Report on the 14th International Biology Olympiad

8-16 July, 2003

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Salutatory word of the

President of Republic of Belarus
A.G.Lukashenko

Dear participant of Olympiad, honorable guests!

I am very happy to welcome all of you, who won the right to participate in the 14th International biology Olympiad and to thank the International coordination committee for the decision to carry out this prestigious forum in Republic of Belarus.

We are very pleased to recognize, that organization of International biology Olympiad in Minsk indicates on recognition of success of Byelorussian schoolboys at the previous Olympiads.

What may be more beautiful than the want of knowledge and willing to more complete capture of intellectual conquests of mankind!

The competition of the brains is always the engine of the human, cultural and economical development and progress.

This International forum is the most important event for further development of biological education in schools in Belarus and all over the world.

Dear young friends, you come together here in Minsk to compete using your knowledge with other fellow. You choose for yourself one of the most intriguing fields of knowledge since biology now brings us constantly new, fantastic discoveries on the miracles of life on our planet Earth.

It is not necessary for me to tell you, the experts in this field, how important today cognition in biology and relative disciplines, to understand the effect of human activities on environment and to undertake some steps for protection of nature.

Biology is one of the most important scientific fields of XXI century. It is the basis for the development of pharmacology and medicine, agriculture and protection of environment, as well as for other fields that are using the discoveries in biotechnology.

Nobel prize winner in physics Pascal de Genen, according to his own confession, who discovered for himself biology to late, noticed:

«Biology is the only concrete science and everyone can get benefits from studies of the basis in this field. Biology develops our abilities to observe, compare and make experiments».

Dear boys and girls!

You are representing your countries at the 14th International biology Olympiad and therefore you are belonging to the best.

Olympiad, first of all, is competition, and everyone wants to be successful or even to become a winner. The victory is important, however not less important is the other old Olympic principle: «The main is not a victory, but participation». You have a unique chance to feel in the full extent of one's power the «luxury of human communication», the possibility to find new friends among representatives of different countries, to tie new friendship contacts, which will help you to build peaceful and deserving of Human future on our planet. Don't miss this chance.

You applied a lot of efforts to become the participants of this Olympiad, and we are hope that this Olympiad exonerate your expectations and everyone will be able to find correct ratio between friendship and success.

I am sure, that we all consider this Olympiad not only as instrument for youth motivation for huge steps in biological science. We also attribute this Olympiad to the International events that facilitate strengthening of friendship and brotherhood, contribute to the convergence of peoples and cultures.

Participating in the main program of Olympiad, you will be also able to acquaint with memorial historical places, make excursions to the natural national parks and museums of Republic.

Let me in conclusion to express acknowledgements to all who helped to organize this Olympiad.

Let success accompany all participants!

Salutatory word of the Minister of Education of Republic of Belarus

Brigadin P.I.

Dear participants of Olympiad!
Ladies and Gentlemen!

Cordially welcome you on hospitable Byelorussian earth! We are very happy to see here in Minsk, the capital of Belarus, the winners of the national Olympiads, honorable teachers, coordinators, scientists, the members of international jury, observers. Here, at 14th International biology Olympiad we have representatives from 58 states (more than at previous Olympiads), the observers from 11 countries are present.

Taking this chance, I am expressing my sincere thanks to all organizers of International Olympiad.

Dear participants of Olympiad!

You are the best confirmation of the fact, that today considerable part of the young generation accepts excellent learning as a sign of distinction and ready to bring benefits to own country and therefore, deserve of state support.

In our Republic, we developed the state program «Talented children», the main direction of activity of which is the maximal development of abilities of students and youth, satisfaction of their educational inquiries, finding of talented children, organization of their education and learning.

The intent attention to realization of this program is paid by the head of state – Lukashenko Alexander Grigorievitch. According his initiative, it was created and successfully functioning the special fund of the President of Republic of Belarus directed to social support of talented pupils and students.

This important intellectual forum gathered from all over the world talented children – the future biologists. The main task of our Olympiad is to present a unique opportunity to talented students to check their abilities in solving theoretical questions and doing experiments, as well as to create conditions for multiple friendship contacts, despite of national, religious, and cultural differences. You will make interesting excursions to the prohibited places of our small, but beautiful Republic.

The 14th International biology Olympiad is taking place at the beginning of XXI century that is going to be the century of biology. I hope that Olympiad will give you new knowledge, enrich you with new ideas and become a start for your future scientific carrier.

Dear participants, you are already proved that in the field of biology you did much more than it is necessary according to school programs. Delightful is your thirst to knowledge, research approach and the abundance of discoveries of our young scientific generation.

We are living during wonderful time of unexpected perspectives opening the new fields of science and technology.

Biology today is one of the most roughly developing sciences of the contemporaneity, accumulating the knowledge necessary for survival and further development of humanity. Great contribution in studies on hydrobiology, ecology, biotechnology and genetics has been done by Byelorussian scientists.

The wide International cooperation of biologists from over the world led to fascinating discovery of mankind – elucidation of human genome, our «life book».

However, the scientists from all countries are not able to eliminate the worried voice of anxiety: would not be the understanding of benefits of using of this discovery and ability to manipulate it the reason of further sharpening of the existing in the world segregation and inequality?

The best way to solve this problem is close cooperation between scientists of all countries and assurance that science and all it's applications in an equal degree are responsible, as bringing blessing to all human family.

Many of you also will apply your knowledge to the opening of secrets of nature, explanation of the lows of surrounded world and understanding of our place in this world. I am sure that in this hall we have future stars of biology, whose great discoveries become well known not only in their countries, but all over the world.

Dear participant, I hope that your stay in Belarus will leave the pleasant memories for all your life.

I wish you success at Olympiad, new discoveries and victories!

The 14th International Olympiad of schoolboys is announced to be open!

Salutatory word of the chairmen of

the Scientific committee

Lysak V.V.

Dear Jury members, Participants, Observers, and Guests!

On behalf of the Organizing committee of the 14th International Biology Olympiad let me cordially welcome all participants and guests.

We are very happy, that in this year Olympiad is taking place in Belarus. Minsk, the capital of Belarus, is the biggest and beautiful city in the center of our country. Minsk is intersection of the ways to Russia cities, Central, West and North Europe. Being completely destroyed during World War II, Minsk now is the modern european city.

The 14th IBO will be held at the Biological Faculty, which was founded in 1921. Soon, after opening, Biology Faculty became one of the main basises for the development of biological science and the support of scientific progress during the period of the Soviet Ages in Belarus and up to now. The Byelorussian State University now is the modern european center of education, research in different branches, development of education and science and public relations.

We are sure that Olympiad, organized by Organizing Committee, will be worm and happy for all our guests. Traditionally, Byelorussian hospitality guaranties interesting and diverse program of your stay here.

We have been preparing our Meeting with great hope and enthusiasm. Let it be the successive chance for fruitful work and communication with the new generation of participants of International Biology Olympiad from all over the world.

Information about IBO?

The International Biology Olympiad (IBO) is a competition for secondary school students. Their skills in tackling biological problems, and dealing with biological experiments are tested. Interest in biology, inventiveness, creativity and perseverance are necessary.

Every participating country sends four students, who are the winners of the respective national competitions. They are to be accompanied by two team leaders as representatives of each country.

In bringing together gifted students, the IBO tries to challenge and stimulate these students to expand their talents and to promote their career as a scientist, so biology talents do not get lost. The olympiad also is focussing on biology as a beautiful and valuable subject. Many biological topics like ethology and ecology stress the importance of biology for society, especially items such as nature preservation and/or environmental protection.

The olympiad offers the opportunity to compare the syllabuses and educational trends in biology in different countries. This is useful information to improve biology education on a national level.

Many institutions are involved in the organization of the national olympiad: ministry of education, industry, teachers' associations, universities, schools.

Contacts between these institutions will lead to a better understanding and communication about their respective activities in the field of biology.

The first international biological competition between Czechoslovakia and Poland from 1985 to 1989 provided ground for the future IBO proper.

Positive experience during international olympiads in other natural sciences and mathematics led to the idea of starting an international biology olympiad. So UNESCO asked the former Czechoslovakia to take the initiative.

Six interested countries (Belgium, Bulgaria, Czechoslovakia, German Democratic Republic, Poland and the Soviet Union) founded the IBO in 1989 (Prague and Brno) and participated in the first IBO which was held in Olomouc in July 1990. Notwithstanding some initial difficulties, this olympiad was a great success and it was decided to

continue with the IBO. In subsequent olympiads the number of participating countries increased rapidly.

Year	Country	City	Number of participating countries
1990	Czechoslovakia	Olomouc	6
1991	Russia	Machatskala	9
1992	Czechoslovakia	Poprad	12
1993	The Netherlands	Utrecht	15
1994	Bulgaria	Varna	18
1995	Thailand	Bangkok	22
1996	Ukraine	Artek	25
1997	Turkmenistan	Ashgabat	28
1998	Germany	Kiel	33
1999	Sweden	Uppsala	36
2000	Turkey	Antalya	38
2001	Belgium	Brussels	38
2002	Latvia	Jurmala-Riga	40
2003	Belarus	Minsk	41

Immediately after the first olympiad, a Coordinating Center was established in Prague and every winter a meeting of appointed coordinators assembles in this center to prepare new proposals and improve regulations, the content, and preparations of future olympiads, etc.

2. ORANIZATIONAL QUESTIONS

Organizing Committee

Brigadin Piotr Ivanovitch - Chairman
(Minister of Education of Belarus)

Zhuk Alexandr Ivanovitch - Vice-chairman
(First vice-minister)

Farino Kazimir Stepanovitch - Vice-chairman
(Vice-minister)

Kozulin Alexandr Vladislavovitch - Vice-chairman
(Rector of Belarus State University)

Romanovets Galina Stepanovna - secretary
(Head inspector of Ministry of education)

Butrim Georgy Alexeevitch - member
(Head of social and pedagogical labor department of Ministry of education)

Gavrilov Valery Leonidovitch - member
(Head of financial department of Ministry of education)

Gapanovitch Boris Adamovitch - member
(Vice-head of secondary education department of Ministry of education)

Zaitseva Lidia Ivanovna - member
(Head of assistance department of Ministry of education)

Ivchenkov Viktor Ivanovitch - member
(Adviser of Minister of education)

Listopad Nikolay Izmailovitch - member
(Director of department of Ministry of education)

Lysak Vladimir Vasilievitch - member
(Dean of biological faculty of Belarus State University)

Maximova Natalia Pavlovna - member
(Chair of department of genetics of BSU)

Makarenkova Galina Grigorievna - member

(Head of preschool training department of Ministry of education)

Parhomenko Vladimir Pavlovitch - member
(Director of National educational Institute)

Subotskaya Lidia Ivanovna - member
(Head of socio-economic development department of Ministry of education)

Tavgen Oleg Ignatievitch - member
(Head of Academy of post-graduate education)

Tihonov Vladimir Jurievitch - member
(Head of international contacts department of Ministry of education)

Scherbo Vladimir Konstantinovitch - member
(Head of secondary education department of Ministry of education)

Scientific Committee

Lysak Vladimir Vasilievitch - Dean of biological faculty of Belarus State University (chairman of the Committee).

Maximova Natalia Pavlovna - Chair of department of genetics of BSU (vice-chairman of the Committee).

Usanov Sergey Alexandrovitch – Chair of the department at the Institute of Bioorganic Chemistry, doctor of sciences, professor (vice-chairman of the Committee).

Romanovets Galina Stepanovna - Head inspector of Ministry of education of Republic of Belarus (member of the Committee).

Burko Leonid Dmitrievitch – chair of the department of zoology, ph.d. (member of the Committee).

Grinchik Vasily Vitalievitch – Chair of the department of common ecology and methods of schooling of biology of BSU, ph.d. (member of the Committee).

Buga Sergey Vladimirovitch – professor of the department of zoology of BSU, doctor of sciences (member of the Committee).

Shalapyonok Elena Semenovna – docent of the department of zoology BSU, ph.d. (member of the Committee).

Zinkevitch Vadim Anatolievitch – docent of the department of zoology BSU, ph.d. (member of the Committee).

Sandakov Dmitri Borisovitch – docent of the department of physiology of human and animals of BSU, ph.d. (member of the Committee).

Chernik Vladimir Vladimirovitch – docent of the department of botany of BSU, ph.d. (member of the Committee).

Sautkina Tamara Alexandrovna – docent of the department of botany of BSU, ph.d. (member of the Committee).

Kakhnovitch Ludmila Vasilievna – docent of the department of the department of physiology and biochemistry of plants of BSU, ph.d. (member of the Committee).

Zeldakova Rimma Anatolienva – docent of the department of microbiology of BSU, ph.d. (member of the Committee).

Pesnyakevitch Alexander Georgievitch – docent of the department of microbiology of BSU, ph.d. (member of the Committee).

Mokhoreva Svetlana Ivanovna - docent of the department of biochemistry, ph.d. (member of the Committee).

Grinev Vasily Victorovitch – assistant of the department genetics, ph.d. (member of the Committee).

Koren'kov Andrey Eduardovitch – lector of the department of physiology and biochemistry of plants of BSU (member of the Committee).

Grineva Irina Alexandrovna – junior scientific researcher of the department of genetics of BSU (member of the Committee).

Russkikh Ivan Anatolievitch – scientific researcher of the department of genetics of BSU (member of the Committee).

Harnostai Ivan Nikolaevitch – post graduate student of the Institute of bioorganic chemistry of NAS of Belarus (member of the Committee).

National committee of the authors of tasks and experts

Chairman – Chair of department of genetics of BSU**, ph.d. Maximova N.P.**

Theoretical tour

1. Group «Biology of cell»:

Orel N.M. – docent of the department of biochemistry, ph.d.
Pesnyakevitch A.G. – docent of the department of microbiology, ph.d..
Glushen C.B. – docent of the department of genetics, ph.d.
Nikolaichik E.A. – docent of the department of molecular biology, ph.d.
Zeldakova R.A. – docent of the department of microbiology, ph.d.
Harnostai I.N. – post graduate student of the Institute of bioorganic chemistry of NAS of Belarus
Grinev V.V. – assistant of the department genetics, ph.d.

2. Group «Anatomy and physiology of plants»:

Polyksenova V.D. – assistant of the department of botany, ph.d.
Kakhnovitch L.V. – docent of the department of physiology and biochemistry of plants, ph.d.
Sautkina N.A. - docent of the department of botany, ph.d.
Chernik V.V. - docent of the department of botany, ph.d.
Smolich I.I. **–** docent of the department of physiology and biochemistry of plants, ph.d.
Koren'kov A**.E. –** lector of the department of physiology and biochemistry of plants

3. Group «Anatomy and physiology animals and human. Ethology»

Burko L.D. – chair of the department of zoology, ph.d.
Buga C.V. – professor of the department of zoology, doctor of sciences
Shalapyonok E.S. – docent of the department of zoology, ph.d.
Zinkevitch V.A. – docent of the department of zoology, ph.d.
Sandakov D.P. – docent of the department of physiology of human and animals, ph.d.
Polukhovitch G.S. – assistant of the department of physiology of human and animals

4. Group «Genetics and evolution»:

Maximova N.P. – chair of the department of genetics, ph.d.
Khranzov E.A. – assistant of the department of genetics, ph.d.
Grinev V.V. – assistant of the department of genetics, ph.d.
Kunitzkya M.P. - assistant of the department of genetics

5. Group «Ecology»

Grinchik V.V. – chair of the department of common ecology and methods of schooling of biology, ph.d.
Kamluck L.V. – professor of the department of common ecology and methods of schooling of biology, doctor of sciences
Makarevitch T.N. – docent of the department of common ecology and methods of schooling of biology, ph.d.

6. Group «Biosystematics»

Buga S.V. - professor of the department of zoology of BSU, doctor of sciences
Shalapyonok E.S. – docent of the department of zoology BSU, ph.d.
Burko L.D. – chair of the department of zoology, ph.d.
Polyksenova V.D.- chair of the department of botany, ph.d.

Practical tour

Laboratory 1. Physiology, anatomy and taxonomy of plants.

Polyksenova V.D.- chair of the department of botany, ph.d.
Chermick V.V. - docent of the department of botany, ph.d.
Sautkina N.A. - docent of the department of botany, ph.d.
Kakhnovitch L.V. – docent of the department of physiology and biochemistry of plants, ph.d.
Koren'kov A**.E. –** lector
Harnostai I.N. – post graduate student of the Institute of bioorganic chemistry of NAS of Belarus

Laboratory 2. Anatomy, morphology and systematic of animals

Buga S.V. - professor of the department of zoology, doctor of sciences
Shalapyonok E.S. – docent of the department of zoology, ph.d.
Zinkevitch V.A. – lector of the department of zoology, ph.d.

Laboratory 3. Microbiology and biotechnology

Zeldakova R.A. – docent of the department of microbiology, ph.d.
Pesnyakevitch A.G. – docent of the department of microbiology, ph.d.
Grineva I.A. – scientific researcher of the department of molecular genetics of bacteria

Laboratory 4. Genetics

Russkikh I.A. – scientific researcher of the department of genetics
Grineva I.A. – scientific researcher of the department of molecular genetics of bacteria
Harnostai I.N. – post graduate student of the Institute of bioorganic chemistry of NAS of Belarus

PARTICIPATING COUNTRIES

1. Argentina
2. Australia
3. Azerbaijan
4. Belarus
5. Belgium
6. Bulgaria
7. People Republic Of China
8. Chinese Taipei
9. Cyprus
10. Czech Republic
11. Estonia
12. Finland
13. India
14. Indonesia
15. Ireland
16. Islamic Republic of Iran
17. Kazakhstan
18. Korea
19. Kuwait
20. Kyrgyzstan
21. Latvia
22. Mexico
23. Moldova
24. Mozambique
25. The Netherlands
26. Poland
27. Romania
28. Russia
29. Singapore
30. Slovakia
31. Slovenia
32. Spain
33. Sweden
34. Switzerland
35. Thailand
36. Turkey
37. Turkmenistan
38. Ukraine
39. United Kingdom
40. USA
41. Vietnam.

Observing Countries

1. Canada

3. PROGRAMME OF 14TH IBO

Date		Time-table	
		For students	For Jury
8 July	Tuesday	8^{00}-19^{00} - Registration 19^{00}- Get-Together party	
9 July	Wednesday	8^{00} - Breakfast 9^{00} - Leaving hotels 10^{00} - Opening Ceremony 13^{00} -14^{00} -Lunch 14^{00} - Excursion 19^{00} - Dinner	8^{00} - Breakfast 9^{00} - Leaving hotels 10^{00} - Opening Ceremony 13^{00} -14^{00} -Lunch 14^{00} - Translating and discussion of practical test tasks 19^{00} - Dinner 20^{00} - Continue of jury work
10 July	Thursday	8^{00} - Breakfast 9^{00} - Practical part 15^{00} - Lunch 16^{00} - Leisure time 19^{00} - Dinner	8^{00} - Breakfast 9^{00} - Leisure time 14^{00} -Lunch 15^{00} - Leisure time 19^{00} - Dinner
11 July	Friday	8^{00} - Breakfast 9^{00} - Leisure time 19^{00} - Dinner	8^{00} - Breakfast 9^{00} - Translating and discussion of theoretical tasks 14^{00} -Lunch 15^{00} - Continue of jury work 19^{00} - Dinner 20^{00} - Continue of jury work
12 July	Saturday	8^{00} - Breakfast 9^{00} - Theoretical part 14^{00} - Lunch 15^{00} - Meeting with team leaders 17^{30} - Leisure time 19^{00} - Dinner	8^{00} - Breakfast 9^{00} - Discussion of practical test results 14^{00} - Lunch 15^{00} - Meeting with students 17^{30} - IBO Coordination Committee meeting 19^{00} - Dinner
13 July	Sunday	8^{00} - Breakfast 9^{00} - Leisure time 19^{00} - Dinner	
14 July	Monday	8^{00} - Breakfast 9^{00} - Leisure time 14^{00} - Lunch 15^{00} - Leisure time 19^{00} - Dinner	8^{00} - Breakfast 9^{00} - Discussion of theoretical test results 14^{00} - Lunch 15^{00} - Observing of student's competitive works 19^{00} - Dinner
15 July	Tuesday	8^{00} - Breakfast 9^{00} - Leisure time 14^{00} - Lunch 15^{00} - Closing Ceremony 19^{00} - Farewell dinner	8^{00} - Breakfast 9^{00} - Jury leaders meeting, approval of Olympiad results 14^{00} - Lunch 15^{00} - Closing Ceremony 19^{00} - Farewell dinner
16 July	Wednesday	8^{00} - Breakfast Departure	

4. 14TH IBO TASKS

4.1 Practical Part

D E A R P A R T I C I P A N T S !

Practical Part

of the 14th International Biology Olympiad

is comprised of four labs:

1. PLANT PHYSIOLOGY, MORPHOLOGY AND ANATOMY;

2. ANIMAL MORPHOLOGY, ANATOMY AND SYSTEMATICS;

3. MICROBIOLOGY AND BIOTECHNOLOGY;

4. GENETICS.

Duration of each lab is **one hour.**

The time for refreshments after each lab is **10-15 minutes.**

Movement between labs will be done **with assistance of accompanying persons**.

GOOD LUCK!

PRACTICAL PART

In the laboratory:

1. Open the envelope. You will be given the text of the tasks and the answer sheet.

Fill your **name, surname and code on the cover page** and only the **code on**

each page of the answer sheet.

2. Only questions concerning materials and equipment are allowed.

3. After one hour **the tasks and answer sheets will be collected** by assistants.

ONLY ANSWER SHEET WILL BE CHECKED.

GOOD LUCK!

4.1.1 Laboratory «PLANT PHYSIOLOGY, MORPHOLOGY AND ANATOMY».

Dear Participants!

In the laboratory "**PLANT PHYSIOLOGY, MORPHOLOGY AND ANATOMY"** you will be given the following three tasks:

Task 1. The study of physical and chemical properties of photosynthetic pigments.

Task 2. The study of angiosperm flowers structure.

Task 3. The study of anatomic structure of a plant organ on a cross section.

Duration of the lab work is **60 minutes.**

Maximum number of points – **68**.

You have to write down your results and answers into the **ANSWER SHEET** which will be collected by an assistant when the time elapses. It is not necessary to write anything in the task sheets.

Result sheets taken away from the laboratory will not be accepted!

Please be careful when performing reactions and do not let the reagents and solutions come in contact with your skin and clothes! Use gloves when necessary!

Contact the assistant in case of any unforseen situations!

Good luck!

Country_____

First name_____ Family name _____

Code_____

<u>Task 1.</u> (35 points) The study of physical and chemical properties of photosynthetic pigments.

The conversion of the energy of light into chemical energy occurs in plants with the help of pigment-protein complexes of chloroplast membranes. These complexes include photosynthetic pigments which determine the activity of the primary photosynthetic processes. An understanding of photosynthesis is impossible without knowledge of photosynthetic pigment properties. Chlorophyll and other photosynthetic pigments have several specific properties: absorption of different wavelengths of light, ability to participate in redox reactions, solubility in different types of solvents, etc.

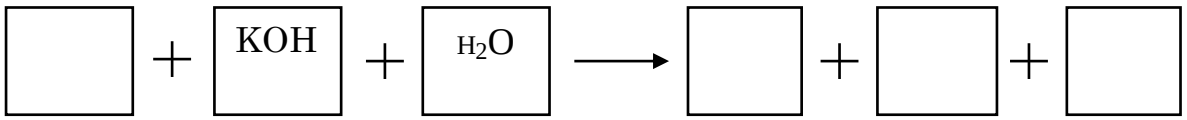
You have to study several of these properties of photosynthetic pigments during this task.

Materials and equipment

1.	A stand with tubes.	1
2.	Pipettes.	5
3.	Ethanol extract of photosynthetic pigments (Flask A).	1
4.	20 % KOH solution (Flask B).	1
5.	Distilled water (Flask C).	1
6.	Petrolic (petroleum) ether (Flask D).	1
7.	A sheet of white paper.	1
8.	A water bath.	1
9.	A tube holder.	1
10.	10 % HCl solution (Flask E).	1
11.	Saturated $(CH_3COO)_2Zn$ solution (Flask F).	1
12.	Saturated ascorbic acid solution (Flask H).	1

1.1. (8 points) Transfer 3 ml of pigment solution from **flask A** into tube № 1 and also 3ml into tube № 2.
Add five drops of 20% KOH from **flask B** and 1 ml of H_2O (from **flask C**) to the tube № 1 and to the tube № 2 - only 1 ml of H_2O.

Fill in the missing components of the chemical reaction you have just observed in scheme 1.1 of the answer sheet. Please use the number corresponding to the appropriate formulae from the list below.



1. $C_{55}H_{72}O_5N_4Mg$ – chlorophyll.
2. $C_{34}H_{30}O_5N_4\ MgK_2$ – potassium salt of the chlorophyllic acid.
3. $C_{55}H_{74}O_5N_4$ – pheophytin (phaeophytin).
4. $C_{20}H_{39}OH$ – phytol.
5. CH_3OH – methanol.
6. C_2H_5OH – ethanol.
7. $MgCl_2$ – magnesium chloride.
8. KCl – potassium chloride.

1.2. (4 points) Add 1 ml of the petrolic (petroleum) ether (from the **flask D**) to the tubes № 1 and № 2, shake well and leave to stand until the fractions separate completely.

Determine the colour of each fraction in the tubes № 1 and № 2. Write down the results in the appropriate cells of the table 1.2 of the answer sheet. Please use single letter colour codes as shown below.

A. violet;
B. blue;
C. green;
D. yellow;
E. red;
F. olive brown;
G. black;
H. colourless;

Tube №	Reagent	Experiment 1.1.	Experiment 1.2.
		ethanol fraction colour	**petrolic ether fraction colour**
1	KOH		
2	**H_2O**		

1.3. (4 points) Which pigments are responsible for the colour of the petrolic fraction on the tubes № 1 and № 2? Write down in the answer sheet (1.3) single letter codes for the compounds from the list below:

№ 1: _____
№ 2: _____

A. anthocyanins;
B. carotenoids;
C. phycobilins;
D. chlorophylls;

1.4. (2 points) Add 3 ml of the pigment extract to the tube № 3 (**flask A**) and add 5 drops of HCl (**flask E**). Mix the tube contents thoroughly by shaking. Record the new colour. Add 1 ml of the saturated $(CH_3COO)_2Zn$ solution (from the **flask F**) to the same tube. Heat the solution on the water bath. Mix by shaking andrecord the new colour of the solution.

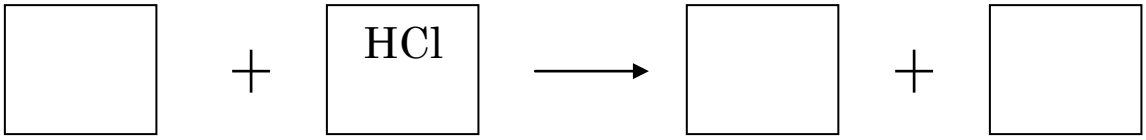
Write the results down in the table 1.4 of the answer sheet. Please use single letter colour codes as shown below.

A. violet;
B. blue;
C. green;
D. yellow;
E. red;
F. olive brown;
G. black;
H. colourless.

Reagent	New colour in the tube
HCl	
$(CH_3COO)_2$ Zn	

1.5. (6 points) In the scheme 1.5 of the answer sheet, please write the possible components of the reaction in the tube № 3 after addition of hydrochloric acid to the

pigment extract. Please use the number corresponding to the appropriate formula from the list below.



1. $C_{55}H_{72}O_5N_4Mg$ – chlorophyll.
2. $C_{34}H_{30}O_5N_4\ MgK_2$ – potassium salt of the chlorophyllic acid.
3. $C_{55}H_{74}O_5N_4$ – pheophytin (phaeophytin).
4. $C_{20}H_{39}OH$ – phytol.
5. CH_3OH – methanol.
6. C_2H_5OH – ethanol.
7. $MgCl_2$ – magnesium chloride.
8. KCl – potassium chloride.

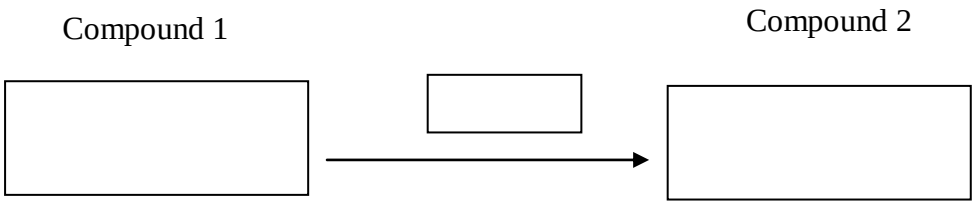
1.6. (1 point) Add 2 ml of the pigment extract and 2 ml of ascorbic acid (**flask H**) to the tube № 4. Mix by shaking until the colour changes.

Please note the colour change. Put the results in the table 1.6 in the answer sheet. Please use the single letter colour codes shown below.

A. violet;
B. blue;
C. green;
D. yellow;
E. red;
F. olive brown;
G. black;
H. colourless.

Extract colour before reaction	Solution colour after reaction
C	

1.7. (6 points) Complete the scheme of this reaction (1.7 in the answer sheet) using compound and condition numbers from the two lists below:



Compounds:

1. chlorophyll;

2. pheophytin (phaeophytin);

3. ascorbic acid;

Conditions:

4. electrons involved;

5. protons involved;

6. light involved.

1.8. (4 points)

Write the results down in the table 1.8 of the answer sheet. Please use single letter colour codes shown below.

A. violet;
B. blue;
C. green;
D. yellow;
E. red;
F. olive brown;
G. black;
H. colourless.

Compound №	Colour before reaction	Colour after reaction
1		
2		

Task 2. (12 points) The study of angiosperm flowers structure.

Materials and equipment

1.	Fixed flower preparations (A, B, C).	x 3
2.	Forceps.	x 1
3.	Dissecting needles.	x 2
4.	A magnifying glass.	x 1

2.1. (6 points) Study the morphology of flowers A, B, C. Using formula numbers (1-14) from the list below, indicate the correct formula for each flower in the answer sheet.

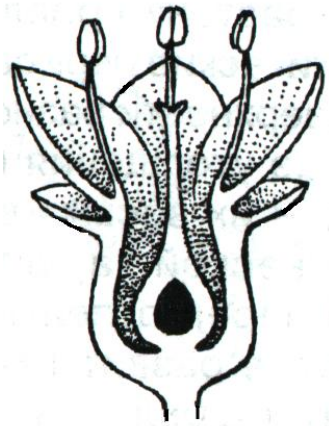
1. $* K_5 C_5 A_\infty \underline{\underline{G_\infty}}$
2. $* P_5 A_\infty \underline{G_\infty}$
3. $* K_5 C_5 A_{5+5} G_{\underline{(3)}}$
4. $* K_{(5)} C_5 A_{5+5} G_{\underline{(5)}}$
5. $* K_5 C_5 A_\infty G_{1-}$
6. $* K_{(5)} C_5 A_\infty G_{\overline{(5)}}$
7. $\uparrow K_{(5)} C_{1,2,2} A_{(5+5)} \underline{G_1}$
8. $\uparrow K_{(5)} C_{1,2,2} A_{(9)1} \underline{G_1}$
9. $* K_0 C_5 A_5 G_{\overline{(2)}}$
10. $* K_{2+2} C_4 A_{2+4} G_{\underline{(2)}}$
11. $\uparrow K_{(5)} C_{(2,3)} A_{2,2} G_{\underline{(2)}}$
12. $* K_{(5)} C_{(5)} A_5 G_{\underline{(2)}}$
13. $\uparrow K_0 C_{(5)} A_{(5)} G_{\overline{(2)}}$
14. $* P_{3+3} A_{3+3} G_{\underline{(3)}}$

* = polysymmetrical

↑ = monosymmetrical

A	B	C

2.2. (3 points) The diagrams show the types of ovaries characteristic of angiosperm flowers. Using the numbers (1-4) from the table below, record the types of ovaries for the flowers A, B and C in the answer sheet.

 **1**.	 **2**.	 **3**.	 **4**.
Superior ovary (Hypogynous flower)	Middle ovary (Perigynous flower)	Half-inferior ovary (Half -epigynous flower)	Inferior ovary (Epigynous flower)

A	B	C

2.3. (3 points) Please indicate in the answer sheet to which family the plants with flowers A, B and C belong. Use the numbers (1-10) from the list below.

1. Ranunculaceae (buttercups)
2. Oleaceae
3. Rosaceae.
4. Leguminosae (Fabaceae), Papilionaceae.
5. Fagaceae
6. Cruciferae (Brassicaceae).

7. Labiatae (Lamiaceae).

8. Solanaceae.

9. Compositae (Asteraceae).

10. Liliaceae.

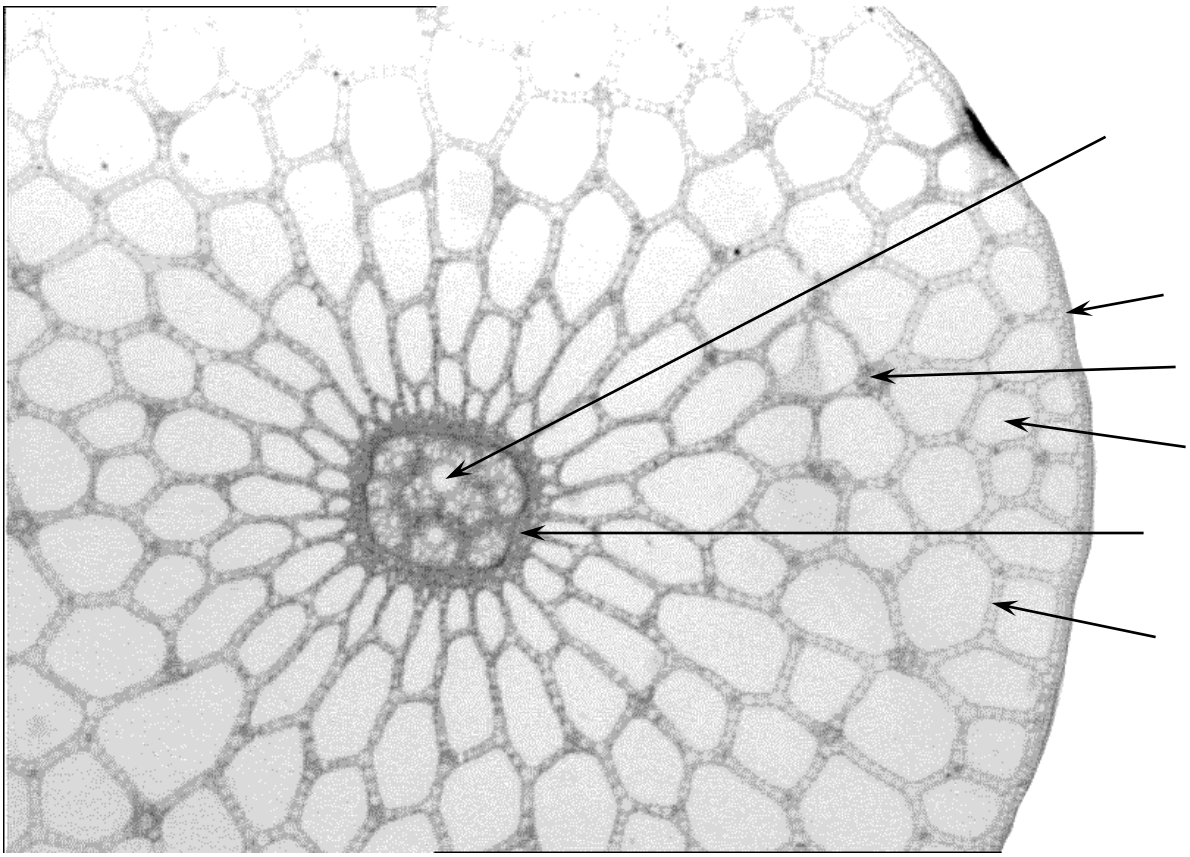
A	**B**	**C**

Task 3. (21 points) The study of anatomic structure of a plant organ on a cross section.

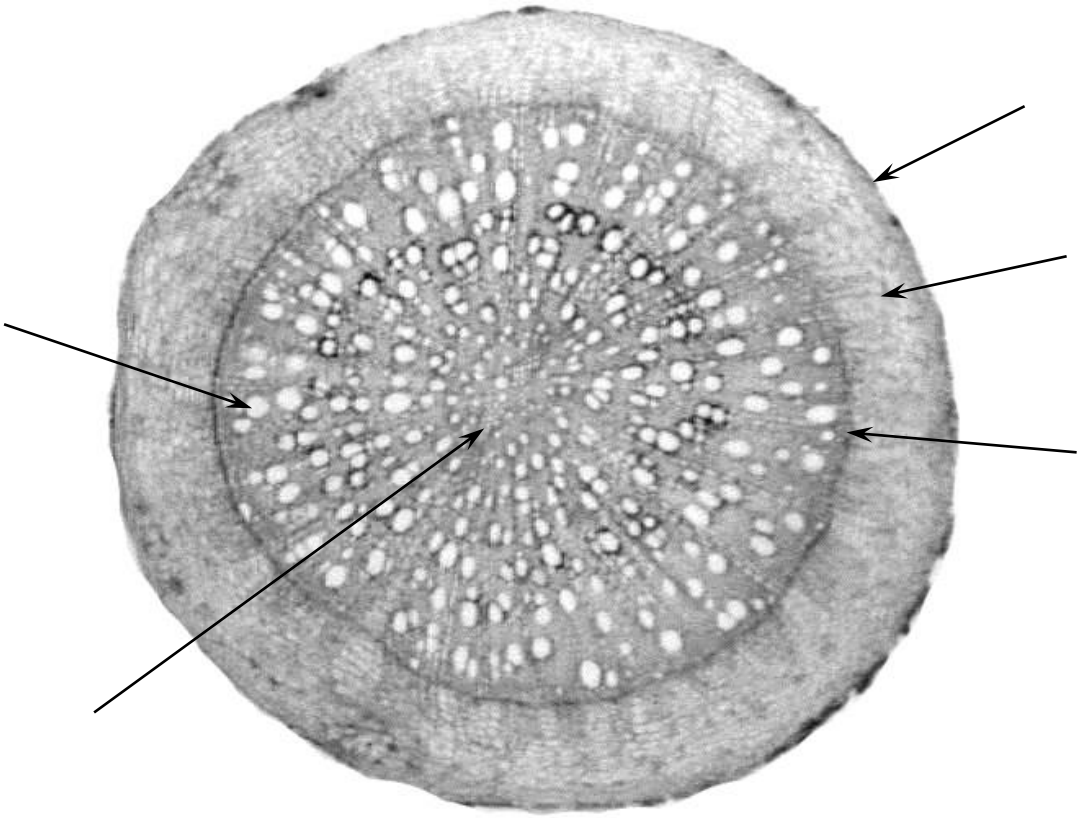
Materials and equipment

1.	Fixed parts of a plant organ.	1
2.	Microscope «Axiostar».	1
3.	Forceps.	1
4.	Dissecting needles.	2
5.	Blade.	1
6.	Glass slides.	2
7.	Cover slips.	4
8.	Dropping bottle with phloroglucin solution.	1
9.	Pipette.	1
10.	10 % HCl solution (Flask E).	1
11.	Distilled water (Flask C).	1

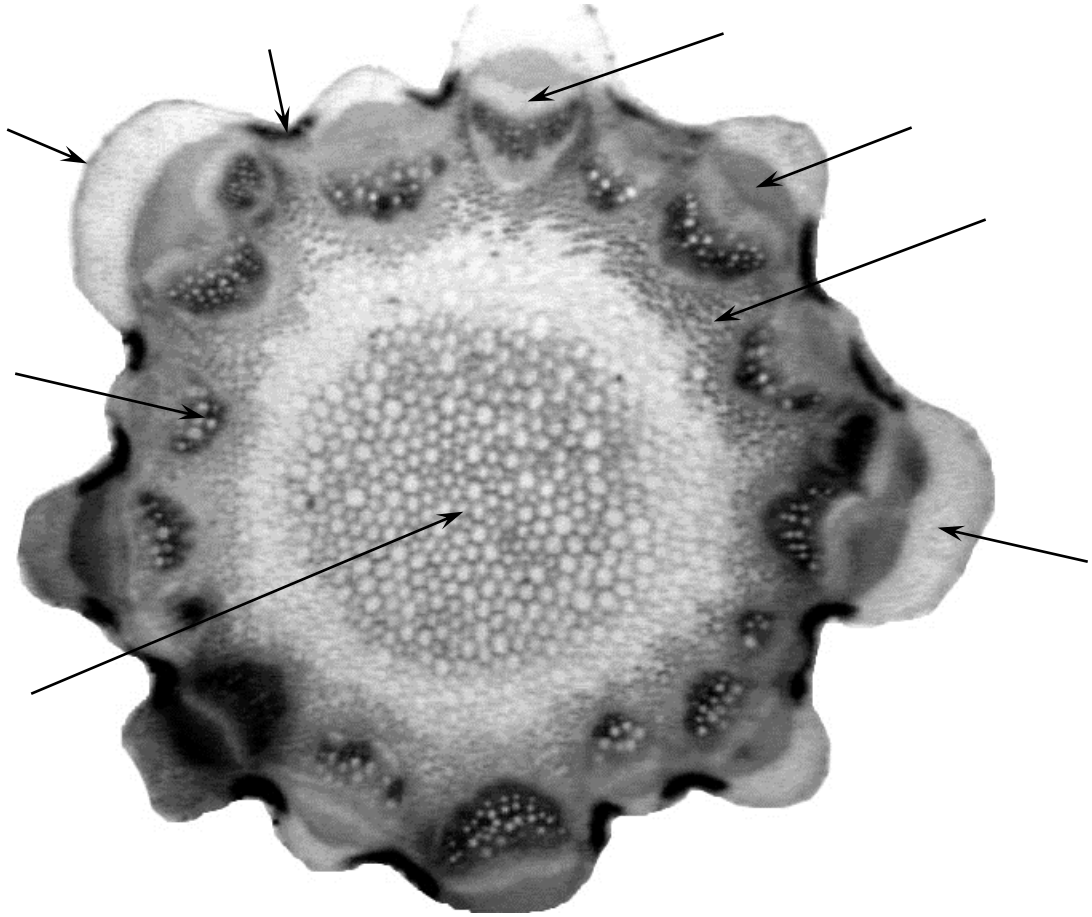
Prepare a cross section of the object you are given. Stain this cross section with phloroglucin and add several drops of HCl. Wash the preparation thoroughly with water for 2-5 minutes and then cover it with a cover slip. Observe the preparation under the microscope. Compare the cross section you have just prepared to the schemes 1-6 below and determine which scheme it corresponds to.



