales
Joseph Edward Harvey
Elizabeth Eva Jefferys
Edwin Lindsay Pynegar

US A
Jonathan Samuel Gootenberg
David Pai Huang
Seungsoo Kim
Jonathan James Liang

Vietnam
Le Thuy Duong
Duong Thu Huong
Nguyen Thi Nhu Quynh
Nguyen Thi Thuy Trang

Team Leaders and Observers:

Argentina (2)
Gladys Beatriz Mori De Moro
Maria Isabel Ortiz

Armenia (2)
Gayane Ghukasyan
Margarita Grigoryan

Australia (3)
Patricia Therese Illing
Mary Colette Oliver
Morgan Blake Sheridan

Azerbaijan (2)
Adalat Farajov
Anar Majidov

Belarus (2)
Natalia Pavlovna Maximova
Galina Stepanovna Romanovets

Belgium (5)
Gerard Cobut
Louis De Vos
Victor B. Rasquin
Marleen Van Strydonck
Hugo Vandendries

Brazil (2)
Ana Lucia Giannini
Rubens Akeshi Macedo Oda

Bulgaria (2)
Iliyan Lazarov Iliev
Mariela Konstantinova Odjakova-Baytocheva

Canada (2)
Christel Yvonne Olivier
Robert James Roddie

China (4)
Yongmei Qin
Xiangjun Tong
Chongren Xu
Jindong Zhao

Chinese Taipei (12)
Yung-Ta Chang
Da-Wei Chao
Jin-Hsin Cheng
Shu-Chuan Hsiao
Bij-Chyi Hwang
Teng-Chiu Lin
Yu-Shan Liu
Kwok-Tung Lu
Jyh-Wei Shin
Jenn-Che Wang
Ying Wang
Chumg-Hsin Wu

Cyprus (3)
Avgousta Hadjineophytou
Michael Hadjineophytou
Christina Sidera

Czech Republic (3)
Jan Cerny
Antonin Reiter
Tomas Soukup

Denmark (4)
Karen Helmig
Mette Miller
Kirsten Woeldike
Birthe Zimmermann

Estonia (3)
Kalle Kipper
Sulev Kuuse
Maarja Soomann

Finland (3)
Tuomas Juha Eero Aivelo
Pinja Kaarina Jaspers
Matias Lommi

France (3)
Jean-Louis Michard
Eric Perilleux
Barbara Zodmi

Germany (3)
Dennis Kappei
Eckhard R. Lucius
Christiane Muehle

Greece (2)
Theodoros - Dimitrios Chr. Oreinos
Despoina Sanoudou

India (3)
Madan Mohan Chaturvedi
Purushottam Gopalkrishna Kale
Anindya Sinha

Indonesia (6)
Devi Nandita Choesin
Sucipto Hariyanto
Maelita Ramdani Moeis
Agus Dana Permana
Iriawati Prayogo
Gunardi Sihhatmanahadi

Iran (4)
Mahnaz Azarnia
Saman Hosseinkhani
Amin Jahanbakhshi
Hossein Lari Yazdi

Ireland (3)
Michael Anthony Cotter
Elaine Darcy
Richard O'Kennedy

Italy (3)
Eva Godini
Isabella Marini
Anna Pascucci

Japan (5)
Hiroko Hasegawa
Harushi Nakajima
Hiroshi Okuda
Junichi Saito
Yukio Sato

Kazakhstan (2)
Amangeldy Kuanbayevich Bissenbayev
Bayram Kenci
Sara Eshmukhambetovna Kudabayeva

Korea (23)
Joon Mo Ahn
Yun Shin Bae
Un Haing Cho
Ahnheum Eom
Kwon-Soo Ha
Jung Hee Han
Ui Wook Hwang
Sang-Hak Jeon
Dai Hag Jung
Ho Kam Kang
Joon Kim
Ki Hong Kim
Ki Joong Kim
Myeong-Sook Kim
Sung-Ha Kim
Tae-Hoon Kim
Hawk Bin Kwon
Pil Sung Yoon
Jeong Kyu Lee
Kil-Jae Lee
Myeong Ok Lee
Chae-Seong Lim
Yun Bae Pak

Kuwait (3)
Samia Abdulaziz Alqattan
Rashed Taher Alshamali
Hajar Zahed Mousawi

Kyrgyzstan (2)
Aigul Akhmatova
Baken Sharsheyeva

Latvia (2)
Maruta Kusina
Janis Liepins

Liechtenstein (2)
Michael Jutzi
Mirjam Staubli

Lithuania (3)
Raimondas Siuksta
Paulius Lukas Tamosiunas
Jurga Turcinaviciene

Mexico (2)
Cristina Revilla
Jorge Hugo

Mongolia (3)
Batjargal Batdorj
Nyambayar Dashzeveg
Naranjargal Sukhragchaa

(The) Netherlands (3)
Eva Deinum
Hans Morelis
Ange Taminiau

New Zealand (3)
Susan Irene Adams
Heather Elizabeth Meikle
Julian Charles Robson

Nigeria (8)
Aishatu M.B Ahmad
Betty Abiola Are
Ayodele Dare Aregbesola
Olarewaju Kayode Fabile
Victoria Kiddam
Abonlanle Olukemi Lasode
Jonathan Ajisafe Ogidi
Tinu .S Oyeniyi

Pakistan (3)
Zafar Mahmood Khalid
Al Hasanat Rasul Mujahid Bin Mumtaz
Muhammad Saeed

Poland (2)
Piotr Bebas
Magda Sobolewska-Lacka

Romania (2)
Traian Saitan
Alexandra Simon-Gruita

Russia (2)
Aleksandr M. Rubtsov
Gleb G. Shvetsov

Singapore (8)
Cheong Hoong Diong
Jie He
Siew Lee Shirley Lim
Shawn Kaihekulani Yamauchi Lum
Hong Kim Tan
Ter Ming Timothy Tan
Foong Yee Tham

Slovak Republic (3)
Pavol Elias
Miroslava Slaninova
Bohuslav Uher

Slovenia (3)
Tatjana Durmic
Andreja Skvarc
Katja Stopar

Spain (4)
Jose Luis Barba Gutierrez
Carmen Diaz Santana
Javier Fernandez-Portal Diaz Del Rio
Maria Jose Lorente Carchano

Sri Lanka (3)
Hiran Samarasinghe Amarasekera
Horadigala Gamage Nandadasa
Mudiyanselage Jayantha Sisirakumara Wijeyarante

Sweden (3)
Mats Carl-Gustav Carlberg
Ulf Lennart Larsson
Lena Ann-Marie Lundquist

Switzerland (6)
Thierry Aebischer
Pascal Burki
Jonas Helfer
Michel Rene Stabler
Daniel Wegmann
Mathias Wenger

Tajikistan (2)
Khayrullo Avgonov
Faysal Yilmaz

Thailand (6)
Supachitra Chadchawan
Chanpen Chanchao
Poonpipope Kasemsap
Noppadon Kitana
Sawinee Moosophon
Pitiwong Tantichodok

Turkey (2)
Ertunc Gunduz
Ismail Turkan

Turkmenistan (1)
Sevki Aydin

Ukraine (3)
Svitlana Fitsailo
Nataliia Skrypnyk
Lidiia Vashchenko

United Kingdom (2)
Neil Thomas Richards
David Calcott Rigby

USA (2)
Melissa Kosinski-Collins
James Saunders

Vietnam (9)
Trinh Thi Lan Anh
Kim Ngoc Chinh
Duong Minh Lam
Pham Van Lap
Nguyen Thi Linh
Dinh Doan Long
Lethi Kim Nhung
Le Dinh Tuan
Mai Sy Tuan

Other (2)
Alex Friedmann
Olga Waksmann

Observing Countries

Hungary (3)
Sandor Ban
Eva Fekete
Bela Gal

Saudi Arabia (2)
Ibrahim Mohammad H. Alhazza
Fuad Eleithah S. Althagafi

UAE (1)
Khalid Abdullah Dawood

3. Schedule

Date	Students	Jury
July 12 (Sun)	12:00-18:30 Arrival and registration (Epochal Tsukuba)	
	18:30-21:30 Orientation (Ninomiya House)	18:30-21:30 Jury reception (Epochal Tsukuba)
July 13 (Mon)	10:00-11:30 Opening ceremony (Epochal Tsukuba) 12:30-14:00 Welcome party (Epochal Tsukuba)	
	15:00-17:30 Practical exam room visits (University of Tsukuba)	14:00- Review and translation of practical test questions (Epochal Tsukuba)
July 14 (Tue)	9:30-17:30 Practical exam (University of Tsukuba)	7:45-19:45 Excursion (Nikko)
	20:00-22:00 Origami Night (Ninomiya House)	
July 15 (Wed)	8:30-17:30 Excursion (Tsukuba science tour)	8:30- Review and translation of theoretical exam questions (Epochal Tsukuba)
July 16 (Thu)	Theoretical exam (University of Tsukuba)	9:20-12:30 Excursion (Tsukuba science tour) 13:00-16:00 Examination of practical exam answers (Epochal Tsukuba)
	18:00-20:30 Tsukuba Night (University of Tsukuba)	
July 17 (Fri)	6:30-21:20 Excursion (Nikko)	9:20-12:30 Examination of theoretical exam answers 14:00-18:30 Coordinators' meeting 20:00-23:00 Medal presentation approval meeting (Epochal Tsukuba)
July 18 (Sat)	8:50-11:30 Excursion (Tsukuba Expo Center)	9:20-12:30 Excursion (Tsukuba science tour)
	14:00-15:30 Special seminar 16:00-17:30 Award ceremony, Closing ceremony 16:30-23:00 Farewell party and Dance party (Epochal Tsukuba)	
July 19 (Sun)	Departure of participants	

Epochal Tsukuba: Tsukuba International Congress Center

12th July The reception desk was opened at Tsukuba International Congress Center (Epochal Tsukuba) for both students and Jury from 12:00 till 23:40 when the last team arrived. Teams from all 59 countries checked in this day. An airport pickup was organized at the Narita International Airport and Tokyo International Airport (Haneda) for teams arriving on the 12th. Teams already in Japan, were picked up at Tsukuba station or their hotel in the city. At the reception desk, participants' health condition and body temperature was checked as measures to combat 2009 H1N1 Flu, in addition to the general reception process such as name check, final collection of participants fee and IBO membership etc. The congress bag personalized by a name tag was also distributed at the reception desk, containing an official program book, an information book, a tour guide for excursions, a brochure for special lectures, a name badge, a quick reference notebook, T-shirt, a holding fan, pin badges, a University of Tsukuba leaflet, a UT college of biological sciences leaflet, note paper, a ballpoint pen, a book "Botanical Gardens Koishikawa & Nikko" and a DVD "The ICORP Organ Regeneration Project, Clarifing the Mechanism of Organ Formation". Additionally, students were given a clinical thermometer, a lab coat, a rain coat and a pouch containing a scientific calculator, an electric chronograph, safety gloves, safety goggles and stationery such as a marker, pencil, ruler etc.

13th July The opening ceremony and the welcome party were held at Epochal Tsukuba with the participation of Their Imperial Highness Prince and Princess Akishino. The program started with the setting of the IBO Cup by Dr. Hideo Mohri, the Vice Chairperson of IBO2009 Tsukuba Organizing Committee The cup was handed to Dr. Mohri by Prof. Arvind Kumar, Chairperson of 19th IBO at Mumbai India last summer. His Imperial Highness Prince Akishino, the honorary president of the 20th IBO, emphasized the importance of biology, and at the same time the importance of basic research such as taxonomy and morphology in his speech, and encouraged the students, stating "I strongly wish you all excellent results in the competition". The words left a deep impression on all participants. After the welcome party, students left Epochal Tsukuba to visit the exam venue and the Jury stayed for the jury session for the practical exam. The discussion ended around 1:00 on 14th, though it was 8:30 when the last team finished the translation.

14th July The practical exam was held at the University of Tsukuba over the entire day. After the examination, the students returned to their lodgings, Ninomiya House and enjoyed learning the skill of Origami, the traditional Japanese art of paper folding, at Origami Night. Meanwhile, the Jury visited world heritage listed Nikko to see

Kegon-no-taki Fall, and Nikko Toshogu Shrine.

15th July Students enjoyed the Tsukuba Science City Tour as their first excursion. They visited AIST (National Institute of Advanced Industrial Science and Technology), JAXA (Japan Aerospace Exploration Agency) and Ibaraki Nature Museum. While the students enjoyed the tour, the Jury discussed the questions of theoretical exam. Surprisingly, the session was over at 18:30. It may be the result of the sub jury meetings which were held from 9th to 12th by some jury members to refine the questions in advance of the IBO2009 Tsukuba. Those members were Dr. Poonpipope Kasemsap (Thailand), Mr. Sung-Ha Kim (Korea), Mr. Hans Morelis (Netherland), Ms. Mary Colette Oliver (Australia), Mr. Aleksandr M. Rubtsov (Russia), Dr. Anindya Sinha (India), Mr. Daniel Wegmann (Switzerland) and Dr. Katsumi Matsuura (Japan). Ms. Olga Waksmann and Mr. Alexnader Friedmann also attended the meeting to translate the questions to Russian language.

16th July Students took the theoretical exam at the University of Tsukuba, while the Jury were taken on the Tsukuba Science City Tour in the morning and to a jury session for reviewing the practical exam in the afternoon. In the evening, the students and Jury met for the first time in days at the University of Tsukuba to attend Tsukuba Night. All participants enjoyed the performances of Japanese drumming by “the Tokimeki Taiko Juku” and of Yosakoi-Soran dance by “the Kiri Kiri Mai”, a UT students’ group. At the end of Tsukuba Night, participants dance in a large group in front of the main stage.

17th July Students visited Nikko. In addition to the Nikko Toshogu Shrine that the Jury saw, they also learned about the natural areas of Nikko at Nikko Yumoto Visitor’s Center, and the farming of freshwater fish at Nikko Laboratory of National Research Institute of Aquaculture. The Jury were engaged in jury session—the review of the theoretical exam in the morning, a coordinators’ meeting in the afternoon, and a medal presentation approval meeting in the evening.

18th July In the morning, the students were taken on an excursion to the Tsukuba Expo Center and the jury were taken on the Tsukuba Science City Tour. The special seminar in commemoration of the 20th IBO and the 200th anniversary of Charles Darwin’s birth was held at Epochal Tsukuba by Makoto Asashima, Professor, University of Tokyo with the title “Life Science—Past, Present and Future”. Following this, the closing ceremony began with a performance of classical Japanese dance. In

attendance were special guests of ambassadors and embassy staff from eight countries—Argentina, Czech Republic, France, Germany, Indonesia, Kuwait, Slovenia and Switzerland. The benefactors of IBO, Mr. Tomas Soukup, the secretary of the IBO Coordinating Centre, Mr. Pavol Elias, the coordinator of Slovak team and Mr. Hans Morelis, the former chairperson of the IBO coordinators were commended by Dr. Poonpipoppe Kasemsap, the chair of the IBO coordinators in commemoration of the 20th anniversary of IBO. The members of the Science Committee then presented 23 gold medals, 46 silver medals and 68 bronze medals and certificates. The top three students were specially honored with the Tsukuba University Award for top place, the JST (Japan Science and Technology Agency) Award for second place, and the Ibaraki-Prefecture Award for third place. These were awarded by the Vice Chairpersons Dr. Hideo Mohri, Dr. Makoto Asashima and Dr. Osamu Numata. Extra prizes were also awarded by Dr. Nobuhiro Yamada, president of the University of Tsukuba, Mr. Koichi Kitazawa, the president of JST, and Mr. Shin Fukuchi, the counselor of Ibaraki prefecture. After the award ceremony, Mr. Tomas Soukup, on behalf of IBO coordinators, awarded a commemorative trophy to Dr. Hiroo Imura, Chairperson of 20th IBO Organizing Committee, by way of appreciation for Japan's the acceptance of 20th IBO at a time of crisis for IBO coordinators. The ceremony concluded with the handing over of the IBO cup from Dr. Hiroo Imura, the chairperson of 20th IBO Organizing Committee (Japan), to Dr. Kil-Jae Lee, Chairperson of 21st IBO (Korea), in the presence of Dr. Poonpipoppe Kasemsap, the chair of the IBO coordinators. The farewell party and subsequent dance party were held at Epochal Tsukuba.

19th July Most teams departed from Tsukuba to Narita International Airport or Tsukuba station by transport supplied by 20th IBO.

4. Opening Ceremony

Monday, July 13, 2009, 10:00 a.m.- 11:30 a.m.
at Tsukuba International Congress Center

Program

10:00	Opening Movie
10:02	Entry of the IBO Cup by Dr. Hideo Mohri, Vice Chairperson, IBO 2009 Tsukuba Organizing Committee
10:03	Competitors Entrance Procession
10:34	Tsukuba Introduction Video
10:43	Opening Declaration by Dr. Hiroo Imura, Chairperson, IBO 2009 Tsukuba Organizing Committee
10:47	National Anthem (Host Country)
10:49	Address ・His Imperial Highness Prince Akishino, Honorary President of IBO 2009 Tsukuba ・Dr. Poonpipope Kasemsap, Chair, IBO Coordinators ・Mr. Ryu Shionoya, Minister, Ministry of Education, Culture, Sports, Science and Technology ・Dr. Akito Arima, Chairman, Japan Science Foundation ・Dr. Nobuhiro Yamada, President, University of Tsukuba ・Mr. Masaru Hashimoto, Governor, Ibaraki Prefectural Government
11:18	Oath by Student Representatives, Mr. Ryota Otsuki & Ms. Mai Yamakawa
11:20	Oath by Jury Representatives, Ms. Shirley Lim, Vice-Chair, IBO Coordinators
11:24	Closing Remarks

Speeches

His Imperial Highness Prince Akishino
Honorary President of the 20th International Biology Olympiad

Distinguished Participants, -Team leader, and Observers, Ladies and Gentlemen,

It is my great pleasure to meet you all today at this opening ceremony of the 20th International Biology Olympiad. Also it is a great pleasure for Japan to host this 20th Olympiad in the 200th commemorative year of Charles Darwin's birth.

Biology is regarded as one of the most important academic areas for mankind and the global environment. The steady progress of biology and biotechnology have contributed greatly to our society throughout the 20th century by elucidating various aspects of the phenomena of life, as well as overcoming many intractable diseases, improving the environment, increasing food production, enhancing food safety, and so on.

On the other hand, some countries have even questioned the necessity of preserving research materials, given that the number of researchers engaged in natural history-related fields, such as taxonomy and morphology, has decreased rapidly in recent years. We can say that research into, and preservation of, materials or specimens in these fields provide a valuable foothold for advancing applied research. Moreover, I think the tendency to seek short term outcomes alone in biology is not desirable.

Under the present circumstances, there are still many issues left to which biology can contribute, in areas such as the environment, nature conservation, energy and resources, and regenerative medicine. I think to cope with these issues, the development of biology as a whole, including the basic areas that I have mentioned, is essential. Therefore I hope that biologists of the younger generation, such as yourselves, will explore extensive areas of biology.

By the way, Japan is a country with a harmonious blend of nature, culture, modern science and technology. I hear that you will visit Nikko, which is a World Heritage Site for its shrines and temples, set amidst the scenic beauty of nature, which has been carefully preserved. Nikko is regarded as a typical example of the harmonious blend of nature and culture. Although you came to Japan to attend the Biology Olympiad, I hope you will also take this opportunity to experience Japanese nature, culture, and history during your stay here.

In concluding my address, I strongly wish you all excellent results in the competition while extending your circle of friends by exchanging information with participants from all over the world and a fruitful time here in Japan. Thank you.

Dr. Poonpipope Kasemsap
Chair of the International Biology Olympiad Coordinators

Ladies and gentlemen, I'd like to draw your attention to the aims of the Olympiad. The Biology Olympiad is dedicated to the proposition that biology is a beautiful and valuable subject. We are here to challenge and to stimulate gifted students, to expand your talents, and to promote your career as biologists, very important for a better world.

This year the whole world realized the value of biology to mankind with the start of the swine flu pandemic. And I would like to thank the organizers for their effort, not only to host this exciting Olympiad, but also to make sure that this Olympiad is fit to survive under tremendous pressure from swine flu. To the participants the Olympiad is about competition and competition has its special role in our lives, imagine a world without competition. Happier world? Easier world? No challenge, no fun. Right? You agree? Without competition is it really possible for evolution to take place? What would the world be like without competition, and maybe a lesser degree of evolution?

Are there any other factors that contribute more to evolution than competition? What about cooperation? Can you name a few biological cooperations that are milestones in evolution? You are biologists, the greatest biologists of your age, maybe in your test tomorrow, or the day afterwards on Thursday who knows? Charles Darwin said in the long history of mankind, those who collaborate and improvise most effectively have prevailed.

I can tell you that the Biology Olympiad is very much concerned with cooperation. It is one of our aims to promote cooperation among competitors and also local and international scientists. But only 60% of you here will win a medal, it doesn't mean that the remaining 40% are losers, because all of you can win the most valuable prize ever, friends. So make friends. This is a very important week. You get the chance to make friends with 220 other competitors. To make friends is the most important step to establish successful and sustainable cooperation that leads to a better chance to prevail. And I will tell you later on what Charles Darwin said about friendship, at the closing ceremony. May I wish you all a great success in this Olympiad. [Japanese] Thank you very much.

Dr. Hiroo Imura
Chair of the 20th International Biology Olympiad Organizing Committee

Your Imperial Highnesses, Prince and Princess Akishino, Distinguished Guests from the Japanese Government, from Ibaraki Prefecture, Tsukuba City and other organizations, Dear Friends from abroad, Ladies and Gentlemen.

On behalf of the Organizing Committee of the IBO 2009 Tsukuba, I would like to extend a very warm welcome to all the students and juries here representing 56 countries and regions. We are very pleased to have such a large number of participants with us in Japan's most prominent science city, Tsukuba.

Over the past decade, biological sciences have made great strides in many areas, especially those based on genomic research. We now know the blue prints of, not only humans, but a variety of organisms. We also better understand the process of evolution from unicellular organisms through to humans. This year, as you know, marks 200 years since Charles Darwin was born, and also the 150th anniversary since first publication of his famous book, "On the Origin of Species". However, so much still remains to be studied. We need to elucidate how our bodies are formed from our genome blue prints, how cells are organized from proteins and how bodies function in changing environments. This is the reason why the 21st century is the century of biological science. I hope that many of you students here today will join the front lines of this research.

I also hope that all of you here in Tsukuba will perform to the best of your ability in both examinations and experiments. I know you will put your well-learned knowledge and skills to good use. Likewise, I know that all juries will cooperate to ensure the success of this IBO meeting in Tsukuba.

So I wish all of you a very enjoyable stay in Japan and hope you will meet many Japanese people, learn much about Japanese culture, enjoy delicious Japanese food, and make many new friends to treasure for a lifetime.

Ladies and gentlemen, I hereby declare that the IBO 2009 Tsukuba has started. Thank you very much for your attention.

Prof. Akito Arima
Chairman of the Japan Science Foundation

Today, we have the pleasure of His Imperial Highness Prince Akishino, and Her Imperial Highness Princess Akishino's, company at IBO2009 Tsukuba. And, as one of the hosts, I would also like to extend my heartiest welcome to the student representatives and jury members who have come to Tsukuba from countries all over the world. In Japan our summer season includes a monsoon period so, at times, it can be very hot and humid. It's a good climate for harvesting rice but not so comfortable for people. So I urge all of you students to take good care of your health. Your hosts want you to be able to give your very best effort while you are here. This will be so important to your future success.

It is said that the 21st century is the biology era. By making good use of developments in physics and chemistry we are going to enjoy some extraordinary results. I am certain these will have a big impact on the history of biology. For example, we have achievements from the complete sequence of the human genome. We also have amazing research into embryonic stem cells and induced pluripotent stem cells. All these achievements are occurring one after another. As such, we can expect that, in several decades from now, humanity will likely advance to a totally different level. This will be a level of knowledge and technology far beyond our existing achievements in the life sciences, including medical science. For example, from both theoretical and experimental physics we have come to understand much about the origin of the Universe, 'the Big Bang'. In the same way, the origin of life on earth will, in due course, become clear. As a scientist and nuclear physicist I hold some great expectations about the possibilities which lie ahead for biology. I believe that all the students taking part in IBO2009 Tsukuba will play an important role in this exciting process. However, the era of research carried out by solitary individuals is over. Researchers around the world too often only compete with one another. Instead we need our researchers to cooperate together more in order to achieve innovative progress. So I hope that each of you will make use of the IBO2009 Tsukuba to make new friendships and thereby form the "seed bed" for your cooperation in future research.

The Year 2009 is the 200th anniversary of Charles Darwin's birth. He played such an important role in biology and, he wrote as follows; "It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change." In his time, "change" meant "change under the given – or received - circumstances". But is this true today? Human abilities have now become so powerful that we are the ones who are changing the environment of nature itself. In this "Year of Darwin", I ask all of you wanting to pursue biology further to also clarify the essence of adaptability and Nature's evolution. I also ask you to please keep up your interest in Nature's sustainability. Always be sure to respect Nature's permissible range of "change". I thank you for your attention.

Dr. Nobuhiro Yamada
President of University of Tsukuba

Their Imperial Highness Prince and Princess Akishino, Minister of Education, Culture, Sports, Science and Technology, Governor of Ibaraki prefecture, Mayor of Tsukuba City and colleagues from all over the world.

It is my great pleasure to welcome you as the one of the hosts of the 20th International Biology Olympiad. As the president of the University of Tsukuba, I'm also pleased to welcome you to our campus for the theory and practical examination, and Tsukuba Night.

The University of Tsukuba is both an old and a new university. The University was constructed in 1973 and so it is only 36 years old. However, its origins can be traced back to 1872, more than hundred years ago, to The Normal University. The University of Tsukuba is one of the largest universities in Japan. It is about 4 km in length and covers an area of 257 hectares. On our campus, 21,000 students and staff study and research every day in various fields such as social sciences, natural sciences, technologies, medical sciences, art, sports etc. In every field, our staff and students lead the competition in Japan.

As I mentioned before, the university campus will host the examination that is one of the main events of IBO2009. All the university staff and students, particularly the members of Biology have worked very hard to organize the event. In addition, the university has renovated the buildings used for the examinations and prepared new equipment for IBO2009 to provide the best environment for you. We hope that you will be able to perform your best. We will also host Tsukuba Night, an activity that celebrates the Japanese summer festival and welcomes exchange between the students and jury members. It will be held just after finishing all examinations so I hope you can enjoy the Summer Night in Japan and promote international friendship, forgetting about the gold medal for a while.

Enjoy the 20th International Biology Olympiad and Good luck!

Mr. Ryu Shionoya
Minister of Ministry of Education, Culture, Sports, Science and Technology

Today, we are greatly honored by the presence of His Imperial Highness Prince Akishino and Her Imperial Highness Princess Akishino, and have the pleasure of their company at this event. I congratulate everyone on organizing such a splendid opening ceremony to launch this 20th International Biology Olympiad in grand fashion. To our participants gathered here from about sixty countries and regions around the world, welcome to Japan. As an opportunity for talented young people from all over the world to gather, our country is greatly pleased to host the International Biology Olympiad.

To us human beings, as living creatures ourselves, biology is a discipline that is familiar to us, as its focus is the living creatures in our immediate environment. At the same time, as biology is frequently utilized in our daily lives and in industry, it is also a discipline that supports society. In the future, in terms of developments in life-supporting medical treatments and pharmaceutical technologies, as well as issues facing our modem societies including food shortages and energy problems, biology can make a tremendous contribution to resolving these global challenges. In addition, along with the major developments in molecular biology as an academic field, we are seeing advances in the application of biology to other fields. As such, I believe that biology will also increasingly contribute to scientific progress.

To date, the International Biology Olympiad has offered a challenging venue for motivated and capable students, playing a major role in cultivating their abilities. Japan has highly valued the significance of this event and offered its support. In the future, all students participating in this event will develop science even further and each one of you has unlimited potential to launch new technologies. We hope that along with realizing the fruits of your talents and efforts, you establish friendships that transcend national borders and last far into the future. We also have high hopes that your experiences at this gathering will form the foundation of your future development as leaders in the field of science and technology.

In closing, I would like to convey my gratitude to the 20th International Biology Olympiad Organizing Committee, the University of Tsukuba, and the Japan Science Foundation for promoting this event. I would also like to express my deep respect for the efforts everyone involved, and we hope for the continuing advancement of the International Biology Olympiad. Thank you for your kind attention.

Mr. Masaru Hashimoto
Governor of Ibaraki Prefectural Government

Your Imperial Highnesses Prince and Princess Akishino, distinguished guests, Ladies and Gentleman.

I would like to extend my heartfelt respect on this occasion of hosting the 20th International Biology Olympiad. We are honored by the presence of Their Imperial Highnesses Prince and Princess Akishino. We are also delighted to welcome so many future scientists from all over the world. Today, the importance of science and technology is becoming greater and greater than ever before. Biology makes an especially significant contribution to modern society. I am very proud and delighted that Ibaraki will host Japan's first IBO.

On this occasion, I would like to introduce Ibaraki Prefecture to you. There are about 3 million people in Ibaraki. Ibaraki is a very well-balanced prefecture as we are productive in both industry and agriculture. Here in Tsukuba, there are about 300 research institutes and universities. About 20,000 scientists, including about 6,000 PhD degree holders, are here in Tsukuba working on research in fields such as nanotechnology and biotechnology. In Tokai region, the world's leading accelerator facility, Japan Proton Accelerator Research Complex, "J-PARC" began operation last December. J-PARC is expected to play an active role in a wide range of fields, such as in the understanding of protein motion and how it applies in biotechnology. We hope that Ibaraki Prefecture will continue to be an important base for the development of science and technology in Japan.

It is my sincere hope that your interest in biology will strengthen through challenging biological theories and experimental questions at this IBO. I also hope you will expand your network around the world as you take part in various events and activities with different people. I heard there will be a science tour for you to visit several Tsukuba's research institutes. Please make the most of your special opportunity to experience the wonder of the cutting-edge research and to talk with the researchers. I truly hope this IBO will provide all of you with opportunities to deepen your interest in biology and so on. I look forward to seeing each one of you displaying your talents within a wide range of fields.

Finally, I would like to express my sincere thanks and respect to all the related individuals who have put so much effort into helping to host IBO. Also, I hope that all of you will enjoy good health and continue to pursue your excellent work. Thank you very much.

5. Closing Ceremony

Saturday, July 18, 2009, 4:00 p.m.- 5:30 p.m.
at Tsukuba International Congress Center

Program

16:00	Opening Remarks
16:02	Address ・Dr. Hiroo Imura, Chairperson, IBO 2009 Organizing Committee ・Ms. Seiko Noda, Minister of State for Science and Technology Policy, Food Safety (Video message) ・Dr. Koichi Kitazawa, President, Japan Science and Technology Agency ・Mr. Humio Isoda, ・Dr. Poonpipope Kasemsap, Chair, IBO Coordinators
16:26	This Week (movie show)
16:36	Overview of examination by Dr. Katsumi Matsuura, Chair, Science Committee of IBO 2009 Tsukuba
16:40	Award Announcements & Medal Presentations
17:35	Presentation of trophy to IBO2009 Tsukuba by Tomas Soukup, Executive Officer, IBO Coordinators Center
17:40	Handing Over the IBO Cup from Dr. Hiroo Imura to Dr. Kil-Jae Lee, Chair of 21st IBO (Korea)
17:47	Closing Remarks

Speeches

Dr. Poonpipope Kasemsap
Chair of the International Biology Olympiad Coordinators

I'm getting old so I'll take a little bit of my time. Dear friends and distinguished guests, how many new friends have you met so far this week? 220? Who has met 220 new friends? Oh, you guys are laughing at me. You are all right! Quantity is not important; it's the quality of your new friends. You have to give your heart out to win some hearts back. Does it seem strange to you to make friends with your competitors? No? You are right. Actually, you should see that your competitors have a lot in common with you. You all share the same passion, the passion in biology. That's why we always think that it should be so easy for you to make new friends in this Biology Olympiad. And I'm sure that your friendship with your new friends will grow on from this moment and it will last forever. I promised you a quote from Charles Darwin and here it is: "A man's friendships are one of the best measures of his worth."

I would like to give you some evaluation of IBO activities of the past week. Let's begin with the jury meeting. In every Olympiad the jury members work so hard to make necessary changes to the questions before their approval. If a question is not good enough for the Olympiad we skip it, we throw it away, we delete it. And normally it takes 12 to 18 hours, sometimes 24 hours, for each test – for theoretical, for practical – so that you can have a 2 to 4 hours test. That means we work so hard for you. Sometimes we finish discussion at 3 or 4 am in the morning, some countries work until dawn, 6 or 7 in the morning. Your papers remain warm when you touch it in the exam room. But something extraordinary really happened in this Olympiad. I'm not sure if it will ever happen again. We have had no skipped questions – all the questions remain. And for the first time in history, we finished looking at the theoretical part at 6 pm in the evening – 12 hours faster than normal. And I can tell you that this reflects the high quality of the test prepared by the organizers, give a big hand to them.

Practical observations, some story here, previous Olympiads, during the practical tests on Tuesday, competitors have to make good biological observations, which is required to get shiny medals. Did you make good observations? I hope so. Some of you are smiling... But this is a special year for we have a special something. The organizers want all participants, competitors and jury members, to really appreciate biology, so we were asked to make observations not just on Tuesday! [holds up thermometer] We have to do this every day, twice a day and make records. Have you turned in your records? It should be credit as one of the requirements to get a medal! I hope you did. This is actually

a creative technique by the organizers to reduce the risk of swine flu and thus to increase the chance for the survival of the weakest in this Olympiad. And boy I can tell that I'm very glad that it worked because all of us who came here during the opening session have come here again at this closing session. Thank you to the organizers.

Excursions. Did you enjoy the excursions? This year's excursion allowed us to visit one of Japan's best tourist destinations – beautiful Nikko. A very special something. Did you learn some local wisdom from Tosho-gu shrine, remember? The monkeys? You know that? Let's do this all together. Put your hands up! What is this? "Hear no evil" – say it together with me – "See no evil," "Speak no evil." Wow! Unbelievable! There are so many wise monkeys participating in this Olympiad.

Dear hosts, you organized a wonderful and memorable Olympiad. This 20th Olympiad is a great success because of your hard work, your dedication and true desire for perfection. May I be allowed to present a token of appreciation to members of the organizers. Professor Hiroo Imura, would you please come up? And I reach for my treasures... Here's to you. Thank you very much. And Professor Hideo Mori, please come up. Thank you very much. Professor Osamu Numata. Thank you very much. And Professor Katsumi Matsuura, please come up. He already got the clock from the jury session so he's got another prize here. Thank you very much. And last, Professor Makoto Asashima. Thank you very much.

This year we celebrate the 20th anniversary of the origin of IBO. This IBO in Tsukuba has been very special. 20 years ago 6 countries; Belgium, Bulgaria, Czechoslovakia, the German Democratic Republic, Poland and the Soviet Union founded IBO in 1989 and then participated in the first IBO held in Olomouc in July 1990. Did you know that today, 20 years later, right here in this hall there are two founders of IBO who have still been active in every IBO during all these years. Please give big hands to Professor Tomas Soukup, please come up on stage. He is still the leader of the IBO Coordinating Center. The second one is Professor Pavol Eliáš, he is still the coordinator for the Slovak Republic. And for the large part of IBO, in the past 16 years in fact, there was only one gentleman who served as the chairman, the First Chairman of IBO, please give big hands to Hans Morélis of the Netherlands. Now I would like to invite Shirley and Gerard, please come up to help me.

Gerard, please give your token of appreciation to Professor Pavol. And Shirley, please give your token of appreciation to Professor Tomas, and I will do it for Hans. I hope I get a hug too!

(Ms. Siew Lee Shirley Lim): And now Dr. Poonpipope will give a token of appreciation to Hans.

(Dr. Poonpipope Kasensap): Shall we ask them to say a few words?

(Mr. Tomas Soukup): I would like to thank our Chairman, and you can see that sometimes it's better to be the second in the row.

(Mr. Hans Morélis): I'm really surprised, I didn't expect this. It's an honor, I don't know what to say. But I still have the feeling that I have to say something, but I know the students are very eager to know their medals, so I better shouldn't say anything. But, you know one picture is better than a thousand words so what I will do is I'll take a picture of all of you to keep it in my heart. Oh sorry, it's 16:40 and we're running out time now, you know Japanese are very precise and I saw some faces on the first row who are a little bit worried about it, please say cheese now! Thank you.

(Dr. Poonpipope Kasensap): Wow, I was so excited I forgot to say something for all of them. Let me say it now. In your life the Biology Olympiad must be one of many places, events you remember. In the past 20 years the Biology Olympiad has changed tremendously. And a lot of those changes are forever. You have been here all along to ensure that the changes are for better. In fact your outstanding commitment and involvement made it better. Thank you very much.

And I also know that you are waiting really anxiously to get your medal, so I just have 10 more pages to go. This Biology Olympiad is about memory. Memory is special, it defies time. Fortunately 20 years of Olympiad experience, even though it can't be fully described and explained to you, it is possible for you to experience it all for yourself. See, you don't really need 20 years, like these three guys, to appreciate the Olympiad or to have wonderful memories. One week is long enough to have great memories. Memory is right here at a moment that you really share something with someone, your friends, your special friends. I know that in this Olympiad there are a lot of memories being shared all together among a lot of us here. I saw you throwing water to one another after the theoretical test – that's a really good memory. A simple walk through the park or dance at Tsukuba night, those are wonderful memories too. This Biology Olympiad lasted, or will last only a few days, in fact it will end tomorrow. But all these wonderful memories we share together will certainly be alive inside our hearts and our souls forever. This is truly an unforgettable Olympiad. Sayonara.

6. Accommodation

Student:

Students lodged at "Ninomiya House"—the Foreign Researcher's Residence of JST (Japan Science and Technology Agency). Though Ninomiya House is usually for foreign researchers on long-term stays, JST made an exception to allow IBO to use the accommodation for IBO students for one week. Ninomiya House, is about 5 km from the exam venue at the University of Tsukuba, and 500 m from Tsukuba International Congress Center (Epochal Tsukuba), the venue for ceremonies and Jury meetings. Students were transported by bus to the University and on foot to Epochal Tsukuba. To prevent contact between students and Jury, leaving Ninomiya House during free time before examinations was strictly prohibited. Ten staff and a medical doctor took care of the students at Ninomiya House.

Leaders and Observers:

The jury stayed at Okura Frontier Hotel Tsukuba (left) or Okura Frontier Hotel Tsukuba Epochal (right), the best hotels in Tsukuba. The former is a 5-15 minute walk from Epochal Tsukuba, the ceremony and Jury meeting venue, while the latter is directly adjacent. Basically, team leaders stayed in Okura Frontier Hotel Tsukuba Epochal and observers stayed in Okura Frontier Hotel Tsukuba. Although there were some exceptions due to members' health conditions and requests. Most of Jury members were assigned a single room, but some observers of the larger teams shared a room.

7. Daily News

A total of seven issues of the daily news was issued during 20th IBO from 13th to 19th, by Team-J, a special team of SCIBO, the volunteer student organization (See item 4 in Appendix). The daily news was named "Kawaraban" which refers to a traditional Japanese newspaper issued from the 17th to 19th century. The original Kawaraban were printed handbills sold in major cities to commemorate major social gatherings or events.

Preparation of Tests

1. Overview

Theoretical tests and practical tests were prepared by the scientific committee, which composed of the theoretical test committee and the practical test committee. Members of the theoretical test committee were 6 university professors who are active in research of various field of biology, and 3 high school teachers who are experienced in biological education and assessment. Members of the practical test committee were 8 professors from Tsukuba University.

Committee members were assigned by the summer of 2007, and the activities were started in the winter of 2008. Both committees were held independently until the final stage of preparation, and in the spring of 2009, questions and tasks were checked by the other committee. Reports on the practical tests were described separately, and we will report only about the theoretical test hereafter in this section.

The committee set the following basic principle on the questions. (1) High level questions suitable for IBO. (2) Original questions which have never be seen. (3) Scientifically clear and correct questions. (4) Basic and not trivial questions. (5) No knowledge-only questions. (6) Emphasis on understanding, finding, and thinking. (7) Good balance of easy and difficult questions. (8) Good balance of various fields of biology. (9) No dependence on countries and regions. (10) Avoid to use too specific or too trivial scientific terms. (11) Clear description and wording of questions. (12) Short questions to avoid translation load.

Following the principle, we send a request e-mail for question proposal to each NBO in November 2008, asking “Questions should not deal with just knowledge, but focus on reasoning, problem solving and understanding.”

252 questions were proposed from 40 countries. They were, Argentina, Australia, Azerbaijan, Belarus, Belgium, Bulgaria, Canada, Czech Republic, Chinese Taipei, Cuba, Cyprus, Denmark, Estonia, Germany, Greece, India, Indonesia, Iran, Japan, Kuwait, Latvia, Liechtenstein, Lithuania, Mexico, The Netherlands, Nigeria, Pakistan, Poland, Romania, Russia, Singapore, Slovak Republic , Spain, Sri Lanka, Sweden, Switzerland, Thailand, Turkey, Turkmenistan, United Kingdom.

The committee also asked to 26 leading Japanese biologists to send us possible questions for IBO2009. They and our committee members send 240 questions. In total, we had 492 proposed questions, in early March 2009. The number was reduced to 200 by mail discussion, and to 120 through three-day hotel meeting in the end of March. For the following four weeks, each member examined and improved questions, and in the next three-day hotel meeting, we examined and improved all questions one by one as the

committee, and finally chose 90 questions and 15 possible substitutions.

The questions were then checked and improved by an English-native biologist and a English language specialist. Two undergraduate and two graduate students and one senior biologist tried to solve the questions, and they gave us many opinions to improve the questions.

In the jury subgroup meeting, one question was deleted, and one question was replaced from the substitution list. Most of other questions were also largely improved, especially in terms of clearness of explanations and options

In the jury session, no questions were deleted from the proposed 89 questions. About 30 questions were significantly improved in the discussion of the jury.

Marking and checking were made three times by different committee members and supporting graduate students with their signatures on every sheet. Computer input, summing up, and statistical analysis were made in two separate lines independently, and the final results were checked between the two lines.

Mark-checking and medal-determining jury sessions and medal ceremony were performed quite smoothly, and we thank all members and participants of IBO2009.

2. Jury subgroup meeting of IBO2009

<Outline>

Original suggestion from the last AB meeting

"The host country invites a Subgroup of six jury members, to scrutinize the practical and theoretical examinations prior to the usual jury sessions during the IBO week."

Japan wanted to increase the number of the Subgroup member to eight.

<Members>

1) Dr. Katsumi Matsuura,	Japan, IBO 2009
2) Dr. Rana Shinha,	India, IBO 2008
3) Dr. Sung Ha Kim,	Korea, IBO 2010
4) Dr. Mary Oliver,	Australia
5) Dr. Hans Morelis,	Netherlands
6) Dr. Alexander M. Rubtsov,	Russia
7) Dr. Daniel Wegmann,	Switzerland
8) Dr. Poonpipope Kasemsap,	Thailand

<Schedule>

July 9 (Thursday)	18:30-20:30	Preliminary discussion
July 10 (Friday)	9:00-18:00	Discussion on Practical test

18:30-21:00 Discussion on Theoretical test

July 11 (Saturday) 9:00-21:00 Discussion on Theoretical test

<Tasks>

- Correction of mistakes.
- Suggestions for more reasoning/understanding oriented questions.
- Improvement of clearness of descriptions.
- Shortening of the descriptions.
- Suggestions to make difficult questions easier.
- Suggestions about partial points and grading.

3. Summary of theoretical test questions: IBO2009

	recommended ratio (%)	Part A question numbers	Part A points	Part A (%)	Part B question numbers	Part B points	Part B (%)	Total Point	Total Point (%)
Cell Biology	20%	14	21	26%	7	21	19%	42.0	22%
Plant Ana. & Phys.	15%	8	12	15%	5	16	15%	28.0	15%
Animal Ana. & Phys.	25%	12	18	22%	7	19.5	18%	37.5	20%
Ethology	5%	2	3	4%	3	7	6%	10.0	5%
Genetics & Evolution	20%	10	15	19%	6	21	19%	36.0	19%
Ecology	10%	6	9	11%	4	11.5	11%	20.5	11%
Biosystematics	5%	2	3	4%	3	12	11%	15.0	8%
Total	100%	54	81	100%	35	108	100%	189.0	100%

4. List of all theoretical questions (DP: discriminating power)

	Q	Key words	Original Proposal	Chief Editor	Point	Average	DP Evaluation
Cell Biology	A1	Hydrogen bond, Water, Structure	Japan-KMa	Matsuura	1.5	71.0	Poor
	A2	Biopolymer, Synthesis, Activation group	Mexico	Matsuura	1.5	39.4	Weak
	A3	Protein interaction, Regulation	Cyprus	Yasugi	1.5	83.3	Good
	A4	Protein interaction, Processing	Cyprus	Yasugi	1.5	56.6	Weak
	A5	Protein structure, Tetramer	Japan-KS	Sugiyama	1.5	50.2	Excellent
	A6	ATP synthesis, Chemiosmotic coupling	Azerbaijan	Matsuura	1.5	72.9	Very Good
	A7	Photosynthesis, Dark reaction	Belgium	Matsuura	1.5	69.2	Poor
	A8	Membrane, Permeability, Hydrophobic	Japan-KS	Sugiyama	1.5	59.7	Very Good
	A9	Cellular organelle, Various organisms	Pakistan	Sugiyama	1.5	87.3	Good
	A10	Mitochondria, Protein synthesis	Belgium	Matsuura	1.5	71.5	Good
	A11	Protein transport, Organelle	Japan-MSu	Sugiyama	1.5	68.3	Very Good
	A12	DNA, Restriction endonuclease	Russia	Sugiyama	1.5	57.9	Very Good
	A13	Operon, Transcription, Regulation	Japan-HI	Sugiyama	1.5	79.2	Good
	A14	Mutation, Duplication, Translation	Singapore	Sugiyama	1.5	70.6	Very Good

Plant Ana. & Phys,	A15	Lignin, Plant tissue, Transpiration	Japan-MSu	Sugiyama	1.5	52.5	Excellent
	A16	Plant tissue, Stem section	Japan-MSu	Sugiyama	1.5	86.4	Weak
	A17	Plant tissue, Adaptation	Russia	Sugiyama	1.5	82.4	Good
	A18	Phytohormone, Development,	Canada	Sugiyama	1.5	51.6	Weak
	A19	Germination, Nitrogen, Translocation	Japan-YN	Sugiyama	1.5	70.6	Good
	A20	Saprophyte, Fertilization, Genotype	Japan-NM	Sugiyama	1.5	57.0	Very Good
	A21	Photosynthesis, pH change	Canada	Sugiyama	1.5	79.6	Good
	A22	Photorespiration, Carbon fixation	Thailand	Matsuura	1.5	66.1	Very Good
Animal Ana.& Phys,	A23	Early development, Transcription	Japan-SY	Wada	1.5	83.7	Weak
	A24	Cell differentiation, Embryo	Japan-HW	Wada	1.5	58.4	Very Good
	A25	Osmotic regul., Environmental adaptation	Japan-HW	Wada	1.5	60.6	Excellent
	A26	Lung, Gas exchange	Indonesia	Wada	1.5	33.5	Good
	A27	Skeletal muscle, Contraction	Indonesia	Yasugi	1.5	44.3	Very Good
	A28	Neuron, Action potential	Argentina	Wada	1.5	56.1	Very Good
	A29	Pancreas, Carbohydrate	Japan-MO	Wada	1.5	57.9	Poor
	A30	Blood glucose, Circulation	The Netherlands	Wada	1.5	39.4	Poor
	A31	Sugar antagonist, Receptor, Transporter	Japan-MO	Wada	1.5	64.7	Very Good
	A32	Poisonous fish, Cultivation	Japan-HC	Wada	1.5	63.3	Weak
	A33	Immunity, Antibody production	Japan-SK	Yasugi	1.5	80.5	Good
	A34	Kidney function,	Sweden	Yasugi	1.5	84.6	Good
Ethology	A35	Animal behavior, Altruistic behavior	Japan-MSh	Shimada	1.5	33.0	Poor
	A36	Bird behavior, Territory defence	Japan-MSh	Shimada	1.5	74.2	Poor

Genetics Evolution	A37	Allele, Chromosome	Argentina	Tajima	1.5	91.4	Poor
	A38	Dominant allele, Probability	Spain	Tajima	1.5	93.7	Poor
	A39	Hardy-Weinberg equilibrium, Frequency	Japan-FT	Tajima	1.5	59.3	Excellent
	A40	Genotype frequency	Japan-TA	Tajima	1.5	42.1	Excellent
	A41	Self fertilization, Mutation, Fixation	Japan-TA	Tajima	1.5	66.5	Very Good
	A42	Nucleotide substitution, Phylogenetic Tree	Japan-YS	Tajima	1.5	63.3	Excellent
	A43	Molecular evolution, Mutation, GC content	Japan-YS	Tajima	1.5	55.2	Excellent
	A44	Evolution, Mutation, Adaptation	United Kingdom	Tajima	1.5	62.0	Very Good
	A45	Adaptive radiation, Speciation	Mexico	Tajima	1.5	83.7	Good
	A46	Multigame family,	Japan-FT	Tajima	1.5	70.1	Very Good
Ecology	A47	Primary production, Biomass	Japan-TMi	Shimada	1.5	60.6	Very Good
	A48	Food web, Community,	Australia	Shimada	1.5	43.4	Weak
	A49	Energy flow, Ecosystem	Denmark	Shimada	1.5	67.9	Excellent
	A50	Energy input,	Japan-KS	Shimada	1.5	75.6	Poor
	A51	Ecosystem stability,	Japan-KS	Shimada	1.5	44.3	Poor
	A52	Population dynamics,	Japan-MSh	Shimada	1.5	49.8	Excellent
Systematics	A53	Phylogeny and function,	Japan-HW	Wada	1.5	65.6	Very Good
	A54	Phylogeny and branching,	Japan-HW	Wada	1.5	58.4	Excellent

	Q	Key words	Original Proposal	Chief Editor	Point	Average	DP Evaluation
Cell Biology	B1	Chemical element, Plant and animal	Japan-TMa	Matsuura	3	64.4	Poor
	B2	Water, Benefit to Organisms	Japan-KSa	Sugiyama	2.5	88.4	Weak
	B3	Protein, Molecular mass, Calculation	Japan-KMa	Matsuura	3	40.3	Excellent
	B4	Glycolysis, Enzyme, Metabolism	Bulgaria/Latvia	Matsuura	3.5	59.0	Very Good
	B5	Cell cycle, Cell type	India	Wada	2	67.9	Very Good
	B6	Number of molecules in a cell,	India	Sugiyama	3	29.4	Excellent
	B7	Gene expression, Regulation	Japan-MSu	Sugiyama	4	65.0	Very Good
Plant Ana. & Phys,	B8	Plant and mineral, Metabolic role	Russia	Sugiyama	3	71.4	Weak
	B9	Root Growth, Experiment	Japan-MSu	Sugiyama	3	31.1	Weak
	B10	Flowering regulation, Florigen	Japan-MSu	Sugiyama	4	86.8	Weak
	B11	Starch synthesis, Enzyme	Japan-KS	Sugiyama	3	74.4	Very Good
	B12	Nodule, Nitrogen fixation, Mutant	Japan-KMi	Sugiyama	3	65.5	Very Good
Animal Ana. & Phys,	B13	Thyroxin, Thyroid stimulating hormone	Japan-YN	Wada	3	65.0	Very Good
	B14	Blood glucose, Hormone	Cuba	Wada	2.5	76.5	Good
	B15	Egg maturation, Starfish	Japan-YN	Wada	4	85.2	Poor

	B16	Nuclear transplantation, development	Japan-SK	Wada	2	70.1	Very Good
	B17	Organ formation, Differentiation	Japan-SY	Yasugi	2	61.0	Poor
	B18	Immunity, HIV	Japan-SK	Yasugi	3	79.8	Good
	B19	Immunity, Blood type	Japan-TW	Yasugi	3	61.0	Very Good
Ethology	B20	Animal behavior, Bee, Social insect	Japan-SB	Shimada	3	77.1	Good
	B21	Social Insect, Ant	India	Shimada	2	54.2	Poor
	B22	Learning, Bird	Japan-SK	Shimada	2	65.6	Very Good
Genetics	B23	Genealogical tree, Blood type	Iran	Tajima	4	49.5	Excellent
Evolution	B24	Chromosome, Crossing over	Denmark	Tajima	4	44.1	Good
	B25	Evolutionary rate, Speciation	Japan-FT	Tajima	3	41.2	Poor
	B26	Molecular evolution, Mutation rate	Japan-FT	Tajima	3	61.2	Very Good
	B27	Polymorphism, Frequency change	Japan-YK	Tajima	4	46.6	Weak
	B28	Speciation, Isolation	Japan-YK	Shimada	3	59.6	Excellent
Ecology	B29	Nitrogen cycling	Sweden	Shimada	3	72.5	Very Good
	B30	Population growth,	Japan-TMi	Shimada	3	33.8	Good
	B31	Competitive exclusion	Japan-YK	Shimada	2.5	76.9	Poor
	B32	Growth dynamics, Plant	Japan-YK	Shimada	3	68.2	Weak
Systematics	B33	Plant systematics, Major traits	Japan-RI	Sugiyama	3	61.8	Very Good
	B34	3 domains, Endosymbiosis	Japan-KMi	Matsuura	5	63.7	Very Good
	B35	Taxonomic analysis	The Netherlands	Wada	4	69.7	Excellent

Analysis of Test Results

1. Statistical Analysis

20th INTERNATIONAL
BIOLOGY OLYMPIAD
Tsukuba, Japan
2009

STATISTICS OF THE
RESULTS

Consolidated Table of Points (Raw Scores)

Total number of students: 221

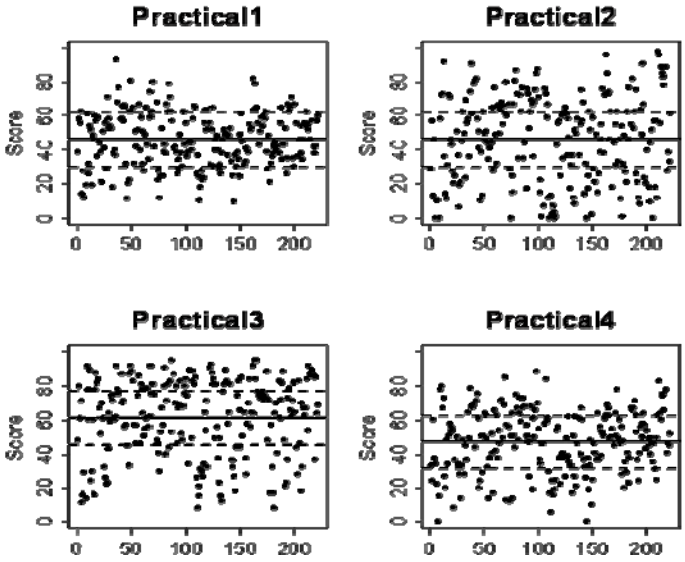
	Maximum obtainable points	Maximum obtained points	Minimum obtained points	Mean	SD
Practical-1	100	93.0	9.0	46.0	16.0
Practical-2	100	98.0	0.0	46.2	25.2
Practical-3	98	95.0	8.0	61.3	22.8
Practical-4	91	89.0	0.0	47.0	18.3
Practical Total	389	338.0	36.0	200.5	68.3
Theory A	81	78.0	16.5	52.1	12.4
Theory B	108	99.1	24.1	67.3	15.8
Theory Total	189	175.4	42.5	119.3	27.1
Grand Total	578	491.2	95.4	319.9	90.5