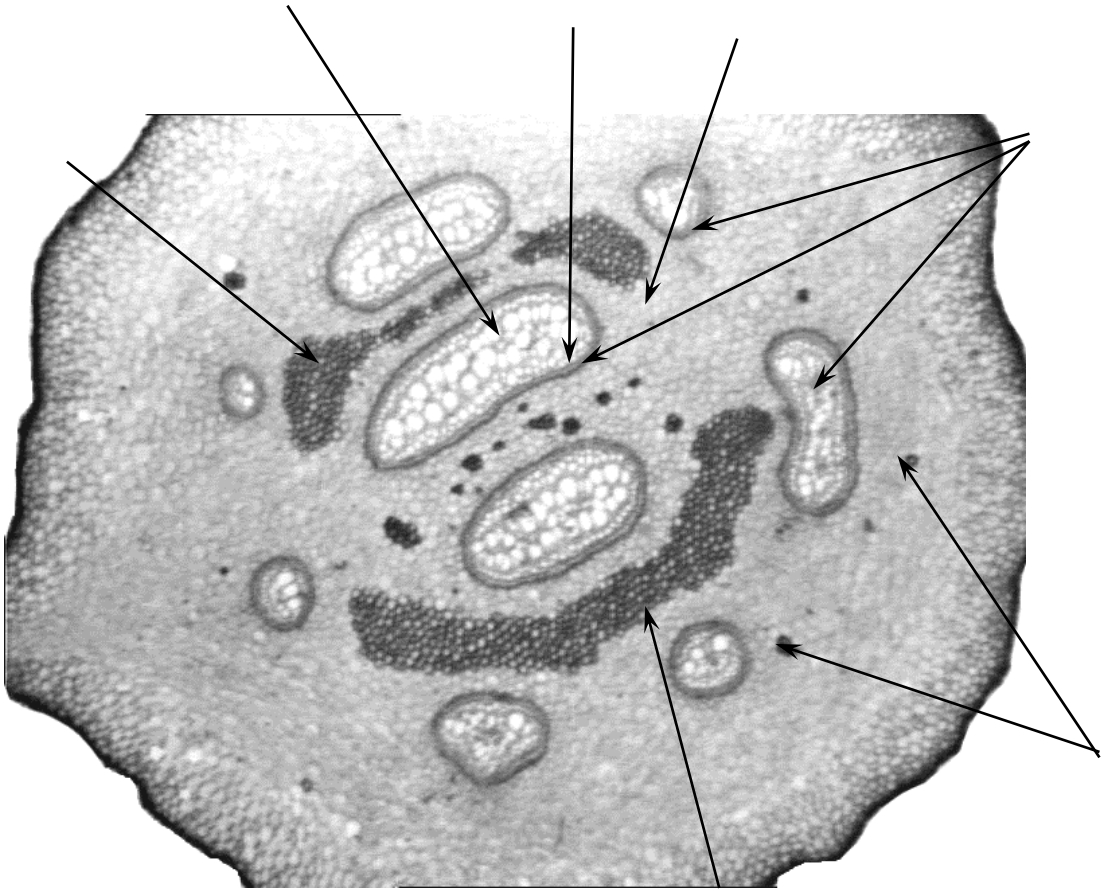
1



2



3



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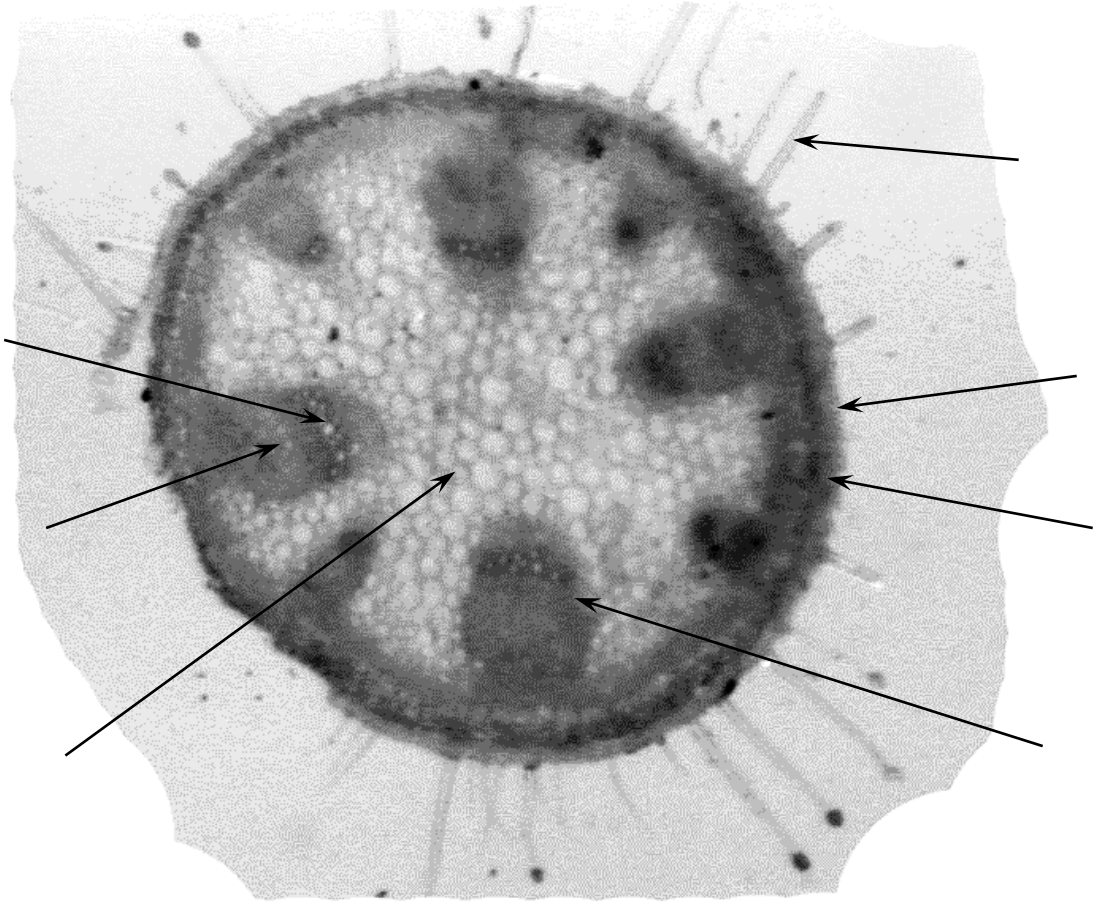

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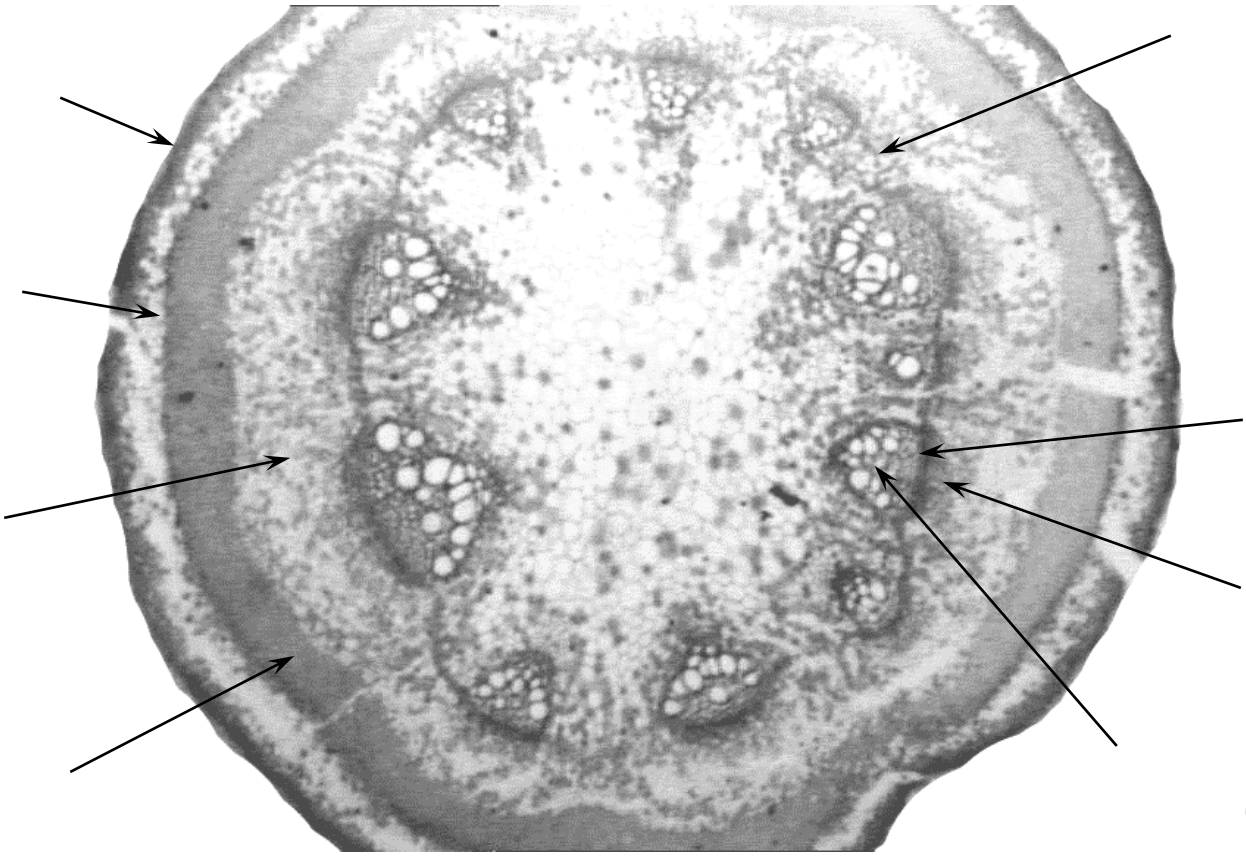


6

3.1. (8 points) Please label (using the numbers from the list below) the tissue elements pointed to by arrows on the scheme corresponding to **your** cross section in the answer sheet.

1. Endodermis.
2. Phloem elements.
3. Phellogen (Cork cambium).
4. Collenchyma.
5. Phelloderma.
6. Chloroplasts.
7. Epidermis.
8. Exodermis.
9. Core (Pith, Medulla).
10. Aerenchyma.
11. Periderm.
12. Sclerenchyma.
13. Pericycle.
14. Xylem elements.
15. Stoma.
16. Chlorenchyma.
17. Cambium.
18. Medullary ray (Pith ray).
19. Interfascicular cambium.
20. Fibrovascular bundle.

3.2. (9 points) What elements (1-18) are coloured by phloroglucin in the presence of HCl? Please, mark with "+" correct answer in the answer sheet.

1. Endoderm cells.
2. Elements of phloem.
3. Cells of phellem (Cork).
4. Cells of collenchyma.
5. Tracheids.
6. Vessel cells.
7. Epidermis.
8. Trichomes.
9. Stomata guard cells.
10. Root hair.
11. Cells of phellogen (Cork cambium).
12. Sclerenchyma fibers.
13. Pericycle cells.
14. Xylem elements.
15. Rhizoids.
16. Cells of parenchyma.
17. Cambium cells.
18. Satellite cells.

3.2.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

3.3. (1 point) What compounds are coloured by phloroglucinin the presence of HCl? Write the corresponding number (1-6) from the list below into the answer sheet.

1. Cellulose.
2. Pectin.
3. Lignin.
4. Suberin.
5. Cutin.
6. Hemicellulose.

3.3.: _____

3.4. (1 point) Determine which organ the cross section was made from. Write the corresponding number (1-6) from the list below into the answer sheet.

1. Root.
2. Stem.
3. Leaf stalk (Petiole).
4. Flower stalk.
5. Runner.
6. Rhizome.

3.4.: _____

3.5. (1 point) Determine which division of higher plants the plant you study belongs to. Write the corresponding number (1-4) from the list below into the answer sheet.

1. Lycopodiophyta.
2. Equisetophyta.
3. Polypodiophyta.
4. Pinophyta.
5. Magnoliophyta.

3.5.: _____

3.6. (1 point) Using the cross section you have just prepared, determine which ecological group (relative to water availability) the plant belongs to. Write the corresponding number (1-4) from the ecomorph list below into the answer sheet.

1. Hygrophyte.
2. Hydrophyte.
3. Mesophyte.
4. Xerophyte.

3.6.: _____

4.1.2 Laboratory «ANIMAL MORPHOLOGY, ANATOMY AND SYSTEMATICS».

Dear Participants!

In the laboratory "ANIMAL MORPHOLOGY, ANATOMY AND SYSTEMATICS" **you will be given the following three tasks:**

Task 1. Detaching pedes (extremities) of crayfish (*Astacus*) and determination of their function.

Task 2. Test for knowledge of animal taxa.

Task 3. Determination of species name of freshwater gastropod molluscs. molluscs.

The duration of the lab work is **60 minutes.**

Maximum number of points – **66.**

You have to write down your results and answers into the **ANSWER SHEET** which will be collected by an assistant when the time elapses. It is not necessary to write anything in the task sheets.

Result lists taken away from the laboratory will not be accepted!

Please note that the results from the task 1 must be shown to the assistant BEFORE the time limit!

Please do not forget to put zoological objects and instruments in their original positions when finished, as these will be used by the next group.

Should the mollusc shells become damaged, you can ask for a replacement.

Good luck!

Country_____

First name_____ Family name _____

Code_____

Task 1. (36 points) Detaching pedes (extremities) of crayfish (*Astacus*) and determination of their function.

Material, instruments and equipment

1.	*Astacus leptodactylus* (♂).	1
2.	A set of instruments (2 forceps, scissors, scalpel, dissecting needles).	1
3.	Dissecting tray	1
4.	A magnifying glass.	1
5.	Cotton sheet.	1
6.	Latex gloves.	1
7.	Pins marked 1 to 18.	18
8.	Foam plate for pins.	1

The narrow-fingered crayfish (*Astacus leptodactylus*) is quite common in fresh water bodies in temperate climates which are characterised by a relatively high content of dissolved oxygen and mineral salts. A magnifying glass is sufficient to study the structure of pedes (appendages) of crayfish.

You need to observe the details of animal's segmentation, to find its body parts and sequentially detach the pedes (appendages excluding the first (antennuales or smallest) pair of antennae) from one side of animal's body, assembling them in order on a plate with the help of pins. Then it is necessary to determine the function of each ped and write it down in the answer sheet.

Description of the techniques.

1. Take the animal in your hand, abdominal (ventral) side up. It is recommended to use a cotton sheet and latex glove. Beware of small spicules ***on the carapace!*** Carefully study the pedes of all body parts (with the help of a magnifying glass if necessary).

2. Using forceps sequentially detach all pedes from one side of animal's body. To do this, hold the ped at its base with the forceps and pull away from the crayfish. You can also use scissors and/or scalpel if necessary.

3. Assemble the pedes on pins with the corresponding numbers (1, 2, 3, etc.). Start umbering from the head. Put the pedes on the foam plate in the correct order.

Attention! The practical results of task 1 must be registered by an assistant on a special control sheet. The correctness of pedes preparation and numbering is scored. If a ped is damaged in the process of preparation to such an extent that it cannot be recognized, the points for this ped are not scored.

Please raise your hand when finished with the first task so that your work can be checked. If the assistant is busy with another participant, you should continue with the next task, but please note that the results of task 1 are not counted if they were shown to the assistant after the total time limit (60 minutes).

In the answer list of **task 1** each ped has 3 variants of its possible function. Study the table, determine the function for each ped, then mark the correct function for each ped in the table with a circle (●). **Note: a participant gets 1 point for every correct answer and loses 0.5 point for every wrong answer.**

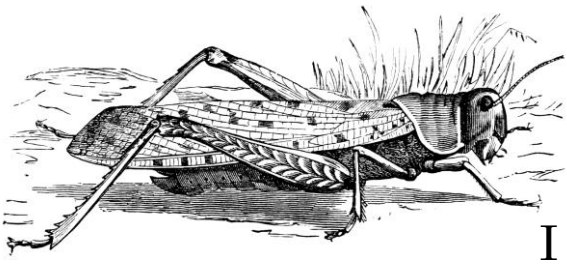
Pedes (extremities)			
№	Functions		
1.	○ sensory	○ respiratory	○ reproductive
2.	○ swimming	○ food grinding	○ respiratory
3.	○ transferring food to mouth	○ respiratory	○ reproductive
4.	○ reproductive	○ transferring food to mouth	○ sensory
5.	○ transferring food to mouth	○ walking	○ defence/attack
6.	○ defence/attack	○ transferring food to mouth	○ reproductive
7.	○ reproductive	○ swimming	○ respiratory
8.	○ swimming	○ capturing and holding food	○ reproductive
9.	○ reproductive	○ respiratory	○ defence/attack
10.	○ reproductive	○ walking	○ sensory
11.	○ reproductive	○ transferring food to mouth	○ walking
12.	○ walking	○ food grinding	○ sensory
13.	○ walking	○ reproductive	○ defence/attack
14.	○ walking	○ respiratory	○ reproductive
15.	○ defence/attack	○ swimming	○ walking
16.	○ swimming	○ food grinding	○ respiratory
17.	○ reproductive	○ sensory	○ swimming
18.	○ swimming	○ transferring food to mouth	○ respiratory

Task 2. (10 points) Animal taxonomy test.

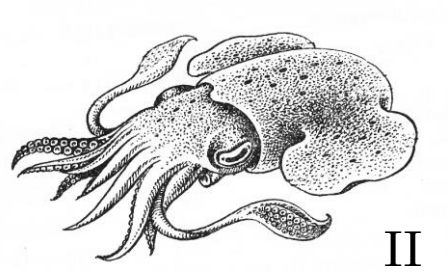
Page 7 has pictures of ten animals numbered with roman numerals. The table below has the names of animal phyla (A–K), subphyla or classes (a–k) and genera (1–10).

Phylum		Subphylum/Class		Genus	
A.	***Annelida.***	**a.**	***Anthozoa.***	**1.**	***Araneus.***
B.	***Arthropoda.***	**b.**	***Cephalopoda.***	**2.**	***Asterias.***
C.	***Chordata.***	**c.**	***Chelicerata.***	**3.**	***Corallium.***
D.	***Cnidaria.***	**d.**	***Crustacea.***	**4.**	***Cyclops.***
E.	***Echinodermata.***	**e.**	***Hydrozoa.***	**5.**	***Fasciola.***
F.	***Mollusca.***	**f.**	***Insecta.***	**6.**	***Hydra.***
G.	***Nematoda (Nemathelminthes)***	**g.**	***Polychaeta.***	**7.**	***Locusta.***
H.	***Platyhelminthes.***	**h.**	***Scyphozoa.***	**8.**	***Musca.***
J.	***Porifera.***	**j.**	***Asteroidea (Stellaroidea)***	**9.**	***Nereis.***
K.	***"Protozoa".***	**k.**	***Trematoda.***	**10.**	***Sepia.***

Please label the taxonomic position of each animal using the information from the table – put the corresponding code for phylum, subphylum/class and genus next to animal picture in the answer sheet.

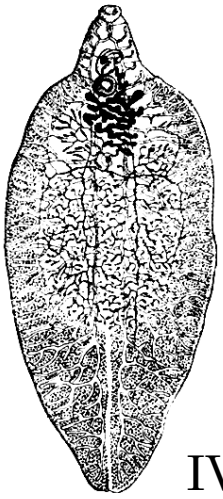


I

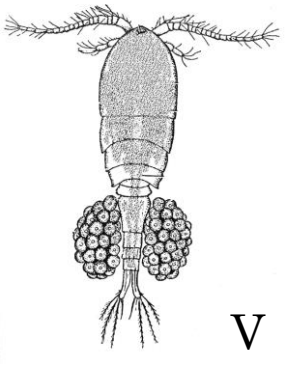


II

III



IV



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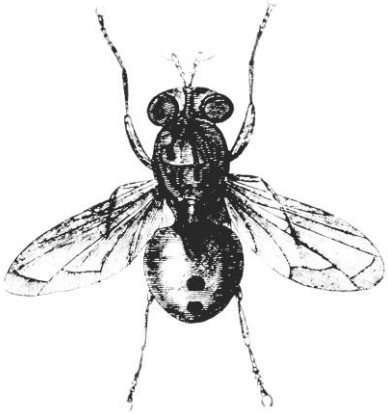

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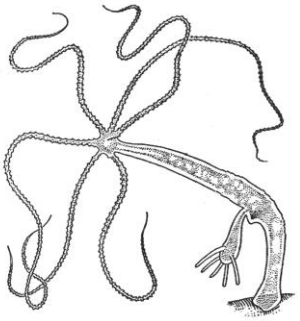
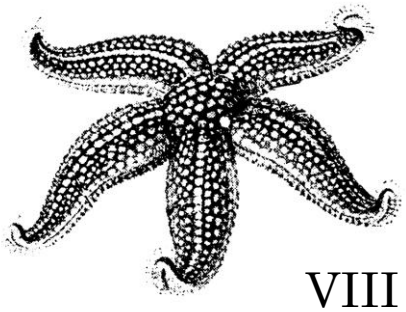
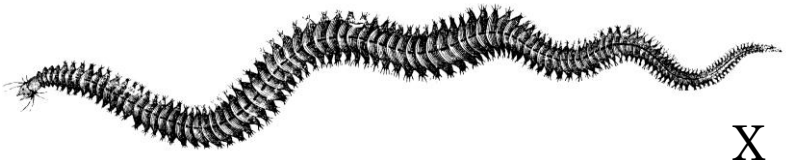


VII



VIII

IX



X

Task 3. (20 points) Determination of species name of freshwater gastropod molluscs.

Materials, instruments and equipment

1.	A tray with 10 shells of gastropod molluscs to be classified.	1
2.	An accessory tray for used shells.	1
3.	A ruler.	1
4.	A set of instruments (forceps, dissecting needles).	1
5.	A magnifying glass.	1

Many species of gastropod molluscs live in fresh water. They play an important role in water ecosystems. Many are specific intermediate hosts of helminthes– parasites of humans and domestic animals. In this connection taxonomic identification of freshwater gastropod molluscs as not only theoretical, but also applied value.

The tray has 10 numbered shells of gastropod molluscs. The classification key below allows the identification of species names and includes illustrations explaining the details of shell structure and measurements. Classify the molluscs you are given and place the numbers written on their shells next to species names in the table in the answer sheet.

Species name	Shell number
Viviparus contectus	
Bithynia tentaculata	
Physa fontinalis	
Aplexa hypnorum	
Radix ovata	
Radix auricularia	
Lymnaea stagnalis	
Planorbarius corneus	
Planorbis planorbis	
Segmentina nitida	

CLASSIFICATION KEY

1a. Shell aperture (opening) has an operculum (lid)……(2)

1b. Shell aperture without an operculum (lid)……..(3)

2a. Shell is at least 20 mm high, green-brown, sometimes with three dark stripes on the last turn of the whorl……. *Viviparus contectus*

2b. Shell is not more than 15 mm high, uniformly brown without stripes……..*Bithynia tentaculata.*

3a. Shell is like a tower or a cone with variable number of turns……(4)

3b. Shell is flat……..(8)

4a. Shell is sinistral……..(5)

4b. Shell is dextral……..(6)

5a. Shell is egg-shaped. Whorl height is less then aperture height. Yellow- brown or light brown……*Physa fontinalis.*

5b. Shell has spindle-like shape. Whorl height is twice the aperture height. Brown or dark brown……*Aplexa hypnorum.*

6a. Aperture height is significantly more than whorl height…(7)

6b. Whorl height is equal or slightly exceeds aperture height. Shell is up to 60 mm high……..*Lymnaea stagnalis.*

7a. Aperture height is approximately twice its width. Shell height is up to 25 mm, width – up to 15 mm……*Radix ovata*

7b. Aperture height and width are approximately equal. Shell height is up to 40 mm, width – up to 30 mm…….*Radix auricularia.*

8a. Aperture has bud-like shape, its height exceeds its width ……*Planorbarius corneus.*

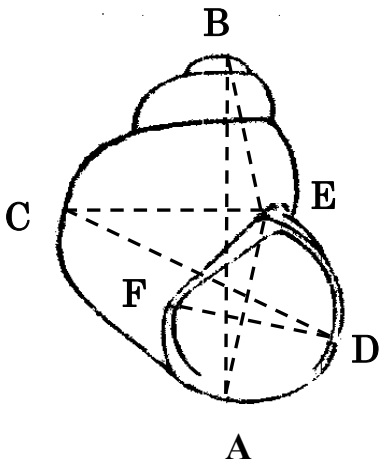
8b. Aperture has another shape, its width exceeds its height… (9)

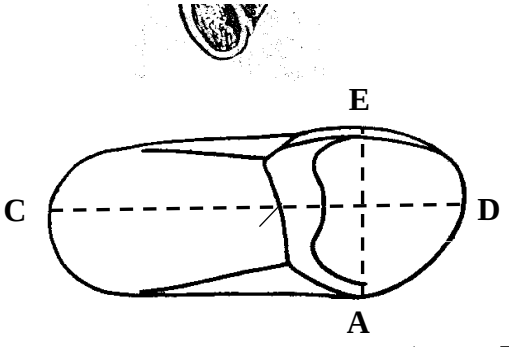
9a. Diameter of the shell is over 8 mm, walls are thick, 5–6 turns, curved at top with flat bottom. Shell walls are opaque, dark-brown ……*Planorbis planorbis.*

9b. Diameter of the shell is less than 8 mm, walls are thin, 4-5 turns, curved at top with plano-concave bottom. Shell walls are semi-transparent, light-brown. ……*Segmentina nitida.*

dextral shell

sinistral shell





Shell measurements of gastropod mollusks:

A–B — shell height,
C–D — shell width,
A–E — aperture height,
D–F — aperture width,
B–E — whorl height.

Should the mollusc shells become damaged, you can ask for a replacement.

Please do not forget to put zoological objects and instruments in their original positions when finished, as these will be used by the next group.

4.1.3 Laboratory «MICROBIOLOGY AND BIOTECHNOLOGY».

Dear Participants!

In the laboratory "**MICROBIOLOGY AND BIOTECHNOLOGY"** you will be given the following two tasks:

Task 1. Identification of microorganisms.

Task 2. Study of Bacterial cultures expressing different genes.

Duration of the lab work is 60 minutes.

Maximum number of points – **64** .

You MUST write down your results and answers on the **ANSWER SHEET** which will be collected by an assistant when the time elapses. It is not necessary to write anything in the task sheets.

Answer sheets taken away from the laboratory will not be accepted!

Please be careful when performing reactions and do not let the reagents and solutions come into contact with your skin and clothes!

PLEASE USE HAND DISINFECTION SOLUTIONS AFTER THIS PRACTICAL EXAMINATION

GOOD LUCK!

Country_____

First name_____ Family name _____

Code_____

Task 1. (46 points) Identification of microorganisms.

Materials and equipment

1. Bacterial strains in:

   - Three petri dishes with solid media (plate "GCO" – 1, plate “protease” – 1, plate “amylase” – 1);

   - tubes with solid medium (for “O/F-test”);

   - tubes with broth (for “H_2S-test” and “NR-test”).

2. Wooden toothpicks for transfer of bacterial biomass from solid medium onto glass slides.

3. Glass slides.

4. Pipettes.

5. KOH solution, 3 %.

6. H_2O_2 solution, 3 %.

7. Dimethylparaphenilendiamine (DMPA) solution, 1 % .

8. Lugol's solution (Lugol).

9. Griess solution, 1% (Griess).

Identification of bacteria is based on the study of certain biological properties, mostly morphological, physiological and biochemical characteristics. You have to identify five bacterial strains labelled № 1-5. For this you will have to perform five biochemical tests (1.1, 1.3, 1.4, 1.6 and 1.8). You will also use the results of the remaining tests given to you (tests 1.2, 1.5, and 1.7). Some tests are followed with additional questions on the corresponding topic that you have to answer.

Please fill your results in the table "Identification of bacteria" in the answer sheet using the following symbols: "+" for a positive reaction, "-" for lack of a reaction. A sample table is given on the next page. **Attention!** In the column "Gram reaction" you have to put "+" for Gram-positive bacteria and "-" for Gram-negative. In the column "O/F-test" put letter "F" for organisms with anaerobic respiration (fermentative metabolism) and letter "O" – for organisms with aerobic respiration (oxidative metabolism).

Fill all columns of the table except for the last one. Then identify your bacterium using identification table in the end of the task sheet and put the letter corresponding to the identified species into the column “ Result of identification”.

Identification of Bacteria (30 points)

Strain	Gram reaction	O\ F-test	The presence of:						Result of identification
			catalase	oxidase	protease	amylase	H_2S production	nitrate reductase	
1									
2									
3									
4									
5									

PLEASE BE CAREFUL WHEN PERFORMING REACTIONS AND DO NOT LET THE REAGENTS AND SOLUTIONS CONTACT YOUR SKIN AND CLOTHES!

PLEASE PUT USED PIPETTES, WOODEN TOOTHPICKS, GLASS SLIDES, FILTER PAPER, ETC. INTO A SPECIAL CONTAINER ON YOUR BENCH!

Test 1.1. Gram reaction

To perform this test you need:

1. Biomass of bacterial strains № 1-5 (from the GCO plate).

2. KOH solution (3 % KOH).

3. Five glass slides.

4. Wooden toothpicks.

Attention! You will need the «GCO» Petri dish later to perform tests 1.3 and 1.4. Please perform the tests in the suggested order: 1.1, 1.3, 1.4.

The method:

Using a dropping bottle, put a small drop of the 3 % KOH solution onto a glass slide. Using a toothpick, transfer some biomass (roughly 3-4 mm in diameter) of one strain to the KOH drop, trying not to transfer the agar. Mix the bacterial mass with the KOH solution thoroughly. If the mass sticks to the toothpick and moves behind it, the strain is Gram-negative, otherwise – Gram-positive. You may repeat the test if the results are not clear.

Using a new toothpick each time, repeat the test with the remaining strains. Put the results in the corresponding column of the "Identification of bacteria" table in the answer sheet using "+" for Gram-positive bacteria and "-" for Gram-negative.

Test 1.2. (O/F- test).

The O/F-test allows the determination of the ability of bacteria to utilise glucose in aerobic (oxidative metabolism) or anaerobic (fermentative metabolism) conditions. To determine the ability of your strains to utilise glucose aerobically and anaerobically, each strain was inoculated in advance into two tubes with agar medium containing the required mineral salts, glucose and a pH indicator ((water blue and rosolic acid) which is pink at neutral pH, blue at acidic pH and red at basic pH). To create anaerobic conditions, medium in the tubes labelled 1a – 5a was covered with vaseline oil immediately after inoculation, while the tubes 1b – 5b had no oil. The tubes were incubated in a thermostat for 24 hours.

Analyse the colour change in the tubes for each strain. Put the results in the column "O/F-test" in the table "Identification of bacteria" in the answer sheet. Use letter "F" for organisms with anaerobic respiration (fermentative metabolism) and letter "O" – for organisms with aerobic respiration (oxidative metabolism).

1.3. Catalase test.

To perform this test you need:

1. Biomass of bacterial strains № 1-5 (on the GCO plate).

2. Hydrogen peroxide solution (3 % H_2O_2).

3. Five glass slides.

4. Wooden toothpicks.

5. Pipettes.

The method:

Using a pipette, put a drop of hydrogen peroxide solution onto a glass slide. Using a toothpick, transfer some biomass of one strain from the GCO plate to the drop, trying not to transfer the agar. Mix the bacterial mass with the hydrogen peroxide solution thoroughly. Record the results while mixing the bacteria with the solution. Repeat the manipulation with the remaining four strains. Put the results in the corresponding column of the "Identification of bacteria" table in the answer sheet("+" if positive, "-" if negative).

Question 1.3.1. (2 points) Which reaction(s) is catalysed by catalase?

A. $3H_2O_2 + FADH_2 \rightarrow 3H_2O + O_2 + H_2 + FAD$

B. $2H_2O_2 \rightarrow 2H_2O + O_2$

C. $H_2O_2 \rightarrow 2HO^{\cdot}$

D. $H_2O_2 \rightarrow 2HO_2^{-} + H_2$

E. $2H_2O_2 + NADH + H^{+} \rightarrow 2H_2O + NAD^{+}$

Put your answer code or codes into the line 1.3.1.

1.3.1. _____

Test 1.4. Cytochrome oxidase test.

To perform this test you need:

1. A Petri dish (GCO), with colonies of strains № 1-5.

1. 1 % solution of DMPA.

The method:

Using a dropping bottle, put a drop of DMPA onto each colony. 30-60 seconds later the colonies of oxidase-positive strains turn pink to dark red. Analyse the colony colour of each strain and fill the results in the corresponding column of the "Identification of bacteria" table in the answer sheet.

Question 1.4.1. (4 points) Which of the following statements are true for cytochrome oxidase positive bacteria?

A. Capable of using O_2 as terminal electron acceptor in the respiratory chain.

B. All are unable to undertake anaerobic respiration.

C. All are strict aerobes (obligate aerobes).

D. All are strict anaerobes (obligate anaerobes).

E. All are facultative anaerobes.

F. Cytochrome oxidase takes part in chemosynthesis in some strains.

Put your answer code or codes into the line 1.4.1.

1.4.1. _____

1.5. Proteolytic activity test.

For determination of proteolytic activity you must analyse a Petri dish with media containing casein, inoculated in advance with strains № 1-5. This plate is labelled "protease". Record the results in the table in the answer sheet.

Test 1.6. Amylase test.

The plate labelled "amylase" contains rich solid medium supplemented with 0.2% of starch and has been inoculated with strains № 1-5 in advance. Cover the surface of this plate with Lugol's solution (Lugol) and determine which bacteria have the amylolytic activity. Record the reaction results into the corresponding column of the "Identification of bacteria" table in the answer sheet.

1.7. Test for hydrogen sulphide generation (H_2S-test).

Here you must analyse five tubes prepared previously. The tubes contain meat broth that was inoculated with test strains some time before. The tubes also contain pieces of white indicator paper saturated with the solution of lead acetate. Record the results in the table in the answer sheet.

Record in the answer sheet the single letter code for the correct answer for each of the two questions below:

Question 1.7.1. (4 points) When bacteria which are capable of producing H_2S grow on meat broth medium, H_2S is generated from:

A. RNA.	**F. Glycine.**
B. DNA.	**G. Thiamine.**
C. Arginine.	**H. Biotin.**
D. Methionine.	**I. Taurine.**
E. Serine.	**J. Cysteine.**

Put your answer code or codes into the line 1.7.1.

1.7.1.: _____

Question 1.7.2. (2 points) Which reaction(s) is/are responsible for the colour change of the indicator paper?

A. $2CH_3COOH + H_2S = (CH_3CO)_2S + 2H_2O$

B. $Pb^{2+} + S^{2-} = PbS$
C. $(CH_3COO)_2Pb + H_2S = 2CH_3COOH + Pb + S$
D. $2CH_3COOH + H_2S = CHSCOOH + 2H_2$
E. $2CH_3COOH + Pb + 2H_2S = 2C_2H_6 + PbSO_4 + S$

Write your answer code or codes down in the line 1.7.2. of the answer sheet

1.7.2.:_____

1.8. Nitrate reductase test (NR-test).

For this reaction you need:

1.Tubes with suspensions of cells of strains № 1-5 marked as "NR".

2. Griess reagent, 1 % (Griess).

3.Pipettes.

Add 1 ml of the 1% Griess (Griess) reagent to the suspension of bacteria. The presence of nitrate reductase activity results in the appearance of red colour within 1 minute. Record the results in the table in the answer sheet.

Question 1.8.1. (4 points) **The presence of nitrate reductase allows:**

A. The use of nitrate as an electron acceptor in the electron transport chain during chemosynthesis.

B. The use of nitrate as an electron donor in the electron transport chain during respiration.

C. The use of nitrate as an electron donor in the electron transport chain during chemosynthesis.

D. The use of nitrate as an electron acceptor in the electron transport chain during respiration.

E. The use of nitrites as nitrogen source.

Write your answer code or codes down in the line 1.8.1. of the answer sheet.

1.8.1.:_____

Use your results and the identification table to identify the species of your strains. Fill the results in the table in the answer list.

Identification table

	Genus, species	Gram reaction	O\ F-test	The presence of:					
				catalase	oxidase	protease	amylase	H_2S production	nitrate reductase
A	Escherichia coli	–	F	+	–	+	–	+	+
B	Xanthomonas campestris	–	O	+	–	+	–	+	–
C	Lactobacillus delbrueckii	+	F	–	–	+	–	+	–
D	Erwinia herbicola	–	F	+	–	–	–	+	+
E	Clavibacter michiganensis	+	O	+	–	–	+	+	–
F	Staphylococcus saprophyticus	+	F	+	–	–	–	–	–
G	Pseudomonas mendocina	–	O	–	+	–	–	–	+
H	Pseudomonas putida	–	O	+	+	+	–	–	–
I	Sarcina lutea	+	F	+	–	+	–	–	–
J	Streptobacillus moniliformes	–	F	–	–	–	–	–	–
K	Agrobacterium tumefaciens	–	O	+	+	–	–	+	+
L	Pseudomonas fluorescens	–	O	+	+	+	–	–	+
M	Bacillus subtilis	+	F	+	–	+	+	+	–
N	Streptococcus lactis	+	F	–	–	+	–	+	+

Task 2. (18 points) Study of Bacterial cultures expressing different genes.

Materials and equipment

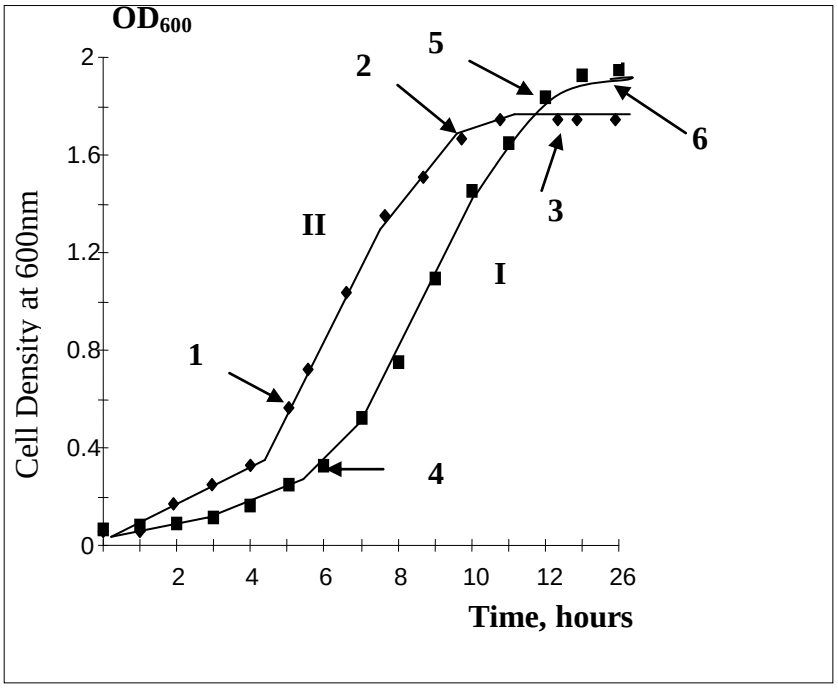
1.	**Six tubes with cells taken from cultures at different stages of growth.**	**6**
2.	**Distilled water (flask A).**	**1**
3.	**Dropping bottle with 0.5 M catechol solution (flask B).**	**1**
4.	**Pipette.**	**1**

The *xylE* gene coding the enzyme catechol-2,3-dioxygenase is often used as a reporter to study the expression of various genes. This enzyme catalyses the conversion of colourless catechol into a yellow coloured product called - hydroxymuconic semialdehyde. Fusing the promoterless *xylE* sequence to the promoter of gene of interest allows the expression of this gene to be analyzed according to the appearance and intensity of the yellow colour of reaction products.

Two strains of *Escherichia coli* have been constructed experimentally in which the *xylE* gene was fused to promoters of two different genes, gene C and gene D. Figure 1 shows growth curves for these bacteria, labelled I and II (I - *E. coli* with *xylE* fused to gene C promoter**,** II - *E. coli* with *xylE* fused to gene D promoter). The arrows in Figure 1 show when the cell samples were taken from the cultures. The number on the tube corresponds to the number of the arrow in Figure 1.

Determine the phases of culture growth in which genes C and D are expressed.

Figure 1



To do this you need to perform the following actions:

1) Fill the pipette to the mark using water (from flask A). Pipette this volume to each tube.

2) using the dropping bottle (flask B), add one drop of catechol solution to each tube and mix the contents of the tube by shaking,

3) leave the tubes at room temperature for 3 to 5 minutes,

4) examine the appearance of yellow colour in each tube.

Determine in which growth phases genes C and D are expressed and fill the table in the answer sheet, putting the "+" sign in the corresponding column.

Strain	Gene	The gene is expressed in		
		early log phase	late log phase	stationary phase
I	**C**			
II	**D**			

4.1.4 Laboratory «GENETICS».

Dear Participants!

In the laboratory **"GENETICS"** you will be given the following two tasks:

Task 1. Genetic analysis of inheritance of seed coat colour in *Phaseolus vulgaris L.*

Task 2. Identification of the *trp* mutations in the yeast *Saccharomyces cerevisiae.*

Duration of the lab work is **60 minutes.**

Maximum number of points – **61**.

You have to write down your results and answers on the **ANSWER SHEET** which will be collected by an assistant when the time elapses. It is not necessary to write anything on the task sheets.

Good luck!

Country_____

First name_____ Family name _____

Code_____

<u>Task 1. (30.5 points)</u> Genetic analysis of inheritance of seed coat colour in *Phaseolus vulgaris L.*

Time for carrying out this task must not exceed 25 minutes

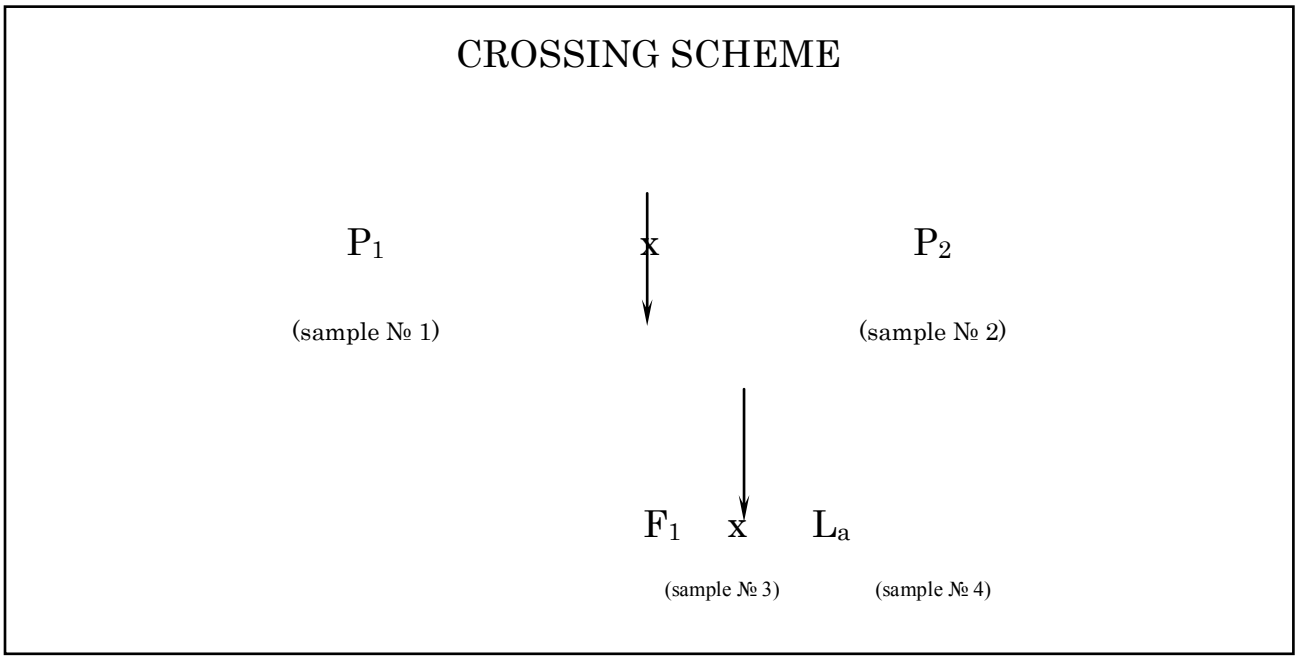
Materials and equipment

1.	Parental sample seeds (P_1).	sample № 1
2.	Parental sample seeds (P_2).	sample № 2
3.	Hybrid seeds (F_1).	sample № 3
4.	Test cross line seeds (L_a).	sample № 4
5.	Seeds of F_a generation.	sample № 5
6.	Petri dishes for seeds.	2
7.	Sheet of white paper.	1

The seed-coat colour of common beans (*Phaseolus vulgaris L.*) is controlled by a number of genes, which are responsible for the synthesis of pigments and distribution of the seed coat colour, as well as modifying genes, that can enhance, attenuate or change colour in another way. In the preliminary experiments breeding of two types of common beans (P_1 and P_2)differing in seed-coat colour was conducted. Seeds of F_1 plants were cultured. Plants (F_1) gave seeds of F_1 phenotype.

On the next stage of the experiment test-crossing of F_1 plants with testcross line plants (L_a) was conducted. Grown hybrids (F_a) gave seeds of F_a phenotype. For the next analysis, one seed from each F_a plant was taken.

Scheme of the experiment.



Stages of the work:

You are given parental sample seeds P_1 (sample № 1) and P_2 (sample № 2), hybrid seeds F_1 (sample № 3), testcross line seeds L_a (sample № 4) and seeds of F_a generation (sample № 5).Differences between parental samples are determined by different combinations of two pairs of non-allelic genes A and B (different gene loci). Gene A controls synthesis of pigment ("A" = dominant allele -pigment is present, "a" = recessive gene -pigment is absent). Gene B is a modifying gene, that influences colour intensity (B = dominant allele – modification is present, and b = recessive allele – modification is absent). Different combinations of two pairs of non-allelic genes A and B cause the development of three types of seed-coat colour (Table 1).

Table 1

Kind of seeds	Seed-coat colour	Code of the colour
	White	**w**
	Yellow-brown	**y**
	Black	**b**

You should accomplish the next problems:

Determine if parental samples P_1 and P_2 are pure-breeding lines (homozygous at each gene locus).

- Determine the type of inheritance of seed-coat colour in common beans (presence of interaction of non-allelic genes A and B).
- Determine the genotypes of the parental forms of P_1 and P_2, hybrid seeds F_1, seeds of F_a generation and testcross line seeds L_a
- Determine if the investigated non-allelic genes are linked.

Attention! The differences in viability of zygotes or gametes of different types of analyzed common bean (***Phaseolus vulgaris L.*****)** samples were not detected. Genes A and B are localized in the nucleus.

Problem 1.1. Determine if the parental samples P_1 and P_2 are pure-breeding lines (homozygous by every pair of non-allelic genes) by seed coat colour ? To answer this question you must analyze F_1 seeds.

1.1.1. (1.5 points) Look over samples № 1 and № 2. Specify the seed phenotypes of parental forms and F_1 using the symbols from Table 1 (Page 4). Fill in the table in the answer sheet:

Plant seeds	Sample	Seed phenotype
P_1	№ 1	
P_2	№ 2	
F_1	№ 3	

1.1.2. (2 points) Analyse the seed-coat phenotypes of parental samples and F_1 hybrids. Select the correct answer. On the answer sheet record in the symbols of correct answers:

A. Both parental plants are homozygous.
B. Both parental plants are heterozygous.
C. Plant P_1 is homozygous, plant P_2 is heterozygous.
D. Plant P_2 is homozygous, plant P_1 is heterozygous.
E. Using the data presented it is impossible to determine, if the parental genotypes are pure-breeding lines.

1.1.2.:_____

Problem 1.2. Determine the type of inheritance of seed-coat colour in common beans. You need to analyze the seeds of F_a plants, which were received after breeding of F_1 plants with L_a plants.

1.2.1. (1 point) Carefully place the seeds from sample № 5 (F_a plant seeds) on to the sheet of white paper. Identify the quantity of the phenotypic classes of F_a by seed-coat colour. Group the seeds of F_a by phenotypic classes by putting them into Petri dishes for seeds. Using the codes from Table 1 specify the phenotypes of F_a. Record in the table in the answer sheet.

№ of class	Seed phenotype
Total number of classes	

1.2.2. (3 points) **Using your findings about the quantity of F_a classes, choose the type of interaction of non-allelic genes A and B, which control seed-coat colour in common beans. Record the symbols of correct answers on the answer sheet.**

A. There is no interaction of non-allelic genes in the experiment conducted.
B. Incomplete dominance.
C. Duplicate genes
D. Epistasis
E. Codominance.
F. Pleiotropic gene action.

1.2.2:_____

Problem 1.3. Determine the genotypes of the parental samples P_1 and P_2, hybrid seeds F_1, seeds of F_a generation and testcross line seeds (L_a)

1.3.1. (4 points) Specify all of the possible genotypes of P_1, P_2, F_1, F_a, and L_a plants using symbols "*A*" and "*B*" to mark the dominant alleles, symbols "*a*" and "*b*" to mark the recessive alleles of the investigated genes in the boxes of the table below. Fill in the table in the answer sheet.

Plants	Seed phenotype		
	Black	**Yellow-brown**	**White**
P_1			
P_2			
F_1			
L_a			
F_a			

Problem 4. Determine if the investigated non-allelic genes A and B are linked.

1.4.1. (1 point) Determine frequency of phenotypic classes in F_a by seed colour. To answer this question calculate the number of seeds in each class. Use the codes from Table 1. Fill in the table in the answer sheet.

№ of class	Seed phenotype	Number of seeds
Total number of seeds		

1.4.2. (3 points) Determine the ratio of the different phenotype classes by the colour of the seeds in F_a. Fill in the answer sheet using the code of the correct answer:

Code	White	Yellow-brown	Black
A.	**0.50**	**0.25**	**0.25**
B.	**0.50**	**0.19**	**0.31**
C.	**0.56**	**0.16**	**0.28**
D.	**0.42**	**0.14**	**0.44**
E.	**0.44**	**0.15**	**0.41**
F.	**0.50**	**0.14**	**0.36**

1.4.2.: _____

1.4.3. (3 points) **To determine whether there is linkage between the genes being investigated you must specify the** expected ratio **in F_a in the case of** no **linkage. You an receive the points for this task only if your answer for 1.2.2. is correct. Record in the table in the answer sheet:**

Phenotypic class	Ratio (%)
White seeds	
Yellow-brown seeds	
Black seeds	

1.4.4. (3 points) **Specify the** expected ratio **by seed colour in F_a if the investigated genes *A* and *B* are linked completely. You can receive the points for this task only if your answer for 1.2.2. is correct. Record in the table in the answer sheet:**

Phenotypic class	Ratio (%)
White seeds	
Yellow-brown seeds	
Black seeds	

1.4.5. (3 points) Using χ^2 method, determine whether to reject or not-reject (accept) your hypothesis

Calculate the χ^2 value for H_0 (null hypothesis)being "No linkage" using the formula below:

$$\chi^2 = \Sigma((E_i - O_i)^2 / E_i),$$

where E_i is the expected frequency of the phenotype class i. O_i is the practically observed frequency of the same class. Use two decimal places during your calculations. Record in the answer sheet by the χ^2 value (with two decimal places).