Consolidated Table of Points (Raw Scores)

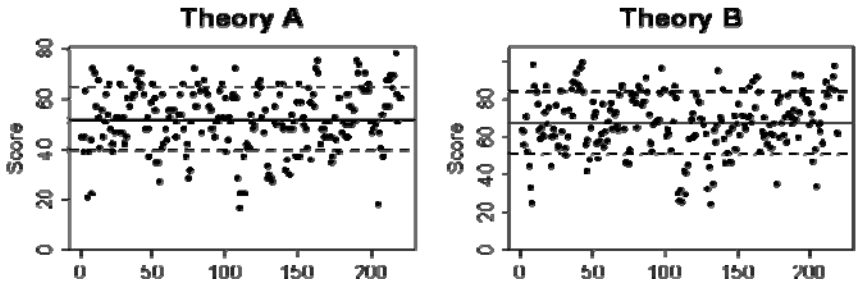
Total number of students: 221

	Maximum obtainable points	Mean	SD	Median	Mode
Practical-1	100	46.0	16.0	46.0	56.0
Practical-2	100	46.2	25.2	49.0	0.0
Practical-3	98	61.3	22.8	66.0	83.0
Practical-4	91	47.0	18.3	49.0	51.0
Practical Total	389	200.5	68.3	211.0	218.0
Theory A	81	52.1	12.4	52.5	51.0
Theory B	108	67.3	15.8	67.3	84.1
Theory Total	189	119.3	27.1	119.8	119.9
Grand Total	578	319.9	90.5	324.8	255.9

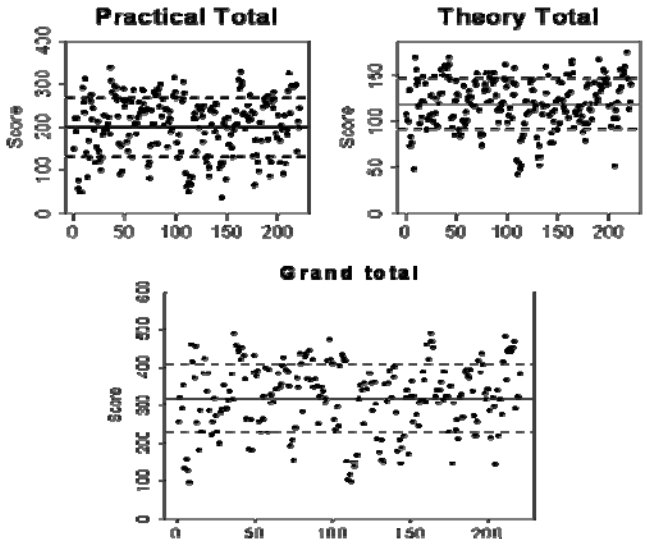
MEAN ± SD
(Practical)

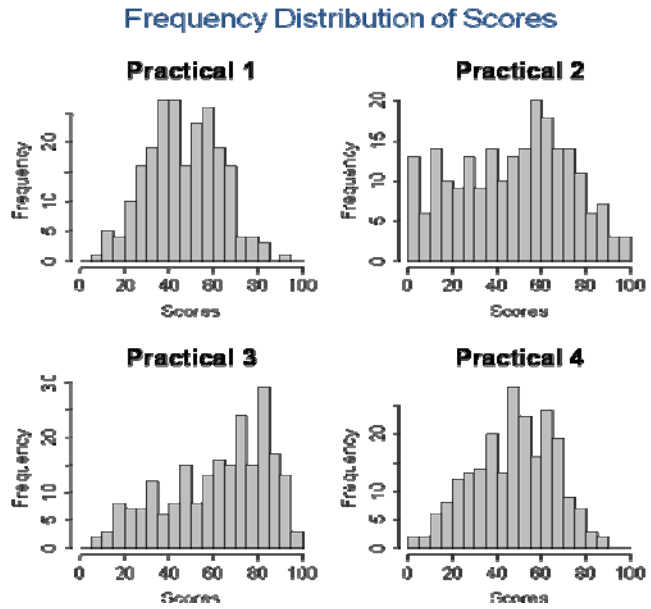


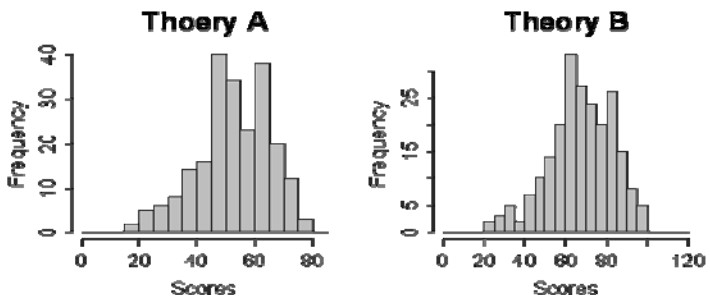
MEAN ± SD
(Theory)

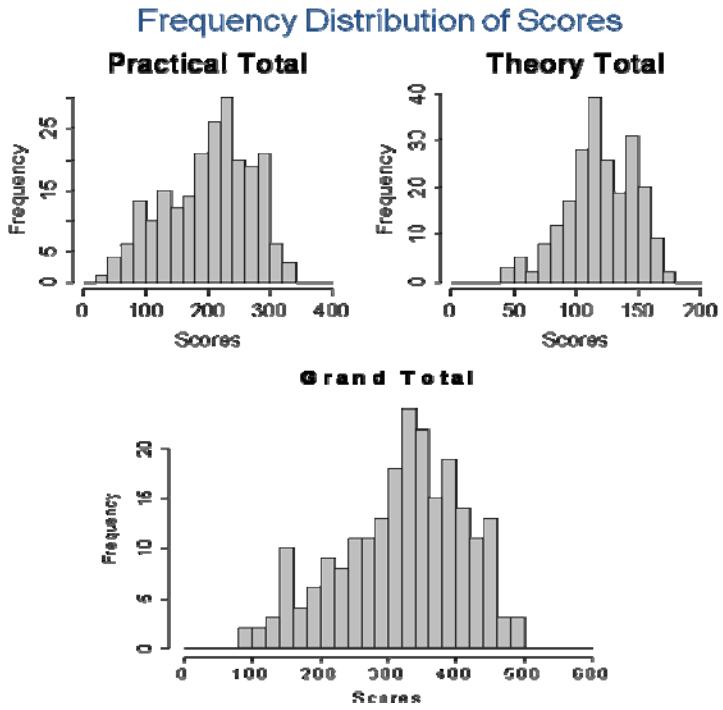


MEAN ± SD
(Totals)




Frequency Distribution of Scores
Practical 1
Practical 2
Practical 3
Practical 4
Frequency
Scores

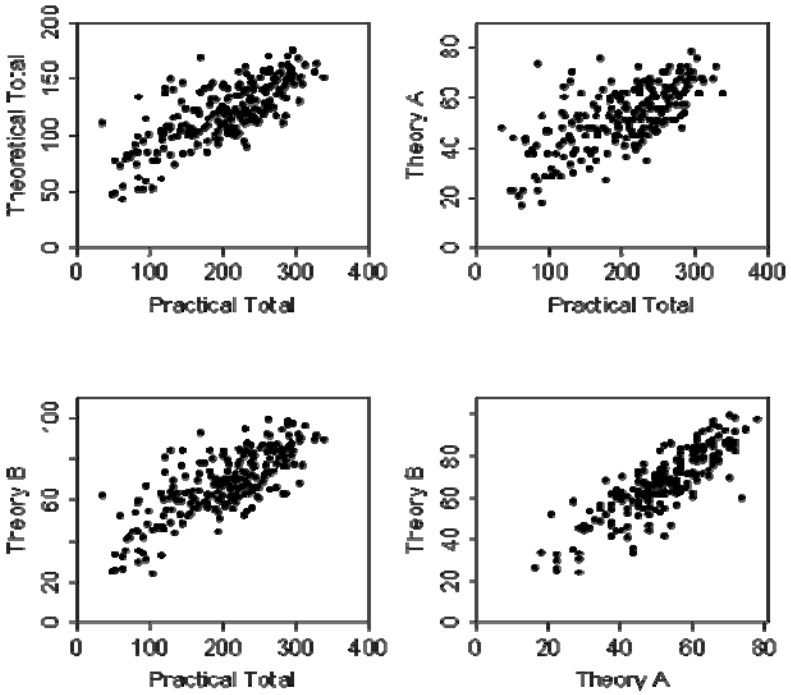

Frequency Distribution of Scores
Thoery A
Theory B
Frequency
Scores


Frequency Distribution of Scores
Practical Total
Theory Total
Grand Total
Frequency
Scores

Correlation Matrix

	Pr-1	Pr-2	Pr-3	Pr-4	Practical Total	Theory A	Theory B	Theory Total	Grand Total
Practical 1	1.00	0.52	0.52	0.49	0.73	0.49	0.57	0.56	0.72
Practical 2		1.00	0.68	0.59	0.88	0.58	0.67	0.65	0.86
Practical 3			1.00	0.61	0.87	0.59	0.64	0.64	0.85
Practical 4				1.00	0.81	0.56	0.64	0.63	0.80
Practical Total					1.00	0.67	0.76	0.75	0.98
Theory A						1.00	0.85	0.95	0.79
Theory B							1.00	0.97	0.87
Theory Total								1.00	0.87
Grand Total									1.00

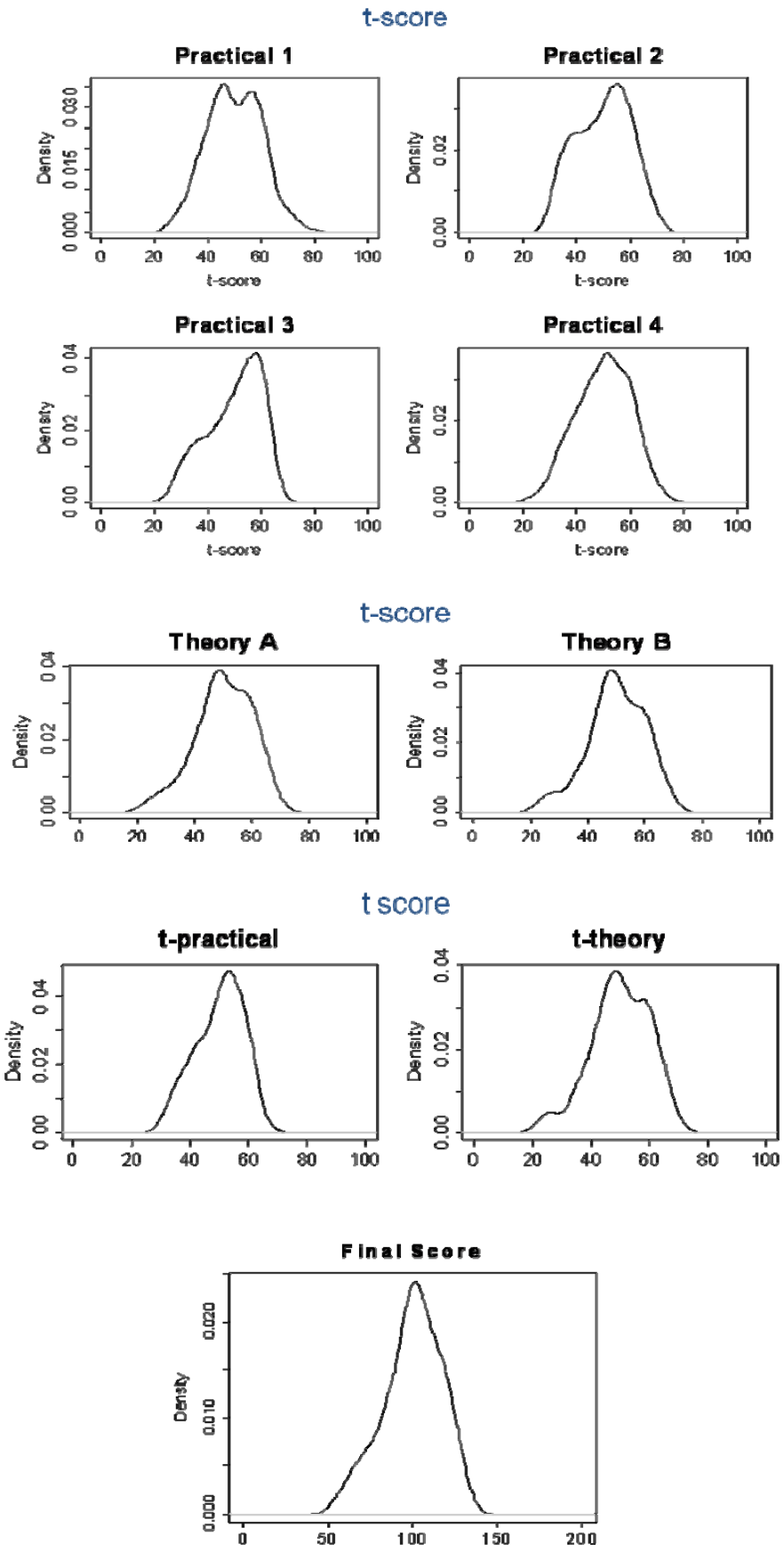
Correlations



Discriminatory Power

Discriminatory Power = SD / MEAN

- Pr-1 0.38
- Pr-2 0.18
- Pr-3 0.75
- Pr-4 0.23
- Pr-Total 0.22
- Theory-A 0.22
- Theory-B 0.28
- Theory Total 0.25
- Grand Total 0.22


t-score
Practical 1
Practical 2
Practical 3
Practical 4
Density
t-score
t-score
Theory A
Theory B
t score
t-practical
t-theory
Final Score

2. Five-Class Analysis of the Discriminating Power of Each Theoretical Test Questionin International Biology Olympiad 2009 Tsukuba

Katsumi Matsuura and Yoko Nagayama

Discriminating power of each question of theoretical test used in International Biology Olympiad 2009 Tsukuba, was analyzed by comparing average score of each question among 5 classes of students, i.e., gold medalists (G: 10%), silver medalists (S: 20%), bronze medalists (B: 30%), upper half of non-medalists (N1: 20%), and lower half of non-medalists (N2: 20%) based on the sum of theoretical and practical test scores. Pattern of the difference of the average score among the 5 classes was visualized in line graphs, and all 89 questions were divided into 8 groups. They are as follows: (1) High-discriminating-power questions (HDPQ), (2) Gold/Silver medal discriminating questions (G/S-MDQ), (3) Silver/Bronze medal discriminating questions (S/B-MDQ), (4) Bronze/No medal discriminating questions (S/N1-MDQ), (5) Upper non-medalist/Lower non-medalist discriminating questions (N1/N2-DQ), (6) Low-discriminating-power questions with high average (LDPQ-HA), (7) Low-discriminating-power questions with middle average (LDPA-MA), (8) Low-discriminating-power questions with low average (LDPQ-LA).

The patterns of score average among the 5 classes were quite different depending on questions. The highest difference between the gold medalists and the lower non-medalists was 82% in the average score, whereas the lowest difference was 1.0%, which means almost no discriminating power for the medal competition. 15 questions out of total 89 showed excellent discriminating power (HDPQ), and 29 questions were judged to be weak or poor in terms of the discriminating power. The rest questions with moderate discriminating power were grouped into four being characterized to be useful to discriminate neighboring two classes.

Many HDPQ include (1) combination of graph /figure/table reading, knowledge and logical thinking, (2) combination of independently-studied several peaces of knowledge, or (3) calculation with several steps. Many LDPQ were (1) too easy since similar questions were familiar to the students, (2) too difficult since knowledge or logic was higher than the level for high-school students, (3) not clear enough in the description, or (4) able to be solved only by reading of graph/figure/table and logical thinking without particular biological knowledge.

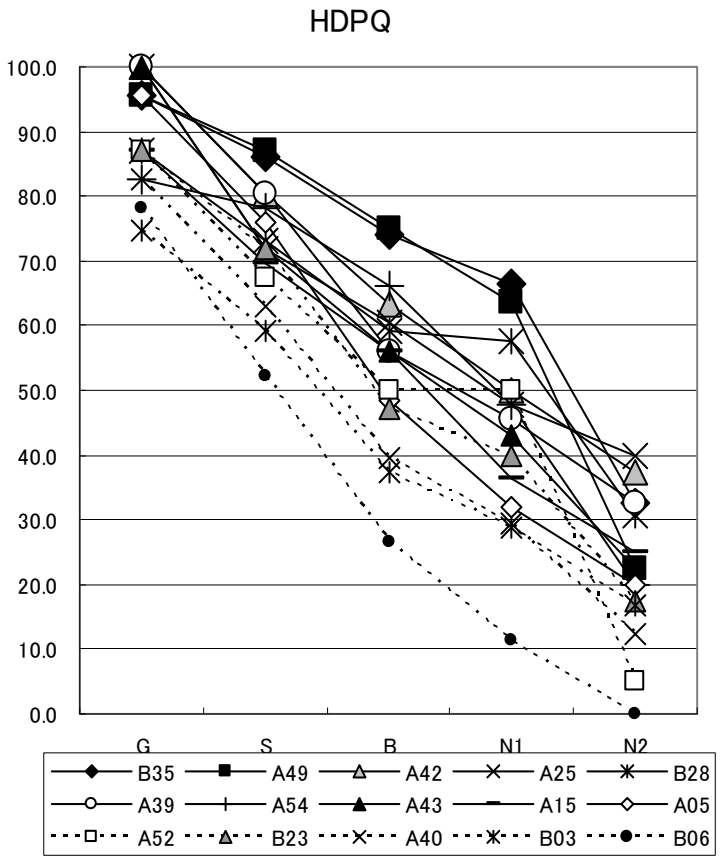
The results and comments for each question are shown below. DP means discriminating power.

The order of the questions is from high to low in average score. Numbers in tables are average score %, and the back tone shows the range of the score as:

90～	80～	70～	60～	50～	40～	～40

(1) HDPQ : High-discriminating-power questions

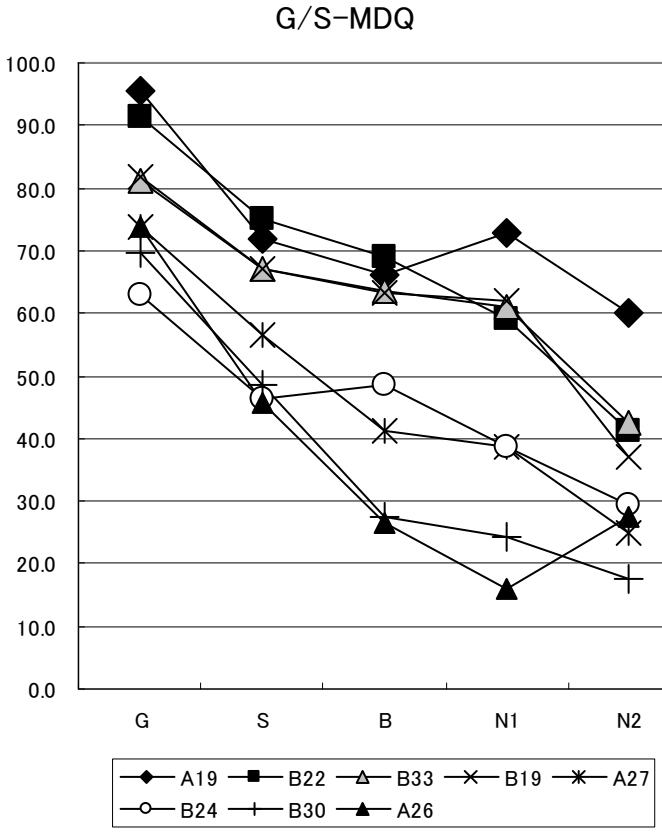
HDPQ	G	S	B	N1	N2
B35	95.5	85.9	74.1	66.4	32.6
A49	95.7	87.0	75.0	63.6	22.5
A42	100.0	80.4	63.2	50.0	37.5
A25	100.0	71.7	60.3	47.7	40.0
B28	87.0	73.2	59.3	57.6	30.8
A39	100.0	80.4	55.9	45.5	32.5
A54	82.6	78.3	66.2	47.7	20.0
A43	100.0	71.7	55.9	43.2	22.5
A15	87.0	69.6	55.9	36.4	25.0
A05	95.7	76.1	48.5	31.8	20.0
A52	87.0	67.4	50.0	50.0	5.0
B23	87.0	71.7	47.1	39.8	17.5
A40	82.6	63.0	39.7	29.5	12.5
B03	74.6	59.1	37.5	28.8	16.7
B06	78.3	52.2	26.5	11.4	0.0



B35	Ave.	69.7	Systematics	Subject	Taxonomic analysis of imaginative organisms
Solution		Make un-rooted and rooted phylogenetic trees based on imaginative 4 different animals.			
Analysis		Excellent DP. Combination of figure observation, knowledge, and logical thinking is needed.			
A49	Ave.	67.9	Ecology	Subject	Production and energy flow of ecosystem
Solution		Judge the difference in productivity and structure of various ecosystems from presented data.			
Analysis		Excellent DP. Combination of table reading, knowledge, and logical thinking is needed.			
A42	Ave.	63.3	Genetics/Evolution	Subject	Phylogenetic tree from nucleotide substitution
Solution		Construct a phylogenetic tree from a table of nucleotide substitutions.			
Analysis		Excellent DP. Combination of table and figure reading, knowledge, and logical thinking is needed.			
A25	Ave.	60.6	Animal Anatomy/ Physiology	Subject	Osmotic regulation in marine amphibian
Solution		Apply basic knowledge on osmotic regulation to a very specific previously unstudied animal.			
Analysis		Excellent DP. Combination of several independently-studied knowledge is needed.			
B28	Ave.	59.6	Genetics/Evolution	Subject	Speciation mechanisms in islands
Solution		Judge the origin of speciation on islands based on phylogenetic trees and community structures.			
Analysis		Excellent DP. Combination of figure reading, knowledge, and logical thinking is needed.			
A39	Ave.	59.3	Genetics/Evolution	Subject	Allele frequency under Hardy-Weinberg equili.
Solution		Find a general formula of an allele frequency applying particular cases with related knowledge.			
Analysis		Excellent DP. Understanding of the concept and thinking with formulas are needed.			
A54	Ave.	58.4	Systematics	Subject	Phylogenetic tree of animals
Solution		Estimate possible phylogenetic trees based on the information of several shared derived characters.			
Analysis		Excellent DP. Combination of knowledge, logical thinking, and figure reading is needed.			
A43	Ave.	55.2	Genetics/Evolution	Subject	Mutation rate and nucleotide frequency
Solution		Calculate GC content at equilibrium under the assumption of given mutation rates of nucleotides.			
Analysis		Excellent DP. Knowledge, careful reading and understanding of text, and calculation are needed.			
A15	Ave.	52.5	Plant Anatomy/ Physiology	Subject	Transpiration and the strength of plant tissue
Solution		Combine the understanding of cell wall strength, water presser, and perspiration in plants.			
Analysis		Excellent DP. Combination independently-studied knowledge and logical thinking is needed.			
A05	Ave.	50.2	Cell/Biochem/Molec.Biol.	Subject	Tetrameric-enzyme activity of heterozygote
Solution		Estimate enzyme activity of tetramer in heterozygous cells with a given assumption.			
Analysis		Excellent DP. Combination of independently-studied knowledge, and logical thinking are needed.			
A52	Ave.	49.8	Ecology	Subject	Species interaction and population dynamics
Solution		Conclude an interspecific relationship based on data presented with a graph.			
Analysis		Excellent DP. Reading of a complicated graph, knowledge, and logical thinking are needed.			
B23	Ave.	49.5	Genetics/Evolution	Subject	Genealogical tree based on blood type
Solution		Conclude phenotype and genotype of individuals based on genealogical tree and an experiment.			
Analysis		Excellent DP. Knowledge, systematic reading of a table, and sophisticated thinking are needed.			
A40	Ave.	42.1	Genetics/Evolution	Subject	Genotype frequency in the next generation
Solution		Calculate heterozygous frequency of the next generation of a given population.			
Analysis		Excellent DP. Understanding, logical thinking, and complicated calculation are needed.			
B03	Ave.	40.3	Cell/Biochem/Molec.Biol.	Subject	Protein molecular mass from nucleotide
Solution		Calculate the molecular mass of a protein from a given number of nucleotide and other information.			
Analysis		Excellent DP. Careful step-by-step calculations, using several basic knowledge, are needed.			
B06	Ave.	29.4	Cell/Biochem/Molec.Biol.	Subject	Number of m-RNA synthesis in a cell
Solution		Calculate number of mRNA molecules based on a radioactively labeled experiment.			
Analysis		Excellent DP. Difficult and complicated calculations for most participants, but not for gold medalists.			

(2) G/S-MDQ : Gold and silver medal discriminating questions

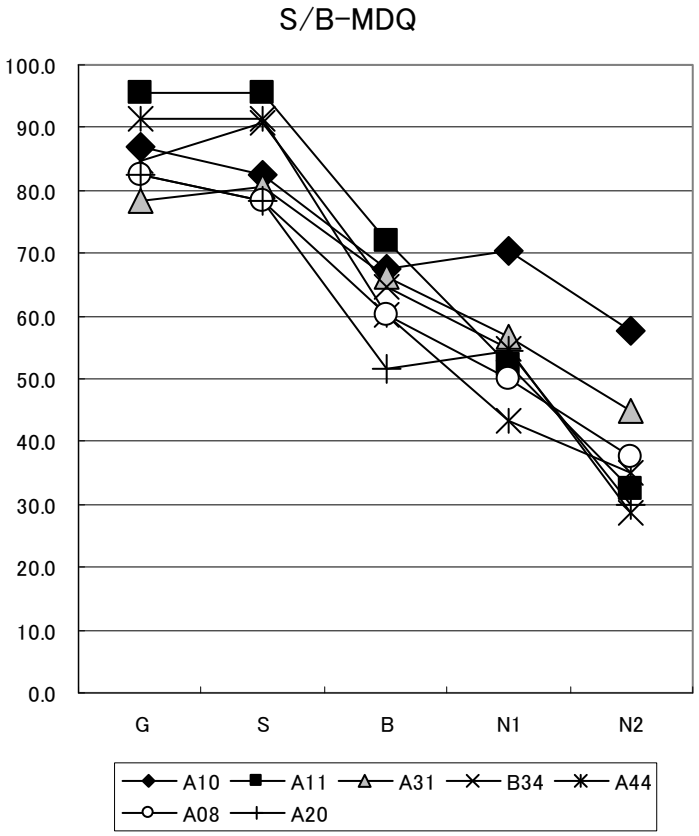
G/S	G	S	B	N1	N2
A19	95.7	71.7	66.2	72.7	60.0
B22	91.3	75.0	69.1	59.1	41.3
B33	81.2	67.0	63.7	61.0	42.5
B19	81.9	67.0	63.2	62.1	37.1
A27	73.9	56.5	41.2	38.6	25.0
B24	63.0	46.2	48.5	38.6	29.4
B30	69.6	48.6	27.5	24.2	17.5
A26	73.9	45.7	26.5	15.9	27.5



A19	Ave.	70.6	Plant Anatomy/ Physiology	Subject	Nitrogen translocation in germination
Solution		Conclude nitrogen dynamics under germination from two graphs.			
Analysis		Good DP. Accurate reading of graph is needed, but it may be answered just by option reading.			
B22	Ave.	65.6	Ethology	Subject	Learning and genetics of bird singing
Solution		Conclude if songs and calls of birds are determined by learning or heredity based on experiments.			
Analysis		Very good DP. Combination of knowledge, reading, and logical thinking are needed.			
B33	Ave.	61.8	Systematics	Subject	Plant evolution and phylogenetic tree
Solution		Relate the phylogenetic tree of green plants with important characters evolved.			
Analysis		Very good DP. Can be solved with combination of independently-studied knowledge.			
B19	Ave.	61.0	Animal Anatomy/ Physiology	Subject	Blood type and immunity
Solution		Answer with knowledge of genetics and physiology of hemolytic disease.			
Analysis		Very good DP. (1) and (2) need calculation and thinking. (3) was only-knowledge question.			
A27	Ave.	44.3	Animal Anatomy/ Physiology	Subject	Contraction and regulation of skeletal muscle
Solution		Answer with accurate knowledge of physiology and biochemistry of skeletal muscle contraction.			
Analysis		Very good DP. Wide and accurate knowledge of the subject is needed, but not thinking.			
B24	Ave.	44.1	Genetics/Evolution	Subject	Recombination rate of double crossing over
Solution		Answer with knowledge and calculation of chromosomal genetics and recombination.			
Analysis		Good DP. (1) and (2) are basic easy questions. (3) requires difficult calculations and is not so good.			
B30	Ave.	33.8	Ecology	Subject	Population density and growth
Solution		Estimate growth curves of populations from growth-rate-density relationship given by a graph.			
Analysis		Good DP. High reading ability of graphs and logical and imaginative thinking are needed.			
A26	Ave.	33.5	Animal Anatomy/ Physiology	Subject	Gas exchange and lung structure
Solution		Answer the consequence of lung disability.			
Analysis		Good DP. Combination of knowledge of a subject is needed, but the subject may not be basic.			

(3) S/B-MDQ : Silver and bronze medal discriminating questions

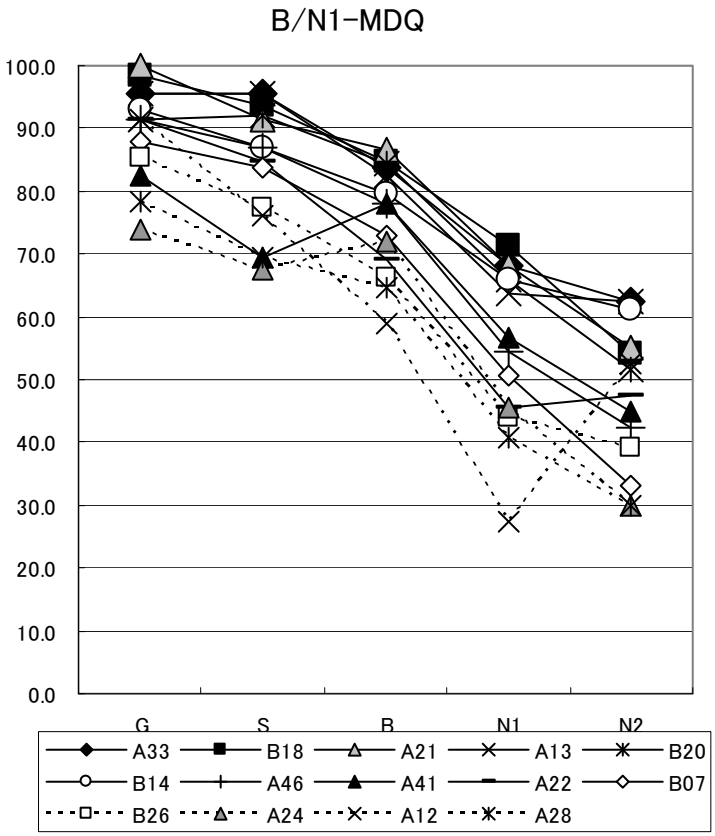
S/B	G	S	B	N1	N2
A10	87.0	82.6	67.6	70.5	57.5
A11	95.7	95.7	72.1	52.3	32.5
A31	78.3	80.4	66.2	56.8	45.0
B34	84.8	90.7	64.6	54.8	28.8
A44	91.3	91.3	60.3	43.2	35.0
A08	82.6	78.3	60.3	50.0	37.5
A20	82.6	78.3	51.5	54.5	30.0



A10	Ave.	71.5	Cell/Biochem/Molec.Biol.	Subject	Gene location of mitochondrial enzyme
Solution		Answer with the knowledge of transcription and translation of nuclear and mitochondrial genes.			
Analysis		Good DP. Accurate understanding of basic knowledge and careful reading of text are needed.			
A11	Ave.	68.3	Cell/Biochem/Molec.Biol.	Subject	Cell organelle for protein excretion
Solution		Understand the experiment of protein translocation in cells and correlate with organelle.			
Analysis		Very good DP. Combination of knowledge, picture/description reading, and thinking are needed.			
A31	Ave.	64.7	Animal Anatomy/ Physiology	Subject	Physiological effect of sugar antagonist
Solution		Speculate the molecular mechanisms of sugar antagonist with given information.			
Analysis		Very good DP. Combination of wide range of knowledge is needed.			
B34	Ave.	63.7	Systematics	Subject	Phylogenetic 3 domains and endosymbiosis
Solution		Understand the reasoning and relatedness of the rooted domain tree and endosymbiosis.			
Analysis		Very good DP. Combination of knowledge, diagram reading, and reasoning is needed.			
A44	Ave.	62.0	Genetics/Evolution	Subject	Evolution of insecticide-resistance
Solution		Explain the origin and development of insecticide-resistance in insect population.			
Analysis		Very good DP. Accurate understanding and combination of knowledge are needed.			
A08	Ave.	59.7	Cell/Biochem/Molec.Biol.	Subject	Membrane permeability to molecules
Solution		Judge the difference in chemical permeability between red blood cells and artificial vesicles.			
Analysis		Very good DP. Application of basic knowledge and comparison in different situation.			
A20	Ave.	57.0	Plant Anatomy/ Physiology	Subject	Genotype and life cycle of fern
Solution		Answer the expected ratio of genotype in fern gametophytes.			
Analysis		Very good DP. Combination of independently-studied knowledge and logical thinking.			

(4) B/N1-MDQ : Bronze and non medal discriminating questions

B/N1	G	S	B	N1	N2
A33	95.7	95.7	83.8	68.2	62.5
B18	98.6	93.5	84.8	71.2	54.2
A21	100.0	91.3	86.8	68.2	55.0
A13	95.7	95.7	82.4	63.6	62.5
B20	91.3	92.0	84.3	65.9	51.7
B14	93.0	87.0	79.7	65.9	61.0
A46	91.3	87.0	77.9	54.5	42.5
A41	82.6	69.6	77.9	56.8	45.0
A22	91.3	84.8	69.1	45.5	47.5
B07	88.0	83.7	72.8	50.6	33.1
B26	85.5	77.5	66.2	43.9	39.2
A24	73.9	67.4	72.1	45.5	30.0
A12	91.3	76.1	58.8	27.3	52.5
A28	78.3	69.6	64.7	40.9	30.0

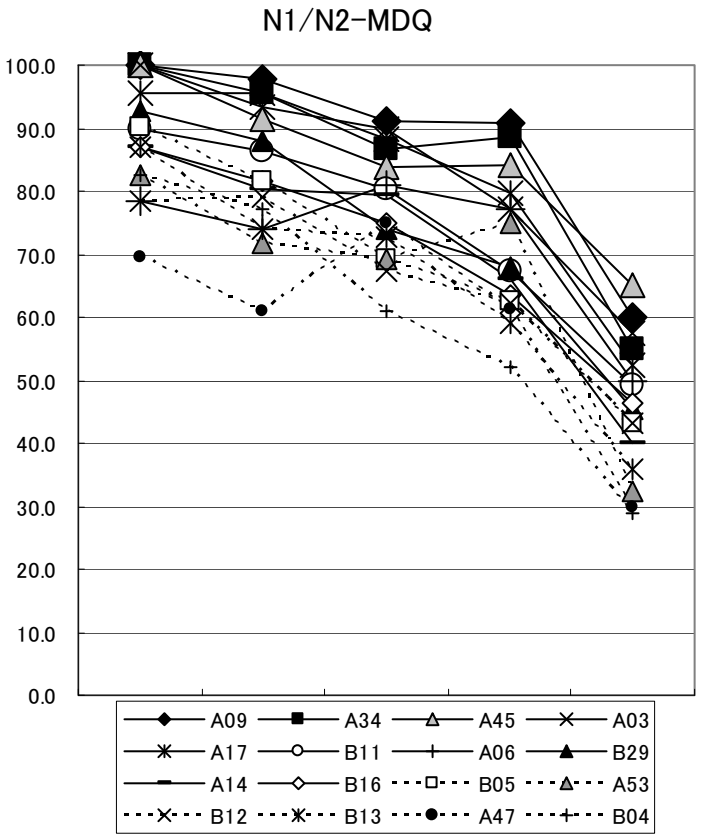


A33	Ave.	80.5	Animal Anatomy/ Physiology	Subject	Antibody production and regulation
Solution		Estimate the cause and background of a immunological disease.			
Analysis		Good DP. A little too easy. Good combination of knowledge, phenomena, and logical thinking.			
B18	Ave.	79.8	Animal Anatomy/ Physiology	Subject	HIV receptor and immunity
Solution		Consider possible experiments and expected results on HIV receptor and immunity.			
Analysis		Good DP. A little too easy. Combination of experiment, knowledge, and logical thinking.			
A21	Ave.	79.6	Plant Anatomy/ Physiology	Subject	Aquatic photosynthesis and pH changes
Solution		Consider pH change and its cause in aquatic photosynthesis.			
Analysis		Good DP. A little too easy. It needs combination of knowledge, but someone may remember as it is.			
A13	Ave.	77.1	Cell/Biochem/Molec.Biol.	Subject	External induction of gene transcription
Solution		Understand the regulation of an operon from explained information.			
Analysis		Good DP. A little easy. Combination of understanding, reading, and logical thinking is needed.			
B20	Ave.	76.5	Ethology	Subject	Learning and genetics of bee behavior
Solution		Read a graph and explanation accurately, and conclude how the bee behavior is determined.			
Analysis		Good DP. A little easy. Combination of graph reading, knowledge, and logical thinking is needed.			
B14	Ave.	70.1	Animal Anatomy/ Physiology	Subject	Regulation of blood glucose by hormones
Solution		Judge composite effect of three hormones to control the blood glucose level.			
Analysis		Good DP. Graph reading is basic and good. Questions are knowledge biased.			
A46	Ave.	66.5	Genetics/Evolution	Subject	Evolution of multigene family
Solution		Answer the factual knowledge of multigene family based on broad understanding.			
Analysis		Very good DP. Accurate understanding of knowledge is needed, but it may be knowledge biased.			

A41	Ave.	66.5	Genetics/Evolution	Subject	Mutant fixation and self fertilization
Solution		Combine the knowledge of self-fertilization and selection of recessive genes.			
Analysis		Very good DP. Combination of knowledge is needed.			
A22	Ave.	66.1	Plant Anatomy/ Physiology	Subject	Carbon fixation and photorespiration
Solution		Deduce the effect of temperature on photorespiration in C3 and C4 plants.			
Analysis		Very good DP. Application of the understanding is needed, but the answer may be remembered.			
B07	Ave.	65.0	Plant Anatomy/ Physiology	Subject	Regulation of gene expression in eukaryote
Solution		Analyze the function of regulatory region of a gene based on deletion/expression experiments.			
Analysis		Very good DP. Combination of graph reading, knowledge, and logical thinking is needed.			
B26	Ave.	66.1	Genetics/Evolution	Subject	Molecular evolution of insulin gene
Solution		Understand the role and evolution of four different region of the insulin gene.			
Analysis		Very good DP. Combination of different knowledge and logical thinking is needed.			
A24	Ave.	65.0	Animal Anatomy/ Physiology	Subject	Cell interaction and development in embryo
Solution		Deduce the role of micromeres on sea urchin development based on removal experiments.			
Analysis		Very good DP. Experiment understanding and logical thinking. Options may be a little difficult.			
A12	Ave.	57.9	Cell/Biochem/Molec.Biol.	Subject	Restriction endonuclease and DNA sequence
Solution		Calculate expected frequency of a restriction sequence on DNA.			
Analysis		Very good DP. Accurate calculation is needed. This question is common and not unique.			
A28	Ave.	29.4	Animal Anatomy/ Physiology	Subject	Action potential conduction in neuron
Solution		Predict what would happen when two action potentials meet in the middle of an axon.			
Analysis		Very good DP. Unique question. Combination of deep understanding and logical thinking.			

(5) N1/N2-DQ : Upper and lower non-medalists discriminating questions

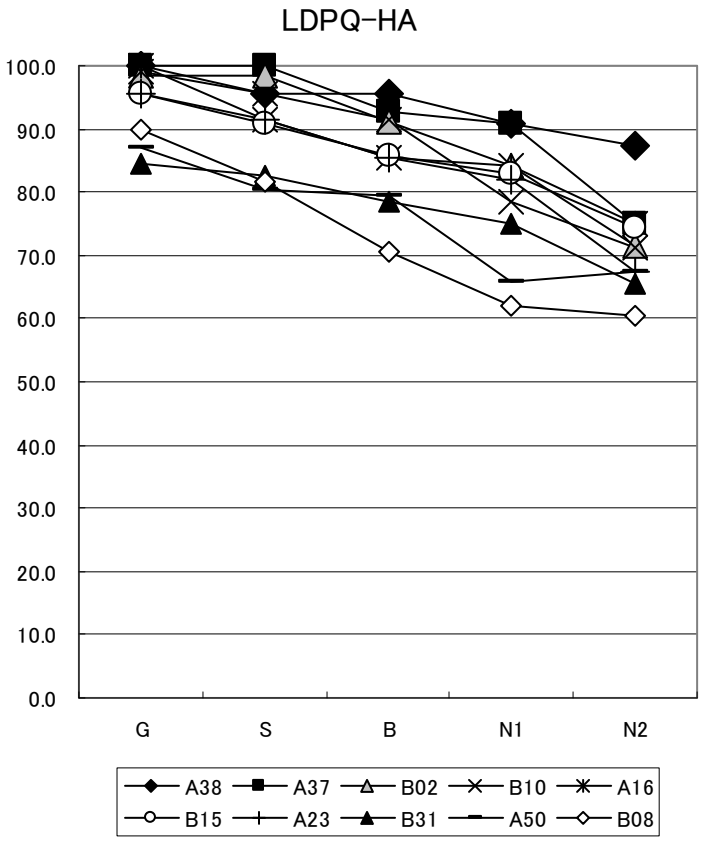
N1/N2	G	S	B	N1	N2
A09	100.0	97.8	91.2	90.9	60.0
A34	100.0	95.7	86.8	88.6	55.0
A45	100.0	91.3	83.8	84.1	65.0
A03	100.0	93.5	89.7	77.3	57.5
A17	95.7	95.7	88.2	79.5	52.5
B11	89.9	86.2	80.4	67.4	49.2
A06	78.3	73.9	80.9	77.3	50.0
B29	92.8	88.0	74.0	67.8	45.4
A14	87.0	80.4	79.4	65.9	40.0
B16	87.0	81.5	75.0	63.6	46.3
B05	90.2	81.5	69.1	62.5	43.1
A53	82.6	71.7	69.1	75.0	32.5
B12	78.3	79.0	67.2	62.1	43.3
B13	87.0	73.9	72.5	59.1	35.8
A47	69.6	60.9	75.0	61.4	30.0
B04	82.5	77.1	60.8	52.2	29.0



A09	Ave.	87.3	Cell/Biochem/Molec.Biol.	Subject	Cellular organelle and organisms
Solution	Correlate cell structures between prokaryote and eukaryote.				
Analysis	Good DP. A little too easy. Knowledge is very basic, but the question is unique.				
A34	Ave.	84.6	Animal Anatomy/ Physiology	Subject	Kidney structure and function
Solution	Clarify the secretion and re-absorption of molecules in kidney, and correlate them with the structure.				
Analysis	Good DP. A little too easy. A little knowledge biased. Picture reading and thinking is needed.				
A45	Ave.	83.7	Genetics/Evolution	Subject	Adaptive radiation and speciation
Solution	Explain adaptive radiation correctly.				
Analysis	Good DP. A little too easy. Accurate understanding of basic knowledge is needed.				
A03	Ave.	83.3	Cell/Biochem/Molec.Biol.	Subject	Protein interaction and functional regulation
Solution	Deduce consequence of an additional experiment on protein interaction and movement regulation.				
Analysis	Good DP. A little too easy. Experimental result reading, knowledge, and thinking are needed.				
A17	Ave.	82.4	Plant Anatomy/ Physiology	Subject	Plant tissue and environment adaptation
Solution	Correlate the structure of plant tissue with environment.				
Analysis	Good DP. A little too easy. Picture reading, wide knowledge, and thinking are needed. Unique.				
B11	Ave.	74.4	Plant Anatomy/ Physiology	Subject	Enzymes for starch synthesis and the evolution
Solution	Correlate biochemical reactions of starch synthesis with the evolution of storage material.				
Analysis	Very good DP. Combination of experimental result reading, knowledge, and thinking is needed.				
A06	Ave.	72.9	Cell/Biochem/Molec.Biol.	Subject	ATP synthesis by chemiosmotic coupling
Solution	Explain chemiosmotic coupling for ATP synthesis correctly.				
Analysis	Very good DP. Accurate understanding of basic knowledge is needed.				
B29	Ave.	72.5	Ecology	Subject	Nitrogen cycling in ecosystem
Solution	Understand meaning and organism of each step of nitrogen cycling in ecosystem.				
Analysis	Very good DP. Combination and application of knowledge are needed.				
A14	Ave.	70.6	Cell/Biochem/Molec.Biol.	Subject	Effect of nucleotide duplication on translation
Solution	Understand nucleotide deletion mutant, reading frame, and translation correctly.				
Analysis	Very good DP. Combination of knowledge and thinking is needed.				
B16	Ave.	70.1	Animal Anatomy/ Physiology	Subject	Nuclear transplantation and development
Solution	Consider an exceptional case based on nature of genetic information during development.				
Analysis	Very good DP. Combination of independently-studied knowledge is needed.				
B05	Ave.	67.9	Cell/Biochem/Molec.Biol.	Subject	Cell cycle patterns in various cells
Solution	Match the diagram of cell cycle pattern to the type of cell.				
Analysis	Very good DP. Combination of figure reading, knowledge, and thinking is needed.				
A53	Ave.	65.6	Systematics	Subject	Phylogeny and protein evolution
Solution	Deduce evolution of proteins from a phylogenetic tree and protein distribution among species.				
Analysis	Very good DP. Combination of phylogenetic tree reading, knowledge, and thinking is needed.				
B12	Ave.	65.5	Plant Anatomy/ Physiology	Subject	Nitrogen fixation in nodules and plant mutation
Solution	Conclude the shoot and root interaction from experiments of root nodule regulation.				
Analysis	Very good DP. Combination of research result reading, knowledge, and logical thinking is needed.				
B13	Ave.	65.0	Animal Anatomy/ Physiology	Subject	Thyroxin and Thyroxin stimulating hormone
Solution	Match experimental data with different deficiency of human hormone.				
Analysis	Very good DP. Combination of research result reading, knowledge, and logical thinking is needed.				
A47	Ave.	60.6	Ecology	Subject	Primary production and biomass in ecosystem
Solution	Match data of primary productivity and biomass to various ecosystems.				
Analysis	Good DP. A little too difficult. Matching and table reading seem to be good.				
B04	Ave.	59.0	Cell/Biochem/Molec.Biol.	Subject	Enzymes in glycolysis and their function
Solution	Analyze biochemical reactions from chemical structures and reaction sequence of glycolysis.				
Analysis	Very good DP. Combination of figure reading, various knowledge, and logical thinking is needed.				

(6) LDPQ-HA : Low discriminating power questions with high average

LDPQ-HA	G	S	B	N1	N2
A38	100.0	95.7	95.6	90.9	87.5
A37	100.0	100.0	92.6	90.9	75.0
B02	98.3	98.3	91.2	84.1	71.5
B10	98.9	95.7	91.4	78.4	71.3
A16	100.0	91.3	85.3	84.1	75.0
B15	95.7	90.8	85.7	83.0	74.4
A23	95.7	91.3	85.3	81.8	67.5
B31	84.3	82.6	78.5	75.0	65.5
A50	87.0	80.4	79.4	65.9	67.5
B08	90.0	81.7	70.5	62.1	60.5

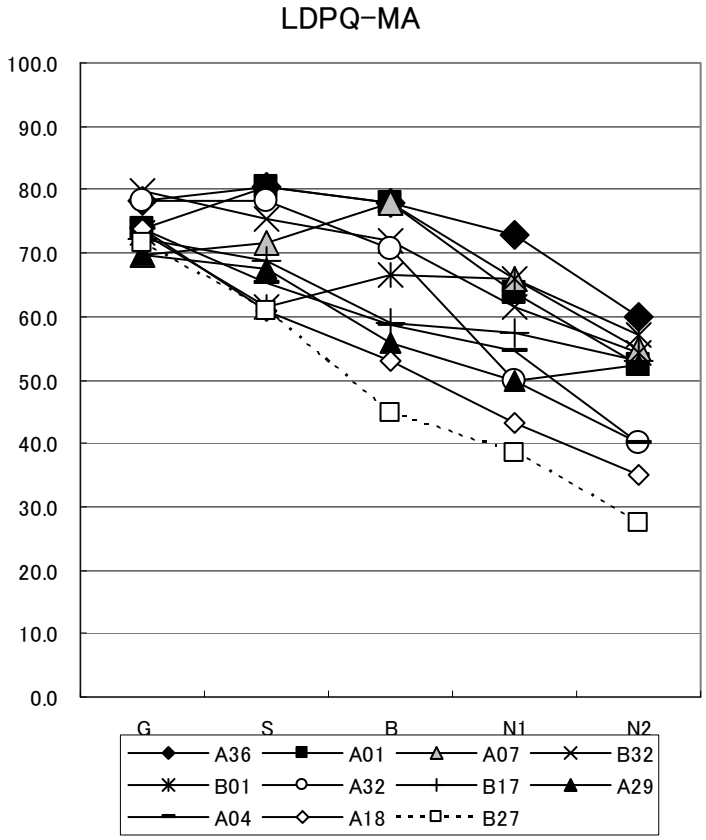


A38	Ave.	93.7	Genetics/Evolution	Subject	Genetic disease probability by a dominant allele
Solution		Calculate the probability of genetic disease based on several assumptions.			
Analysis		Poor DP. Too easy. Similar questions are familiar to the students and they are trained.			
A37	Ave.	91.4	Genetics/Evolution	Subject	Chromosome and inheritance pattern
Solution		Judge allele location and dominant/recessive from several assumptions.			
Analysis		Poor DP. Too easy. Similar questions are familiar to the students and they are trained.			
B02	Ave.	88.4	Cell/Biochem/Molec.Biol.	Subject	Water characteristics and benefit to organisms
Solution		Correlate chemical nature of water to its biological benefit.			
Analysis		Weak DP. Too easy. Knowledge biased.			
B10	Ave.	86.8	Plant Anatomy/ Physiology	Subject	Flowering regulation by florigen
Solution		Deduce the location of production and response of florigen based on some experiments.			
Analysis		Weak DP. Too easy. It can be solved by simple thinking after reading without particular knowledge.			
A16	Ave.	86.4	Plant Anatomy/ Physiology	Subject	Stem section structure in flowering plant
Solution		Judge the direction of stem center from a section picture.			
Analysis		Weak DP. Too easy. Figure is familiar, and the option is practically only 2.			
B15	Ave.	85.2	Animal Anatomy/ Physiology	Subject	Factors affecting egg maturation in starfish
Solution		Deduce hypotheses on substance to affect egg maturation from a series of experiments.			
Analysis		Poor DP. Too easy. It can be solved by simple thinking after reading without particular knowledge.			
A23	Ave.	83.7	Animal Anatomy/ Physiology	Subject	Transcription/translation in early development
Solution		Understand the changes of transcription and translation in early-development experiments.			
Analysis		Weak DP. Too easy. It is good basic question but similar questions may be familiar to the students.			

B31	Ave.	76.9	Ecology	Subject	Competitive exclusion in community
Solution		Answer accurate understanding of competitive exclusion among species.			
Analysis		Poor DP. A little too easy. Knowledge biased. The description may be confusing to some students.			
A50	Ave.	75.6	Ecology	Subject	Primary production and energy in ecosystem
Solution		Answer accurate understanding of energy input to the ecosystem.			
Analysis		Poor DP. A little too easy. Knowledge biased. Options were not so systematic and a little confusing.			
B08	Ave.	71.4	Plant Anatomy/ Physiology	Subject	Physiological roles of minerals in plant
Solution		Answer the role, translocation, and deficiency effect of minerals in plants.			
Analysis		Weak DP. A little too easy. Inappropriate combination of easy and hard-to-think questions.			

(7) LDPQ-MA : Low discriminating power questions with middle average

LDPQ-MA	G	S	B	N1	N2
A36	78.3	80.4	77.9	72.7	60.0
A01	73.9	80.4	77.9	63.6	52.5
A07	69.6	71.7	77.9	65.9	55.0
B32	79.7	75.4	72.1	61.4	54.2
B01	73.2	61.6	66.7	65.9	57.1
A32	78.3	78.3	70.6	50.0	40.0
B17	72.2	68.7	59.0	57.3	53.1
A29	69.6	67.4	55.9	50.0	52.5
A04	73.9	65.2	58.8	54.5	40.0
A18	73.9	60.9	52.9	43.2	35.0
B27	71.7	60.9	44.9	38.6	27.5

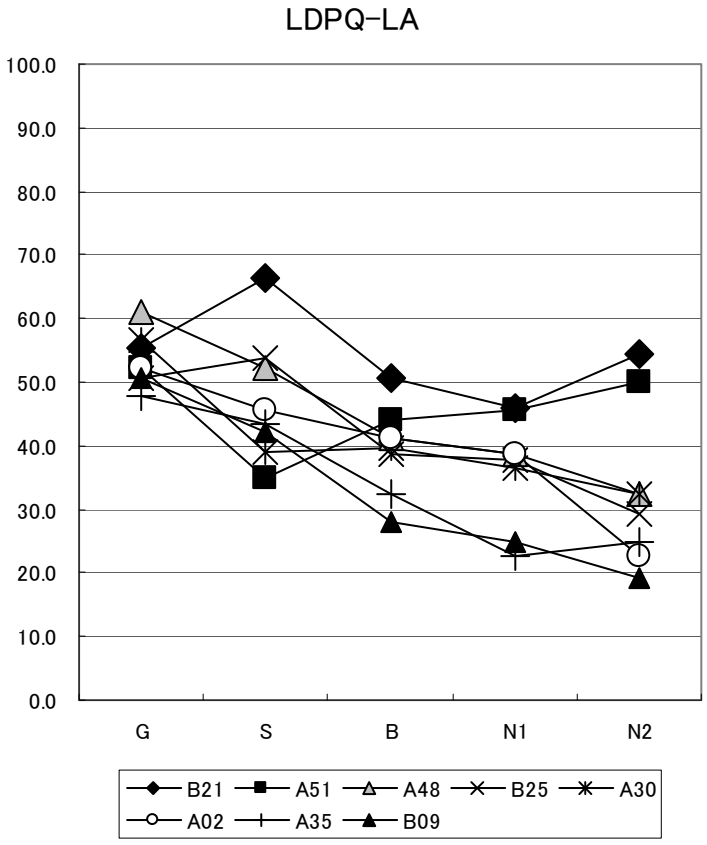


A36	Ave.	74.2	Ethology	Subject	Bird behavior and territory defense
Solution		Predict a sequence of attack behavior based on bird-model experiments.			
Analysis		Poor DP. Specific knowledge may be needed. Options may be a little too complicated.			
A01	Ave.	71.0	Cell/Biochem/Molec.Biol.	Subject	Hydrogen bonds in water, DNA, and proteins
Solution		Answer the nature of hydrogen bonds comparing various biological molecules and treatments.			
Analysis		Poor DP. Accurate chemical knowledge in various biological molecules may be too difficult.			
A07	Ave.	69.2	Cell/Biochem/Molec.Biol.	Subject	Carbon fixation and light-electron transfer
Solution		Predict expected experimental results on the carbon fixation in photosynthesis.			
Analysis		Poor DP. Required knowledge, although historically important, may be too specific for the students.			
B32	Ave.	68.2	Ecology	Subject	Competition and growth in plants
Solution		Conclude the effect of light and soil on plant growth from the experiments shown.			
Analysis		Weak DP. It may only need figure reading and logical thinking without particular knowledge.			

B01	Ave.	64.4	Cell/Biochem/Molec.Biol.	Subject	Contents of chemical elements in organisms
Solution		Estimate and compare approximate contents of major chemicals in plants and mammals.			
Analysis		Poor DP. Required chemical knowledge and thinking ability may be too wide for the students.			
A32	Ave.	63.3	Animal Anatomy/ Physiology	Subject	Cultivation of fish and origin of its poison
Solution		Deduce information from culture experiments on the origin of toxin in a species of fish.			
Analysis		Weak DP. Experiments and options may not be clear enough. No particular knowledge is needed.			
B17	Ave.	61.0	Animal Anatomy/ Physiology	Subject	Differentiation and organ formation in animals
Solution		Answer fate determination in differentiation of various cells in vertebrates.			
Analysis		Poor DP. Knowledge biased. Similar questions may be familiar to some students.			
A29	Ave.	57.9	Animal Anatomy/ Physiology	Subject	Digestive enzyme from pancreas
Solution		Deduce consequence of experiments of digestive enzyme on carbohydrate metabolism.			
Analysis		Poor DP. Expected combination of knowledge may be too difficult and unfamiliar to the students.			
A04	Ave.	56.6	Cell/Biochem/Molec.Biol.	Subject	Protein processing and modification
Solution		Propose possible methods to inhibit protein processing to cause a disease.			
Analysis		Weak DP. The subject may be too complicated and unfamiliar for the high-school students.			
A18	Ave.	51.6	Plant Anatomy/ Physiology	Subject	Development and plant hormones
Solution		Answer names of plant hormones affecting the development of cultured tissue.			
Analysis		Weak DP. Knowledge biased. Similar questions may be familiar to some students.			
B27	Ave.	46.6	Genetics/Evolution	Subject	Enzyme polymorphism and allele frequency
Solution		Calculate allele frequency from population isozyme data and discuss the results.			
Analysis		Weak DP. Figure reading and calculation part was too difficult.			

(8) LDPQ-LA : Low discriminating power questions with low average

LDPQ-LA	G	S	B	N1	N2
B21	55.4	66.3	50.7	46.0	54.4
A51	52.2	34.8	44.1	45.5	50.0
A48	60.9	52.2	41.2	38.6	32.5
B25	50.7	53.6	38.7	37.9	29.2
A30	56.5	39.1	39.7	36.4	32.5
A02	52.2	45.7	41.2	38.6	22.5
A35	47.8	43.5	32.4	22.7	25.0
B09	50.7	42.0	27.9	25.0	19.2



B21	Ave.	54.2	Ethology	Subject	Social behavior and role differentiation
Solution		Speculate the different role in ant society from a picture of walking paths around the nest entrance.			
Analysis		Poor DP. Too difficult. It may be solved by speculation without biological knowledge and training.			
A51	Ave.	44.3	Ecology	Subject	Factors affecting ecosystem stability
Solution		Answer an important factor affecting the stability of terrestrial ecosystem.			
Analysis		Poor DP. Too difficult. Some technical words and concepts may not be studied in high schools.			
A48	Ave.	43.4	Ecology	Subject	Food web and population dynamics
Solution		Answer the consequence of disturbance on a given food web in ecosystem.			
Analysis		Weak DP. Too difficult. Figure reading and option descriptions may be too complicated.			
B25	Ave.	41.2	Genetics/Evolution	Subject	Mutation, speciation and evolutionary distance
Solution		Calculate the evolutionary distance (definition given) and separate DNA/species divergence.			
Analysis		Poor DP. Too difficult. Gene/species relative divergence time seems beyond the student level.			
A02	Ave.	39.4	Cell/Biochem/Molec.Biol.	Subject	Activation group and biopolymer synthesis
Solution		Categorize biopolymer elongation reactions into two types.			
Analysis		Weak DP. Too difficult. The categorical understanding of biochemical reactions may be too far.			
A30	Ave.	39.4	Animal Anatomy/ Physiology	Subject	Liver and blood glucose concentration
Solution		Speculate relative glucose concentration in veins around liver and terminal after glucose taking.			
Analysis		Poor DP. Too difficult. The relation of vein, liver, and intestine may not be studied in most students.			
A35	Ave.	33.0	Ethology	Subject	Altruistic behavior of mammals
Solution		Plan experiments to confirm reciprocal altruism behavior.			
Analysis		Poor DP. Too difficult. The subject and experiment planning are not studied in most high school.			
B09	Ave.	31.1	Plant Anatomy/ Physiology	Subject	Growth analysis of plant root
Solution		Deduce expected results as graphs from the description of experiments of root growth.			
Analysis		Weak DP. Too difficult. Related knowledge may not be studied in most high school.			

Final Students Scores

	Name		Country	Code	Raw Scores								Final T-score	Medal
					Practical Test					Theoretical Test				
	First Name	Family Name			Pr 1	Pr 2	Pr 3	Pr 4	Total Pr	Th A	Th B	Total Th		
					100	*100*	*98*	*91*	*389*	*81*	*108*	*189*		
1	Yangzi	Dong	Singapore	4202	79	85	95	69	328	72	91.2	163.2	131.88	Gold
2	Jonathan James	Liang	USA	5504	42	89	86	78	295	78	97.4	175.4	131.22	Gold
3	Wei Han	Tan	Singapore	4203	79	73	84	67	303	75	91.6	166.6	130.47	Gold
4	Thomas	Brereton	Australia	0301	61	58	92	78	289	72	98.1	170.1	129.83	Gold
5	Siyang	Hao	China	1001	93	74	92	79	338	61.5	89.3	150.8	129.45	Gold
6	Ryota	Otsuki	Japan	2502	62	85	76	89	312	66	96.0	162.0	129.42	Gold
7	Joseph Edward	Harvey	United Kingdom	5402	62	96	84	83	325	67.5	89.3	156.8	128.66	Gold
8	Yu-Chi	Kuo	Chinese Taipei	1102	66	82	70	71	289	66	96.5	162.5	126.82	Gold
9	I-Chun	Lee	Chinese Taipei	1103	57	58	71	76	262	70.5	99.1	169.6	126.44	Gold
10	Zhengda	Li	China	1003	77	61	76	67	281	67.5	93.9	161.4	126.17	Gold
11	Seungsoo	Kim	USA	5503	57	78	90	66	291	69	91.5	160.5	125.79	Gold
12	Chenyu	Zhang	China	1004	58	79	87	69	293	70.5	87.7	158.2	125.28	Gold
13	Georgy A.	Nosov	Russia	4104	82	72	92	61	307	61.5	89.8	151.3	125.26	Gold
14	Chengxiang	Yuan	Singapore	4204	65	74	95	63	297	70.5	83.2	153.7	124.28	Gold
15	Rong	Huang	China	1002	68	91	78	68	305	61.5	88.6	150.1	123.92	Gold
16	Jonathan Samuel	Gootenberg	USA	5501	46	85	87	74	292	69	86.1	155.1	123.54	Gold
17	Woo Jin	Jeon	Korea	2703	66	59	81	59	265	72	86.7	158.7	122.71	Gold
18	Nantanuj	Vutthikraivit	Thailand	5003	65	91	66	58	280	70.5	84.5	155.0	122.58	Gold
19	David Pai	Huang	USA	5502	46	83	86	76	291	64.5	86.1	150.6	121.84	Gold
20	James Nicolas	Woodmansey	Australia	0304	54	92	90	73	309	67.5	77.1	144.6	121.81	Gold
21	Anugerah	Erlaut	Indonesia	2102	67	72	71	64	274	66	87.2	153.2	121.71	Gold
22	Arya	Haj Mirzaian	Iran	2201	71	77	83	67	298	67.5	77.5	145.0	121.54	Gold
23	Vidhi	Hathi	India	2003	39	87	80	75	281	72	81.7	153.7	121.49	Gold
24	Virapat	Kieuvongngam	Thailand	5001	67	64	73	56	260	64.5	92.1	156.6	121.30	Silver
25	Irfan	Haris	Indonesia	2103	62	72	81	73	288	63	84.5	147.5	121.16	Silver
26	Edwin Lindsay	Pynegar	United Kingdom	5404	52	89	92	60	293	67.5	81.0	148.5	121.08	Silver
27	Fatemeh	Kashani	Iran	2203	57	44	95	68	264	63	91.4	154.4	120.99	Silver
28	Michael	Mikat	Czech Republic	1302	81	50	92	64	287	66	78.6	144.6	120.86	Silver
29	Mel	Chen	Australia	0302	26	72	78	80	256	70.5	86.8	157.3	119.76	Silver
30	Dave	Hartig	Germany	1801	62	61	76	85	284	61.5	81.5	143.0	119.50	Silver
31	Anton Alexandrovich	Kavaleuski	Belarus	0502	57	71	88	58	274	61.5	87.2	148.7	119.44	Silver
32	Jelle	Zijlstra	The Netherlands	3504	50	37	83	61	231	66	94.7	160.7	119.25	Silver
33	Ruei-Je	Chang	Chinese Taipei	1101	58	81	87	44	270	64.5	85.5	150.0	119.04	Silver
34	Atsuhito	Nakayama	Japan	2501	62	75	68	66	271	63	82.8	145.8	118.44	Silver
35	Geoffrey Vincent	Hoggins	New Zealand	3603	53	57	81	60	251	66	84.8	150.8	117.70	Silver
36	Soo Jin	Kim	Korea	2704	65	67	85	61	278	60	80.1	140.1	117.20	Silver
37	Jatuporn	Wanichanont	Thailand	5004	71	67	62	64	264	63	79.4	142.4	116.87	Silver
38	Ayako	Yanaka	Japan	2504	56	71	84	55	266	60	84.1	144.1	116.73	Silver
39	Na Ye	Choi	Korea	2702	58	73	89	84	304	61.5	68.0	129.5	116.38	Silver
40	Alexey A.	Agapov	Russia	4101	55	46	84	53	238	64.5	86.5	151.0	116.37	Silver
41	Clinton Jia	Wang	Canada	0903	40	58	60	65	223	72	84.8	156.8	116.35	Silver
42	Jan	Krieghoff	Germany	1803	42	60	75	57	234	66	87.4	153.4	116.16	Silver
43	Mai	Yamakawa	Japan	2503	43	88	80	70	281	52.5	84.9	137.4	115.52	Silver
44	Qi Yan	Ang	Singapore	4201	64	96	64	63	287	57	75.7	132.7	115.16	Silver
45	Inji	Chang	Korea	2701	44	76	83	58	261	60	82.7	142.7	115.14	Silver
46	Phun-Phai	Somkearti	Thailand	5002	63	49	79	50	241	63	82.4	145.4	114.90	Silver
47	Khurshedi	Davronzod	Tajikistan	4901	43	26	48	53	170	75	92.6	167.6	114.67	Silver
48	Sarah	Gales	United Kingdom	5401	54	98	67	63	282	57	75.8	132.8	114.16	Silver
49	Mark	Gimbutas	Estonia	1501	67	65	86	41	259	61.5	77.0	138.5	114.11	Silver
50	Chetan	Srinath	India	2004	43	73	91	67	274	57	77.8	134.8	113.88	Silver

	Name		Country	Code	Raw Scores								Final T-score	Medal
					Practical Test					Theoretical Test				
	First Name	Family Name			Pr 1	Pr 2	Pr 3	Pr 4	Total Pr	Th A	Th B	Total Th		
					100	*100*	*98*	*91*	*389*	*81*	*108*	*189*		
51	Justas	Lavisius	Lithuania	3203	65	65	81	27	238	67.5	77.9	145.4	113.87	Silver
52	Ilia	Kats	Germany	1802	80	80	81	13	254	54	85.8	139.8	113.73	Silver
53	Andrei Yurjevich	Sukhareuski	Belarus	0504	59	43	84	56	242	66	75.6	141.6	113.64	Silver
54	Julius	Juodakis	Lithuania	3202	52	62	88	38	240	66	78.8	144.8	113.59	Silver
55	Erik Olof Johannes	Wannerberg	Sweden	4704	38	55	83	67	243	61.5	81.2	142.7	113.34	Silver
56	Po- Fan	Wu	Chinese Taipei	1104	66	41	56	61	224	61.5	83.2	144.7	113.29	Silver
57	Nguyen Thi Thuy	Trang	Vietnam	5604	60	61	69	52	242	60	80.4	140.4	112.95	Silver
58	Arad	Iranmehr	Iran	2202	63	35	53	73	224	63	78.7	141.7	112.43	Silver
59	Tomasz Jakub	Klaus	Poland	3902	61	29	85	46	221	66	76.9	142.9	111.79	Silver
60	Linus	Meier	Switzerland	4801	56	82	61	66	265	57	72.4	129.4	111.38	Silver
61	Jan	Smycka	Czech Republic	1304	65	51	83	63	262	55.5	72.8	128.3	111.32	Silver
62	Kristijan	Jovanoski	Australia	0303	32	73	60	67	232	57	83.5	140.5	110.85	Silver
63	Elizabeth Eva	Jefferys	United Kingdom	5403	55	56	54	64	229	57	81.0	138.0	110.78	Silver
64	Tereza	Nedvedova	Czech Republic	1303	63	45	89	49	246	60	70.6	130.6	110.01	Silver
65	Fatemeh	Moghadas	Iran	2204	41	17	87	57	202	61.5	83.5	145.0	109.97	Silver
66	Stefanie	Tanner	Switzerland	4804	43	75	89	63	270	51	73.7	124.7	109.59	Silver
67	Mircea	Sofonea	France	1704	59	66	92	69	286	54	62.8	116.8	109.44	Silver
68	Mireille	Carrere	France	1701	43	64	79	71	257	55.5	71.7	127.2	109.41	Silver
69	Usnish	Adhikari	India	2001	53	67	67	51	238	51	82.1	133.1	109.41	Silver
70	Jana	Faltynkova	Czech Republic	1301	63	62	87	51	263	58.5	64.7	123.2	109.02	Bronze
71	Natallia Siarheeuna	Bukhtarevich	Belarus	0501	60	72	78	51	261	51	72.6	123.6	108.70	Bronze
72	Nina	Turk	Slovenia	4403	58	63	74	78	273	51	65.9	116.9	108.27	Bronze
73	Enes	Karabacak	Turkey	5101	35	23	71	57	186	66	79.6	145.6	108.08	Bronze
74	Elbert	Wijaya	Indonesia	2104	79	63	44	59	245	46.5	76.3	122.8	107.84	Bronze
75	Sebastian	Vishnopolska	Argentina	0104	63	46	71	38	218	63	70.8	133.8	107.80	Bronze
76	Milda	Jakutaviciute	Lithuania	3201	31	35	93	41	200	61.5	81.1	142.6	107.77	Bronze
77	Martin	Michel	Switzerland	4802	65	53	72	67	257	49.5	70.4	119.9	107.76	Bronze
78	Larisa A.	Akulkina	Russia	4102	52	76	56	52	236	58.5	71.0	129.5	107.74	Bronze
79	Francis Samuel	Duffy	Ireland	2301	42	76	70	51	239	57	71.7	128.7	107.28	Bronze
80	Kotryna	Vaidziulyte	Lithuania	3204	30	61	84	49	224	64.5	69.7	134.2	107.20	Bronze
81	Amit	Gupta	India	2002	25	81	57	44	207	61.5	79.1	140.6	107.11	Bronze
82	Uku-Laur	Tali	Estonia	1503	59	77	81	66	283	48	62.5	110.5	106.59	Bronze
83	Claudia	Simonett	Switzerland	4803	34	63	82	71	250	55.5	66.4	121.9	106.28	Bronze
84	Justus	Mutanen	Finland	1603	49	50	55	54	208	55.5	77.8	133.3	106.25	Bronze
85	Sophia Louise	Frentz	New Zealand	3602	48	75	65	67	255	49.5	68.6	118.1	105.85	Bronze
86	Delyan Tsvetanov	Georgiev	Bulgaria	0802	53	62	64	48	227	52.5	73.6	126.1	105.58	Bronze
87	Juris	Kibilds	Latvia	3002	64	56	54	56	230	54	69.0	123.0	105.56	Bronze
88	Lukasz	Truszkowski	Poland	3904	31	49	65	37	182	58.5	84.1	142.6	105.54	Bronze
89	Marine	Leve	France	1703	74	55	62	49	240	51	65.6	116.6	104.59	Bronze
90	Osman Aykan	Kargin	Turkey	5102	30	20	82	43	175	63	77.9	140.9	104.57	Bronze
91	Leonie Van	Steijn	The Netherlands	3501	46	52	77	62	237	57	62.8	119.8	104.52	Bronze
92	Geoffrey James	Osgood	Canada	0902	38	56	75	37	206	57	73.9	130.9	104.12	Bronze
93	Daniel Patrocinio	Zen	Brazil	0704	71	21	23	14	129	66	83.8	149.8	103.92	Bronze
94	Alvaro	Lafuente Romero	Spain	4503	48	54	72	56	230	52.5	67.0	119.5	103.55	Bronze
95	Vida	Set	Slovenia	4401	54	55	77	64	250	51	60.8	111.8	103.39	Bronze
96	Mikko Johannes	Tiusanen	Finland	1604	65	50	61	46	222	55.5	64.2	119.7	103.31	Bronze
97	Zigmunds	Orlovskis	Latvia	3003	52	57	71	38	218	51	72.2	123.2	103.27	Bronze
98	Philip	Will	The Netherlands	3503	49	58	90	46	243	49.5	66.0	115.5	103.24	Bronze
99	Le Thuy	Duong	Vietnam	5601	38	28	37	41	144	61.5	84.1	145.6	103.13	Bronze
100	Alime Gokce	Kocaarslan	Turkey	5103	67	40	65	54	226	51	65.8	116.8	103.10	Bronze
101	Aaron	Ramirez	Mexico	3302	46	58	81	62	247	46.5	66.0	112.5	102.86	Bronze
102	Sameera Erandaka	Ariyarathna	Sri Lanka	4601	32	32	57	47	168	60	77.9	137.9	102.77	Bronze
103	Max	Biggs	New Zealand	3601	37	55	58	40	190	61.5	70.2	131.7	102.70	Bronze
104	Marcel	Kuckelkorn	Germany	1804	68	67	48	56	239	48	64.0	112.0	102.57	Bronze
105	Mathis	Funk	France	1702	34	68	56	72	230	45	72.7	117.7	102.51	Bronze
106	Mahym	Mansoor	Pakistan	3803	34	52	83	48	217	51	71.5	122.5	102.38	Bronze
107	Fan	Zhu	Canada	0904	37	36	62	49	184	60	71.3	131.3	102.33	Bronze
108	Lassi Ilmari	Helanti	Finland	1601	32	32	78	63	205	55.5	68.3	123.8	102.06	Bronze
109	Sebastian	Haelg	Liechtenstein	3101	56	60	91	40	247	49.5	61.0	110.5	101.98	Bronze
110	Dzmitry Sergeevich	Kuzmin	Belarus	0503	36	46	82	53	217	54	66.4	120.4	101.90	Bronze

	Name		Country	Code	Raw Scores								Final T-score	Medal
					Practical Test					Theoretical Test				
	First Name	Family Name			Pr 1	Pr 2	Pr 3	Pr 4	Total Pr	Th A	Th B	Total Th		
					100	*100*	*98*	*91*	*389*	*81*	*108*	*189*		
111	Veronika	Nogellova	Slovak Republic	4304	59	44	76	45	224	45	70.3	115.3	101.67	Bronze
112	Michal Piotr	Banacki	Poland	3901	49	59	66	25	199	58.5	66.8	125.3	101.44	Bronze
113	Gianmarco	Messa	Italy	2402	49	67	83	19	218	51	68.7	119.7	101.22	Bronze
114	Nguyen Thi Nhu	Quynh	Vietnam	5603	57	33	64	45	199	60	61.4	121.4	101.19	Bronze
115	Roxanne Angelika	Lau	Ireland	2302	39	73	80	47	239	55.5	56.4	111.9	100.87	Bronze
116	Michele	Candrina	Italy	2401	29	69	69	68	235	45	67.3	112.3	100.72	Bronze
117	Artem	Komissarov	Ukraine	5301	54	57	70	46	227	46.5	66.0	112.5	100.62	Bronze
118	Hilola	Hakimova	Tajikistan	4902	53	21	21	37	132	70.5	69.3	139.8	100.34	Bronze
119	Lena Margareta	Kallsten	Sweden	4702	40	77	70	23	210	49.5	70.3	119.8	99.96	Bronze
120	Samuel	Genzor	Slovak Republic	4302	43	63	74	50	230	48	62.4	110.4	99.70	Bronze
121	Rustam	Esanov	Turkmenistan	5202	36	44	83	40	203	51	67.9	118.9	99.48	Bronze
122	Pier Luigi	Susini	Italy	2404	30	68	48	50	196	52.5	69.1	121.6	99.43	Bronze
123	Jaakko Tapani	Hyypia	Finland	1602	28	66	51	38	183	52.5	74.0	126.5	99.42	Bronze
124	Anastasiya	Kravets'	Ukraine	5303	46	57	67	25	195	54	67.2	121.2	99.37	Bronze
125	Dehiwala Pathirannehelage Udari Tankana	Samarasiri	Sri Lanka	4603	42	27	17	35	121	60	80.9	140.9	98.91	Bronze
126	Duong Thu	Huong	Vietnam	5602	42	39	85	46	212	51	61.8	112.8	98.71	Bronze
127	Piers Martin	Murphy	Ireland	2304	34	62	67	47	210	48	66.2	114.2	98.42	Bronze
128	Lorenzo	Pallini	Italy	2403	38	36	52	61	187	51	67.5	118.5	98.31	Bronze
129	Yahia	Al-Jebari	Sweden	4701	44	62	64	41	211	51	60.9	111.9	97.99	Bronze
130	Nejc	Umek	Slovenia	4404	62	33	73	49	217	45	61.2	106.2	97.91	Bronze
131	Azam	Kozizoda	Tajikistan	4904	35	8	37	41	121	64.5	73.0	137.5	97.69	Bronze
132	Aaron Joseph	Hakim	Canada	0901	18	69	71	36	194	60	59.9	119.9	97.64	Bronze
133	Tayyaba Maqbool	Malik	Pakistan	3802	39	63	74	33	209	48	64.6	112.6	97.57	Bronze
134	Miguel Angel	Ramos	Mexico	3303	48	47	56	35	186	55.5	61.5	117.0	97.31	Bronze
135	Azad	Alizada	Azerbaijan	0403	48	11	60	48	167	55.5	64.4	119.9	97.02	Bronze
136	Samuel	Vandewaeter	Belgium	0604	51	51	61	50	213	46.5	60.2	106.7	96.97	Bronze
137	Sukru	Sogut	Turkey	5104	56	18	44	49	167	46.5	72.3	118.8	96.94	Bronze
138	Nasser Camara	Magalhaes	Brazil	0701	41	37	32	33	143	52.5	76.3	128.8	96.66	
139	Jorge Ivan	Aguirre	Mexico	3301	40	37	49	39	165	52.5	69.1	121.6	96.53	
140	Mihaela	Georgescu	Romania	4003	40	39	58	56	193	48	63.8	111.8	96.43	
141	Mirela Diana	Ilie	Romania	4004	39	55	70	39	203	40.5	70.0	110.5	96.38	
142	Lucian	Craciun	Romania	4001	33	15	38	64	150	52.5	71.4	123.9	96.31	
143	Malte	Thodberg	Denmark	1404	52	44	74	52	222	40.5	61.2	101.7	96.30	
144	Talap	Kossybakov	Kazakhstan	2603	44	1	90	46	181	52.5	61.3	113.8	96.18	
145	Danang	Crysnanto	Indonesia	2101	38	35	40	48	161	57	64.3	121.3	96.15	
146	Kristina	Kicova	Slovak Republic	4303	51	18	73	55	197	48	59.6	107.6	96.04	
147	Danique Van	Vliet	The Netherlands	3502	52	50	81	21	204	51	57.0	108.0	95.75	
148	Tina	Subic	Slovenia	4402	60	31	72	51	214	45	55.9	100.9	95.61	
149	Anastasia O.	Maslova	Russia	4103	53	38	65	51	207	36	67.8	103.8	95.51	
150	Matias Roberto	Landino	Argentina	0102	58	57	80	24	219	39	62.2	101.2	95.17	
151	Adrija	Kalvisa	Latvia	3001	56	43	65	54	218	40.5	58.5	99.0	95.11	
152	Katarina	Dlugosova	Slovak Republic	4301	56	46	77	49	228	42	52.1	94.1	94.24	
153	Eero	Vaher	Estonia	1504	51	49	64	42	206	43.5	57.9	101.4	94.06	
154	Maria Svetomirova	Atanasova	Bulgaria	0801	58	45	43	33	179	46.5	62.2	108.7	93.91	
155	Santiago	Sosa	Argentina	0103	56	13	61	60	190	45	55.8	100.8	93.18	
156	Farhat	Rahimov	Turkmenistan	5203	46	52	46	49	193	49.5	53.6	103.1	93.18	
157	Elena	Collado Lledo	Spain	4501	39	46	89	60	234	34.5	54.1	88.6	92.37	
158	Artoghrul	Alishbayli	Azerbaijan	0401	52	36	24	27	139	52.5	63.0	115.5	91.68	
159	Jiangyuan (Jenny)	Liu	New Zealand	3604	33	68	36	37	174	48	58.6	106.6	91.28	
160	Timur	Khabibullin	Tajikistan	4903	26	12	23	24	85	73.5	59.5	133.0	91.16	
161	Gergana Venkova	Velikova	Bulgaria	0804	53	23	74	45	195	45	50.4	95.4	91.09	
162	Adina -Ioana	Dinu	Romania	4002	41	26	28	37	132	49.5	65.9	115.4	90.73	
163	Andrey Svetlinov	Ivanov	Bulgaria	0803	54	50	59	28	191	42	54.1	96.1	90.21	
164	Gunda	Zvigule	Latvia	3004	64	25	32	22	143	48	59.6	107.6	89.75	
165	Martin Alexander	Norlin	Sweden	4703	42	46	41	38	167	45	57.4	102.4	89.65	
166	Martin Facundo	Bresnal	Argentina	0101	39	29	48	33	149	45	63.0	108.0	89.64	
167	Charlotte	Callewaert	Belgium	0601	44	28	67	54	193	48	43.9	91.9	89.35	
168	Olga	Povorozniuk	Ukraine	5304	56	12	63	49	180	37.5	56.4	93.9	89.26	
169	Andreas	Petrides	Cyprus	1203	20	39	45	51	155	48	58.0	106.0	89.05	
170	Michalis	Georgiou	Cyprus	1201	32	51	57	20	160	48	55.4	103.4	88.25	

	Name		Country	Code	Raw Scores								Final T-score	Medal
					Practical Test					Theoretical Test				
	First Name	Family Name			Pr 1	Pr 2	Pr 3	Pr 4	Total Pr	Th A	Th B	Total Th		
					100	*100*	*98*	*91*	*389*	*81*	*108*	*189*		
171	Nazym Nurlanovna	Bashkenova	Kazakhstan	2601	36	15	74	37	162	39	60.3	99.3	87.98	
172	Roman	Langolf	Kazakhstan	2604	40	7	49	46	142	51	52.6	103.6	87.88	
173	Pawel Przemyslaw	Stepniewski	Poland	3903	45	21	51	41	158	37.5	60.9	98.4	87.67	
174	Pedro Sabino Gomes	Neto	Brazil	0702	56	6	26	34	122	52.5	54.9	107.4	87.52	
175	Nicolas	Lepers	Belgium	0603	21	25	70	37	153	39	63.9	102.9	87.51	
176	Ruslan Vladimirovich	Kalizhan	Kazakhstan	2602	39	22	34	34	129	43.5	63.5	107.0	87.18	
177	Resad	Cobanli	Azerbaijan	0404	46	31	16	34	127	45	60.4	105.4	86.60	
178	Aoife	Mccarthy	Ireland	2303	26	53	46	27	152	48	51.8	99.8	85.93	
179	Mirihanage Dona Maheshi Sandunika	Wijeyabandara	Sri Lanka	4604	38	21	8	29	96	46.5	67.1	113.6	85.82	
180	Ellen L.	Freese	Denmark	1401	32	44	57	32	165	34.5	56.4	90.9	84.58	
181	Kevin	Doello Gonzalez	Spain	4502	29	11	48	46	134	37.5	61.0	98.5	84.57	
182	Camilla Verner	Klejs	Denmark	1403	42	41	57	38	178	27	57.8	84.8	84.42	
183	Sameera Gamlath	Gamlath Ralalage	Sri Lanka	4602	36	48	32	20	136	39	59.4	98.4	83.98	
184	Sergii	Kostrikov	Ukraine	5302	34	18	32	31	115	40.5	62.6	103.1	83.93	
185	Jeanne	Fourmentin	Belgium	0602	39	20	52	8	119	42	59.9	101.9	83.53	
186	Madis	Hurt	Estonia	1502	40	28	46	17	131	42	54.6	96.6	83.09	
187	Saima	Hanif	Pakistan	3801	30	25	44	19	118	54	46.4	100.4	82.68	
188	Margarita	Papatheodoridi	Greece	1904	24	15	53	64	156	31.5	53.2	84.7	82.10	
189	Shohrat	Allayev	Turkmenistan	5201	36	9	28	45	118	48	46.7	94.7	81.73	
190	Rainne Andre	Siqueira	Brazil	0703	29	19	22	28	98	46.5	54.1	100.6	80.82	
191	Bolette Mose	Jakobsen	Denmark	1402	51	34	46	14	145	34.5	48.4	82.9	79.95	
192	Sofia – Grigoria	Athanasopoulou	Greece	1902	28	0	41	51	120	42	45.8	87.8	79.29	
193	Aduramo Abigael	Lasode	Nigeria	3702	25	32	36	26	119	36	51.6	87.6	77.95	
194	Nihat	Aliyev	Azerbaijan	0402	19	14	30	20	83	40.5	58.5	99.0	77.95	
195	Janssel	Reyes	Mexico	3304	40	17	38	33	128	33	49.0	82.0	77.93	
196	Ioanna	Kyprianou	Cyprus	1202	11	10	45	24	90	52.5	41.4	93.9	76.62	
197	Edidiong Victor	Udoyen	Nigeria	3703	9	0	27	0	36	48	61.8	109.8	75.92	
198	Anastasia – Paraskevi	Aliferi	Greece	1901	22	29	46	12	109	37.5	46.3	83.8	74.97	
199	Souzana Eirini	Xyda	Cyprus	1204	22	13	33	29	97	37.5	47.9	85.4	74.87	
200	Raheel Sufian	Siddiqui	Pakistan	3804	24	2	44	10	80	37.5	53.5	91.0	74.77	
201	Khongorzul	Mungunkhuyag	Mongolia	3402	31	37	49	17	134	30	43.8	73.8	74.50	
202	Chidozie	Ugwoke	Nigeria	3704	37	17	18	38	110	30	46.7	76.7	73.99	
203	Askhatbek	Temirkulov	Kyrgyzstan	2904	23	1	34	25	83	40.5	44.4	84.9	73.22	
204	Mohammed	Idris	Nigeria	3701	25	14	32	32	103	31.5	45.4	76.9	72.61	
205	Anna	Gevorgyan	Armenia	0202	28	10	16	22	76	39	43.9	82.9	71.77	
206	Emil	Semetei Uulu	Kyrgyzstan	2903	22	0	27	19	68	42	40.6	82.6	70.52	
207	Damirbek	Abibillaev	Kyrgyzstan	2901	18	7	31	16	72	37.5	41.4	78.9	69.26	
208	Pablo	Rivera Perez De Rada	Spain	4504	21	1	17	28	67	43.5	35.3	78.8	69.20	
209	Myagmarsuren	Bat-Erdene	Mongolia	3401	29	31	23	33	116	28.5	32.7	61.2	68.28	
210	Sofia – Ifigeneia	Chrysoglou	Greece	1903	12	25	30	14	81	28.5	45.3	73.8	67.84	
211	Varsik	Avanesyan	Armenia	0201	14	0	11	34	59	21	51.7	72.7	65.91	
212	Ariundalai	Tsogbadrakh	Mongolia	3404	38	8	12	27	85	27	35.1	62.1	65.71	
213	Armen	Nazaryan	Armenia	0203	12	10	29	0	51	43.5	32.9	76.4	65.29	
214	Abdulrazaq	Alawadhi	Kuwait	2801	26	12	26	30	94	28.5	30.2	58.7	64.92	
215	Bayanbaatar	Munkhsaikhan	Mongolia	3403	26	12	15	51	104	28.5	24.1	52.6	64.34	
216	Orazdurdy	Rahimov	Turkmenistan	5204	38	0	18	35	91	18	33.5	51.5	62.76	
217	Kuban	Duishenbekov	Kyrgyzstan	2902	28	3	30	24	85	22.5	29.3	51.8	61.42	
218	Aishah Mohammad	Alsaleh	Kuwait	2803	24	13	21	6	64	22.5	32.2	54.7	59.41	
219	Suaad Soud	Alfaraj	Kuwait	2802	37	0	8	17	62	16.5	26.0	42.5	55.73	
220	Hussain Ali	Dashti	Kuwait	2804	10	2	15	24	51	22.5	25.5	48.0	55.46	
221	Arpine	Torosyan	Armenia	0204	19	0	14	15	48	22.5	24.9	47.4	55.11	

Average	46.02	46.16	61.31	47.02	200.5	52.06	67.28	119.3
Standard deviation	15.97	25.22	22.75	18.3	68.29	12.39	15.83	27.13

The Theoretical Tests

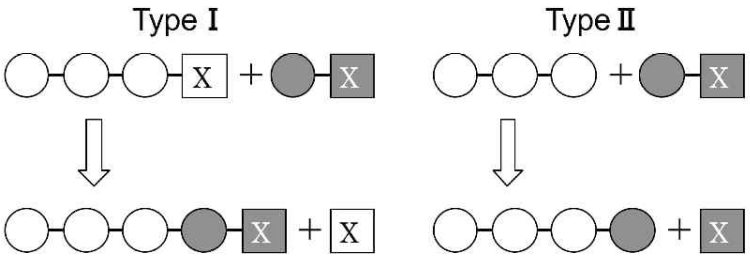
1. Part A

Cell Biology

A1. Which treatment is most effective in breaking as many hydrogen bonds as possible in an aqueous solution (pH 7.0) of 1 mg/mL DNA and 10 mg/mL protein?

A. Addition of hydrochloric acid to make the pH 1.0.
B. Addition of sodium hydroxide solution to make the pH 13.0.
C. Addition of urea to a concentration of 6 mol/L.
D. Addition of sodium dodecyl sulfate (a detergent) to a concentration of 10 mg/mL.
E. Heating the solution to 121°C.
F. Freezing the solution to -80°C.

A2. For the elongation of biopolymer molecules, there are two basic mechanisms, as shown below. In Type I elongation, the activation group (marked with an X) is released from the chain of growth. In Type II elongation, the activation group is released from the unit which is coming into the chain of growth. By which of these mechanisms are DNA (D), RNA (R),and protein (P) biosynthesized?



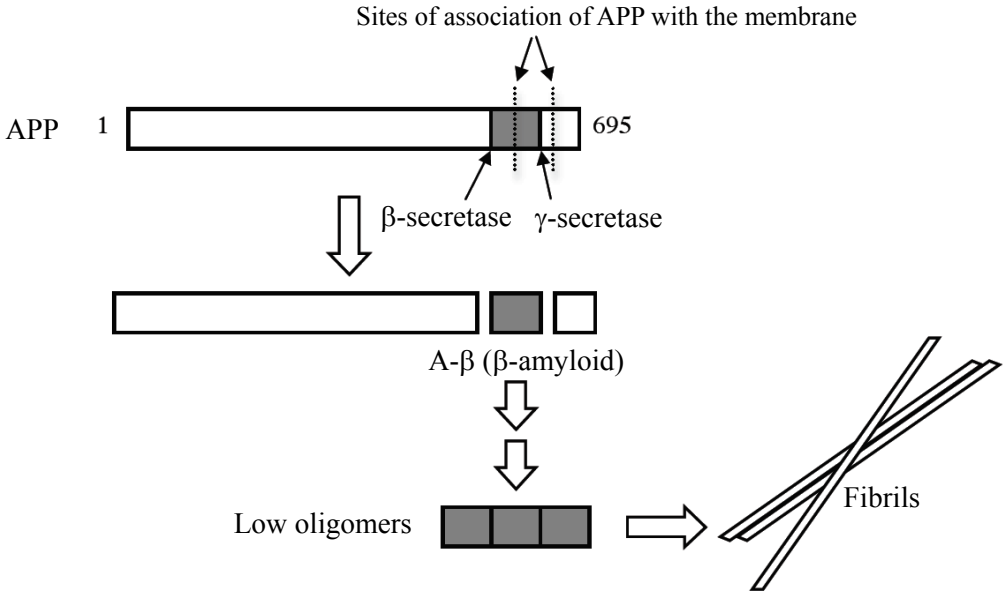
	Type I	Type II
A	(D)	(R), (P)
B	(P)	(D), (R)
C	none	(D), (R), (P)
D	(R), (P)	(D)
E	(D), (R)	(P)
F	(D), (R), (P)	none

A3. The movement of a ciliated protozoan is controlled by a protein called RacerX. When this protein binds to another protein, Speed, found at the base of the cilia, it stimulates the cilia to beat faster and the protozoan to swim faster. Speed can only bind to RacerX after phosphorylation of a specific threonine residue. How would you expect the mutant protozoan to behave if this threonine residue in Speed is replaced by an alanine residue?

A. Swims fast occasionally.
B. Always swims fast.
C. Never swims fast.

D. Switches rapidly back and forth between fast and slow swimming.
E. Cannot move at all.

A4. It is suggested that Alzheimer's disease is manifested by increased accumulation of a small peptide known as β-amyloid (A-β, 40-42 residues). Production of A-β occurs by proteolytic cleavage from a much longer protein APP, a membrane-inserted protein, by two proteases. The figure below shows the hypothesis for the production of the A-β molecule (the gray shaded box), displaying the sequential action of β-secretase to form the N-terminus of A-β and γ-secretase to cleave its substrate within a phospholipid membrane to produce the C-terminus of A-β. The produced A-β monomers then associate to form insoluble oligomers and toxic fibrils.



Which of the following is effective as an anti-Alzheimer therapy based on the above mechanisms?

I. Inhibiting the activity of β-secretase
II. Inhibiting the membrane targeting of γ-secretase
III. Inhibiting the oligomerization of A-β
IV. Enhancing the cellular mechanism of removal and degradation of A-β oligomers

A. Only I, II, IV
B. Only I, II, III
C. Only I, III, IV
D. Only II, III, IV
E. I, II, III, IV

A5. Human acetaldehyde dehydrogenase acts as a tetramer. Two alleles, *N* encoding a normal polypeptide and *M* encoding a mutant polypeptide, are known for the gene of this enzyme. Tetramers containing one or more mutant polypeptides have effectively no enzymatic activity. If the acetaldehyde dehydrogenase activity of the *NN* homozygote cells is 1, what is the activity of the *NM* heterozygote cells, assuming that both alleles are expressed at equal rates?

A. 1/2
B. 1/4
C. 1/8
D. 1/16
E. 1/32

A6. In 1961 Mitchell proposed a highly original explanation for ATP synthesis, which he called the chemiosmotic coupling model. Which of the following is correct?

A. ATP synthesis in mitochondria can be explained by the chemiosomotic model, but in chloroplasts it cannot.
B. ATP synthesis in mitochondria and chloroplasts can be explained by the chemiosomotic model only when the concentration of H^+ ions in the cell is higher than 0.1 mmol/L.
C. The energy source for mitochondria is electrons from nutrients, but for chloroplasts the energy source is electrons from water.
D. In mitochondria H^+ ions are pumped into the matrix, but in chloroplasts they are pumped into the thylakoid lumen.
E. H^+ ions are transferred through ATP synthase both in mitochondria and chloroplasts.

A7. A scientist, studying the process of photosynthesis, illuminates a culture of unicellular green algae for a certain period of time. Then she turns off the light and adds radioactive CO_2 by bubbling it in the culture for 30 minutes. Immediately she measures radioactivity in the cells. What is she likely to observe?

A. No radioactivity in the cells, because light is necessary to produce sugars starting from CO_2 and water.
B. No radioactivity in the cells, because CO_2 is used to produce O_2 during the light-dependent reactions.
C. No radioactivity in the cells, because CO_2 is taken by the plant cells only during illumination.
D. Radioactivity in the cells, because CO_2 is used to produce sugars even in the dark.
E. Radioactivity in the cells, because CO_2 is incorporated into NADPH in the dark.

A8. Which of the following are true for the relative permeabilities of human red blood cells and artificial phospholipid bilayer vesicles (called artificial vesicles hereafter) to glucose and ethanol?

I. Both red blood cells and artificial vesicles are more permeable to glucose than to ethanol.
II. Both red blood cells and artificial vesicles are more permeable to ethanol than to glucose.
III. In both red blood cells and artificial vesicles, the permeability to ethanol is almost the same as that to glucose.
IV. While red blood cells and artificial vesicles show almost the same permeability to glucose, red blood cells have a higher permeability to ethanol than artificial vesicles.
V. While red blood cells and artificial vesicles show almost the same permeability to ethanol, red blood cells have a higher permeability to glucose than artificial vesicles.

A. I, IV
B. I, V
C. II, IV
D. II, V
E. III, IV
F. III, V

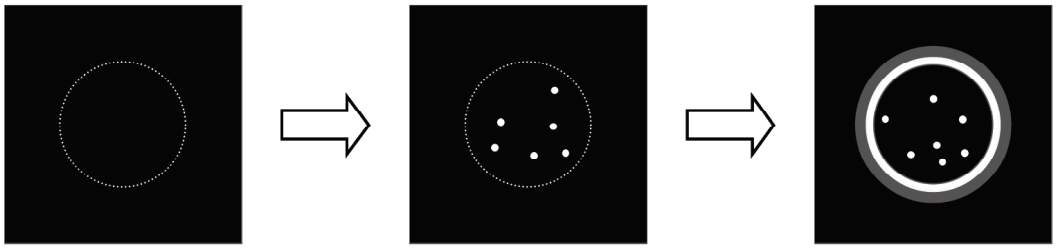
A9. A previously unknown organism that lacks nuclear membrane and mitochondria has just been discovered. Which of the following would this organism most likely possess?

A. Lysosome
B. Cilium
C. Endoplasmic reticulum
D. Chloroplast
E. Ribosome

A10. In eukaryotic cells, the oxidative phosphorylation reactions are catalyzed by various enzymes. Which of the following is correct?

A. All of these enzymes are coded in nuclear DNA, synthesized in ribosomes and imported into mitochondria.
B. Some of these enzymes are coded in mitochondrial DNA. Their messenger RNA is exported outside mitochondria and the enzymes are synthesized in ribosomes. The enzymes are then imported back into mitochondria.
C. Some of them are coded in mitochondrial DNA and synthesized in mitochondrial ribosomes.
D. All of them are coded in mitochondrial DNA and synthesized in mitochondrial ribosomes.
E. A copy of mitochondrial DNA is exported outside mitochondria. The synthesized enzymes are imported into mitochondria.

A11. Jellyfish-derived genes encoding fluorescent proteins, such as green fluorescent protein (GFP), are widely used in molecular biological studies particularly for the purpose of tagging and visualizing proteins of interest. PLX is a plant gene encoding an unknown protein. A chimeric gene consisting of the PLX gene and the GFP gene was constructed to produce a PLX-GFP fusion protein under an inducible promoter, and introduced into mesophyll protoplasts by electroporation. The following figures show schematic images of fluorescence micrographs of the same protoplast at various times after the induction of PLX-GFP expression.



Before the induction (dotted line indicates the protoplast outline)

Shortly after the induction

Long after the induction

In consideration of the change in the spatial pattern of the fluorescent signals,

speculate which of the following cell structures most likely corresponds to the fluorescent signals in the middle picture.

A. Nucleoli
B. Mitochondria
C. Golgi apparatuses
D. Nuclear pores
E. Chloroplasts
F. Peroxisomes

A12. The recognition sequence for the restriction endonuclease *Ava*I is CYCGRG, where Y is any pyrimidine and R is any purine. What is the expected distance (in bp = base pairs) between the restriction sites of *Ava*I in a long, random DNA sequence?

A. 4096 bp
B. 2048 bp
C. 1024 bp
D. 512 bp
F. 256 bp
G. 64 bp

A13. The arabinose operon of *Escherichia coli* is not expressed in the absence of arabinose. This is attributable to the AraC protein, which binds to the promoter of the arabinose operon and acts as a suppressor to prevent its transcription. Normally the arabinose operon is expressed in the presence of arabinose. In mutants that lack the *AraC* gene, however, the arabinose operon is not expressed even in the presence of arabinose. Based on this information, which of the following can be reasonably inferred with respect to AraC?

A. The transcription of the *AraC* gene is induced by arabinose.
B. The transcription of the *AraC* gene is blocked by arabinose.
C. The AraC protein is converted into an activator in the presence of arabinose.
D. The AraC protein is degraded in the presence of arabinose.

A14. Nucleotide sequence duplications in a gene cause severe effects on its function in some cases while they do not in other cases. Which of the following duplication events would most likely result in the synthesis of a **non-functional** protein?

A. A base pair is duplicated just before the translation initiation site.
B. Three base pairs are duplicated just before the translation initiation site.
C. A base pair is duplicated in the coding region near the translation initiation site.
D. Three base pairs are duplicated in the coding region near the translation initiation site.
E. A base pair is duplicated in the coding region near the stop codon.
F. Three base pairs are duplicated in the coding region near the stop codon.

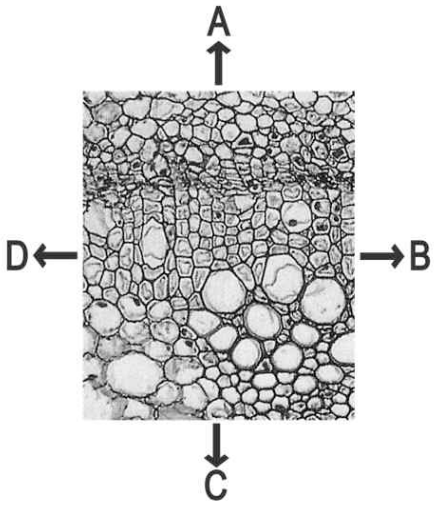
Plant Anatomy and Physiology

A15. Cell walls of vessels and tracheids of vascular plants contain a phenolic polymer called "lignin", which together with cellulose confers mechanical strength to these water-conducting tissues. If vessels/tracheids are deficient in lignin, they:

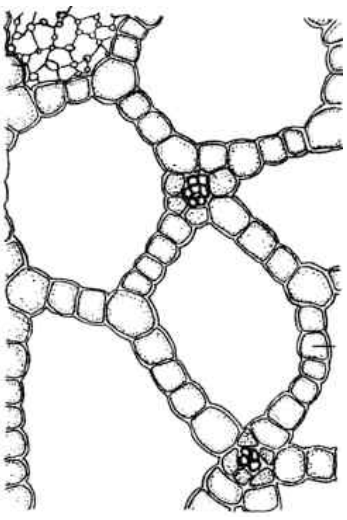
A. burst outward when transpiration is very active.

B. burst outward when transpiration is very inactive.
C. collapse inward when transpiration is very active.
D. collapse inward when transpiration is very inactive.

A16. The following micrograph shows a part of the transverse section of the stem of a dicot plant. Which arrow indicates the direction towards the center of the stem?



A17. The plant tissue shown below is likely to be from a:



A. xerophyte
B. mesophyte
C. halophyte
D. hydrophyte
E. epiphyte

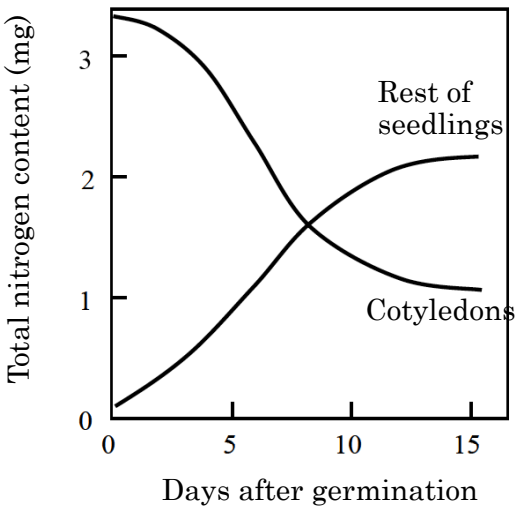
A18. To examine the effect of phytohormones P1 and P2 in plant tissue culture, leaf segments were excised from plants grown under the light, placed on medium that contained P1 and/or P2, and cultured in the dark. As a control experiment, leaf segments were cultured without P1 or P2 in the dark.

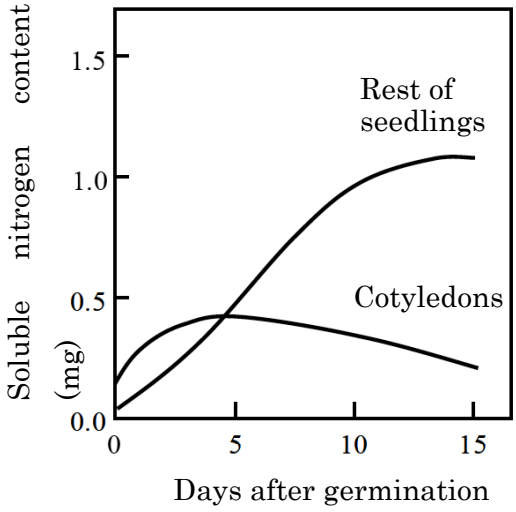
(a) When only P1 was added to the medium, adventitious roots formed on the explants.
(b) When only P2 was added to the medium, neither organogenesis nor callus formation occurred. The explants retained green color for a longer period than the explants of the control experiment.
(c) When both P1 and P2 were added to the medium, callus formed on the explants.

Based on this information, P1 and P2 were:

	P1	P2
A	Auxin	Gibberellin
B	Auxin	Cytokinin
C	Gibberellin	Auxin
D	Gibberellin	Cytokinin
E	Cytokinin	Gibberellin
F	Cytokinin	Auxin

A19. Exalbuminous (endospermless) seeds of a certain plant species were immersed in pure water, germinated, and grown in the dark. Total nitrogen content and soluble nitrogen content (nitrogen in low-molecular-weight compounds such as amino acids) were measured for cotyledons and the other parts of the seedlings. The results are shown in the following figures. With respect to the nitrogen metabolism in seedlings of this plant, which of the following statements is the most appropriate explanation?





Proteins in cotyledons were degraded to produce amino acids,

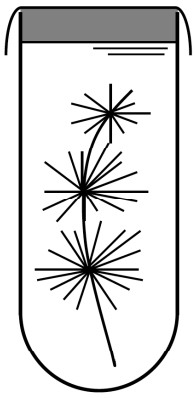
A. which were eventually consumed as nitrogen sources for the growth of cotyledons.
B. which were eventually excreted from seedlings as wastes.
C. which were translocated and provided almost all of the nitrogen sources required for the initial growth of seedlings.

D. which were translocated and provided about half of the nitrogen sources required for the initial growth of seedlings.

A20. Two alleles *G* and *g* are present at a particular locus of a fern species. Spores were collected from a heterozygous sporophyte with *Gg* genotype of the fern species. Gametophytes were grown from the spores and self-fertilized by isolating each sexually matured gametophyte. What is the expected ratio of the *GG* : *Gg* : *gg* genotypes of the sporophytes?

A. 1 : 2 : 1
B. 2 : 1 : 1
C. 3 : 0 : 1
D. 0 : 3 : 1
E. 1 : 0 : 1
F. 0 : 1 : 1

A21. Totally submerged aquatic plants can cause a pH change in the surrounding water when they carry out photosynthesis. What pH change happens and what causes it?



A. The pH falls because carbon dioxide is absorbed.
B. The pH rises because carbon dioxide is absorbed.
C. The pH falls because oxygen is released.
D. The pH rises because oxygen is released.

A22. If the ambient temperature rises by 5°C, photorespiration would:

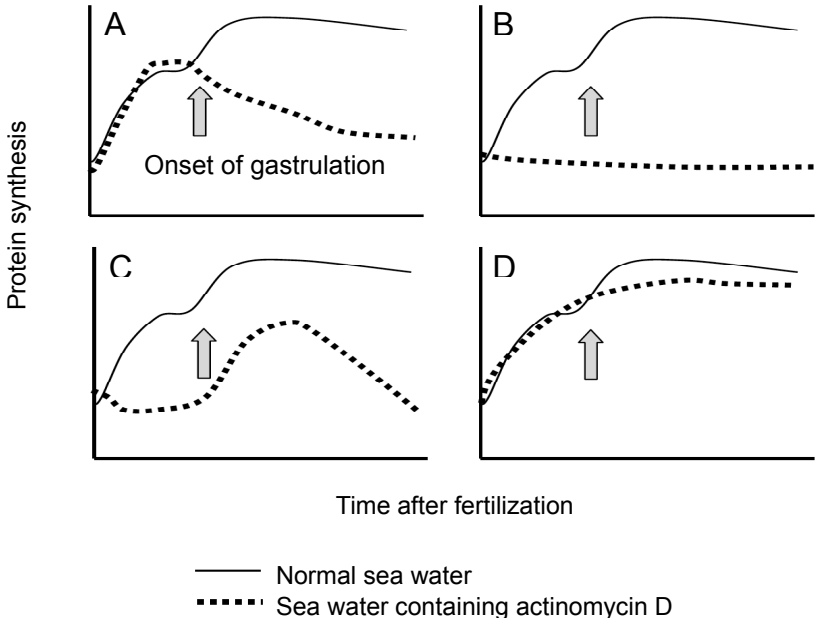
A. Increase in rice, decrease in maize
B. Increase in maize, decrease in rice
C. Increase in rice, little effects on maize
D. Increase in maize, little effects on rice
E. Increase in both species
F. Decrease in both species

Animal Anatomy and Physiology

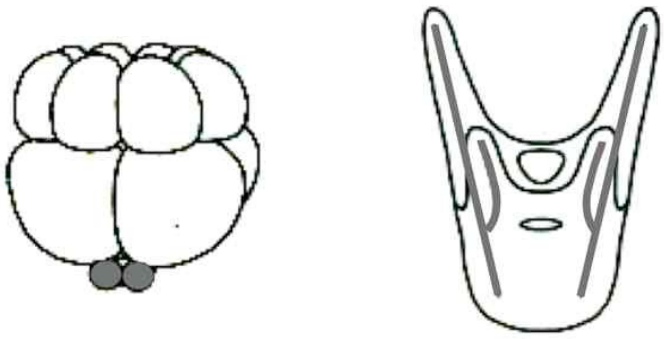
A23. When fertilized sea urchin eggs were reared in sea water containing actinomycin D, an inhibitor of transcription, eggs developed normally until the blastula stage, but stopped development after that. This is due to the fact that in embryos the process of transcription

does not take place during the cleavage period, and the proteins necessary for the development are translated from mRNA stored in the eggs.