1.4.5. _____

1.4.6. (3 points) Use the table of χ^2 distribution to determine what is the maximum probability (p) of your H_0 (null hypothesis)not being rejected (being accepted). Write the codes of the answers on your answer sheet.

Table of χ^2 distribution

df	Value (p) of a significance level χ^2									
	0.99	**0.95**	**0.90**	**0.75**	**0.50**	**0.25**	**0.10**	**0.05**	**0.025**	**0.01**
1	-	-	0.02	0.10	0.45	1.32	2.71	3.84	5.02	6.63
2	0.02	0.10	0.21	0.58	1.39	2.77	4.61	5.99	7.38	9.21
3	0.11	0.35	0.58	1.21	2.37	4.11	6.25	7.81	9.35	11.34
4	0.30	0.71	1.06	1.92	3.36	5.39	7.78	9.49	11.14	13.28
5	0.55	1.15	1.61	2.67	4.35	6.63	9.24	11.07	12.83	15.09
6	0.87	1.64	2.20	3.45	5.35	7.84	10.64	12.59	14.45	16.81
7	1.24	2.17	2.83	4.25	6.35	9.04	12.02	14.07	16.01	18.48
8	1.65	2.73	3.49	5.07	7.34	10.22	13.36	15.51	17.53	20.09
9	2.09	3.33	4.17	5.90	8.34	11.39	14.68	16.92	19.02	21.67
10	2.56	3.94	4.87	6.74	9.34	12.55	15.99	18.31	20.48	23.21

A. < 0.01
B. > 0.01
C. < 0.05
D. > 0.05
E. 0.01
F. 0.05

1.4.6. _____

1.4.7. (3 points) **Using your value of p, determine if genes A and B are linked. Calculate the distance between genes A and B (in cM) if they linked. Record in the answer sheet the code of correct answer.**

A. There is complete linkage between genes A and B. The distance between the genes is 6.94 cM.

B. There is complete linkage between genes A and B. The distance between the genes is 12.36 cM.

C. There is complete linkage between genes A and B. The distance between the genes is 27.78 cM.

D. There is incomplete linkage between genes A and B. The distance between the genes is 6.94 cM.

E. There is incomplete linkage between genes A and B. The distance between the genes is 12.36 cM.

F. There is incomplete linkage between genes A and B. The distance between the genes is 27.78 cM.

G. Genes A and B are not linked. The distance between the genes is 6.94 cM.

H. Genes A and B are not linked. The distance between the genes is 12.,36 cM.

I. Genes A and B are not linked. The distance between the genes is 27.78 cM

J. Genes A and B are not linked

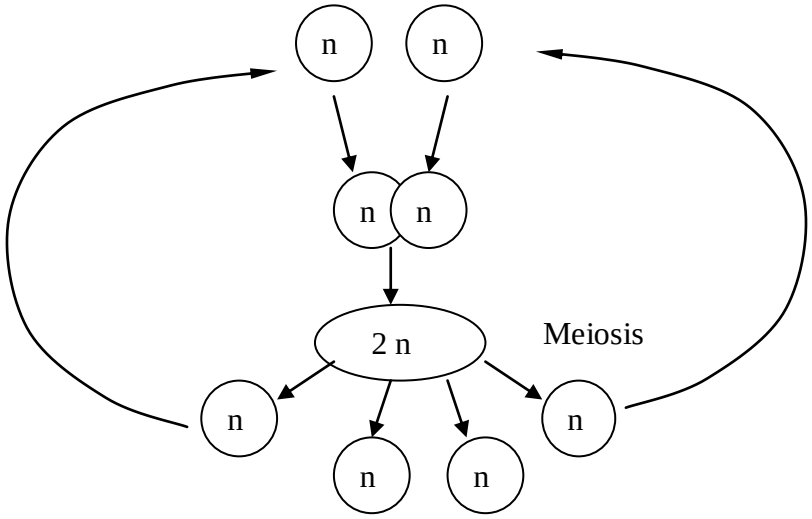
1.4.7: _____

Task 2: (30.5 points) Identification of *trp* mutations in yeast *Saccharomyces cerevisiae*

Materials and equipment

1.	Tubes with culture liquid.	12
2.	A plate with 12 wells.	1
3.	A tube with Erlich reagent.	1
4.	A tube with indole solution.	1
5.	A tube with anthranilate solution.	1
6.	A tube with water.	1
7.	1 ml pipette.	13
8.	A sheet of white paper.	1
9.	A container for used pipettes.	1
10.	Paper towels.	1

You are given the yeast *Saccharomyces cerevisiae* as an experimental organism. The scheme of life cycle of this organism is presented below.



These yeasts have alternating haploid and diploid phases during their life cycle. The fusion of haploid cells gives rise to a diploid cell which through meiosis can produce four haploid cells with different genotypes.

The scheme below shows the pathway of tryptophan biosynthesis in the yeast *Saccharomyces cerevisiae.* The scheme shows some intermediate products and genes responsible for the synthesis of enzymes of this pathway.

chorismate ⟶ anthranilate ⟶ ⟶ ⟶ indole ⟶ ⟶ tryptophan

trp2 gene *trp4* gene *trp5* gene

Mutations in the *trp* genes lead to the accumulation of the intermediates in the culture liquid. Two intermediates of this biosynthetic pathway, anthranilate and indole, can be detected in the culture liquid of the corresponding mutants through colour reactions with the Erlich reagent.

2.1. (1.5 points) Using a special pipette, add 0.5 ml of Erlich reagent to the control tubes with standard solutions of anthranilate, indole and to the tube with water (with no anthranilate and indole). Observe the colour change and record it in the table in the answer sheet using single letter colour code.

Compound	Colour after Erlich reagent addition
Water	
Anthranilate	
Indole	
Colour code:	У – yellow
	R – red
	N – no colour change

2.2. (1.5 points) Which compounds will accumulate in the culture liquid if the mutants are grown in the rich medium? Fill in the table below in the answer sheet using one letter code.

Mutant	Accumulated intermediate
trp 2 $^-$	
trp 4 $^-$	
trp 5 $^-$	
Code:	A – anthranilate
	I – indole
	O – neither anthranilate nor indole

2.3. (6 points) **Three classes of double mutants have been constructed in haploid *S. cerevisiae* named as *trpX*$^-$ *trpY*$^-$ *trpZ*$^+$; *trpX*$^-$ *trpY*$^+$ *trpZ*$^-$; *trpX*$^+$ *trpY*$^-$ *trpZ*$^-$(sign «– » denotes mutant genes, sign « + » denotes wild type genes; all *trp* genes are located on different chromosomes).**

Three matings between these mutants have been performed as shown in the table below. Each mating has generated all possible types of haploid progeny. Please write down in the answer sheet the genotypes of all possible progeny from each cross.

№	**Mating**	**Possible progeny genotypes**
I	***trpX*** $^-$ ***trpY*** $^-$ ***trpZ*** $^+$ × ***trpX*** $^-$ ***trpY*** $^+$ ***trpZ*** $^-$	
II	***trpX*** $^-$ ***trpY*** $^-$ ***trpZ*** $^+$ × ***trpX*** $^+$ ***trpY*** $^-$ ***trpZ*** $^-$	
III	*trpX*$^-$ *trpY*$^+$ *trpZ*$^-$ × *trpX*$^+$ *trpY*$^-$ *trpZ*$^-$	

2.4. (12 points) **Clones produced by these matings have then been grown in liquid medium, cells removed by centrifugation and supernatant collected for analysis. You now need to identify these clones.**

Please test each of the 12 culture liquid samples for the presence of the tryptophan metabolic intermediates and use these data for the identification of the *trpX*$^-$, *trpY*$^-$ and *trpZ*$^-$ mutations. You are given tubes with supernatants from 12 cultures of *S. cerevisiae.* The tubes are labelled according to the mating (I, II and III) and clone number (1-4).

To test the accumulation of particular compounds, transfer 1 ml of liquid from each tube to the wells of the 12-well plate. Use a new pipette for each transfer!

Add 0.5 ml of the Erlich reagent (using a special pipette) to each well containing the 1 ml of supernatant. Record the colour changes (using a single letter code) in the table in the answer sheet.

Determine which compound has accumulated in each culture and record this in the same table in the answer sheet using a single letter code.

№	Mating	Tube №	Colour after Erlich reagent addition	Accumulated intermediate
I	***trpX*$^-$ *trpY*$^-$ *trpZ*$^+$ × *trpX*$^-$ *trpY*$^+$ *trpZ*$^-$**	I.1		
		I.2		
		I.3		
		I.4		
II	***trpX*$^-$ *trpY*$^-$ *trpZ*$^+$ × *trpX*$^+$ *trpY*$^-$ *trpZ*$^-$**	II.1		
		II.2		
		II.3		
		II.4		
III	*trpX*$^-$ *trpY*$^+$ *trpZ*$^-$ × *trpX*$^+$ *trpY*$^-$ *trpZ*$^-$	III.1		
		III.2		
		III.3		
		III.4		
Code:			У – yellow	A – anthranilate
			R – red	I – indole
			N – no colour change	O – neither anthranilate nor indole

2.5. (3 points) **Identify the *trpX*⁻, *trpY*⁻ and *trpZ*⁻ mutations. Write down names of the genes in which the *trpX*⁻, *trpY*⁻ and *trpZ*⁻ mutations are located in the table in the answer sheet.**

Gene	Mutation
trp 2	
trp 4	
trp 5	

2.6. (3 points) **How would the experimental results change if the *trpX*⁻ and *trpY*⁻ genes were completely linked? Record in the answer sheet the letter corresponding to the correct answer:**

A. The number of different progeny genotypes would be reduced.
B. The results would not be changed.
C. Phenotypically wild type yeast may be produced.
D. The number of single and triple mutants would increase.

2.6.:_____

2.7. (1.5 points) **How many genotype classes would be obtained if the three genes were located on the same chromosome and were 100 per cent linked? Write the number for each mating in the answer sheet.**

2.7.: I_____

II_____

III_____

2.8. (0.5 points) **Which mating will give the single mutant accumulating anthranilate? Write the mating number (I, II or III) in the answer sheet.**

2.8.:_____

2.9. (0.5 point) **Write the genotype of this mutant in the answer sheet using the actual gene names (*trp 2*, *trp 4* or *trp 5*).**

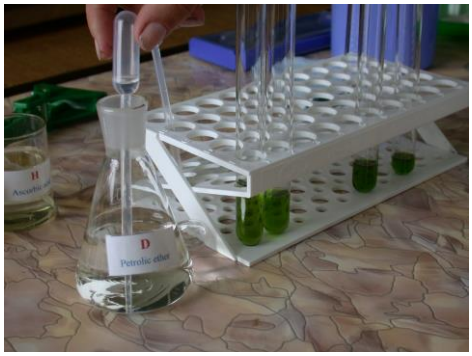
2.9.:_____

2.10. (1 point) **Which of the double mutants has to be mated with this anthranilate-accumulating single mutant to get progeny with wild type genotype? Write the genotype of this double mutant in the answer sheet using the actual gene names (*trp 2*, *trp 4* or *trp 5*).**

2.10.:_____

4.2 The correct answers to the practical tests.

4.2.1 Laboratory «PLANT PHYSIOLOGY, MORPHOLOGY AND ANATOMY».

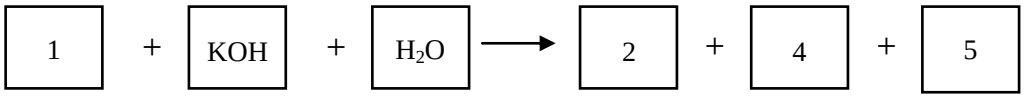


Transfer 3 ml of pigment solution from flask A into tubes № 1 and № 2. Add five drops of 20% KOH from flask B and 1 ml of H_2O (from flask C) to the tube № 1 and to the tube № 2 - only 1 ml of H_2O.

Add 1 ml of the petrolium ether (from the flask D) to the tubes № 1 and № 2, shake well and leave to stand until the fractions separate completely.

Task 1

1.1.



1.2.

Tube №	Reagent	Experiment 1.1.	Experiment 1.2.
		Ethanol fraction colour	Petrolic ether fraction colour
1	KOH	C	D
2	H_2O	C	C

1.3.

№1 B

№2 D

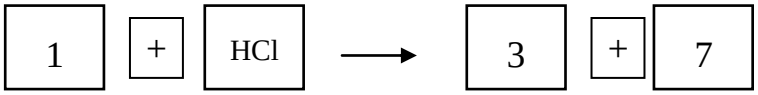
Add 3 ml of the pigment extract to the tube № 3 (flask A) and add 5 drops of HCl (flask E). Mix the tube contents thoroughly by shaking and note the colour change. Add 1 ml of the saturated $(CH_3COO)_2Zn$ solution (from the flask F) to the same tube. Heat the solution on the water bath. Mix by shaking, note the colour change.

Add 2 ml of the pigment extract and 2 ml of ascorbic acid (flask H) to the tube № 4. Mix by shaking until the colour changes.

1.4.

Reagent	Solution colour in the tube
HCl	**F**
$(CH_3COO)_2$ Zn	**C**

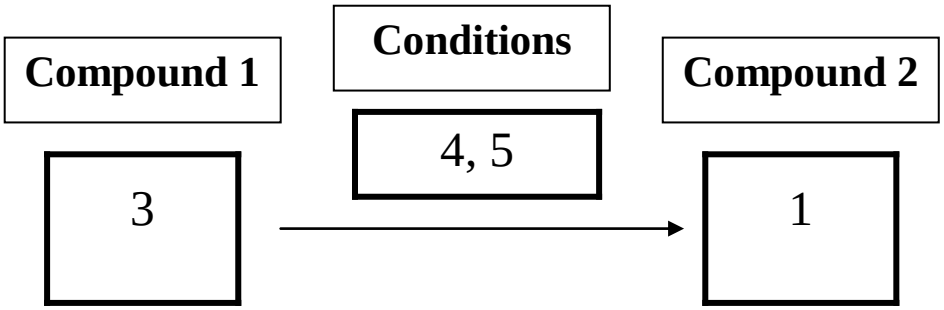
1.5.



1.6.

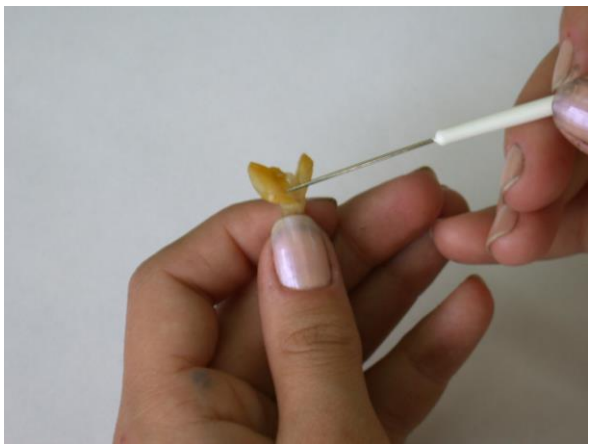
Extract colour before reaction	Solution colour after reaction
C	**D**

1.7.



1.8.

Compound №	Colour before reaction	Colour after reaction
1	H	H
2	C	D



Study the morphology of flowers A, B, C. Using formula numbers (1-14) from the list below, indicate the correct formulas for each flower in the answer sheet.

Task 2.

2.1.

A	B	C
11	6	8

2.2.

A	B	C
1	4	1

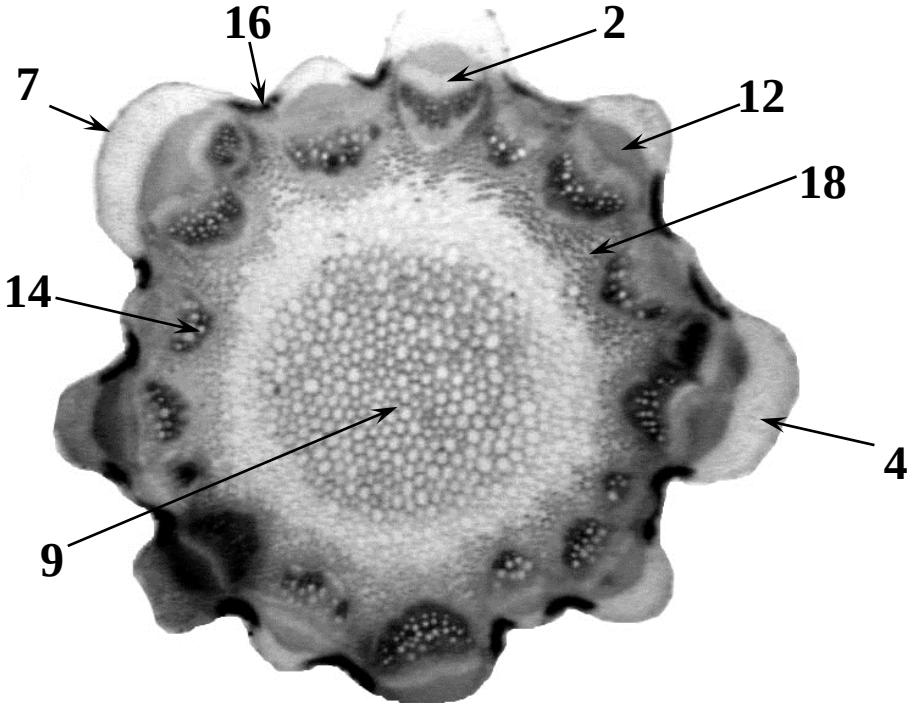
2.3.

A	B	C
7	3	4

Prepare a cross cut of the object you are given. Colour this cross cut with phloroglucine and add several drops of HCl. Wash the preparation thoroughly with water after 2-5 minutes and then cover it with a cover slip. Observe the preparation under the microscope. Compare the crosscut you just prepared to the schemes 1-6 below and determine which scheme it corresponds to.

Task 3.

3.1



3.2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
				+	+						+		+				

3.3
3

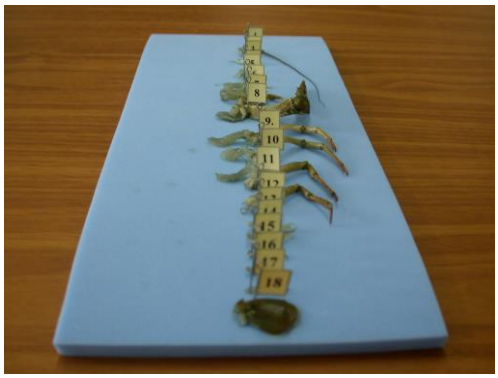
3.4
2

3.5
5

3.6
3

4.2.2 Laboratory «ANIMAL MORPHOLOGY, ANATOMY AND SYSTEMATICS».

You need to observe the details of animal's segmentation, to find its body parts and sequentially detach the appendages (excluding antennula [antenna 1]) from one side of animal's body, assembling them in order on a plate with the help of pins. Then it is necessary to determine the function of each appendage and write it down in the answer sheet.

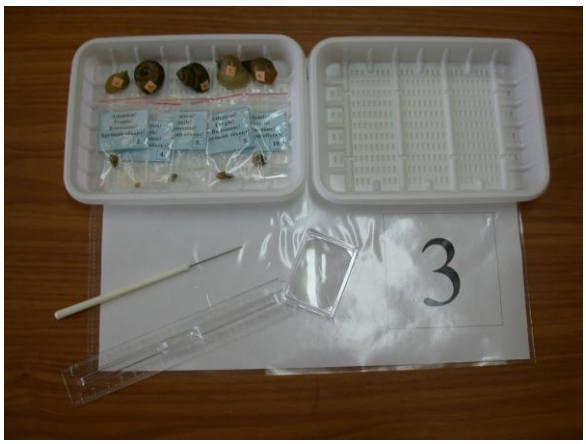


Task 1.

Pedes (extremities)			
№	Functions		
1.	● sensory	○ respiratory	○ reproductive
2.	○ swimming	● food grinding	○ respiratory
3.	● transferring food to mouth	○ respiratory	○ reproductive
4.	○ reproductive	○ transferring food to mouth	○ sensory
5.	○ transferring food to mouth	○ walking	○ defence/attack
6.	○ defence/attack	○ transferring food to mouth	○ reproductive
7.	○ reproductive	○ swimming	● respiratory
8.	○ swimming	● capturing and holding food	○ reproductive
9.	○ reproductive	● respiratory	○ defence/attack
10.	○ reproductive	● walking	○ sensory
11.	○ reproductive	○ transferring food to mouth	● walking
12.	● walking	○ food grinding	○ sensory
13.	○ walking	○ reproductive	○ defence/attack
14.	○ walking	○ respiratory	● reproductive
15.	○ defence/attack	● swimming	○ walking
16.	● swimming	○ food grinding	○ respiratory
17.	○ reproductive	○ sensory	● swimming
18.	● swimming	○ transferring food to mouth	○ respiratory

Task 2.

№	Code		
	Phylum	**Subphylum/Class**	**Genus**
I	**B**	**f**	**7**
II	**F**	**b**	**10**
III	**D**	**a**	**3**
IV	**H**	**k**	**5**
V	**B**	**d**	**4**
VI	**B**	**f**	**8**
VII	**D**	**e**	**6**
VIII	**E**	**j**	**2**
IX	**B**	**c**	**1**
X	**A**	**g**	**9**



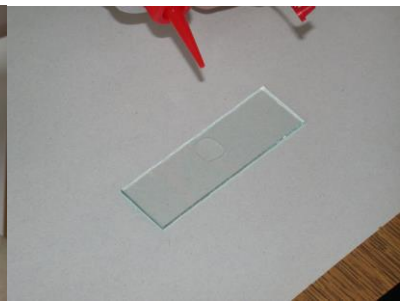
Classify the molluscs you are given and place the numbers written on their shells next to species names in the table in the answer sheet.

Task 3.

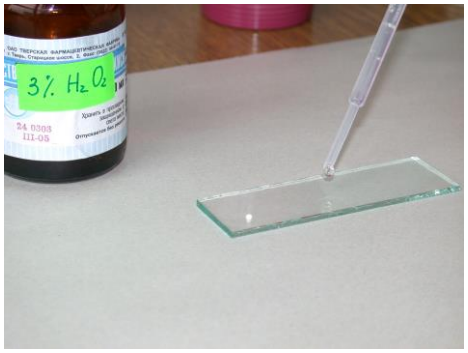
Species name	Shell number
	6
Viviparus contectus	**2**
Bithynia tentaculata	**5**
Physa fontinalis	
Aplexa hypnorum	**1**
Radix ovata	**7**
Radix auricularia	**9**
Lymnaea stagnalis	**3**
Planorbarius corneus	**10**
Planorbis planorbis	**4**
Segmentina nitida	

4.2.3 Laboratory «MICROBIOLOGY AND BIOTECHNOLOGY».

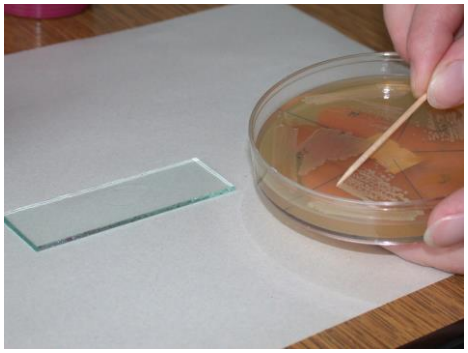
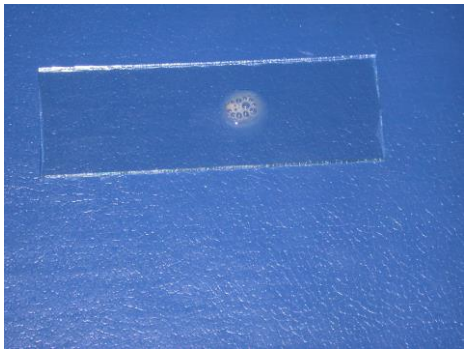


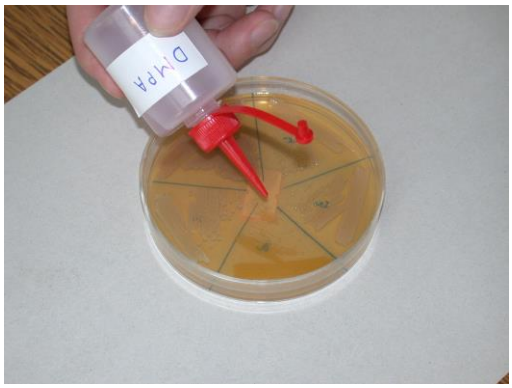


Using a dropping bottle, put a small drop of the 3 % KOH solution onto a glass slide. Using a toothpick, transfer some biomass (roughly 3-4 mm in diameter) of one strain to the KOH drop, trying not to transfer the agar. Mix the bacterial mass with the KOH solution thoroughly. If the mass sticks to the toothpick and moves behind it, the strain is Gram-negative, otherwise – Gram-positive. You can repeat the test if results are not clear

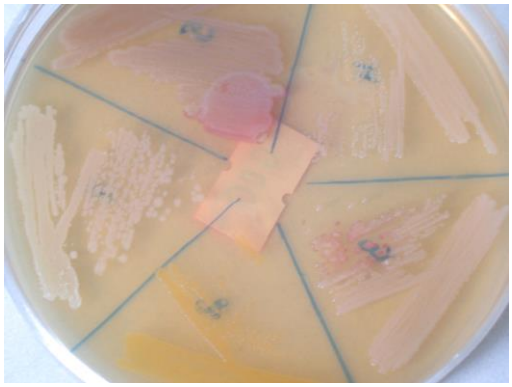



Using a pipette, put a drop of hydrogen peroxide solution onto a glass slide. Using a toothpick, transfer some biomass of one strain from the GCO plate to the drop, trying not to transfer the agar. Mix bacterial mass with the hydrogen peroxide solution thoroughly. Register the results while mixing the bacteria with the solution. Repeat the manipulation with the remaining strains

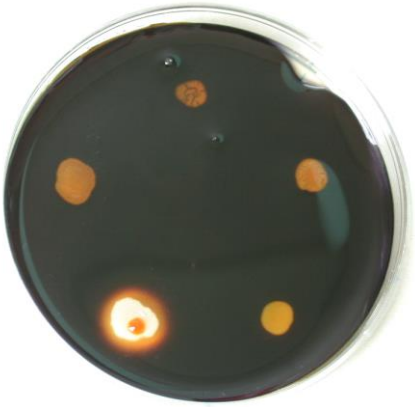


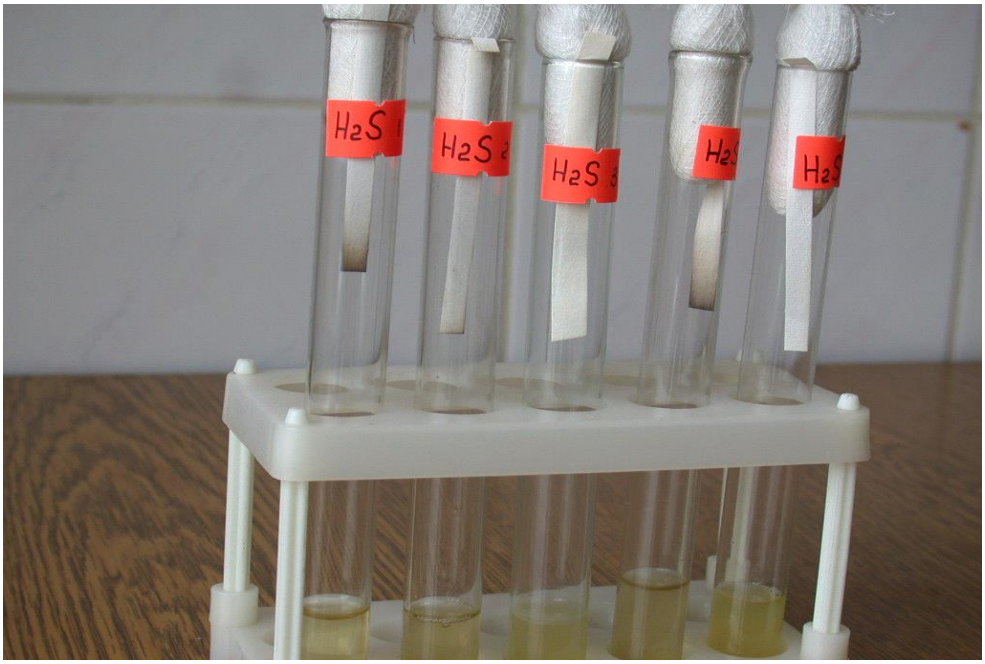
Using a dropping bottle, put a drop of DMPA onto each colony. 30-60 seconds later the colonies of oxidase-positive strains turn dark red (pink).



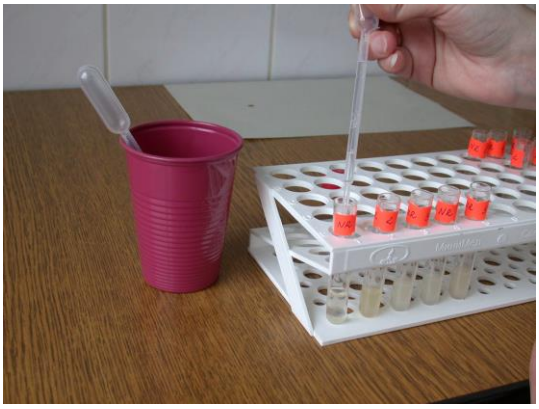
For determination of proteolytic activity you have to analyse a Petri dish with media containing casein, inoculated in advance with strains № 1-5. This plate is labelled "protease".

The plate labelled "amylase" contains rich solid medium supplemented with 0.2% of starch and has been inoculated with strains № 1-5 in advance. Cover the surface of this plate with Lugol's solution (Lugol) and determine which bacteria have the amylolytic activity





Here you have to analyse five tubes prepared before. The tubes contain meat broth and were inoculated with test strains some time before. The tubes also contain pieces of white indicator paper saturated with the solution of lead acetate

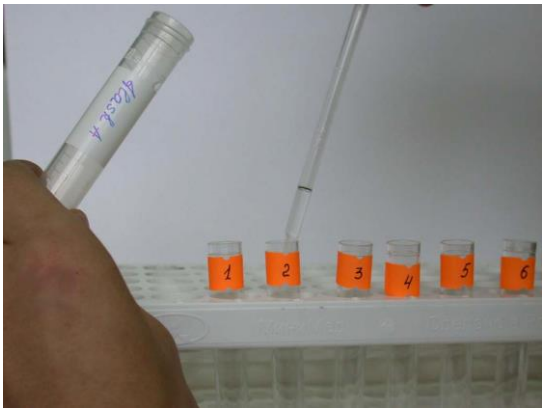


Add 1 ml of the 1% Griess reagent to the to suspension of bacteria. The presence of nitrate reductase activity results in the appearance of red colour within 1 minute.

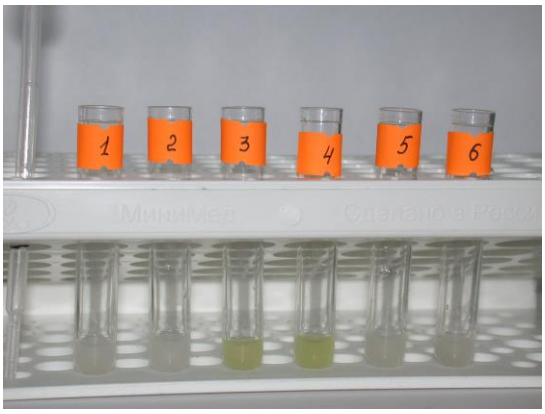
Task 1.

Strain	Gram reaction	O\ F-test	The presence of: catalase	oxidase	protease	amylase	H_2S production	nitrate	Result of identification
1	+	F	+	-	+	+	+	-	M
2	-	F	+	-	+	-	+	+	A
3	-	O	+	+	+	-	-	-	H
4	-	O	+	+	-	-	+	+	K
5	-	O	+	+	+	-	-	+	L

1.3.1.	1.4.1.	1.7.1.	1.7.2.	1.8.1.
B	**A, F**	**D, J**	**B**	**A, D**



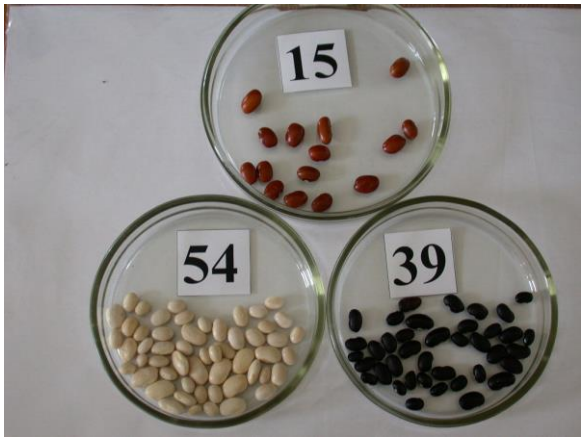
Determine the phases of culture growth in which genes C and D are expressed.



Task 2.

Strain	Gene	The gene is expressed in		
		early log phase	late log phase	stationary phase
I	C	+	–	–
II	D	–	–	+

4.2.4 Laboratory «GENETICS».



Determine if parental samples P_1 and P_2 are inbreed lines (homozygous by every pair of non-allelic genes).
Determine the type of inheritance of seed-coat color in common beans (presence of interaction of non-allelic genes A and B).
Determine the genotypes of the parental forms of P_1 and P_2, hybrid seeds F_1, seeds of F_a generation and analyzing line seeds L_a
Determine if the investigated non-allelic genes are linked.

Task 1.

1.1.1.

Plant seeds	Sample	Seed phenotype
		b
		w
		y

1.1.2.

A

1.2.1.

№ of class	Seed phenotype
1	**w**
2	**b**
3	**y**
Total	**3**

1.2.2.

D

1.3.1.

Plants	Seeds phenotype		
	Black	Yellow-brown	White
P_1	AAbb		
P_2			aaBB
F_1		AaBb	
L_a			aabb
F_a	Aabb	AaBb	aabb aaBb

1.4.1.

№ of class	Seeds phenotype	Number of seeds
1	w	54
2	b	39
3	y	15
Total of seeds		108

1.4.2.

1.4.3.

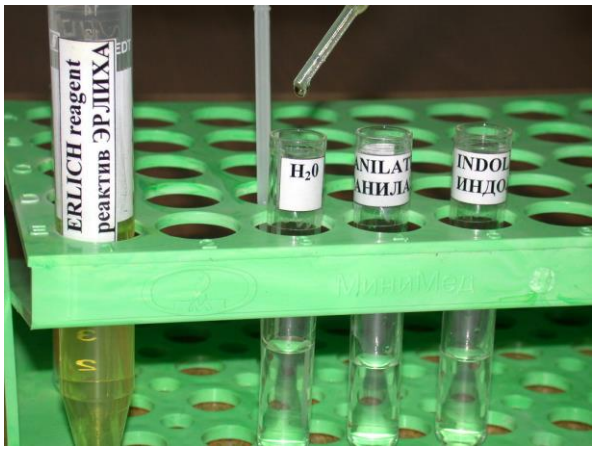
Phenotypic class	Ratio (%)
White seeds	50
Yellow-brown seeds	25
Black seeds	25

1.4.4.

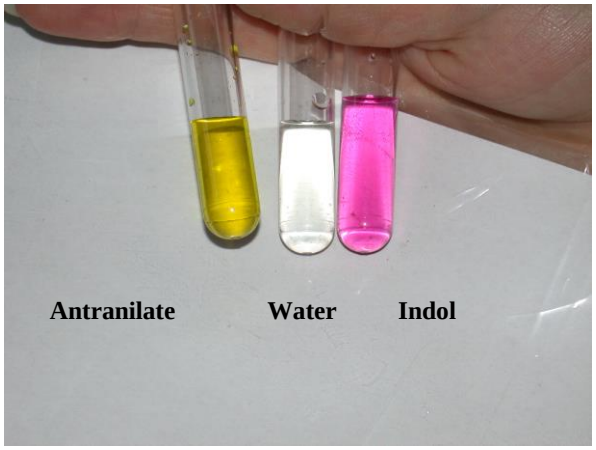
Phenotypic class	Ratio (%)
White seeds	**50**
Yellow-brown seeds	**0**
Black seeds	**50**

1.4.5. **1.4.6.** **1.4.7.**

10,67 **A, C** **F**



Identification of *trp* mutations in yeast *Saccharomyces cerevisiae*
Using a special pipette, add 0.5 ml of Erlich reagent to the control tubes with standard solutions of anthranilate, indole and to the tube with water (with no anthranilate and indole). Observe the colour change.



Task 2.

2.1.

Compound	Colour after Erlich reagent addition
Water	N
Anthranilate	Y
Indole	R
Colour code:	У – yellow
	R – red
	N – no colour change

2.2.

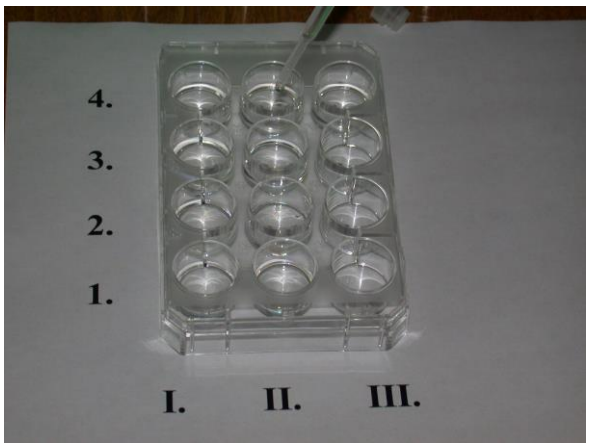
Mutant		
trp 2 $^{-}$	**O**	
trp 4 $^{-}$	**A**	
trp 5 $^{-}$	**I**	
Code:	**A – anthranilate**	
	I – indole	
	O – neither antranilate nor indole	

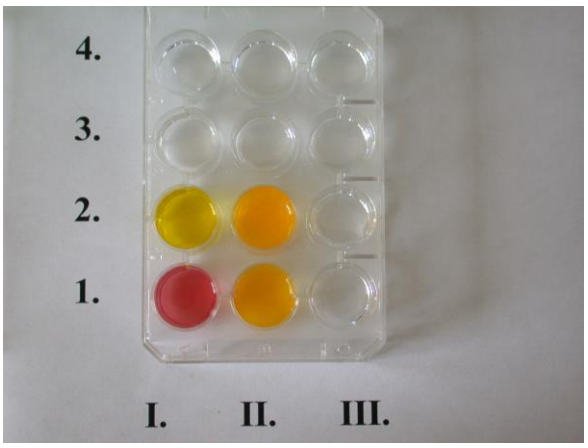
chorismate ⟶ anthranilate ⟶ ⟶ ⟶ indole ⟶⟶ tryptophan

trp2 **gene** ***trp4*** **gene** ***trp5*** **gene**

2.3.

№	**Mating**	**Possible progeny genotypes**
№		
I	***trpX*** $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{+}$ × ***trpX*** $^{-}$ ***trpY*** $^{+}$ ***trpZ*** $^{-}$	***trpX*** $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{+}$
		trpX $^{-}$ ***trpY*** $^{+}$ ***trpZ*** $^{-}$
		trpX $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$
		trpX $^{-}$ ***trpY*** $^{+}$ ***trpZ*** $^{+}$
II	***trpX*** $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{+}$ × ***trpX*** $^{+}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$	***trpX*** $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{+}$
		trpX $^{+}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$
		trpX $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$
		trpX $^{+}$ ***trpY*** $^{-}$ ***trpZ*** $^{+}$
III	***trpX*** $^{-}$ ***trpY*** $^{+}$ ***trpZ*** $^{-}$ × ***trpX*** $^{+}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$	***trpX*** $^{-}$ ***trpY*** $^{+}$ ***trpZ*** $^{-}$
		trpX $^{+}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$
		trpX $^{-}$ ***trpY*** $^{-}$ ***trpZ*** $^{-}$





F

To test the accumulation of particular compounds, transfer 1 ml of liquid from each tube to the wells of the 12-well plate.
Add 0.5 ml of the Erlich reagent (using a special pipette) to each well with 1 ml of supernatant. Record the colour changes

2.4.

			Colour after Erlich reagent	
I	$trpX^- trpY^- trpZ^+$ × $trpX^- trpY^+ trpZ^-$	I.1	R	I
		I.2	Y	A
		I.3	N	O
		I.4	N	O
II	$trpX^- trpY^- trpZ^+$ × $trpX^+ trpY^- trpZ^-$	II.1	Y	A
		II.2	Y	A
		II.3	N	O
		II.4	N	O
III	$trpX^- trpY^+ trpZ^-$ × $trpX^+ trpY^- trpZ^-$	III.1	N	O
		III.2	N	O
		III.3	N	O
		III.4	N	O
Code:			У – yellow	A – anthranilate
			R – red	I – indole
			N – no colour change	O – neither antranilate or indole

2.5.

Gene	Mutation
trp 2	***trp Z*** $^{-}$
trp 4	***trp Y*** $^{-}$
trp 5	***trp X*** $^{-}$

2.6.

A

2.8.

II

2.7.

I _____2_____
II_____2_____
III_____2_____

2.9.

trp5 $^{+}$ ***trp4*** $^{-}$ ***trp2*** $^{+}$

2.10.

4.3 Theoretical part

14-th International Biology Olympiad
Minsk – Belarus,
8th-16th July, 2003

THEORETICAL TEST

Dear competitors!

You will have 4.5 hours for answering all the tasks of parts A and B. Tasks for **part A** have **only one** correct answer. You have to mark it by filling in the circle opposite the test number on the **answer sheet**. Answers written in the question paper will not be taken into account.

Tasks for **part B** may have **several (more than one)** correct answers. You must fill them in the **answer sheet part B**. The marks for the questions of **part B** depend on the number and complexity of the questions.. The marks are shown in the text.

Be attentive while filling in the answer sheet. Make sure the correct circle corresponding to the appropriate question is filled in. Any corrections in **answer sheet** should be avoided!
Note there are some questions which are marked SKIPPED. **Do Not** answer these.
Please read all possible answers before attempting the question, as many questions continue over from one page to the next page.

4.3.1 Part A.

Cell Biology (14 questions, 20 points).

A1. (1 point). List the following proteins in the order of decreasing evolutionary

conservativeness of their primary structure:

1. Somatotropin.
2. Catalytic subunit of a DNA – polymerase.
3. Histone H1.
4. Prolamines (storage proteins of cereals).

A. 1, 4, 3, 2.
B. 2, 3, 1, 4.
C. 3, 2, 1, 4.
D. 4, 1, 2, 3.
E. 1, 2, 3, 4.

A2. (1 point). What is the common feature of amino acids encoded by codons XUX, where X is any base, U is uracil?

A. Hydrophobicity.
B. Positive charge.
C. Negative charge.
D. Sulfur in the side chain.
E. No common feature.

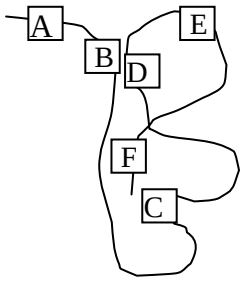
A3. (1 point). A denatured polypeptide chain containing amino acids of different chemical properties is shown in the figure.

Amino acid properties:

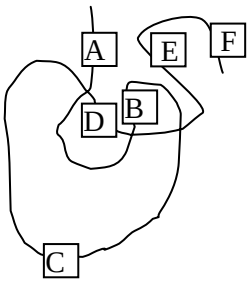
A and E: Have negatively charged side groups.	B: With many electropositive atoms.
C and F: Have hydrophobic side groups.	D: With many electronegative atoms.

If renatured, the most stable configuration of the above polypeptide in the cytoplasmic environment will be:

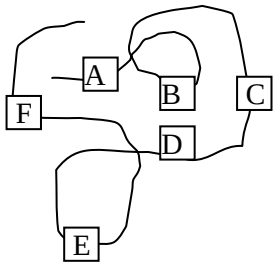
A.



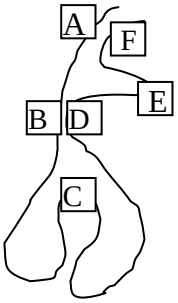
B.



C.



D.



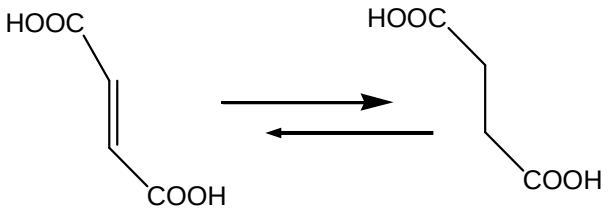
A4. (1 point). Nucleoside phosphates can be interphosphorylated enzymatically. Which one of the following reactions is impossible?

A. ADP + ADP = AMP + ATP.
B. AMP + GTP = ADP + GDP.
C. ATP + GDP = ADP + GTP.
D. ATP + UMP = ADP + UDP.
E. ADP + AMP = ATP + adenosine.

A5. (1 point). Which nucleotides predominate in the genome of extremely thermophilic bacteria *Thermus aquaticus* in comparison to *E.coli*?

A. A-T.
B. C-T.
C. G-A.
D. G-C.
E. T-G.

A6. (2 points). Define from reaction written below:



A6.1. (1 point). To which class does the enzyme catalyzing the reaction of formation of succinic acid (Succinate) from fumaric acid (Fumarate) belong?

A. Isomerase.
B. Dehydrogenase.(Oxidoreductases)
C. Hydrolase.
D. Synthase.
E. Transferase.

A6. 2. (1 point). The coenzyme of this reaction is the derivative of which vitamin?

A. B_1 - thiamine
B. B_2. - riboflavin
C. B_6. - pyridoxalphosphate
D. B_{12}. - cyancobalamine
E. B_c. – folic acid

A7. (1 point). It is known that cyanides (CN^-) and carbon monoxide bind specifically to the

reduced and oxidized form of cytochrome a_3 (cyt a_3) (part of complex IV of electron

transport chain), respectively, in mitochondria. Which of the following statements are

correct:

1. Cyanides and carbon monoxide are equally toxic to mitochondria.

2. Cyanides are far more toxic for mitochondria than carbon monoxide.

SKIPPED

3. Carbon monoxide is more toxic for animals since it is capable of binding other iron-

containing substances, e.g. hemoglobin.

4. Carbon monoxide is less toxic for animals since it is capable of binding other iron-

containing substances, e.g. hemoglobin.

5. Cyanides are more toxic for animals since they are only capable of binding to

   cytochrome a_3.

   A. 1, 2, 4.
   B. 2, 3, 5.
   C. 1, 4, 5.
   D. Only 4.
   E. Only 1.

A8. (1 point). *Lactobacilli* lack electron transport chain. However, under special circumstances, up to 50% of ATP is synthesized by membrane-linked H^+ - ATPase. What are the circumstances to generate a proton gradient to drive ATP formation mechanism.?

1. If the concentration of lactic acid is higher in the cell than it is in the medium.
2. If the concentration of lactic acid is lower in the cell than it is in the medium.
3. Uniport (unidirectional)of lactic acid.
4. Symport (both in or both out) of lactic acid with H^+.
5. Antiport (one in and one out) of lactic acid with H^+.