If protein synthesis is measured during this experiment, which of the following graphs would be obtained?



A24. At the 16-cell stage, the sea urchin embryo consists of three types of cells: eight mesomeres, four macromeres and four micromeres, from animal pole to vegetal pole. When four micromeres were labeled by fluorescent dye, all the spicule forming cells in the resulting 2-day-old larva were fluorescent (see figure).



Thus, in normal larvae, spicule forming cells are derived solely from micromeres. However, even if all the micromeres are removed from a 16-cell embryo, spiculogenesis still occurs in 2-day-old larva. From this we can conclude that:

A. all the cells in a 16-cell-stage embryo can form spicules when receiving an appropriate signal from micromeres.
B. all the cells in a 16-cell-stage embryo can form spicules when the micromeres are removed.
C. micromeres or their descendent cells send a spiculogenesis-inhibiting signal to other cells.
D. micromeres or their descendent cells send a spiculogenesis-inducing signal to

other cells.

A25. The crab-eating frog is a unique amphibian which has adapted to the marine habitat and lives in mangroves. Different from marine bony fish, these frogs deal with the osmotic problem by:

A. drinking sea water and excreting excess salt.
B. excreting a large amount of excess water as urine.
C. excreting nitrogen waste as ammonia.
D. storing urea in their body fluid.

A26. Which of the following states occurs if the lung alveoli lose their elasticity?

I. Residual volume decreases.
II. pO_2 in the air inhaled has to increase in order to keep the saturation of hemoglobin at the same level.
III. Blood pH increases.

A. Only I
B. Only II
C. Only III
D. I and II
E. I and III
F. II and III

A27. Which of the following statements about skeletal muscle is NOT correct?

A. The length (distance) of a single muscle contraction depends on the concentration of Ca^{2+} ions in the sarcoplasmic reticulum.
B. Muscles with short sarcomeres contract faster than muscles with long sarcomeres.
C. The velocity of muscle contractions is determined by myosin-ATPase activity.
D. Tetanus is the effect of repeated stimulations within a very short interval.
E. Rigor mortis (death rigidity) appears when the concentration of Ca^{2+} in cytoplasm is high but ATP is lacking.

A28. Which of the following would occur if a neuron was experimentally stimulated simultaneously at both ends?

A. The action potentials would pass in the middle and travel to the opposite ends.
B. The action potentials would meet in the middle and then be propagated back to their starting positions.
C. The action potentials would stop as they meet in the middle.
D. The stronger action potential would override the weaker action potential.
E. Summation would occur when the action potentials meet in the middle, resulting in a larger action potential.

A29. What happens when the pancreatic duct of a certain mammal is temporarily ligated for an experiment? Note that carbohydrate and other nutrients in the diet are in proper amounts and ligation of the pancreatic duct is not critical for survival of the animal.

The amount of carbohydrate:

A. increases in feces, decreases in urine.

B. increases in feces, does not change in urine.
C. decreases in feces, increases in urine.
D. decreases in feces, does not change in urine.
E. increases both in feces and urine.
F. decreases both in feces and urine.

A30. Shown is the change of glucose concentration in the blood, measured by taking small blood samples from the fingertip of a person who drank a solution containing 50 g of glucose.

Time after drinking the solution (min)	Glucose conc. in the blood (mmol/L)
0	4.9
15	6.1
30	7.7
45	6.4
60	4.2
90	4.2
120	4.0
150	4.8

Has the glucose concentration at any time during the experiment been equal to or higher than 7.7 mmol/L in the hepatic portal vein and the hepatic vein?

	hepatic portal vein	hepatic vein
A.	no	no
B.	no	yes
C.	yes	no
D.	yes	yes

A31. A substance from the plant *Gymnema sylvestre* blocks the sweet taste of sugar and also blocks absorption of sugar by the small intestine. What can be assumed from these two phenomena?

A. It metabolizes sucrose to glucose and fructose.
B. It polymerizes sugar into oligosaccharides.
C. It binds with sugar receptors and transporters.
D. It binds with certain neurotransmitter receptors and transporters.
E. It binds with insulin receptors.

A32. When a species of poisonous fish was fertilized *in vitro* and cultured in an indoor plastic tank filled with artificial seawater, they were never poisonous. Young fish grown in this tank were next divided into two groups and placed in separate pens in a bay where they were exposed to real seawater. One pen had a horizontal net that prevented the fish from reaching the sea bottom, while the other pen had no horizontal net. Subsequently, no poison was detected from the fish cultured in the pen with the net, but poison was found in fish from the other pen.

What do you conclude from this experiment? To be toxic:

I. some component not in artificial seawater but in natural seawater is necessary.
II. it is necessary that they grow up to adults.

III. it is necessary that they can reach the sea bottom.

A. Only I
B. Only II
C. Only III
D. Both I and II
E. Both I and III
F. Both II and III

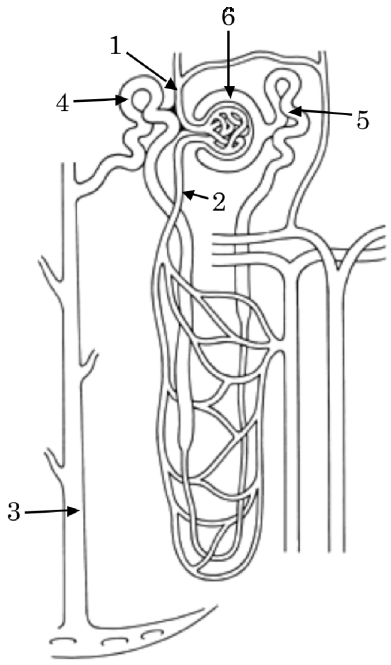
A33. What can be most likely inferred from the following statements (1 to 4) about a disease of patient X?

1. Patient X has a disease that makes her very sensitive to infection by bacteria and viruses.
2. The IgG gene of this patient is normal.
3. This disease is caused by the abnormality of gene “x” which does not work at all.
4. When T cells of a normal person and B cells of patient X are mixed and cultured in the presence of reagents that activate these cells, IgG is secreted into the culture medium. However, when B cells of a normal person and T cells of patient X are combined, IgG is not secreted.

A. Gene “x” needs to be expressed in B cells for the production of IgG.
B. T cells of patient X are normal.
C. IgG is produced by T cells.
D. Gene products of gene “x” are necessary for T cells to induce B cells to produce IgG.
E. The genome of B cells does not contain gene “x”, while that of T cells does.

A34. The diagram shows a simplified kidney tubule and associated blood vessels, and the table shows the presence or absence of substances (X, Y, Z) in each part (1–6) of the diagram.

Identify the substances X to Z.



	X	Y	Z
1	Present	Present	Present
2	Present	Present	Present
3	Absent	Present	Absent
4	Absent	Present	Absent
5	Present	Present	Absent
6	Present	Present	Absent

	X	Y	Z
A	Urea	Glucose	Proteins
B	Urea	Proteins	Glucose
C	Glucose	Urea	Proteins
D	Glucose	Proteins	Urea
E	Proteins	Glucose	Urea
F	Proteins	Urea	Glucose

Ethology

A35. The vampire bat of Costa Rica is often not able to acquire blood from a mammal on a given night. Wilkinson (1984) trapped bats which were not allowed to feed for a night and found that they were given regurgitated blood by certain cave-mates. Based on this knowledge, which of the following observations are indispensable to confirm the occurrence of reciprocal altruism in this species?

Data showing that:

I. blood is exchanged only between kin.
II. blood is exchanged between non-kin.
III. weak bats are frequently given blood even if they cannot give it to others.
IV. bats who are given blood donate it to those who have given it to them before.

Combinations:

A. Only I
B. Only IV
C. I, III
D. I, IV
E. II, III
F. II, IV

A36. In a certain bird species, territory-holding males are sexually mature, have red chest feathers and aggressively drive out intruders. Several models, shown below, were built to test territory defense in this species. What is the most likely sequence of attack on these models in decreasing order of aggression?

I. A model of a normal juvenile bird with brown chest feathers
II. A model of a normal adult bird with red chest feathers
III. A model of an adult bird with brown chest feathers
IV. A model of a juvenile bird with red chest feathers

Sequences

A. I $\rightarrow$ III$\rightarrow$ IV $\rightarrow$ II
B. I $\rightarrow$ IV $\rightarrow$ III $\rightarrow$ II
C. II $\rightarrow$ III $\rightarrow$ IV $\rightarrow$ I
D. II $\rightarrow$ IV $\rightarrow$ III $\rightarrow$I

Genetics and Evolution

A37. A man with a genetic disease marries a phenotypically normal woman. They have four girls and four boys; all of the girls have the same disease as their father, but none of the boys does. What is the most likely explanation?

The disease is caused by:

A. an autosomal dominant allele.
B. an autosomal recessive allele.
C. an X-linked dominant allele.

D. an X-linked recessive allele.
E. a Y-linked allele.

A38. There is a degenerative disease which develops in people between 35 and 45 years old. It is caused by a dominant allele. A couple has two children, who are both younger than 20 years old. One parent has the disease (heterozygote), but the other parent, who is 50 years old, does not. What is the probability that the **both** children will develop this disease when they become older?

A. 1/16
B. 3/16
C. 1/4
D. 9/16
E. 3/4

A39. There are n+1 alleles at a particular locus on an autosome. The frequency of one allele is 1/2 and the frequencies of the other alleles are all 1/(2n). Under the assumption of Hardy-Weinberg equilibrium, what is the total frequency of heterozygotes?

A. (n – 1)/(2n)
B. (2n – 1)/(3n)
C. (3n – 1)/(4n)
D. (4n – 1)/(5n)
E. (5n – 1)/(6n)

A40. At a locus for an enzyme which is inherited independently of sex, the frequencies of genotypes in a population were as follows.

	FF	*FS*	*SS*
Female	30	60	10
Male	20	40	40

Predict the frequency of the *FS* genotype in the next generation, assuming that they will mate randomly.

A. 0.46
B. 0.48
C. 0.50
D. 0.52
E. 0.54

A41. How does the occurrence of self-fertilization relative to cross-fertilization affect the fixation of an advantageous and recessive allele that newly appeared in a population by mutation?

A. The allele will be fixed most quickly when the relative occurrence of self-fertilization is highest.
B. The allele will be fixed most quickly when the relative occurrence of self-fertilization is lowest.
C. The allele will be fixed most quickly when the relative occurrence of self-fertilization is moderate.
D. The relative occurrence of self-fertilization does not affect the fixation of the allele.

E. The relative occurrence of self-fertilization affects the fixation of the allele only when the population is very small.

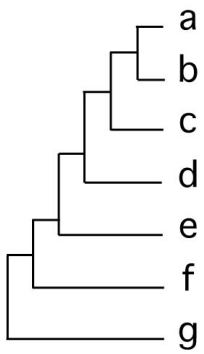
A42. The following table shows the number of estimated nucleotide substitutions that have occurred in a gene among seven species.

The number of estimated nucleotide substitutions between each pair of species

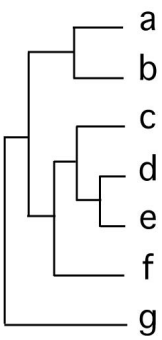
	B	c	d	e	f	g
a	39	72	128	126	159	269
b		81	130	128	158	268
c			129	127	157	267
d				56	154	271
e					151	268
f						273

Which is the most appropriate tree that shows the phylogenetic relationship among these seven species?

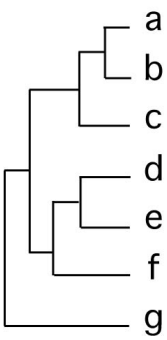
A.



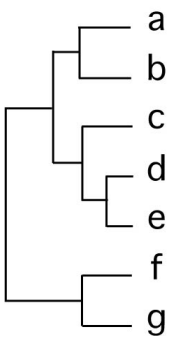
B.



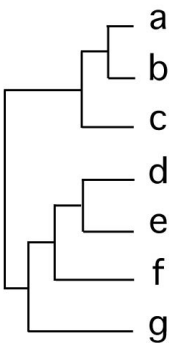
C.



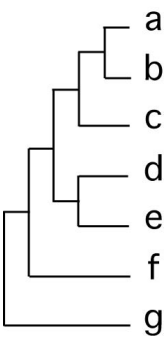
D.



E.



F.



A43. Suppose that at a neutrally evolving genomic region of a species the mutation rate from the base pair GC to AT is three-times the mutation rate from AT to GC. What is the expected GC content at equilibrium?

A. 1/2
B. 1/3
C. 1/4
D. 1/5
E. 1/6

A44. A species of insect was found to have developed resistance to a commonly used insecticide. Which of the following is the most likely explanation?

A. Stabilizing selection caused development of resistance in the insect population.
B. The original gene pool included genes that conferred resistance to the insecticide.
C. The insecticide stimulated development of resistance in certain individuals and this was inherited.
D. The insecticide caused a mutation that was favorable to resistance and this was inherited.

A45. Darwin's finches are a prime example of adaptive radiation. Which of the following best describes this adaptive radiation correctly?

A. The genetic variability that can be found among individuals of the same species.
B. The evolutionary process by which different forms, adapted to different niches, arose from a common ancestor.
C. A sudden diversification of a group of organisms from closely related species.
D. The evolutionary process that allows for the changes that occur within the same lineage.
E. The evolutionary process of adaptation of species through a kind of polymorphism.

A46. Multigene families are groups of two or more identical or very similar genes. Which of the following statements about multigene families is correct?

A. Globin gene families do not have pseudogenes, because globins are essential for oxygen transport.
B. Ribosomal RNA gene families in multicellular eukaryotes have many identical genes, because many ribosomes are required for active protein synthesis.
C. Compared with multicellular eukaryotes, prokaryotes have many multigene families, because prokaryotes have to reproduce very quickly.
D. The number of genes in a multigene family always increases by unequal crossing over.

Ecology

A47. The following table shows the net primary productivity and biomass without soil organic matter in five ecosystems.

Ecosystem	Net primary productivity ($g/m^2/year$)	Biomass (kg/m^2)
Tropical rainforest	2200	45

I	2000	15
II	1200	30
III	900	4
Boreal forest	800	20

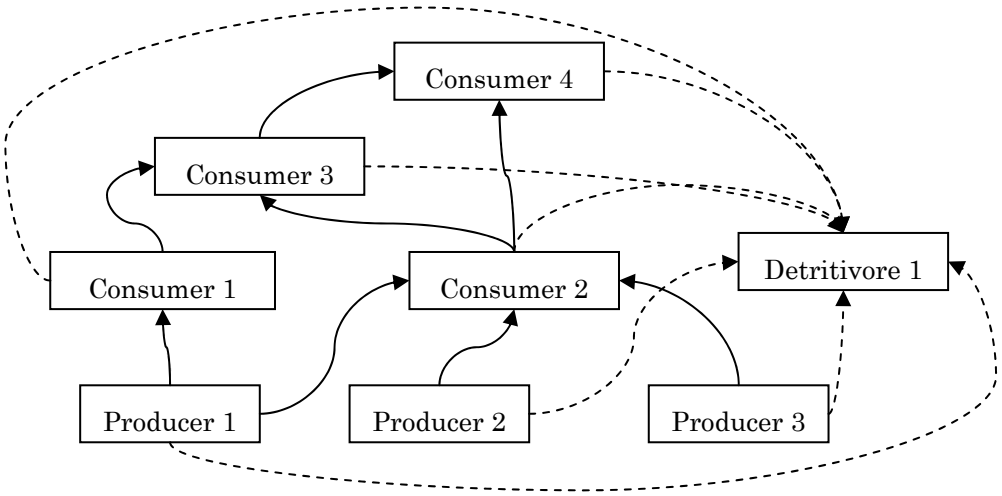
Choose from A to F in the table below the most appropriate combination of ecosystems for I, II and III above.

	I	II	III
A	African dry savanna	Tropical swamp & marsh	Temperate deciduous forest
B	African dry savanna	Temperate deciduous forest	Tropical swamp & marsh
C	Temperate deciduous forest	African dry savanna	Tropical swamp & marsh
D	Temperate deciduous forest	Tropical swamp & marsh	African dry savanna
E	Tropical swamp & marsh	African dry savanna	Temperate deciduous forest
F	Tropical swamp & marsh	Temperate deciduous forest	African dry savanna

A48. The diagram below represents the relationships between organisms in a remote pond ecosystem.

From this information, which of the following is the most likely to be correct?

A. DDT present in the ecosystem would accumulate to the highest concentrations in the tissues of Detritivore 1.
B. The introduction of Consumer 4 individuals from an external population would lead to a temporary increase in numbers of Producer 2.
C. Disease in the Producer 1 population would lead to an increase in the Producer 3 population.
D. Extermination of Consumer 3 would cause a sustained increase in the population of Consumer 2.
E. Consumer 1 is more adaptable with regard to its food source than Consumer 3.



A49. The table below shows the results of measurements of production in two ecosystems in the temperate zone: a rainforest and a field with an annual crop. All results are stated in MJ/m^2 / year (1 MJ = 10^6J).

	[I] Rainforest	[II] Field with an annual crop
Gross Primary Production (GPP)	188	102
Respiration (autotrophs)	134	38
Respiration (heterotrophs)	54	3

Of these two ecosystems, which has a higher ratio of respiration by heterotrophic organisms to net primary production (NPP)? What is the reason? Choose the correct option from A to F.

A. [I] < [II] : The rainforest has larger GPP and more consumers than the crop field.
B. [I] < [II] : The rainforest has larger NPP and more consumers than the crop field.
C. [I] < [II] : The rainforest has larger NPP and less consumers than the crop field.
D. [II] < [I] : The rainforest has smaller GPP and more consumers than the crop field.
E. [II] < [I] : The rainforest has smaller NPP and more consumers than the crop field.
F. [II] < [I] : The rainforest has smaller NPP and less consumers than the crop field.

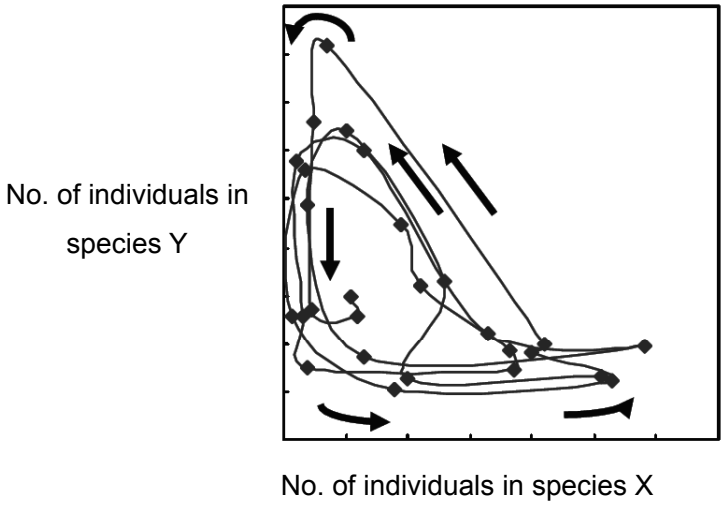
A50. What does the energy input into most food webs typically depend on? Choose the most likely factor from the following.

A. Grazing rate of the primary consumers
B. Material cycling efficiency rate of the whole ecosystem
C. Efficiency rate of producers converting solar radiation energy into chemical energy
D. Action of nitrogen-fixing bacteria
E. Heat-energy costs due to respiration within each trophic level

A51. Which factor most promotes the stability of population dynamics in a developed terrestrial ecosystem?

A. Food webs that have many trophic levels each of which consists of few species only
B. A few species of producers with very high production rates
C. Rapid nutrient recycling by active decomposers
D. Food webs that have very few trophic levels and limited niche overlaps
E. A few eminent and competitively-dominant species

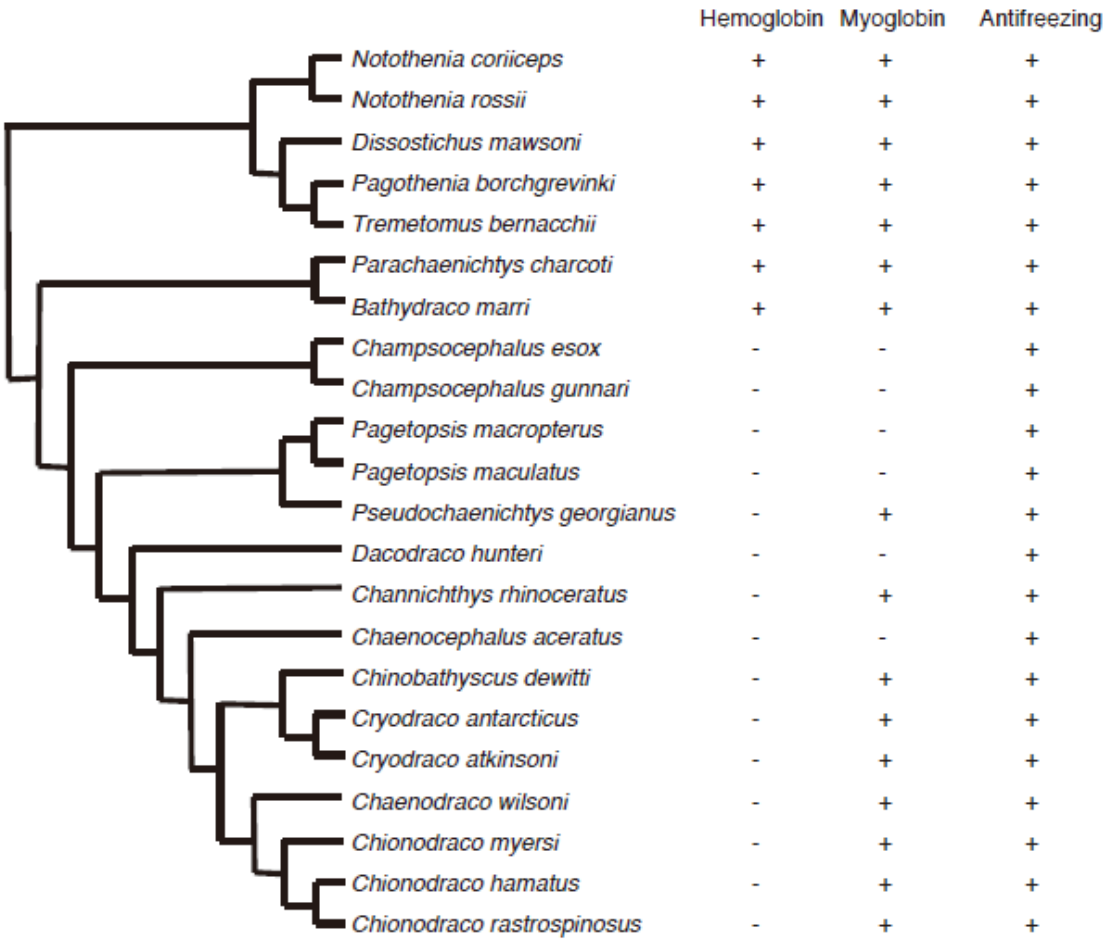
A52. Animal species X and Y have a temporal negative correlation of population abundances, in which arrows indicate the anti-clock-wise (counter-clock-wise) orbit of population dynamics. Choose the most likely combination of explanation and its reasoning.



	Relationship between species X and Y	Reasoning
A.	interspecific competition between X and Y	Y decreases at high density of X Y increases at low density of X
B.	interspecific competition between X and Y	Y increases at intermediate density of X X decreases at intermediate density of Y
C.	predator (X) and prey (Y)	Y decreases when X increases from low density Y increases when X decreases from high density
D.	prey (X) and predator (Y)	

Biosystematics

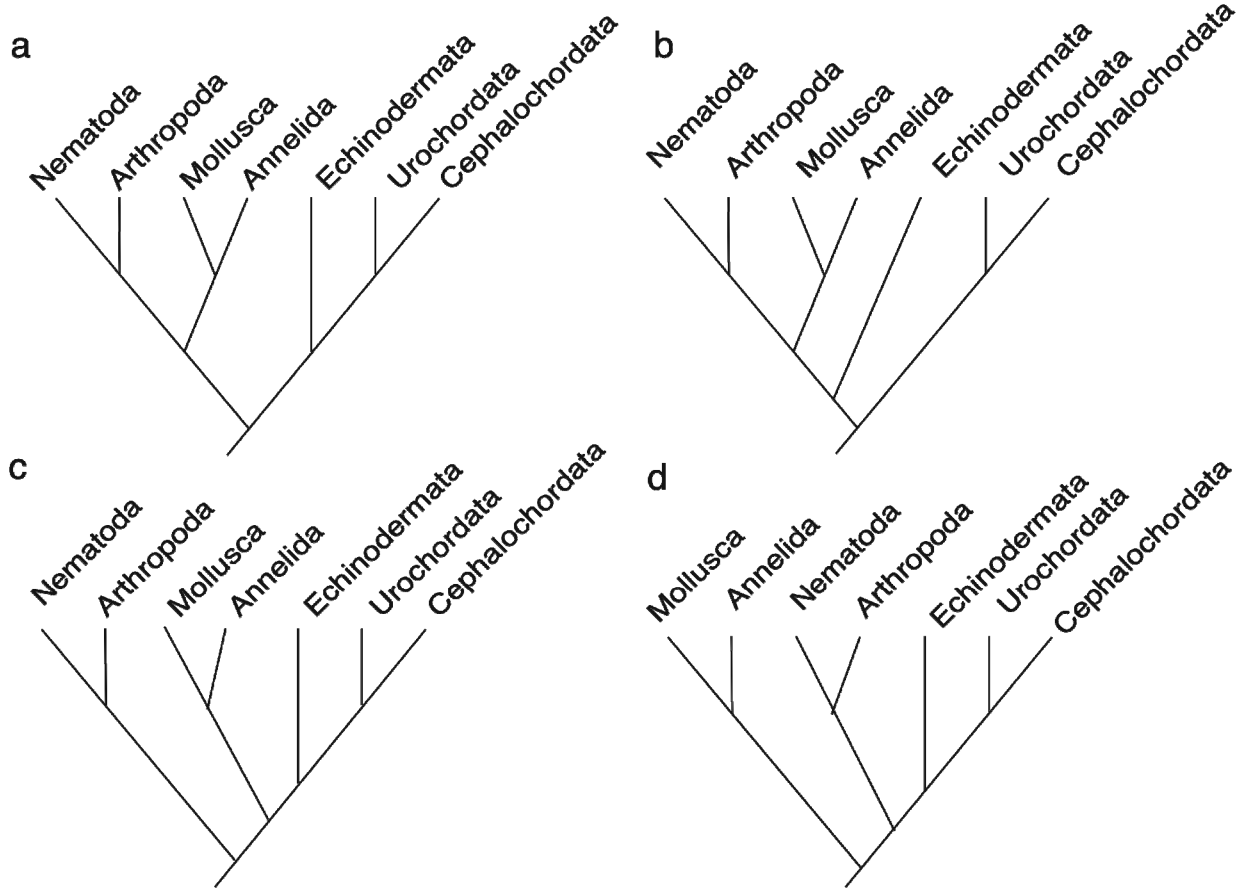
A53. The following phylogenetic tree shows the relationships among Antarctic icefish and their relatives. Icefish refer to all the species in the tree that have lost hemoglobin and thus possess clear blood. Some icefish species also lost myoglobin which is usually found in muscle cells. In these species, myoglobin lost its function due to distinct mutations. In addition, icefish and relatives possess an anti-freezing glycoprotein to arrest the growth of ice crystals in their tissues. To the right of the tree, whether or not each species possess hemoglobin, myoglobin and the anti-freezing glycoprotein is shown. What conclusion can you draw from the tree?



A. Anti-freezing glycoprotein has originated in the icefish clade relatively recently.
B. Myoglobin was lost multiple times in the icefish clade.
C. The anti-freezing glycoprotein was necessary before the icefish could lose hemoglobin.
D. The loss of hemoglobin appears to be a more recent trait than the loss of myoglobin.
E. Because myoglobin can substitute for the functions of hemoglobin, icefish could lose hemoglobin.

A54. A list of the shared derived characters for some metazoan phyla is shown below. Identify **all** the phylogenetic tree(s) which are consistent with the statements below.

I. Presence of trochophore larva is a shared derived character of the Mollusca and the Annelida.
II. Molting is a shared derived character of the Arthropoda and the Nematoda.
III. Presence of a notochord is a shared derived character of the Urochordata and Cephalochordata.
IV. Developmental fate of blastopore to form the anus is a shared derived character of the Urochordata, Cephalochordata and Echinodermata.



A. a
B. a, c
C. a, d
D. b, c
E. a, b, d
F. a, c, d.

**********END OF PART A**********

2. Part B

Cell Biology

B1. (3 point) On a dry matter basis, is the average proportion of the following elements significantly higher in herbaceous vascular plants or in mammals? For each element mark 'X' in the appropriate box.

A. Nitrogen
B. Oxygen
C. Calcium
D. Potassium
E. Sodium
F. Phosphorus

B2. (2.5 points) Match each of the following properties of water with a benefit to organisms by putting a letter (A to E) in the appropriate box.

Property

I. Low light absorption in the visible region
II. High heat capacity
III. High heat released during fusion
IV. High heat of vaporization
V. Polarity of molecules

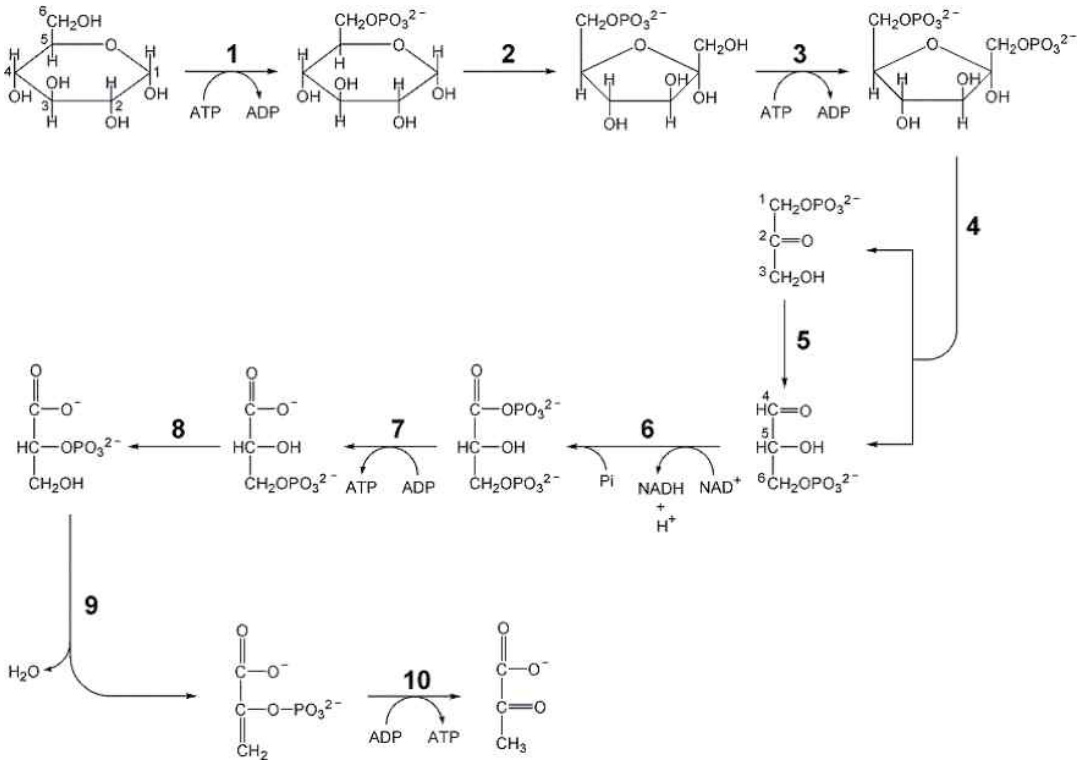
Benefit to organisms

A. Biological membranes composed of lipid molecules are thermodynamically stable.
B. Terrestrial plants and animals can cool themselves with minimum loss of water content.
C. Temperature changes in plants and animals are minimized under fluctuating environmental conditions.
D. Plants can efficiently utilize solar radiation for photosynthesis.
E. Plants and animals are protected against freezing at low temperatures.

B3. (3 points) A coding region of a gene consists of 735 base pairs without stop codon. Calculate the molecular mass of the protein from this gene. The average molecular mass of the free amino acid in this protein is assumed to be 122. Five disulfide bonds are present in the protein. Show your calculations.

B4. (3.5 points) Glycolysis is essential for all organisms.

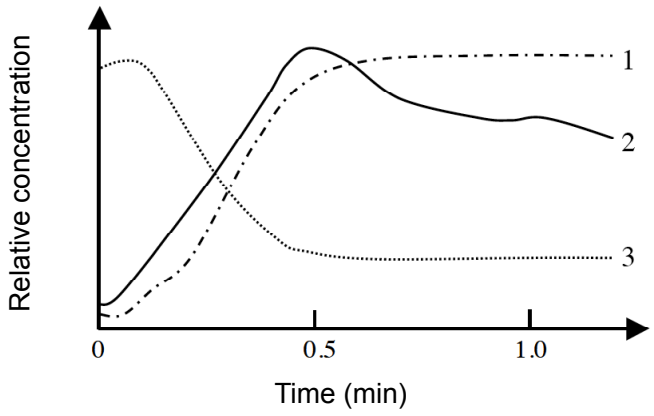
(1) The figure below shows the reactions of glycolysis. The numbers in the figure indicate enzymes which catalyze the reactions. Categorize each enzyme into the "enzyme type" listed below and put each reaction number in an appropriate box. Note that some enzyme types may be missing.



Enzyme type:

A. Oxidoreductase
B. Transferase
C. Hydrolase
D. Lyase
E. Isomerase
F. Ligase

(2) A cell culture of muscle cells was incubated in oxygenated medium that was then quickly made anoxic. The concentrations of three compounds which are important in glucose metabolism were measured immediately after oxygen removal (marked as time 0) and shown in the graph below:

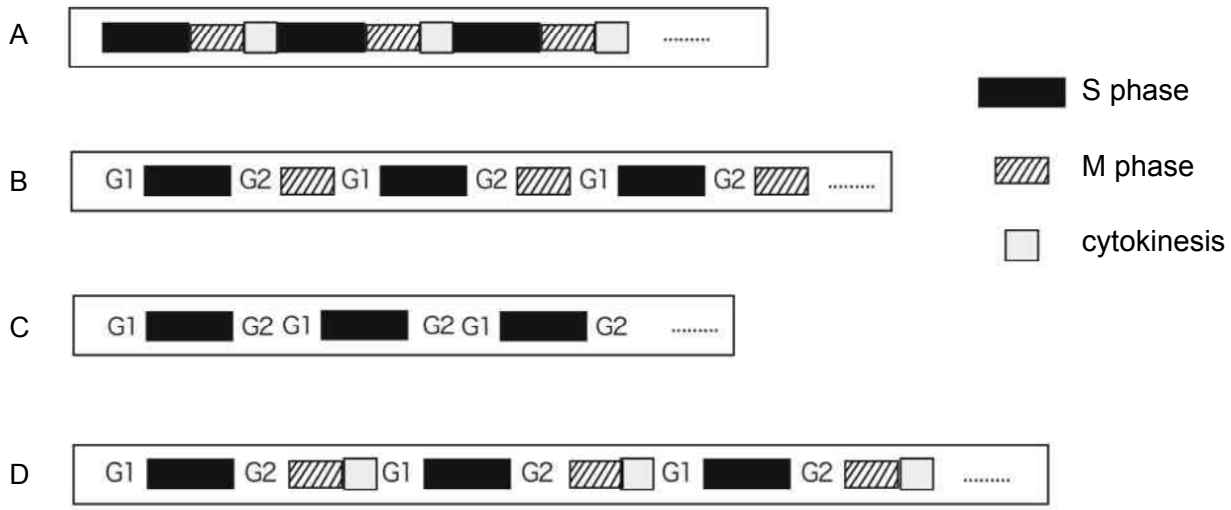


Match each curve of the graph (1, 2, and 3) with the metabolite whose concentration change it depicts:

Metabolites:

A. Glucose-6-phosphate
B. Lactate
C. Fructose-1,6-bisphosphate

B5. (2 points) Different patterns of cell cycling (A to D) are shown below. Correctly match them with the given cell types they represent.

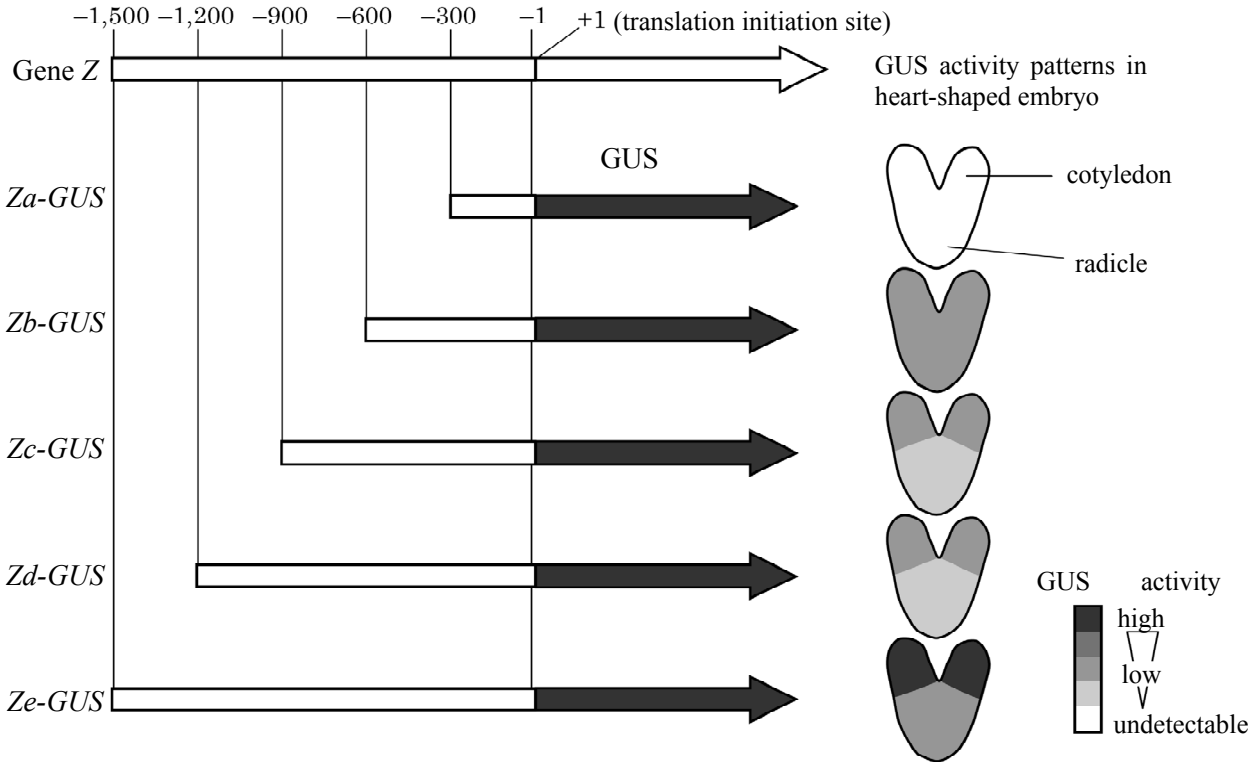


Cell types

I. Human epithelial cell
II. Sea urchin embryonic cells up to 128-cell stage
III. Drosophila salivary gland cell
IV. Plasmodium of slime mold

B6. (3 points) A cell suspension of a microorganism was fed with [^{3}H]-labeled uridine and incubated. Cell components were fractionated from these cells and radioactivity in the mRNA fraction was measured, which revealed that 2.5 picomoles of uridine were incorporated into mRNA in 1 x 10^6 cells. Assuming that the base composition of mRNA is random and that the average length of mRNA is 3,000 bases, calculate how many molecules of mRNA were synthesized in each individual cell during incubation.
(Avogadro's number: 6 x 10^{23})

B7. (4 points) From the model plant *Arabidopsis*, 0.3, 0.6, 0.9, 1.2, and 1.5-kbp genomic fragments upstream of the translation start site of gene *Z* were isolated and designated *Za*, *Zb*, *Zc*, *Zd*, and *Ze*, respectively. These fragments were fused to the structural gene of β-glucuronidase (GUS) of *Escherichia coli*. *Arabidopsis* was transformed with the resultant chimeric genes *Za-GUS*, *Zb-GUS*, *Zc-GUS*, *Zd-GUS*, and *Ze-GUS*, and examined for GUS activity by in-situ chromogenic reaction. The following figure schematically shows construction of the chimeric genes and the GUS activity patterns in heart-shaped embryos of the transgenic *Arabidopsis* carrying these chimeric genes.



Based on this result, identify the function of each upstream region of *Z*.

Upstream region
- I. –1,500 to –1,201
- II. –1,200 to –901
- III. –900 to –601
- IV. –600 to –301

Functions
- A. promotes gene expression in a tissue-non-specific manner
- B. promotes gene expression in cotyledons only
- C. promotes gene expression in tissues other than cotyledons only
- D. suppresses gene expression in cotyledons
- E. suppresses gene expression in tissues other than cotyledons
- F. little influence on gene expression

Plant Anatomy and Physiology

B8. (3 points) Deficiency of a particular mineral element in the soil elicits a specific pattern of leaf discoloration in plants (chlorosis), which is related to metabolic roles and mobility (translocation) of the mineral element in the plant. The following describes the deficiency symptoms (leaf discoloration), metabolic roles, and mobility of magnesium (Mg), iron (Fe), and nitrogen (N).

Deficiency symptoms

A. Deficiency of this mineral causes chlorosis initially in young leaves
B. Deficiency of this mineral causes chlorosis initially in old leaves

Mineral mobility

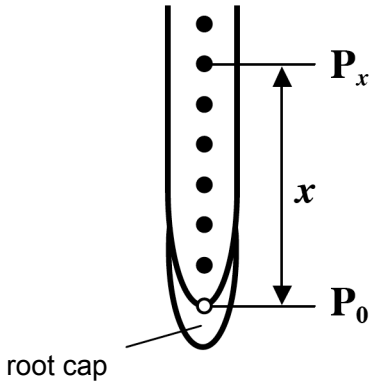
C. This mineral is highly mobile in plants.
D. This mineral is largely immobile in plants.

Metabolic roles

E. This mineral is involved as a component in the electron transfer system and is also required for the synthesis of some of chlorophyll-protein complexes.
F. This mineral serves as a constituent of many plant cell components including amino acids, nucleic acids, and chlorophyll.
G. This mineral is involved in the activation of various enzymes and serves as a part of the ring structure of chlorophyll.

Connect each mineral element to the appropriate descriptions of the above three categories (A or B for Deficiency symptoms; C or D for Mineral mobility; E, F, or G for Metabolic roles).

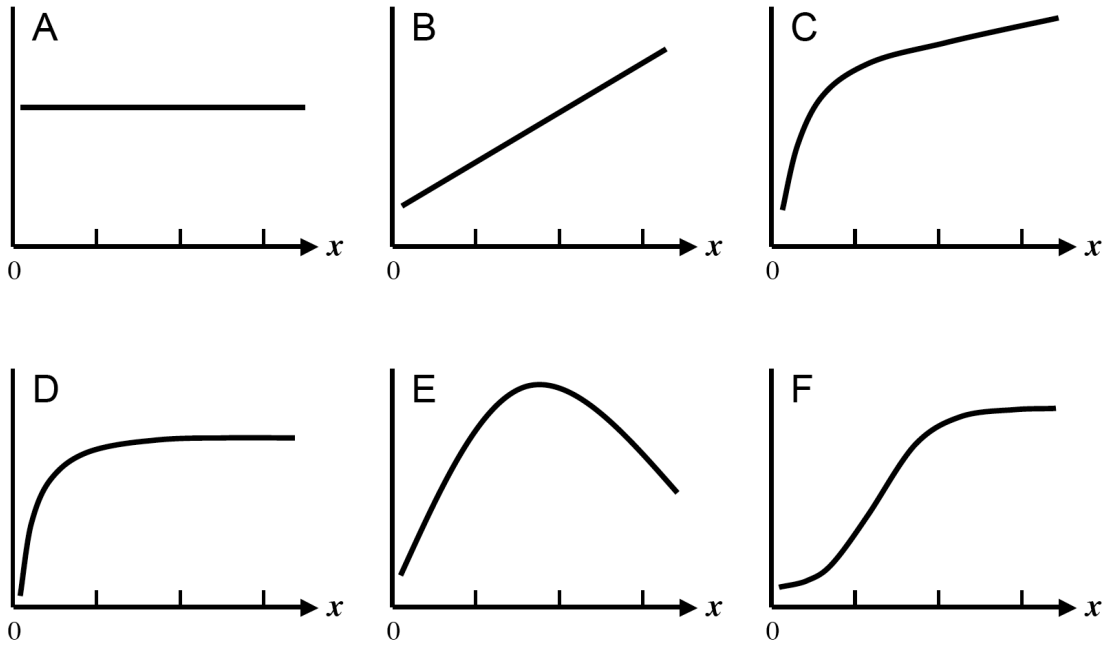
B9. (3 points) Growing plant roots were analyzed with respect to spatial patterns of cell division and elongation growth. The roots were marked with graphite particles (P) at various positions along the root axis, where *x* was the distance from the root apex just behind the root cap to P_x.



For each P_x, the following data were collected.

I. Number of total epidermal cells present between P_0 and P_x
II. Number of mitotic epidermal cells present between P_0 and P_x
III. Velocity of displacement (movement away) of P_x from P_0

When the data are plotted against *x*, what types of profiles do these data sets show? For each data set, choose the most appropriate profile from the followings.

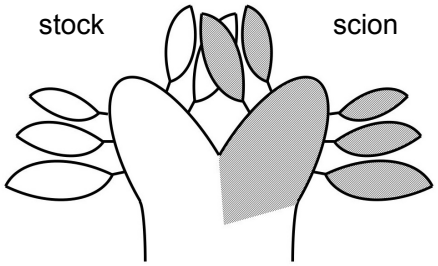


B10. (4 points) Henbane (*Hyoscyamus niger*) is a medicinal plant. Two varieties of this plant, one of which is annual and the other biennial, were characterized for flowering.

In the first experiment, effects of cold treatment and day length on flowering were examined in the annual and biennial varieties. For this purpose, cold-treated and untreated plants were grown under the short-day condition or the long-day condition. The following table indicates whether the plants flowered or not.

		Flowering	
Variety	Treatment	Short-day	Long-day
Annual	Cold-treated	No	Yes
	Untreated	No	Yes
Biennial	Cold-treated	No	Yes
	Untreated	No	No

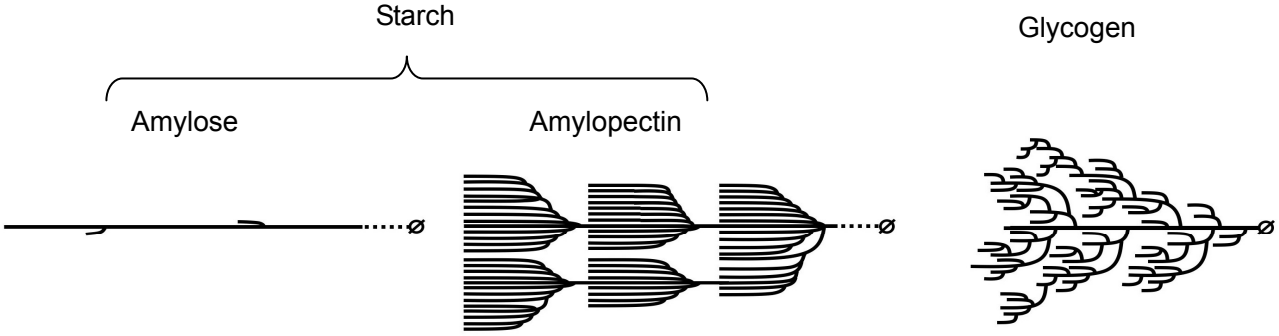
In the second experiment, cold-treated and untreated plants of the annual and biennial strains were grafted as shown in the following figure, and then grown under the long-day condition. Whether the stock and scion flowered or not was recorded. The results of the two types of grafts (#1 and #2) are summarized in the table.



		Strain	Treatment	Flowering
Graft #1	Stock	Annual	Untreated	Yes
	Scion	Biennial	Untreated	Yes
Graft #2	Stock	Biennial	Cold-treated	Yes
	Scion	Biennial	Untreated	Yes

Assuming the involvement of florigen in flowering of this species, identify the properties of the shoot apical meristems and leaves of the annual and biennial plants, based on the above results. Mark the appropriate boxes with "X" about florigen response (1) and florigen productivity (2).

B11. (3 points) Plants and animals accumulate starch and glycogen as a storage polysaccharide, respectively. Starch consists of two sorts of large, water-insoluble polymers of glucose, amylose and amylopectin. Amylose is essentially unbranched and linear while amylopectin is highly and regularly branched, which forms branch clusters. Glycogen is also a branched glucose polymer, but unlike amylopectin, it is relatively small and water-soluble. In the glycogen molecule, branches are shorter, irregular, and not clustered.



(1) Biosynthesis of starch involves three classes of enzymes: chain elongation enzymes, branching enzymes, and debranching enzymes. *Sugary*, a rice mutant, is deficient in a particular debranching enzyme. The endosperm of this mutant is characterized by the accumulation of glycogen-like polysaccharide instead of amylopectin. In consideration of this information, the role of the wild-type debranching enzyme in

starch biosynthesis is:

A. to remove all branches from amylopectin to form amylose.
B. to shorten every branch of amylopectin.
C. to regulate the branching pattern of amylopectin.
D. to cut α1→4 glycosidic bonds of amylopectin.

(2) The seeds of the *Sugary* mutant of rice are not different from the wild-type seeds in the size and appearance before desiccation which is associated with seed maturation. During desiccation, however, the *Sugary* seeds become shrunk and wrinkled. This phenomenon suggests that before desiccation, as compared with the wild-type seeds, the *Sugary* seeds contain:

	storage polysaccharide	water
A	More	less
B	More	more
C	Less	more
D	Less	less

(3) Bacteria including cyanobacteria accumulate a glycogen-like polysaccharide for storing glucose. Which of the following can reasonably explain the evolution of storage polysaccharides?

The common ancestor of plants and animals could synthesize:

A. both amylopectin and glycogen, but plants have lost the ability of glycogen synthesis during evolution.
B. both amylopectin and glycogen, but animals have lost the ability of amylopectin synthesis.
C. amylopectin but not glycogen, and animals have acquired the ability of glycogen synthesis.
D. glycogen but not amylopectin, and plants have acquired the ability of amylopectin synthesis.

B12. (3 points) Soybean roots form nodules when infected by *Rhizobium*. HN is a recessive mutant of soybean that exhibits a hypernodulating phenotype. As shown in Figure 1, the roots of the HN mutant form more nodules than the wild-type (WT) roots, and the shoot growth of the HN mutant is retarded compared to WT. Figure 2 schematically shows the nodulation phenotypes observed in grafting experiments with WT and the HN mutant. In the absence of *Rhizobium*, the HN mutant is not phenotypically different from WT in any aspects.

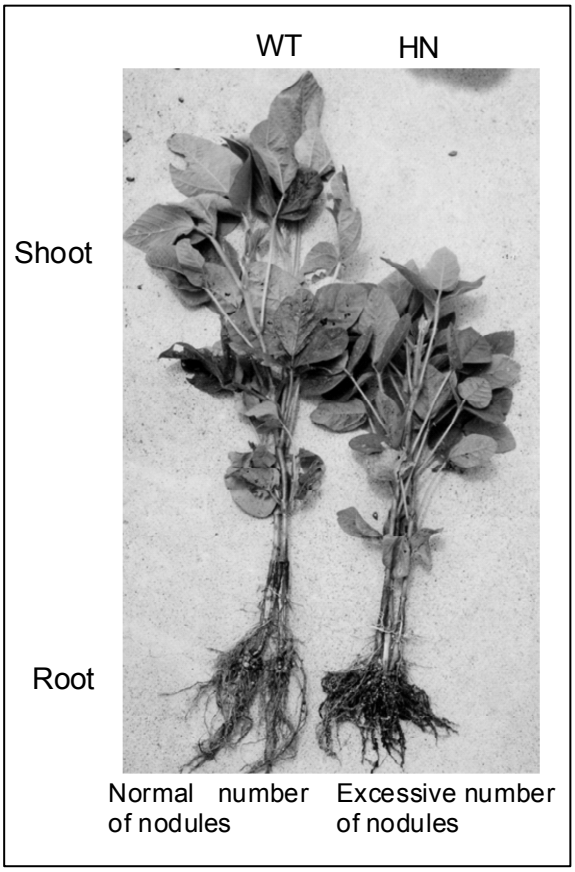


Figure 1

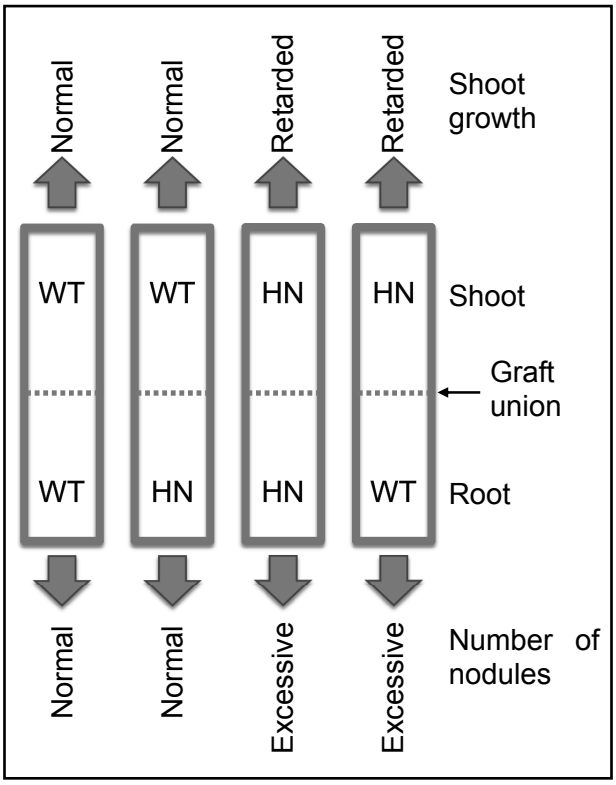


Figure 2

From the above information, what can be reasonably inferred? For each of the following statements, mark “X” in the appropriate box choosing the option in the bracket.

I. In the HN mutant, the {A. shoot / B. root} determines the hypernodulation phenotype.

II. The shoot of WT {A. positively regulates / B. negatively regulates / C. is neutral for the regulation of} the number of nodules.

III. In the HN mutant, hypernodulation {A. the cause / B. the result / C. independent} is of retarded growth of the shoot.