   A. 1, 3.
   B. 1, 4.
   C. 1, 5.
   D. 2, 5
   E. 2, 4.

A9. (3 points). The lactose operon of *E.coli* consists of three genes:
***lacZ* encodes β-galactosidase,**
***lacY* encodes galactosidepermease which carries out lactose transport to the cell,**
***lacA* encodes galactoside-transacetylase.**

Lac operon is under the control of LacI (repressor), which is inactive in the presence of lactose (inductor). There is a wide diversity of the chemical lactose analogs, for example:

Orthonitrophenyl-β-D-galactoside (ONPG) – is a substrate for β-galactosidase but not an inductor. The product of this reaction orthonitrophenol is toxic for a cell.

Isopropyl-β-D-thiogalactoside (IPTG) - is an inductor but not a substrate for β-galactosidase.

Phenyl-β-D-galactoside (PG) - is a substrate for β-galactosidase but not an inducer. The products of its hydrolysis are nontoxic for a cell.

A9.1. (1 point). Which cells will grow in the medium with PG as the only source of carbon and energy?

A. *lacI* $^{-}$.
B. *lacZ* $^{-}$.
C. *lacy* $^{-}$.
D. *lacZ* $^{-}$ *lacy* $^{-}$.
E. *lacI* $^{-}$ *lacZ* $^{-}$.

A9.2. (1 point). Will these cells grow in the medium with ONPG?

A. Yes.
B. No.

A9.3. (1 point). Galactose is a toxic compound for the cells which have galE^{-} mutation. Which cells with this mutation will grow in the IPTG+PG medium (with arabinose as an additional source of carbon and energy available)?

A. *lacI* $^{-}$.
B. *lacZ* $^{-}$.
C. *lacA* $^{-}$.
D. *lacI* $^{-}$ *lacA* $^{-}$.

A10. (2 points). A protein synthesis assay was carried out *in vitro*. A polyribonucleotide containing U and C in proportion 1:5 (positions of U and C are random) was used as a template. Which amino acids and in what proportions will be incorporated into the synthesized polypeptide molecules?

A. *1Phe : 5Pro : 3Leu.*
B. *1Leu : 1Pro : 1Ser : 1Phe.*
C. *1Phe : 5Ser : 5Pro : 5Leu.*
D. *1Phe : 25Pro : 5Ser : 5Leu.*
E. *5Leu : 5Pro.*

For questions 11 and 12 use the table of genetic code at the beginning of the question paper.

A11. (3 points). The strand of DNA molecule isolated from *E. coli* bacteria has sequence: 5′ –GTAGCCTACCCATAGG – 3′. Assume that an mRNA is transcribed from the corresponding double-stranded DNA, the template strand being complementary to the strand isolated.

A11.1. (1 point). What is the sequence of this mRNA?

A. 3′ – CAUCGGAUGGGUAUCC – 5′.
B. 5′ – GUAGCCUACCCAUAGG – 3′.
C. 5′ – GGAUACCCAUCCGAUG – 3′.
D. 5′ – CACAGAUACCCAGAUG – 3′.

A11.2. (1 point). Which peptide will be synthesized if its translation begins precisely at 5′– end of this mRNA? (Assume that start codon is not required).

A. - *Gly - Tyr - Pro - Ala – Asp.*
B. - *His - Arg - Met - Gly – Ile.*
C. - *Val - Ala - Tyr – Pro.*
D. - *His - Arg - Tyr - Pro – Ala.*

A11.3. (1 point). When $tRNA^{Ala}$ separates from ribosome, which tRNA will bind next?

A. $tRNA^{Tyr}$.
B. $tRNA^{Pro}$.
C. $tRNA^{Val}$.
D. $tRNA^{Arg}$.
E. $tRNA^{His}$.

A12. (1 point). The transcriptional activity of which kind of RNA polymerase in eukaryotes can be seen by using a light microscope (without any methods of colouration)?

A. RNA-polymerase I.
B. RNA-polymerase II.
C. RNA-polymerase III.
D. Primase.
E. Impossible to determine.

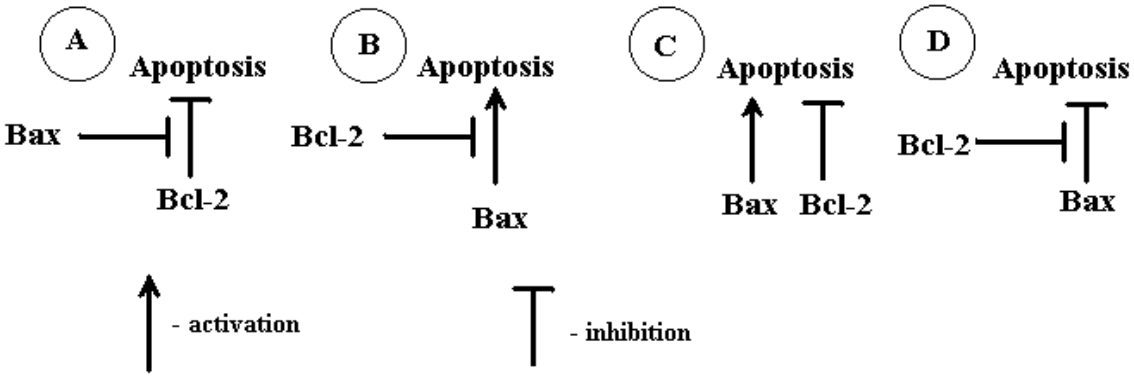
A13. (1 point). Phalloidin, a very toxic compound isolated from the mushroom *Amanita phalloides*, has a very high affinity for actin polymers. Phalloidin can be marked by covalently linking it to a fluorescent molecule, like fluorescein, without affecting its affinity properties.
If a microscopic slide with methanol-fixed sperm is stained with a reagent containing luorescein-marked phalloidin (excess reagent being washed away), which part of the spermatozoids will be glowing under a fluorescence microscope?

A. Acrosome.
B. Flagellum.
C. Head.
D. Mitochondria.
E. Whole spermatozoid.

A14. (2 points). On the basis of the following experimental facts, decide which of the four models (A, B, C or D) of Bax and Bcl-2 proteins' action in regulation of programmed cell death (apoptosis) is correct.

Experimental facts:

- Mice with inactivated bcl-2 gene had a high rate of apoptosis in various tissues, which could be corrected by the absence of Bax protein.
- Bax gene in a single genome copy was able to promote apoptosis in the absence of Bcl-2 protein.
- However, bcl-2 gene suppressed apoptosis in the absence of Bax protein.



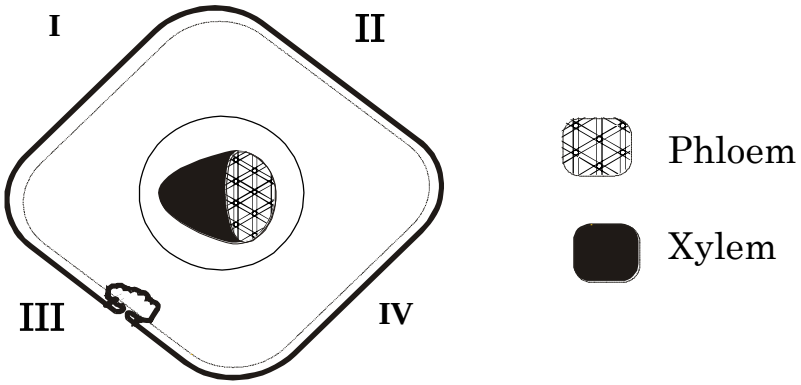
A. Bax protein inhibits the action of Bcl-2 protein, which blocks apoptosis (look at A in the figure).
B. Bcl-2 protein is an inhibitor of Bax protein, which promotes apoptosis (look at B in the figure).
C. Bcl-2 and Bax proteins act independently, resulting in either survival or death, (look at C in the figure).
D. Bcl-2 protein blocks inhibitory action of Bax protein on apoptosis (look at D in the figure).

Plant anatomy and physiology (10 questions, 12 points).

A15. (1 point). If the vascular system of a plant tendril is represented by the only one closed collateral (xylem & phloem are touching) bundle, the tendril is formed by the metamorphosis of which organ?

A. Shoot.
B. Leaf.
C. Stem.
D. Root.
E. Impossible to determine.

A16. (1 point). A transverse microscopic section of a spruce needle leaf is shown in the diagram below. Which roman numerals indicates the upper surface of the leaf?



A. I and II.
B. II and IV.
C. I and III.
D. III and IV.
E. II and III.

A17. (1 point). The endosperm in conifers develops from:

A. The central nucleus resulting from double fertilization.
B. The ovule after fertilization.
C. The megaspore before fertilization.
D. The megaspore after fertilization.
E. The megasporangium cells before fertilization.

A18. (1 point). Which compounds are the main substrates for growth of xylophilous fungi

(accomplishing decomposition of wood), which elicit white (1) and brown (2) rot?

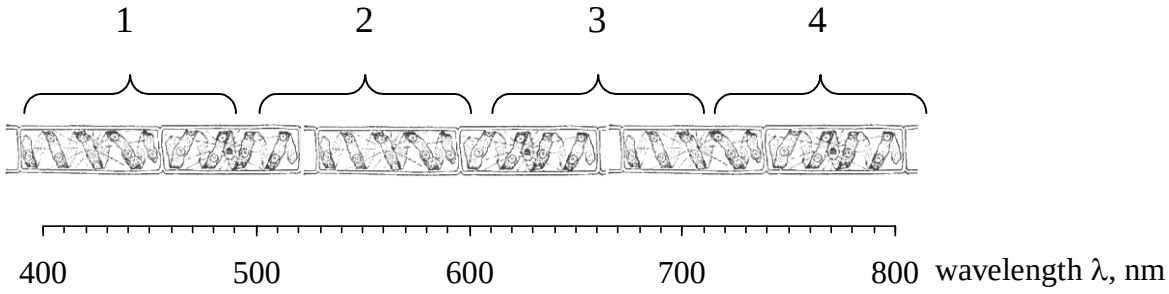
1. 2.
A. Cellulose. Suberin.

B. Cellulose.	Lignin.
C. Lignin.	Cellulose.
D. Suberin.	Cellulose.
E. Pectin	Hemicellulose.

A19. (1 point). Which is the correct rank order of the pH value in cytosol (1), chloroplast stroma (2) the inside of thylakoids (3) in plant cells exposed to light:

A. 1>2>3.
B. 1>3>2.
C. 2>1>3.
D. 2>3>1.
E. 3>1>2.

A20. (1 point). Spirogyra filaments were placed in a medium, in which strict (obligate) aerobic bacteria were incubated without access to oxygen for some time. Then part of the spirogyra filament was illuminated with a narrow beam, which passed through a prism to obtain a spectrum (see figure below).



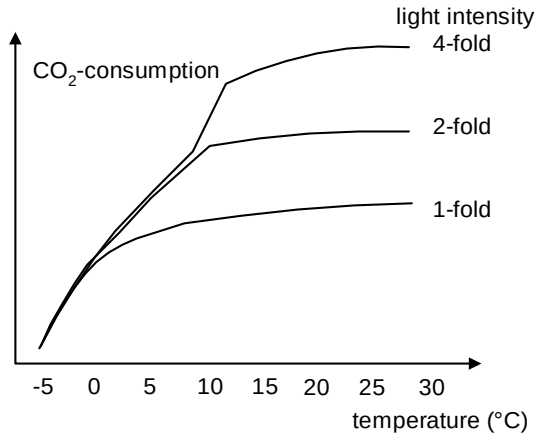
In which parts of the filament will the greatest concentration of bacteria be observed?

A. 1,3.
B. 1,4.
C. 2,3.
D. 2,4.
E. 3,4.

A21. (2 points). Plants of wild type corn whose Rubisco function was normal were compared with a mutant corn variety whose Rubisco is not able to catalyze an oxygenation reaction. Which of the following statements regarding the photosynthetic capacity of this mutant corn and the wild type is correct and why would it be correct? Assume the same temperature conditions.

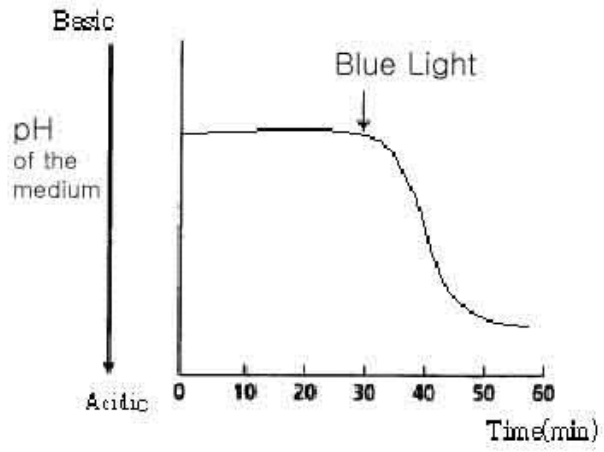
	Photosynthetic capacity of the mutant	**Reason**
A.	It would show much lower capacity compared to the wild type.	Rubisco in the bundle sheath cell loses its oxygen fixation capacity.
B.	It would show much lower capacity compared to the wild type.	Rubisco in the bundle sheath cell loses its carbon dioxide fixation capacity.
C.	It would show much higher capacity compared to the wild type.	Since mesophyll cells photorespire, photosynthetic capacity of the mutant would not be affected by this mutation.
D.	It would show the same capacity as the wild type.	Since mesophyll cells photorespire, photosynthetic capacity of the mutant would not be affected by this mutation.
E.	It would show the same capacity as the wild type.	Since CO_2 concentration in the bundle sheath cells is high enough, both wild type and mutant corn do not photorespire.

A22. (2 points). Photosynthesis in plants is dependent on temperature (T) and light intensity(L). The following graphs show the results of measurements of CO_2 consumption forthree plants of the same species under different light intensities. Which combination of statements concerning limiting factors in the temperature ranges (I) –5 °C to 0°C and (II) +20 °C to + 30°C is correct under the light intensity used?



	Temperature range from –5 to 0°C (I)	**Temperature range from +20 to +30°C (II)**
A.	T and L limiting factor.	T and L not limiting factor.
B.	T limiting, L not limiting.	T not limiting, L limiting.
C.	T limiting, L not limiting.	T limiting, L not limiting.
D.	T not limiting, L limiting.	T limiting, L not limiting.
E.	None of the above combinations is correct	

A23. (1 point). The result of an experiment which uses guard cell protoplasts of *Vicia faba* is given below. Protoplasts were incubated in a suspension medium with isotonic osmotic pressure. After 30 min under saturating red light they were irradiated with blue light for 30 sec. During the experiment in which the protoplasts were cultured the pH of the medium was monitored.



What would be the most plausible conclusion based on the above results?

A. Blue light may help guard cells to take up protons from outside into the cell.

B. Blue light may enhance the ability of guard cells to pump protons out of the cell.

C. Blue light may be a very effective wavelength of light for the respiration of the guard cells.

D. Blue light may activate all of the protoplasts to give away their energy.

E. Not only blue light but also other wavelengths of light may help guardcells to transfer protons.

A24. (1 point). If an oat coleoptile deprived of its epidermis is placed in a physiological solution with pH = 5.0, relatively fast lengthening of the coleoptile occurs. The action of which hormone does this experiment imitate?

A. Auxin.
B. Gibberellic Acid
C. Cytokinins.
D. Ethylene.
E. Abscisic Acid

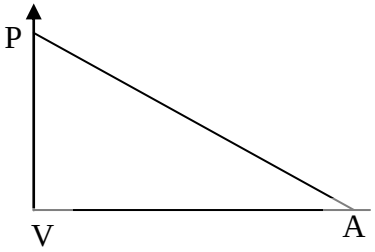
Animal Anatomy & Physiology (10 questions, 12 points).

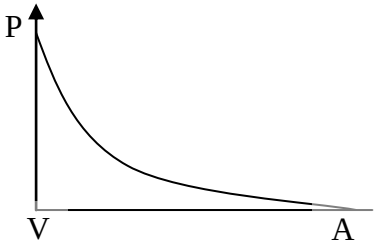
A25. (1 point). In which animals is the volume of the lungs relatively constant during all the stages of ventilation (breathing)?

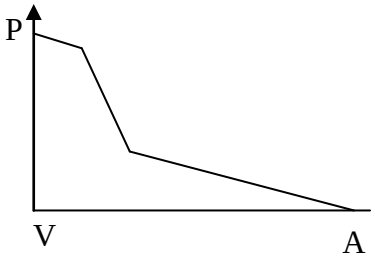
A. In insects.
B. In birds.
C. In mammals.
D. In reptiles.

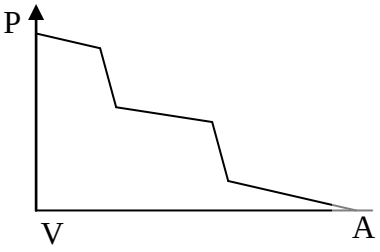
A26. (1 point). During the blood flow from the ventricle to atrium in fishes, how does the pressure change?

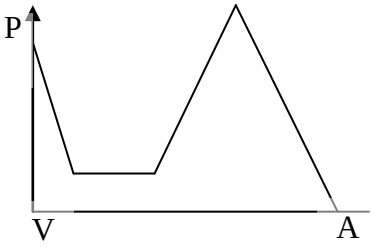
A - Atrium.
V - Ventricle.
P - Pressure.

A.


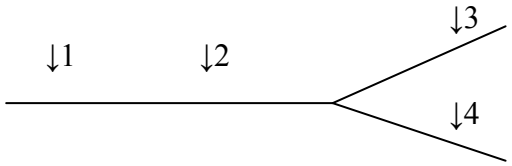
B.


C.


D.


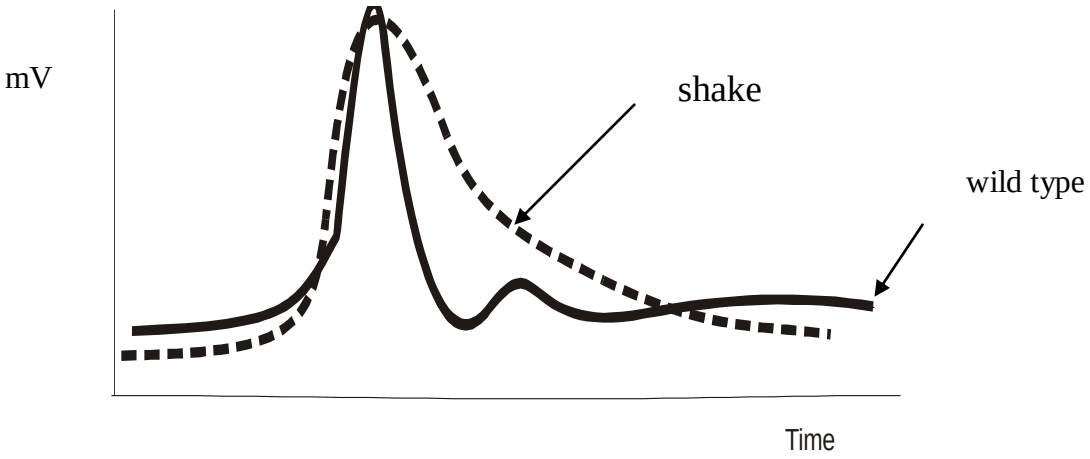
E.


A27. (1 point). A branched axon is stimulated at the site '1' (see figure below). The excitation is transferred from site '1' to '2' and then to '3' and '4'. The excitation is measured atthese sites. Which statement of impulse frequencies (I) measured at these sites is correct?



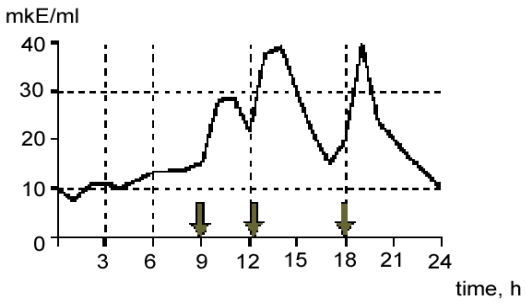
A. I(1) > I(2) > I(3), I(3) = I(4), I(3) + I(4) = I(2).
B. I(1) > I(2) > I(3), I(3) = I(4), I(3) x I(4) = I(2).
C. I(1) < I(2) < I(3), I(3) = I(4).
D. I(1) = I(2) > I(3), I(3) = I(4), I(3) + I(4) = I(2).
E. I(1) = I(2) = I(3) = I(4).

A28. (1 point). *Drosophila* flies homozygous for the *shake* mutation are extremely ensitive to diethyl ether that causes convulsions in homozygous individuals. Convulsions are caused by abnormalities in nerve impulse conduction. (see graph below). The function of which structures is impaired in the *shake* mutations?



A. Na^+-channels.
B. K^+-channels.
C. Ca^{2+}-channels.
D. K^+/Na^+-ATPase.
E. H^+-pump.

A29. (1 point). Daily changes in the concentration of which hormone are represented by the following graph?



Arrows indicate the time of food consumption.

A. Thyroxine
B. Glucagon.
C. Insulin.
D. Cortisol.
E. Parathormone.

A30. (1 point). Thyroiditis is an autoimmune disease, which is caused by the hyperactivity of the thyroid gland. In this disease the TSH (thyroid stimulation hormone) concentration in the blood is below normal. Antibody binding to hormone receptor sites may activate or block the receptor. The cause of this disease is the binding of autoimmune antibodies to:

A. Thyroxin receptors.
B. Thyroxin.
C. TSH receptors.
D.TSH.
E. Thyreoliberin receptors.

A31. (3 points). There are two recessive mutations *ob*$^-$ and *db*$^-$ in mice. These mutations cause the same phenotype: obesity, adipose tissue hypertrophy and predisposition to obesity related diseases (hypertension, physiological *diabetes insipidus* and so on). The mutations are not linked. Three experiments of parabiosis (surgically joining blood circulation systems of two mice with different genotypes) were carried out to define the roles of the products of these genes in weight regulation. Two weeks after the parabiosis, the weight of each mouse was determined (see table).

	***ob*$^-$/*ob*$^-$ + *wt*$^+$**		***db*$^-$/*db*$^-$ + *wt*$^+$**		***ob*$^-$/*ob*$^-$ + *db*$^-$/*db*$^-$**	
Weight	**Loss of weight**	**Without changes**	**Without changes**	**Loss of weight**	**Loss of weight**	**Without changes**

<u>A31.1</u>. (1 point). What is the consequence of the *<u>ob</u>* gene:

A. Peptide hormone favouring obesity.
B. Peptide hormone favouring loss of weight.
C. Hormone receptor favouring obesity.
D. Hormone receptor favouring loss of weight.
E. Nonpeptide hormone favouring obesity.

<u>A31.2.</u> (1 point). What is the consequence of the *<u>db</u>* gene:

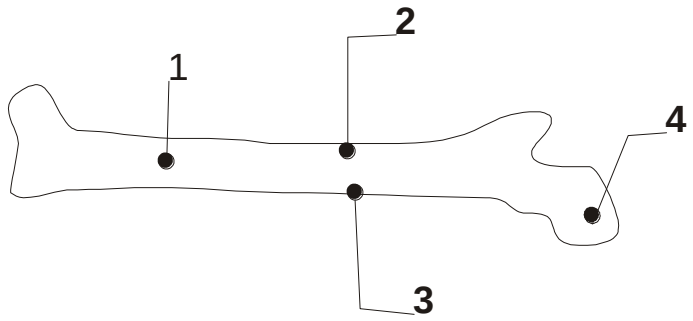
A Peptide hormone favouring obesity.
B. Peptide hormone favouring loss of weight.
C. Hormone receptor favouring obesity.

D. Hormone receptor favouring loss of weight.
E. Nonpeptyde hormone favouring obesity.

A31.3. (1 point). What segregation by phenotype will be seen in F_2 after interbreeding of individuals with the genotypes *ob*$^-$ / *ob*$^-$ and *db*$^-$ / *db*$^-$?

A. 9:3:3:1.
B. 9 :7.
C. 15:1.
D. 1:2:1.
E. 3:1.

A32. (1 point). If four gold rods are implanted into a tibia-bone of a newborn rat (as shown in the figure), the distances between which of these rods will be maximally altered with growth?



A. 1 and 2.
B. 2 and 3.
C. 3 and 4.
D. 3 and 1.

A33. (1 point). Quick movement of the individuals of genus *Dryocopus* (wood-pecker) on tree

trunks is enabled thanks to the fact that:

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A. All its leg fingers are directed forward.

B. Two its leg fingers are directed forward and two leg fingers are directed to the back.

C. Three its leg finger are directed forward and one leg finger is directed to the back .

D. One its leg finger is directed forward and three leg fingers are directed to the back.

A34. (1 point). The major difference between humoral immunity and cellular immunity is that:

A. Humoral immunity is non-specific, whereas cellular immunity is specific for a particular antigen.
B. Only humoral immunity is a function of lymphocytes
C. Humoral immunity cannot function independently; it is always activated by cellular immunity.
D. Humoral immunity acts against free-floating antigens, whereas cellular immunity works predominantly against pathogens that have entered body cells.
E. Only humoral immunity displays immunological memory.

Ethology (2 questions, 2 points).

A35. (1 point). Which of the following cases result in optimal conditioning (Pavlovian)?

A. Unconditional stimulus is delivered before conditional stimulus and unconditional stimulus is stronger than conditional stimulus.

B. Unconditional stimulus delivered before conditional stimulus and unconditional stimulus is weaker than conditional stimulus.

C. Conditional stimulus starts delivered unconditional stimulus and conditional stimulus is stronger than unconditional stimulus.

D. Conditional stimulus starts delivered unconditional stimulus and conditional stimulus weaker than unconditional stimulus.

A36. (1 point). The cuckoo (*Cuculus canorus*) and its hosts is a well studied system of co-evolution as a long never ending process. A cuckoo lays its eggs in the nest of small passerines (*Passeriformes*). The cuckoo and its hosts have adopted different behaviours that result from the co-evolution between them.

Which combination of the following statements (1 – 6) are true?

1. The hosts lay their eggs in the afternoon.
2. The cuckoo eats ant eggs.
3. The host is aggressive towards a cuckoo.
4. The cuckoo eggs do not mimic the host´s eggs.
5. The cuckoo is aggressive towards a host.
6. The cuckoo tries to avoid being seen in the host nest.

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

Genetics (10 questions, 12 points).

A37. (1 point). In birds, for instance chickens, sex is determined by a combination of sex chromosomes Z and W. At an early age it is difficult to determine their sex. However, it is commercially very important to distinguish males and females at this age. Using a genetic marker, it is possible to conduct such crosses so that sex will be determined by phenotypic expression of the marker gene. On which chromosome must the marker gene (I) be located and which crossing allows discrimination of the males from females (II)?

	Marker gene localization (I)	Crossing (II)
A.	On Z chromosome.	Female with recessive phenotype is crossed with a male homozygous for dominant allele.
B.	On W chromosome.	Female with recessive phenotype is crossed with a male homozygous for dominant allele.
C.	On Z chromosome.	Female with dominant phenotype is crossed with a male homozygous for recessive allele.
D.	On an autosome.	Female with recessive phenotype is crossed with a male heterozygote.
E.	On Y chromosome.	Female with dominant phenotype is crossed with a male heterozygote.

A38. (1 point). a*bcde* genes are closely linked on the *E. coli* chromosome. Short deletions within this region lead to the loss of some genes. For example:

deletion 1 – *bde* genes

deletion 2 – *ac* genes

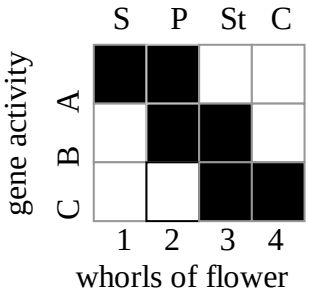
deletion 3 – *abd* genes

What is the gene order on the genetic map of the *E. coli* chromosome?

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

A39. (2 points). According to the model proposed for floral organization, each whorl is determined by a unique combination of three genes, namely, A, B and C.

It has been shown that genes A and C mutually repress each other. The expression pattern of these genes in wild type flowers is shown below.



S: sepal formation
P: petal formation
St: stamen formation
C: carpel formation

A39.1. (1 point). The morphology of flower that lacks the functional gene A will be:

A. (**–** **–** **St** **C**) 1 2 3 4

B. (**C** **St** **St** **C**) 1 2 3 4

C. (**C** **P** **P** **C**) 1 2 3 4

D. (**–** **P** **St** **C**) 1 2 3 4

A39.2. (1 point). The whorls of a flower that lacks the functional gene C will be:

A. | C | P | St | P |
   | 1 | 2 | 3 | 4 |

B. | – | – | – | C |
   | 1 | 2 | 3 | 4 |

C. | S | P | P | S |
   | 1 | 2 | 3 | 4 |

D. | S | P | St | – |
   | 1 | 2 | 3 | 4 |

A40. (2 points). Colour of the plant endosperm is determined by a single gene located in the

centromere region. Expression of this gene takes place only in the cells of endosperm.

Experiment 1. Inbred plant line with coloured endosperm (CE) was pollinated by the

pollen of inbred plant line with colourless endosperm (CLE). F_1 seeds were with

coloured endosperm.

Experiment 2. After pollination of F1 plants with pollen of CLE line all F2 seeds were

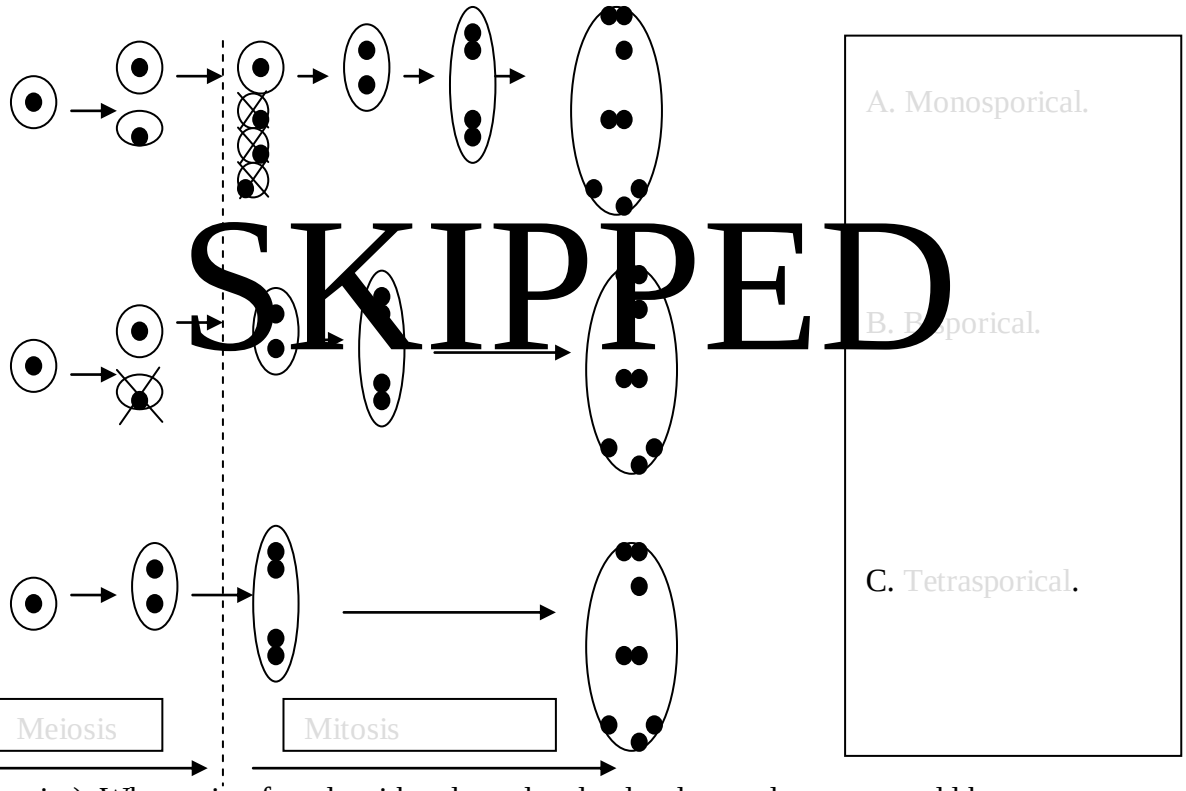
with coloured endosperm as well.

Experiment 3. After pollination of F2 plants with pollen of CLE line 50% of plant gave

seeds were with coloured and 50% with colourless endosperm.

A40.1. (1 points). According to the results of three experiments, determine which

type of embryo sack is typical for this plant species?



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A40.2. (1 point). What ratio of seeds with coloured and colourless endosperm would be observed in experiment 2, if the gene of colouration of endosperm were located in >50 cM distance from gene "mei-2"?

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A. 3:1.
B. 1:3.
C. 7:1.
D. All with coloured endosperm.
E. All with colourless endosperm.

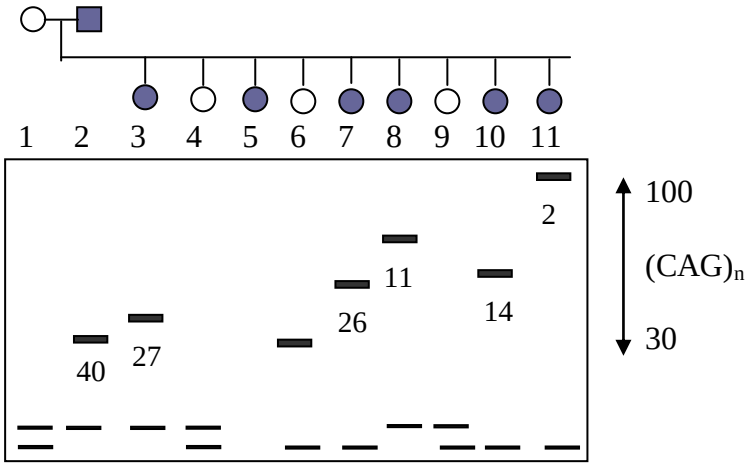
A41. (1 point). In humans PKU (phenylketonuria) is a disease caused by an enzyme dysfunction at step A in the following simplified reaction sequence, and AKU (alkaptonuria) is due to an enzyme inefficiency in one of the steps summarized as step B here:

$$\text{Phenylalanine} \xrightarrow{\mathbf{A}} \text{tyrosine} \xrightarrow{\mathbf{B}} \longrightarrow \longrightarrow CO_2 + H_2O$$

A person with PKU marries a person with AKU. What are the expected phenotypes for their children? Note: both diseases (PKU and AKU) are not sex linked. Both parents are not heterozygous.

A. All children will be ill.
B. All children will be normal
C. Half of their children will have PKU, but the other half will be normal.
D. Half of their children will have AKU, but the other half will be normal.

A42. (1 point). The figure shows the results of electrophoresis of PCR-amplified DNA fragments obtained from members of a single family: mother (1), father (2) and 9 children. Father and 6 children (3, 5, 7, 8, 10, 11) in this family have symptoms of Huntington's disease (HD). Father first showed symptoms of the disease after he was 40 years old; the onset age of the disease in children is shown in the figure near corresponding DNA fragments. What is the probability of 4th, 6th and 9th child in this family falling ill with the disease?



A. Child 4 and child 9 are healthy and will never develop Huntington's disease, whereas child 6 has high probability of developing the disease.

B. Short PCR fragments correspond to appearance of HD at an early age.

C. Child 4, child 6 and child 9 all have chances to develop HD at an older age.

D. There is no correlation between the age of children with disease symptoms and the rate of migration of PCR-amplified fragments.

E. Huntington disease is an infectious disease therefore most children of the family must be ill.

A43. (1 point). The long corolla of tobacco is inherited as a recessive monogenic characteristic. If in a natural population 49% of plants have a long corolla, what is the probability that the result of test crossing plants with a short corolla from this population in F_1 will have uniformity of progeny?

A. 82,4 %.
B. 51 %.
C. 30 %.
D. 17,7 %.
E. 42 %.

A44. (1 point). In a genetically balanced population involving alleles T and t. 51 % of the individuals show the dominant phenotype. Suddenly the living conditions change causing death of all recessive individuals before they reach maturity. After this, conditions return to normality. What will be the frequency of allele t after one generation?

A. 0,41.
B. 0,3.
C. Impossible to determine.
D. 0,7.
E. 0,58.

A45. (1 point). On land the process of evolution proceeds faster than in the sea, because:

A. Life started in the sea.
B. Selection pressure is higher in the sea so surviving is more difficult.
C. More fossils are found in depositions of the sea.
D. Living conditions in the sea are more stable.

A46. (1 point). The phenomenon of reduction in organism complexity during the process of

evolution is called:

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A. Biological regress.

B. General degeneration.

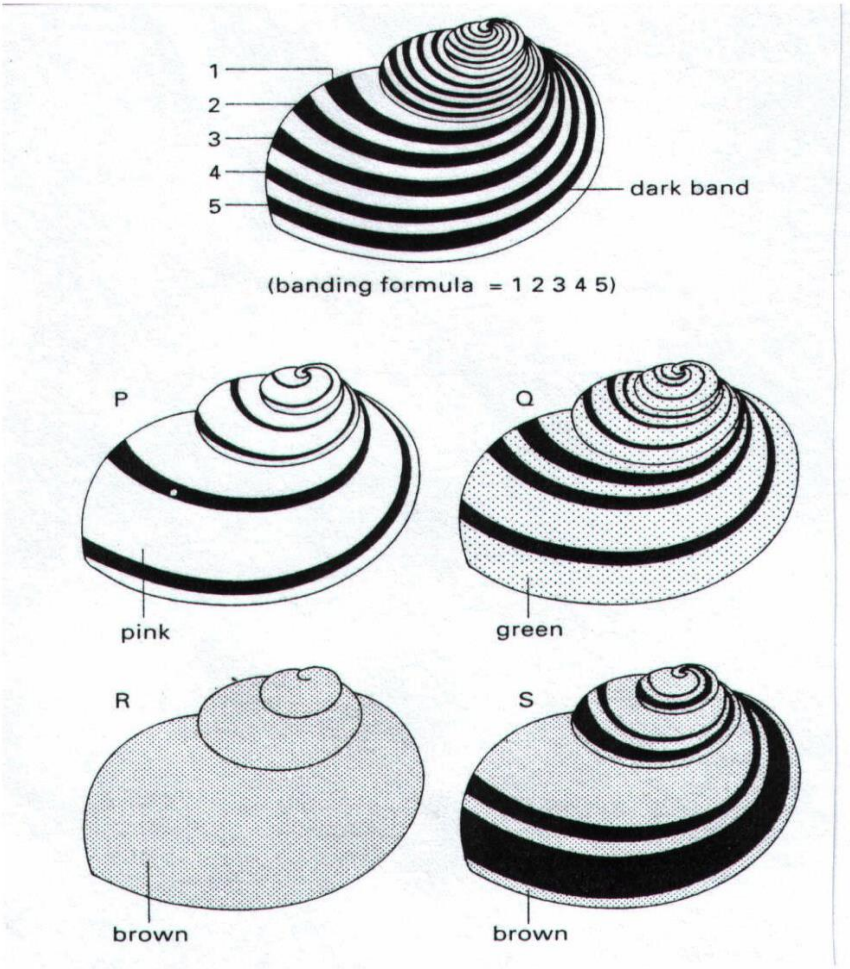
C. Idioadaptation.

D. Aromorphosis.

E. Disjunction.

<u>Ecology</u> (8 questions, 10 points).

A47. (3 points). The shell of the land snail shows variation in both colour and banding pattern. In order to construct a 5-figure banding formula, bands are numbered from the top of the largest whorl, as shown in the diagram. '0' is used to represent the absence of a band and square brackets indicate the fusion of two bands.



<u>A47.1.</u> (1 point). Using the appropriate letter, indicate the banding formula of shell S.

A. 030[45].
B. 03045.
C. 02045.
D. 003[45].

<u>A47.2.</u> (1 point). Thrushes (which have good colour vision) smash the shells of land snails against stones (anvils) in order to feed on the soft inner body. If snail types P, Q, R and S began in equal numbers in a habitat of grassland, which would be the most popular among birds?

A. P.
B. Q.
C. R.
D. S.

A47.3. (1 point). A survey of broken shells collected from thrush anvils amongst dead beech leaves in a woodland area was carried out. Predict which of the following sets of results was obtained.

Options	Broken shells of each type (%)			
	P	Q	R	S
A.	13	33	1	5
B.	11	1	34	6
C.	5	1	14	32
D.	6	21	20	5

A48. (1 point). Which combination of the following statements, referring to the process of ecological succession, is correct?

1. **Nutrient availability generally increases.**
2. **Species diversity decreases as the process proceeds.**
3. **A new group of plant species achieves dominance over time and ousts the previous species.**
4. **The height and biomass of the vegetation usually increases as the process proceeds.**
5. **Each group of species modifies the habitat making it more favourable for other species.**

A. 1, 2, 3.
B. 2, 3, 4.
C. 3, 4, 5.
D. 1, 3, 4, 5.
E. 1, 2, 4, 5.

A49. (1 point). Which matching of factors influencing the growth of a population is correct?

	Factors depending on the population's density.	**Factors independent of the population's density.**
A.	Development of territories, cannibalism.	Wind, parasites, light.
B.	Migration, amount of food.	Temperature, crowding factor.
C.	Development of territories, temperature.	Humidity, wind, light.
D.	Overcrowding factor, light.	Wind, quality of the soil.
E.	Parasites, predators.	Quality of the soil, humidity.

A50. (1 point). A typical feature of the climax stage of an ecological succession is:

A. The ecosystem is very stable
B. The increase of biomass is at its maximum.
C. The number of plant and animal species continues to increase.
D. The net production of the ecosystem has remarkable but regular differences from year to year.

A51. (1 point). In ecological pyramids, normally each higher trophic level is smaller. Possible exceptions leading to inverted pyramids are:

I. A pyramid of numbers with one big producer.
II. A pyramid of mass when producers have a very short life cycle.
III. A pyramid of energy in extremly hot ecosystems.

Which combination is correct?

A. Only I and II.
B. Only II and III.
C. Only I and III.
D. I, II and III.
E. None of these.

A52. (1 point). You and your family are stranded on a remote island with one cow and a large stock of wheat for cow food. To obtain the highest amount of energy and survive for the longest period of time, you should:

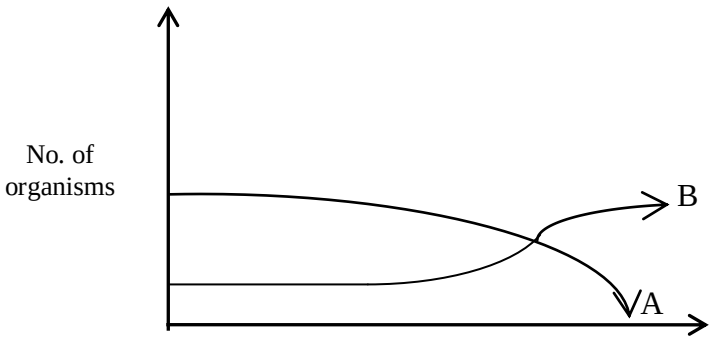
A. Feed the wheat to the cow, then drink the milk.
B. Eat the cow, then eat the wheat.
C. Feed the wheat to the cow, drink the milk, then eat the cow.

D. Drink the milk, eat the cow when milk production ceases, then eat the wheat.

A53. (1 point). If an area has a total energy, K, in the sunlight available, the net energy productivity of the fourth trophic level in the area is roughly:

A. $10^{-3} \times K$
B. $10^{-5} \times K$
C. $10^{-7} \times K$
D. $10^{-4} \times K$
E. $10^{-6} \times K$

A54. (1 point). Assume first that the graph below shows the changes in two populations of herbivores in a grassy field. A possible reason for these changes is that:



A. All of the plant population in this habitat decreased.

B. Population B competed more successfully for food than did population A.

C. Population A produced more offspring than population B did.

D. Population A consumed the members of population B.

E. Over time, both populations will have the same average number.

Biosystematics (6 questions, 6 points).

A55. (1 point). To assign ascidia to subphylum *Urochordata* it is necessary to know the features of the larval stage of ascidia. Which is the correct combination of statements I-IV ?

I. They possess a notochord in the larval stage.
II. They are highly specialised.
III. They possess a hollow dorsal neural tube, which in metamorphosis is reduced.
IV. They possess a propulsive tail, pharynx and branchial slits

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

A56. (1 point). Which are the characteristics of *Cnidaria* ?

A. Oceanic/marine or freshwater, mainly predators.
B. Only oceanic/marine, mainly predators.
C. Oceanic/marine or freshwater, filter feeding.
D. Only oceanic/marine, always filter feeding.
E. Only freshwater, predators or parasites.

A57. (1 point). Which of the following statements can be used as evidence to prove the close evolutionary relationship between Phylum *Annelida* and Phylum *Mollusca*?

A. Both of them have bodies with bilateral symmetry.
B. Their digestive systems have similar parts.
C. Their bodies consist of similar tegmata (segments).
D. Both of them have a closed circulatory system.
E. Many molluscs and marine annelids have a trochophore larva in their life cycle.

A58. (1 point). Zoologists place chordates and echinoderms on one major branch of the animal phylogenetic tree, and molluscs, annelids, and arthropods on another major branch. Which of the following is a basis for this separation?

A. Whether or not the animals have skeletons.
B. What type of symmetry they exhibit.
C. Whether or not the animals have a body cavity.
D. How the body cavity is formed.
E. Whether or not the animals are segmented.

A59. (1 point). Phylogenetic connections between three extant (a, b, c) and two extinct (d, e)

taxonomic groups are shown below in the cladogram. What kind of their association into

a taxon of the highest rank (encircled with dotted line) would be in concord with

principles of natural systematics (monophyletic or paraphyletic groups)?

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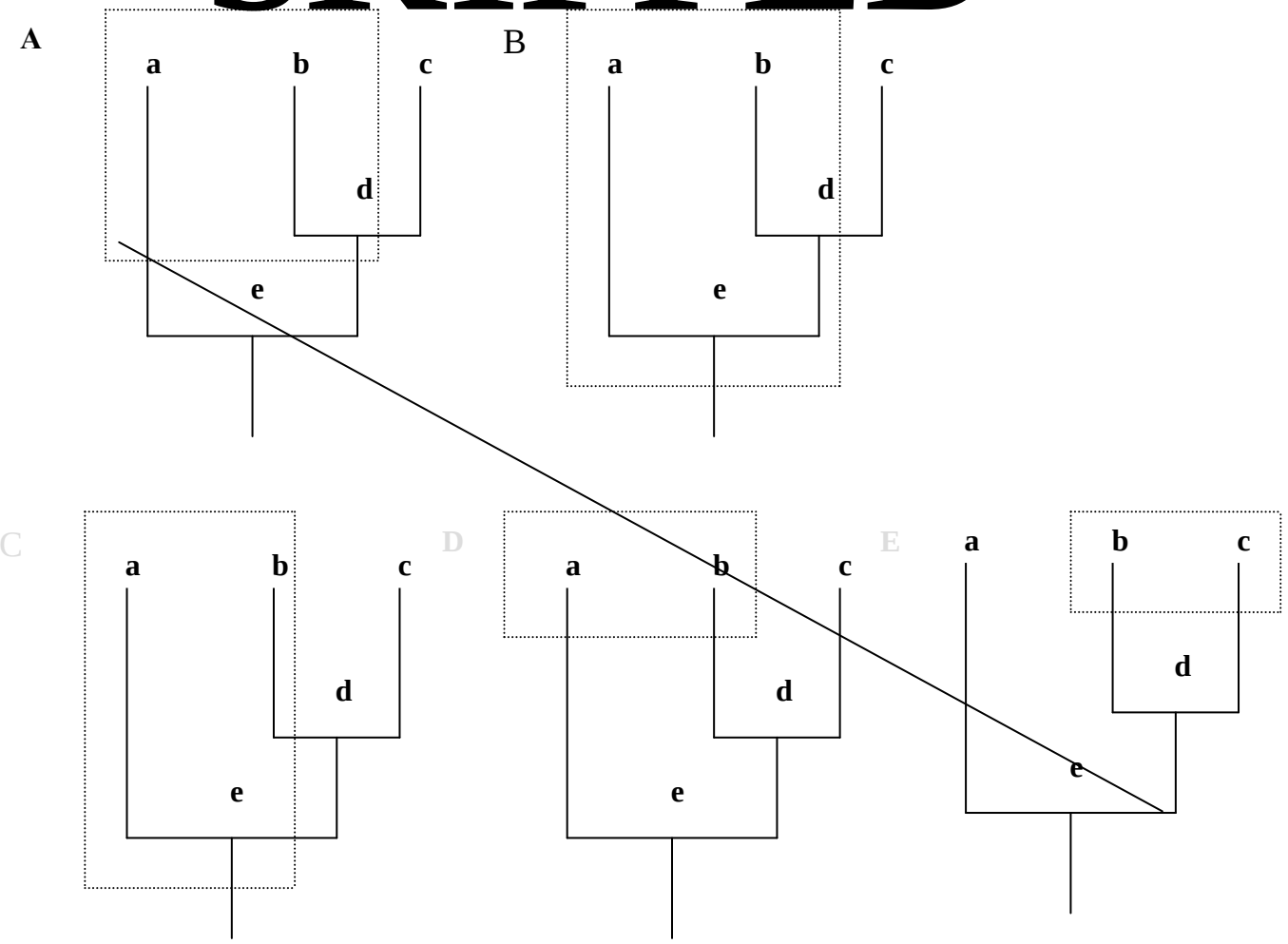


A60. (1 point). There are five species (K, L, M, N, O) in a single family. They belong to the same genus. The table lists data concerning the presence or absence of six features in these species:

Species	Features					
	1	2	3	4	5	6
K.	+	–	+	+	+	–
L.	–	–	–	–	+	–
M.	+	–	–	–	–	–
N.	–	+	–	–	–	–
O.	+	–	+	+	–	–

Based on the assumption that the most probable scheme of phylogenetic development is that which required the least number of evolutionary changes, indicate the species that is the most probable ancestor of species O.

A. K
B. L
C. M
D. N

4.3.2 Part B.

Cell biology (10 questions, 51 points).

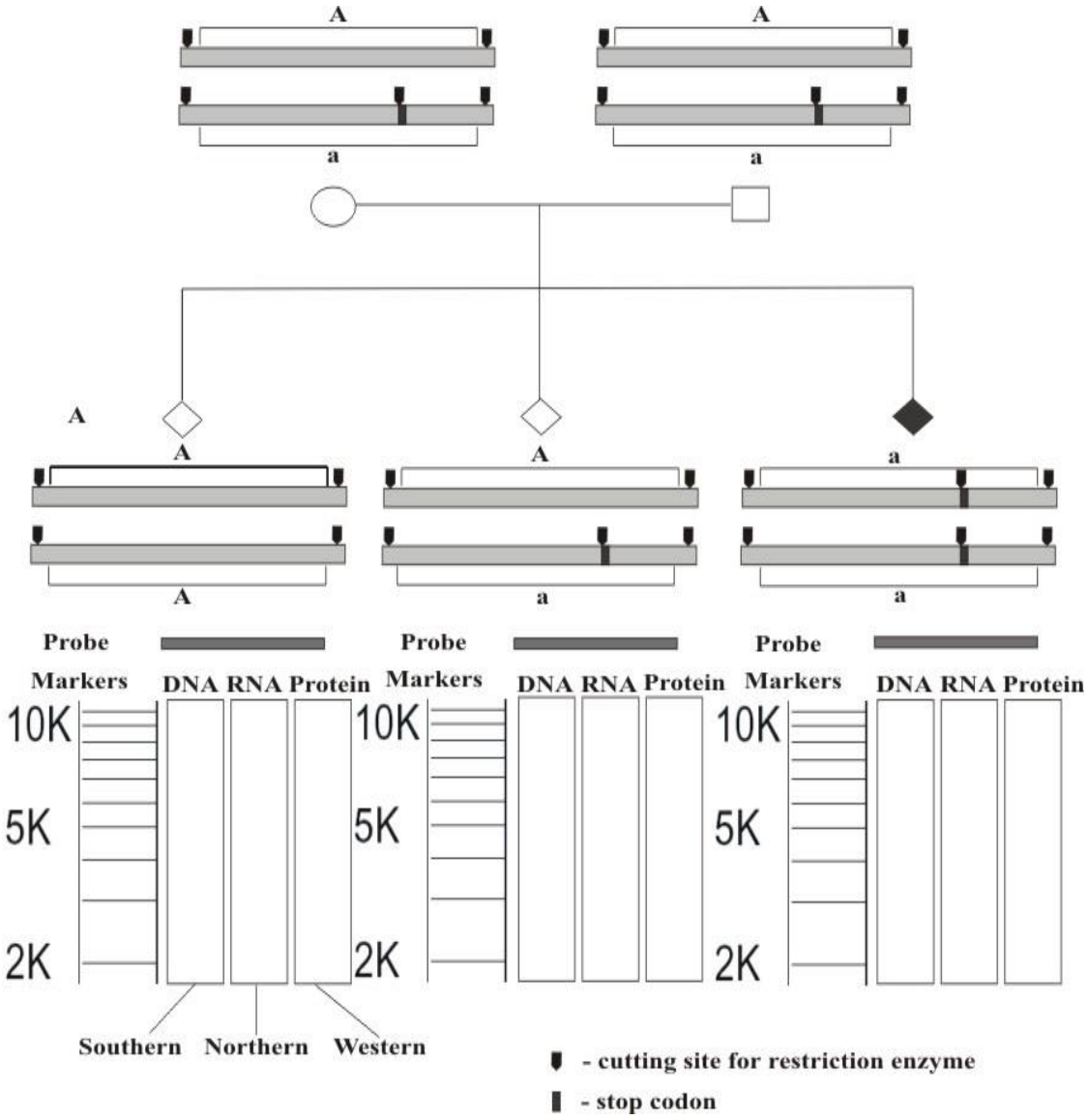
B1. (6 points). It is known that ribosomes of cytoplasm, ribosomes of endoplasmic reticulum (ER) and mitochondrial ribosomes take part in protein biosynthesis. Write the numbers of the proteins in the list below in the correct box, according to the site of their synthesis.

1. Elastin	5. Glycogen synthase	9. Prothrombin
2. Collagen	6. Receptors for glucagon	10. Keratin
3. Somatotropin	7. Casein	11. Lactate dehydrogenase
4. Actin	8. Phosphofructokinase	12. Tubulin

Answers:

ER-bounded ribosomes	
Cytoplasmic ribosomes	
Mitochondrial ribosomes	

B2. (9 points). The Human condition albinism is inherited in the autosomal recessive manner (see figure). The cause of this condition is a mutation from wild type allele *A* to recessive allele *a*, which introduces a stop codon into the middle of the gene, resulting in a shortened polypeptide. The mutation also introduces a new target site for a restriction enzyme, which makes it possible to detect mutated genes by restriction mapping.



Task:

Depict the expected results of Southern-, Northern-, Western-blot hybridization analyses of all genotypes (*aa*, *Aa*, *AA*). Results of Southern-blot hybridization should be depicted according to the length of the largest restriction fragment (11 kb) and length markers shown to the left of each Southern-blot hybridization lane. Markers have to do only with the length of DNA fragments.
Results of Northern- and Western-blot hybridization should be depicted without scale, but taking into account the respective positions of different restriction fragments for different genotypes.

B3. (3 points). Three human-mouse hybrid cell lines have been created (X, Y and Z). The table below summarizes their characteristics. Each cell line has several human chromosomes carrying genes coding for particular enzymes.

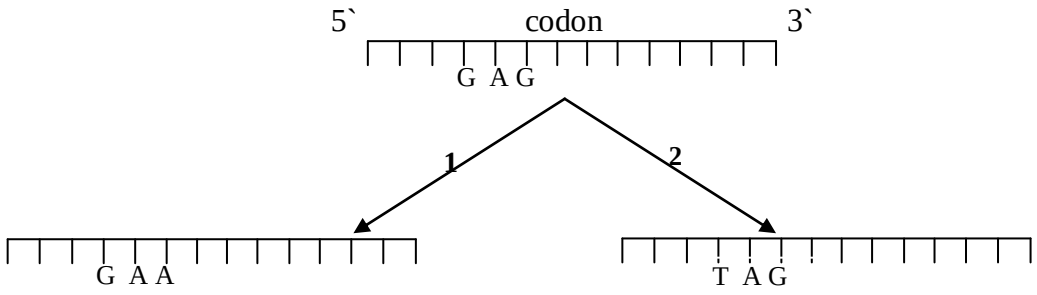
Human chromosome or enzyme	**Line X**	**Line Y**	**Line Z**
Chromosome 3	–	+	–
Chromosome 7	–	+	+
Chromosome 9	–	–	+
Chromosome 11	+	+	–
Chromosome 15	+	–	–
Chromosome 18	+	+	+
Chromosome 20	+	–	+
Glutathione reductase	+	+	–
Malate dehydrogenase	+	–	–
Galactokinase	–	+	+

Identify by giving the number, the human chromosome that carries the gene of each enzyme.

Answers:

Gene of Enzyme	Chromosome number
Glutathione reductase	
Malate dehydrogenase	
Galactokinase	

B4. (3 points). Two independent mutations event of a DNA segment lead to the following results. Mark the type(s) of mutations observed. (See Genetic Codes in the front of Part A)



A. Point mutation.

B. Transition.

C. Silent mutation.

D. Transversion.

E. Neutral mutation.

F. Missense mutation.

G. Nonsense mutation.

Answer

1: ……
2: ……

B5. (3 points). Mark the correct statements by '+' and the incorrect ones by '–' in the appropriate box.

A. In any region of the DNA double helix only one chain of DNA that is usually used as a template for transcription. ☐

B. In bacteria the transcription of all classes of RNA is carried out by RNA polymerase of a single type, whereas in eukaryotic cells three types of RNA polymerase are used. ☐

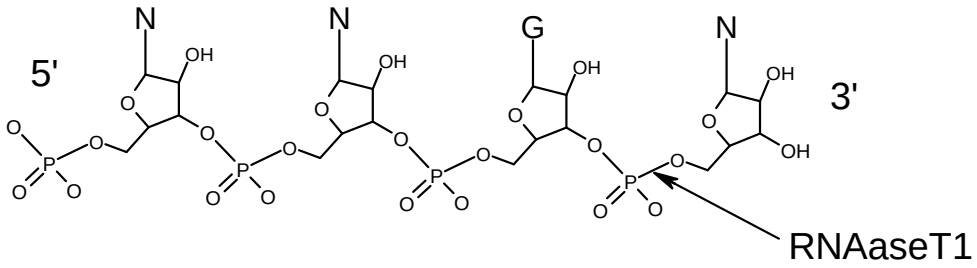
C. Formation of the peptide bond is carried out by enzyme peptidyl transferase, which binds to large subunit of ribosome after the initiation of translation. ☐

D. Since the start codon for protein synthesis is AUG, methionine is only found in N termini of polypeptide chains. ☐

E. Many antibiotics used in medicine today selectively inhibit protein synthesis only in prokaryotes because of structural and functional differences between ribosomes of prokaryotes and eukaryotes. ☐

F. Modified nucleotides, which are in the composition of tRNA molecule, form as a result of covalent modification of standard nucleotides after their incorporation into RNA-transcripts. ☐

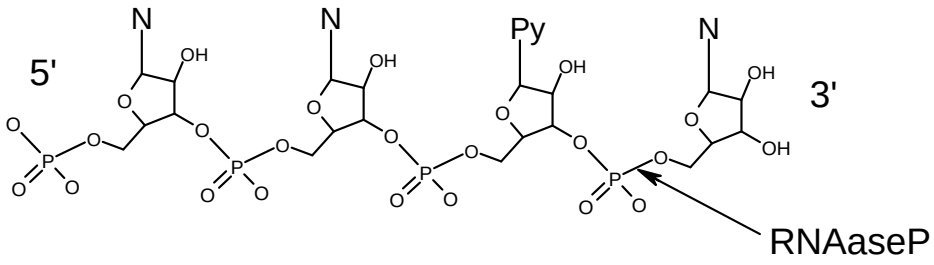
B6. (5 points). Oligoribonucleotide X was treated with phosphatase (for removal of 3′ and 5′ - terminal phosphates), then with RNAase T1, which cleaves all phosphodiester bonds located in a 3′ position of guanosine in a 5′-specific manner.



As a result, oligonucleotides L, M and N were generated in equal amounts. Each of them was further treated with phosphatase and subjected to alkaline hydrolysis. Results are listed in the table below.

Oligoribonucleotide	Content, mole/mole of oligoribonucleotide
L	UMP (1), AMP (1), CMP (1), Guanosine (1)
M	AMP (1), Cytidine (1)
N	CMP (2) , Guanosine (1)

Then experiment was modified: oligoribonucleotide X after treatment with phosphatase was hydrolyzed with RNAaseP, which cleaves all phosphodiester bonds in a 3′-position of pyrimidines in a 5′ - specific manner.



This hydrolysis yielded five products in approximately equimolar concentrations: uridine monophosphate, cytidine monophosphate and oligonucleotides P, Q and R. After resolution of the mixture and alkaline hydrolysis of these oligonucleotides data listed in the table below were obtained.

Oligoribonucleotide	Content, mole/mole of oligoribonucleotide
P	CMP (1), GMP (1)
Q	GMP (1), AMP (1), Cytidine (1)
R	AMP (1), CMP (1)

Using the results given above, deduce the nucleotide sequence of oligoribonucleotide X.

Answer: _____

B7. (5 points). The amino acid cysteine (Cys) has three ionizable groups:

- **α-amino group**
- **α-carboxyl group**
- **a side chain that can be negatively charged.**

The pK values are 8.18, 1.71 and 10.28, respectively. In the answer table, enter the ionic charge of cysteine at pH 1, 5, 9 and 12. Using an appropriate letter for each direction, show migration of cysteine in an electric field at different pH values.

A. To cathode (–)

B. To anode (+)

C. Does not migrate

Also in the table, circle the pH value nearest to the pI (isoelectric point) of this amino acid.
Answer:

pH	Ionic charge	Migrates toward
1		
5		
9		
12		

B8. (8 points). Listed in the two tables below are vitamins (A-K) and functions (1-12).

Designation	Vitamin
A.	B_1 (thiamine)
B.	B_2 (riboflavin)
C.	B_6 (pyridoxine)
D.	Folic acid
E.	A (retinol)
F.	D (calciferol)
G.	E (tocoferol)
H.	K (menaquinone)
I.	C (ascorbic acid)
J.	B_{12} (cobalamin)
K.	PP (nicotinic acid / niacin)

Number	Functions of vitamins or consequences of deficiency
1.	Antioxidant
2.	Regulation of calcium and phosphate metabolism
3.	Group transfer to or from amino acids
4.	Precursor of light absorbing group in visual pigments
5.	Blood coagulation
6.	Scurvy
7.	Beri beri
8.	Pellagra
9.	Anaemia
10.	------leave this part blank--------

11.	Co-Enzymes of dehydrogenases
12.	Rickets

Match each of the vitamins with its appropriate biological functions and/or lack of deficiency of this vitamin or its derivatives. There may be more than one answer per question.
Answers:

Vitamin	Function
A.	
B.	
C.	
D.	
E.	
F.	

Vitamin	Function
G.	
H.	
I.	
J.	
K.	

B9. (4 points). **The table below shows haploid or partial diploid *lac* operon of *E.coli*, where:**

- **Gene *lacI* codes for repressor.**
- **P and O are promoter and operator, respectively.**
- ***LacZ* and *lacY* represent genes encoding for *β*-galactosidase and *β*-galactoside permease, respectively.**
- **O^c is a constitutive mutation in the operator.**
- **I^s represents a mutation in the *lacI* gene, which causes mutant repressor protein not to be separated from the operator once it binds to it.**

Assume that there is no glucose in the bacterial culture medium. In the following table write 'O' if *β*- galactosidase is synthesized, and 'X' if it is not.

Strain	Genotype	Lactose absent	Lactose present
1	$I^- O^c Z^+ Y^-$		
2	$I^+ O^c Z^- / I^+ O^+ Z^+$		
3	$I^- P^+ O^c Z^+ Y^+ / I^+ P^- O^+ Z^+ Y^-$		
4	$I^s P^+ O^+ Z^+ Y^- / I^- P^+ O^c Z^- Y^+$		

B10. (5 points). Match the number of the organism in the left column with the corresponding letter for the disease in the right column.

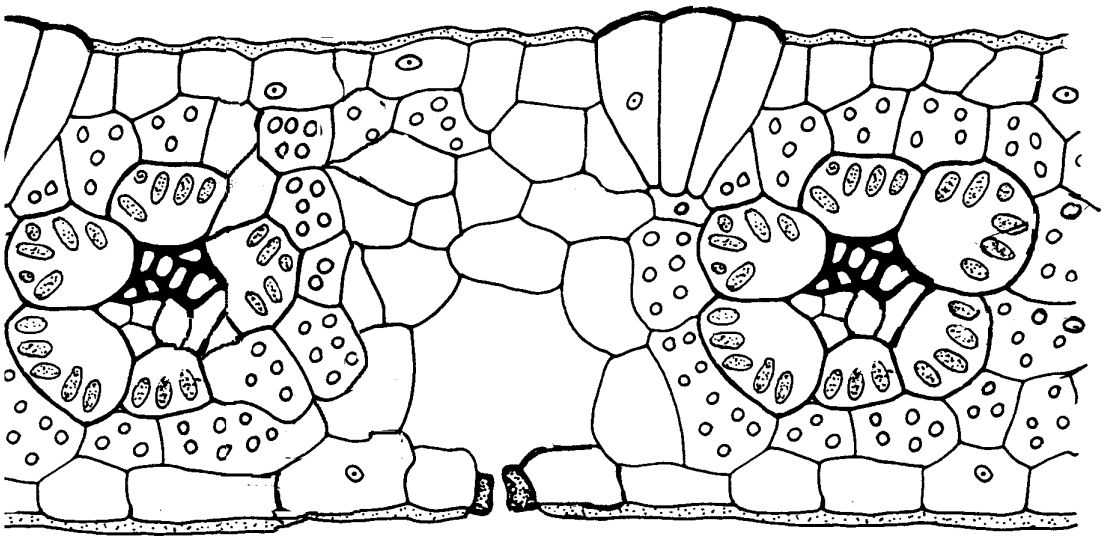
Organism	**Disease**
1. *Bacillus anthracis*	A. African sleeping sickness
2. *Borrelia burgdorferi*	B. Anthrax
3. *Escherichia coli*	C. Cholera
4. Filarial nematodes	D. Elephantiasis
5. *Plasmodium vivax*	E. Lyme disease
6. *Streptococcus pyogenes*	F. Malaria
7. *Tryponema pallidum*	G. Plague
8. *Trypanosoma gambiense*	H. Tuberculosis
9. *Vibrio cholerae*	I. Strep throat
10. *Yersinia pestis*	J. Syphilis
	K. Urinary tract infection

Answers:

1	2	3	4	5	6	7	8	9	10

Plant anatomy and physiology (6 questions, 29 points).

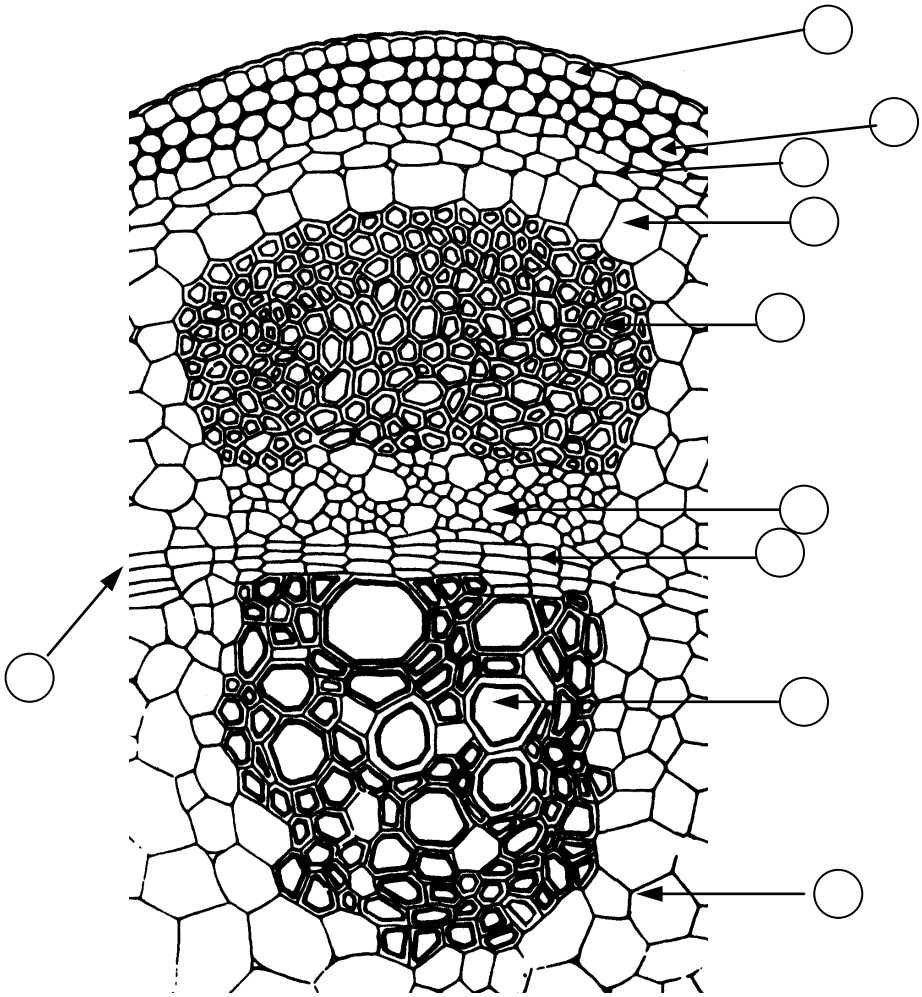
B11. (5 points). The figure shows a cross section of part of a plant leaf.



Indicate which of the following statements concerning this plant are true (+) and which are false (–).

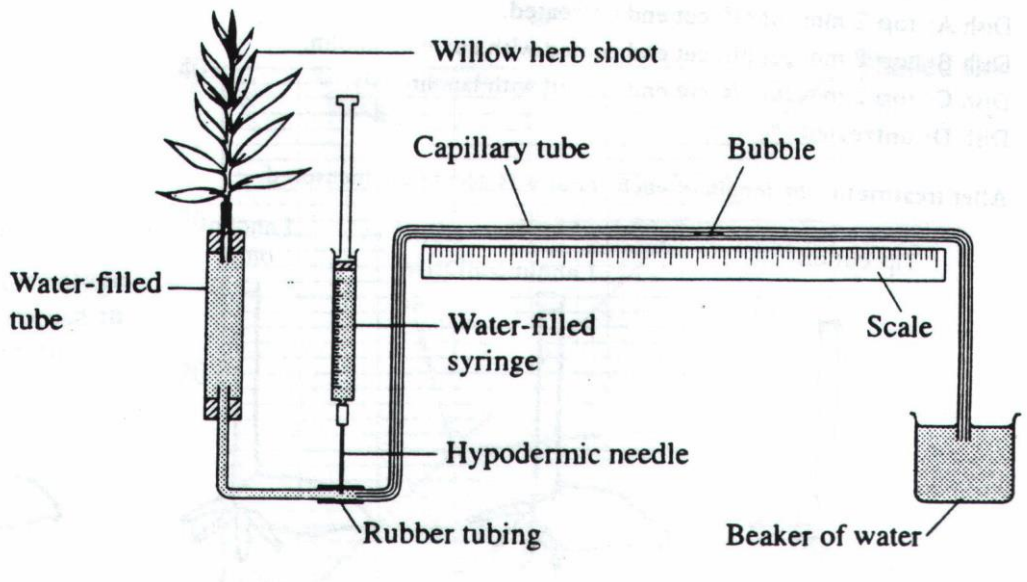
1.	Aquatic (Hydrophytic) habitat.	
2.	C_4 -photosynthetic pathway.	
3.	"Kranz" anatomy	
4.	Mesophyll with isolateral organization.	
5.	Terrestrial Dry habitat (Xerophytic) and plants of tropics and subtopics.	
6.	C_3 photosynthetic pathway.	
7.	Pinnate venation.	
8.	Asteraceae(*Compositae*) Family.	
9.	Poaceae (*Gramineae)* Family.	
10.	Parallel venation.	

B12. (5 points). Label the plant structures in the following diagram, by inserting the number in the appropriate circle on the answer sheet.



1. **Phloem.**
2. **Xylem.**
3. **Endodermis.**
4. **Fascicular cambium.**
5. **Epidermis.**
6. **Parenchyma.**
7. **Cortex parenchyma.**
8. **Sclerenchyma.**
9. **Interfascicular cambium.**
10. **Collenchyma.**

B13. (5 points). The potometer can be used to measure transpiration in a cut shoot such as rose-bay willow plant, by measuring water uptake.



Indicate which of the following statements are true (+) and which are false (–).

A. **The potometer is usually assembled under water** ☐

B. **The water-filled syringe is used to suck water out of the apparatus when air bubbles appear.** ☐

C. **The shoot must be sealed over the cut point with vaseline immediately after it is cut from the plant.** ☐

D. **The hypodermic needle is used to introduce the air bubble into the potometer.** ☐

E. **Enclosing the shoot in a black plastic bag will reduce the transpiration** ☐

F. **The rate of transpiration will be high in still, humid air.** ☐

G. **The rate of transpiration will be highest in warm, dry moving air.** ☐

H. **The rate of water uptake and the rate of transpiration are not always equal.** ☐

I. **Low cohesive properties between the water molecules create problems for potometer experiments.** ☐

J. **Results from potometer experiments can never be quantitative.** ☐

B14. (2,5 points). For a short-day plant, indicate which treatments, as listed below, would <u>inhibit flowering</u>. All the treatments were conducted at night. Mark correct statements with "+", incorrect statements with "–".

A. Exposure to red light and far-red light, consecutively. ☐

B. Exposure to red light, far-red light, and red light, consecutively. ☐

C. Exposure to red light, far-red light, and white light, consecutively. ☐

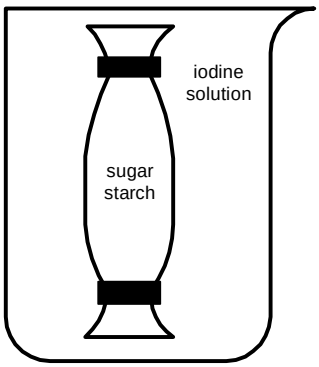
D. Exposure to white light and far-red light, consecutively. ☐

E. Exposure to red light, far-red light, white light, red light, and white light, consecutively. ☐

B15. (6,5 points). Diffusion and osmosis are important for the passive transport of molecules in the cell.

01. (2,0 points). The figure shows an experiment with a dialysis (visking) membrane filled with sugar and starch (colorless) suspended in a beaker with diluted iodine solution (orange – brown). Use '+' to indicate which colour you would expect in the beaker and in the tube after several hours of dialysis.

	Solution in the beaker.	Solution in the dialysis tube.
Colorless		
Orange-brown		
Pink-red		
Greenish-yellow		
Blue-black		



02. (2.5 points). In a similar experiment, dialysis membranes are filled with solutions with different concentrations of molecules and left in beakers with solutions withdifferent molecule concentrations. The dialysis tubes all have the same mass at the beginning of the experiment. The size of the molecules is bigger than the pore size of the membrane. Mark with "+" the experimental settings in which the beaker contains a hypotonic solution compared to the dialysis tube, and mark with "–" the ones which do not.

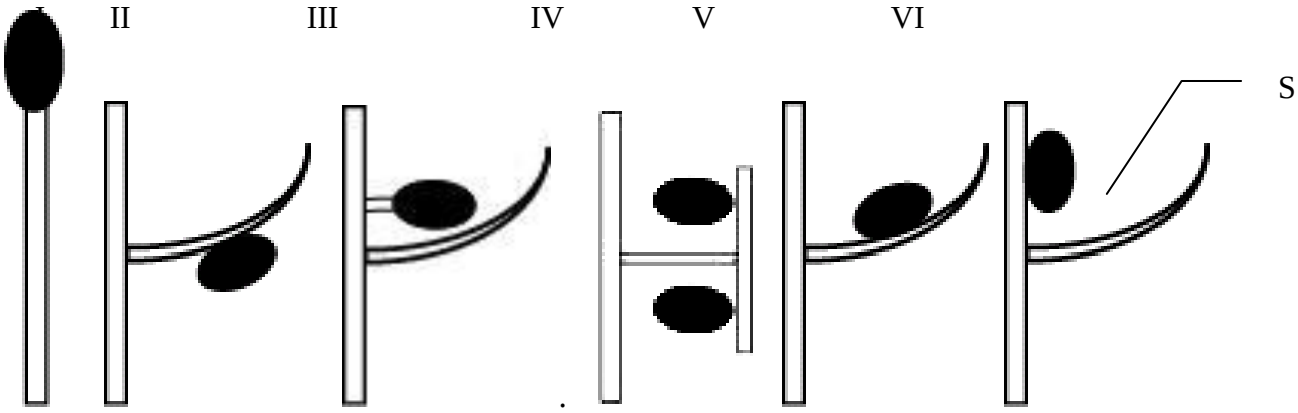
Experiment	A	B	C	D	E
Concentration in the dialysis tube (M).	0.1	0.8	0.4	0.2	0.4
Concentration in the beaker (M).	0.8	0.1	0.2	0.4	0.4
Hypotonic solution.					

03. (2 points). The tubes are weighed after several hours of dialysis. Their mass is compared to that before the dialysis. Write the letters of the experiments in the order of the final mass of the dialysis tube, beginning with the tube having the lowest mass.

Order of the tubes with regard to their mass:

Answers: _____

B16. (5 points). Which position of sporangia is characteristic of present day representatives of the higher plants phyla listed below?



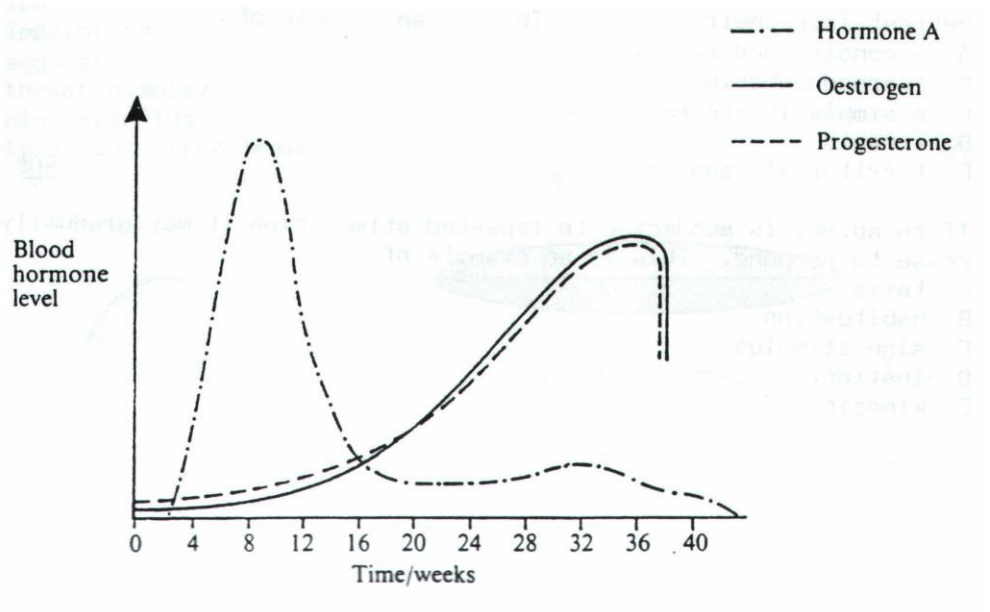
S- sporangium

Phylum	Plant number
Bryophyta (Liverworts and mosses)	
Lycopodiophyta (Club moss)	

Equisetophyta (Horse-tails)	
Pterophyta *(Polypodiophyta)* (Ferns)	

Animal Anatomy & Physiology (6 questions, 26 points).

B17. (5 points). The graph indicates the blood levels of three hormones produced in a pregnant woman.



<u>01.</u> (2 points). Using + (true) and – (false), indicate whether each of the following is true or false.

A.	Hormone A is produced by the ovary	
B.	Hormone A is human chorionic gonadotrophin.	
C.	Hormone A is prolactin.	
D.	Hormone A is made by the chorion.	

<u>02.</u> (1 point). Which hormone keeps the smooth muscle of the uterus relaxed during pregnancy? (mark with '+').

A.	Progesterone.	
B.	Prolactin.	
C.	Oxytocin.	
D.	FSH.	
E.	LH.	

<u>03.</u> (2 points). Two other hormones, not shown on the graph, are also produced during pregnancy. These are prostaglandins and oxytocin. Indicate whether the following statements are true (+) or false (–).

A.	These two hormones are produced by the ovaries.	
B.	These two hormones are responsible for milk formation.	
C.	These two hormones are responsible for contractions of the uterine wall.	
D.	These two hormones are made by the endometrium and pituitary gland, respectively.	

B18. (3 point). Name the germ layers of a metazoan embryo from which the following systems or organs developed:

A.	Brain.	
B.	Hair.	
C.	Autonomic ganglia.	
D.	Lungs.	
E.	Cardiac muscle.	
F.	Cartilage.	

1. Ectoderm.

2. Endoderm.

3. Mesoderm.

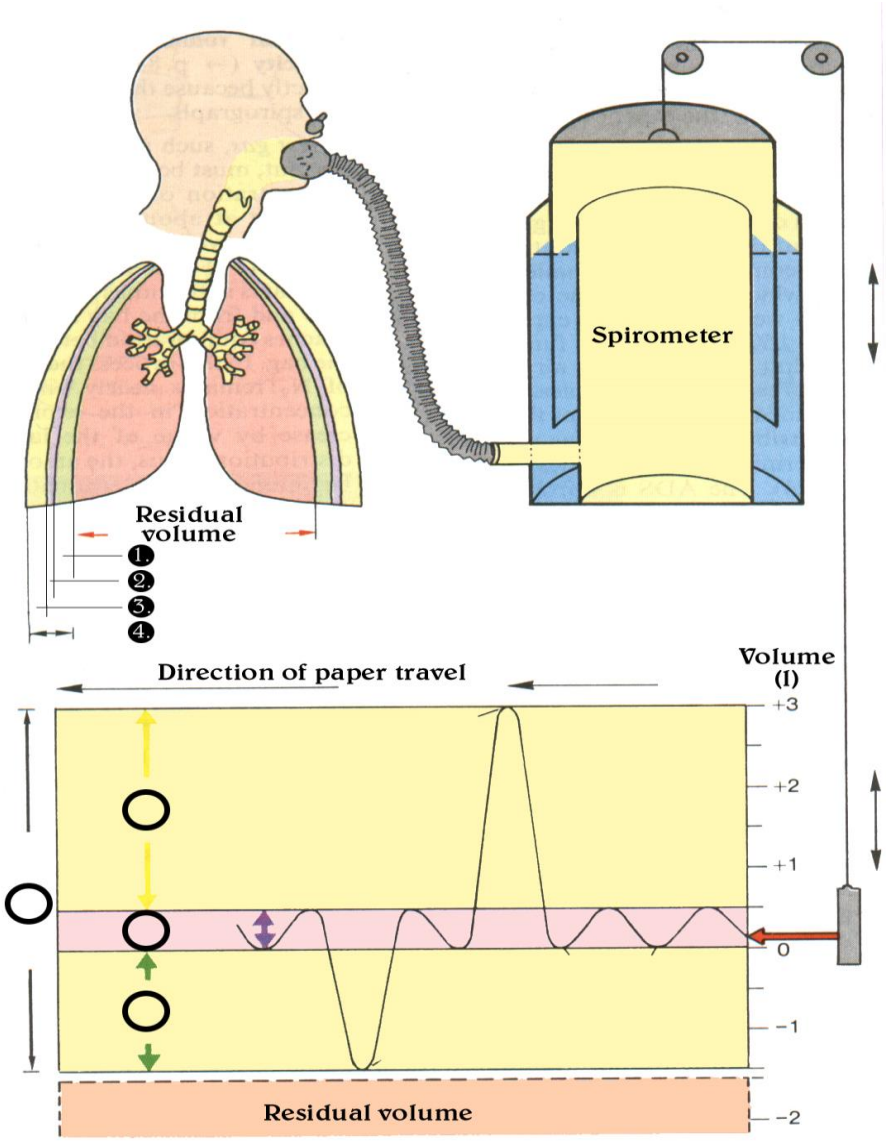
B19. (3 points). Match the protein (1 to 6) with its function (A to F):

1. Myoglobin.	A. Blood clotting.
2. Prothrombin.	B. Regulation of water excretion.
3. Ferritin.	C. Light-sensitive pigment of rod cells.
4. Vasopressin.	D. Oxygen-storage in skeletal muscles.
5. Collagen.	E. Iron storage in spleen, liver and bone marrow.
6. Rhodopsin.	F. Major fibrous protein of connective tissue.

Answers:

1	2	3	4	5	6

B20. (4 points). For the curve below, fill in the circles on the answer sheet using appropriate numbers from the upper figure. In the table, for every number put a correct letter corresponding to a term given below.

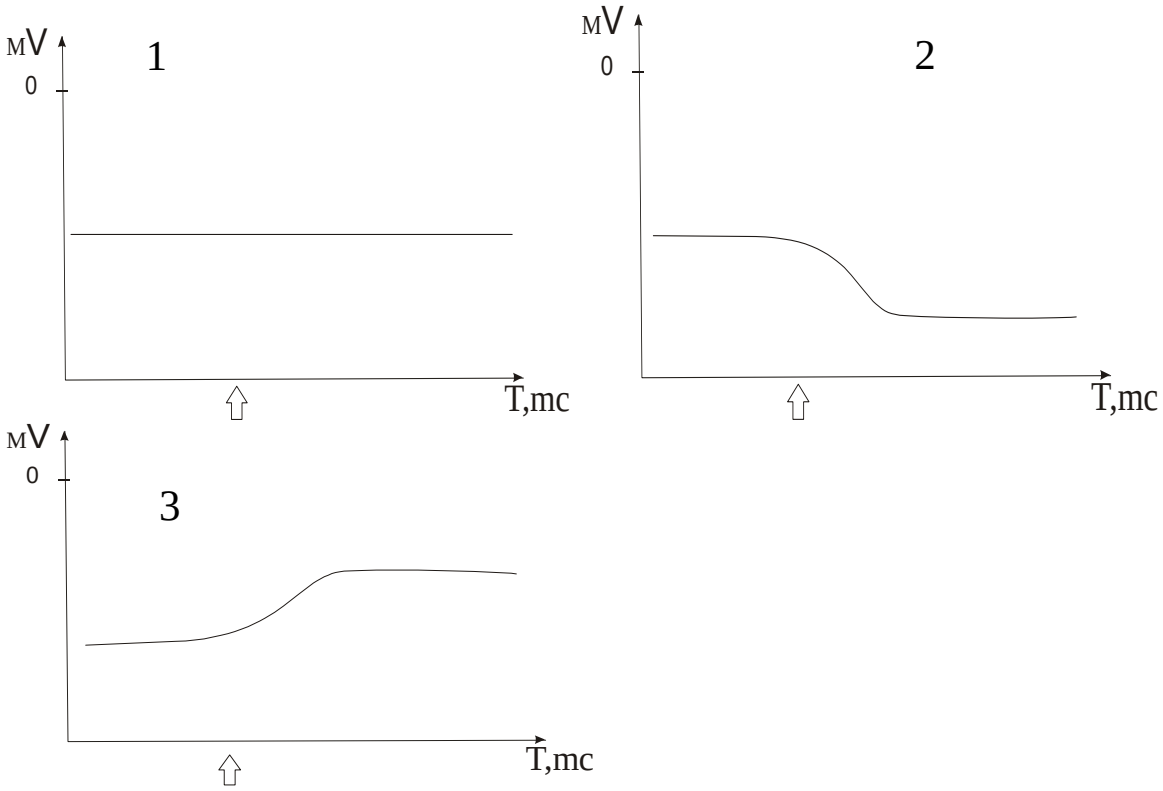


Respiratory volumes	
Number in the diagram and curve	Term letter
1.	
2.	
3.	
4.	

A. Expiratory reserve volume.
B. Tidal volume.
C. Inspiratory reserve volume.
D. Vital capacity.

B21. (7 points). How can the resting potential of a cell change after addition of the biologically active compounds listed below (compound addition is marked by an arrow ⇧)?

01. (5 points). Determine which graph reflects the addition of which compound. Fill the results in the table.



Nistatin (Na^+- ionophore): _____

Tetrodotoxin (inhibitor of Na^+-channels): _____

Valinomycin (K^+- ionophore): _____

<u>02.</u> (2 points). What is the change of transmembrane potential, in graphs 2 and 3 called?

A. Hyperpolarisation.

B. Depolarisation.

T,ms

C. Repolarisation.
D. Action potential.
E. Overshoot.

Answers:

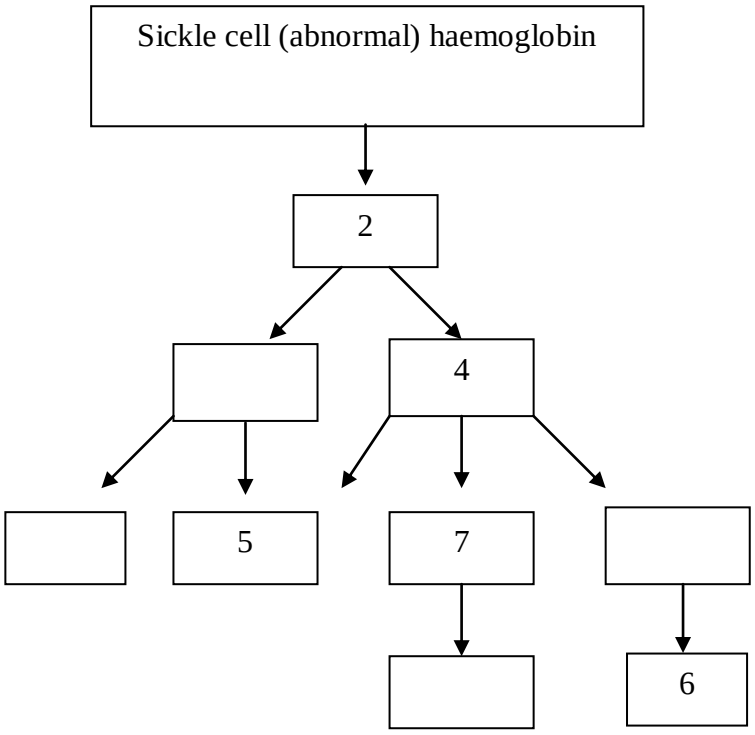
2 – _____

3 – _____

B22. (4 points). A mutation in the haemoglobin gene (*HbS*) causes sickle cell disease that produces a cascade of symptoms such as:

1. Anaemia.
2. Sickle shaped red blood cells.
3. Breakdown of red blood cells.
4. Clumping of cells and clogging of small blood vessels.
5. Heart failure.
6. Kidney failure.
7. Brain damage.
8. Damage to other organ.
9. Paralysis.

In the following diagram, the symptom in the box on top of the arrow causes the symptom inthe box below the arrow. Fill the empty boxes with the number of the appropriate symptoms.



Ethology (2 questions, 12 points).

B23. (3 points). Guppies are often called ‘millionaire fishes’ because of their abundant progeny.

In 1966, Professor C.M. Breder, then director of the New York aquarium, decided to perform an experiment, in order to learn more about fish reproduction. He put pair of Guppies (one adult male and one adult female) into a small aquarium, with 27.5 liters of water capacity supplied with enough food and oxygen to maintain up to 100 fish. During the 6 following months and with an interval of 4 weeks between each breeding (these fishes are ovoviviparous), the female produced 102, 87, 94, 51 and 89 offspring, it means a total of 443 guppies. A later recount showed that only 9 were alive: 6 females and 3 males.

The rest had been eaten by their own mothers.

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In another aquarium with the same size and conditions, the researcher placed 8 adult males, 8 adult females and 8 young fishes, a total of 24 guppies. Females got abundant progeny, too. Data of proliferation during the course of the following 6 months from the introduction of the original group of 24 guppies in the aquarium, are shown in the following tables.

FEMALE 1

		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	**Males**	**29**	**24**	**31**	**30**	**33**
	Females	**58**	**48**	**64**	**58**	**68**
	Total	**87**	**72**	**95**	**88**	**101**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 2						
		Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**
Number of offspring after each hatching	**Males**	**32**	**26**	**33**	**28**	**29**
	Females	**65**	**50**	**66**	**56**	**58**
	Total	**97**	**76**	**99**	**84**	**87**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

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FEMALE 3						
		Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**
Number of offspring after each hatching	**Males**	**32**	**29**	**25**	**34**	**28**
	Females	**64**	**56**	**51**	**69**	**55**

	Total	**96**	**85**	**76**	**103**	**83**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 4						
		Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**
Number of offspring after each hatching	**Males**	**28**	**25**	**35**	**30**	**29**
	Females	**57**	**49**	**69**	**61**	**60**
	Total	**85**	**74**	**104**	**91**	**89**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

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FEMALE 5					
Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**

Number of offspring after each hatching	**Males**	**33**	**30**	**30**	**23**	**30**
	Females	**67**	**59**	**64**	**47**	**60**
	Total	**100**	**89**	**94**	**70**	**90**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 6						
		Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**
Number of offspring after each hatching	**Males**	**30**	**29**	**26**	**35**	**25**
	Females	**62**	**57**	**53**	**70**	**52**
	Total	**92**	**86**	**79**	**105**	**77**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

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FEMALE 7						
		Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**
Number of offspring after each hatching	**Males**	**29**	**24**	**33**	**28**	**29**

	Females	**60**	**50**	**71**	**57**	**62**
	Total	**89**	**74**	**104**	**85**	**91**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 8						
		Week 4	**Week 8**	**Week 12**	**Week 16**	**Week 20**
Number of offspring after each hatching	**Males**	**26**	**32**	**33**	**28**	**28**
	Females	**52**	**65**	**64**	**58**	**57**
	Total	**78**	**97**	**97**	**86**	**85**
Number of offspring counted some hours after hatching	**Males**	**0**	**0**	**0**	**0**	**0**
	Females	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**
Observation: The just hatched guppies were devoured by their own mother						

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ORIGINAL NUMBER OF FISH			
	ADULTS		**YOUNGS**
	Males	**Females**	

Initial number of guppies in the aquarium	**8**	**8**	**8**
N° of guppies recounted one year later	**3**	**6**	**0**
Observations: The young of the original establishment were devoured by the adults. Some adults of the original establishment died by unknown causes.			