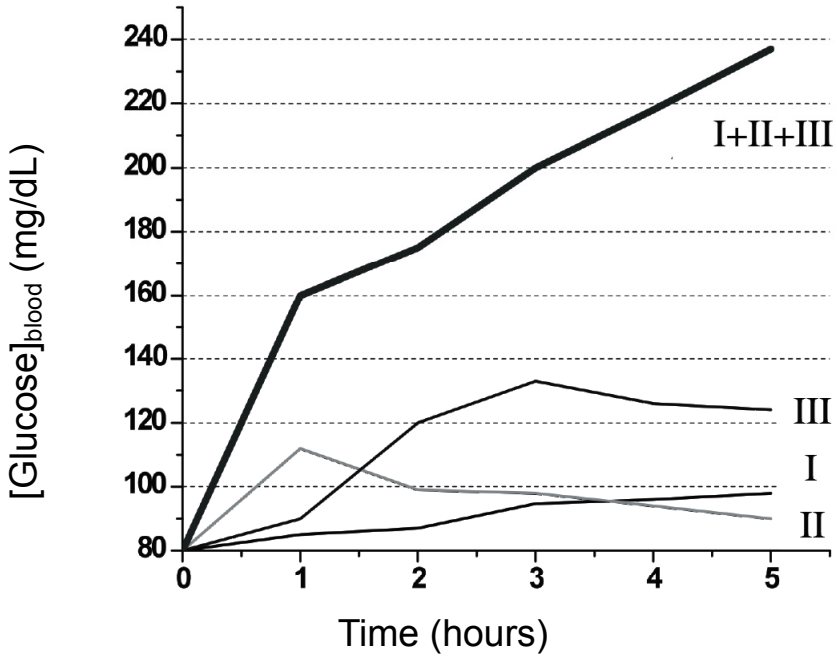
Animal Anatomy and Physiology

B13. (3 points) Three patients I, II and III show symptoms of low thyroxine levels. Defects are found in the hypothalamus for patient I, in the anterior pituitary for patient II, and in the thyroid for patient III. After thyroid-stimulating-hormone-releasing hormone (TRH) is given to these patients, the concentration of thyroid-stimulating hormone (TSH) before and after (30 min) TRH administration is measured in each patient.

	Before TRH administration	After TRH administration
Healthy person	Lower than 10	Between 10 and 40
A	Lower than 10	Between 10 and 40
B	Between 10 and 40	Higher than 40
C	Lower than 10	Lower than 10

Fill the letter of the appropriate data (A–C) for each patient (I–III).

B14. (2.5 points) The graph below shows the blood glucose level after three hormones I, II and III are administered separately or together.



(1) How do you classify these hormones?

A. Hypoglycemic
B. Hyperglycemic

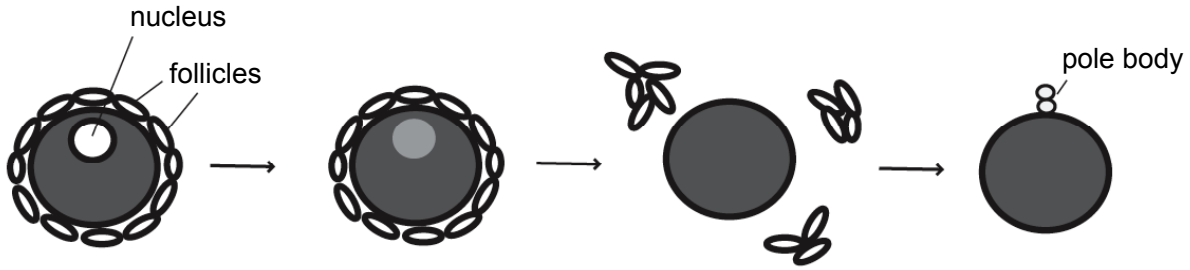
(2) Choose the type of interaction between these hormones.

A. Additive
B. Antagonistic
C. Synergistic
D. None

(3) Pick the three possible hormones that are consistent with the results shown in the graph.

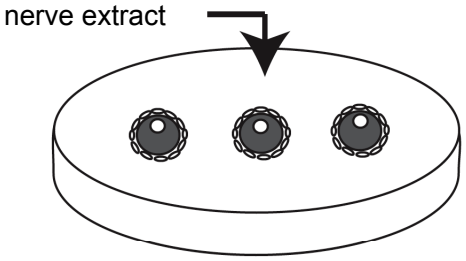
A. Insulin
B. ADH (Vasopressin)
C. Adrenalin (Epinephrine)
D. Renin
E. Glucagon
F. Angiotensinogen
G. Cortisol
H. Calcitonin
I. Atrial natriuretic peptide

B15. (4 points) The oocytes of a starfish grow within the provided follicle in the gonad. Eventually they cease meiosis at prophase I, and wait as a state of immature eggs. The immature eggs resume meiosis when stimulated and lose their nuclear envelop as shown below.

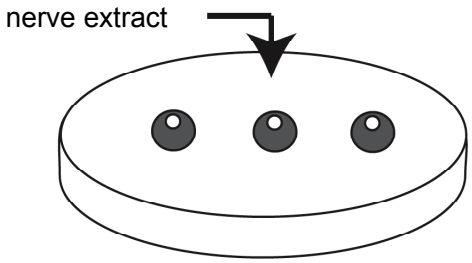


In order to understand the mechanism of this resumption, the following experiments were conducted.

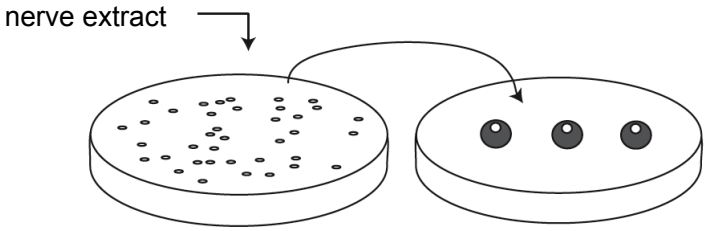
Experiment 1: When extract from the nerve tissue of adult starfish was added to immature eggs surrounded by follicles, meiosis resumed.



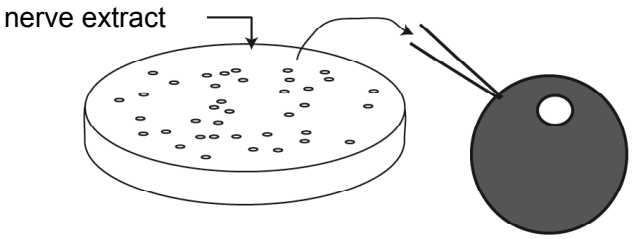
Experiment 2: When extract from the nerve tissue of adult starfish was added to immature eggs from which follicles were removed, meiosis did NOT resume.



Experiment 3: When extract from the nerve tissue of adult starfish was added to follicles after they had been separated from immature eggs, and subsequently the medium was added to immature eggs without follicles, meiosis resumed.



Experiment 4: When extract from the nerve tissue of an adult starfish was added to follicles after separated from immature eggs, and the medium was injected to immature eggs without follicles, meiosis did NOT resume.



Based on these results, four hypotheses were developed.

Hypothesis 1: The extract from the nerve tissue contains a substance which directly acts on immature eggs causing them to resume meiosis.

Hypothesis 2: The extract from the nerve tissue contains a substance which acts on immature eggs to resume meiosis, but the follicle blocks the substance from reaching the immature eggs.

Hypothesis 3: The extract from the nerve tissue contains a precursor of a substance that causes meiosis to resume, which is processed by the follicle into an active compound that causes immature eggs to resume meiosis.

Hypothesis 4: The extract from the nerve tissue induces follicles to secrete a substance which then acts on the cell surface of an immature egg to cause a resumption of meiosis.

Indicate whether each hypothesis is rejected or not.

B16. (2 points) After the nucleus is removed from a fertilized frog egg, it is re-transferred back into the enucleated egg. In another experiment, the nucleus from a gut epithelial cell is transferred to an enucleated egg. In both cases, the eggs grow well and develop normally into tadpoles.

(1) Choose the correct statement from A to E below.

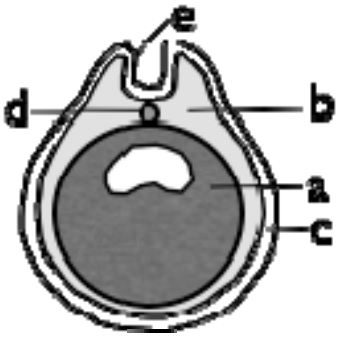
During differentiation from fertilized eggs to tadpole gut epithelial cells:

A. gene expression patterns do not change.
B. some genes are not expressed, but the genes themselves are not lost during development.
C. all the genes are expressed.
D. the amount of proteins does not change.
E. the amount of RNAs does not change.

(2) In the experiment above, frog gut epithelial cells were used. If this experiment were performed in mammals, theoretically almost all cell types can be used as a nucleus donor, but a few cell types cannot. Which of the following cell types is NOT appropriate as a donor cell?

A. B lymphocyte
B. Liver cell
C. Mammary gland cell
D. ES (embryonic stem) cell
E. Cone cell

B17. (2 points) The figure below represents a cross section of a vertebrate neurula stage embryo.



(1) The following are statements about the tissues and organs derived from (a), (b), (c) and (d) of the figure. Identify whether each statement is True or False and mark “X” in the appropriate box.

A. Tissues derived from (a) are always associated with those from (b).
B. The developmental fate of (c) sometimes changes.
C. (d) differentiates into the backbone (vertebra).
D. Most of the circulatory system arises from (b).

(2) Neural tube arises from (e). The following are statements about the formation and later development of the neural tube. Identify whether each statement is True or False and mark “X” in the appropriate box.

A. Cells in the wall of neural tube later differentiate into glial cells as well as nerve cells (neurons).
B. Lumen in the neural tube is later completely occluded.
C. Almost all nervous tissue derived from neural tube is central nervous system.
D. The retinal pigment epithelium in the eye derives from optic vesicle formed from the neural tube.

B18. (3 points) For intracellular infectious bacteria and viruses to successfully invade a cell, they must bind to receptors on the cell surface. HIV, specifically infects helper T cells, which express the CD4 molecule, but not CD8 on their cell surface, making it possible to distinguish helper T cells from other lymphocytes. Thus, CD4 is hypothesized to be a receptor for HIV.

(1) Which TWO of the following experiments would confirm this hypothesis?

Experiments that examine whether:
A. an antibody against CD4 added to a co-culture system of CD4-positive T cells and HIV can inhibit HIV infection of T cells
B. an antibody against CD8 added to a co-culture system of CD8-positive T cells and HIV can inhibit HIV infection of T cells
C. an antibody against HIV added to a co-culture system of CD4-positive T cells and HIV can inhibit HIV infection of T cells
D. forced expression of the CD4 gene in HIV-resistant CD4-negative T cells causes a recovery of susceptibility to HIV infection
E. forced expression of the CD8 gene in HIV-resistant CD8-negative T cells causes a recovery of susceptibility to HIV infection

(2) It is known that HIV cannot infect mice, although the mouse has CD4-positive helper T cells, because mouse CD4 cannot bind to HIV. To study further the mechanism of HIV infection in human cells, the following experiments were carried out, and the results are as follows:

1. When the human CD4 gene is expressed in mouse T cells, HIV can bind to the cells but cannot infect them.
2. When human chemokine receptor (CXCR4) is expressed in addition to human CD4 in mouse cells, HIV is able to infect the cells.
3. When human CD4 and CXCR4 genes are expressed in mouse cells and the cells are cultivated in the presence of SDF-1a, a ligand of CXCR4, infection by HIV is perturbed.

Which of the following sentences states the correct conclusion based on the above experiments?

A. If CXCR4 is expressed in mouse cells, CD4 is not required for the infection of

HIV.

B. Human CD4 is required for the binding with HIV, and the binding is enhanced by the SDF-1a ligand.
C. Even if human CD4 is expressed in mouse T cells, CXCR4 is required for binding of HIV to the T cells.
D. Human CD4 is required for the binding with HIV, but infection of HIV into cells requires help of CXCR4.

B19. (3 points) The majority of humans have erythrocytes that express the Rh (Rhesus) antigen on their cell surface, but some are negative for the Rh antigen.

An Rh-negative woman marries to a heterozygous Rh-positive man and has three children.

(1) What is the probability that all three of their children become Rh-positive?

A. 1
B. 1/2
C. 1/4
D. 1/8
E. 0

(2) In which combination below could the second child suffer from hemolytic disease?

	First child	Second child
A.	Rh-positive	Rh-negative
B.	Rh-negative	Rh-positive
C.	Rh-negative	Rh-negative
D.	Rh-positive	Rh-positive

(3) Which molecules or cells are mainly involved in causing hemolytic disease in the fetus and newborn infant in case of Rh blood group antigen-incompatibility? Choose TWO correct options from A to F.

A. T cells
B. IgM antibody
C. Complement
D. Interferon gamma
E. IgG antibody
F. Perforin

Ethology

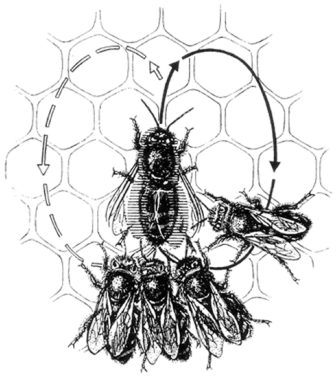
B20. (3 points)

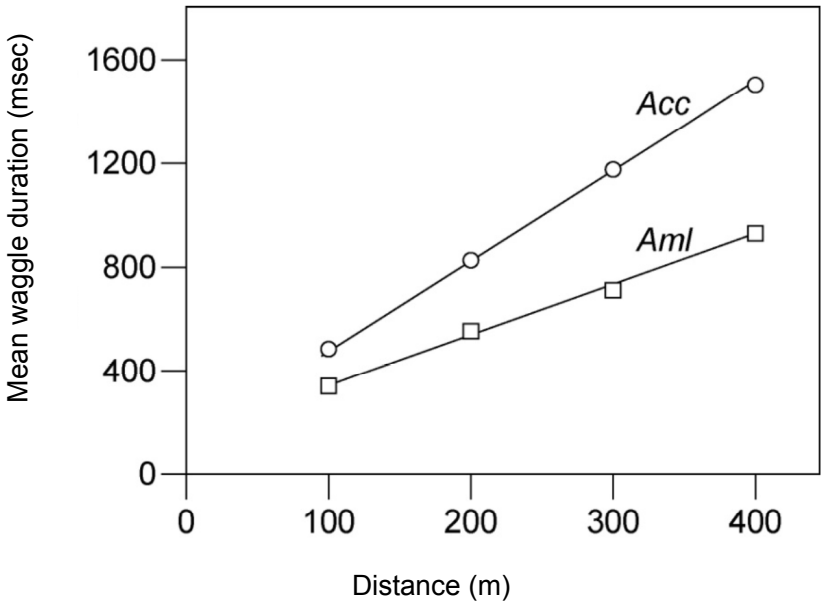
(1) Foraging honeybees usually perform a waggle dance (Figure 1) when they find an attractive food source 100 m or more away from their hive. The duration of the waggle dance indicates the distance to the food source.

The duration of the waggle dance was studied in two honeybee species, *Apis cerana cerana* (*Acc*) and *Apis mellifera ligustica* (*Aml*), when food was placed at varying distances from the hives and the data shown in the graph below.

Figure 2

Figure 1





What were the distances (m) indicated when the average duration of the waggle dances of *Acc* and *Aml* both lasted 800 msec? Answer the distance for each species from the following numbers.

130 160 190 220 250 280 310 340 370 400

(2) Mixed colonies of *Acc* and *Aml* were successfully established by introducing *Aml* pupae into *Acc* colony and *vice versa*. The young individuals of both species were accepted by the colony members of the other species. When the same experiment (Figure 2) was performed on the mixed colonies, the introduced *Acc* and *Aml* workers each showed exactly the same patterns that these species had shown earlier.

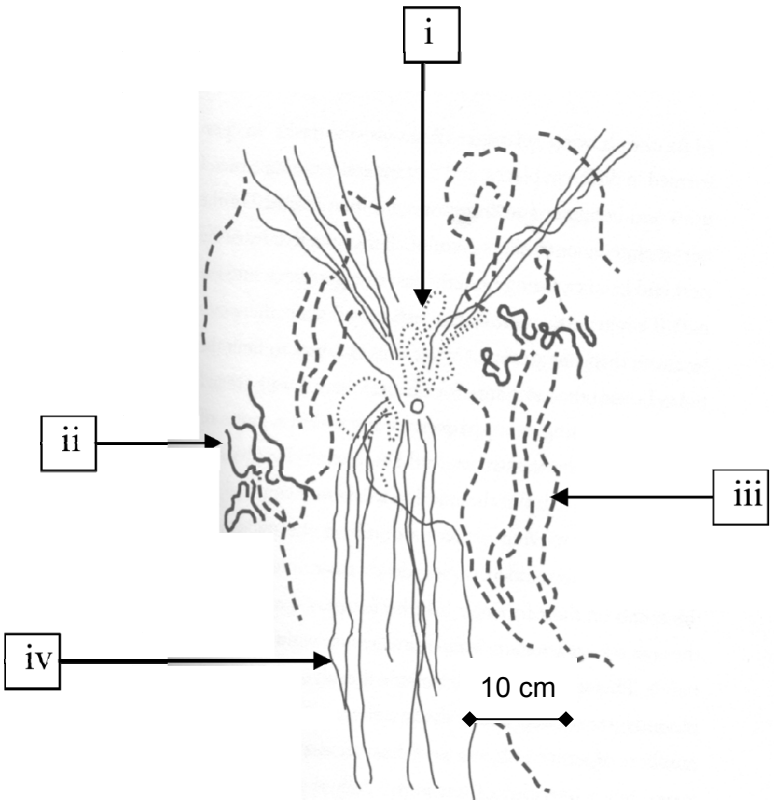
In the final experiment, food was placed at 400, 500 and 600 m, all in the same direction, and the introduced *Aml* bees trained to forage at the food source 500 m away. When these bees recruited *Acc* bees from the hive, the latter were found to forage at the food site exactly 500 m away. This was also seen when the reverse experiment was done with *Acc* bees recruiting *Aml* bees.

From these experiments, what can we conclude about the transfer of the encoded and decoded information between the actor and receiver bees, respectively?

	Encoded information (the actor)	Decoded information (the receiver)
A.	genetically determined	genetically determined

B.	genetically determined	socially learnt
C.	socially learnt	genetically determined
D.	socially learnt	socially learnt

B21. (2 points) Red harvester ants (*Pogonomyrmex barbatus*) are social insects and live in underground colonies, in which various functions are carried out by different groups of ants. Below is a picture of one such ant colony. The open circle in the center is the nest entrance. The four types of lines (i to iv) indicate paths followed by different groups of these ants. Match the appropriate groups (A to D) with these lines:



Groups:

A. Foragers
B. Patrollers
C. Nest maintenance ants
D. Midden workers or refuse pile sorters (those who pile fecal matter outside the nest)

B22. (2 points) In birds, there are many ways of singing. This is caused by the fact that brain regulates the action of the syrinx (vocal organ of birds). In a certain species of birds, two kinds of vocalization can be recognized: longer **songs** produced by males in the breeding season, and other simpler **calls** heard outside the breeding season.

(1) If the young chicks of such birds are reared in an environment without sound, adult birds cannot produce the exact longer songs. Which of the following is the most appropriate as explanation of the above statement?

A. In an environment without sound, differentiation between males and females cannot be attained.
B. The song is a mode of behavior which is determined by learning after hatching.
C. In an environment without sound, imprinting of the gene responsible for the song cannot occur.
D. In an environment without sound, the auditory sense cannot develop.

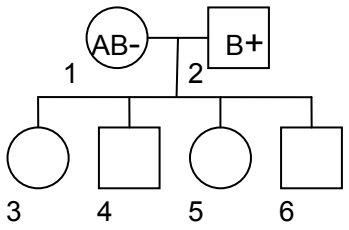
(2) Although chicken and quail are closely related, their calls are different. An experiment was carried out in which the presumptive brain region of 5-day-old white chicken embryo was substituted by that of a brown quail embryo of the same age. Then the host chicken embryo was incubated. The hatched chicken had some brown parts in its brain, which indicates that these parts were derived from quail. The calls of this chicken were more similar to that of quail rather than that of chicken. Which of the following is the most appropriate conclusion deduced from the experiment?

I. Calls are species-specific and are determined genetically.
II. Calls are determined after hatching.
III. Calls are determined by the structure of the syrinx.

A. Only I
B. Only II
C. Only III
D. I and II
E. I and III
F. II and III

Genetics and Evolution

B23. (4 points) In an experiment on the members of a family with the pedigree shown below, blood plasma and blood cells from different individuals were mixed in pairs to test the presence (p) or absence (a) of coagulation. In this pedigree AB- means that the phenotypes of individual 1 (mother) are AB type and Rh negative (Rh^-), and B+ means that the phenotypes of individual 2 (father) are B type and Rh positive (Rh^+).



The results of this experiment are shown below. A blank box in this table indicates a combination that was not tested in this experiment.

Plasma donor

Cell donor	1	2	3	4	5	6
1		p	a	p		p
2	p		a			p
3	p	p		p	p	p
4	a	a	a		p	
5	p	p				
6	a	p		p	a	

(1) What are the phenotypes of individual 6?

A. A type and Rh^+
B. A type and Rh^-
C. B type and Rh^+
D. B type and Rh^-
E. AB type and Rh^+
F. AB type and Rh^-

(2) Which member of this family is probably homozygous with respect to both the ABO blood group and the Rh loci?

A. Individual 2
B. Individual 3
C. Individual 4
D. Individual 5
E. Individual 6

B24. (4 points) In maize a single locus determines the color of the seed; allele *A* results in colored seeds, and allele *a* in colorless seeds. Another locus determines the shape of the seeds; allele *B* results in a smooth shape of the seeds, and *b* in wrinkled seeds.

In a crossbreeding between the plant that grew from a colored and smooth seed and the plant that grew from a colorless and wrinkled seed, the offspring were documented as:

376 had colored and smooth seeds
13 had colored and wrinkled seeds
13 had colorless and smooth seeds
373 had colorless and wrinkled seeds

(1) What are the genotypes of the parents?

A. *AABb* x *aaBb*
B. *AaBb* x *aabb*
C. *AAbb* x *aaBB*
D. *AaBb* x *AaBb*
E. *aabb* x *AABB*

(2) What is the frequency of recombinants?

A. 0.335%
B. 1.68%
C. 3.35%
D. 6.91%
E. 48.52%

(3) Three loci C, D and E are located on the same chromosome in this order. Using similar experiments to the above, we found that the frequency of recombinants between C and D is 10% and that between D and E it is 20%. Assuming that crossing over occurs randomly on the chromosome, what is the expected frequency of recombinants between C and E?

B25. (3 points) The evolutionary distance is defined as the number of nucleotide substitutions per nucleotide site between two DNA sequences, and the evolutionary rate is defined as the number of nucleotide substitutions per nucleotide site per year. We sampled two DNA sequences from two species (one sequence from each species), and found that the evolutionary distance between the two sequences is 0.05. We assume that the evolutionary rate is 10^{-8}.

(1) How many years ago did the two sequences diverge?

(2) What is the relationship between the divergence time between the two **sequences** (T1) and the divergence time between the two **species** (T2) in general?

A. T1 < T2
B. T1 = T2
C. T1 > T2

B26. (3 points) Preproinsulin is the primary product of the insulin gene, and consists of 4 major parts: signal, B-chain, C, and A-chain peptides. After several modifications including removal of the signal and C peptides, insulin is obtained.

(1) Which of the following peptides is responsible for the transport of polypeptide into the endoplasmic reticulum?

A. A-chain peptide
B. B-chain peptide
C. C peptide

D. signal peptide

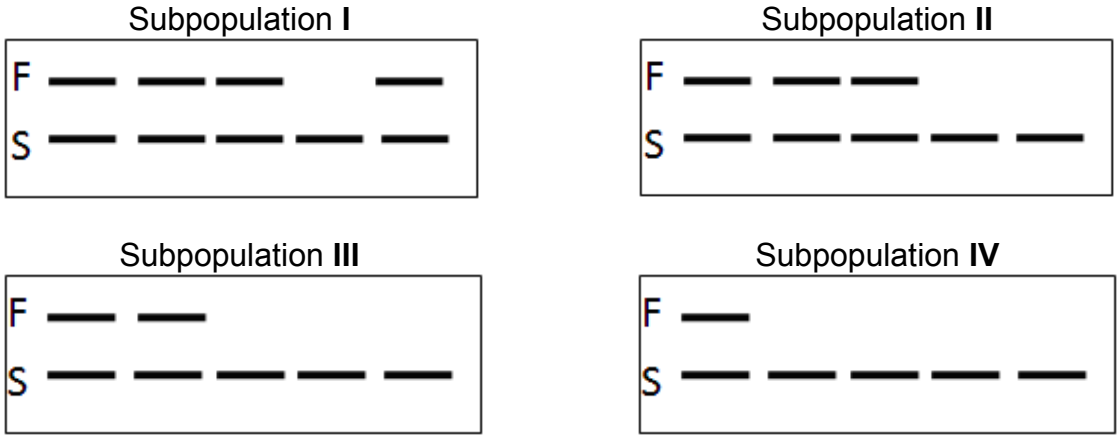
(2) Comparisons of amino acid sequences among mammals show that the sequence similarity between species varies substantially among the peptides. Which of the following is the most likely explanation?

A. directional selection
B. frequency-dependent selection
C. overdominant selection (heterozygote advantage)
D. purifying selection (selection against deleterious mutations)

(3) Which peptide is likely to differ the most among mammals?

A. A-chain peptide
B. B-chain peptide
C. C peptide
D. signal peptide

B27. (4 points) In order to quantify genetic diversity of an endangered plant species, genetic variation in subpopulations (I–IV) was examined at the protein level. Subpopulation I is the largest in this species, and the number of individuals in all other subpopulations II, III and IV are each 1/7 of that in subpopulation I. In each subpopulation 5 individuals were sampled. The diagram below shows the results of proteins separated by gel electrophoresis. The band pattern in each lane, which consists of alleles *F* and/or *S*, represents the genotype of each individual at a certain locus.



(1) Estimate the frequency of *F* in this species.

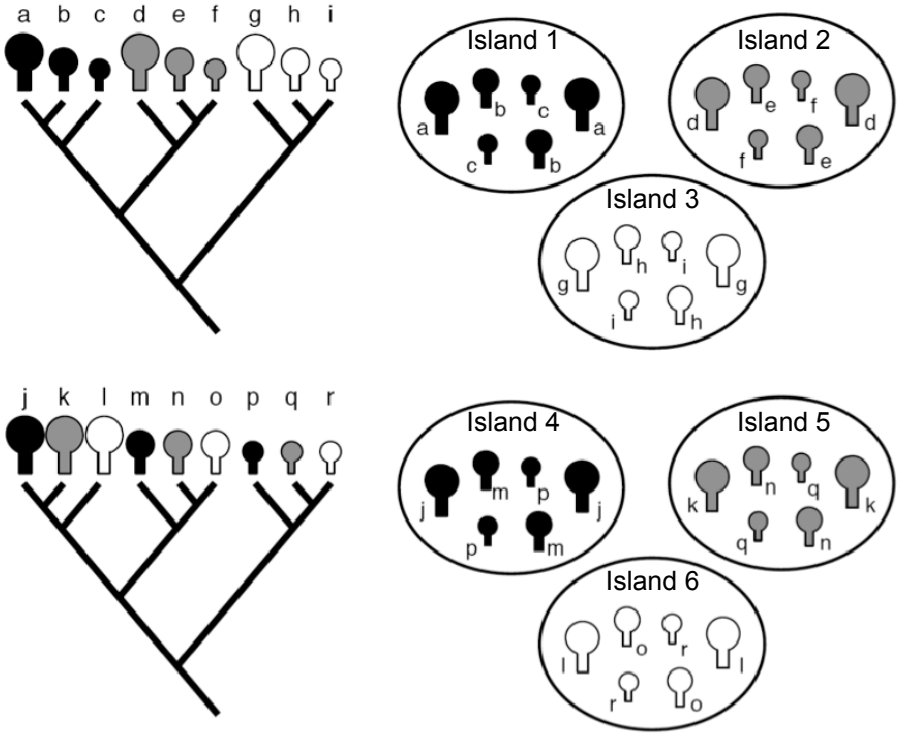
(2) Which subpopulation is thought to be the most isolated group?

(3) After several generations, we found that the frequency of *F* changed substantially in subpopulations II, III and IV, compared with that of subpopulation I. What is the most likely explanation?

A. Genetic drift
B. Migration

C. Mutation
D. Natural selection

B28. (3 points) Islands are considered as “experimental sites” for biological evolution and community assembly. The diagram below shows two phylogenetic trees, each consisting of 9 species (a–i and j–r) and community assemblies on 6 islands. Phenotypic traits of the species are represented by size and color.



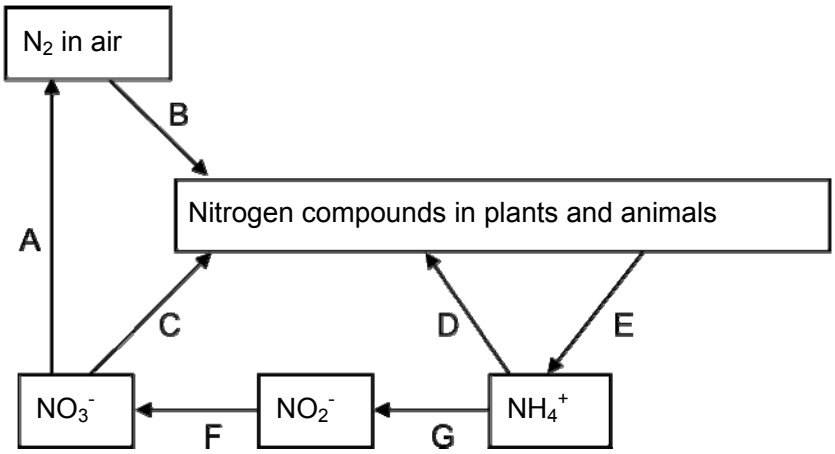
Which of the following explanations are responsible for the mechanisms of community assembly on these islands? Choose THREE correct options from A to H.

Options	Islands	Evolutionary and genetic structure of species	Ecological interactions between species
A	1, 2, 3	Phylogenetically closely related	Competitive exclusion in descendent species
B	1, 2, 3	Adaptive radiation	Niche specialization in descendent species
C	4, 5, 6	Adaptive radiation	Niche overlap in descendent species
D	4, 5, 6	Sympatric speciation	Niche specialization with competitive interaction
E	4, 5, 6	Phylogenetically distant species	Niche specialization with competitive interaction

F	1, 2, 3	Often seen in oceanic islands rather than land-bridge islands
G	4, 5, 6	Often seen in isolated island rather than those close to the mainland
H	1, 2, 3 vs 4, 5, 6	The community on 4, 5 and 6 are more sensitive to the invasion by an alien species than that on 1, 2 and 3

Ecology

B29. (3 points) The following diagram shows the cycle of nitrogen compounds in an ecosystem.

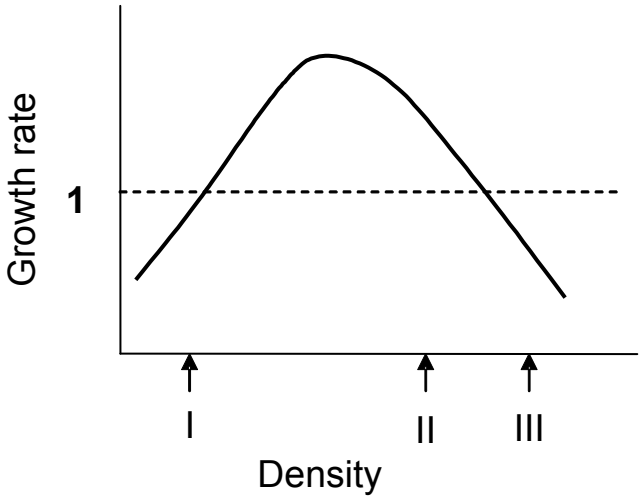


(1) In which of the processes do NOT bacteria participate? Choose TWO from A to G.

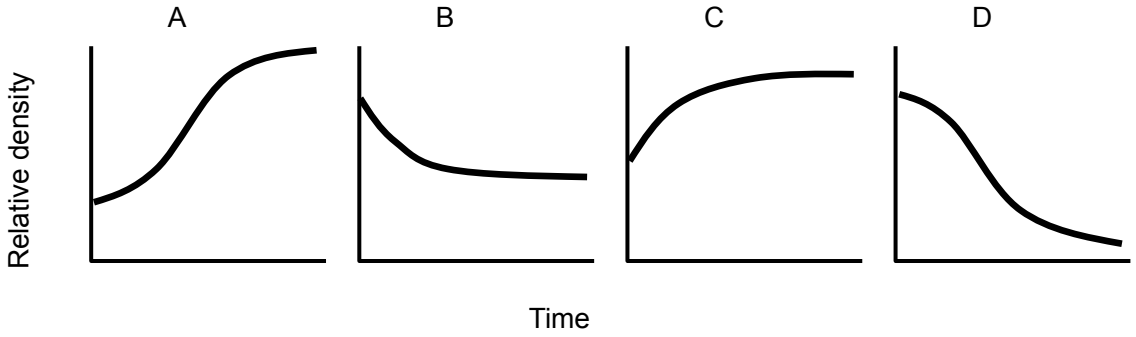
(2) Which of the processes may include a symbiotic relationship between a species of plant and a species of bacterium?

(3) Which of the processes do farmers want to inhibit in agricultural land?

B30. (3 points) The relationship between population density (N_t) and population growth rate ($R = N_{t+1} / N_t$) in a certain animal species is shown below.



Choose from the following graphs the appropriate population growth patterns that would be obtained if the population is at the densities (I, II, III) shown in the graph above. Note that the y-axis in A to D is relative density that cannot be compared to the absolute density in the figure.

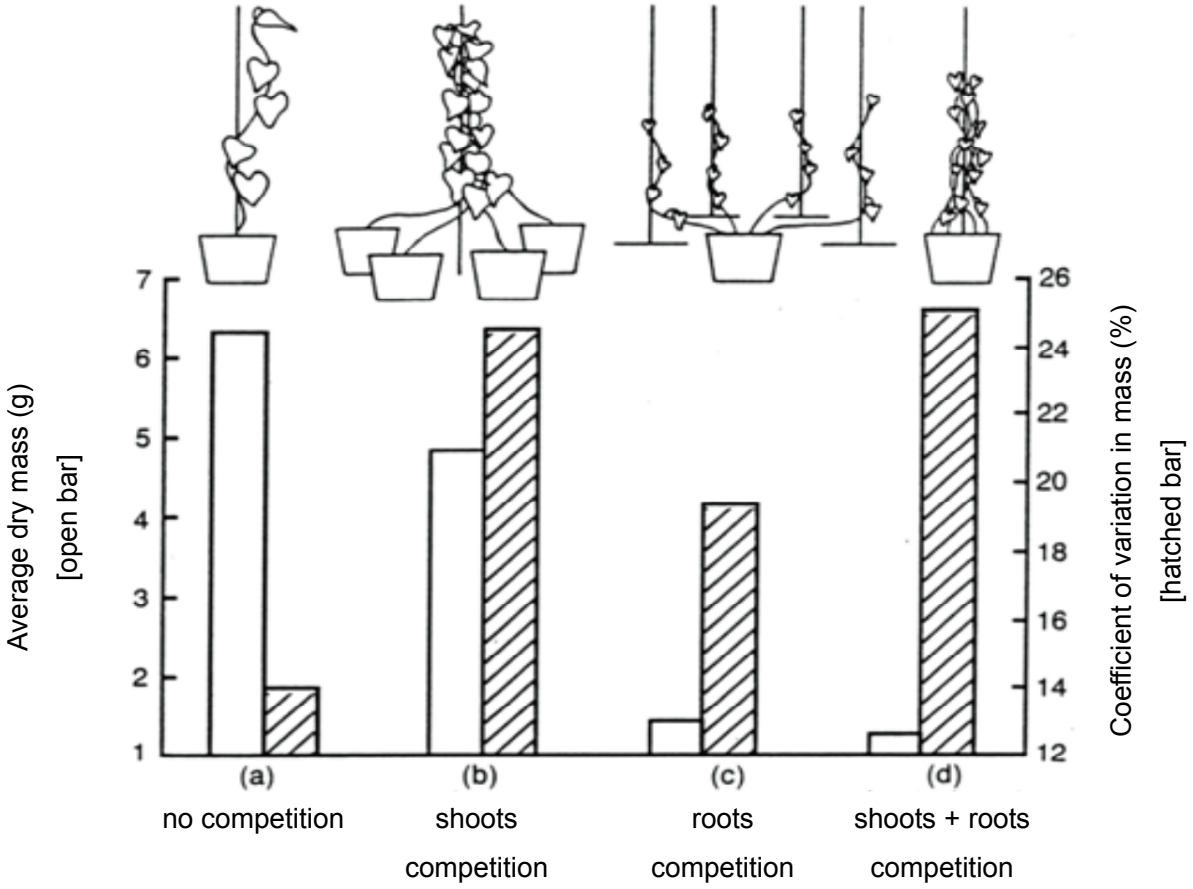


B31. (2.5 points) Competitive exclusion among species is regulated by various ecological factors. Identify whether the following statements are True or False about this process, and mark “X” in the appropriate boxes.

Competitive exclusion:

A. is intense among species with similar ecological niches.
B. is occasionally interrupted by environmental disturbances.
C. is promoted by species succession.
D. is alleviated by habitat segregation among species.
E. occurs because of keystone species.

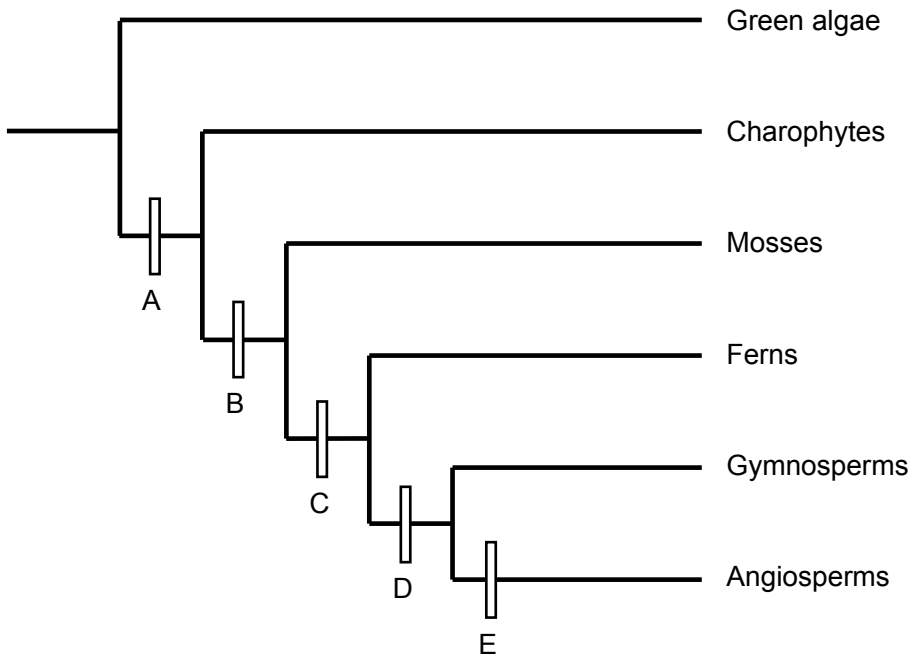
B32. (3 points) The diagram below shows the results of an experiment on the vine *Ipomoea tricolor*, in which root competition and shoot competition were separated. The average dry mass is indicated by open bars, and the coefficient of variation (ratio of standard deviation / mean) of mass among plants is indicated by hatched bars. Based on the data presented, identify whether the following statements are True or False about the competition mode of this plant species, and mark "X" in the appropriate boxes



A. Competition for light has more influence on the average mass than competition for soil nutrients.
B. The differences in competitive strength among these plants are larger when competing for soil nutrients than for light.
C. When grown individually, soil nutrients constitute a limiting factor for growth, but light does not.

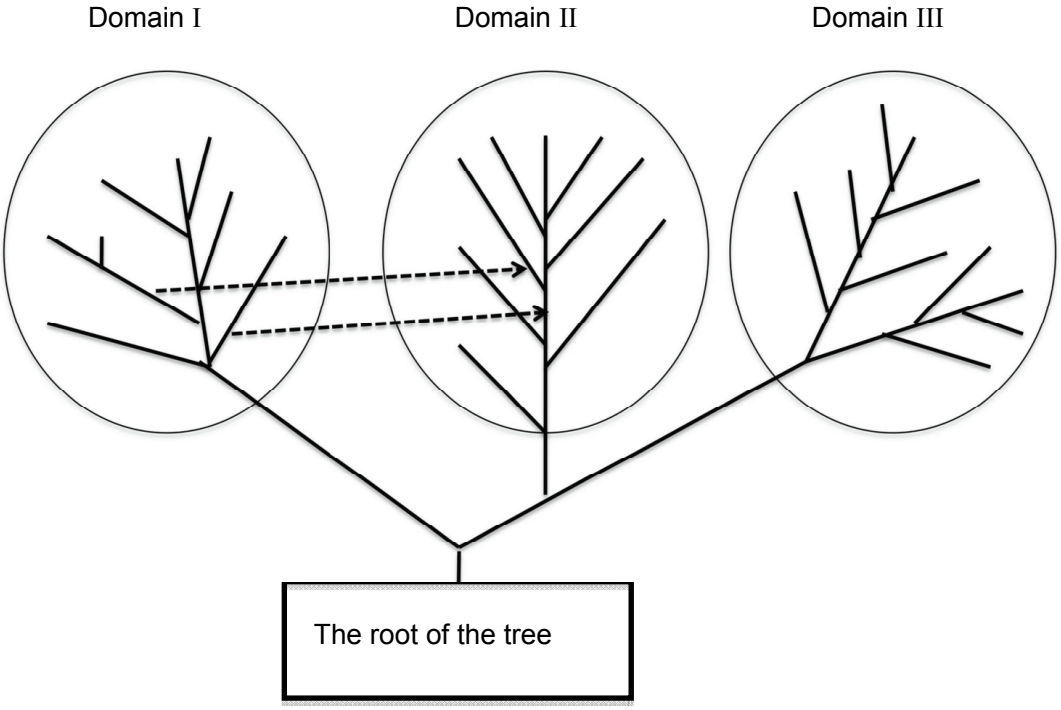
Biosystematics

B33. (3 points) At which branches A to E in this phylogenetic tree of green plants were the traits I to VI listed below acquired?



I. Pollen
II. Tracheid
III. Cuticle
IV. Seed
V. Carpel
VI. Multicellular embryo

B34. (5 points) The universal phylogenetic tree based on molecular sequencing analysis shows three major groups of living organisms as shown below. Woese proposed the concept of three domains in living organisms in the 1990s based on such a tree.



(1) What was the molecule used for the construction of the universal phylogenetic tree? What was the benefit of this molecule for the universal tree? Choose the combination of the molecule and benefit.

	Molecule	Benefit
A	Ribosomal protein	Low substitution rate of amino acid sequences
B	Ribosomal protein	High substitution rate of amino acid sequences
C	Ribosomal RNA	Low substitution rate of nucleotide sequences
D	Ribosomal RNA	High substitution rate of nucleotide sequences
E	Globin	Low substitution rate of amino acid sequences
F	Globin	High substitution rate of amino acid sequences
G	Transfer RNA	Low substitution rate of nucleotide sequences
H	Transfer RNA	High substitution rate of nucleotide sequences

(2) The two broken arrows indicate hypothesized endosymbiotic events whereby members of Domain I became endosymbionts of Domain II. What are the two organisms that were involved in these events, what did they become in the cells of Domain II and what is their current biological function in the Domain II organisms?

	Domain I	Domain II	Function
Older symbiosis			
Newer symbiosis			

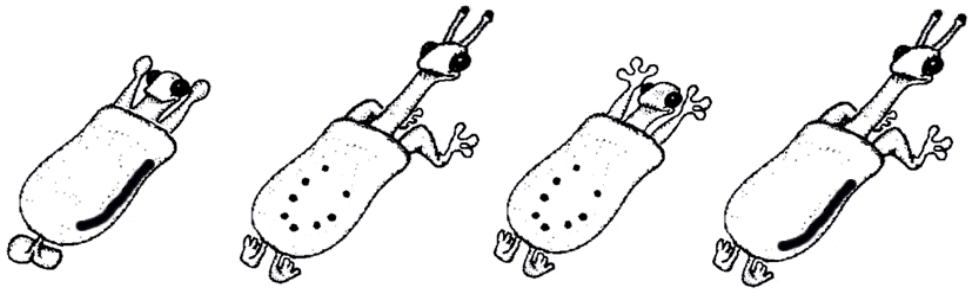
Domain I	Domain II	Biological function
1. Cyanobacteria	1. Mitochondria	1. Photosynthesis
2. Chlorella	2. Respiratory chain	2. Nitrogen fixation
3. Gram-negative respiratory bacteria	3. Flagella	3. Glycolysis
	4. Chloroplast	4. Respiration
4. Gram-positive fermentative bacteria	5. Chlorophyll	5. Conjugation
	6. Nucleus	6. Movement
5. Spirochaeta		
6. Virus		

(3) Which of the following corresponds to domains I, II or III?

A. Archaea
B. Bacteria
C. Eukarya

B35. (4 points) Joseph Camin, a taxonomist, invented artificial non-existing creatures, the *Caminalcules*, for his students. Below are depicted four different Caminalcules.

Take a close look at the following four Caminalcules:

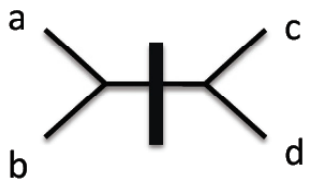


a b c d

(1) For these four Caminalcules, choose an appropriate cladogram by focusing upon the following characteristics. The most likely tree should be the one where the largest number of characters can be mapped in the internal branch.

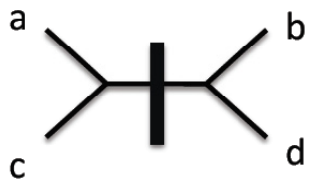
1. Antenna
2. Belly spots
3. Elbow
4. Fingers
5. Neck
6. Line at the side
7. Posterior legs

A



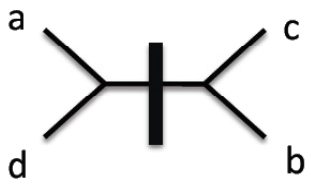
Internal branch

B



Internal branch

C

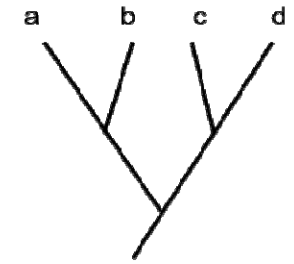


Internal branch

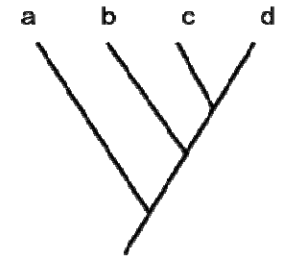
(2) Choose characteristics from the list in question (1) which presumably evolved convergently (independently lost or acquired) in two species of the four.

(3) Assuming that “Caminalcule a” is a sister taxon of the other species, choose an appropriate rooted tree from the following.

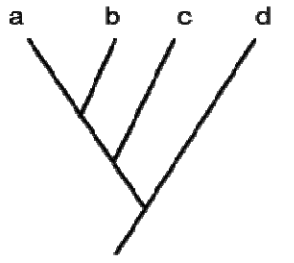
A



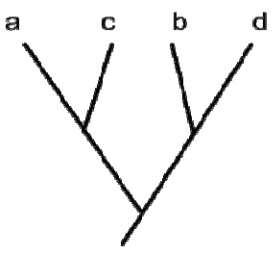
B



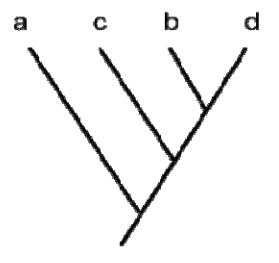
C



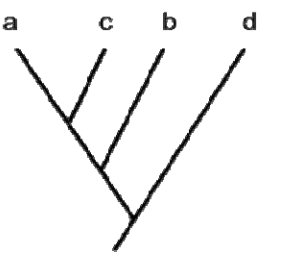
D

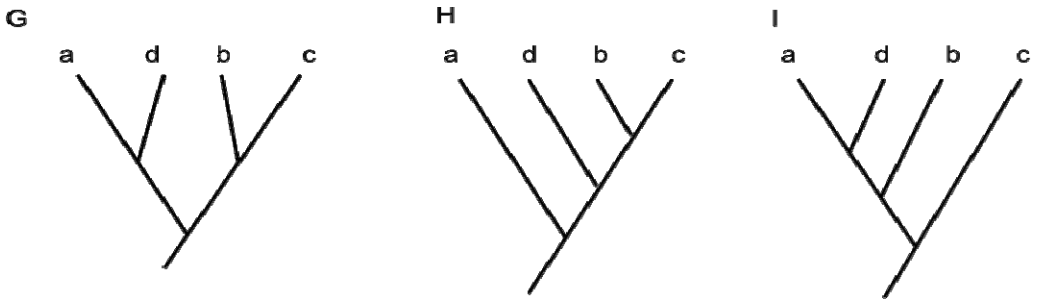


E



F





**********END OF PART B**********

Answer Key to the Theoretical Tests

1. 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							
A16			X				A36				X									
A17				X			A37			X										
A18		X					A38			X										
A19			X				A39			X										
A20					X		A40				X									

2. Part B

B1. (0.5 points x 6 = 3 points)

	A	B	C	D	E	F
Plants		**X**		**X**		
Mammals	**X**		**X**		**X**	**X**

B2. (0.5 points x 5 = 2.5 points)

I	II	III	IV	V
D	**C**	**E**	**B**	**A**

B3. (0.5 points x 6 = 3 points)

$$\frac{735}{3}\times 122-\left\{\left(\frac{735}{3}-1\right)\times 18\right\}-\{5\times(2\times 1)\}$$
$$=245\times 122-244\times 18-5\times 2$$
$$=29890-4392-10$$
$$=25488$$

When the N-terminal Met residue is assumed to have been removed,

$$\left(\frac{735}{3}-1\right)\times 122-\left\{\left(\frac{735}{3}-1-1\right)\times 18\right\}-\{5\times(2\times 1)\}$$
$$=244\times 122-243\times 18-5\times 2$$
$$=29768-4374-10$$
$$=25384$$

Partial point:
(0.5) Division by 3.
(0.5) Subtraction of water mass of peptide bonds.
(0.5) Number of peptide bonds: number of amino acids *minus* 1.
(0.5) Correct molecular mass of one water molecule.
(0.5) Subtraction of ten hydrogen molecules of five disulfide bonds.
(0.5) Correct calculations.

B4. (3.5 points)

(1) (0.3 points x 10 = 3 points)

A	**6**
B	**1, 3, 7, 10**
C	
D	**4, 9**
E	**2, 5, 8**
F	

(2) (0.5 point : if all are correct)

1	2	3
B	**C**	**A**

B5. (0.5 points x 4 = 2 points)

I	II	III	IV
D	**A**	**C**	**B**

B6. (3 points)

2000

(or 2007 by using more precise Avogadro's number.)

B7. (1 points x 4 = 4 points)

I	II	III	IV
A	**F**	**E**	**A**

B8. (3 points)

	Deficiency symptoms (0.3x3)	Mineral mobility (0.3x3)	Metabolic roles (0.4x3)
Mg	**B**	**C**	**G**
Fe	**A**	**D**	**E**
N	**B**	**C**	**F**

B9. (1 points x 3 = 3 points)

I	II	III
C	**D**	**F**

B10. (4 points)

(1) (0.5 points x 4 = 2 points)

		can respond to Florigen.	cannot respond to Florigen.
The shoot apical meristems of	cold-treated annual plants	**X**	
	untreated annual plants	**X**	
	cold-treated biennial plants	**X**	
	untreated biennial plants	**X**	

(2) (0.5 points x 4 = 2 points)

		produce Florigen under the long-day condition.	do not produce Florigen in either photoperiodic condition.
The leaves of	cold-treated annual plants	**X**	
	untreated annual plants	**X**	
	cold-treated biennial plants	**X**	
	untreated biennial plants		**X**

B11. (3 points)

(1) (1 point)

A	B	C	D
		X	

(2) (1 point)

A	B	C	D
		X	

(3) (1 point)

A	B	C	D
			X

B12. (1 points x 3 = 3 points)

	A	B	C
I	**X**		
II		**X**	
III	**X**		

B13. (1 points x 3 = 3 points)

I	II	III
A	**C**	**B**

B14. (2.5 points)

(1) (0.5 point)

A	B
	X

(2) (0.5 point)

A	B	C	D

		X	

(3) (0.5 points x 3 = 1.5 points)

C	**E**	**G**

B15. (1 points x 4 = 4 points)

	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Rejected	**X**	**X**		
Not rejected			**X**	**X**

B16. (2 points)

(1) (1 point)

A	B	C	D	E
	X			

(2) (1 point)

A	B	C	D	E
X				

B17. (2 points)

(1) (0.2 point x 4 = 0.8 points)

	A	B	C	D
TRUE	**X**	**X**		**X**
FALSE			**X**	

(2) (0.3 points x 4 = 1.2 points)

	A	B	C	D
TRUE	**X**		**X**	**X**
FALSE		**X**		

B18. (3 points)

(1) (1 points x 2 = 2 points)

A	B	C	D	E
X			**X**	

(Choosing more than 2 gives no point.)

(2) (1 point)

A	B	C	D
			X

B19. (3 points)

(1) (0.5 point)

A	B	C	D	E

			X	

(2) (0.5 point)

A	B	C	D
			X

(2) (1 points x 2 = 2 points)

A	B	C	D	E	F
		X		**X**	

(Choosing more than 2 gives no point.)

B20. (3 points)

(1) (1 points x 2 = 2 points)

Acc	**190**	m
Aml	**340**	m

(2) (1 point)

A	B	C	D
	X		

B21. (0.5 points x 4 = 2 points)

i	ii	iii	Iv
C	**D**	**B**	**A**

B22. (2 points)

(1) (1 point)

A	B	C	D
	X		

(2) (1 point)

A	B	C	D	E	F
X					

B23. (4 points)

(1) (2 points)

A	B	C	D	E	F
	X				

(2) (2 points)

A	B	C	D	E
		X		

B24. (4 points)

(1) (1 point)

A	B	C	D	E
	X			

(2) (1 point)

A	B	C	D	E
		X		

(3) (2 points)

26	%

B25. (3 points)

(1) (2 points)

2.5 X 10^6	
(**2,500,000**)	years

5 X 10^6 (**5,000,000**) years: 1 point

(2) (1 point)

A	B	C
		X

B26. (3 points)

(1) (1 point)

A	B	C	D
			X

(2) (1 point)

A	B	C	D
			X

(3) (1 point)

A	B	C	D
		X	

B27. (4 points)

(1) (2 points)

34	%

or 0.34

(2) (1 point)

I	II	III	IV
			X

(3) (1 point)

A	B	C	D

X			

B28. (1 points x 3 = 3 points)

A	B	C	D	E	F	G	H
	X			**X**	**X**		

B29. (3 points)

(1) (0.5 point x 2 = 1 points)

A	B	C	D	E	F	G
		X	**X**			

(Choosing more than 2 gives no point.)