Which of the following statements arise from the analysis of the previous data? Mark with 'X'

correct statements.

I. Guppies eat their own offspring ('infanticide' behaviour). ☐

II. Guppies show 'indiscriminate' cannibalism, eating all individuals belonging to its species. ☐

III. Guppies show 'selective' cannibalism, eating the individuals belonging to its species which are shorter than threshold level. ☐

IV. Guppies show 'selective' cannibalism eating only foreign progeny. ☐

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B24. (8 points). Two young men (Hans and Henri), behaviour researchers of more or less the same age and appearance, are going to do some investigations about sexual preferences of human females. For this purpose they select six nice outdoor cafés popular with young women and hire two similar bikes of which one is provided with an extra child saddle (see diagram).

Hans and Henri expect that a man having a bike with a child's saddle is more attractive to young women. This is checked on a sunny afternoon in July. Hans and Henri make a tour along the six outdoor cafés, indicated A to F. At every café they halt for 15 minutes. While standing in front of the café with their bikes and pretending they are having a talk together, they both try individually to make eye contact with as many as possible of the females sitting outside. The numbers are recorded and after each café Hans and Henri change bikes. The results of this experiment are shown in the table.

	Number of hits (eye contacts) at café A to F						
	A	B	C	D	E	F	Total
Hans	**12**	10	**14**	7	**17**	12	72
Henri	9	**17**	10	**10**	12	**20**	78
Total	21	27	24	17	29	32	150

Remark: underlined are the hits obtained by man (Hans or Henri)+bike with child saddle.

Hans and Henri expect that the man with a bike having an extra child saddle will be more attractive to females than the man with the bike without a child saddle. Possible arguments supporting this idea are based on the hypothesis that female organisms often show behaviour focusing on objects related to survival of species.

01. (1 point). Which of the following statements is a correct Null Hypothesis for the experiment of Hans and Henri?

1. Hans and Henri do have the same attractiveness for females.
2. The attractiveness of a man + bike with child's saddle is the same as man + bike without child's saddle.

3. The six cafés do not differ in the character of the visiting females.
4. Having eye contact between a male and a female is not an indicator of attraction.
5. The attractiveness of a man+bike with child's saddle is greater than that of a man+bike without child's saddle.

<u>02</u>. (1 point). Hans and Henri do some calculations with their results.

	Number of hits per café	
	Mean (average)	**Standard deviation**
Hans	**12**	**3.4**
Henri	**13**	**4.5**
Hans+Henri	**25**	**5.5**
<u>Situation A:</u> **Man + bike with child's saddle**	**15 (n_A)**	**3.7 (S_A)**
<u>Situation B:</u> **Man + bike without child's saddle**	**10 (n_B)**	**1.9 (S_B)**

You have to check the significance of the differences between situation A and B using the t-test. The following table should be used.

Level of significance	**Critical t-value**
10.0 %	**2.02**
5.0 %	**2.57**
2.5 %	**3.37**
1.0 %	**4.03**
0.5 %	**6.86**

Calculate the standard deviation of the difference between the means of the two situations A and B in using the formula:

S =

$$s = \sqrt{\{(s_A{}^2/n_A) + (s_B{}^2/n_B)\}}$$

<u>03</u>. (1 point). Calculate t, using the formula:

t=d/s

t =

d – difference between means (situation A and situation B).

<u>04</u>. (1 point). How sure can we be about rejecting the Null hypothesis (i.e. the difference between situation A and B is significant)

1. Less than 75.0 %
2. In between 75.0 % and 90.0 %
3. In between 90.0 % and 95.0 %
4. In between 95.0 % and 97.5 %
5. In between 97.5 % and 99.0 %
6. In between 99.0 % and 99.5 %
7. Over 99.5 %

<u>05</u>. (1 point). Hans and Henri show their results to Paula, their boss. Paula claims that Hans and Henri made a big mistake looking at the total number of hits per café

since the six cafés differ too much as a spread of 17 up to 32 is too much. Hans and Henri do not agree with Paula and want to prove their point of view using the χ^2 test. Determine the χ^2 using the following formula.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

χ^2 =

<u>06</u>. (1 point). Indicate the degree of freedom (df) for this test:

<u>07</u>. (1 point). Determine the probability (P) for this χ^2 test, using the following table. Estimate the answer in %.

(df)	Probability of random deviation (P)									
	0.995	0.975	0.9	0.5	0.3	0.25	0.1	0.05	0.025	0.01
1	0.00	0.00	0.02	0.46	1.07	1.32	2.71	3.84	5.02	6.64
2	0.01	0.05	0.21	1.39	2.41	2.77	4.61	5.99	7.38	9.214
3	0.07	0.22	0.58	2.37	3.67	4.11	6.25	7.82	9.35	11.35
4	0.21	0.48	1.06	3.36	4.88	5.39	7.78	9.49	11.14	13.28
5	0.41	0.83	1.61	4.35	6.06	6.63	9.24	11.07	12.83	15.09
6	0.68	1.24	2.20	5.35	7.23	7.84	10.65	12.59	14.45	16.81
7	0.99	1.69	2.83	6.35	8.383	9.04	12.02	14.07	16.0	18.48

<u>08.</u> (1 point). Which of the following conclusions based upon this χ^2 test is correct? Look at the total number of hits per cafe

1. The café's are different, but the differences are not significant
2. The differences between the cafés are significant
3. The results are dubious or questionable, something must be wrong in the design of this experiment. The cafés are not different, but this is not significant
4. The cafés are not different and this is significant

Genetics (7 questions, 26 points).

B25. (4 points). For each species listed in the table below, indicate whether it can be routinely used to study, investigate or manipulate one or more of the numbered items.

1. Obtain gene mutations.
2. Obtain chromosomal mutations in eukaryotes
3. Make gene maps.
4. Investigate meiosis.
5. Investigate mitosis.
6. Investigate X-chromosome.
7. Obtain extranuclear mutations.
8. Use *Agrobacterium tumefaciens* Ti-plasmid for gene transfer to the cells of given organisms.
9. Perform the gene transfer by transduction.
10. Investigate the *lac*-operon regulation.
11. Determine the DNA sequences.

Indicate the correct statements by "X" in corresponding box of answer table:

Object	Item number(s)										
	1	2	3	4	5	6	7	8	9	10	11
Zea mays											
Drosophila melanogaster											
Saccharomyces cerevisiae											
Caenorhabditis elegans											
Escherichia coli											
Bacteriophage λ											
Prions											

B26. (5 points). The birth records for 4 children were lost at a hospital. The ABO blood groups of the four babies are known to be A, B, AB, and O. To determine parentage all of their parents were tested for blood group. (The father of third child wasn't found). The results are shown in the following table.

<u>01.</u> (4 points). Match the babies with their parents by marking the right blood types in the table .

Families		Blood group of each parent	Blood group of a baby
Parents 1	Father	AB	
	Mother	O	
Parents 2	Father	A	
	Mother	O	
Parents 3	Father	Unknown	
	Mother	A	
Parents 4	Father	O	
	Mother	O	

<u>02.</u> (1 points). What is/are the possible blood group(s) the unknown father could have?

B27. (3 points). Connect the terms widely used in population genetics in the left column with the correct statement in the right column.

	Term
1	Inbreeding depression.
2	Gene flow.
3	Selection.
4	Outbreeding depression.
5	Genetic drift.
6	Mutation.

	Statement
A	Fixes advantageous alleles and removes disadvantageous alleles.
B	Increases genetic diversity within and between sub-populations, but occurs rarely.
C	Increases variation between sub-populations and decreases variations within sub-populations.
D	Fitness reduces due to increase in homozygosity, expression of deleterious alleles increases as a consequence of mating between closely related individuals.
E	Reduction of fitness due to mating of genetically divergent individuals.
F	Decreases variation between sub-populations and increases variation within sub-populations.

Term	1	2	3	4	5	6
Answers:						

B28. (4 points). In an isolated human population of 8400 persons, the frequency of allele I^A is 30% and allele I^B is 10%.

What is the number and % of people with each blood group?

Group	People number	%
O		
A		
B		
AB		

B29. (4 points). Suppose that the difference between 10 cm high maize and 26 cm high maize is due to four pairs of additive genes. The individuals with 10 cm have the aabbccdd genotype and the 26 cm - AABBCCDD.

01. (1 point). Determine the phenotype of F1 if it is known that the parental plants are 10 cm and 26 cm of high.

Answer:

F1:

02. (1 point). How many phenotypes classes would be in F2?

Answer:

F2:

03. (1 point). Determine the phenotypes of F2 if it is known, that the parental plants are 10 cm and 26 cm high.

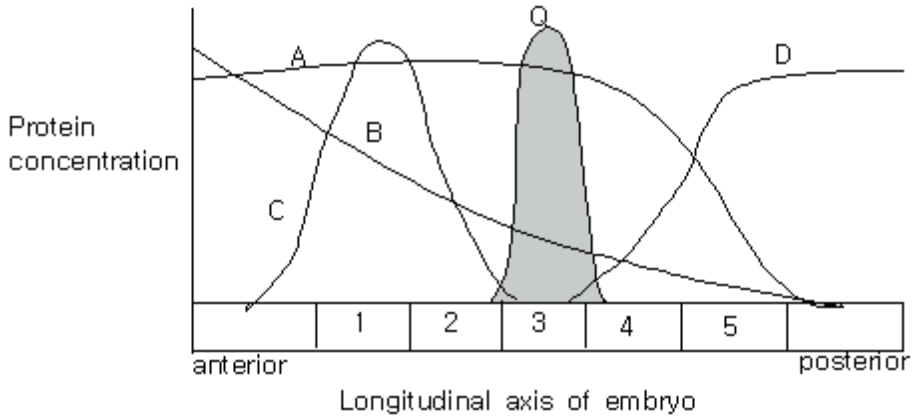
Answers:

04. (1 point). What fraction of the total number of plants in F2 will be 18 cm high ?

Answer:

B30. (4 points). The following figure shows the distribution of the concentrations of five hypothetical proteins in a *Drosophila* embryo. The anterior end is on the left and

the posterior end is on the right. A and B gene products activate the expression of Q gene, and C and D gene products repress the expression of Q gene.



If one of the A, B, C and D genes is mutated, where would the protein Q be found? Choose the number of the correct answer.

	Expression pattern of Q gene
Mutant A	
Mutant B	
Mutant C	
Mutant D	

I. Would be found in the anterior end of the embryo body.

II. Would be found in the posterior end of the embryo body.

III. No significant change

IV. Expression of Q gene would decrease significantly.

B31. (2 points). It is known that in some dioecious plants sex can be determined genetically as in animals. Examine the results of analysis of different types of polyploids and ascertain the type (mechanism) of sex determination in the given plant species.

Choose the correct statement and put its number in the appropriate box.

Rumex acetosa		*Silene latifolia*	
Genotype	Sex	Genotype	Sex
2A+2X	♀	2A+2X	♀
2A+X+Y	♂	2A+X+Y	♂
2A+X+2Y	♂	2A+X+2Y	♂
2A+X+3Y	♂		
2A+2X+Y	♀	2A+2X+Y	♂
2A+2X+2Y	♀		
3A+X+2Y	♂		
3A+X+3Y	♂		
3A+X+4Y	♂		
3A+2X	♀♂	3A+2X	♀
3A+2X+Y	♀♂	3A+2X+Y	♂
3A+2X+2Y	♀♂		
3A+2X+3Y	♀♂		
3A+3X	♀	3A+3X	♀
3A+3X+Y	♀	3A+3X+Y	♂
3A+3X+2Y	♀	4A+X+Y	♂
4A+2X+2Y	♂	4A+2X	♀
4A+2X+3Y	♂	4A+2X+Y	♂
4A+2X+4Y	♂	4A+2X+2Y	♂
4A+3X	♀♂	4A+3X	♀
4A+3X+Y	♀♂	4A+3X+Y	♂
4A+3X+4Y	♀♂	4A+3X+2Y	♂
4A+4X	♀	4A+4X	♀
4A+4X+Y	♀	4A+4X+Y	♀♂
4A+4X+2Y	♀	4A+4X+2Y	♂
5A+5X	♀		
6A+4X+4Y	♀♂		

A – haploid number of autosomes.

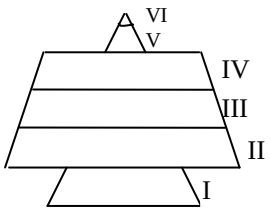
1. Sex determination as in human.
2. Sex determination as in *Drosophila.*
3. Sex determination as in birds.
4. Sex determination as in bees.
5. In given plants X-chromosome determines maleness and Y-chromosome determines femaleness.
6. The presence of the Y-chromosome is a necessary and sufficient condition for the formation of male flowers.
7. Y-chromosome doesn't take part in sex determination.
8. X-chromosome doesn't take part in sex determination.

01. *Rumex acetosa* ____

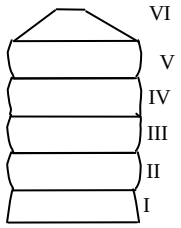
02. *Silene latifolia* ____

Ecology (5 questions, 19 points).

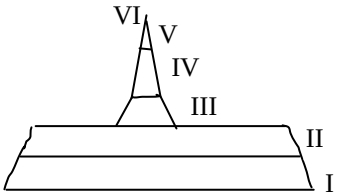
B32. (3 point). Three pond ecosystems (1, 2 and 3) were used for fish production. When the total number of fish in each pond was measured, the following pyramids were obtained. (Age of the fish is divided into six class intervals).



1.



2.



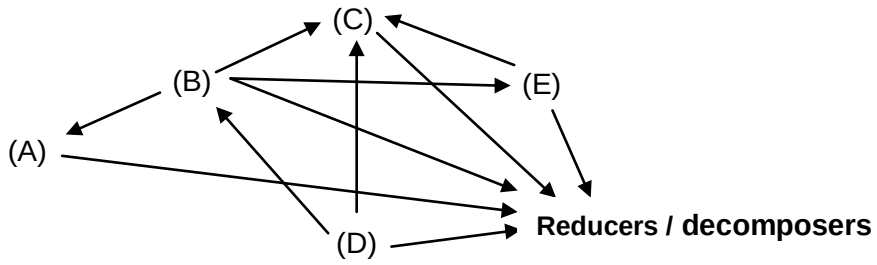
3.

Assign to these pyramids the appropriate features from the list below. Using letters indicate the answer(s) in the table.

A. Pond with very intensive fish cropping.
B. Pond with selective cropping of baby fish.
C. Pond with limited fish cropping.
D. Eutrophic pond.
E. Pond cropped regularly.
F. Pond with excessive turbidity and excessive phytoplankton.
G. Pond with optimal age structure.

Pond	Statement
1	
2	
3	

B33. (2.5 points). The following figure shows the food web of a certain ecosystem with five species (A-E). Arrows indicate the flow of energy. Match the letters to the descriptions of the species:



Producer	
Herbivore	
Omnivore	
Carnivore	

B34. (8.5 points). Fresh water bodies can be subdivided into still-water systems (lentic waterbodies = ponds and lakes) and moving water systems (lotic waterbodies =creeks and rivers). Both groups differ in the abiotic factors and in their flora and fauna.

<u>01.</u> (2,5 points). Indicate with a '+' which characteristics are typical of the lentic and lotic systems.

Water system characteristic	Water system type	
	lotic	lentic
Rapid decrease of the light density with the depth		
Normally staggered water temperature		
Occurrence of long-lasting plankton communities		
Streamlined animal bodies		
Animals with suction cups (suckers)		

<u>02</u>. (3 points). Rivers show a marked profile of various water quality parameters along their length. Samples taken near the source of the river show different values for various parameters compared to

samples from down stream parts of the river. Mark the expected tendency of this difference using the symbols ' +' for increase, ' -' for decrease or '=' for no change.

From near the river's source ⟶ To lower part of the river.

A. Water temperature.

B. Oxygen content.

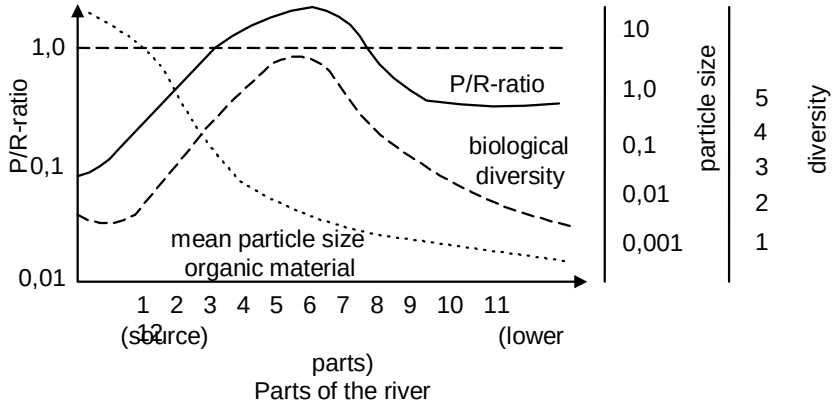
C. Turbidity.

D. Amount of sediments.

E. Amount of nutrient minerals.

F. Velocity of the flow.

<u>03.</u> (3 points). The graph shows values measured along a river (river continuum). The P/R ratio represents the ratio of production to respiration in the given part of the river. From the graph choose the correct parts of the river for the questions below.



Answer the three questions. Write the numbers of river parts in the boxes.

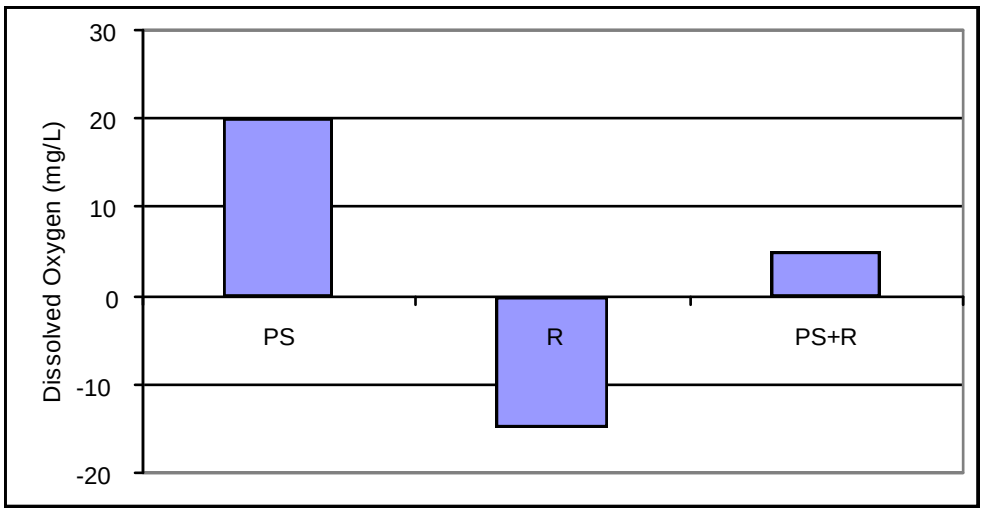
A. Which parts of the river are autotrophic?

B. In which parts is organic material (such as tree leaves) essential for the consumers?

C. In which parts can predators be found?

B35. (1 point). A student wished to estimate the size of a population of an endangered water beetle species in a small pond. He captured 30 individuals, marked and then released them back in the pond. After 24 hours, once again he captured 30 individuals. Of the newly captured individuals, only 14 were marked. Assume that no individuals were born, died, immigrated to or emigrated from the population during the experiment.
What would be the student`s estimation of the endangered water beetle population in the pond? Estimated population size of endangered water beetle in the pond is:

B36. (4 points). The graph shows the productivity of an aquatic ecosystem measured in terms of dissolved oxygen produced and consumed by green plants and photosynthetic algae where PS = photosynthesis and R = respiration.



Study the graph and answer the following questions, writing your answers in the box.

<u>01.</u> (1 points). Which bar represents net primary productivity?

<u>02.</u> (3 points). An algal bloom occurs until nutrient levels are exhausted. Then the algae die off and microbial decomposition begins. How will this affect the graph parameters PS and R?

<u>02.1</u>. (1 point). What will happen during the algal bloom?

1. PS will be increased, R will be decreased.
2. PS will be decreased, R will be increased.
3. PS and R will not change.
4. PS + R will increase.
5. PS + R will decrease.
6. PS + R will remain unchanged.

<u>02.2.</u> (1 point). What will happen after decomposition has begun?

1. PS will be increased.
2. PS will be decreased.
3. R will be increased.
4. R will be decreased.
5. PS + R will be increase.
6. PS + R will be decrease.
7. PS + R remain unchanged.

SKIPPED

<u>02.3.</u> (1 point). How would the graphs (parameters PS, R and PS+R) change if the net

community productivity per dissolved oxygen levels was measured?

1. PS will be increased, R will be decreased.
2. PS will be decreased, R will be increased.
3. 3. PS and R will not change.
4. PS + R will increase.
5. PS + R will decrease.
6. PS + R will remain unchanged.

SKIPPED

Biosystematics (4 questions, 16 points).

B37. (3 points). Below is a list of extant (living) mammalian genera. Assign them to the continents and subcontinents where they live and indicate the Order to which they belong. Insert the number of the animal into the correct boxes of tables 01 and 02.

GENUS	
1.	*Ursus* (Bears)
2.	*Cebus* (New world monkeys)
3.	***Pan* (Chimpanzees)**
4.	***Pongo* (Orangutans)**
5.	***Elephas* (Elephants)**
6.	***Macropus* (Kangaroos)**

01. (1.8 points). Continents & subcontinents.

Australia	
North America	
India	
Africa	
Europe	
Asia	
South America	

02. (1,2 points). Order

Marsupialia	
Proboscidea	
Carnivora	
Primates	

B38. (3 points). Match the terms in the left column (1 to 6) with the names of organisms in the

right column (A to F).

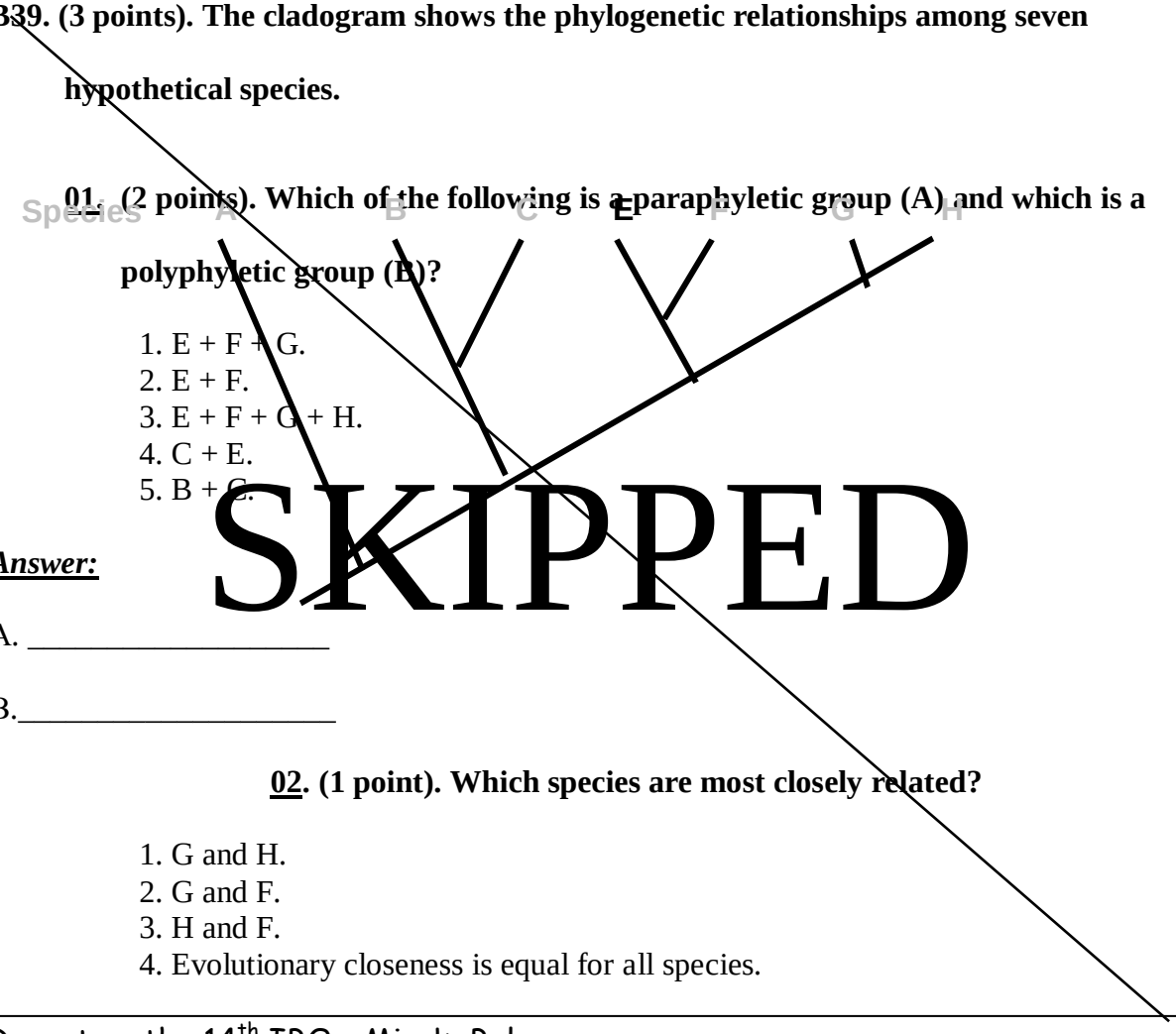
1. Polyembryony.	A. Fasciola
2. Heterogony.	B. *Helix.*
3. Metagenesis	C. Apis
4. Hermaphroditу.	D. Ichnemon
5. Parthenogenesis.	E. Aurelia
6. Parthenocarpy.	F. Axolotl (*Ambystoma*).

SKIPPED

Answer:

1	2	3	4	5	6

B39. (3 points). The cladogram shows the phylogenetic relationships among seven hypothetical species.



01. (2 points). Which of the following is a paraphyletic group (A) and which is a polyphyletic group (B)?

1. E + F + G.
2. E + F.
3. E + F + G + H.
4. C + E.
5. B + C.

SKIPPED

Answer:

A. _____

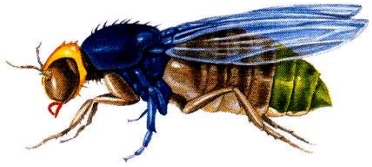
B._____

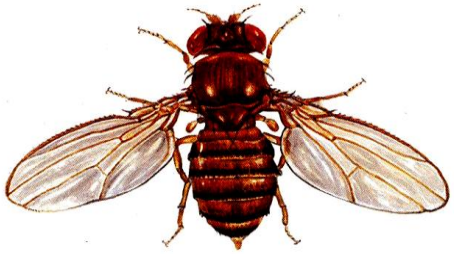
02. (1 point). Which species are most closely related?

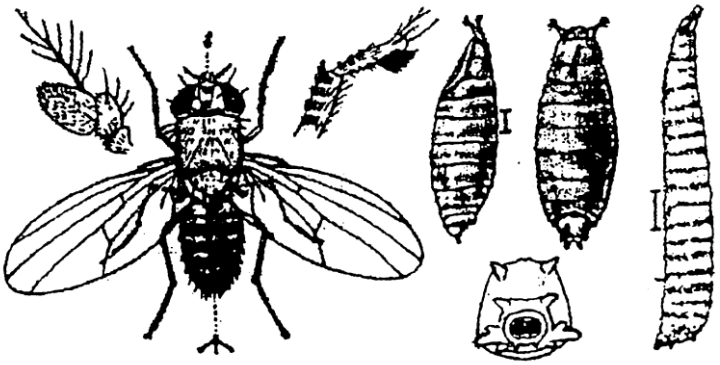
1. G and H.
2. G and F.
3. H and F.
4. Evolutionary closeness is equal for all species.

B40. In the figure is shown a well known organism.

<u>01.</u> (1,2 points). Give its systematic position by choosing suitable numbers from the list below.







1 – Animalia;	11 – Gastropoda;	21 – Drosophila;
2 – Arthropoda;	12 – Annelida;	22 – Aphis;
3 – Echinodermata;	13 – Protozoa;	23 – Leptinotarsa;
4 – Mollusca;	14 – Viviparus	24 – Coleoptera;
5 – Fungi;	15 – Hymenoptera	25
6 – Chilopoda;	16	26 – Oligochaeta;
7 – Insecta;	17 – Arachnida;	27 – Lepidoptera;
8	18 – Cnidaria;	28 – Anopheles;
9 – Plantae;	19 – Diptera;	29 – Locusta;
10 – Apis;	20	30.

Kingdom	
Phylum:	
Class:	
Order:	
Genus:	

02. (1 point). Choose the number corresponding to the type of the insect's leg.

1. Leaping.
2. Burrowing.
3. Swimming.
4. Gathering.
5. Walking.
6. Prehensile.

<u>03</u>. (1 point). Using the letters, list the leg structural elements this insect possesses in sequence (beginning with those closest to the body).

A. Femur.
B. Tibia.
C. Trochanter.
D. Coxa.
E. Tarsus.

<u>04.</u> (1 point). Give the number corresponding to the type of insect mouthpart.

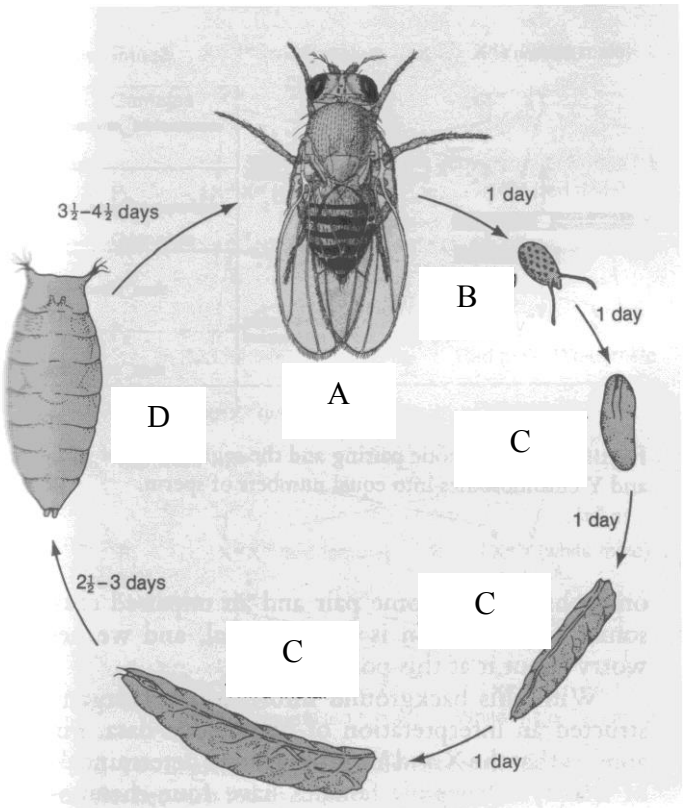
1.Piercing-suctorial.
2. Licking.
3. Biting.
4. Suctorial.

<u>05</u>. (1 point). Select the numbers of organs of other organisms, which are homologous to the wings of the insect concerned.

1. Sparrow wing.
2. Crayfish gills.
3. Bat wings.
4. Fish dorsal fin.
5. Fish pectoral fin.
6. Potato beetle elytrum.
7. Frog legs.

<u>06</u>. (0,8 point). In the answer table assign the developmental stages of this insect according to the letters in the figure.

1. Sporocyst.
2. Egg.
3. Graaf vesicle.
4. Larva.
5. Imago.
6. Redia.
7. Pupa.
8. Hydatid cyst.



<u>Answer:</u>

A	B	C	D

<u>07</u>. (1 point). What is the significance of the species for humans?

1. Animal and human parasite.
2. Crop pest.
3. Object of genetic investigation.
4. Entomophagous.
5. Vector of sleeping sickness agent.

4.4 The correct answers to theoretical tests.

4.4.1 Part A.

№	Answer
Cell biology.	
1.	C.
2.	A.
3.	A.
4.	E.
5.	D.
6.1.	B.
6.2.	B.
7.	SKIPPED
8.	B.
9.1.	A.
9.2.	B.
9.3.	B.
10.	D.
11.1.	B.
11.2.	C.
11.3.	B.
12.	A.
13.	C.
14.	C.
Plants anatomy and physiology.	
15.	B.
16.	C.
17.	C.
18.	SKIPPED
19.	C.
20.	A.
21.	E.
22.	B.
23.	B.
24.	A.
Animals anatomy and physiology.	
25.	B.
26.	D.
27.	E.
28.	B.
29.	C.
30.	C.
31.1.	B.

31.2.	D.
31.3.	B.
32.	C.
33.	SKIPPED
34.	D.
Ethology	
35.	C.
36.	A.
Genetics and Evolution.	
37.	C.
38.	D.
39.1.	B.
39.2.	A.
40.1.	SKIPPED
40.2.	SKIPPED
41.	B.
42.	A.
43.	D.
44.	A.
45.	D.
46.	SKIPPED
Ecology.	
47.1.	D.
47.2.	C.
47.3.	A.
48.	D.
49.	E.
50.	A.
51.	A.
52.	B.
53.	B.
54.	B.
Biosystematics.	
55.	D.
56.	A.
57.	E.
58.	D.
59.	SKIPPED
60.	A.

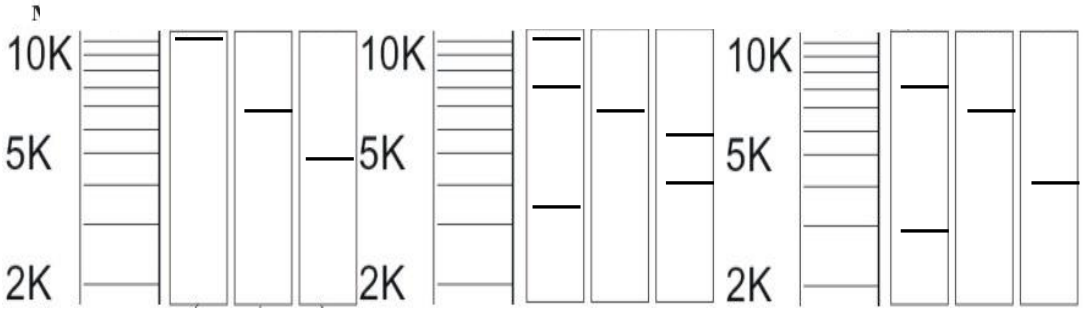
4.4.1 Part B.

Cell biology (10 questions, 51 points).

B1. (6 points) (0,5 pt. x 12).

ER-bound ribosomes	1, 2, 3, 6, 7, 9
Cytoplasmic ribosomes	4, 5, 8, 10, 11, 12
Mitochondrial ribosomes	-

B2. (9 points) (1 pt. x 9).



B2. (3 points) (1 pt. x 3).

Enzymes:	Chromosome
Glutathione reductase	**11**
Malate dehydrogenase	**15**
Galactokinase	**7**

B4. (3 points) (0,5 pt. x 6).

1: **A, B, C**

2: **A, D, G**

B5. (3 points) (0,5 pt. x 6, minus penalty points).

A.	**-**
B.	**+**
C.	**-**
D.	**-**
E.	**+**
F.	**+**

B6. (5 points).

5' UACGCCGAC-3'

B7. (5 points) (0,5 pt. x 8 + 1 pt.- pH=5).

pH	Net charge	Migrates toward
1	+1	A
5	0	C
9	-1	B
12	-2	B

B8. (8 points) (0,5 pt. x 16, minus penalty points).

A	7
B	11
C	3
D	9
E	1,4
F	2,12
G	1
H	5,10
I	1,6
J	9
K	8,11

B9. (4 points) (0,5 pt. x 8).

Strain	Genotype	lactose absent	lactose present
1	$I^- O^c Z^+ Y^-$	0	0
2	$I^+ O^c Z^- / I^+ O^+ Z^+$	x	0
3	$I^- P^+ O^c Z^+ Y^+ / I^+ P^- O^+ Z^+ Y^-$	0	0
4	$I^s P^+ O^+ Z^+ Y^- / I^- P^+ O^c Z^- Y^+$	x	x

B10. (5 points) **(0,5 pt. x 10).**

.

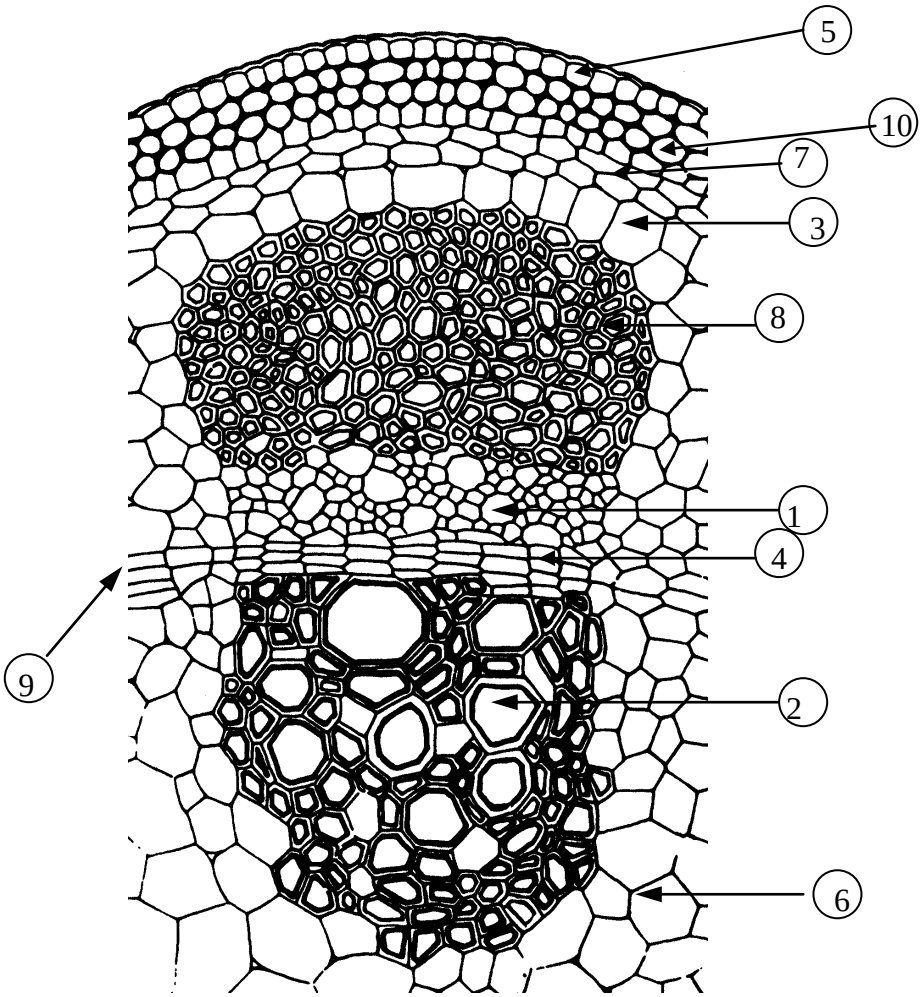
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	**E**	**K**	**D**	**F**	**I**	**J**	**A**	**C**	**G**

Plant anatomy and physiology (6 questions, 29 points).

B11. (5 points) **(0,5 pt. x 10,** minus penalty points).

1.	-
2.	+
3.	+
4.	-
5.	+
6.	-
7.	-
8.	-
9.	+
10.	+

B12. (5 баллов) **(0,5pt. x 10).**



B13. (5 points) (0,5 pt x 10, **minus penalty points).**

A.	+
B.	-
C.	-
D.	-
E.	+
F.	-
G.	+
H.	+
I.	-
J.	-

B14. (2,5 points) (0,5 pt. x 5, **minus penalty points).**

A.	-
B.	+
C.	+
D.	-
E.	+

B15. (6,5 points)

01. (2 points) (1 pt. x 2).

	Solution in the beaker	Solution in the membrane
Colorless		
Orange-brown	X	
Pink-red		
Greenish-yellow		
Blue-black		X

02. (2,5 points) (0,5 pt. x 5, minus penalty points).

Experiment	A	B	C	D	E
Hypotonic solution		X	X		

03. (2 points)

Answer: **A,D,E,C,B**

B16. (5 points) (1 pt. x 5, minus penalty points).

Phylum	Plant number
Bryophyta	I
Lycopodiophyta	III, V
Equisoetophyta	IV
Polypodiophyta	II

Anymal anatomy & physiology.(6 questions, 26 points).

B17. (5 points).

. 01. (2 points) (0,5 pt. x 4, minus penalty points).

A.	-
B.	+
C.	-
D.	+

02. (1 point).

A.	+
B.	
C.	
D.	
E.	

03. (2 points) (0,5 x4, minus penalty points).

.

A.	-
B.	-
C.	+
D.	+

B18. (3 points) (0,5 x 6, minus penalty points).

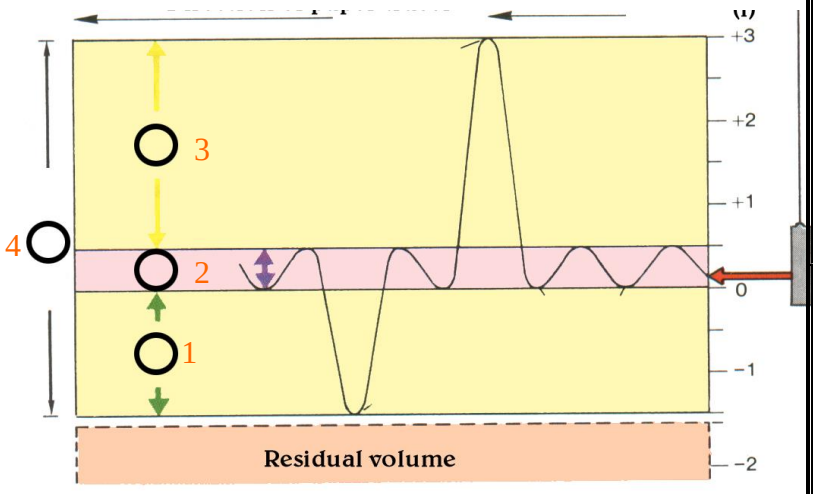
.

A.	**1**
B.	**1**
C.	**1**
D.	**2**
E.	**3**
F.	**3**

B19. (3 points).

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

B20. (4 points)(0,5 pt. x 8).



Respiratory volumes	
Number in the picture and curve	Term letter
1.	A
2.	B
3.	C
4.	D

B21. (7 points).

<u>01</u>. (6 points).

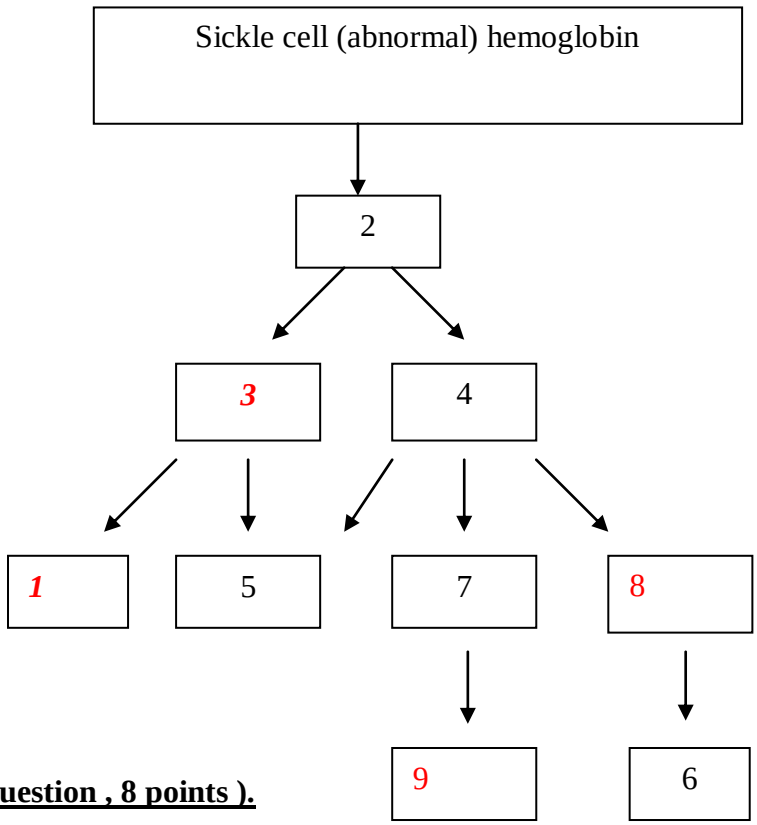
Nistatin (Na^+- ionophore*):_____3
Tetradoxin (ingibitor of Na^+-channels):_____ 1
Valinomycin (K^+- ionophore):_____ 2

<u>02</u>. (1 points).

2 – _____A_____

3 – _____B_____

B22. (4 points) (1 pt. x 4).



Ethology (1 question , 8 points).

B23. SKIPPED

B24. (8 points).

01.(1 point).	**2**
02. (1 point).	**s = 1,7**
03. (1 point).	**t =2,9**
04. (1 point).	**4**
05. (1 point).	**χ^2 ≈ 6,0**
06. (1 point).	**5**
07. (1 point).	**30 %**
08. (1 point).	**1**

Genetics (7 questions, 26 points).

B25. (**7,6 points**) (0,1 pt. x 77, minus penalty points).

Object	Statement number(s)										
	1	2	3	4	5	6	7	8	9	10	11
Zea mays	X	X	X	X	X	X	X	X			X
Drosophila melanogaster	X	X	X	X	X	X	X				X
Saccharomyces cerevisiae	X	X	X	X	X	X	X				X
Caenorhabditis elegans	X	X	X	X	X	X	X				X
Escherichia coli	X		X						X	X	X
Bacteriophage λ	X		X						X		X
Priones											

B26. (5 points).

01. (4 points) (1 pt. x 4).

		Blood type of each parent	**Blood type of a baby**
parent 1	Father	AB	B
	Mother	O	
parent 2	Father	A	A
	Mother	O	
parent 3	Father	Unknown	AB
	Mother	A	
parent 4	Father	O	0
	Mother	O	

02. (1 point) (0,5 pt. x 2).

AB or B

B27. (3 points) (0,5 pt. x 6).