(2) (1 point)

A	B	C	D	E	F	G
	X					

(3) (1 point)

A	B	C	D	E	F	G
X						

B30. (1 points x 3 = 3 points)

I	II	III
D	**C**	**B**

B31. (0.5 points x 5 = 2.5 points)

	A	B	C	D	E
TRUE	**X**	**X**		**X**	
FALSE			**X**		**X**

B32. (1 points x 3 = 3 points)

	A	B	C
TRUE			**X**
FALSE	**X**	**X**	

B33. (0.5 points x 6 = 3 points)

I	II	III	IV	V	VI
D	**C**	**B**	**D**	**E**	**B**

B34. (5 points)

(1) (1 point)

A	B	C	D	E	F	G	H
		X					

(2) (0.5 points x 6 = 3 points)

	Domain I	Domain II	Function
Older	**3**	**1**	**4**
Newer	**1**	**4**	**1**

(3) (1 point: if all are correct)

I	II	III
B	**C**	**A**

B35. (4 points)

(1) (2 points)

A	B	C
	X	

(2) (1 point)

2, 6

Since the number of correct choice is not stated in the question, the points are calculated by (number of the correct answer) x 0.5 – (number of the wrong answer) x 0.3.

(3) (1 point)

A	B	C	D	E	F	G	H	I
				X				

Since the answer of (3) is consequence of the question (1), the combination of the wrong answer (1) A and the answer of (3) B gives 0.5 point for (3), and that of (1) C and (3) H, gives 0.5 point for (3).

The Experimental Tests

1. Animal and Plant Anatomy (100 points, 90 minutes)

Dear Participants,

- In this test, you have been given the following 2 tasks:
  Task 1: Animal anatomy (50 points)
  Task 2: Plant anatomy (50 points)
- **You must 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 and equipment listed for each task. If any of these items are missing, please raise your hand.
- At the end of the test, put the Answer Sheet and Question Paper in the envelope. The supervisor will collect this envelope.

Good Luck!!

Task 1. Animal Anatomy (50 points)

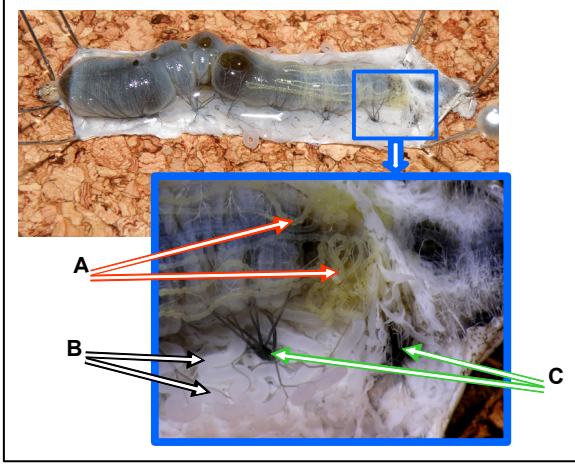
Materials and Equipment	**Quantity**
1. Vessel containing two caterpillars anesthetized	1
2. Vessel containing one caterpillar non-anesthetized	1
3. Dissecting plate	1
4. Forceps	2
5. Scissors	1
6. Disposable pipette	1
7. Dissecting needle equipped with holder	2
8. Dissecting pins	20
9. Compound binocular microscope (equipped with illuminator)	1
10. Set of color pencils: one “O” (orange), one “B” (blue), and one “G” (green)	1
11. Photo of a dissected caterpillar (included in your envelope)	1
12. A Petri dish for discarding dissected larva	1

Introduction

Even in insects which undergo complete metamorphosis, the body structure of the adult and larva are basically common. After closely observing a non-anesthetized caterpillar and dissecting and closely observing anesthetized caterpillars or moth (*Bombyx mori* Linné) larvae (silk worm), answer the following questions. When you dissect the caterpillars, do it in the dissecting plate filled with water, using suitable equipments such as forceps, scissors, dissecting needle with holder, dissecting pins.

Task 1

Photo of dissected caterpillar, dorsal view



Q.1.1. (1 point×2 = 2 points) The insect body is composed of three regions, the head, thorax and abdomen. Show the boundary

between the head and thorax by drawing an orange line with orange color pencil “O” and the boundary between the thorax and abdomen by drawing a blue line with blue color pencil “B” on the photo of the caterpillar in the Answer Sheet.

Q.1.2. (3 points) On each side of the caterpillar’s head, you will find an eye patch. How many small eyes are in the eye patch of one side of the caterpillar head in front of you? Answer using numerals.

Q.1.3. (3 points) Insects breathe by means of a tracheal system, with external openings called spiracles. How many pairs of spiracles do the caterpillars in front of you have? Answer using numerals.

Q.1.4. (6 points +[2+2]×3 points = 18 points) The photo in your envelope shows a dorsal view of a dissected caterpillar. Dissect an anesthetized caterpillar by yourself **exactly as shown in photo**. (You may use the second caterpillar if required) When you have finished the dissection, call your assistant by raising your hand. Your assistant will take a photograph of your specimen for evaluation **(6 points)**. *You should check the photograph of your dissected specimen after it has been taken*.

Closely observe the internal structures of the caterpillar, focusing on where the tubular structures A, B and C arise. Answer the name and function of each of the tubular structures A, B and C by choosing the appropriate answer for the name from numerals 1-10 and function from the alphabet a-j.

Names 1: salivary gland; 2: oviduct; 3: malpighian tubule; 4: appendix;
5: trachea; 6: prothoracic gland; 7: silk gland; 8: corpora allata;
9: fat body; 10: seminal duct

Functions a: secretion of juvenile hormone; b: support of digestion;
c: respiration; d: secretion of silk; e: secretion of prothoracic hormone;
f: restoration of fat; g: excretion; h: transport of egg;
i: transport of sperm; j: secretion of saliva

Q.1.5. (2 points×3 = 6 points) The insect body contains different kinds of internal organ systems. Closely observing non-anesthetized and dissected caterpillars, show the positions of the central nervous system, digestive system (gut) and circulatory system (heart), by drawing them into the image of the caterpillar prepared in the Answer Sheet using the colors as indicated below.

Central nervous system - orange color pencil “O”
Digestive system - blue one “B”
Circulatory system - green one “G”.

Notice: If you can show the positions of the systems in the image of the caterpillar, there is no need to copy their exact shapes: however, in drawing the digestive systems, you should clearly show both ends.

Q.1.6. (4 points) The central nervous system of insects is composed of the aggregations of cell bodies or the ganglia and the bundles of nerve fibers or the nerve cords connecting ganglia. How many ganglia does the dissected caterpillar have? Answer using numerals.

Q.1.7. (4 points×3 = 12 points) Show the positions of the anteriormost, anterior-second and posteriormost ganglia by drawing arrows and labeling with “A” for anteriormost, “2” for anterior – second and “P” for posteriormost with black pencil in the image of the caterpillar

used in **Q.1.5**.

Q.1.8. (2 points) How many nerve cords are there between each pair of ganglia? Answer using numerals, choosing the correct number from 1 to 4.

Task 2. Plant Anatomy (50 points)

In this task, fruit and flower morphology are examined and the developmental process is studied.

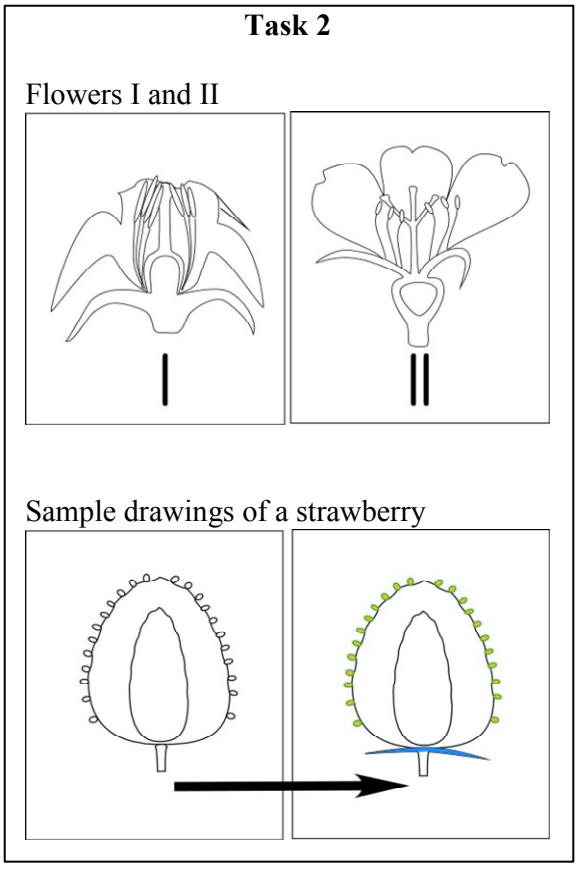
Part A. Seed morphology and reserve substances

Materials and equipment	Quantity
1. Petri dishes containing seeds labeled I to IV	4
2. Compound binocular microscope (used in Task 1)	1
3. Forceps (used in Task 1)	2
4. Knife	1
5. Scalpel	1
6. Bottles of staining and rinsing solutions (IKI, IKI-R, CBB, CBB-R, OR, OR-R)	6
7.Small Petri dishes for staining	12

Introduction

Morphology and reserve substances vary across plant species. Reserve substances can be distinguished by staining.

Q.2.A.1. (27 points) There are 4 kinds of seed (I to IV) in Petri dishes. The seeds labeled IV are *Vigna angularis*, a kind of legume which are given as an example. The seeds have been soaked for 24 hours. From some seeds, the seed coat was removed. Dissect the seeds using scalpel or knife, and stain each of them and their sections separately using all three staining solutions. Then, observe the stained seed samples including the sections of tissues under the stereomicroscope, and examine the degree of staining. Look at the samples carefully and fill the degree of staining in the Box of Q.2.A.1. in the answer sheet using the following symbols: "±" for weak staining, "+" for medium staining, "++" for strong staining. Use "-" for samples not stained, and "N" for seeds which do not have the indicated tissue.



Caution

· Some seeds are potential allergens. Wear gloves and do not touch them with your bare hands.

· Do not allow the staining solutions to contact your skin. If they touch your skin, rinse the area thoroughly with distilled water.

Staining and rinsing solutions:

Staining solution	Rinsing solution	Stain for	Color	Property
IKI	IKI-R	Starch	Purple	Aqueous solution
CBB	CBB-R	Protein	Blue	Contain ethanol and acetic acid
OR	OR-R	Lipid	Red	Contain ethanol

Staining method:

· Use small Petri dishes for staining and rinsing.
· Stain for 5 to 10 minutes in staining solution.
· Then, rinse the specimens well with rinsing solution.

Part B. Development of fruits

Materials and equipment	**Quantity**
1. Tomato fruits labeled (A)	3
2. An apple fruit labeled (B)	1
3. Drawings of flowers labeled (I and II) and strawberry fruits (included in your envelope)	1
4. Forceps (used in Task 1)	2
5. Knife	1
6. Colored pencils (orange (O), blue (B), green (G)) (used in Task 1)	3
7. White tray	1

Introduction

A fruit may develop from some part of a single flower. Therefore, the morphological features of a fruit are closely related to those of its flower.

Q.2.B.1. (4 points) There are fruits of tomato (A) and apple (B). Cut the fruits transversely and vertically on a paper towel in the white tray. Compare the fruits and flower drawings (I and II). Enter the number of the flower (I or II) that corresponds to each fruits (A, B) in the Box of Q.2.B.1. in the Answer Sheet.

Q.2.B.2. (11 points) Using a black pencil, draw and indicate ovules (or seeds), carpels (and/or tissue derived from carpel), and sepals on the vertical illustrations of the fruits (A1 and B1) of Q.2.B.2. in the Answer Sheet. Then, color the following tissues on the same fruit drawings (A1 and B1) in the colors designated. Refer to the strawberry drawings.

Ovule (or seeds): color pencil O (orange)
Carpels (and/or tissue derived from carpel): color pencil G (green)
Sepals: color pencil B (blue)

Q.2.B.3. (8 points) Complete the drawings of the transverse illustrations of the fruits (A2 and B2) of Q.2.B.3. in the Answer Sheet. Draw additional lines and color the ovules (or seeds) and carpels (and/or tissue derived from carpel) in the colors designated.

Ovule (or seeds): color pencil O (orange)
Carpels (and/or tissue derived from carpel): color pencil G (green)

**********END OF PRACTICAL TEST 1**********

2. Biochemistry (100 points, 90 minutes)

Dear Participants,

- In this test, you have been given the following 2 tasks:
  Task 1: Measurement of acid phosphatase activity (70 points)
  Task 2: Protein determination (30 points)
- **You must 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 and equipment listed for each task. If any of these items are missing, please raise your hand.
- At the end of the test, put the Answer Sheet and Question Paper in the envelope. The supervisor will collect this envelope.

Good Luck!!

How to use the spectrophotometer

1. The screen of spectrophotometer (Shimadzu UVmini-1240) must show 400 nm (Fig. 1). If not, raise your hand. ABS value shown may not be 0.000.
2. Fill a plastic semi-micro cuvette with distilled water (DW) at least up to the shoulders inside (Fig. 2)
3. Insert the cuvette into the cuvette holder of the instrument, with the transparent surfaces facing to the left and right (Fig. 3).
4. Shut the lid (Fig. 4).
5. Press 'AUTO ZERO' button (Fig. 5). By this manipulation, the instrument regards the level of absorbance by the cuvette plus water as zero. This will be used as the blank control for the rest of this experiment.
6. Now, you are ready to measure absorbance of samples.
7. Replace the water with a sample solution and read an ABS value after the lid is shut. The absorbance is caused by solutes in the sample solution.
8. You do not have to wash the cuvette after every measurement, if you measure a series of samples from the dilute to the concentrated.

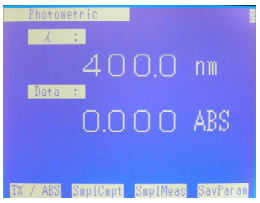


Fig. 1

Fig. 2

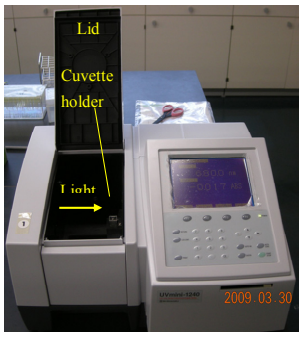


Fig. 3


Fig. 4

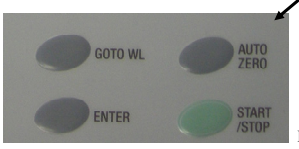


Fig. 5

Introduction

Acid phosphatase liberates phosphate ions from phosphorylated molecules under acidic conditions. The purpose of this experiment is to determine the specific activity of the acid phosphatase. You will measure activities of the acid phosphatase using a crude extract from potato in Task 1, and determine a protein concentration of the crude extract in Task 2.

Specific activity, which is the activity per unit time per unit weight of protein, is obtained from Tasks 1 and 2. Specific activity is an index of purity; it increases as the enzyme is purified.

Caution

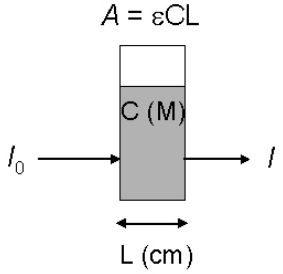
1. You will be handling small amounts of toxic substances (*p*-nitrophenol and NaOH).You can choose to wear disposable gloves and safety goggles in the experiments if you like.
2. In calculations where answers to previous questions are needed, partials marks will be given if calculated formulas are correct, even if answers are incorrect.

Materials and Equipments	**Quantity**
1. Spectrophotometer	1
2. Micropipettes (P1000)	2
3. Micropipettes (P200)	1
4. Tips (one box each for P1000 and P200)	2
5. Plastic cuvette	1
6. Test tube holder that accommodates 6-1 to 6-6	1
6-1. Crude extract of acid phosphatase (4 ml in a 15-ml plastic tube, labeled '1x enzyme')	1
6-2. 0.5 M Na acetate buffer (pH 5.6) (2 ml in a 15-ml plastic tube)	1
6-3. 5 mM pNPP (4 ml in a 15-ml plastic tube)	1
6-4. 0.5 M NaOH (8 ml in a 15-ml plastic tube)	1
6-5. 3% NaCl (10 ml in a 15-ml plastic tube)	1
6-6. Test tubes (Glass)	6

Task 1. Measurement of Acid Phosphatase Activity (70 points)

The activity of acid phosphatase is measured by an enzymatic reaction that converts p-nitrophenyl phosphate (pNPP) to *p*-nitrophenol (pNP), liberating phosphate. The product, pNP, absorbs light whose wavelength is 400 nm with an absorption coefficient* ($\varepsilon_{400\ nm}$) of 19000 M^{-1} cm^{-1} at extremely alkaline pH. Reaction mixture for an acid phosphatase is slightly acidic. Thus, it must be alkalinized for quantification of pNP. In Task 1, you will measure a time course of the reaction and obtain absorbance change per minute that is caused by 1 ml of crude extract. The absorbance change is converted to concentration change by using $\varepsilon_{400\ nm}$. Then, you will calculate a mol number of pNP molecules produced during the reaction by multiplying the concentration change by a volume of sample that is subjected to the measurement of absorbance.

＊What is an absorption coefficient？



A, absorbance
ε, absorption coefficient (M^{-1} cm^{-1})
C, concentration (M=mol $litre^{-1}$)
L, light path length (cm)
I_0, intensity of incident light
I, intensity of transmission light
Absorbance (A) is a physico-chemical property of solution that expresses to what extent a

solute absorbs light at a specific wavelength. Absorbance is in proportion to concentration (C) and light path length (L). The constant in the equation is a value characteristic to the solute, and is termed the absorption coefficient (ε). Thus, the relationship is formulated as $A=\varepsilon C$ (M=mol litre^{-1}) L (cm). Absorbance can be converted to concentration, since ε is given and L is 1 cm in this experiment. The dimension of ε is M^{-1} cm^{-1}, because absorbance is an absolute number without units.

Two enzyme concentrations are to be examined in Task 1. Find the test tube on which '1x enzyme' is labeled, which contains a crude extract of acid phosphatase. Next, find the 15-ml tube that contains 3% NaCl and remove 1ml of the solution so that the tube now contains 9 ml of 3% NaCl. Add 1 ml of the '1x enzyme' solution to it by using a micropipette, which makes '0.1x enzyme' solution. Relabel the tube as '0.1x'. Next, find 6 empty test tubes. Label each tube with an enzyme concentration and a reaction time as follows.

'0.1x', 20 min
'1x', 20 min
'0.1x', 10 min
'1x', 10 min
'0.1x', 1 min
'1x', 1 min

Q.1.1. (10 points) First, make an experimental schedule in order to perform all reactions, by describing start (○) and stop (●) signs for each reaction in the table in the Answer Sheet, allowing at least 1 min between the beginning of each reaction. An example for the reaction of '0.1x, 20 min' has been described in the table in the Answer Sheet.

Q.1.2. (15+10 points) Perform the enzymatic reactions according to the protocol described below and the schedule you made in Q.1.1. Use a new pipette tip in every manipulation. Agitate a mixture by tapping a test tube immediately after an addition. After you perform all the reactions, measure A_{400} of the samples. Write the obtained values in the table in the Answer Sheet, and plot them in the graph. **Please note that since water has been used as blank, the line will not pass through 0 (zero) on Y-axis (origin).**

Protocol for measurement of acid phosphatase activity

1) Mix 0.12 ml of 0.5 M Na acetate buffer (pH 5.6) and 0.24 ml of 5 mM pNPP in a test tube. Start the reaction by adding 0.24 ml of an enzyme solution.
2) After the reaction times of 1, 10, and 20 min, respectively, stop the reaction by adding 0.6 ml of 0.5 M NaOH. NaOH stops the reaction and converts the pNP produced into a yellow-colored (A_{400}-absorbing) form.
3) After all reactions are stopped, measure A_{400} of the samples.

Assay of potato acid phosphatase

0.5 M Na acetate buffer(pH 5.6)	0.12	ml
5 mM pNPP	0.24	ml
Enzyme	0.24	ml
0.5 M NaOH	0.6	ml
Sum	1.2	ml

Q.1.3. (15 points) Which enzyme concentration gave better linearity in the relationship between time and A_{400}? Circle the correct one on the Answer Sheet. Read the slope of this straight line from the graph.

Q.1.4. (5 points) Using the slope obtained in Q. 1.3, calculate the activity in the form of A_{400} change per min per 1 ml of an enzyme solution of concentration '1x'. The length of the light path (L) is 1cm. Your answer should be written with your calculations and the appropriate unit in the Answer Sheet.

Q.1.5. (5 points) Convert the absorbance change obtained in Q.1.4 to a concentration change by assuming the ε_{400} of pNP to be 19000 M^{-1} cm^{-1}. Your answer should be written with your calculations and the unit per min per 1 ml of '1x enzyme' solution in the Answer Sheet.

Q.1.6. (5 points) Convert the concentration change obtained in Q.1.5. to a change in number of moles of pNP. Your answer should be written with your calculations in moles per min per ml of '1x enzyme' solution in the Answer Sheet.

Q.1.7. (5 points) Calculate the total activity (in moles per min) in 4 ml of '1x enzyme' solution that was initially given.

Task 2. Protein Determination (30 points)

Protein concentration is determined by using a standard protein such as bovine serum albumin (BSA). In Task 2, you will determine a BSA-equivalent concentration of the 1x enzyme solution by the Bradford method. The Bradford method takes advantage of an increase in absorption of Coommassie Brilliant Blue at 595 nm when it is bound to protein.

By diluting a concentrated BSA solution (0.4 mg protein ml^{-1}) with 3% NaCl, a 1/2-dilution series was made (0.4, 0.2, 0.1, and 0.05 mg protein ml^{-1}). The dilution series of BSA and the 0.1x enzyme solution, which was made in Task 1, were all similarly treated with dye. Optical density at 595 nm (OD_{595}) of these samples was measured and recorded in the table below.

Table

Sample	[BSA] ($mg \cdot ml^{-1}$)	OD_{595}
	0.00	0.000
	0.05	0.070
	0.1	0.143
	0.2	0.261
	0.4	0.521
0.1x enzyme solution		0.180

Optical density (OD), a measure of the extent to which a substance transmits light or the 'absorbance' of suspension of particles.

Q.2.1.(10 points) Plot OD_{595} against BSA concentration in the graph in the Answer Sheet and depict an approximate straight line.

Q.2.2.(10 points) Estimate a protein concentration of the 0.1x enzyme solution from the graph, and obtain the protein concentration of the 1x enzyme solution.

Q.2.3.(10 points) Calculate the specific activity (activity per min per mg protein) of the 1x enzyme solution. Your answer should be written with your calculations and the unit per min per mg protein in the Answer Sheet.

**********END OF PRACTICAL TEST 2**********

3. Genetics (98 points, 90 minutes)

Dear Participants,

- This test includes the following 5 tasks:

Task 1:	Phenotypic observation of mutant flies	(9 points)
Task 2:	Inheritance of white eye mutation	(33 points)
Task 3:	Separation of eye pigments	(18 points)
Task 4:	Reading chromatography	(14 points)
Task 5:	Analysis of White Protein	(24 points)

- **You must 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 and equipment listed for each task. If any of these items are missing, please raise your hand.
- At the end of the test, put the Answer Sheet and Question Paper in the envelope. The supervisor will collect this envelope.
- This series of practicals are time consuming. You will need to be well organized and work quickly to complete the five tasks.

Good Luck!!

Task 1. Phenotypic Observation of Mutant Flies (9 points)

Materials and Equipment	**Quantity**
1. Petri dishes numbered (1)-(4) containing live fruit flies	1 set
2. Stand loupe (magnifying glass)	1

Introduction

Fruit flies are commonly used materials in genetics studies. Petri dish (1) contains the wild type, and each of the Petri dishes (2)-(4) contains different mutant flies. Observe the flies carefully by using the loupe (magnifying glass), but do not open the lid of the dishes. You may adjust the height and angle of the loupe for your observations.

Q.1.1. (9 points) In the case of each mutant, what kind of trait differs from the wild type? Choose the characteristic phenotype of the mutant trait from the following list.

A. eye color	B. eye shape	C. wing shape	D. bristle length
E. antenna shape	F. bristle shape	G. leg shape	H. proboscis shape
I. body color	J. abdomen length		

Task 2. Inheritance of White Eye Mutation (33 points)

Materials and Equipment	Quantity
1. 1.5 ml tubes containing anesthetized fruit flies labeled (5a) and (5b), (6a) and (6b), and (7)	1 set
2. Empty Petri dishes	5
3. White cardboard (place under the Petri dishes for easy observation)	1
4. Forceps	2
5. Stand loupe (magnifying glass) (used in Task 1)	1
6. 1.5 ml tube rack	1

Introduction

Wild type fruit flies (WT) have red eyes, while the mutant flies (*w*) have white eyes. *w* is a recessive mutation and located on the X chromosome. Each of tubes (5a) and (5b) or (6a) and (6b) separately contains male or female flies obtained from two different crossings. Tube (7) contains flies of both sexes from another crossing. Note that flies can be sexed by their patterns of the posterior dorsal abdomen, which is uniformly black in males.

Female

Male

Q.2.1. (8 points) Remove the flies from tubes (5a) and (5b) into different Petri dishes, and observe them by using the loupe (magnifying glass). Examine sex and eye color, and complete the table with the numbers of flies, including zero.

Q.2.2. (8 points) Remove the flies from tubes (6a) and (6b) into different Petri dishes, and observe them by using the loupe (magnifying glass). Examine sex and eye color, and complete the table with the numbers of flies, including zero.

Q.2.3. (8 points) Remove the flies from tube (7) into a Petri dish, and observe them by using the loupe (magnifying glass). Examine sex and eye color, and complete the table with the numbers of flies, including zero.

Q.2.6. (9 points) Which of the following crossings produce the flies of tubes (5a) and (5b), (6a) and (6b), and (7)? Choose all possible cases and answer with symbols.

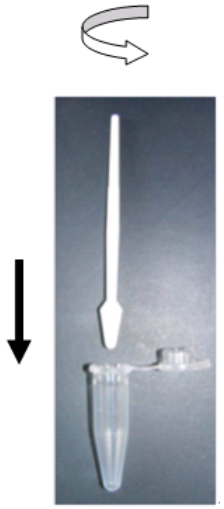
A. Homozygous red-eyed females and hemizygous red-eyed males
B. Homozygous white-eyed females and hemizygous white-eyed males
C. Homozygous red-eyed females and hemizygous white-eyed males
D. Homozygous white-eyed females and hemizygous red-eyed males
E. Heterozygous females and hemizygous red-eyed males
F. Heterozygous females and hemizygous white-eyed males

Task 3. Separation of Eye Pigments (18 points)

In addition to the materials and equipment used in Task 2, you will use the following set of equipment in this task.

Materials and Equipment	**Quantity**
1. 1.5 ml tubes (8) and (9) containing eye-pigments extraction solution	1 set (1 spare set)
2. Empty 1.5 ml tubes (10) and (11)	1 set (1 spare set)
3. Micropestles (in 15 ml tube)	2 (1 spare)
4. Centrifuge	1
5. Micropipette (P20)	1
6. Pipette tips (for P200 and P20)	1 pack
7. Empty 1.5 ml tubes (no numbers written on the lid)	2 (2 spares)
8. Cellulose/plastic sheet	1 (1 spare)
9. Micropipette (P2)	1
10. Pipette tips (P2)	1 pack
11. 50 ml tube containing solvents	1
12. Tube rack for the 50 ml tube	1

Procedure



1. Select five red-eyed and five white-eyed flies classified in Task 2 (either females or males), and remove their heads from the bodies using two pairs of forceps. ***Be sure not to crush eyes and abdomen of the flies.**
2. By using forceps transfer the heads of red-eyed flies into tube (8), the heads of white-eyed flies into tube (9), the bodies of red-eyed flies into tube (10), and the bodies of white-eyed flies into tube (11). Tubes (10) and (11) will be used in Task 5.
3. Insert a micropestle in each of tubes (8) and (9) and grind fly heads by revolving and pressing the pestle against the bottom of the tube with your hand. Use different pestles for different samples.
4. Centrifuge tubes (8) and (9) at 14,000 rpm for 3 min **(see the "Instruction for the centrifuge" at the end of this test, pages 18-19, and ask the supervisor for assistance if required)**.
5. Transfer 5 µl of supernatant from tubes (8) and (9) into new tubes.
6. Look at the cellulose/plastic sheet. The shorter sides of the cellulose/plastic sheet are the top and the bottom, and the non-glazy surface is the cellulose surface, which is used in this experiment. Write your student code with pencil at the top of the cellulose surface.
7. First, spot 1µl of the red-eyed heads extract at 1/3 from the left side and about 2 cm from the bottom of the sheet. Do not draw a line using a pencil or a marker pen, which may scratch the cellulose coating.
8. Then, spot 1µl of the white-eyed heads extract at 1/3 from the right side and about 2 cm from the bottom of the sheet.
9. When the spots dry, set the sheet into the 50 ml tube so that the bottom of the sheet touches the solvent, and close the cap tightly. Make sure the spots are not touched by the solvent. Open and close the cap of the tube quickly to minimize the leak of vapor.
10. Keep the tube straight on the tube rack to start solvent development. You can

continue with task 4 and 5 in the test and come back to this section. **Please read part 11 below before you continue**.

11. When the solvent front on the sheet reaches the 30 ml graduation mark of the tube, take the sheet out from the tube, let it dry on a piece of paper towel and close the cap of the tube. Raise your hand once the cellulose sheet is dry. (Your assistant will collect your sheet to evaluate the result.) **(18 points)**

Task 4. Reading Chromatography (14 points)

Introduction

Although some of the eye pigments involved in the compound eyes of fruit flies are invisible to our eyes, they can be visualized under UV lamp. Figure 1 shows an example of eye pigment spots resolved by chromatography and recorded under UV light. Note that the samples include not only WT (wild type) and *w* (white eyes) but also *se* (sepia eyes), *bw* (brown eyes), and *cn* (cinnabar eyes).

There are two pathways of eye pigment production in fruit flies, ommochrome pathway and pteridin pathway. The wild type eye color is formed if all pigments produced in both of the pathways are normally transferred to the compound eyes. Eyes are white if both the ommochrome and the pteridin pigments are absent. Of the pigments and their intermediate compounds involved in the two pathways, only those of the pteridin pathway can be separated by chromatography of this experiment.

The migration of each pigment during chromatography is determined by the chemical nature of the compound, the solubility of the compound to the solvent, and the migration distance of the solvent. The migration distance of a given pigment depends on the developing time of chromatography, but the Rf value is constant for each pigment, which is calculated by the following equation.

$$Rf = \frac{\text{Distance from the base line to the center of the spot}}{\text{Distance from the baseline to the solvent front}}$$

Table 1 summarizes color under UV lamp and Rf value of each pigment separated from the compound eyes of fruit flies.

Table 1. Characters of pteridin pigments in compound eyes of fruit flies

Code	Name	Color under UV lamp	Rf value
A	2-amino-4-hydroxypteridin	blue	0.57
B	biopterin	blue	0.61
C	drosopterin	orange	0.21
D	sepiapterin	yellow	0.52
E	isoxanthopterin	yellow	0.69
F	xanthopterin	green-blue	0.38
G	isosepiapterin	violet-blue	0.25

Q.4.1. (5 points) Choose the pigment from Table 1 that corresponds to each of the spots separated in the Figure 1 chromatography. Answer with the code in the table. How are the compositions of the pteridin eye pigments of the mutants different from that of the wild

type? Estimate the approximate amount of each pigment deduced from the Figure 1 chromatography. Write "++" if there is a lot more of the pigment as compared with the wild type, "+" if the pigment is present in similar amounts as in wild type, and "-" if the pigment is not present.

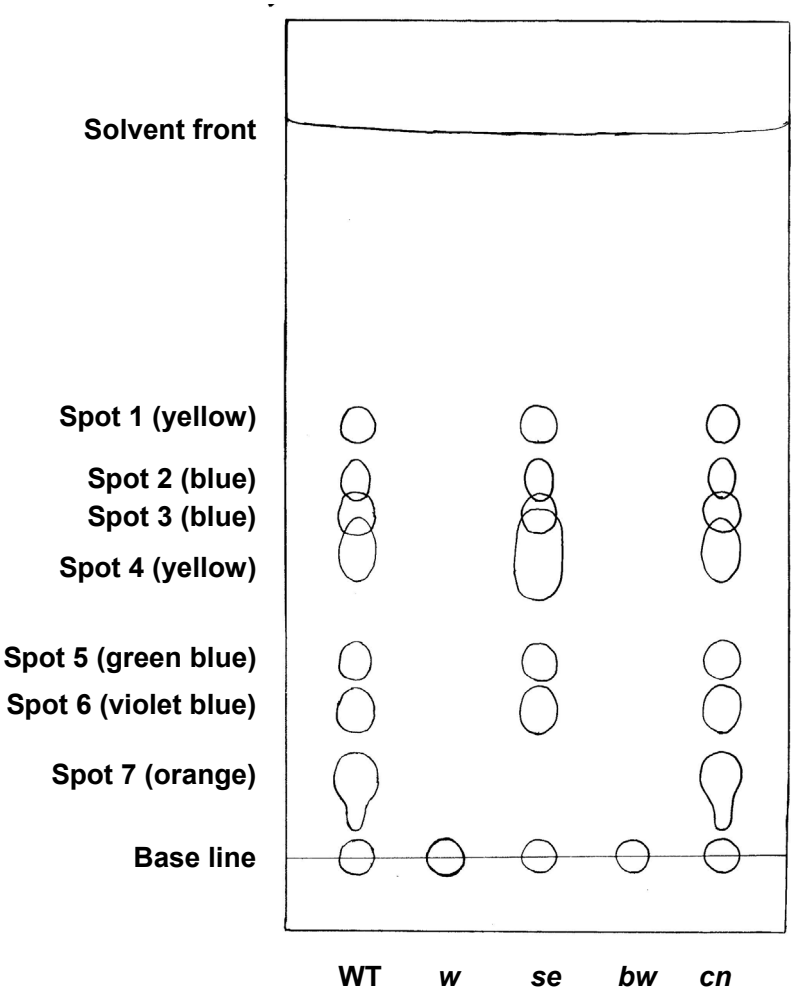


Figure 1. Chromatography of eye pigments from wild type and mutant flies

Q.4.2. (9 points) Given the eye color and the results of chromatography shown in Figure 1, which of the following abnormalities do *se* (sepia eyes), *bw* (brown eyes), and *cn* (cinnabar eyes) have? Write the corresponding alphabet.

A. Ommochrome pigments must be absent.
B. All pteridin pigments are absent but ommochrome pigments must be present.
C. Both ommochrome and pteridin pigments are absent.
D. Constituent of pteridin pigments differs from the wild type.

Task 5. Analysis of White Protein (24 points)

Materials and Equipment	**Quantity**
1. 1.5 ml tube A: Protein extraction buffer	1
2. 1.5 ml tubes (two are (10) and (11) of Task 3)	4
3. Micropestles (in 15 ml tube)	2 (1 spare)

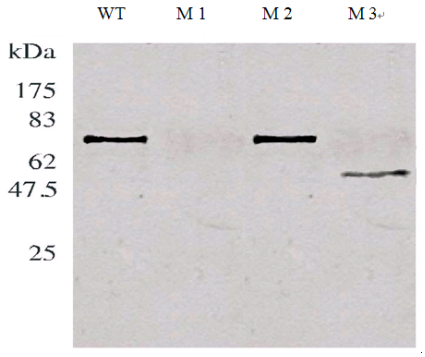
4. Electrophoresis apparatus with precast gel	1
5. Micropipetter (P200)	1
6. Micropipetter (P20)	1
7. Pipette tips (for both P200 and P20)	1 pack
8. 1.5 ml tube rack	1
9. 1.5 ml tube C: Protein electrophoresis marker	1

Protein extraction and electrophoresis

1. Add 50 µl protein extraction buffer (tube A) in the tube (10) (bodies of red-eyed flies) and (11) (bodies of white-eyed flies) prepared in Task 3. Crush the flies with the micropestle. Use different micropestles for wild type and mutant samples.
2. Centrifuge tubes (10) and (11) at 14,000 rpm for 3 min, and then transfer supernatant into fresh 1.5 ml tube **(see the "Instruction for the centrifuge" at the end of this test, pages 18-19, and ask the supervisor for assistance if required).**
3. The assistant has prepared a gel for you and it is ready for use. Load 5 µl of each sample on the slots in the middle of the gel plate in the order of molecular weight marker, red eye and white eye (from left to right). When you have finished sample loading, raise your hand for the supervisor. Your assistant will take care of the apparatus and start electrophoresis.
4. After 5 min, call your assistant by raising your hand. Your assistant will collect the lower part of the apparatus and take a photograph of the gel for evaluation **(18 points). Please check the image on the camera with your assistant.**

Analysis of protein electrophoresis data

M1, M2 and M3 flies are different mutant lines for the eye pigment genes. After separating proteins of these mutant flies through SDS polyacrylamide gel, proteins were transferred onto a nylon filter to be probed with antibody that specifically recognizes the protein encoded by the *white* gene. The following result was obtained.



Q.5.1. (3 points) Which of the following defects of eye pigment genes causes the electrophoresis results of M1, M2 and M3? Choose the corresponding symbols from A, B and C.

A. The mRNA initiation site of the *white* gene is deleted, and the gene is not expressed.
B. A stop codon mutation has occurred in the coding region of the White protein, resulting in failure of translation of carboxyl terminal peptide sequence corresponding to molecular weight 20 kDa.
C. Although a normal White protein is synthesized, genes involved in the synthesis of ommochrome pigments are defective.

Q.5.2. (3 points) Choose another defect of eye pigment gene from A, B and C that would cause the same phenotypes as M1, M2 and M3.

A. The coding sequence of the *white* gene is fused with the coding sequence of another gene by chromosomal translocation, resulting in a novel sequence encoding a fusion protein that retains antibody reacting sites but exhibits about 30 % lower molecular weight.
B. A single base substitution has occurred in the protein-coding region of the *white*

gene changing an amino acid coding sequence into another amino acid coding sequence. However, immunological reactivity of the altered protein for the antibody is not lost.

C. A large deletion exists in the chromosomal region that involves the entire *white* gene.

Instructions for the centrifuge

Ask the supervisor for assistance if required

1. Press the OPEN button at the upper-right of the operation panel (Fig. 1 - 1) to open the centrifuge lid (2).
2. The rotor is covered by a plastic cap (Fig. 2 - 3). To remove the cap, hold the cap with one hand, and unfasten the central black screw (4) anti-clockwise with the other hand.
3. There are 24 holes inside the rotor (Fig. 3). Set the sample tubes in a symmetric position, considering their balance.
4. Turn the rotor cap screw (4) clockwise to fasten the cap on the rotor.
5. Close the centrifuge lid firmly. You should hear a beep that tells complete closure.
6. The centrifuge speed (140 x 100 rotation per minute) and time (3 min) is preset. Confirm the set parameters in the windows (5) and (7) by pressing the DISP/CE button (6), and press the START button (8) to start centrifugation.
7. When centrifugation is finished, the lid (2) is automatically unlocked. Then, open the lid (2) fully and remove the rotor cap by unfastening the screw (4) anti-clockwise while holding the rotor cap with the other hand.
8. In order to not disturb the precipitates, take out the sample tubes carefully from the rotor. Leave them on the tube stand.
9. Replace the rotor cap (3) and fasten the screw (4) clockwise, and close the centrifuge lid (2).

Figure 1

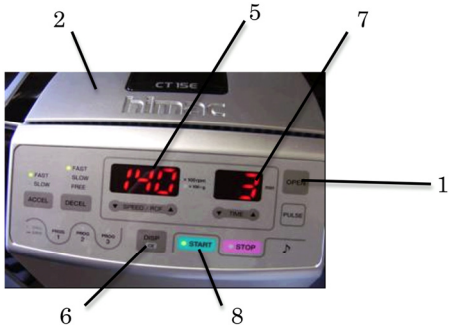


Figure 2

Figure 3

**********END OF PRACTICAL TEST 3**********

4. Cell Physiology (91 points, 90 minutes)

Dear Participants,

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

Task 1: Study on the cell cycle (61 points)
Task 2: Study on the motile mechanism of unicellular algae (30 points)

- **You must 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 and equipment listed for each task. If any of these items are missing, please raise your hand.
- At the end of the test, put the Answer Sheet and Question Paper in the envelope. The supervisor will collect this envelope.

Good Luck!!

Task 1. Study on the Cell Cycle (61 points)

Introduction

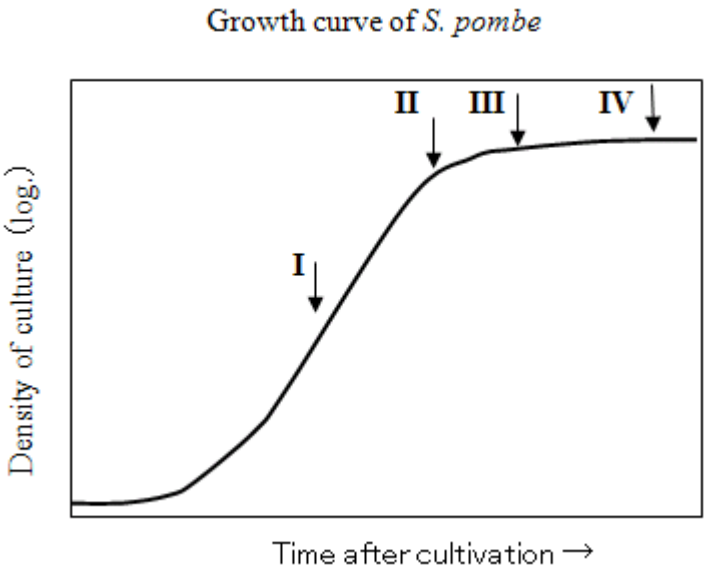
In many unicellular organisms, gene duplication and segregation occur in a controlled manner as the cell body grows. When the environmental conditions in which cells are growing become less favorable or stressful, genetic exchange is often seen via cell conjugation (mating) between cells of different mating types. That phenomenon is essential for life and is controlled by both internal and external condition of the cells. To date, we have tried to reveal these mechanisms by studying mutants in several model organisms. For example, the investigation of mutants in the fission yeast, *Schizosaccharomyces pombe* has provided us with invaluable information. Wild-type *S. pombe* cells proliferate by repeated cell elongation followed by symmetric cell division. On the other hand, under stressful conditions such as starvation, cells undergo arrested growth at an appropriate stage of the cycle, and spore formation is induced via cell conjugation to overcome the stressful conditions. The following task involves examining cell proliferation using *S. pombe*.

Materials and equipment	**Quantity**
1. Fixed culture of wild-type strain; a	1
2. Fixed culture of wild-type strain; b	1
3. Fixed culture of wild-type strain; c	1
4. Fixed culture of wild-type strain; d	1
5. Micro tube stand	1
6. Microscope	1
7. Disposable cell counter	1
8. Counter	1
9. 1.5ml microtube	3
10. Box of glass slides	1
11. Box of coverslips	1
12. Micropipette P-20 (capacity 2-20 µL)	1
13. Box containing micropipette tips	1
14. Fixed culture of wild-type strain incubated at 25°C; W25	1
15. Fixed culture of wild-type strain incubated at 36°C; W36	1
16. Fixed culture of *cdc25* mutant strain incubated at 25°C; M25	1
17. Fixed culture of *cdc25* mutant strain incubated at 36°C; M36	1
18. Photograph of cells stained with Calcofluor and DAPI	1

Part A

The growth curve of *S. pombe* wild-type haploid (n=1) incubated at 25°C is shown below.

Sampling of culture medium has been carried out at time points indicated by an arrow. Culture media a, b, c and d on the bench correspond to a sample of the culture taken at a certain time of cultivation I, II, III or IV. Observe each of the media with a microscope, and answer the following questions. Please stir the microtube just before observation.



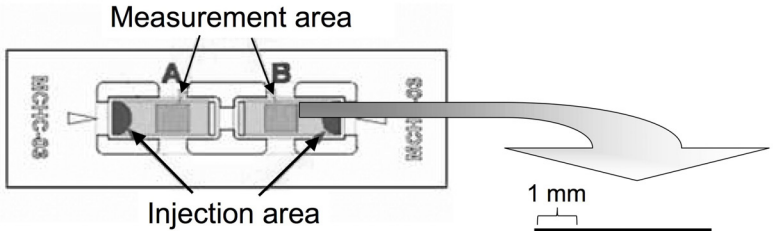
Q.1.A.1. (2x2points) Compare the cells in sample a with those in sample b, and answer the following questions.

1 In which sample are the cells rounder?

2 In which sample is there a higher population of cells undergoing cytokinesis?

Cytokinesis is defined as the part of the cell cycle from initiation of septum formation to the separation of daughter cells.

Q.1.A.2. (6 points) Measure the number of cells per 1 ml culture medium in sample a by using the cell counter as indicated below. Daughter cells that have not separated should be counted as a single cell. Write your Answer on the Answer Sheet. Notice that each student has received one cell counter but each counter has two counting chambers. You can make two measurements with this counter.



Two chambers are equipped. Sample is penetrated throughout the chamber by capillary effect if you put it on the injection area.

Chamber depth: 0.2 mm
Required sample volume: >20 μL

Q.1.A.3. (5 points) Measure the percentage of cells undergoing cytokinesis in the culture medium in sample a. You should count more than 100 cells in total by choosing several optical fields at random. You must write the percentage of cells undergoing cytokinesis AND the total number of cells you counted on the Answer Sheet.

Q.1.A.4. (4 points) Estimate the time period required for one round of the cell cycle of cells in logarithmic phase, provided that it takes 25 min from the beginning of cytokinesis to the separation of the daughter cells. Enter both the formula and your answer in the Answer Sheet.

Q.1.A.5. (3 points) What applies to the cells in culture medium c?

A vigorously growing
B forming spores
C conjugating
D most of cells are dead
E undergoing meiosis

Q.1.A.6. (8 points) Which culture medium (I, II, III, or IV) corresponds to a, b, c and d, respectively?

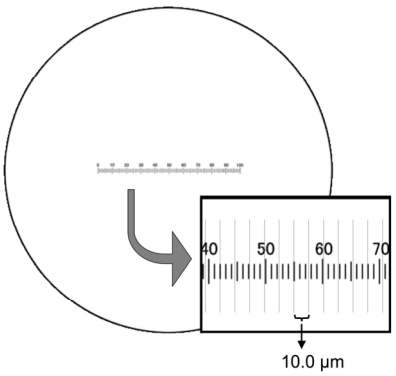
Part B

Both wild-type and *cdc*25-mutant strains were incubated at 36°C for 4 hrs after logarithmic growth at 25°C.

Q.1.B.1. (3 points) By observing the phenotypes of the cultures W25, W36, M25 and M36, what can we conclude?

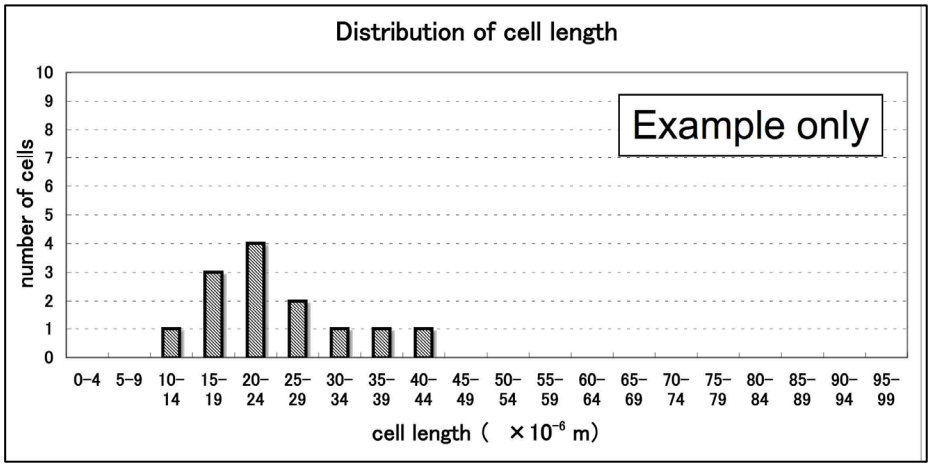
	Condition	Most of *cdc25* mutant cells	Wild type cells
A	25°C	Do not undergo cytokinesis	Undergo cytokinesis
B	25°C	Undergo cytokinesis	Do not undergo cytokinesis
C	36°C	Do not undergo cytokinesis	Undergo cytokinesis
D	36°C	Undergo cytokinesis	Do not undergo cytokinesis
E	25°C and 36°C	No significant difference in cytokinesis between *cdc25* mutant and wild type cells	

Q.1.B.2. (4 points) To measure cell length, your microscope is equipped with a micrometer in the eyepiece lens. In order to calibrate the eyepiece micrometer, a second micrometer, called the stage micrometer, is place on the stage of the microscope. The distance between any two adjacent lines on the stage micrometer is known to be 10.0 μm. By matching the lines on both micrometers, we can determine the distance between two adjacent lines of the eyepiece micrometer. Determine this distance in μm to two decimal places using the figure shown below.



Q.1.B.3. (12 points) Measure the longitudinal length of more than 10 cells selected at random in culture media of M36. Graph your results in the Answer Sheet according to the example indicated below. The scale of your eyepiece micrometer is 4 μm. Do not forget to

indicate the unit of length.



Q.1.B.4.(2 points) What can you conclude from your observations of each culture? *cdc25* cells are longer than wild-type cells at:

A both 25°C and 36°C.
B 36°C but not 25°C.
C 25°C but not 36°C.
D There is no significant difference in cell length between wild-type and *cdc25* cells at both 25°C and 36°C.

Part C

The following experiment was done using wild-type cells and 5 mutant strains (A-E). These mutant strains grow at 25°C as well as wild-type cells but are not able to grow at 36°C. All cells undergoing logarithmic growth at 25°C were then incubated at 36°C for an additional 4 hrs before chemical fixation. Fixed cells were stained with both Calcofluor (stains septa) and DAPI (stains DNA) for observation using fluorescence microscopy (as seen in the photograph provided on the bench).

Q.1.C.1.(10 points) The following statements describe the phenotype of the mutants incubated at 36°C. Identify the descriptions that correspond with each of the mutant strains (A-E), respectively.

1. Cytokinesis is repeated independently of progression of the cell cycle.
2. Cell cycle progresses but cytokinesis has not begun.
3. Cell cycle is arrested at interphase.
4. Karyokinesis is severely defective.
5. Completion of cytokinesis is suppressed.

Task 2. Study on the Motile Mechanism of Unicellular Algae (30 points)

Introduction

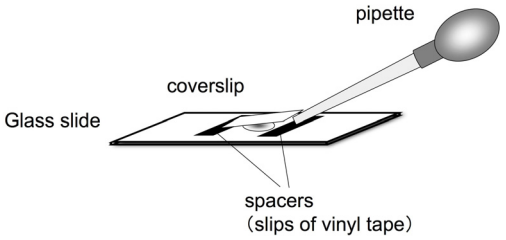
Some unicellular algae and zygotes of multicellular algae swim actively. This behavior is important for migration to appropriate conditions for growth and sexual reproduction. *Chlamydomonas reinhardtii*, an unicellular green alga, swims using flagella movement. Flagella often fall out when in contact with some stimuli, and some are absorbed into the cell body at a specific stage of the cell cycle.

This task concerns the machinery of flagella movement and flagella regeneration in *C. reinhardtii*.

Materials and equipment	**Quantity**
1. *C. reinhardtii* wild-type cells (wt)	1
2. *C. reinhardtii oda1*mutant (oda)	1
3. *C. reinhardtii pf17* mutant (pf)	1
4. Microscope	1
5. Box of glass slides	1
6. Box of glass coverslips	1
7. Acetic acid solution (A)	1
8. Neutralizing solution (N)	1
9. Disposable pipette（1 ml）	10
10. 1.5 ml microtube	5
11. Vinyl tape	1
12. Scissors	1

Caution

C. reinhardtii flagella frequently stick to glass slides. As a result, the swimming ability of the cell is hindered. Therefore, cells immobilized on a glass slide should be excluded from observations for cell movement. It is recommended to make a chamber as indicated below for the observation. Slips of vinyl tape are stuck on a glass slide in parallel, and a coverslip is mounted on the slips after the samples are loaded by pipette. This chamber will provide a space for the cells to swim.



Part A

Microscopically compare the wild-type (wt) and *pf17* mutant (pf) cells. This mutant has a normal shape and cellular structure but lacks a component of the radial spoke head in its flagella.

Q.2.A.1. (6 points) In comparison to wild-type cells, *pf17* mutant cells:

A swim in the same manner
B swim but more slowly
C swim but more rapidly
D do not swim at all

Q.2.A.2. (2 points) What can you conclude about the function of the radial spoke head?

A essential for flagella movement
B no effect on flagella movement
C suppresses flagella movement
D coordinates flagella movement

Part B

Microscopically compare the wild-type (wt) and *oda1* mutant (od). This mutant lacks a kind of dynein in flagella whereas the shape and other cellular structures are normal.

Q.2.B.1. (6 points) In comparison to wild-type cells, *oda1* mutant cells swim:

A in the same manner
B more slowly and smoothly
C more slowly and jerkily
D more rapidly and smoothly
E rapidly and jerkily

Q.2.B.2. (2 points) What can you conclude about the function of the dynein lost in the *oda1* mutant?

A essential for flagella movement
B no effect on flagella movement
C increases flagella movement
D coordinates flagella movement

Part C

Study the effect of acetic acid on flagella as follows:

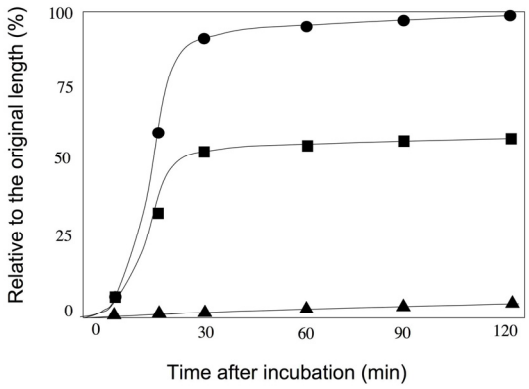
(i) Measure the percentage (A) of wild-type cells with flagella in 20 cells.
(ii) Transfer about 1 ml of the culture selected in (i) into a 1.5 ml microtube by disposable pipette, and add one drop of acetic acid solution
(iii) Add one drop of neutralizing solution after 30 seconds
(iv) Measure the percentage (B) of cells containing flagella in 20 cells after the treatment

Q.2.C.1.((4points x 2)=8 points) Calculate the percentage of cells containing flagella in the pretreatment (A) and posttreatment (B) samples.

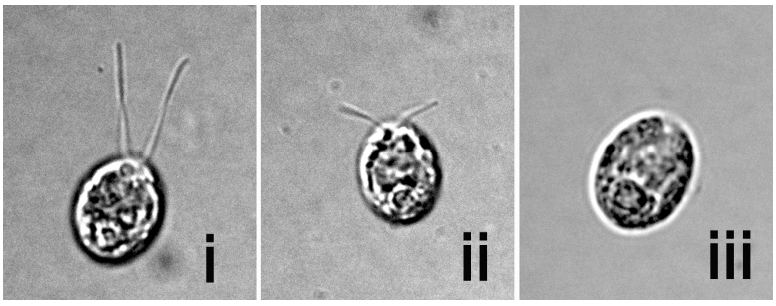
Part D

Wild-type cells with their flagella removed were incubated under different conditions (i, ii or iii). The following graph indicates the flagella length relative to its original length at different time points.

(i) control (incubated without inhibitors) (●)
(ii) incubated with cycloheximide, an inhibitor of protein synthesis (■)
(iii) incubated with colchicine, an inhibitor of microtubule formation (▲)



In addition, photographs of cells after incubation for 120 min are shown.



Q.2.D.1.(4 points) Are the following statements supported by observing the results of cells incubated with cycloheximide? Put a cross mark (x) in the appropriate boxes in the answer sheet.

1. All proteins incorporated in regenerated flagella are synthesized *de novo*
2. Regenerated flagella show no motility because of a lack of dynein
3. *De novo* synthesis of protein is essential for the complete regeneration of flagella.
4. *De novo* synthesis of protein is essential for the formation of the basal body of flagella

Q.2.D.2.(2 points) Based on your observations of cells incubated with colchicines, what is required for the regeneration of flagella?

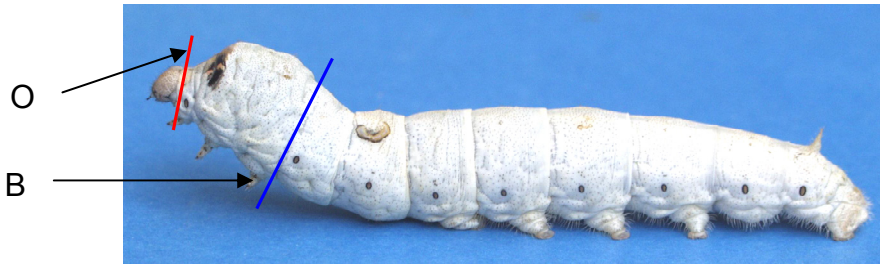
A Polymerization of tubulin
B Polymerization of actin
C Polymerization of keratin
D Depolymerization of tubulin
E Depolymerization of actin
F Depolymerization of keratin

**********END OF PRACTICAL TEST 4**********

Answer Key to the Experimental Tests

1. Animal and Plant Anatomy (100 points, 90 minutes)

Q.1.1. (1 point x 2 = 2 points)



(In the above figure, “B” and “O” were notes for black-and-white print, showing blue and orange, respectively)

Q.1.2. (3 points) 6

Q.1.3. (3 points) 9

* The answer "8" is scored as one point: the spiracles in the first thoracic segment is apt not to be noticed, because the first thoracic spiracles are unique in the insects.

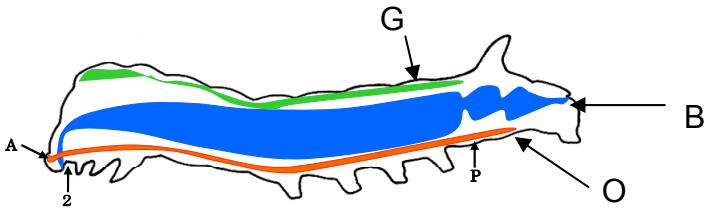
Q.1.4. (6 points +[name: 2 points + function: 2 point] ×3 points= 18 points)
Photograph of specimen (6 points)

* The students skillfully made a dissection exactly as shown in the photo prepared are given full marks. Even if the dissection is not so skillful, the dissection, which may be good enough for the students themselves to distinguish and identify the tubular structures concerned, is given 4 points. The dissection without sufficient quality is only given 3 points.

	name	Function
A	3	g
B	7	d
C	5	c

Q.1.5. (2 points × 3 = 6 points), Q.1.7. (4 points × 3 = 12 points)

* Q.1.5.: The students have to answer the questions, based on their own direct observations on the dissected and non-anesthetized caterpillars. As for the circulatory system, the students could observe only the heart beating in the dorsum of the abdomen, and this has to be clearly shown in the drawings: the other information is not evaluated. As for the central nervous system, the following points are important: 1) the crossing with the gut around the oesophagus, 2) the brain in the head, and 3) ventral localization. As for the digestive system, the anterior and posterior ends have to be clearly shown. For each structure, the answers missing only one of key points mentioned-above are given 1 point.
* Q.1.7. The anteriomost and the anterior-second gangia are clearly shown in the head and just posterior to the point crossing with the gut, respectively. The posteriormost ganglion shoud be shown in the seventh abdominal segment; the other answer is given 2 points, so far as it is shown in the range of the post abdomen.



(In the above figure, “B”, “G” and “O” were notes for black-and-white print, showing blue, green and orange, respectively)

Q.1.6. (4 points) 13

* The correct answer is "13", but the "12", "11" and "10 are respectively given 3, 2 and 1 points.

Q.1.8. (2 points) 2

Q.2.A.1. (3 point x 9 = 27 points)

Starch

seeds	Embryo	endosperm
I	±	+
II	±	N
III	±	++
IV	+	N

Protein

seeds	Embryo	endosperm
I	±	+
II	±	N
III	±	±
IV	+	N

Lipid

seeds	Embryo	endosperm
I	++	+
II	++	N
III	+	-
IV	+	N

I barley *Hordeum vulgare*
II sunflower *Helianthus annuus*
III buckwheat *Fagopyrum esculentum*
IV azuki bean *Vigna angularis*

Starch

seeds	correct combination of symbols		pattern of the correct answers
	embryo	endosperm	
I	-,±	+	<
	+	++	
II	± or +	N	± or +, N*
III	-, ±	+	<

	-,±,+	++	

* Partially point (1 point) are given to “-, N”, and “++, N” pairs.

Protein

seeds	correct combination of symbols		pattern of the correct answers
	embryo	endosperm	
I	-,±	+	<
	+	++	
II	+, ++, (+**)	N***	+, N*
III	±	±	=
	+	+	
	++	++	

* Two points are given to “+, N” pair.
** One point is given to “+” in II-embryo box.
*** One point is given to “N” in II-endosperm box.
No points are given when the both box of a seed are filled with “N”.

Lipid

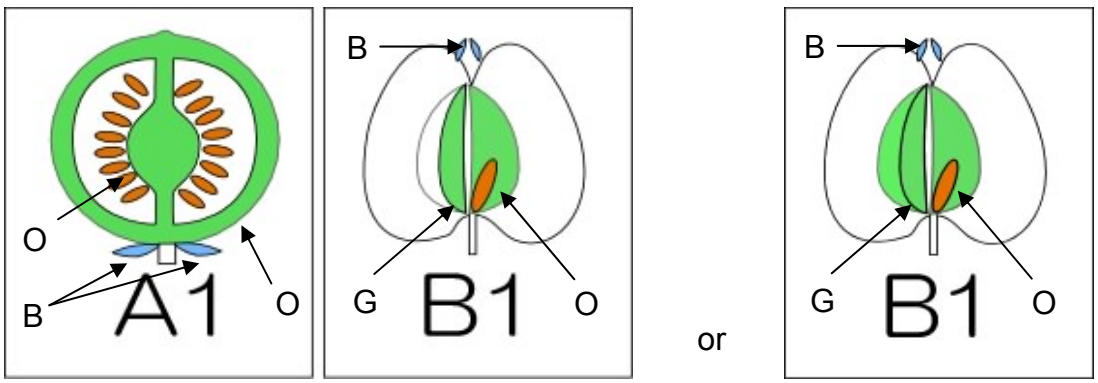
seeds	correct combination of symbols		pattern of the correct answers
	embryo	endosperm	
I	±	-	>
	+	±	
	++	+	
II	+	N**	+, N or ++,N*
	++	N**	
III	+	- , (+**)	+,- or ++,-
	++	-, (+**)	

* One point is given to “N” in II-endosperm box.
** Partially points (2 points) are given to “+, +” or “++, +” pairs.
No points are given when the both box of a seed are filled with “N”.

Q.2.B.1. (2 points x 2 = 4 points)

Fruit	Flower
A	I
B	II

Q.2.B.2. (1 point x 11 = 11 points)

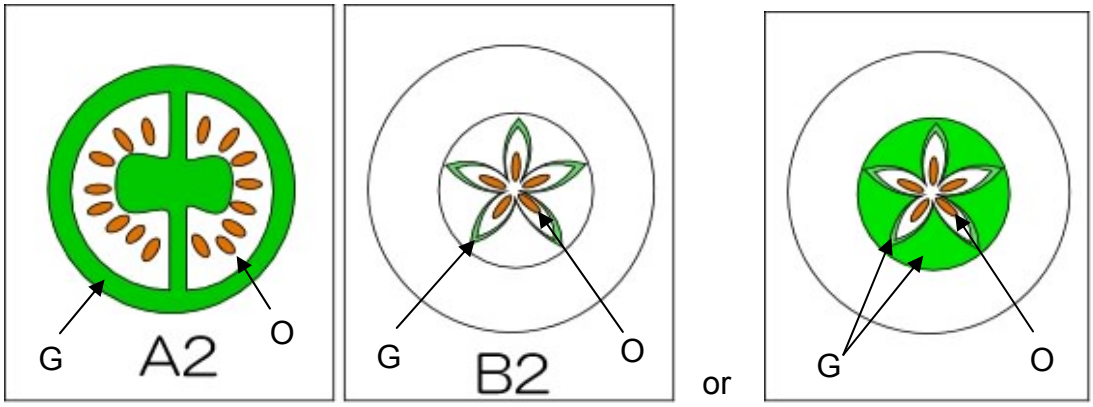


(In the above figure, “B”, “G” and “O” were notes for black-and-white print, showing blue, green and orange, respectively)

A1: 1. Sepals are drawn.
2. Sepals are painted in blue
The point is given when a student color the edible part of an apple in blue.
3. Ovules (or seeds) are drawn
4. Ovules (or seeds) are painted in orange
5. Carpels (and/or tissue derived from carpel) are painted in green

B1: 6. Sepals are drawn.
7. Sepals are painted in blue
8. Ovules (or seeds) are drawn
9. Ovules (or seeds) are painted in orange
10. A line indicating the border of carpels are drawn
11. Carpels (and/or tissue derived from carpel) are painted in green
(The answer shown below is also acceptable)

Q.2.B.3. (2 points x 4 = 8 points)



(In the above figure, “G” and “O” were notes for black-and-white print, showing green and orange, respectively)

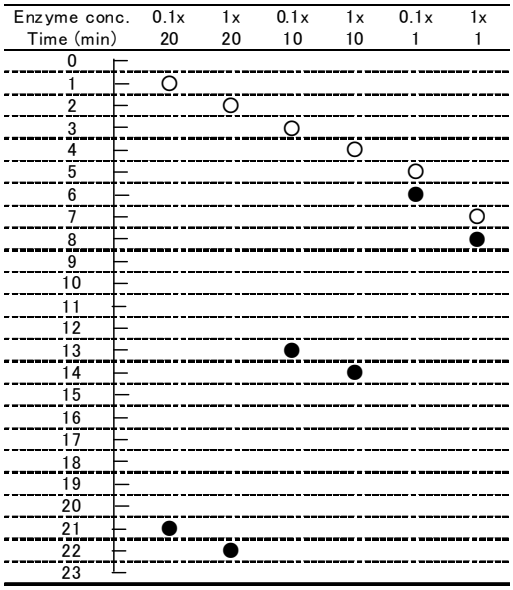
A2: 1. Two carpels are shown (there are three carpels in some fruits)
Carpels are shown (1 point), and painted in green (1 point).
2. Ovules (or seeds) are drawn
Ovules are shown (1 point), and painted in orange (1 point).
B2: 3. Five carpels are shown (there are more or less carpels depends on fruits)
(The answer shown below is also acceptable)
Carpels are shown (1 point), and painted in green (1 point).
4. Ovules (or seeds) are drawn
Ovules are shown (1 point), and painted in orange (1 point).

**********END OF PRACTICAL TEST 1**********

2. Biochemistry (100 points, 90 minutes)

Q.1.1. (10 points)

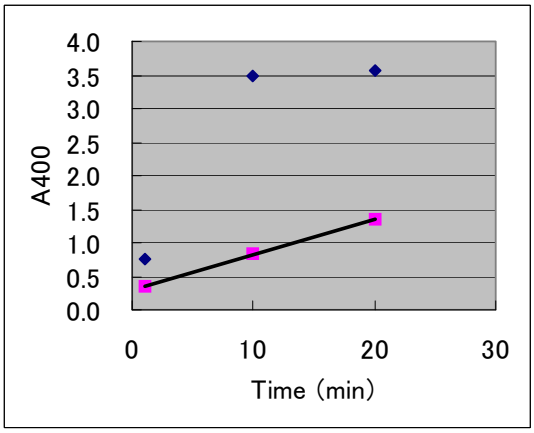
Taking a time course of enzymatic reactions is time-consuming if individual reactions are performed in series. Thus, this kind of time schedule is necessary to save time. The key points are that the 1-min reactions are done within the time of a 10-min reaction and the 10-min reactions are done within the time of a 20-min reaction.



Q.1.2. (15+10 points)

When new samples are tested for an enzymatic reaction, it is necessary to perform the reaction at different enzyme concentrations. In the case of Q.1.2., one cannot estimate the initial rate of the reaction from the data of 1x enzyme; one cannot linearly link the 1-min point and the 10-min point, because the 20-min point is not on the line projected from the 1-min and 10-min points. The saturation of absorbance observed with 1x enzyme is due to inability of spectrophotometers towards too much concentrated samples. The reaction with 0.1x enzyme proceeded linearly within the time range, and the initial rate of the reaction is calculated from these data. In this case, time is the independent variable, which must be plotted on the X-axis, while absorbance is dependent variable, which must be plotted on the Y-axis. Principally, both axes should be labeled with unit, but absorbance is an absolute number having no units.

Time (*min*)	Enzyme concentration	
	1x	0.1x
1	0.766	0.338
10	3.491	0.825
20	3.578	1.342



Q.1.3. (15 points)

Linearity : 1x (0.1x)

Slope = (1.342 - 0.338)/(20 - 1)=0.053 min^{-1}

The slope is calculated from the data point as described in the above box or directly read

from the graph.

Q.1.4.(5 points)

ΔA = Ans (Q.1.3.) x (1/0.24) x 10 = 0.053 x 4.17 x 10 =2.2 ml^{-1} min^{-1}

The slope obtained with 0.24 ml of 0.1x enzyme is proportionally converted to what would be obtained with 1 ml of 1x enzyme solution.

Q.1.5. (5 points)

$\Delta C = \Delta A/\varepsilon L$ = Ans(Q.1.4.)/ε = 2.2/19000 = 1.2 x 10^{-4} M min^{-1} ml^{-1}

The rate obtained as the absorbance change per min per ml of 1x enzyme is converted to a concentration change by using the absorption coefficient of pNP, 19000 M^{-1} cm^{-1}. Note that L is 1 cm, as described in the box in the Question paper.

Q.1.6. (5 points)

ΔN = ΔC x 0.0012 (L) = Ans(Q.1.5.) x 0.0012 = 1.4 x 10^{-7} (mol min-1 ml-1)

Mol number is calculated by multiplying the concentration change by the volume of mixture that was subjected to the measurement of absorbance, that is 1.2 ml. Remember that M (molar) is mol/liter, and the unit of the volume must be liter, not milliliter.

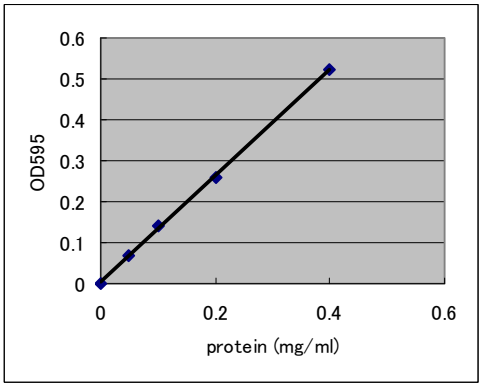
Q.1.7. (5 points)

Total activity = Ans(Q.1.6.) x 4 = 5.6 x10^{-7} (mol min^{-1})

Total activity is calculated by multiplying the activity per ml of 1x enzyme solution by the volume of 1x enzyme solution.

Q.2.1. (10 points)

Optical density is the 'absorbance' of suspension, and can be treated like absorbance in Task 2*. Protein concentration is the independent variable, which must be plotted on the X-axis, while optical density is the dependent variable, which must be plotted on the Y-axis. Both axes should be labeled with unit, but optical density is an absolute number having no units like absorbance.



*Absorbance is a term for solutions, but cannot be used for suspensions. In the Bradford method, mixing of soluble proteins with the Bradford dye yields insoluble materials that absorb 595-nm light and are precipitated by low speed centrifugation.

Q.2.2. (10 points)

Concentration of 0.1x enzyme solution = 0.135 mg ml^{-1} Concentration of 1x enzyme solution = -1.35 mg ml^{-1}

The plot of 5 point gives a straight line. The intersection of the straight line and an OD=0.18 line shows that the concentration of 0.1x enzyme is 0.135 mg ml^{-1}. The concentration of 1x enzyme solution can be obtained by multiplying the concentration of 0.1x enzyme by 10.

Q.2.3. (10 points)

Specific activity= Ans(Q.1.6.)/Ans(Q.2.2.)
$=1.4 \times 10^{-7}$ (mol min^{-1}) (1.35 mg protein) $^{-1}$
$=1.0 \times 10^{-7}$ (mol min^{-1} mg^{-1}protein)

Specific activity is the activity per unit weight (mg) of protein. The 1x enzyme solution has the activity of 1.4×10^{-1} (mol min^{-1} ml^{-1}) and the protein concentration of 1.35 mg ml^{-1}. Thus, the specific activity is calculated by dividing the former by the latter.

**********END OF PRACTICAL TEST 2**********

3. Genetics (98 points, 90 minutes)

Q.1.1. (3 points x 3 = 9 points)

(2)	C
(3)	B
(4)	I

Q.2.1. (8 points)

	red females	white females	red males	white males
(5a)	10	0	0	0
(5b)	0	0	10	0

No points if other numbers for “0” is written.

Q.2.2. (8 points)

	red females	white females	red males	white males
(6a)	10	0	0	0
(6b)	0	0	0	10

Four points for each complete row.
Two points if other numbers for “10” is written.
No points if other numbers for “0” is written.

Q.2.3. (2 points x 4 = 8 points)

	red females	white females	red males	white males
(7)	10	0	5	5

For “red females”, one point for the numbers 8, 9, 11 or 12.
For “white females”, only zero is acceptable and other numbers receive no point.
For “red males” and “white males, one point for 4 or 6.

Q.2.6. (3 points x 3 = 9 points)

(5a) and (5b)	A, C
(6a) and (6b)	D
(7)	E

For “(5a) and (5b)”, one point if only one answer is chosen.

Task 3 (18 points)

Criteria

1. At least one sample spot is confirmed on the sheet (4 points).

2. Solvent front is moved as specified (~3 cm) (4 points).
3. Pigments are migrated in near straight line (4 points).
4. At least two pigment spots are separated (6 points).

Q.4.1. (5 points)

Spot No.	Pigment (A-G)	WT	*w*	*se*	*bw*	*cn*
1	E	+	-	+	-	+
2	B	+	-	+	-	+
3	A	+	-	+	-	+
4	D	+	-	++	-	+
5	F	+	-	+	-	+
6	G	+	-	+	-	+
7	C	+	-	-	-	+

One point for each column with correct answers for all

Q.4.2. (3 points x 3 = 9 points)

se	D
bw	B
cn	A

Photograph of the gel (18 points)

Criteria
1. Loading of the molecular weight marker and two samples (3 x 3 points).
2. Separation of the molecular weight marker with several bands visible (3 points).
3. BPB dye bands are well migrated for the two samples (2 x 3 points).

Q.5.1. (3 points)

M1	M2	M3
A	C	B

3 points only when all answers are correct. No partial points.

Q.5.2. (3 points)

M1	M2	M3
C	B	A

3 points only when all answers are correct. No partial points.

**********END OF PRACTICAL TEST 3**********

4. Cell Physiology (91 points, 90 minutes)

Q.1.A.1. (4 (2 x 2) points)

1	b
2	a

Q.1.A.2. (6 points)

e.g. 4.8×10^6 cells/ml

1. Actual length of cell is $4.79 \pm 0.60 \times 10^6$ cells /ml. This value is determined in two

independent experiments by 10 graduate students.
2. Full point is given for 2.4 x 10^6 x 9.6 x 10^6 cells /ml.
3. 3 point is given for answer between 1 x 10^6 x 9.9 x 10^6 cells /ml except range prescribed in 2.
4. 1 point is given for answer between 1 x 10^5 x 9.9 x 10^7 cells /ml except range prescribed in 2 and 3.

Q.1.A.3. (5 points)

Total cells counted e.g. 120	19 %

1. Actual percentage of cells undergoing cytokinesis is 19.4 ± 5.1%. This value is determined in two independent experiments by 10 graduate students.
2. To fill in a number more than 100 is required for the mark. In the case of under 100 or no entry, 2 points are subtracted.
3. Points are given as follows,
   For 5 points, 0.1-38%*
   3 points, 39-50%
   · Minimum value 0.1% is provided. Because, students who are not familiar with adjustment of iris in microscope may underestimate a percentage of cells undergoing cytokinesis because they tend to miss a cell containing thin septum. Under 0.1% may not be acceptable because students are unable to practically count more than 1,000 cells.
   · Maximal value for full marks is twice 19%.
   · 50% is a limit for marks because it has never occurred more than half of cells are undergoing cytokinesis in an asynchronous culture in wild-type of *S. pombe*.

Q.1.A.4. (4 points)

Formula	solution
e.g. 100% / 19% x 25 min	132 min

1. Formula or calculation process must be shown for fill marks.
2. Value found in Q.1.A.3 must be applied.
3. Miscalculation is subtracted 2 points.

Q.1.A.5. (3 points)

B (C, D, E are also possible*)

*More than half of cells in culture medium c are forming spores. But a few percentages of cells are conjugating or undergoing meiosis. Moreover, some dead cells are included there. Answer of B, C, D, or E with A is given 1 point because there is no cell vigorously growing.

Q.1.A.6. (8 (2 x 4) points)

a	b	c	d
I	II	IV	III

Q.1.B.1.(3 points)

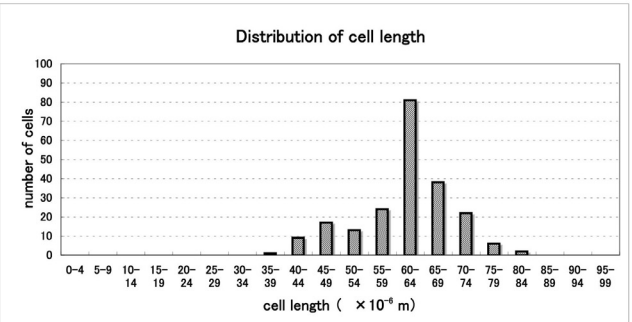
C	Plural choice is null.

Q.1.B.2.(4 points)

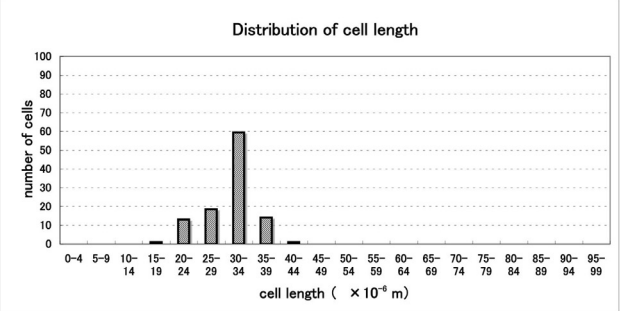
3.85 μm Two points are given for 3.7-4.0.

Q.1.B.3.(12 points)

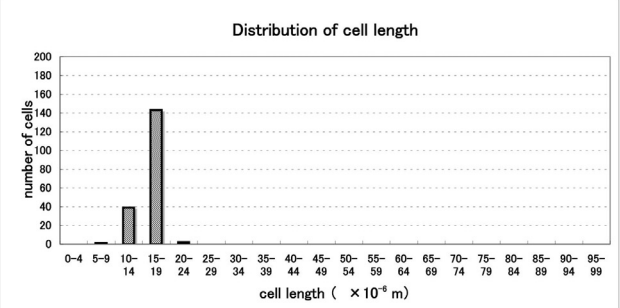
1. It is essential for full mark that students make a graph similar to one of above four. Top is a summarized result by 10 graduate students when they used objective lens (x40). Three lower graphs may be possible if x4, x10, or x20, are applied. Because, there is no description which objective lens should be used for experiment in the problem.
2. 3 points are subtracted if student does not fill the appropriate unit in the bottom bracket.



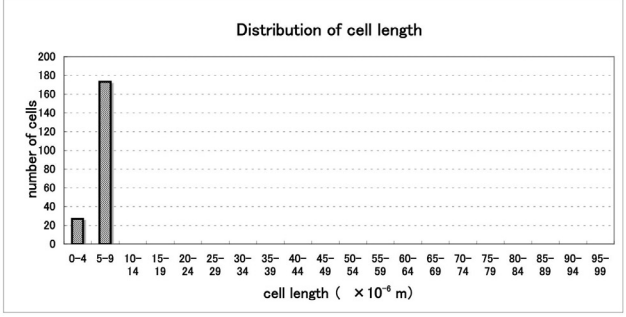
×40



(×20)



(×10)



(× 4)

Q.1.B.4.(2 points)

A Plural choice is null.

Q.1.C.1. (10 (2 x 5) points)

1	2	3	4	5
D	C	A	E	B

Q.2.A.1. (6 points)

D Plural choice is null.

Q.2.A.2. (2 points)

A Plural choice is null

Q.2.B.1. (6 points)

C Plural choice is null

Q.2.B.2. (2 points)

C and/or D

Q.2.C.1. (8 (4x2) points)

A	B
e.g. 95 %	0 %

1. In A 4 points are given for value more than 70% since almost all cells contain flagella. Value under 70% is subtracted 2 points because of miss probably caused by inadequate technique for observation.
2. In B 4 points are given for 0%. Because effect of acetic acid on removal of flagella is absolute in this experimental condition. Other value smaller than A is subtracted 2 points.

Q.2.D.1. (4 (1x4) points)

	Supported	Not-supported
1		x
2		x
3	x	
4		x

Q.2.D.2. (2 points)

A Plural choice is null

**********END OF PRACTICAL TEST 4**********

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3. Poster

Japanese version

English version

4. Daily News (Kawaraban)

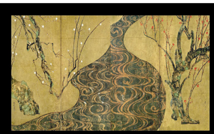
Welcome To Tsukuba

The 20th International Biology Olympiad (IBO2009) has now started with all of you gathered in this part of the world. Perhaps some of you have been to Japan before, but you have probably never been to Tsukuba. So, what is this city like? Tsukuba is known as an educational and scientific city with its many schools and top-level research centers. However, this was not so 50 years ago. Before a huge urban development project in 1963, the Tsukuba area was mainly farmland and paddy fields. The same scenery can still be seen around the university grounds, but of course there was no sign of the campus back then. The University of Tsukuba, formerly named Tokyo University of Education, was moved from Tokyo to its current location as part of the development project. What is perhaps more famous than Tsukuba itself is Mt. Tsukuba. Seen northeastwards from the campus grounds, this mountain is often paired with Mt. Fuji for its great beauty. There is an ancient phrase which says "Mt. Fuji of the West, and Mt. Tsukuba of the East". There is even a piece in the famous Japanese poem series, "Ogura Hyakunin Isshu", where Mt. Tsukuba is mentioned by a poet from the first century! Also the mountain's characteristic two-peaked form gave rise to the legend that this was the place where Japan's founding gods came. This is just a peek of what Tsukuba is all about. The city is a unique blend of many different ages and cultures. Please make yourself at home, relax, and add a little bit of your own color to the air during your stay. Last but not least, welcome to Tsukuba, and enjoy the 20th International Biology Olympiad!

Bio e-Café, a Pre-IBO2009 Event

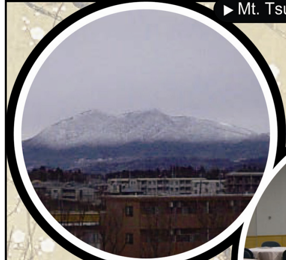
There have been some activities at the University of Tsukuba to introduce the International Biology Olympiad (IBO) to the younger generations. On June 6, 2009, a "Bio e-Café" event was held at the university, and 25 secondary school students attended. Two IBO medalists, Mr. Yu Uchiumi and Mr. Kentaro Honda lectured about the concept and schedule of the IBO, and about their own personal experience. Following this introduction, Bio e-Café student staff gave lectures on four biological topics, which made reference to IBO-related exam questions. The 25 students enjoyed observing microalgae, dissecting a clam, and asked the student staff a lot of questions. Although they only had a short time together, everyone who was there got on very well. The 25 students seemed to be very interested in biology and the IBO. I expect more students will come to know of and take part in the IBO, and enjoy studying biology.

▲ Sesondary school students are dissecting clams.



Background Picture:
Kohaku Bai-Zu
by Ogata Korin

This picture was drawn by Ogata Korin, who was a popular Japanese artist. A large, swirling river appears at the middle of this picture, and Japanese apricot trees are drawn at both sides of it. The tree on the right, which has red blossoms, is young and growing up. On the other hand, the one on the left has white blossoms and is old. Because Japanese apricots blossom at the beginning of spring, people love them as the flower which heralds the coming of spring.



▶ Mt. Tsukuba

Team Chinese Taipei

One of us has been to Japan about four times in the past, including once to the southern islands known as Okinawa. Through the IBO, it will be great if we can make some new friends.

Registration!!

Team Greece

Japan is an interesting country. It is very quiet and organized, as seen from the structure of Tsukuba International Congress Center. The Japanese writing like kanji, hiragana and katakana seem so neat. The IBO exam questions are different from the material we learn in Greece, so a high score might be difficult. But we will do our best.

Arrival

Dinner Time

Team Singapore

It feels a little cooler in Japan than in Singapore. We visited the National Museum yesterday, and it was very interesting. Many people from all over the world will be participating in the IBO, and it will be a great experience for sure.

Ninomiya House

Participants receive instruction

Kitchen!!

Team Slovenia

Orientation at Ninomiya House

After registration at the International Congress Center, participants moved to Ninomiya House, guided by the student volunteer team guides. Even though they had experienced long journeys, the participants were lively and the atmosphere was friendly.

They moved to the rooms they will stay in during IBO2009, and listened to explanations from the team guides. The explanations included how to use the facilities, and some other cautions about using the rooms. The team guides worked hard to overcome language and cultural barriers, to help all participants understand. The rooms were not so unusual for the competitors, and they seemed quite satisfied. One said that she would be able to spend a comfortable time at Ninomiya House.

After orientation, participants had free time until dinner. Students who arrived earlier could rest in their rooms, but some were walking around Ninomiya House, and some were even having conversations with other participants. That gave us, the journalist team, the impression that they are motivated to socialize, and were having fun meeting new people. The same sight was seen during dinner time. Two or more countries assembled at one table and ate dinner (by the way, it was curry and rice) in a light mood.

From today, the actual program of IBO2009 begins, and the competitors will be very busy. We hope that they refresh themselves at Ninomiya House and spend every day cheerfully!

Chairman of IBO Coordinators, Dr. Osamu Numata

To all participants and jury members, Welcome to Japan! Welcome to Tsukuba! The entire staff has worked as one, always dreaming of this day to come. Personally, I devoted myself to heaving up recognition of IBO—participating in events at Ueno Zoo, Osaka Aquarium Kaiyukan, and so on.

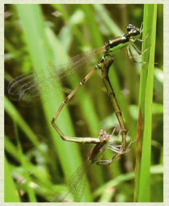
Every single person taking part in this big event will, with no doubt, gain something somewhat significant in their life. Now that the curtains are up, my advice is to enjoy it to the fullest, and to let your abilities be fully demonstrated. I wish you all the best of luck.

かわらばん Kawaraban

Volume 2
July 14th 2009
— The Daily News of IBO 2009 —

In the Lab

Discovering Nature Piece by Piece



"You have to be all-rounded", says Professor Mamoru Watanabe at the University of Tsukuba, as he talks about the difficulties of being an ecologist. To study the life cycles of animals and plants you need to have knowledge and techniques from the fields of statistics, genetics, biochemistry, physiology, and a lot more. A wide variety of tools are needed and, he remarks, "you need to get the most out of what you've got".

In this way Dr. Watanabe has sought to draw potential out of a broad range of interests. He has uncovered many exhilarating findings such as male damselflies that rake out the sperm of rival males from their mate, male swallowtail butterflies that charm their cherished female with attractive gifts, and how each of these unique lifestyles and morphologies have evolved. In studying some of these topics, his lab makes field trips with citizens from various social backgrounds. Subsequent discussion of the results they find together presents the participants with amazing views of life and the world.

Mortonagrion hirosei, an endangered species of damselfly, inhabits dense reed beds in estuaries, and its larvae grow in brackish water. The Watanabe lab leads a project in Mie prefecture to conserve them. In order to replace the original habitat (soon to be turned into a sewage treatment plant), reed rhizomes were densely planted in a larger adjacent site. The new, artificially-established habitat grew to become the same as the original and, simultaneously, the population of *M. hirosei* successfully increased. However, effective maintenance has become imperative since reed density began to fall after five years.

It may be impossible to achieve a perfect score when attempting to restore nature. However, through ecological research that one by one reveals the purpose and function of every living thing, we can carefully extract nature's clues. These can help us find some answers on how to live side by side with nature.

This is Japan

History of Nikko

The history of Nikko began in the eighth century when a priest built a temple there named Shihonryu-ji. This temple is now known as Rinno-ji temple. The famous Toshogu shrine was built in 1617 for the enshrinement of Japan's first *shogun* (master of the samurai), Tokugawa Ieyasu. In 1636, the third *shogun*, Tokugawa Iemitsu, rebuilt it as the more luxurious shrine that we know today. In 1999, 103 buildings of Toshogu shrine, Futarasan-jinja shrine, Rinno-ji temple, and the natural environment around them, were all registered as a World Heritage site—the "Shrines and Temples of Nikko."

There are many artistic works within Toshogu shrine. The "Nakiryu" painting, as well as the "Sanzaru" and "Nemurineko" wood sculptures are particularly famous. The "Nakiryu" ("Crying Dragon"), for example, is a big painting of a dragon on the ceiling in the Yakushi-do hall. If you clap your hands under the dragon's mouth, it sounds like the dragon is howling.

There are more interesting spots in Nikko which express the Japanese spirit. Please feel the Japanese spirit while you are in Nikko during the excursion, and tell your friends and family in your country about it.

Have a nice trip to Nikko.

Today's Quiz

Within the grounds of a temple in Nikko there is a famous woodcarving called "Nemurineko" or 'sleeping cat'. Immediately behind the cat are carvings of other creatures. What are they?

A. monkeys B. mice C. sparrows

(By the way, "Nemurineko" is small and not very obvious, so be careful not to miss it when you visit Nikko.)

Answer to yesterday's quiz : B
"*Gorilla gorilla*" is the scientific name for the Western Gorilla. It is divided into two sub-species, the Western Lowland Gorilla (*G. g. gorilla*) and the Cross River Gorilla (*G. g. diehli*).

Students' Community of IBO (SCIBO) Team-J
Contributors: Yui Miyachi, Kaoru Takeshita, Yuri Matsuoka, Nozomi Morita, Yumi Washizawa, Kumpei Ito, Saki Tsukada, Syu Shirato, Shinya Ueda, Ayako Kikuchi, Yusuke Kurumazaki, Naoko Shidehara, Takaaki Abe, Tomomi Sawada, Takuo Teramoto, Yuna Takatani, Takeshi Nakayama, Matthew Wood, Kenichiro Ishida
Acknowledgement: Timothy R. Lemon

"All of You Are Already Winners!"

The opening ceremony of IBO2009 was held at the main hall of the Tsukuba International Congress Center. The students entered the hall holding the flags of their countries.

Team Argentina entered first, followed by Team Armenia. Team Armenia is one of two countries which join IBO for the first time this year. The other is Team Sri Lanka.

Each team gave a cheerful greeting on the stage and some had their own very original way to present themselves. Team Greece announced loudly "ここに来られて、うれしいです", (*Kokoni korarete ureshii desu*) in Japanese, which means "I'm happy to be here". Team Liechtenstein received loud applause, perhaps because the 'team' was only one student in total, and Team New Zealand performed and shouted the *haka* dance of the Maori people.

Dr. Poonpipope Kasemsap, the Chair- person of IBO Coordinators, con- gratulated students for winning their national Olympiads and said "All of you are already winners!" He concluded that "all of you can win the most valuable prize ever—friends". He believes friends are important for students to improve their future chances.

The Oath by Student Representatives was read out by students from Team Japan. Later they said they had practiced for about two months, and the hardest part for them was the pronunciation of "solemnly".

After the ceremony, the teams had a chance to talk to each other in the hall. Compared to the first day, more teams were enjoying talking with their friends from other countries.

In fact, when a Jury member from Ireland asked Kawaraban to take photos of his team, for a moment he couldn't find his students because they were chatting so happily with other teams. According to Dr. Kasemsap, a member of Team Argentina declared that he would make 220 friends this week, which is the number of all the other IBO2009 competitors.

Not all teams had recovered from their trip, however. Team Switzerland looked slightly tired and they rested in their seats. One of them said he had jet lag.

Yesterday IBO2009 Tsukuba started officially and today the students will have their practical exam, which is one of the most important events of the week. To get a good score is not the only aim of the IBO, but it is certainly important. So, good luck everybody!!

Preparation Is Complete

After the welcome party, students visited the University of Tsukuba, where the practical and theoretical exams will be held. Everyone seemed to be enjoying themselves, chatting and looking around in excitement at unfamiliar things.

The participants were divided into three groups, and walked around the examination venues following their team guides. Although unaccustomed to speaking English, team guides explained in detail which classroom to go to, how to use the chairs, how to use Japanese toilets, and so on. *Otohime* was the center of curiosity—the fake toilet flushing sound (to disguise embarrassing bodily noise) exists only in few countries.

Throughout the laboratory tour, the participants seemed to be calm and relaxed as they chatted freely. Some students commented on the flags attached to the desks, saying that the flags will cheer them up and motivate them during the exam. There was one tense moment when a team member was separated from her team guide, but they were able to reunite smoothly. Their obvious relief when they found each other showed how close they have become in just one day.

Satisfied with the laboratory, the contestants left in high spirits. Everyone and everything is now prepared. Let the exams begin!

Today's Schedule

Students Schedule		Jury & Observers Schedule	
6:30 - 8:00	Breakfast	7:00 - 7:45	Breakfast
9:30 - 17:30	Practical Exams	7:45 - 19:45	Excursion (Nikko)
13:00 - 14:00	Lunch		Lunch
17:30 - 18:30	Dinner	20:00 - 21:00	Dinner
20:00 - 22:00	Origami Night		

Fine weather with evening shower

High	29℃
Low	21℃
Humidity	63%
Chance of rain	50%

Participants Enjoy Welcome Party!!

After the opening ceremony, the mood in the Tsukuba International Congress Center had become more relaxed and cheerful, and it was time for the Welcome Party. During the party, while everybody was enjoying a delicious lunch, Their Imperial Highnesses Prince and Princess Akishino talked briefly with participants around the floor. They encouraged the contestants to do their best in the competition.

To decide the menu for this party a national recipe contest was held among high school students. The name of the winning dish was *ibarakisaisai*. It is a kind of sushi using tomatoes, green peppers, and lotus roots. It was very popular among contestants, along with regular kinds of sushi. Some mentioned that it was difficult to use chopsticks, because they had rarely used them before, perhaps only for eating Chinese food.

It was obvious that many of the students are beginning to make friends with participants from other countries. As an indication of friendship, team members from Denmark, France, and Kyrgyzstan had a lot of fun exchanging their costume hats. Dressing up for the opening event had provided much entertainment, as well as a chance to see each other's traditional national dress.

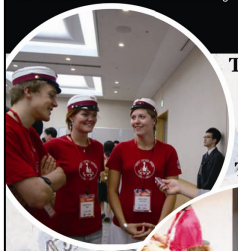
The Color of IBO

The participants had a lively air about them today, both physically and mentally. The special, characteristic outfits worn by many countries was not only visually colorful , but seemed to brighten up the contestants' spirits. Many wore traditional clothes from their home countries, like *osari* from Sri Lanka, and *dishdasha* and *abaya* from Kuwait. Others added accents to their coordinated styles by wearing colorfully patterned ties, like the UK and the USA, or unique shaped hats, like France and Mexico. Some participants had even dyed their hair in their nation's colors. Looking around the party hall, many cultures could be seen together. Apart from competing, this is what IBO is all about: meeting people from all over the world and making new friends!

▲ We made new friends!

"Kanagawaoki Namiura" by Katsushika Hokusai

This picture is an ukiyoe wood-block print named "Kanagawaoki Namiura" made by Katsushika Hokusai. *Ukiyoe* prints show scenes of everyday life in the Edo period (1603-1868). This is one of the famous works included in "Thirty-six Views of Mt. Fuji". It portrays waves off the coast of Kanagawa prefecture, with Mt. Fuji behind. It is said that Hokusai had great difficulty in sketching this picture because the waves were moving, and the curves needed to be described in fine detail. So this is a masterpiece that took him half a year.



Team Denmark

Team Thailand

Team India

Team New Zealand

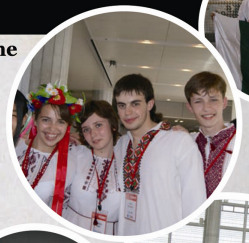
Ibarakisaisai

Their Imperial Highnesses Prince and Princess Akishino gave words to the winner of the recipe contest, Mana Ametaki.

Throwing hats
--- entertaining performance by Team France ▶

Team China

This IBO has the most participants so far --- 221 students from 56 countries and regions. How many have you met?



Team Ukraine

Team Pakistan ▶

Team Vietnam

Bushy hair!

Team Korea

Party time!

Jury session ▶

▲ Participants arrived for the orientation at University of Tsukuba.

Comments at the Cafeteria

The last event of the long day yesterday was dinner at the cafeteria of the University of Tsukuba. As a measure against swine flu, the participants disinfected their hands before entering, and they could chose whatever food they liked. After spending one or two days in Tsukuba, they seemed to be relaxed, and more conversations with other participants and volunteer staff were seen.

Here are some comments from students facing the first exam.

Team China:

Our aim is simple: Do our best and get the best score we possibly can. When checking the practical test room and the apparatus placed there, we could identify some of the instruments and recognize how to use them. So what we need to do is not panic, and just be our natural selves. We also like Japan's clean environment. So if time permitting, we want visit the city and go shopping.

Team Korea:

We are very motivated! We cannot guess what kind of questions will come up, but we are not so nervous about it. We have been working hard, so we think we can gain what we deserve. But we will try our best. We are also looking forward to talking with other participants after the exam so that we can exchange opinions and make new friends.

It was a Long Night for the Jury

As the practical exams are starting today, a jury session was held yesterday in the Tsukuba International Congress Center from 2 pm. The spacious hall had three large screens at the front of the room, and the jury members from the various countries from around the world seated themselves at their assigned tables, one by one.

There were two main tasks for the jury members in this session: one, to discuss and revise the exam questions and, secondly, to translate them for the students to solve. One jury member commented that these are absolutely necessary factors within IBO. Reaching a consensus amongst jury members is essential in order to ensure a fair contest, and appropriate translation is needed for the participants to demonstrate the best of their abilities.

Because of the difficulty and quantity of the questions, one jury member said it would take hours (perhaps until 5 am in the morning) to reach a conclusion. It was surely a long night for the jury, but their effort and enthusiasm is key to constructing the framework of IBO2009 and leading it to success.

かわらばん Kawaraban

Volume 3
July 15th 2009
— The Daily News of IBO 2009 —

In the Lab

The Great Potential of Genetics

Newton's law of motion established the basic concepts of physics. Mendeleev's periodic table allows us to classify the elements. Similarly, the discovery of the genome is one of the most important achievements in biological research. The genome has genetic instructions to construct all essential components in living organisms, and contains all the information used in development and functioning.

Associate Professor Kouji Nakamura at the University of Tsukuba is an expert researcher engaged in genome studies, and he is fascinated by his work. He uses a tiny single-cell bacterium, *Bacillus subtilis*, to research special RNAs that are not translated into proteins. Those RNAs are called "non-coding RNAs (ncRNAs)". They are considered to have significant roles in cells such as transient gene expression. Dr. Nakamura has identified the structure of several ncRNAs in *B. subtilis*, and now he is about to analyze their function in cells. He also seeks to discover a new mechanism of gene expression regulated by ncRNA, which has never been reported before.

Dr. Nakamura is also studying the expression of ncRNAs in another bacterium, *Clostridium perfrigens*. This bacterium produces poisonous substances under certain conditions, which can cause sickness in humans. A specific ncRNA is involved in this system, so inhibiting the function of the ncRNA may be a key for designing new drugs to control the toxicity of *C. perfrigens*.

Dr. Nakamura's message to all Olympiad participants is that learning and studying biology will help you widen your perspectives, and enlighten your views of life and the world. Broadening your interests will help you to deal with any circumstances. Remember "Be almighty!"

This is Japan

Bonsai, a Living Art

Bonsai is an art by which a larger natural landscape is expressed and suggested within a small flowerpot. The bonsai enthusiast plants a miniature tree in a pot, trims its branches, and ties it with wires to slowly and purposefully bend it into a shape imitating a larger tree in the wild. For added effect, a stone may be set with the tree as a rock feature. Art works, such as paintings, generally remain permanent creations, but bonsai are works that change throughout the four seasons and constantly delight the viewer in new ways. As living art, bonsai are never completed works. They may grow for over 100 years, nurtured by many generations of artist and caretaker.

You may be wondering why bonsai art developed in the first place. In the Edo era (1603–1868), ordinary city-dwellers only had small gardens, if any land at all. They could not plan large garden arrangements similar to English gardens, so instead they created bonsai miniatures. This way, they could still enjoy the magnificence of natural scenery, even in confined garden spaces.

Today's Quiz

Satori is the name of a mutant fruit fly and also the name of its mutant gene. The mutation was named *Satori* (meaning "enlightenment" in Japanese) because of the unusual behavioral characteristic it causes. What is that behavior?

A. Fasting
The fly believes food is not necessary.

B. No interest in females.
The male fly will not copulate with females.

C. Gathering in lines
The fly feels it is safe in a group.

Answer to yesterday's quiz: C
The carvings are an analogy for a peaceful time in human history. The cat is fast asleep and harmless, so the cheerful sparrows can fly around freely.

LOCAL LIFE Tsukuba

Tsukuba's Fukuro

Fukuro is the Japanese name for the Ural Owl of the species *Strix uralensis*. In Japan, the owl is known as 'the forest's philosopher' and recognized as a symbol of intelligence. This makes it an appropriate symbolic bird for Tsukuba city.

In Japanese, "*fu*" means "not" and "*kuro*" means "suffering". So together, the name means "free from suffering"—a very auspicious name! *Fukuro* owls belong at the top of the forest food chain and need to hunt large volumes of prey. As such, they make good indicators of forest biodiversity. Let's be smart like the *fukuro* and conserve their forests and environment.

Trembling with Nerves and Excitement

With a mixture of expectation and anxiety, the practical exams were finally held on the third day of IBO2009. The participants, in groups of different-colored lab jackets (white, blue, green and yellow) moved to the University of Tsukuba, guided by volunteer team guides.

On the way to the exam venue, contrasting expressions could be seen on the faces of the students. Some seemed to be terribly nervous, and some to be enjoying the moment of peace before the big battle by chatting with team members and new friends from other countries. As participants must take each exam individually, they looked a little uneasy when they were separated from their teammates.

The practical exams were divided into four sections; biochemistry, cell physiology, genetics, and animal and plant anatomy. Each exam took 90 minutes—six hours in total. The exams required knowledge which is taught from high school to university. However, there were sufficient explanations for questions requiring advanced knowledge or skills, which were thought to be above high school level. In clean, newly-renovated, laboratories with new instruments and supporting volunteer staff, everything had been prepared for competitors to exhibit their full abilities.

The four groups, with different-colored lab jackets, took the same exam at different times, so a tremendous amount of work was carried out behind the scenes to avoid the four groups encountering each other. Detailed meetings were held beforehand to coordinate routes within the limited number of corridors, and intense communication between staff members made everything run according to plan. Swiftly moving around large panels with "keep out" signs played a big roll in this. During the ten minutes between exams, strict checks of the rooms for signs of cheating had to be carried out, as well as simultaneously setting up the apparatus for the next group. Students were called into their exam rooms one by one, and volunteer team guides could be seen patting their backs and encouraging them. All of this was to make sure the exam was carried out fairly and smoothly.

Students entered the laboratories and took their seats, which they had seen during the laboratory tour the day before. The atmosphere in the exam rooms was tense, with hints of excitement here and there. Before the test began, participants earnestly checked the apparatus and handouts laid out on the benches to which their flags were attached. The spirit in their eyes seemed to suggest the brilliant results we can expect during this long, long fight.

Jury Early Birds Head to Nikko

The jury members were at an all-night meeting on Monday night, and then had to join an excursion leaving for Nikko very early the next morning. So, on the coach, only the lady tour guide had the energy to speak. Some of the jury probably didn't even have the energy to listen to her explanations.

First the coach party arrived at Lake Chuzenji (中禅寺湖). The early birds now seemed more awake and were strolling around freely. They were having a lot of fun taking photos of the lake and Mt. Nantai (男体山) behind. Obviously it is not only Japanese people who love to take lots of photos!

Next, the participants went to Kegon no taki (華厳の滝) one of the biggest and most beautiful waterfalls in Japan. But the jury from Belgium wasn't satisfied "It's a pity the waterfall isn't beer!" he joked.

Next was the famous World Heritage site known as Toshogu Shrine (東照宮) . Because it is a popular destination for school trips, many elementary school students were visiting at the same time. They treated one member of the jury as if he were a superstar. About ten of them excitedly took pictures with him, and happily shook his hand. Perhaps foreigners are still a very rare sight for them.

On the coach back to Tsukuba, some passengers were clearly exhausted. Some were asleep with their mouths wide open, which amused the others. So a few embarrassing photos were secretly taken!

Hopefully the jury was refreshed by the break after the all night meeting.

Mostly Sunny

The rainy season ended yesterday!

Today's Schedule

Students Schedule

6:30 - 8:00 Breakfast
8:30 - 17:30 Excursion
(Tsukuba Science Tour)
Lunch at museum
18:00 - 19:00 Dinner

Jury & Observers Schedule

7:30 - 8:00 Breakfast
8:30 → Jury Session
Lunch
18:30 - 20:00 Dinner

High 32°C
Low 23°C
Humidity 60%
Chance of rain 30%

Students' Community of IBO (SCIBO) Team-J
Contributors: Yui Miyachi, Kaoru Takeshita, Yuri Matsuoka, Nozomi Morita, Yumi Washizawa, Kumpei Ito, Saki Tsukada, Syu Shirato, Ayako Kikuchi, Yusuke Kurumazaki, Naoko Shidehara, Takaaki Abe, Takuo Teramoto, Tomomi Sawada, Yuna Takatani, Takeshi Nakayama, Matthew Wood, Kenichiro Ishida
Acknowledgement: Timothy R. Lemon

2009 Tsukuba Japan IBO THE 20th INTERNATIONAL BIOLOGY OLYMPIAD

One Down, One to Go

The exams, of course, are the main reason why everyone is at IBO2009, and the first one was held yesterday. Despite exam anxiety, the intense ten-hour session seems to have brought existing friendships closer, especially between members from different countries. Separating teammates into four groups was actually a splendid opportunity for all the nations to mix together.

The exam itself may be a lonely battle, but lunch was a time to gather and make new friends. Although all contestants were from different countries they were all in the same boat, and that common challenge united them. Some seemed very tense, even down to their stomachs. However, just being back in a classroom – a place familiar to all school students - let them unwind a little.

Afterwards, voices of relief were heard everywhere around the cafeteria. There was twice as much conversation as the day before and so much more to talk about.

Team Thailand: During the exam I was nervous and sweating, but maybe it was because the lab jacket was long-sleeved. It's comfortable to wear, but I've taken it off because I want to relax while eating.

Team Indonesia: I loved the exam! I enjoyed it because this is a special chance in my life. I'll take a good break during tomorrow's excursion. My teammate says he's lucky to get the white lab jacket, but I think my green one is the best. It's a pity not to have sushi or sashimi for dinner, but anyway, *itadakimasu*!

Origami Night: a Big Success

After the practical exams, a special event awaited participants at Ninomiya House – the Origami Night.

It was an independent event suggested by a student at the University of Tsukuba, Misaki Makino. She had enjoyed exchanging pin-badges at a previous event and was inspired to plan a similar event using origami – a symbol of Japanese culture and easy to learn.

Origami Night started with a quiz contest about origami folding methods, and moved on to an 'origami class'. The atmosphere was enthusiastic throughout. Participants' eyes were set on origami folding instructions and completed examples. For most participants, such as Mr. Edidiong Victor Udoyen from Team Nigeria, it was the first time to try. He enjoyed learning origami, and wished to take some back to show his family. Some were experienced at origami like Team Pakistan's Ms.Tayyaba Maqbool Malik. She learned origami on the Internet, and had been looking forward to Origami Night.

The participants were so fascinated that many remained until the room was locked up. They certainly enjoyed origami, along with the Japanese *tenugui* cloths, which were given away as prizes, and most of all, getting to know people from other countries. A chance like this is another prize of IBO2009.

Background Picture: Tokugawa Jugodai-ki by Oiso Honen

This is a print made in the Edo era by Oiso Honen, and shows a scene from a match of *sumo* wrestling. *Sumo* is the Japanese national sport. It was originally a religious event and held at shrines, but in the Edo era it became a kind of show business, which is similar to what we can see today.

A moment of peace

Having lunch with contestants from different countries. Most of them seemed to enjoy their sushi lunch.

lab jacket with message

Korean partacipant's lab coat carried messages from friends. This must be a good memory of IBO.

At the foot of Mt. Nantai

It was very clear on July 14, 2009. So the view from Lake Chuzenji was very nice. Mt. Nantai received us.

Team Turkmenistan

Relaxing over dinner after the exam.

Team Kyrgyzstan reunited

Relieved to be finished.

Sanzaru

They imitated "Sanzaru", which were carved on the building behind them.

Sight of origami night

Even though participants did a hard exam, all of them joined in.

Nejirihachimaki

Nejirihachimaki is Japanese festival style.

Team Ireland

Marching into battle!!

Features of the Science Tour

While in Tsukuba, all the IBO2009 participants will be taking a "science tour". Here are some of the centers they will visit. We wish you a great time.

1. JAXA (Japan Aerospace Exploration Agency)

As you pass through the main gate, you can see an actual H-II Launch Vehicle and feel the energy of this 50-meter long space-bound rocket. One exhibit, a full-scale model of the Japanese Experiment Module (known as KIBO), is part of the International Space Station project and was developed at JAXA.