Term	1	2	3	4	5	6
Answers	**D**	**F**	**A**	**E**	**C**	**B**

B28. (4 points) (0.5 x 8).

Group	**Peoples number**	**(%)**
O	3024	36
A	3780	45
B	1092	13
AB	504	6

B29. (4 points).

01. (1 point). **F1:** 18 cm

02. (1 point). **F2:** 9

03. (1 point).

10 cm 12 cm 14cm 16cm 18cm 20cm 22cm 24cm 26cm

04. (1 point).

Answer: 70 or 70/256 or 27 %

B30. (4 points).

	Expression pattern of Q gene
Mutant A	IV
Mutant B	III
Mutant C	I
Mutant D	II

B31. (2 points).

01. (1 point). **:_____2_____**

02. (1 point). **:_____1 & 6_____**

Ecology (5 questions, 17 points).

B32. (3 points) (1 pt. x 3).

Pond	Statement
1.	**C**
2.	**E**
3.	**G**

B33. (2,5 points) (0,5 pt. x 5).

Producer	D
Herbivore	B
Omnivore	C
Carnivore	E & A

B34. (8,5 points).

01. (2,5 points) (0,5 pt. x 5)

	Lotic water systems	Lenitic water systems
rapid decrease of the light density with the depth		X
normaly staggered water temperature		X
occurence of long-lasting plankton communities		X
streamline body of the animals	X	
animals with suction cups (suckers)	X	

02. (3 points) (0,5 pt. x 6).

A.	+
B.	-
C.	+
D.	+
E.	+

F.	**-**

03. (3 points).

A.	**from 3-4 to 7-8**
B.	**from 1 to 3-4**
C.	**all**

B35. (1 point).

64 (or 65)

B36. **(2points).**

01. (1 point).

PS + R

02.

02.1. **(1 point).**

4

Biosystematics (4 questions, 16 points).

B37. (3 points).

01. **(**1,8 points) (0,2 pt. x 9).

Australia	6
North America	1
India	5
Africa	3
Europe	1
Asia	1,4,5
South America	2

02. (1.2 points) (0,2 pt. 6).

Marsupialia	6

Proboscidea	5
Carnivora	1
Primates	2,3,4

B38 skipped B39 skipped

B40. (7 points).

01. (1,0 points).

Kingdom	**1**
Phylum:	**2**
Classis:	**7**
Order:	**19**
Genus:	**21**

02. (1 point). **5**

03. (1,2 point). D,C,A,B,E

04. (1 point). **2 or 4**

05. (1 point). **6**

06. (0,8 points).

A	B	C	D
5	2	4	7

07. (1 point). **3**

4.5 OBSERVERS FOR 14TH IBO Exam

Practical Exam (THURSDAY 10) **Meet at hotel front at 7:45am**	**Theory Exam (SATURDAY 12)** **Meet at hotel front at 7:45am**
Andrew Walter (Australia)	Andrew Walter (Australia)
Madonna Stevenson (Australia)	Madonna Stevenson (Australia)
Robyn Rose (Australia)	Peta Bonham-Smith (Canada)
Peta Bonham-Smith (Canada)	Andrea Regier (Canada)
Andrea Regier (Canada)	Chary Rangacharyulu (Canada)
Uldis Kondratovichs (Latvia)	Maruta Kusina (Latvia)
Zhi Gang Tiang (China)	Zhi Gang Tiang (China)
Irina Bogacheva (Belarus)	Irina Bogacheva (Belarus)
Rakhmetkaji I. Bersimbaev (Kazakhstan)	Rakhmetkaji I. Bersimbaev (Kazakhstan)
Hidayat Muchtar (Indonezia)	Hidayat Muchtar (Indonezia)

5. Results and Statistical analysis.

5.1. The results of 14th IBO.

№	Family name	First name	Country	Code	Practical test					Theoretical test			Total	Total result with correction	Rank	Rank (corrected)	Medal
					Lab I	Lab II	Lab III	Lab IV	Total	Part A	Part B	Total					
					(68.00)	*(68.00)*	*(64.00)*	*(59.50)*	*(259.50)*	*(68.00)*	*(171.00)*	*(239.00)*	*(498.50)*				
1	**Kuzmin**	**Ilja**	**Russia**	**37-3**	55,00	67,50	46,00	53,50	222,00	56,00	133,90	189,90	411,90	952,40	1	1	Gold
2	**Huang**	**Pu**	**China**	**12-3**	55,50	61,50	56,00	49,80	222,80	50,00	130,10	180,10	402,90	926,69	2	2	Gold
3	**Guo**	**Qin Xi**	**China**	**12-2**	49,00	62,00	60,00	51,75	222,75	46,00	125,60	171,60	394,35	902,72	3	3	Gold
4	**Konchakova**	**Darja**	**Belarus**	**09-1**	42,50	46,00	58,00	58,00	204,50	53,00	132,40	185,40	389,90	900,43	4	4	Gold
5	**Pugach**	**Xenia**	**Russia**	**37-2**	62,50	64,00	57,00	37,75	221,25	53,00	112,60	165,60	386,85	882,51	5	5	Gold
6	**Chaibang**	**Adisorn**	**Thailand**	**45-4**	36,00	60,00	55,00	40,25	191,25	60,00	128,20	188,20	379,45	878,50	6	6	Gold
7	**Mok**	**Vincent**	**Australia**	**07-1**	42,00	45,50	64,00	48,00	199,50	50,00	126,80	176,80	376,30	865,05	7	8	Gold
8	**Soh**	**Qing Yi Shirleen**	**Singapore**	**38-4**	34,50	65,50	50,00	54,00	204,00	49,00	124,10	173,10	377,10	864,78	8	7	Gold
9	**Meng**	**Lin Yan**	**China**	**12-1**	51,00	61,50	32,00	47,50	192,00	49,00	130,10	179,10	371,10	854,65	9	11	Gold
10	**Subernetcaia**	**Olga**	**Moldova**	**30-1**	58,50	51,10	54,00	53,00	216,60	49,00	109,20	158,20	374,80	851,29	10	9	Gold
11	**Makheenko**	**Sergey**	**Belarus**	**09-2**	48,00	54,00	54,00	38,25	194,25	52,00	123,70	175,70	369,95	850,16	11	13	Gold
12	**Razov**	**Roman**	**Russia**	**37-4**	53,00	64,00	50,00	47,25	214,25	48,00	111,50	159,50	373,75	849,65	12	10	Gold
13	**Sae-Seaw**	**Juthamas**	**Thailand**	**45-2**	54,00	58,00	53,00	39,80	204,80	49,00	116,60	165,60	370,40	845,53	13	12	Gold
14	**Lee**	**Min Sung**	**Korea**	**25-3**	49,50	44,50	36,00	53,50	183,50	57,00	123,50	180,50	364,00	839,47	14	14	Gold
15	**Wangkanont**	**Kittikhun**	**Thailand**	**45-1**	52,00	49,50	45,00	47,50	194,00	46,00	120,30	166,30	360,30	823,22	15	15	Gold
16	**Hsu**	**Wei-Tse**	**Chinese Taipei**	**13-1**	34,00	40,50	57,00	45,75	177,25	52,00	126,80	178,80	356,05	820,65	16	17	Gold
17	**Mahindroo**	**Ankur**	**India**	**19-3**	27,00	59,00	52,00	48,30	186,30	52,00	118,30	170,30	356,60	817,13	17	16	Gold
18	**Hong**	**Enping**	**Singapore**	**38-2**	46,50	53,50	47,00	43,00	190,00	47,00	118,70	165,70	355,70	812,54	18	18	Silver
19	**Xiang**	**Michael**	**USA**	**50-2**	36,50	35,50	54,00	56,20	182,20	50,00	120,80	170,80	353,00	809,32	19	21	Silver
20	**Liu**	**Zi Wei**	**United Kingdom**	**48-2**	58,00	34,50	62,00	47,55	202,05	42,00	111,60	153,60	355,65	805,67	20	19	Silver
21	**Infarovich**	**Sergeуй**	**Belarus**	**09-4**	48,00	59,50	35,00	53,00	195,50	45,00	113,80	158,80	354,30	805,54	21	20	Silver
22	**Kim**	**Jae Mun**	**Korea**	**25-1**	42,50	52,50	38,00	53,00	186,00	52,00	112,70	164,70	350,70	800,74	22	22	Silver
23	**Ivakov**	**Alexander**	**Australia**	**07-4**	53,00	46,00	39,00	40,00	178,00	49,00	121,60	170,60	348,60	799,32	23	24	Silver
24	**Aull**	**Katherine**	**USA**	**50-4**	45,50	47,50	28,00	39,25	160,25	53,00	131,00	184,00	344,25	797,03	24	27	Silver

№	Family name	First name	Country	Code	Practical test					Theoretical test			Total	Total result with correction	Rank	Rank (corrected)	Medal
					Lab I	Lab II	Lab III	Lab IV	Total	Part A	Part B	Total					
					(68.00)	*(68.00)*	*(64.00)*	*(59.50)*	*(259.50)*	*(68.00)*	*(171.00)*	*(239.00)*	*(498.50)*				
25	**Ho**	**Jiang Hai**	**Singapore**	**38-3**	50,00	58,00	22,00	52,00	182,00	44,00	122,50	166,50	348,50	796,80	25	25	Silver
26	**Kim**	**Hye In**	**Korea**	**25-2**	37,50	49,00	42,00	53,00	181,50	53,00	111,80	164,80	346,30	790,91	26	26	Silver
27	**Dietterle**	**Vera**	**Germany**	**18-4**	50,00	57,00	53,00	41,25	201,25	33,00	114,70	147,70	348,95	787,31	27	23	Silver
28	**Hong**	**Jin Myung**	**Korea**	**25-4**	42,00	60,00	23,00	46,00	171,00	54,00	117,90	171,90	342,90	787,23	28	29	Silver
29	**Vitak**	**Nazariy**	**Ukraine**	**49-3**	44,50	66,00	32,00	38,75	181,25	48,00	114,40	162,40	343,65	783,61	29	28	Silver
30	**Chew**	**Guo-Liang**	**Singapore**	**38-1**	47,00	52,00	23,00	45,75	167,75	45,00	127,40	172,40	340,15	781,33	30	32	Silver
31	**Khosravi**	**Amir**	**Iran**	**21-3**	42,50	61,50	29,00	50,50	183,50	47,00	111,30	158,30	341,80	777,16	31	30	Silver
32	**Tan**	**Hao**	**China**	**12-4**	48,00	63,00	39,00	35,75	185,75	47,00	109,00	156,00	341,75	775,76	32	31	Silver
33	**Genz**	**Christian**	**Germany**	**18-2**	47,50	38,50	52,00	40,30	178,30	45,00	116,80	161,80	340,10	775,29	33	33	Silver
34	**Abbassi**	**Bita**	**Iran**	**21-4**	36,50	49,00	34,00	40,55	160,05	55,00	119,90	174,90	334,95	771,03	34	37	Silver
35	**Goyal**	**Praveg**	**India**	**19-2**	40,00	34,00	38,00	45,50	157,50	52,00	124,60	176,60	334,10	770,07	35	38	Silver
36	**Yen**	**I-Weng**	**Chinese Taipei**	**13-3**	44,00	48,00	36,00	52,75	180,75	45,00	112,60	157,60	338,35	769,01	36	35	Silver
37	**Hielpos**	**Maria Soledad**	**Argentina**	**06-2**	53,00	58,50	38,00	41,00	190,50	38,00	110,40	148,40	338,90	765,11	37	34	Silver
38	**Nettelblad**	**Carl**	**Sweden**	**42-3**	35,50	35,00	58,00	52,50	181,00	41,00	115,00	156,00	337,00	765,08	38	36	Silver
39	**Villasenor**	**Roberto**	**Mexico**	**29-1**	50,50	43,50	32,00	45,00	171,00	45,00	117,20	162,20	333,20	760,00	39	39	Silver
40	**Aghazadeh-Tabrizi**	**Golnaz**	**Iran**	**21-1**	40,50	40,50	44,00	37,50	162,50	52,00	115,80	167,80	330,30	756,61	40	45	Silver
41	**Nartok**	**Duygu Ilke**	**Turkey**	**46-3**	40,50	49,00	54,00	36,25	179,75	46,00	106,80	152,80	332,55	753,29	41	40	Silver
42	**Abovjan**	**Levan**	**Russia**	**37-1**	44,50	50,50	44,00	39,00	178,00	45,00	109,10	154,10	332,10	753,00	42	41	Silver
43	**Erkul**	**Yusuf**	**Turkey**	**46-1**	45,00	52,50	33,00	38,45	168,95	51,00	110,30	161,30	330,25	752,87	43	46	Silver
44	**Limpitikul**	**Worawan**	**Thailand**	**45-3**	38,00	55,00	28,00	47,50	168,50	49,00	111,60	160,60	329,10	749,89	44	48	Silver
45	**Sallum**	**Darin**	**Belarus**	**09-3**	54,50	31,00	38,00	52,75	176,25	56,00	98,20	154,20	330,45	749,35	45	43	Silver
46	**Borchenko**	**Natalia**	**Ukraine**	**49-2**	42,50	48,00	46,00	43,00	179,50	33,00	118,20	151,20	330,70	748,24	46	42	Silver
47	**Nunvar**	**Jaroslav**	**Czech Republic**	**15-4**	46,50	60,00	35,00	38,05	179,55	40,00	110,80	150,80	330,35	747,23	47	44	Silver
48	**Spacilova**	**Pavla**	**Czech Republic**	**15-3**	50,00	57,50	46,00	25,55	179,05	31,00	119,70	150,70	329,75	745,82	48	47	Silver
49	**Trivedi**	**Kovid**	**India**	**19-4**	37,50	51,00	43,00	40,50	172,00	44,00	109,40	153,40	325,40	737,55	49	49	Silver
50	**Ding**	**Chien-Kuang**	**Chinese Taipei**	**13-4**	32,00	54,00	36,00	39,75	161,75	45,00	115,50	160,50	322,25	734,44	50	51	Silver
51	**Baumbach**	**Janina**	**Germany**	**18-1**	47,00	51,50	54,00	34,30	186,80	37,00	100,30	137,30	324,10	725,63	51	50	Bronze
52	**Chao**	**Shih-Lung**	**Chinese Taipei**	**13-2**	47,00	64,50	7,00	38,00	156,50	45,00	115,50	160,50	317,00	722,64	52	56	Bronze
53	**Petasch**	**Jan**	**Germany**	**18-3**	44,50	45,00	34,00	43,00	166,50	37,00	114,90	151,90	318,40	720,98	53	53	Bronze

№	Family name	First name	Country	Code	Practical test					Theoretical test			Total	Total result with correction	Rank	Rank (corrected)	Medal
					Lab I	Lab II	Lab III	Lab IV	Total	Part A	Part B	Total					
					(68.00)	*(68.00)*	*(64.00)*	*(59.50)*	*(259.50)*	*(68.00)*	*(171.00)*	*(239.00)*	*(498.50)*				
54	**Filipescu**	**Dan**	**Romania**	**36-2**	49,00	54,50	33,00	15,50	152,00	43,00	120,20	163,20	315,20	720,10	54	60	Bronze
55	**Arnett**	**Simon**	**Australia**	**07-3**	42,50	39,50	50,00	31,30	163,30	42,00	111,70	153,70	317,00	718,84	55	56	Bronze
56	**Mahlinets**	**Svitlana**	**Ukraine**	**49-1**	49,00	41,00	46,00	35,50	171,50	40,00	106,10	146,10	317,60	715,94	56	55	Bronze
57	**Marinov**	**Georgi**	**Bulgaria**	**11-3**	38,50	52,00	43,00	43,55	177,05	36,00	104,90	140,90	317,95	713,82	57	54	Bronze
58	**Peters**	**Stacey**	**Australia**	**07-2**	39,50	36,00	32,00	43,25	150,75	48,00	113,60	161,60	312,35	712,80	58	61	Bronze
59	**Marwood**	**Joe**	**United Kingdom**	**48-3**	52,00	52,00	39,00	45,50	188,50	39,00	91,00	130,00	318,50	708,96	59	52	Bronze
60	**Buryova**	**Ivana**	**Slovakia**	**39-1**	52,50	51,50	38,00	35,75	177,75	34,00	104,20	138,20	315,95	707,81	60	58	Bronze
61	**Proost**	**Sebastian**	**Belgium**	**10-3**	41,50	39,00	46,00	54,50	181,00	38,00	96,70	134,70	315,70	705,30	61	59	Bronze
62	**Harris**	**Kelley**	**USA**	**50-1**	48,00	12,50	46,00	37,80	144,30	49,00	110,80	159,80	304,10	693,24	62	63	Bronze
63	**Slack**	**Adam**	**United Kingdom**	**48-4**	32,00	26,50	50,00	47,00	155,50	43,00	103,20	146,20	301,70	680,25	63	65	Bronze
64	**Li**	**Victor**	**USA**	**50-3**	37,00	39,00	48,00	42,50	166,50	33,00	103,30	136,30	302,80	677,19	64	64	Bronze
65	**Gaublomme**	**Djoere**	**Belgium**	**10-4**	35,00	65,00	50,00	35,00	185,00	28,00	92,40	120,40	305,40	674,15	65	62	Bronze
66	**Aminzadeh**	**Behzad**	**Iran**	**21-2**	28,00	38,00	16,00	48,50	130,50	46,00	117,50	163,50	294,00	672,61	66	70	Bronze
67	**Ruiz**	**Maria Sol**	**Argentina**	**06-3**	28,00	57,50	38,00	44,50	168,00	30,00	103,40	133,40	301,40	672,42	67	66	Bronze
68	**Setiawan**		**Indonesia**	**20-4**	40,00	57,50	22,00	36,25	155,75	42,00	100,00	142,00	297,75	669,02	68	67	Bronze
69	**Astley**	**Holly**	**United Kingdom**	**48-1**	49,00	36,50	44,00	37,25	166,75	34,00	96,20	130,20	296,95	660,63	69	68	Bronze
70	**Perez Ben**	**Celeste**	**Argentina**	**06-1**	36,50	57,50	23,00	38,00	155,00	32,00	106,20	138,20	293,20	656,67	70	72	Bronze
71	**Reijnders**	**Koen**	**Netherlands**	**34-2**	40,00	35,00	40,00	45,50	160,50	37,00	95,90	132,90	293,40	654,16	71	71	Bronze
72	**Schut**	**Christine**	**Netherlands**	**34-1**	42,50	47,00	50,00	35,10	174,60	39,00	82,20	121,20	295,80	653,02	72	69	Bronze
73	**Nguyen**	**Binh Minh**	**Vietnam**	**52-3**	28,00	45,50	43,00	42,25	158,75	33,00	97,90	130,90	289,65	644,61	73	73	Bronze
74	**Madhavan**	**Srivats**	**India**	**19-1**	35,00	34,50	28,00	28,30	125,80	49,00	107,10	156,10	281,90	641,27	74	77	Bronze
75	**ten Grotenhuis**	**Gerben**	**Netherlands**	**34-4**	37,00	51,50	24,00	32,95	145,45	41,00	98,60	139,60	285,05	639,13	75	74	Bronze
76	**Cetinkaya**	**Arda**	**Turkey**	**46-4**	33,00	14,00	30,00	29,80	106,80	50,00	119,30	169,30	276,10	635,61	76	83	Bronze
77	**Nguyen**	**Thi Thuy Duong**	**Vietnam**	**52-4**	47,50	45,50	23,00	34,75	150,75	32,00	101,40	133,40	284,15	633,64	77	75	Bronze
78	**Gunarsa**	**I. Made**	**Indonesia**	**20-1**	34,50	29,50	34,00	42,50	140,50	36,00	101,90	137,90	278,40	623,23	78	81	Bronze
79	**Dudnik**	**Alexey**	**Kazakhstan**	**23-2**	47,00	30,50	26,00	31,25	134,75	40,00	101,60	141,60	276,35	620,69	79	82	Bronze
80	**Chmatal**	**Lukas**	**Czech Republic**	**15-1**	41,50	48,50	52,00	23,60	165,60	25,00	91,50	116,50	282,10	619,59	80	76	Bronze
81	**Synek**	**Petr**	**Czech Republic**	**15-2**	46,00	40,50	46,00	32,50	165,00	26,00	89,90	115,90	280,90	616,56	81	79	Bronze

№	Family name	First name	Country	Code	Practical test					Theoretical test			Total	Total result with correction	Rank	Rank (corrected)	Medal
					Lab I	Lab II	Lab III	Lab IV	Total	Part A	Part B	Total					
					(68.00)	*(68.00)*	*(64.00)*	*(59.50)*	*(259.50)*	*(68.00)*	*(171.00)*	*(239.00)*	*(498.50)*				
82	**Holmblad**	**Elin**	**Sweden**	**42-1**	40,00	44,50	50,00	35,50	170,00	27,00	84,00	111,00	281,00	614,05	82	78	Bronze
83	**Tran**	**Thu Huong**	**Vietnam**	**52-2**	45,00	49,50	28,00	39,00	161,50	30,00	87,80	117,80	279,30	614,02	83	80	Bronze
84	**Kolodziejczyk**	**Lukasz**	**Poland**	**35-1**	51,00	41,00	29,00	16,25	137,25	44,00	91,40	135,40	272,65	608,91	84	85	Bronze
85	**Surya-Utami**	**Ni Luh Gede**	**Indonesia**	**20-2**	40,50	40,50	42,00	33,00	156,00	28,00	91,80	119,80	275,80	607,27	85	84	Bronze
86	**Nguyen**	**Minh Huong**	**Vietnam**	**52-1**	37,50	30,50	32,00	43,75	143,75	35,00	93,90	128,90	272,65	605,28	86	85	Bronze
87	**Allen**	**Sarah**	**Sweden**	**42-4**	41,00	48,50	20,00	38,00	147,50	40,00	83,80	123,80	271,30	599,39	87	87	Bronze
88	**Rumkovska**	**Inga**	**Latvia**	**28-4**	30,00	56,50	14,00	41,90	142,40	37,00	89,10	126,10	268,50	594,38	88	90	Bronze
89	**Aivelo**	**Tuomas**	**Finland**	**17-1**	30,50	35,00	34,00	37,75	137,25	36,00	94,20	130,20	267,45	594,31	89	91	Bronze
90	**Vaschenko**	**Ann**	**Ukraine**	**49-4**	46,00	52,50	16,00	37,00	151,50	35,00	83,40	118,40	269,90	593,23	90	88	Bronze
91	**Jasko**	**Janis**	**Latvia**	**28-1**	30,00	30,00	50,00	39,00	149,00	39,00	81,40	120,40	269,40	593,22	91	89	Bronze
92	**Kaszubowski**	**Lukasz**	**Poland**	**35-3**	30,00	18,00	55,00	28,80	131,80	45,00	85,10	130,10	261,90	581,78	92	94	Bronze
93	**Webster**	**Paul**	**Ireland**	**22-1**	40,50	39,50	22,00	32,50	134,50	35,00	91,80	126,80	261,30	578,59	93	96	Bronze
94	**Hernandez**	**Ericel**	**Mexico**	**29-3**	24,00	50,50	44,00	35,00	153,50	35,00	76,40	111,40	264,90	578,08	94	93	Bronze
95	**Asgarov**	**Elchin**	**Azerbaijan**	**08-2**	23,00	27,00	36,00	34,50	120,50	42,00	95,70	137,70	258,20	577,71	95	97	Bronze
96	**Kokina**	**Agnese**	**Latvia**	**28-3**	35,00	29,00	46,00	47,75	157,75	32,00	75,30	107,30	265,05	576,12	96	92	Bronze
97	**Stepien**	**Barbara**	**Poland**	**35-2**	37,00	41,50	16,00	10,75	105,25	46,00	100,60	146,60	251,85	568,41	97	101	Bronze
98	**Abil**	**Zhanar**	**Kazakhstan**	**23-1**	41,00	42,50	28,00	21,25	132,75	42,00	82,10	124,10	256,85	567,08	98	98	Bronze
99	**Nikolov**	**Miroslav**	**Bulgaria**	**11-4**	32,00	50,50	52,00	31,00	165,50	27,00	69,40	96,40	261,90	562,95	99	94	Bronze
100	**Rendon**	**Matilde**	**Argentina**	**06-4**	40,50	26,00	35,00	37,50	139,00	32,00	81,80	113,80	252,80	552,21	100	100	
101	**Cristescu**	**Teodor Razvan**	**Romania**	**36-1**	41,50	24,50	21,00	26,25	113,25	47,00	86,90	133,90	247,15	550,75	101	107	
102	**Samsa**	**Ziga**	**Slovenia**	**40-4**	29,00	53,50	36,00	31,50	150,00	29,00	74,10	103,10	253,10	546,91	102	99	
103	**Garcia**	**Cinthia**	**Mexico**	**29-4**	32,00	38,50	34,00	36,50	141,00	24,00	85,70	109,70	250,70	545,20	103	102	
104	**Herpigni**	**Basile**	**Belgium**	**10-1**	39,00	37,00	18,00	46,25	140,25	32,00	77,30	109,30	249,55	542,39	104	103	
105	**Zapala**	**Lukasz**	**Poland**	**35-4**	31,50	51,00	16,00	38,50	137,00	41,00	70,80	111,80	248,80	542,11	105	104	
106	**Sibler**	**Rahel**	**Switzerland**	**43-2**	42,50	26,00	38,00	32,30	138,80	30,00	78,40	108,40	247,20	536,61	106	106	
107	**Jacobsson**	**Jesper**	**Sweden**	**42-2**	36,00	37,00	26,00	29,55	128,55	40,00	76,40	116,40	244,95	536,02	107	110	
108	**Zunda**	**Irena**	**Latvia**	**28-2**	43,00	30,50	24,00	39,00	136,50	30,00	78,90	108,90	245,40	532,84	108	109	
109	**Ciglic**	**Monika**	**Slovenia**	**40-1**	35,00	48,50	36,00	32,55	152,05	30,00	65,90	95,90	247,95	531,31	109	105	
110	**Akmatbekov**	**Aibek**	**Kyrgyzstan**	**27-1**	37,00	29,00	37,00	33,45	136,45	30,00	78,00	108,00	244,45	530,20	110	111	
111	**Reinhold**	**Daniela**	**Switzerland**	**43-4**	36,00	42,00	35,00	37,75	150,75	16,00	80,00	96,00	246,75	528,67	111	108	

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					Lab I	Lab II	Lab III	Lab IV	Total	Part A	Part B	Total					
					(68.00)	*(68.00)*	*(64.00)*	*(59.50)*	*(259.50)*	*(68.00)*	*(171.00)*	*(239.00)*	*(498.50)*				
112	**Mulyono**		**Indonesia**	**20-3**	1,00	57,50	32,00	43,80	134,30	21,00	87,70	108,70	243,00	527,33	112	112	
113	**Bercan**	**Irina**	**Romania**	**36-3**	33,00	45,00	30,00	17,00	125,00	35,00	76,90	111,90	236,90	515,41	113	114	
114	**Ivanov**	**Miroslav**	**Bulgaria**	**11-2**	32,00	48,50	22,00	32,90	135,40	39,00	62,80	101,80	237,20	510,44	114	113	
115	**Yuce**	**Erkan**	**Turkey**	**46-2**	24,00	18,50	28,00	4,75	75,25	38,00	111,30	149,30	224,55	508,55	115	121	
116	**Castillo**	**Edgar**	**Mexico**	**29-2**	35,00	30,50	26,00	24,80	116,30	30,00	83,10	113,10	229,40	499,22	116	116	
117	**Crea**	**Philip**	**Ireland**	**22-2**	36,50	22,00	30,00	20,30	108,80	39,00	79,90	118,90	227,70	498,64	117	118	
118	**Shakhanov**	**Demeu**	**Kazakhstan**	**23-3**	38,00	29,00	32,00	12,10	111,10	30,00	85,80	115,80	226,90	495,11	118	119	
119	**Luuk**	**Ott**	**Estonia**	**16-1**	39,00	48,00	25,00	17,50	129,50	31,00	69,00	100,00	229,50	492,12	119	115	
120	**Kranjc**	**Matic**	**Slovenia**	**40-2**	25,50	55,00	4,00	31,75	116,25	41,00	68,60	109,60	225,85	489,28	120	120	
121	**Lehtovirta**	**Laura**	**Finland**	**17-4**	36,00	46,50	26,00	31,80	140,30	30,00	58,60	88,60	228,90	484,40	121	117	
122	**Jafarov**	**Murad**	**Azerbaijan**	**08-4**	34,50	34,00	16,00	33,25	117,75	34,00	72,50	106,50	224,25	483,95	122	122	
123	**Bricelj**	**Urska**	**Slovenia**	**40-3**	33,50	37,50	24,00	33,25	128,25	28,00	67,00	95,00	223,25	475,28	123	123	
124	**Allakuliyev**	**Muhammet**	**Turkmenistan**	**47-1**	34,00	18,00	8,00	14,85	74,85	36,00	98,60	134,60	209,45	466,39	124	129	
125	**Chiose**	**Vladimir**	**Moldova**	**30-4**	31,50	41,50	7,00	43,25	123,25	36,00	59,10	95,10	218,35	464,32	125	124	
126	**Alazemi**	**Ayeshah**	**Kuwait**	**26-1**	18,00	28,50	38,00	15,40	99,90	25,00	85,90	110,90	210,80	456,18	126	126	
127	**Goranova**	**Silviya**	**Bulgaria**	**11-1**	11,00	29,00	6,00	37,75	83,75	33,00	90,80	123,80	207,55	456,08	127	130	
128	**McGovern**	**Claire**	**Ireland**	**22-3**	25,00	9,00	46,00	28,35	108,35	22,00	81,90	103,90	212,25	455,52	128	125	
129	**Ivanic**	**Tomas**	**Slovakia**	**39-2**	38,00	31,50	36,00	10,75	116,25	26,00	68,00	94,00	210,25	445,50	129	127	
130	**Kralovic**	**Martin**	**Slovakia**	**39-3**	39,00	42,00	22,00	16,00	119,00	29,00	62,20	91,20	210,20	443,82	130	128	
131	**Arnos**	**Pantelis**	**Cyprus**	**14-1**	27,00	22,50	35,00	32,00	116,50	25,00	63,70	88,70	205,20	431,18	131	131	
132	**Shaninov**	**Arman**	**Kazakhstan**	**23-4**	26,00	39,00	10,00	26,65	101,65	33,00	67,20	100,20	201,85	430,08	132	133	
133	**McFadden**	**Noirin**	**Ireland**	**22-4**	40,50	26,50	16,00	30,05	113,05	23,00	66,10	89,10	202,15	424,55	133	132	
134	**Pajusalu**	**Mihkel**	**Estonia**	**16-2**	11,00	27,50	48,00	14,75	101,25	30,00	68,30	98,30	199,55	423,85	134	134	
135	**Matei**	**Ioan Valentin**	**Romania**	**36-4**	32,00	47,00	6,00	11,75	96,75	46,00	55,40	101,40	198,15	422,43	135	136	
136	**Chynaliev**	**Bektur**	**Kyrgyzstan**	**27-3**	22,00	34,00	6,00	22,50	84,50	32,00	78,40	110,40	194,90	420,15	136	137	
137	**Buchel**	**Barbara**	**Switzerland**	**43-1**	38,50	24,50	14,00	33,25	110,25	21,00	67,80	88,80	199,05	417,41	137	135	
138	**Qubadov**	**Murad**	**Azerbaijan**	**08-1**	30,50	33,50	18,00	23,75	105,75	36,00	52,20	88,20	193,95	405,61	138	138	
139	**Allahverdiyev**	**Orxan**	**Azerbaijan**	**08-3**	20,00	15,00	12,00	35,00	82,00	26,00	80,40	106,40	188,40	403,31	139	142	
140	**Zankl**	**Janine**	**Switzerland**	**43-3**	31,50	22,00	27,00	26,80	107,30	25,00	60,60	85,60	192,90	401,80	140	139	
141	**Chicu**	**Cristina**	**Moldova**	**30-3**	22,50	27,00	22,00	26,50	98,00	19,00	72,10	91,10	189,10	396,33	141	140	

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					Lab I	Lab II	Lab III	Lab IV	Total	Part A	Part B	Total					
					(68.00)	*(68.00)*	*(64.00)*	*(59.50)*	*(259.50)*	*(68.00)*	*(171.00)*	*(239.00)*	*(498.50)*				
142	**Hudaynazarov**	**Muhamednazar**	**Turkmenistan**	**47-2**	29,00	22,50	18,00	28,00	97,50	29,00	60,20	89,20	186,70	389,87	142	143	
143	**Khudadah**	**Mohamed**	**Kuwait**	**26-4**	19,50	43,00	28,00	22,00	112,50	22,00	54,10	76,10	188,60	386,82	143	141	
144	**Panaghiu**	**Nadejda**	**Moldova**	**30-2**	35,50	31,50	1,00	9,75	77,75	27,00	73,70	100,70	178,45	377,75	144	144	
145	**Granroth**	**Janne**	**Finland**	**17-3**	12,00	43,50	14,00	14,75	84,25	25,00	63,70	88,70	172,95	358,68	145	145	
146	**Jancikova**	**Paulina**	**Slovakia**	**39-4**	43,00	24,00	3,00	10,05	80,05	20,00	71,70	91,70	171,75	357,66	146	147	
147	**Taliadoros**	**Athanasios**	**Cyprus**	**14-4**	29,00	5,00	29,00	21,10	84,10	23,00	62,80	85,80	169,90	350,21	147	148	
148	**Jefimova**	**Natalia**	**Estonia**	**16-4**	36,00	29,00	6,00	35,25	106,25	17,00	49,10	66,10	172,35	344,71	148	146	
149	**Duyshoev**	**Nurlan**	**Kyrgyzstan**	**27-2**	22,00	25,50	10,00	16,05	73,55	31,00	55,90	86,90	160,45	329,58	149	149	
150	**Vosa**	**Urmo**	**Estonia**	**16-3**	23,00	27,50	8,00	24,50	83,00	25,00	49,40	74,40	157,40	315,73	150	150	
151	**Husainova**	**Rinata**	**Kyrgyzstan**	**27-4**	29,00	29,00	4,00	10,00	72,00	23,00	52,10	75,10	147,10	292,97	151	151	
152	**Turcksin**	**Bruno**	**Belgium**	**10-2**	27,00	13,00	21,00	18,80	79,80	21,00	40,40	61,40	141,20	272,05	152	152	
153	**Alwazan**	**Batoul**	**Kuwait**	**26-3**	22,00	14,00	8,00	3,70	47,70	17,00	70,10	87,10	134,80	272,03	153	155	
154	**Constantinou**	**Pavlos**	**Cyprus**	**14-2**	17,00	4,00	16,00	26,50	63,50	21,00	51,80	72,80	136,30	267,41	154	154	
155	**Georgiou**	**Alexandros**	**Cyprus**	**14-3**	22,00	10,50	25,00	15,30	72,80	16,00	49,10	65,10	137,90	266,70	155	153	
156	**Alballol**	**Mashael**	**Kuwait**	**26-2**	32,00	22,50	4,00	7,70	66,20	25,00	38,20	63,20	129,40	246,53	156	156	
157	**Mantysaari**	**Mika**	**Finland**	**17-2**	12,00	24,00	24,00	17,00	77,00	23,00	24,70	47,70	124,70	227,30	157	157	
158	**Mahesso**	**Sonia Armando**	**Mozambique**	**32-3**	7,00	9,00	4,00	9,50	29,50	19,00	45,50	64,50	94,00	167,68	158	158	
159	**Cumbe**	**Helder Anselmo**	**Mozambique**	**32-1**	11,00	9,50	4,00	9,75	34,25	23,00	36,10	59,10	93,35	163,20	159	159	
160	**Nhaliginga**	**Joaquim Junior**	**Mozambique**	**32-2**	2,00	2,00	4,00	1,15	9,15	21,00	50,20	71,20	80,35	140,74	160	161	
161	**Ovezdurduyev**	**Dovran**	**Turkmenistan**	**47-3**	12,00	7,00	13,00	2,50	34,50	18,00	29,80	47,80	82,30	132,04	161	160	
162	**Nhantumbo**	**Stelio Rafael**	**Mozambique**	**32-4**	2,00	5,00	2,00	9,50	18,50	10,00	40,90	50,90	69,40	104,78	162	162	
163	**Kil**	**Laurens**	**Netherlands**	**34-3**	29,00	29,50	0,00	0,00	58,50	0,00	0,00	0,00	58,50	51,83	163	163	

5.2. Correlation between results of Olympiad tasks.

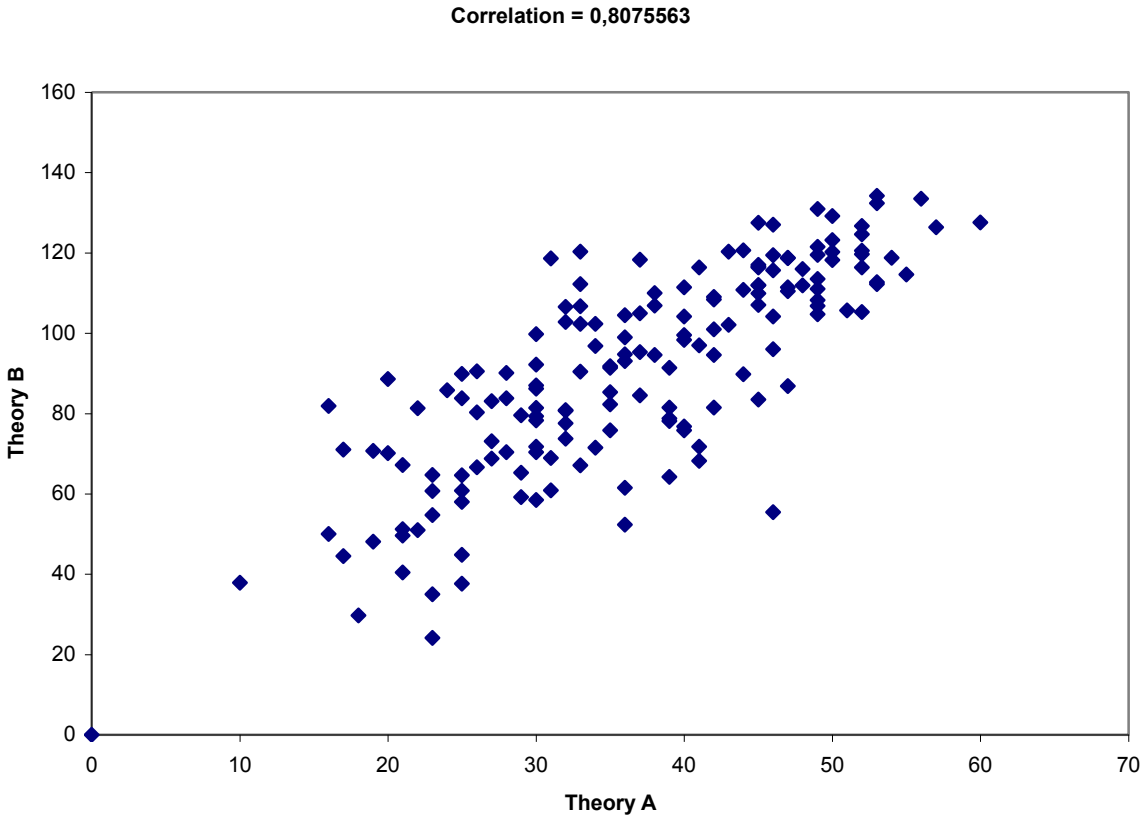

Diagram 1. Correlation between parts A and B of theoretical test.

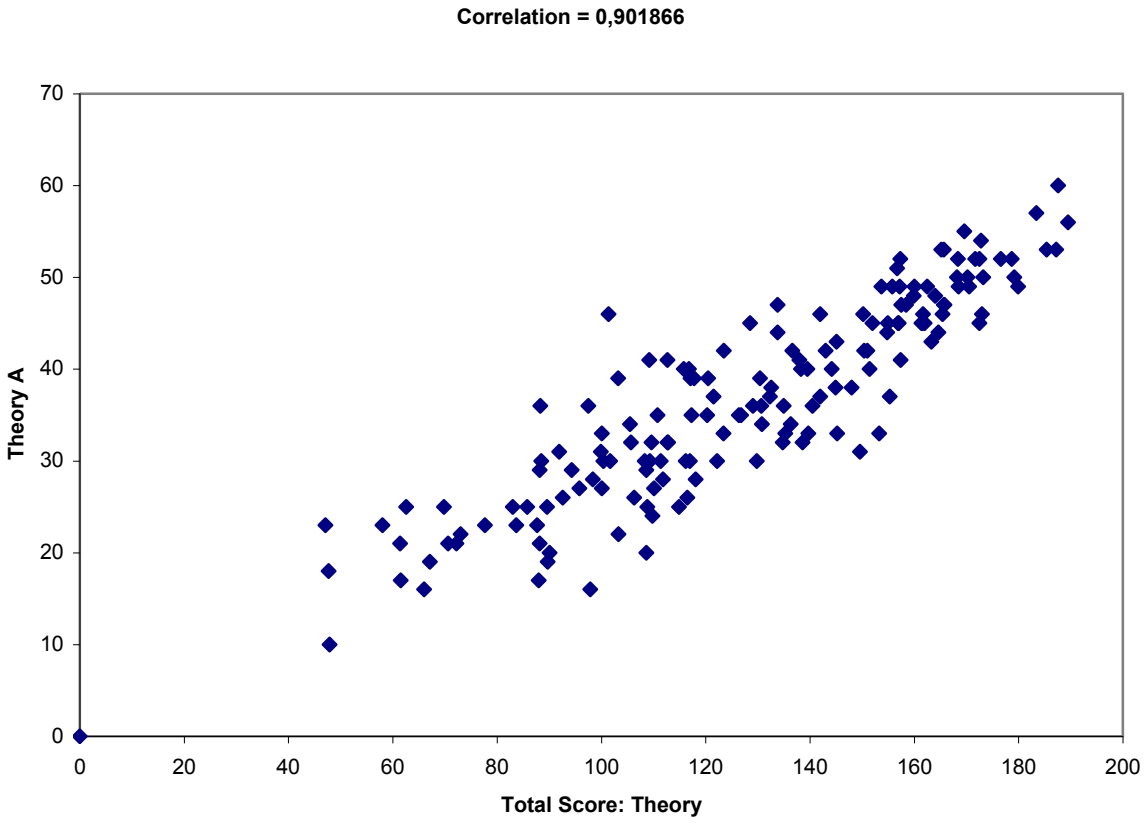

Diagram 2. Correlation between part A and total results of theoretical test.

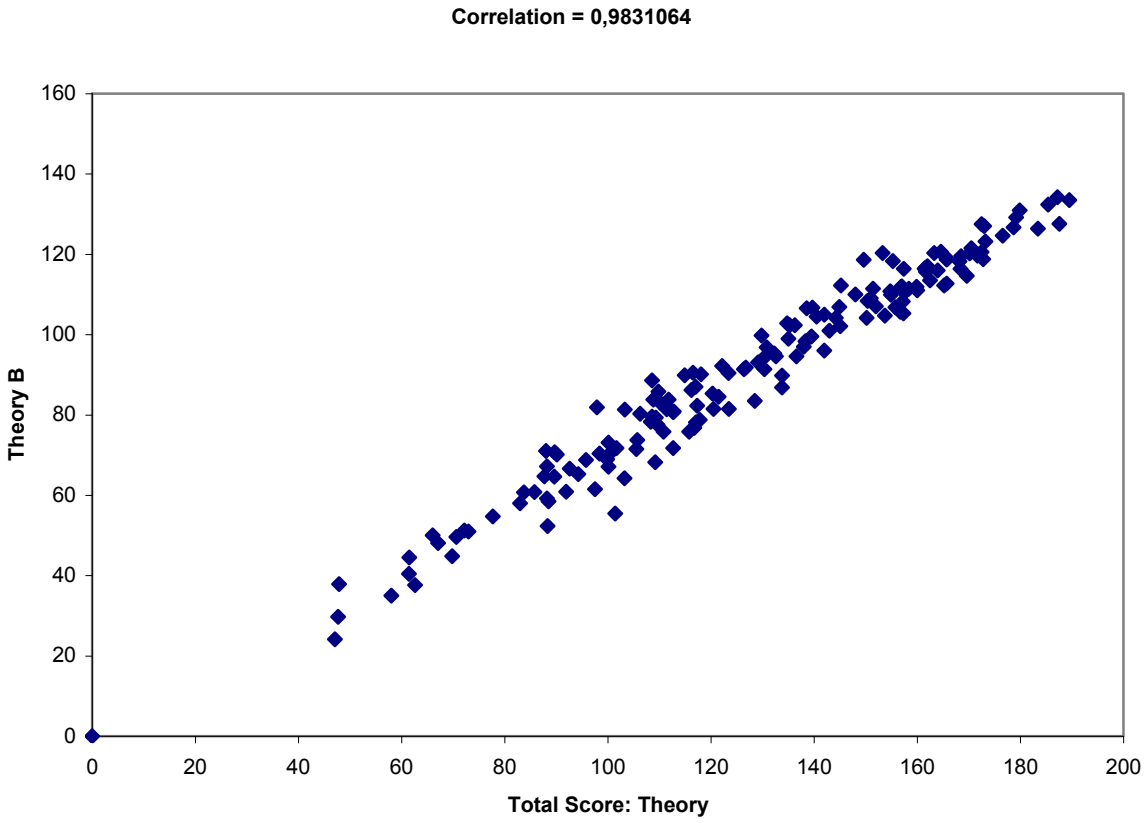

Diagram 3. Correlation between part B and total results of theoretical test.