2. Ibaraki Nature Museum

First, the mammoth, *Mammuthus sungari*, welcomes you to the museum. Then, from visitor you become an explorer, following your curiosity from the evolution of the universe to the wonder of life. There are many interesting exhibits at the museum, but especially recommended is the "Room of the Cell", where you can feel what it is like to be inside a cell.

3. AIST (National Institute of Advanced Industrial Science and Technology)

• Science Square Tsukuba: This museum is based on the concept "Come and feel the future". There are many wonderful displays such as the extraordinary "Humanoid Robot" - shaped like a human being – which can walk upright all by itself!

• Geological Museum: This Museum is one of the world's most unique facilities on the subject of geology. There are moving models to show the history of the earth and other technologies.

The 'Science Tour' has many surprises and excitements in store for you. Be sure to come back with your head full of new scientific discoveries and inspirations!

What is SCIBO?

Have you noticed that there are many the people wearing pink or orange T-shirts? They are the volunteers who are working devotedly to make IBO2009 much more enjoyable.

They belong to a group called SCIBO. SCIBO is formed entirely of students of the Department of Biology at the University of Tsukuba, and about 100 students are involved. SCIBO has been working since last year when the first Seibutsu Challenge (the selection for Team Japan) was held at the university.

It was a member of SCIBO, Ms. Michika Fukushi, who created this elegant name. She was thinking of a name for the student volunteer group, when she suddenly came up with an idea to combine "Science" and "IBO". The sound of SCIBO is similar to "*saibou*", meaning "cell" in Japanese, and since it also stands for Students' Community of IBO, SCIBO became the official name for the group.

SCIBO is composed of Team-G, the guides in pink T-shirts, Team-J, the journalists in orange T-shirts and Team-R, the radio broadcasting staff. Please don't forget that they are also participants of IBO2009.

かわらばん Kawaraban

Volume 4
July 16th 2009
— The Daily News of IBO 2009 —

In the Lab

Associate Professor Ryuichiro Machida – Seeking Truth through His Own Truth

Associate professor Ryuichiro Machida is an animal taxonomy lecturer at the University of Tsukuba. However, when not in Tsukuba, he is usually in the Sugadaira area of Nagano prefecture, Japan. He passionately conducts his research in one of the few laboratories located in mountainous area of Japan. The area also offers a rare observation site for different stages of forest succession.

Dr. Machida has been studying the relationships between Hexapoda, Chelicerata, Crustacea, and Myriapoda. Ultimately he is trying to reconstruct the arthropod taxonomical map. The unique point of his research is that he studies the topic by comparative embryology, an approach taken only by his lab. Why only his lab?

Many researchers have left the field of comparative embryology due to the difficulty of making section samples, and because of the exciting possibilities of genome analysis. Yet disappointingly, genome analysis has not been much help for Dr. Machida's research since it only reveals the separation of the insect group about 450 million years ago, and leaves species relationships hidden behind the "noise". Dr. Machida is not against the genomic approach, but he believes that revealing the insect "ground plan" is necessary in unveiling taxonomical relationships. For this, he believes researching homologous characteristics by comparative embryology is an effective method. His idea is often opposed for being too subjective but he points out that drawing conclusions with a personal view is unavoidable when it is based on an accumulation of personal experiences. We should not forget that the study of morphology was founded by Goethe, a historical philosopher.

Dr. Machida's theme is grand, and may not be recognized by all scientists, but he wishes to live through the field of comparative embryology with the "ground plan" as his lifelong theme. He believes that what is important is to be true to oneself and not to be dissuaded by others. This is very apparent in the passion he has for his field.

This is Japan

What's Your Choice?

Have you heard of "Doraemon" or "Sen to Chihiro no Kamikakushi" (Spirited Away)? These are popular titles within the world of *manga* (a Japanese form of comic strip) and *anime* (Japanese animated films).

Manga and *anime* have been highly acclaimed worldwide because their stories are often attractive to both children and adults alike. The tales may express, for example, thought-provoking views of nature, views of the world, science, or many other themes.

Everybody attending IBO2009 is very knowledgeable about biology. Now, and in the future, you will probably spend a lot of time talking to others about science or research findings. When you're doing that, don't forget there are many forms of expression to convey your ideas. You might explain them in a thesis, a book, newspaper, picture book or science café. Alternatively, you could also present them in *manga* or *anime* !

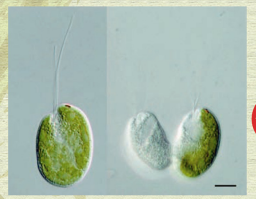
Today's Quiz

The staple food of the Japanese people is rice. Rice grains are harvested six months after planting seedlings. At harvest time, how many grains of rice do you think can be obtained from one seed planted?

A. 500 B. 1600 C. 3000

Answer to yesterday's quiz: B
When male fruit flies with the mutant gene '*satori*' are put together, they chase each other's tails to form a "chain" as seen in the picture in the yesterday's quiz.

NOVEL LIFE



An Evolutionary Chimera: *Hatena arenicola*

Hatena arenicola is an extraordinary single-celled organism recently discovered by a graduate student, Dr. Noriko Okamoto, and her supervisor, Dr. Isao Inouye at the University of Tsukuba. Living symbiotically inside of *H. arenicola* is a deformed photosynthetic eukaryote—a kind of green alga called *Nephroselmis* sp.

When *H. arenicola* divides, only one daughter cell inherits the alga while the other cell develops predatory organs and seeks to take in new alga.

Because of this amazing process, *H. arenicola* is thought to demonstrate a form of evolutionary link between animals and plants. As such, it may hold the key to helping us understand mysteries in the diversity of life we see today.

2009 Tsukuba Japan IBO
http://ibo2009.org/

Stepping Out into the Scientific City

For the students, it was a day to have fun yesterday. The excursion around Tsukuba's scientific facilities begun under a cheerful sunny sky, but it was a little too hot to spend the day comfortably. Many students were fanning themselves and some from northern regions were wearing sunglasses. It was the hottest day of IBO2009 so far.

The tour visited three facilities which Tsukuba city is proud of: Ibaraki Nature Museum, AIST, and JAXA. Visitors can explore nature from different points of view at Ibaraki Nature Museum, and be exposed to the latest research and technology at AIST Science Square and JAXA. Another facility of AIST, the Geological Museum, was the place to check out Japan's past and present geological characteristics.

Ibaraki Nature Museum seemed to be the most interesting place to visit for the students. From the time they entered the museum, their eyes fixed on the fossil of a mammoth at the entrance hall. They were intently taking pictures and looked disappointed when they had to leave there for orientation. After orientation, they looked around the seven usual exhibitions and one special exhibition, titled "Trace Fossils", where dinosaur footprints, fossils, and so-called 'living fossils' were displayed. These were perhaps the absolute favorites of many of the participants. Of course they are interested in anything to do with biology, but many were seen eagerly studying and taking photos of exhibits such as living horseshoe crabs and gigantic dinosaur footprints. They also made bookmarks using fallen leaves, which had been collected from all around Japan. They enjoyed choosing leaves and matching them to different colored base paper and strings, which clearly showed their individual sense. Some arranged leaves in the shape of faces, fish, flowers and so on, and many wrote messages, their names, or words such as "IBO2009". The members of Team Argentina even wrote "Japan" in Japanese lettering (*kanji*). Visiting the museum must have been a good break between the exams.

Everyone seemed to enjoy themselves, and their only disappointment was that they did not have enough time to look around as much as they wanted. For these future scientists, who are hungry for knowledge, it was not enough to satisfy their curiosity. It was, however, a good opportunity to nurture their passion.

The Jury Behind the Doors

After enjoying a full day in Nikko on Tuesday, starting yesterday morning, the jury members began to discuss the theoretical exam questions for today. They had shown their playful side only the day before but switched overnight to their more serious and professional personas to participate in this weighty jury meeting. Not only are the jury members biology specialists, but they also seem to be experts at putting on their game faces when they need to.

Behind the heavy doors of the Congress Centre meeting room, the brains and combined knowledge of the Jury was assembled. Thanks to their hard work and high motivation, a high-level competition, judged to be fair for all contestants, was eventually tailor-made.

To aid the discussion, biology textbooks from each country were set along the side of the room. They all varied in size, volume, language, and appearance. Now and then jury members picked them up for reference.

Like all the contestants, the jury members themselves are the finest in their field, officially selected to represent their country's biology education. Despite their tough schedule, all these dedicated experts applied their stamina and enthusiasm for their country's contestants.

IBO is an arena for future biologists to challenge each others abilities. At the same time, it is also a chance to benefit from the challenges thrown at them from today's biology experts. Everyone is looking forward to seeing what the challengers will be confronted with today, when the theoretical exam commences.

Today's Schedule

Students Schedule	Jury & Observers Schedule
6:30 - 8:00 Breakfast	7:00 - 8:00 Breakfast
9:30 - 16:00 Theoretical Exams	9:20 - 12:00 Excursion (Tsukuba Science Tour)
12:00 - 13:00 Lunch	12:00 - 13:00 Lunch
18:00 - 20:30 Tsukuba Night	13:00 - 16:00 Jury Session
	16:00 Bus
	18:00 - 20:30 Tsukuba Night
	20:30 Bus

Sunny Weather & Clothes

High	33℃
Low	23℃
Humidity	56%
Chance of rain	20%

Students' Community of IBO (SCIBO) Team-J
Contributors: Yui Miyachi, Kaoru Takeshita, Yuri Matsuoka, Nozomi Morita, Yumi Washizawa, Kumpei Ito, Saki Tsukada, Syu Shirato, Ayako Kikuchi, Yusuke Kurumazaki, Naoko Shidehara, Miho Shimizu, Takuo Teramoto, Tomomi Sawada, Yuna Takatani, Yuko Ikegami, Takeshi Nakayama, Matthew Wood, Kenichiro Ishida
Acknowledgement: Timothy R. Lemon

Get Ready for Tsukuba Night!

Tonight there will be an event called 'Tsukuba Night'. There'll be good food, chances to chat, great dance performances and much, much more. When you get there just forget about your exams and results and join in the fun!

Highlights of Tsukuba Night will be performances by Tokimeki Taiko-Juku drumming group and Kirikirimai dance group.

Tokimeki Taiko-Juku is a group that plays traditional Japanese instruments such as Japanese *wadaiko* drums. *Wadaiko* drums are an essential part of Japanese festivals—the deep sounds are so powerful. The group said, "For IBO we'll be able to put on our biggest show, so we're really fired up. We're aiming for a high-spirited performance that will reach right to your heart. Please look forward to it!"

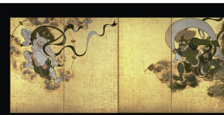
The second group is Kirikirimai which is organized by University of Tsukuba students, and they perform a dance called Yosakoi Soran. Actually, Yosakoi and Soran-bushi are individual traditional Japanese dances, from Kochi and Hokkaido respectively. However, the two dances have fused recently, and now it is performed and danced at festivals all over Japan. The dancers asked, "First, please watch our Yosakoi Soran performance and feel the excitement in the rhythm. After that, we want you to join in. During the dance, please remember to say the key word "*dokkoisho*" with us. We hope we can become one big dance group together."

Both these acts will show you the fullness of the Japanese spirit at its most lively. This will be a heart to heart way to learn about Japanese culture.

So, get ready for a great night!

Mini Episode at the Museum

There was a small encounter at Ibaraki Nature Museum during the Science Tour yesterday. Students of a nearby elementary school were also visiting the museum, and there were some occasions for the children and the participants of IBO2009 to meet in the corridors. The children showed great interest in people from other countries and were gazing at them. Some had the courage to speak to them, and were saying "hello, hello" to the participants. It was a heartwarming scene indeed, and it became more wonderful when some participants answered back "*konnichiwa*", the word "hello" in Japanese! This was another kind of precious communication which can be experienced at IBO.



Background Picture: Hujin Raijin Zu by Tawaraya Sotatsu

This glittering picture, "Hujin Raijin Zu", was drawn by Tawaraya Sotatsu at the beginning of the 17th Century and is his most famous masterpiece. The composition itself is especially noteworthy. The gods Hujin (on the right side) and Raijin (on the left side) are arranged at the furthest extremity of either end. The space in the middle, between the two gods, creates an ominous and tense atmosphere.

The Theoretical Exam Begins!

The practical exam was held on Tuesday, and today the IBO2009 competitors face their second trial—the theoretical exam. Let's hope they were able to regain some of their energy during the excursion.

This examination will be conducted from 9:30 to 16:00 - five hours excluding the 90-minute break for lunch. Competitors are required to apply their knowledge from a broad area of biology in order to solve the questions. In addition, speed and ability in arithmetic are prerequisites for any participant of IBO2009.

Since their pens, paper and knowledge are the only things they can rely on in a theoretical exam, some of them may find it harder than the practical exam which can be easier for those with good hand skills.

But after the exams, an exciting event named "Tsukuba Night" (つくばナイト) is waiting for them. This event will be in a traditional Japanese festival style and should be an unforgettable night for all. There is a Japanese proverb "*Yoku manabe yoku asobe*" (よく学べよく遊べ), which means "work while you work, play while you play". So we hope that, as this phrase suggests, competitors will avoid any later regrets by doing their very best both during the examination and while having fun!

Magnificient "G"

We introduced SCIBO (Students' Community of IBO) in the previous issue of Kawaraban. Today we'll tell you about the members of Team-G, who are very close to the IBO2009 competitors.

Participants must already know something about what Team-G is. Firstly, they wear pink T-shirts. The "G" in Team-G refers to "Guide" and that's exactly what they do. They guide and support the competitors in every way. They manage competitors' schedules, take care of their daily lives in an unfamiliar country, and even monitor their health. They are important staff supporting IBO2009 and its competitors.

Some members of Team-G helped with last year's Seibutsu Challenge (生物チャレンジ), which was held to select Team Japan for IBO2009. Others are new members who joined from this year.

Team-G is united by a common feeling—as team guides they all feel connected to the members of their team. When their team is happy, they also feel happy. When their team has a problem, it is their problem too.

With frequent meetings, Team-G is in constant contact with each other, and always ready to solve any situation immediately, whenever a student has trouble.

Team-G has been making a great effort behind the scenes of IBO2009 and the event would not have been possible without them.

かわらばん Kawaraban

Volume 5
July 17th 2009
— The Daily News of IBO 2009 —

In the Lab

Science Communication – Dr. Jennifer Manyweathers at the University of Tsukuba

I teach science communication in the biology department at the University of Tsukuba. I am a vet by training and it was while working in Australia that I discovered the importance of science communication for the progress of science and research. Without good communication, scientific knowledge and research has no real meaning.

So what is science communication? It is about being able to explain science ideas and research to any audience, whether they are children or adults, whether they have existing science knowledge or none at all. Even people who have no science training can think about science and may have some good ideas for the progression of research.

Also, science is all around us and it is important for everyone to think about how science can help them live a better life and to ask questions about the things they see around them.

I hope that all of you who go on to careers in science research and teaching will understand the importance and excitement of science communication.

This is Japan

The Use of Japanese Around the World

The Japanese language, as a mother tongue, is only spoken by the people living on the Japanese archipelago (population approx. 128 million). However, far less measurable is the influence of the words of the language. Why is it that some Japanese words are now spoken the world over? Examples include "mottainai", "kawaii", "sumo", "tsunami", "manga", "sushi", and "samurai". See the attached table for meanings if you don't already know.

"Mottainai" (勿体無い) can be translated into English to mean "wasteful". This is a useful translation but the original Japanese expresses a number of meanings. In fact, "mottainai" has four meanings, "reduce", "reuse", "recycle" and "respect". The Kenyan ecologist, Wangari Muta Maathai, who won the 2004 Nobel Peace Prize, turned "mottainai" into a popular catch-phrase which has since spread all over the world. She used this word precisely because it carries all these ecological meanings.

"Kawaii" (かわいい), now exported worldwide, is often used to express the characters of Japanese comic books or animated films. In these modern times it means "small", "a dear thing" or "a cute girl", all of which connote a lovely innocence. Yet, the original meaning of "kawaii" is "pity", or "poor." That is an interesting linguistic evolution!

The two examples above show us that Japanese is often a language of words with multiple meanings and a single wise word can be enough to explain something more complex. Maybe that is why some Japanese words have become popular around the world. Maybe many more will follow?

JAPANESE		MEANING
sumo	相撲	Japanese-style wrestling
tsunami	津波	a huge wave caused by an earthquake etc.
manga	漫画	Japanese comic books
sushi	寿司	a type of Japanese food
samurai	侍	ancient Japanese warrior
kawaii	かわいい	cute, pretty
moitainai	勿体無い	wasteful

LOCAL LIFE

Nikko

Stoneworts: Endangered Jewels of the Lake

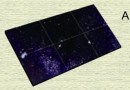
Do you know what stoneworts are? They are green, immobile and very beautiful plants. However, you don't usually see them in your daily life because they are hidden under water. Yes, they are a group of freshwater green algae. Their main axes (stems) have whorls of short lateral branches at intervals so they look like axles and wheels. This is why they are called *shaziku-mo* in Japanese (*shaziku* = axle; *mo* = algae).

The stoneworts are an important group within the evolution of plants as they are the closest relatives to land plants. They play an important role for the environment because they can help clear muddy lake water. They also supply safe and comfortable homes for many lake creatures. As such, they are a vital element within the lake environment.

Unfortunately, most species of stoneworts are now endangered. There is little opportunity to see them in Japan. In Nikko, however, there are two famous lakes—Lake Chuzenji and Lake Yuno—which are home to large communities of two such endangered stoneworts, *Nitella flexilis* and *Chara braunii*.

Today's Quiz

Living creatures have some amazing characteristics that we humans continue to learn from and apply to even our most complex technologies. For example, the folding mechanism of the solar panels on the International Space Station was modeled on a wing folding pattern of a certain creature. Which one provided the model?



A. the cicada pupa B. the peacock C. the cockroach

Answer to yesterday's quiz: B

One grain grows up to about 20 ears. One ear would fruit about 80 grains. So one seed of rice becomes 1600 grains. By the way rice is also called "*Hitotsubu manbai*" meaning many can be harvested from just one grain of rice.

Students' Community of IBO (SCIBO) Team-J

Contributors: Yui Miyachi, Kaoru Takeshita, Yuri Matsuoka, Nozomi Morita, Yumi Washizawa, Kumpei Ito, Saki Tsukada, Syu Shirato, Kana Murakami, Ayako Kikuchi, Yusuke Kurumazaki, Naoko Shidehara, Takaaki Abe, Takuo Teramoto, Tomomi Sawada, Yuna Takatani, Yuko Ikegami, Takeshi Nakayama, Matthew Wood, Kenichiro Ishida

Acknowledgement: Timothy R. Lemon

2009 Tsukuba Japan IBO

http://ibo2009.org/

Matsuri Time!

The exams were over, and it was time to celebrate! Tsukuba Night, a perfect *matsuri*, ("festival" or "celebration"), was readied for all to enjoy.

The stage was set within the university grounds right next to the exam venue. All those involved in IBO2009—the participants, jury, and team guides—as well as some local residents joined in for the fiesta. Following the first opening address by the Mayor of Tsukuba, Kenichi Ichihara, a speech was given by Yukio Hattori, a food coordinator who supervised the national recipe contest to decide the menu for IBO2009 events. He was followed by Dr. Nobuhiro Yamada, president of the University of Tsukuba, and Dr. Osamu Numata, chairman of the IBO2009 exective committee. With a toast from Dr. Numata, the music sounded and the party began.

But nothing can be started on an empty stomach, and everyone flowed into the cafeteria for food. Tonight, the second and third place dishes from the national recipe contest were served, as well as many Japanese dishes such as sushi. Aside from the welcome party, this was another occasion to try chopsticks and Japanese food, which many seemed to enjoy.

However, Tsukuba Night was not only for filling up on good food, but more for filling up on great memories. With the drum roll of Tokimeki Taiko-Juku, the show was underway. Many shapes and sizes of traditional Japanese drums (*wadaiko*) combined to create an exciting rhythmic adventure—the dancing drummers making it a spectacular performance not only to the ears, but for the eyes as well. Everyone came out of the cafeteria to watch the scene, and many gathered on the lawn in front of the stage to get a closer view. They were so drawn into the drumming that they needed to move back for the next performance, Yosakoi Soran—one of Japan's traditional dances. The dance was performed by a student group at the University of Tsukuba, Kirikirimai, and a local group called Tsukuba Yosakoi-ren.

Yosakoi Soran captivated the people present with energetic dances. When asked to stand and join in the dance, participants, jury, team guides, and others danced and enjoyed alike. Many came from the back rows to join the crowd in front of the stage. There were no barriers between them. Where they were from or why they were here didn't matter. All that mattered was to have fun at that moment. They were so excited that they happily danced Yosakoi Soran a second time.

Everyone's expressions were so bright during Tsukuba Night. It was especially true for the contestants, whose faces shone like never before. The pressure is off for the students, and in the special air of *matsuri*, it perhaps became one of the most memorable nights of IBO2009.

The Last Hurdle

Yesterday was the fifth day of IBO2009 and one of the main events, the theoretical exam, was held.

Several hours before the theoretical exam, the participants were in various states at Ninomiya House. Some were singing songs from their home country, as usual. Others were so nervous that they couldn't eat much breakfast. A few were a little panicked, forgetting some necessary items. It seemed a small commotion, but according to the team guides, the challengers were much more relaxed than they had been for the practical tests. However, there was no disputing that the participants were nervous, and many were studying their notes on their way to the exam venue.

The students had two tests in a single day, each taking more than two hours apiece. The questions were chosen from a wide variety of areas, with difficulty ranging up to biological concepts normally learned in first and second years of university.

This was the last hurdle for the participants to clear, and the team guides, who have come to form close bonds with the participants, have heard some of their honest thoughts. Reuniting with the jury members, after being completely separated from them since the beginning of IBO2009, is one of the things the participants are looking forward to most. Some of them commented that they could not wait to see the jury, and wanted to tell them how the tests have gone. The special event held last night, Tsukuba Night, was another event on the students' minds. They were certainly ready to have fun after all the hard work, and to fully enjoy all that awaited them. Hopefully the participants were able to unwind and feel satisfied with all their efforts.

Today's Schedule

Students Schedule

6:30 - 21:20 Excursion (Nikko)
21:20 - 22:00 Dinner

Jury & Observers Schedule

7:00 - 8:00 Breakfast
10:00 → Jury Session
12:00 - 13:00 Lunch
18:30 - 20:00 Dinner

High	23℃
Low	20℃
Humidity	80%
Chance of rain	60%

Dokkoisho!

The heat, the smell, the hustle, the shouts and screams of joy—it all feels like a vivid dream. Last night was a moment when all nations at IBO2009 became one.

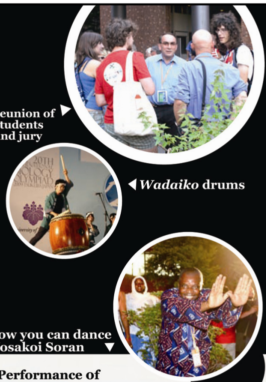
What a sound the *wadaiko* drums made! The stage performance at Tsukuba Night kicked off with the low rolling beats of *wadaiko* drums, performed by Tokimeki Taiko-juku. The audience felt the drums resonate with their pulse, and their excitement gradually built up.

The program then proceeded to the Yosakoi Soran 'fishermen' dance by Kirikirimai and Tsukuba Yosakoi-ren. As the inspirational *soran-bushi* song started playing, muscular dancers appeared on stage. The students in the front row were startled by the dancers as they rushed up face to face. The third performance, with the *shake* (Salmon) movement seemed to be the favourite of one of the performers, and some of them competed to see who could jump higher while they were explaining how to dance the "*Shake* Samba". The music started, and it was at that moment that the audience really switched on.

The excitement built up even more as they moved on to the Yosakoi Soran dance. At every call of '*Dokkoisho*!', the barriers between people were blown away. Students, staff, jury members, local high school students, and performers—all fused into one large wave, and together swayed back and forth to the music, their faces glowing with exultation.

Both the drummers and the dancers confidently said that this had been their best performance ever. "We feel so honored to represent the spirit of Japan like this. Everyone here is so psyched–I love these people!"

With the heat of the dance still hanging in the air, people reluctantly headed home to rest.



reunion of students and jury

Wadaiko drums

Now you can dance Yosakoi Soran

Enjoying a Moment of Freedom

Staying in an air-conditioned room may seem like a pleasant choice for many people, but it was no picnic for the jury members who were in the Congress Center checking, finalizing, and fine-tuning questions for the theoretical exam for hours on Wednesday. By yesterday morning they needed to get some fresh air. Since they had more meetings in the afternoon, time was limited and they were asked to choose between JAXA (Japan Aerospace Exploration Agency) and AIST (Advanced Industrial Science and Technology) for their brief outing. Under the dazzling sun, jury members got onto their allocated buses, with signs of fatigue showing from the long discussions.

The AIST group visited Science Square Tsukuba and the Geological museum. There was one particular exhibit in the Science Square that attracted the visiting jury members. A new device to measure the stiffness of arteries was invented by AIST, and visitors could experience the new technology themselves. The jury members, who have been working hard these past few days, seemed to be concerned about their "arterial health" and a lot of them tried the redesigned blood pressure meter.

On the other hand, the group that visited JAXA was fascinated by the science of space development, which is quite dissimilar to their own speciality. Everyone walked around studying the exhibits in their own way; having their photo taken with life-size cut-outs of astronauts, enthusiastically throwing questions at the JAXA guide, and so on. Their eyes sparkled with curiosity as if they had returned to their childhoods. Their spirit of inquiry must be one of the factors that keep them young!

"Sakana zukushi - carp"
by Utagawa Hiroshige

The artist, Utagawa Hiroshige, is famous for landscapes, but he also drew humans and other living things. This piece, drawing swimming carp, is from his work "Sakana zukushi". The carp is a favorable motif for Japanese people because of its behavior. Carp swim up rapid streams, symbolizing strength, courage, and patience-dispositions that Japanese are fond of.

dramatic performance by Kirikirimai

It's Japanese style *happi*

the rhythm of drums...

a minute away from the exam

Performance of Tokimeki Taiko-Juku

after the exam

Using chopsticks for the first time

We are young!!

jury in JAXA

Team Brazil

it begins soon...

Team Tajikistan

Dokkoisho!!

receiving question sheets nervously

Kamae!!

with Japanese children

you can be astronaut!

with Mr. Hattori

waiting and concentrating

in front of the rocket

love sweets!!

It's Over!!

There was a two-hour gap between the end of the exam and Tsukuba Night, and during that time, many smiling faces were seen. Students were chatting and relaxing happily while waiting for the jury members to arrive. An instant victory celebration place sprang up outside the exam venue, with many contestants squirting each other with bottles of water! Release from the enormous pressure of IBO allowed them to be high school students again. When the jury members came, both students and jury seemed to be very delighted to meet each other again. They were excitingly talking about the exams and other events during the days of separation. Some jury members looked much happier than the students—it must be an anxious thing to leave their students alone in a foreign country. But now they were reunited and ready to have fun at Tsukuba Night.

Comment from a member of Team Tajikistan

The theoretical exam was OK and there was enough time, but the second part, which had many calculations, was hard work. It made me so tired and so were the others, and we were very sleepy after lunch. My teammates and I already talked with our jury about the exams. The result of our practical exam was not like we hoped, but it was quite difficult because we had to use special technologies. There was not enough time, either. But today I did my best and now the whole exam is finished, so I will hope, rest, and wait for the result!

Comment from members of Team Brazil

Two of us were in the last IBO, and we felt that the questions were easier than that time. Also, there was plenty of time to take the exam. But if everyone felt it was easy, then there might be some difficulties finding differences between the results. We are looking forward to seeing our jury because we like them and we missed them after not seeing them for three days! When they come, we want to ask them how they are expecting our result. It was enjoyable to be in IBO2009.

Team Latvia

After the theoretical exam, participants' faces looked relieved.

Jury's Voice
Comments on IBO2009

While other jury members joined the excursion to science institutions in Tsukuba, the jury members of Team Nigeria enjoyed a little shopping instead. They went to the Ishimaru electronic shop just in front of the International Conference Center and bought an automatic dish washing machine and a foot massager as souvenirs. They seemed happy and said that these things are difficult to buy in their country.

According to them, the jury conferences are well planned and organized, so they don't have time to feel sleepy or bored. They also said "We feel proud because we are not only the representatives of Nigeria, but also of all of Africa since we are the only country which joined IBO from Africa."

Team Sri Lanka jury members hoped their students, who have never visited any overseas countries before, enjoy interacting with students from many other countries. They felt that just being able to participate in IBO is important for them.

A German jury member was enjoying a cup of coffee outside, just before a jury meeting started. He was tired because of the demanding IBO schedule. He mentioned that their government expects them to get a good result, such as several gold medals, but that the team doesn't feel so much pressure. He agreed with Dr. Kasemsap's words at the Opening Ceremony; that all students are already winners in their own countries. He said he wanted his team members to be creative by studying all subjects rather than just getting good scores on a specific exam.

It seems that jury members are hoping for intangible benefits for their students, rather than tangible results.

かわらばん Kawaraban

Volume 6
July 18th 2009
— The Daily News of IBO 2009 —

In the Lab

Unlocking the Mysteries of Development

Born on Sado Island, Professor Makoto Asashima grew up learning from, and being inspired by the nature surrounding him. Now he is one of the world's most honored developmental biologists, and continues to inspire the younger generation.

How do all the complex tissues and organs develop from a single cell? The immeasurable mystery of life motivated him to pursue the mechanism of egg development. Many biologists in the past had strived and failed to discover the substances inducing the creation of life, but the fact it was unresolved only drove his enthusiasm higher—even to lead projects in space to investigate the effect of gravity on developmental physiologies.

The mesoderm induction is the first induction event occurring between the morula stage and the blastocyst stage of embryo development. The Asashima team discovered and isolated the inducing factor, activin. Activin was then found to induce cells to differentiate into various kinds of tissues depending on its concentration. Furthermore, they found that activin induces a variety of homeotic gene expressions in undifferentiated cells. Their works have opened new windows in the field of developmental biology. This led them to successfully build several organs *in vitro*, such as pulsating hearts.

Dr. Asashima's team has also researched the interaction between signal transducers and gene expression in mesoderm induction. Recently, they have applied their results to mice and human stem cells to help reveal how our organs and body are created.

Dr. Asashima's mottos are distinct and strong—"Be passionate in your desires to research science, and possess a passion that transcends that passion. To reveal what is in front of you is the most important thing. If things do not go the way you expect, seek new ideas from your mistakes and value them."

This is Japan

Ninja

Ninja were secret agents who made their reputation during the years of Japan's civil war. Ninja groups were primarily hired by feudal lords (the *Daimyo*) and strategically positioned to protect the lord and his land against raiders. However, ninja also acted as spies and scouts, sneaking into enemy territory to find out their strengths and plans. They achieved this through stealth and disguise.

Ninja fought their enemies using unorthodox weapons such as *shuriken* (star-shaped blades for throwing) or chained sickles. Ninja could also hide underwater for long periods of time, scale impossibly high walls, or seem to vanish instantly. Part of their disguise was to live as farmers. This also enabled them to grow medicinal herbs which could also be used for making gunpowder. Ninja trained to keep their bodies strong, but also worked to improve their memory. Even in sleep they were on guard, never making a sound, and with their left side down to protect the heart. In short, their whole life was training.

LOCAL LIFE Tsukuba

Symbolic Tree of Tsukuba

The *keyaki* tree (Japanese Zelkova) is Tsukuba City's symbolic tree. Tsukuba is well known as a science city and hosts many research laboratories. This tree was chosen as a symbol, because it is tall, powerful, and has unlimited growth potential.

Keyaki is a deciduous broad-leaved tree. Several magnificent *keyaki* trees in Yamanashi prefecture are designated as national natural treasures. In Japan, *keyaki* wood is sometimes used for buildings, especially shrines and temples. Some streets at the University of Tsukuba are lined with *keyaki* trees. If you have time, try taking a walk underneath these magnificent trees.

Today's Quiz

This Galapagos giant tortoise (*Geochelone nigra porteri*) is the longest living land dwelling animal according to the Guinness Book of Records. How long did it live?

A. 150 years B. 175 years C. 300 years

Answer to yesterday's quiz: A

Insects need to unfold their wings efficiently when hatching from their pupa. This extraordinary mechanism has been attracting a lot of attention from engineers. Interestingly, this method is similar to a map-folding method called "Miura map folding", invented by Japanese scientist Koryo Miura, which allows easy and repeated unfolding and refolding.

Students' Community of IBO (SCIBO) Team-J
Contributors: Yui Miyachi, Kaoru Takeshita, Yuri Matsuoka, Nozomi Morita, Yumi Washizawa, Kumpei Ito, Saki Tsukada, Syu Shirato, Naoko Shidehara, Takaaki Abe, Takuo Teramoto, Tomomi Sawada, Yuna Takatani, Takato Honda, Yuko Ikegami, Takeshi Nakayama, Matthew Wood, Kenichiro Ishida
Acknowledgement: Timothy R. Lemon

2009 Tsukuba Japan IBO THE 20th INTERNATIONAL BIOLOGY OLYMPIAD
http://ibo2009.org/

Exams are Over, Enjoy the Sunshine

Both students and team guides were still shaking off their fatigue when they boarded the bus yesterday morning. It was the day to travel to Nikko, one of Japan's famous tourist sites.

One hundred fifty kilometers inland from Tsukuba, Nikko is located amidst green, woody mountains. The bus carrying the party had to climb some steep winding roads before reaching the day's destinations: Nikko Toshogu shrine, Senjogahara, Fish and Forest Bio-Park, and Nikko Yumoto Visitor Center.

Toshogu shrine is the only spot in all the scheduled excursions where traditional Japanese architecture could be seen. This place is special for having mixed characteristics of Shinto and Buddhism—the two major components of Japanese religion. Many were taking photos of the different buildings and symbolic structures, and some questioned the guides for further details. Students were taken on a brief tour around the shrine before taking some time to look around on their own. During this time, many climbed the 207 steps to the grave of the founding person of the Toshogu shrine, Tokugawa Ieyasu. It seemed a long and tiring way for most team guides, but many contestants quickly made their way up—curiosity seeming to win over the tiredness they must have been feeling.

The wetland called Senjogahara was another spot in this day's list of cultural and historical sites. It is described in a myth as the spot where Mt. Nantai transformed into snakes and Mt. Akagi transformed into centipedes to battle over the claim of Lake Chuzenji. Nothing could be said for sure about snakes and centipedes, but there sure were many birds and butterflies to be seen, and many students were closely observing those that came nearby.

Fish and Forest Bio-Park, and Nikko Yumoto Visitor Center were sites with biological themes. The Bio-Park was a cold water fish research center where contestants fed, or sometimes tried to catch, the fish raised in the ponds. The Visitor Center introduced common organisms seen in the Oku-Nikko area, with hands-on models and actual samples. Although the visit was short, it probably was fun for the contestants of IBO to be in contact with anything to do with biology.

It sure was a long day, and there were many things to see. A lot of students as well as team guides seemed quite tired out from the trip. However, being after the exams, it was a more relaxed mood than the previous excursion. Hopefully, everyone was able to enjoy the day, cheer up, and feel bright and refreshed for the last day of IBO2009. After all, the meaning of the name Nikko is "sunshine."

Jury Selects Medalists

The final jury conference of IBO2009 was held at the Tsukuba International Congress Center while students were at Nikko yesterday. The conference was to decide the medalists by combining the results of the practical exam and the theoretical exam. This was the most important task for the jury. To hand down an impartial judgment, a screen was installed behind the doors of the conference room, providing a much more confidential atmosphere than at previous meetings.

The meeting was positive and went smoothly. Most jury members had the impression that it was well organized. Despite the long discussions, they were not feeling tired and one of the Pakistani jury said, "We are mentally ready to have discussions", demonstrating their commitment to IBO.

IBO2009 was, however, not only a series of meetings for them. Jury members could frequently be seen communicating with each other during breaks. They also enjoyed other events such as Tsukuba Night, where they had lots of fun enjoying a nimble Japanese dance. They also exchanged presents and generally deepened their connections with each other.

Today, the results of IBO2009 will be announced at the Closing Ceremony. So while you are congratulating the winners, also give thanks to the jury members for their contribution.

Today's Schedule

Students Schedule

6:30 - 8:00	Breakfast
8:50 - 11:30	Excursion (Expo Center)
12:00 - 13:00	Lunch
14:00 - 15:30	Special Seminar
16:00 - 17:30	Closing Ceremony
18:30 - 21:00	Farewell Party
22:00 - 23:00	Dance Party

Jury & Observers Schedule

7:00 - 8:00	Breakfast
9:20 - 12:00	Excursion (Tsukuba Science Tour)
12:00 - 13:00	Lunch
14:00 - 15:30	Special Seminar
16:00 - 17:30	Closing Ceremony
18:30 - 21:00	Farewell Party
22:00 - 23:00	Dance Party

Cloudy & partly Rainy Weather & Clothes

High	35°C
Low	27°C
Humidity	88%
Chance of rain	20%

Three Points to Enjoy at Tsukuba Expo Center

Tsukuba Expo Center, with its towering full-scale H-II rocket, is easily found by visitors. The Center has exhibits on the development of space, marine, and nuclear technologies. Additionally, the Center operates one of the largest planetariums in the world.

Let's look at some of the most interesting exhibitions!

1. There is a lot of movie data on many deep-sea benthic feeders that were taken by the Shinkai 6500 submersible research vehicle. These intriguing marine organisms are not ordinarily seen, so these movies are popular with visitors.

2. The Biogeocenosis Simulation is a game for maintaining the balance of a biogeocenosis pyramid. You can control the size of each block with your own finger. If just one group dies out, it can mean that the whole biogeocenosis collapses and that's GAME OVER!

3. A special exhibition Mushitech (*mushi* (=insects) + technologies) is currently being held. Amazing technologies based on the special structure and ability of insects are on display.

A feature of this center is that visitors not only view the exhibits but can experience them first hand. There are many exhibits that demonstrate scientific mechanisms using your actual body. Thus, people of all ages can become more familiar with science while having a good time.

Jury's Comments After the Final Conference

The sound of applause could be heard from inside the tightly restricted conference room. Shortly after that, jury members emerged with large smiles on their faces. Some of them were even skipping. The conference had been concluded and the results of IBO2009 were finally fixed.

The jury members had some advice for competitors as they wait to hear their results.

• Making good friends can be as valuable as getting a gold medal, since good communication with people from many countries is important for scientific achievement. That's because, like the dance performances at Tsukuba Night, group work is essential for scientific achievement.

• Just forget about the competition now that it is over, and start working on what you are here on Earth to do.

• I hope students have been able to expand their points of view through the influence from other students, and that their experiences might help encourage basic science education in our country.

• Have fun! All students did a really good job. It was a very precious experience for them just to have visited Japan and known what it is like.

So as we await the announcement of the results for IBO2009, it is important to keep in mind that while a medal at IBO is an admirable achievement, medals are not the only things to be gained. As the jury and coordinators have often emphasized, making friends here is a precious experience, and it is this that will assist competitors with their futures.

Background picture: "Ujigawa no Senjin arasoi" by Soga Shohaku

This picture was painted by Soga Shohaku (1730–1781). In this picture, two samurai (Kajiwara Kagesue and Sasaki Takatsuna) are vying with each other to reach the enemy camp first. The man who reaches first shows his courage and determination for self-sacrifice to his boss. This action symbolizes the *bushi* spirit.

Neptis rivularis

Biologist Being Tourists for the Day

Released from stress and the expectations of many people, the student representatives were back to their normal teenage selves as they left on their excursion to Nikko.

The buses carrying student representatives and team guides made a rest stop on the way to Nikko. Although it was only a 15-minute break, the natural life around the rest area seemed to attract the students more than anything else. They carefully observed plants and flowers, caught a dragonfly in a plastic bag from the bus, and took pictures of a mother swallow feeding her chicks. Perhaps, this is the best way for biologists to get fresh air! Their role as "competitors" may have finished, but they cannot quit being biologists.

Student representatives and team guides, who themselves belong to the College of Biological Sciences at the University of Tsukuba, livened up when they observed mosses with loupes, and discussed the ages of ancient trees in the precincts of Toshogu shrine. It was a pity that none of the jury members and teachers were there—they would have enjoyed joining in those conversations.

A member from Kuwait who was greatly interested in Japan, mentioned that they have something very similar to the San-zaru (Three monkeys) in their country. Similarly, a Canadian student had learned about Japanese history at school, and mentioned the importance of actually seeing the Golden shrine buildings.

It is a mystery where they had such energy left, but a group of students were leaping over streams in the Fish and Forest Bio-Park. A Nigerian boy who had the longest legs amongst them "accidentally" dipped his left foot in the water. In the Bio-Park, a few romances were witnessed here and there, and rays of sunshine filtering through the branches fell on them.

The beautiful landscape of the mountains and lakes soothed the feeling of the students, who were getting fed up with the bus they had been traveling on for most of the excursion. An Australian student reached out of the windows to battle rock, paper, scissors with students in the bus parked next to them. They continued to battle even after the bus started to move, until they could not see each other.

While the team guides slept all the way back to Tsukuba, many students were tireless, chatting non-stop. In fact, the whole IBO group looked more like a school group out on a field trip.

Orange Deliverers

We have introduced Team-G, a magnificent group of SCIBO in a previous issue of Kawaraban. Today, we briefly write about us, Team-J, which is another part of SCIBO.

The "J" of Team-J stands for journalists. The Kawaraban (Daily News of IBO2009), you are reading just now, is a compilation by Team-J. This group consists of about 20 volunteer students and three organizers.

You can easily find people in orange T-shirts around—they are members of Team-J. We attend the events of IBO2009 along with you, the participants, to make the familiar Daily News. It is a great pleasure to listen to the voices and see the various faces of readers. A lot of encouraging voices and smiles become our motivation to work on publishing this newsletter. The members research, write and evaluate each article, and come up with the unique designs. Each member's ideas, along with your encouragement, support making the Daily News.

To deliver Kawaraban, we are working 24 hours a day, seven days a week. We want not only to deliver information of daily events' of IBO2009, but also to help preserve them as memories in your lives.

Catch me if you can ▾

Delivering Kawaraban

Looking Back on IBO2009

IBO2009 started on July 12 at Tsukuba City with the arrival of participants from 56 different countries and regions. The following day, the Opening Ceremony and the Welcome Party were held, with the presence of Their Imperial Highnesses Prince and Princess Akishino.

Although tired from the long journey, contestants were all able to recover and sit the exams, thanks to the dedicated work of staff and team guides. The jury sessions were well organized, without causing too much stress for the jury.

The excursions and Tsukuba Night were blessed with good weather, and provided opportunities for everyone to see a little of what Japan is really like. Many participants commented that they enjoyed Japanese culture and nature.

IBO2009 concluded on July 18 with another full day of activities and events. The results were announced and the medalists were congratulated. Participants exchanged presents and email addresses with friends they could only have made at IBO, and reluctantly made their farewells.

Looking back on IBO2009, one of the contestants summed it up best when she commented, "I'm very lucky to have been able to participate and to come to Japan".

from Japan...

to Korea

Welcome Address from the IBO 2010

As you may know, the 21st International Biology Olympiad will be held from July 11 to 18, 2010, in Changwon City, Korea.

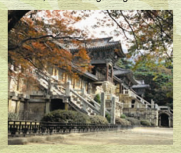
I know well the true meaning of the IBO, which makes biology-loving students of the world build international relationships through the fair competitions and cultural exchanges with their welcome friends and unknown colleagues.

IBO 2010 will be a more enjoyable festival than a competition. For all participants, cultural experiences on Korea, visits to the historic places and to the industrial complexes, and looking around the marshland to be protected for the mankind, which is an evidence of a healthy ecosystem will be provided.

The IBO 2010 Organizing Committee wholeheartedly invites all of you to the IBO 2010 in Korea.

Come and enjoy sparkling Korea!

Prof. Kil-Jae Lee, Ph.D.
Chairman, IBO 2010 Organizing Committee



◀Gyeongju Historical District

Answer to yesterday's quiz: B

On the topic of longevity, the oldest living organisms known are bristlecone pines (*Pinus longaeva*) at Inyo National Forest, California. The oldest of them have been alive for a little less than 5,000 years!!

Students' Community of IBO (SCIBO) Team-J

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http://ibo2009.org/

かわらばん Kawaraban

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And the Winners Are...

As students, jury, team guides, and others involved with IBO gathered at the Congress Center, the elegant movement of Japanese traditional dancers marked the beginning of the Closing Ceremony.

This was followed by speeches from Dr. Hiroo Imura (IBO2009 Organizing Committee Chairperson), Ms. Seiko Noda (Minister of Special Mission Related to Science and Technology Policy and Food Safety), Dr. Humio Isoda (Director of the Research Promotion Bureau at the Ministry of Education, Culture, Sports, Science, and Technology, Japan), Dr. Koichi Kitazawa (Chairperson of Japan Science and Technology Agency), and Dr. Poonpipope Kasemsap (Chairman of IBO Coordinators). Dr. Kasemsap stressed that IBO2009 has progressed unusually smoothly, despite so little time for preparation. He expressed appreciation to the organizers, and to the founders and chairman of IBO, and reminded the students about the importance of memories. All the speakers indicated that they expect the young scientists of IBO2009 will do well in their futures.

After the speeches, a short movie brought back memories of the past six days. Snapshots of special events, exams, and scenes of daily life filled the hall, sometimes prompting laughter. This was just a ten-minute trip through IBO2009, but it was densely packed, reminding everyone what a great event it has been.

Next was the most awaited part of the program—the award announcement and medal presentation. A total of 66 bronze medalists, 46 silver medalists, and 23 gold medalists were introduced one by one. Loud applause and cheers rose up to congratulate them as they were called onto the stage to receive their medals and certificates. Many were colorfully dressed in their traditional clothing. Some medal-winners responded with victory gestures. The loudest congratulations went to the gold medalists and the top three contestants: Wei Han Tan winning third place, Jonathan James Liang winning second place, and Yangzi Dong winning first place.

Amidst the excitement, Dr. Tom Soukup, Head of IBO Coordinators, praised the Japanese organizers for preparing this large event in such a short time. This was followed by the handing over of the IBO cup to the next host country, Korea. The Chairman of IBO2010 Organizing Committee, Dr. Kil-Jae Lee, expressed his strong enthusiasm to make the next IBO a successful and authentically Korean-flavored contest.

With the conclusion of the ceremony, the contestants flooded the stage to take photos, just as they did after the Opening Ceremony. However, the tone of voice, smiles, and tears were different from the scene six days ago. That difference is what they have earned and won at IBO2009.

Study the Past for the Future

Dr. Makoto Asashima gave a special seminar at the International Congress Center before the Closing Ceremony yesterday. By introducing the significant progress of science in human history, from past to present, he demonstrated the importance of studying the past and learning from it for the future. In particular he explained how it is necessary to persist with research over a long period, citing the example of Barbara McClintock who contributed to the discovery of transposons.

He then went on to give an outline of his own research using activin to induce cell differentiation. The audience seemed impressed when he showed a movie of a beating heart cell, and a picture of a frog in which he had induced extra heart tissue to grow.

In conclusion, he sent a message to future scientists to "learn from nature", and "challenge with passion". He added that nature is our teacher and cited the words of Dr. Louis Agassiz—"Study nature, not books". He also said "Don't chase fashionable studies". He believes that good scientists have "passion with persistence". He said persistent research will lead mankind to great achievement.

Today's Schedule

Students Schedule

7:00 - 8:00 Breakfast
6:30 - 13:00 Departure for Airport

Jury & Observers Schedule

7:00 - 8:00 Breakfast
6:30 - 13:00 Departure for Airport

Cloudy

High	31℃
Low	24℃
Humidity	84%
Chance of rain	24%

Till We Meet Again

It became the place for all participants of IBO2009 to share their joy and triumph!

After the Closing Ceremony, students, jury, team guides and guests moved to the entrance hall of Tsukuba International Congress Center to attend the Farewell Party. The results of IBO2009 had been announced in the Closing Ceremony and students seemed to be fully released from all the tension of the past six days. They enjoyed a buffet-style dinner with friendly smiles, talking with their teammates and new friends. Some medalists, however, were less interested in the party, and were excitedly chatting with their jury members in the Main Hall, where the Closing Ceremony had been held. Many cheerful photos were taken, and most of the medalists phoned or emailed their family and teachers about their results. Of course, some contestants did not received medals, but they were not resentful in any way, and congratulated the medalists from the bottom of their hearts. Like Dr. Kasemsap said at the Opening Ceremony, they won the most valuable prize—friends.

There were other people who celebrated the results with students and jury members. The team guides who had been with the contestants for six days also jumped with joy as the names of the medalists were announced. Some of them were almost in tears to see all the members of their team on the stage. Many were thanked by their students and jury as well, and asked to join in photos. They seemed satisfied to accomplish their missions, and enjoyed being able to relax with their friends again for the first time in a week.

With good food and great friends, the cheerful mood of the Farewell Party continued until it was time for the participants to take their joy and exhilaration to the Dance Party.

Dance! Dance! Dance!

Yet another event awaited the participants and student volunteers after the Farewell Party—this time it was the Dance Party!

Relaxed students wearing big smiles filled the conference room, which had hosted the jury sessions. The room had been dramatically transformed into a dance floor with colored lights mixing in the darkness, creating a fantastic mood. Students danced joyfully with the rhythm of the music, forgetting all their difficulties of the past few days. One medalist even laughed saying "What am I doing!?" All dancers enjoyed their rediscovered freedom.

Last night, students from different countries dancing together showed that there are no borders in dance, nor in biology. The place was filled with excitement, and paper cranes hanging from their necks fluttered in the air.

This is one of the most famous pictures of "Thirty-six Views of Mt. Fuji", made by Katsushika Hokusai. In this picture, a phenomenon known as "Red Fuji" is shown. In clear weather, Mt. Fuji sometimes changes to a red color for a few minutes while the sun rises. It's so rare that people who see it are said to have good luck.

Background picture: "Gaifu-Kaisei" by Katsushika Hokusai

Dr. Kasemsap

Oh Yeah!!!

Dr. Imura

Ms. Noda

No.2 Jonathan James Liang

Dance!

Dance in Line

NO.1 Yangzi Dong

with Ms.Japan

Deutschland

Wow!!!

The Colors Are the Same.

Congratulations Ryota!

Dr. Isoda

Dr. Kitazawa

sleepy...

Team Azerbaijan

Present from Team Japan

No.3 Wei Han Tan

Heroes & Heroines

•Gold Medal•23

Yangzi Dong
Jonathan James Liang
Wei Han Tan
Thomas Brereton
Siyang Hao
Ryota Otsuki
Joseph Edward Harvey
Yu-Chi Kuo
I-Chun Lee
Zhengda Li
Seungsoo Kim
Chenyu Zhang
Georgy A. Nosov
Chengxiang Yuan
Rong Huang
Jonathan Samuel Gootenberg
Woo Jin Jeon
Nantanuj Vutthikraivit
David Pai Huang
James Nicolas Woodmansey
Anugerah Erlaut
Arya Haj Mirzaian
Vidhi Hathi

•Silver Medal•46

VirapatKieuvongngam
Irfan Haris
Edwin Lindsay Pynegar
Fatemeh Kashani
Michael Mikat
Mel Chen
Dave Hartig
Anton Alexandrovich Kavaleuski
Jelle Zijlstra
Ruei-Je Chang
Atsuhito Nakayama
Geoffrey Vincent Hoggins
Soo Jin Kim
Jatuporn Wanichanont
Ayako Yanaka
Na Ye Choi
Alexey A. Agapov
Clinton Jia Wang
Jan Krieghoff
Mai Yamakawa
Qi Yan Ang
Inji Chang
Phun-Phai Somkearti
Khurshedi Davronzod
Sarah Gales
Mark Gimbutas
Chetan Srinath
Justas Lavisius
Ilia Kats
Andrei Yurjevich Sukhareuski
Julius Juodakis
Erik Olof Johannes Wannerberg
Po- Fan Wu
Nguyen Thi Thuy Trang
Arad Iranmehr
Tomasz Jakub Klaus
Linus Meier
Jan Smycka
Kristijan Jovanoski
Elizabeth Eva Jefferys
Tereza Nedvedova
Fatemeh Moghadas
Stefanie Tanner
Mircea Sofonea
Mireille Carrere
Usnish Adhikari

•Bronze Medal•68

Jana Faltynkova
Natallia Siarheeuna Bukhtarevich
Nina Turk
Enes Karabacak
Elbert Wijaya
Sebastian Vishnopolska
Milda Jakutaviciute
Martin Michel
Larisa A. Akulkina
Francis Samuel Duffy
Kotryna Vaidziulyte
Amit Gupta
Uku-Laur Tali
Claudia Simonett
Justus Mutanen
Sophia Louise Frentz
Delyan Tsvetanov Georgiev
Juris Kibilds
Lukasz Truszkowski
Marine Leve
Osman Aykan Kargin
Leonie Van Steijn
Geoffrey James Osgood
Daniel Patrocinio Zen
Alvaro Lafuente Romero
Vida Set
Mikko Johannes Tiusanen
Zigmunds Orlovskis
Philip Will
Le Thuy Duong
Alime Gokce Kocaarslan
Aaron Ramirez
Sameera Erandaka Ariyarathna
Max Biggs
Marcel Kuckelkorn
Mathis Funk
Mahym Mansoor
Fan Zhu
Lassi Ilmari Helanti
Sebastian Haelg
Dzmitry Sergeevich Kuzmin
Veronika Nogellova
Michal Piotr Banacki
Gianmarco Messa
Nguyen Thi Nhu Quynh
Roxanne Angelika Lau
Michele Candrina
Artem Komissarov
Hilola Hakimova
Lena Margareta Kallsten
Samuel Genzor
Rustam Esanov
Pier Luigi Susini
Jaakko Tapani Hyypia
Anastasiya Kravets'
Dehiwala Pathirannehelage Udari Tankana Samarasiri
Duong Thu Huong
Piers Martin Murphy
Lorenzo Pallini
Yahia Al-Jebari
Nejc Umek
Azam Kozizoda
Aaron Joseph Hakim
Tayyaba Maqbool Malik
Miguel Angel Ramos
Azad Alizada
Samuel Vandewaeter
Sukru Sogut

5. Photo Gallery

Arrival and registration (12th July)



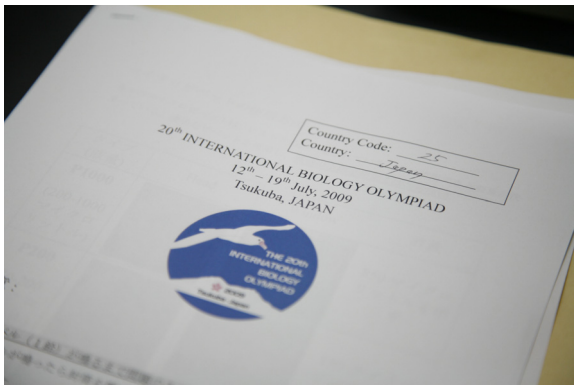



Opening ceremony (13th July)


Exam room visits (13th July)

Jury meeting (13th, 15th, 16th and 17th July)

Tests (14th and 16th July)



Origami Night and Tsukuba Night (14th and 16th July)

Excursion (14th, 16th and 18th July for jury, 15th, 17th and 18th for students)


見えない光でものを見る
MAKING IT VISIBLE WITH "INVISIBLES"

Closing ceremony (18th July)

Departure (19th July)