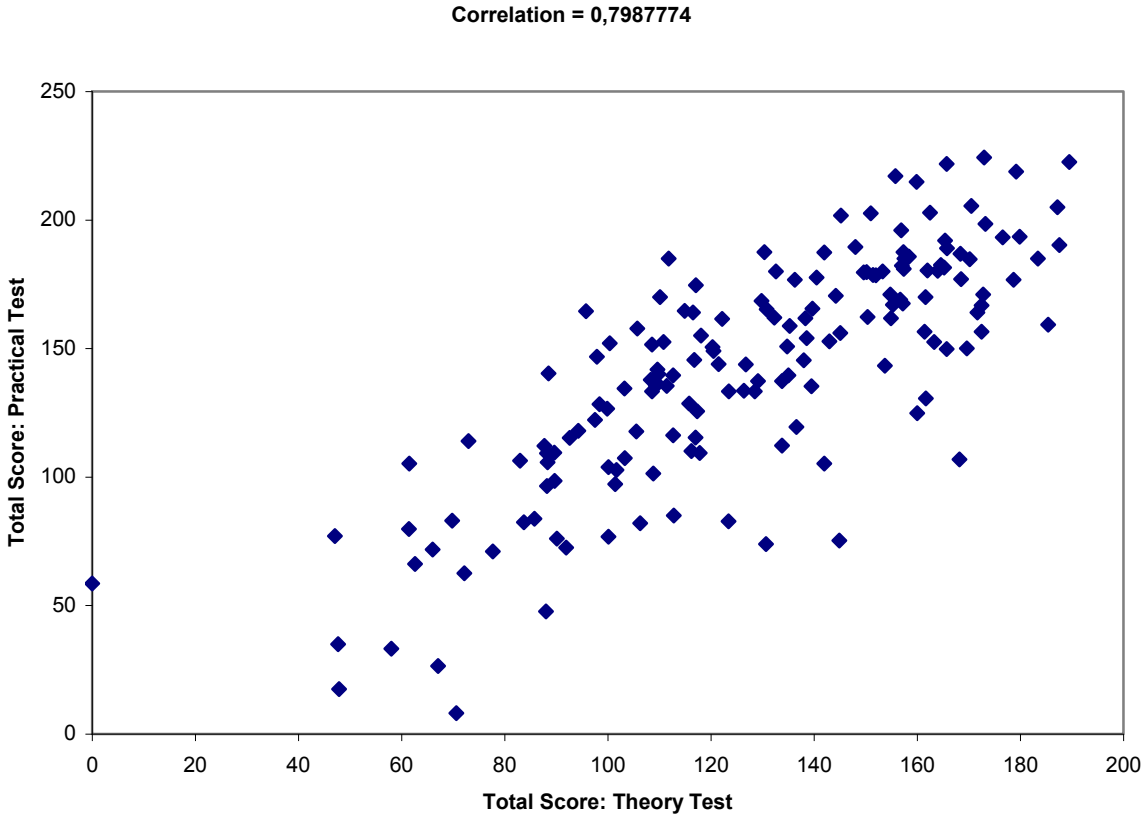

Diagram 4. Correlation between total results of theoretical and practical tests.

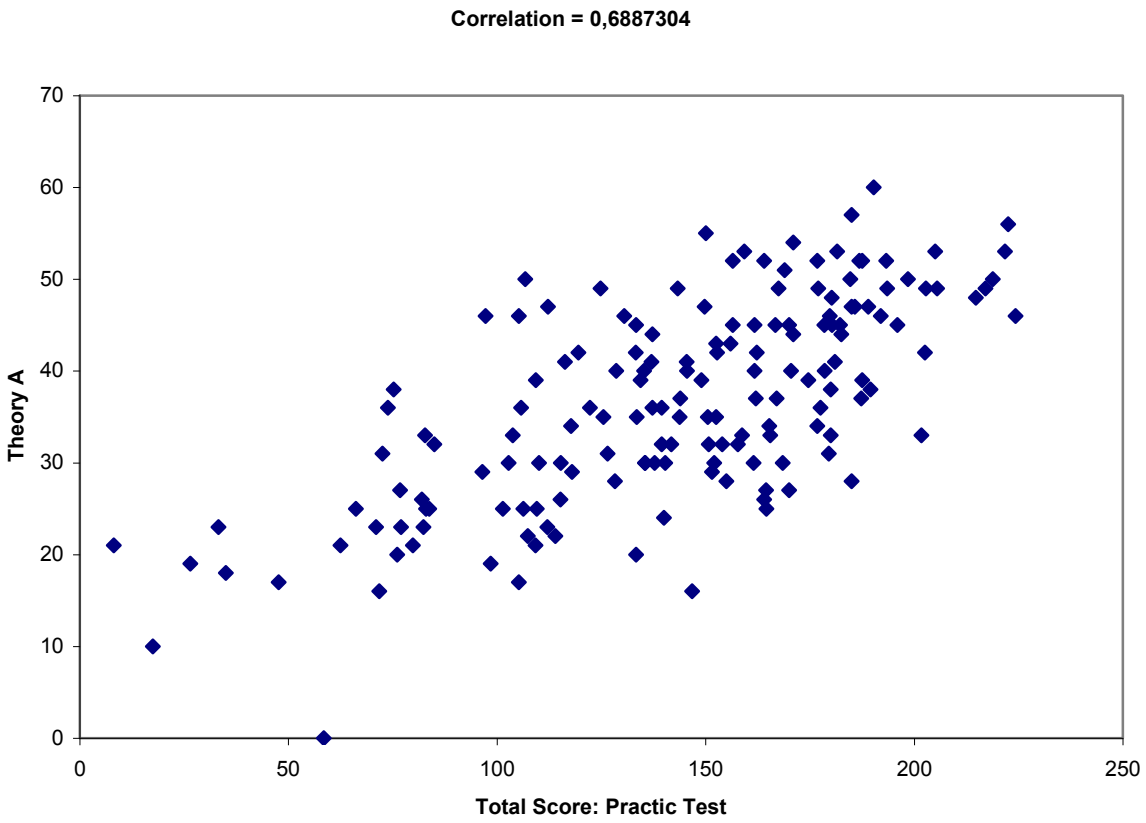

Diagram 5. Correlation between part A of theoretical test and total results of practical test.

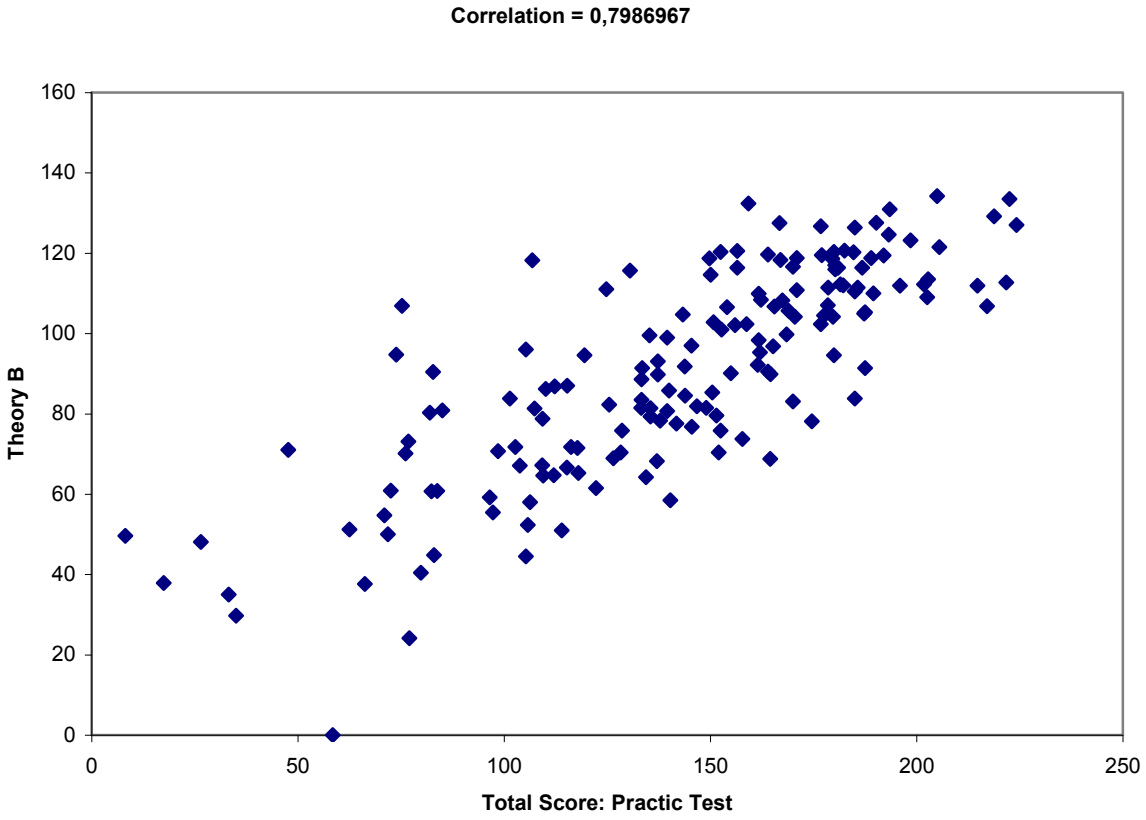

Diagram 6. Correlation between part B of theoretical test and total results of practical test.

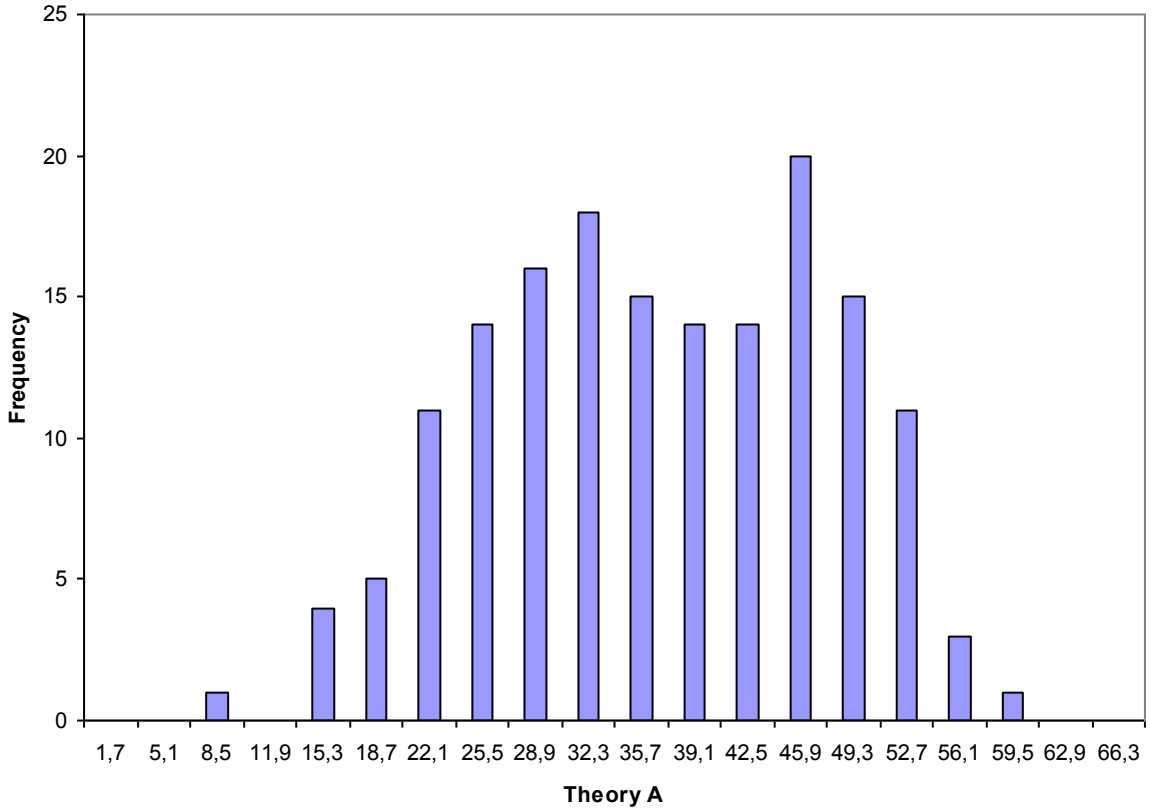

Diagram 7. Distribution of students frequency depending from results of part A of theoretical test.

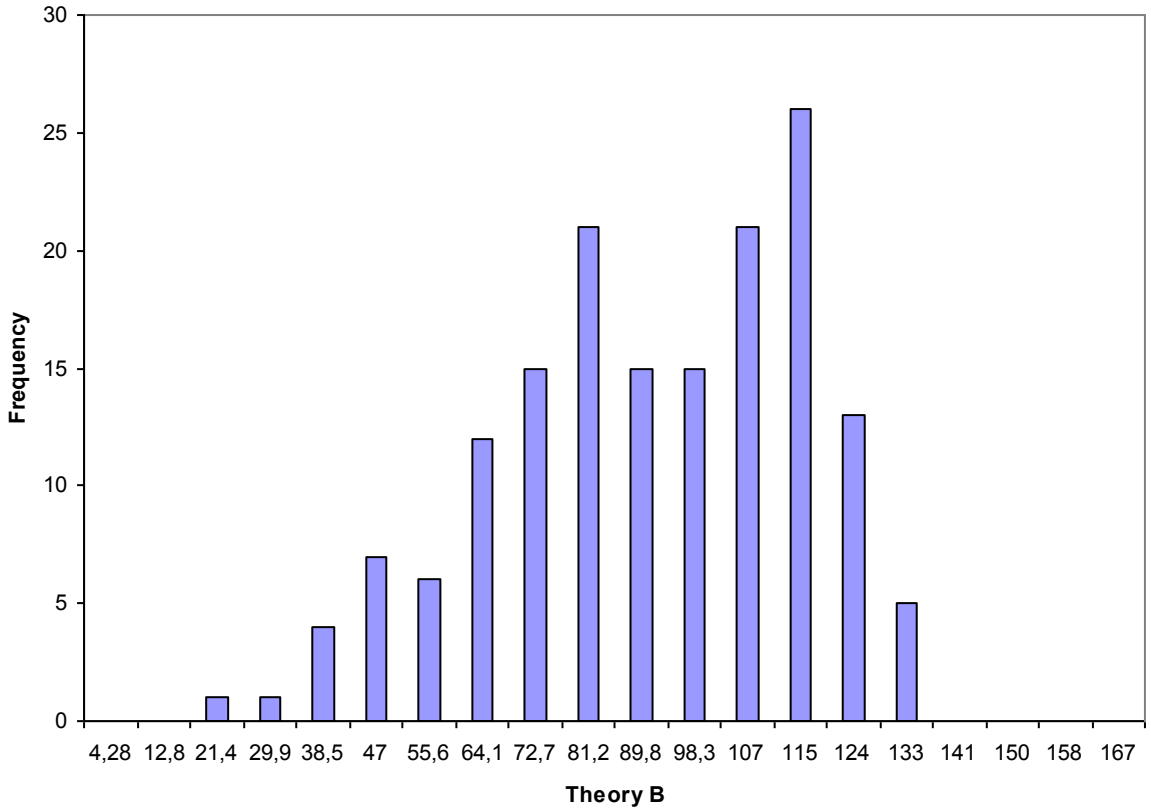

Diagram 8. Distribution of students frequency depending from results of part B of theoretical test.

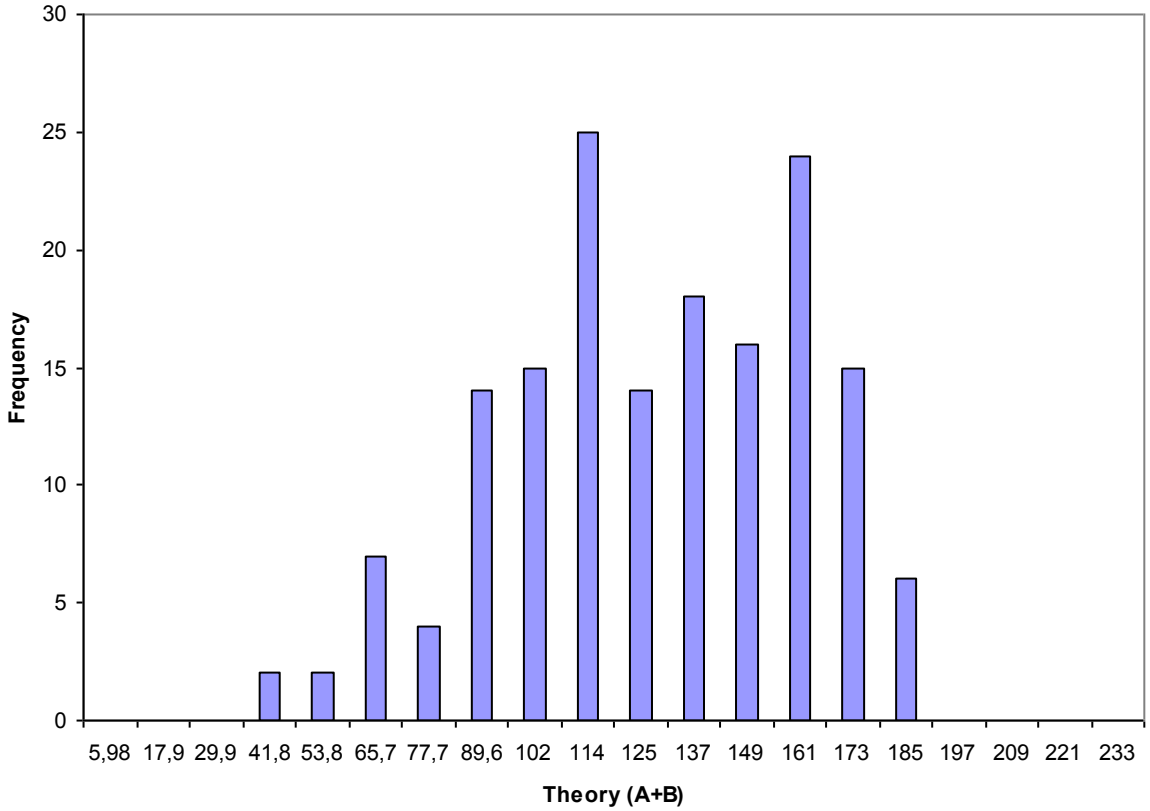

Diagram 9. Distribution of students frequency depending from total results of theoretical test.

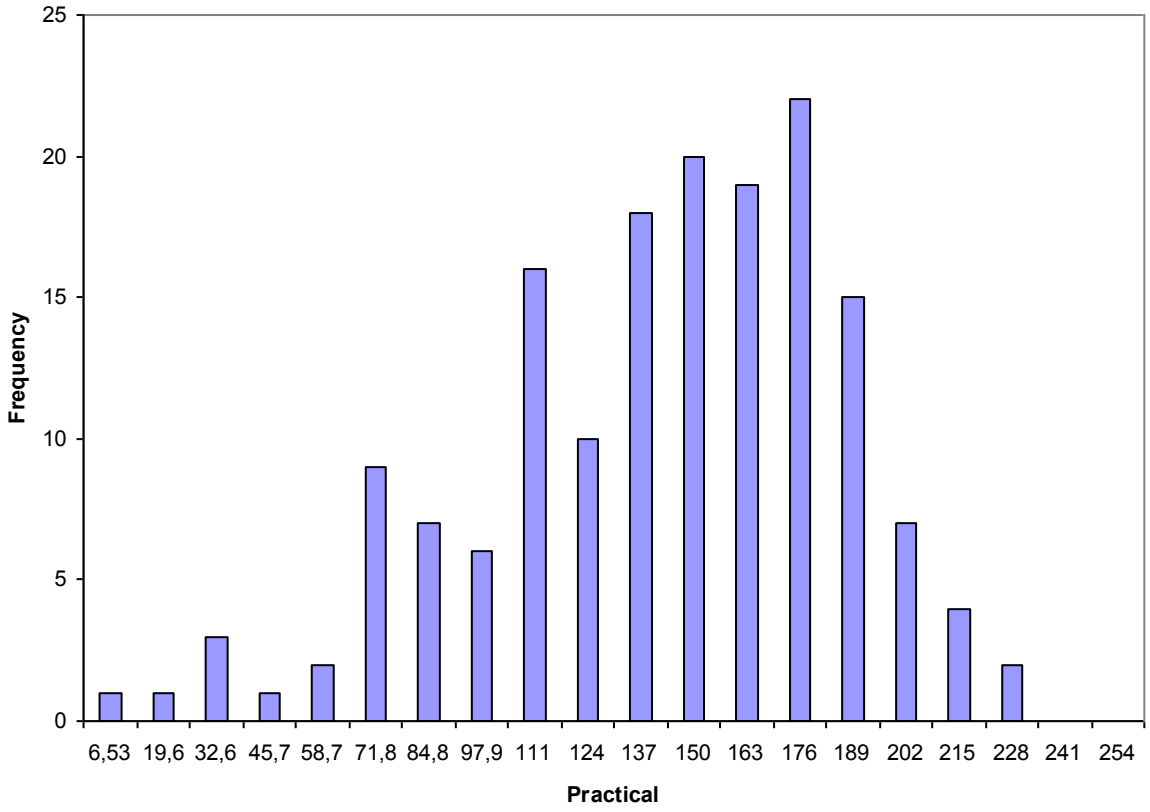

Diagram 10. Distribution of students frequency depending from total results of practical test.

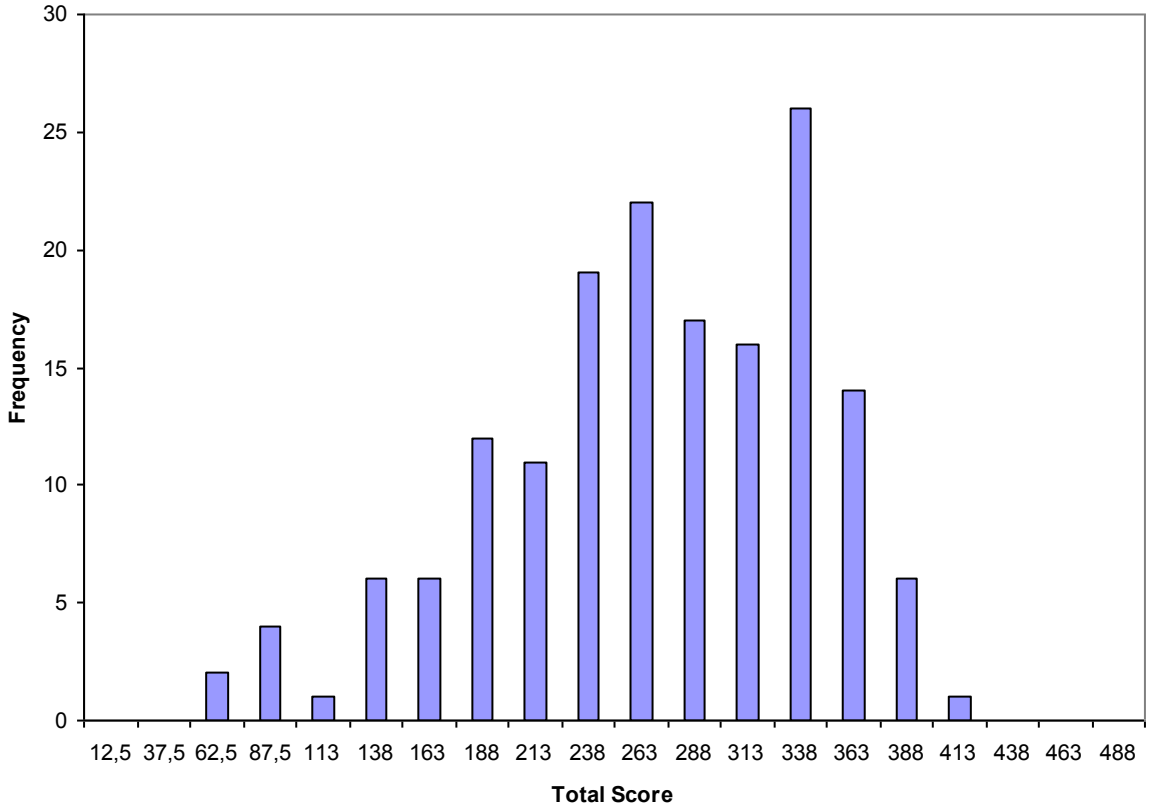

Diagram 11. Distribution of students frequency depending from total results of Olympiad tests.

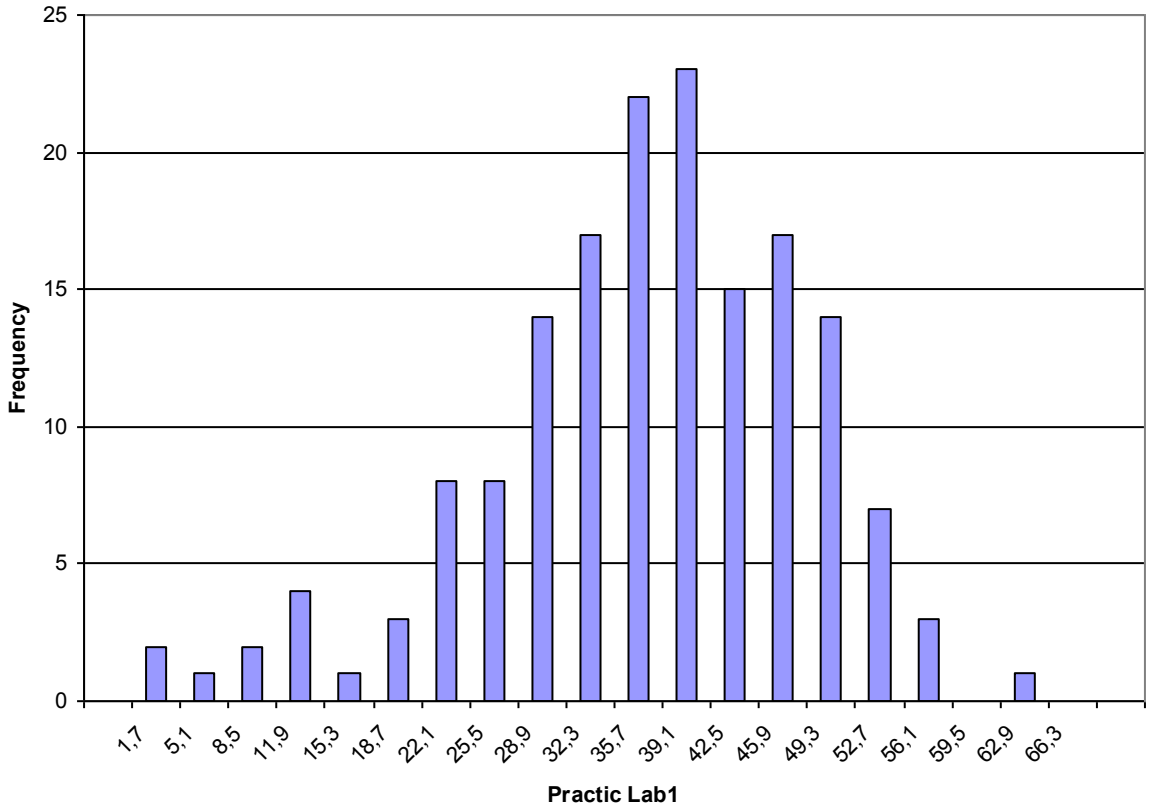

Diagram 12. Distribution of students frequency depending from results of Lab 1 of practical test.

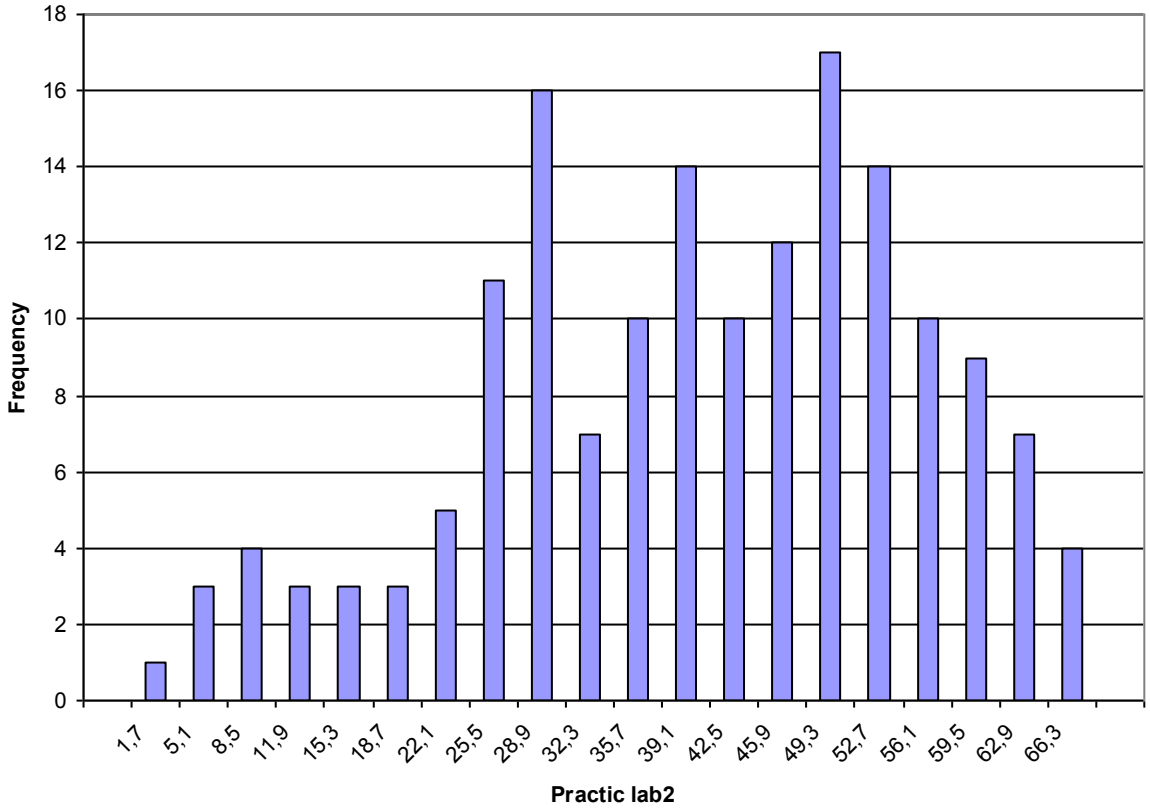

Diagram 13. Distribution of students frequency depending from results of Lab 2 of practical test.

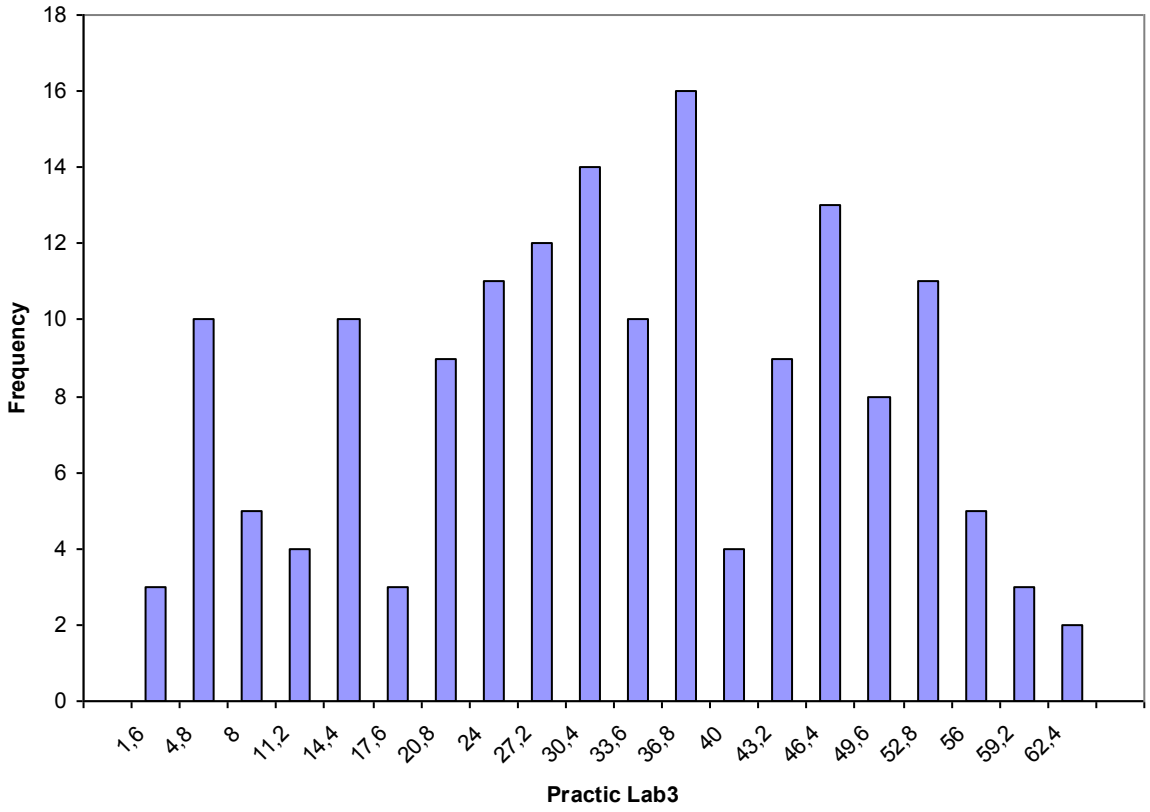

Diagram 14. Distribution of students frequency depending from results of Lab 3 of practical test.

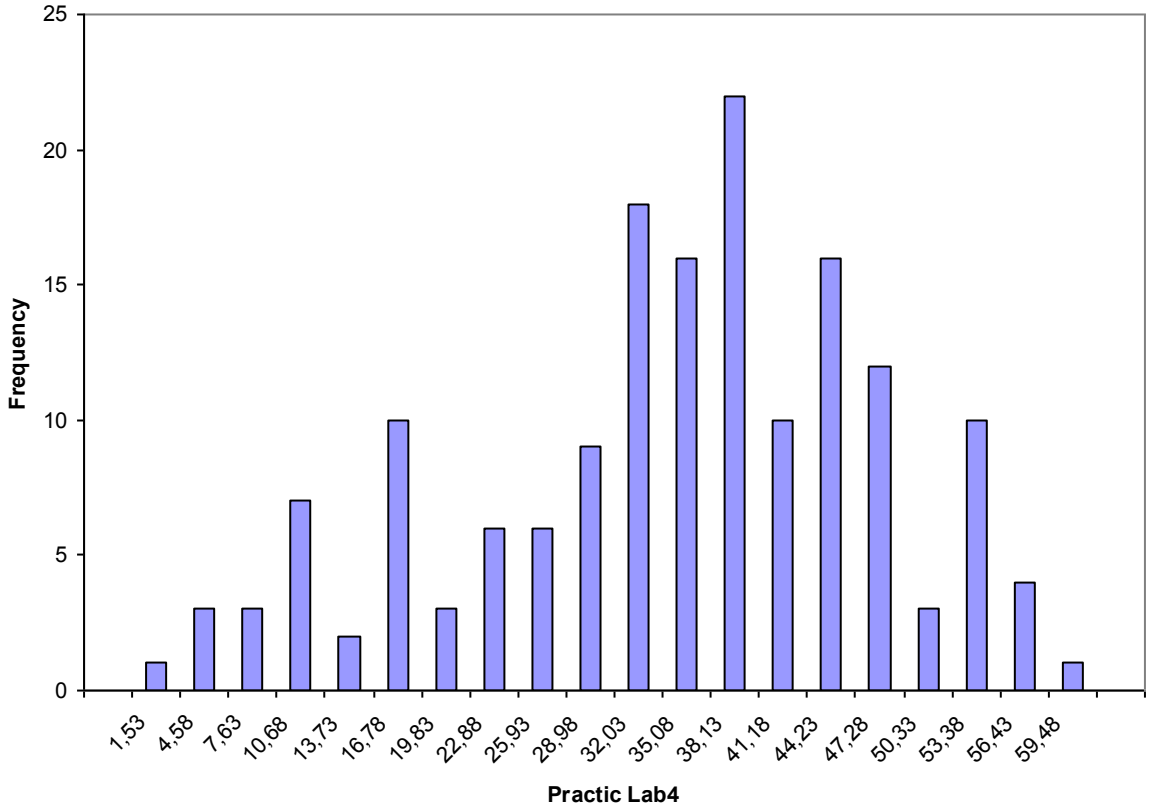

Diagram 15. Distribution of students frequency depending from results of Lab 4 of practical test.

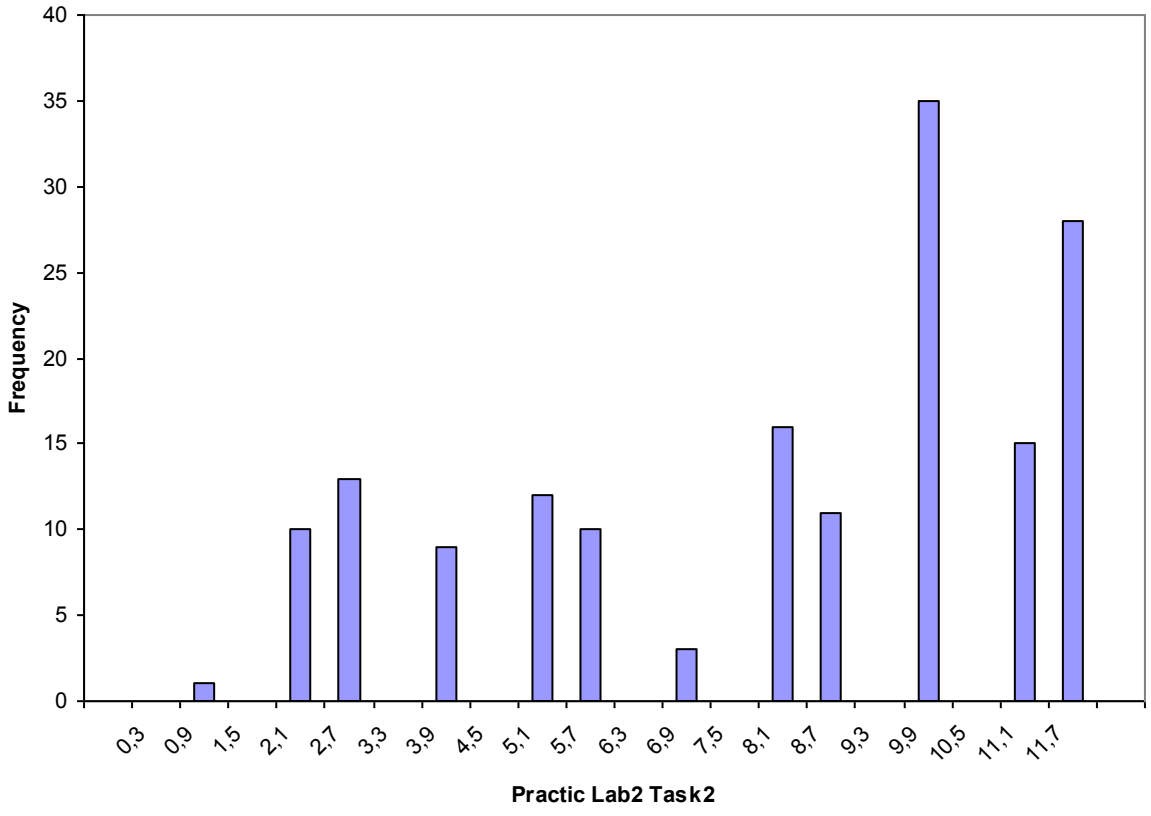

Diagram 16. Distribution of students frequency depending from results of Lab 2 of practical test (task 2).

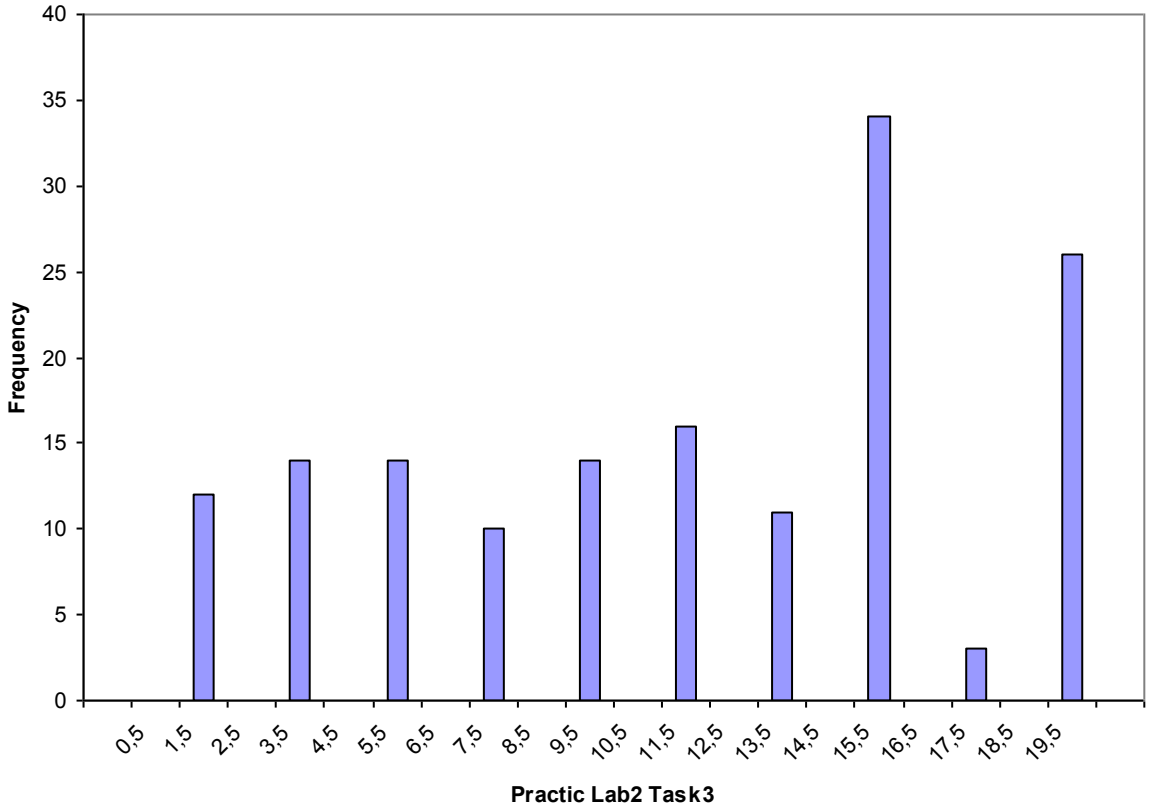

Diagram 17. Distribution of students frequency depending from results of Lab 2 of practical test (task 3).

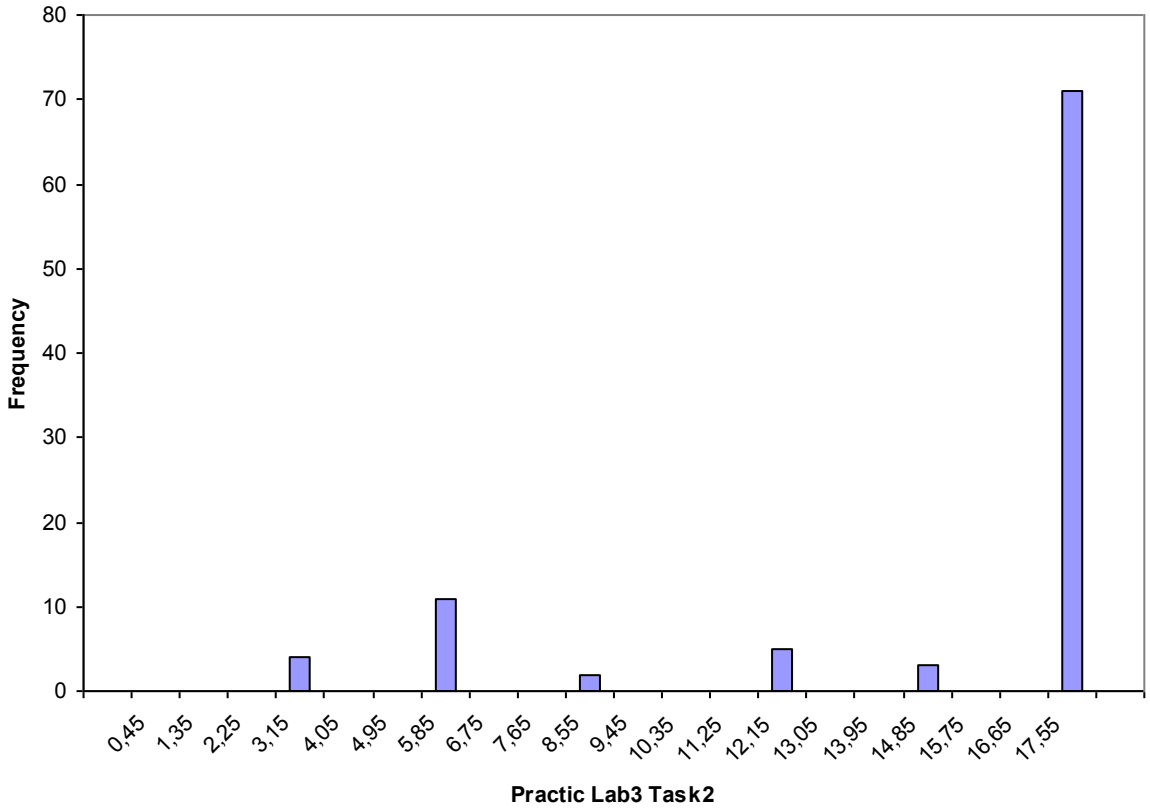

Diagram 18. Distribution of students frequency depending from results of Lab 3 of practical test (task 2).

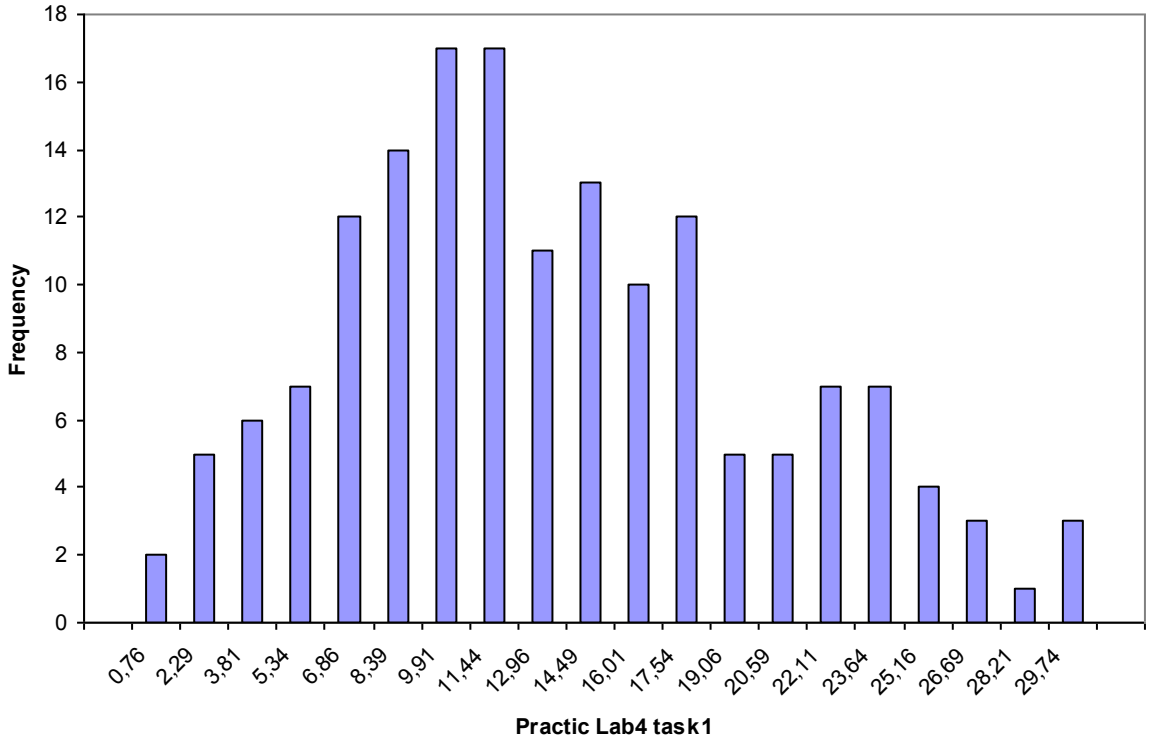

Diagram 19. Distribution of students frequency depending from results of Lab 4 of practical test (task 1).

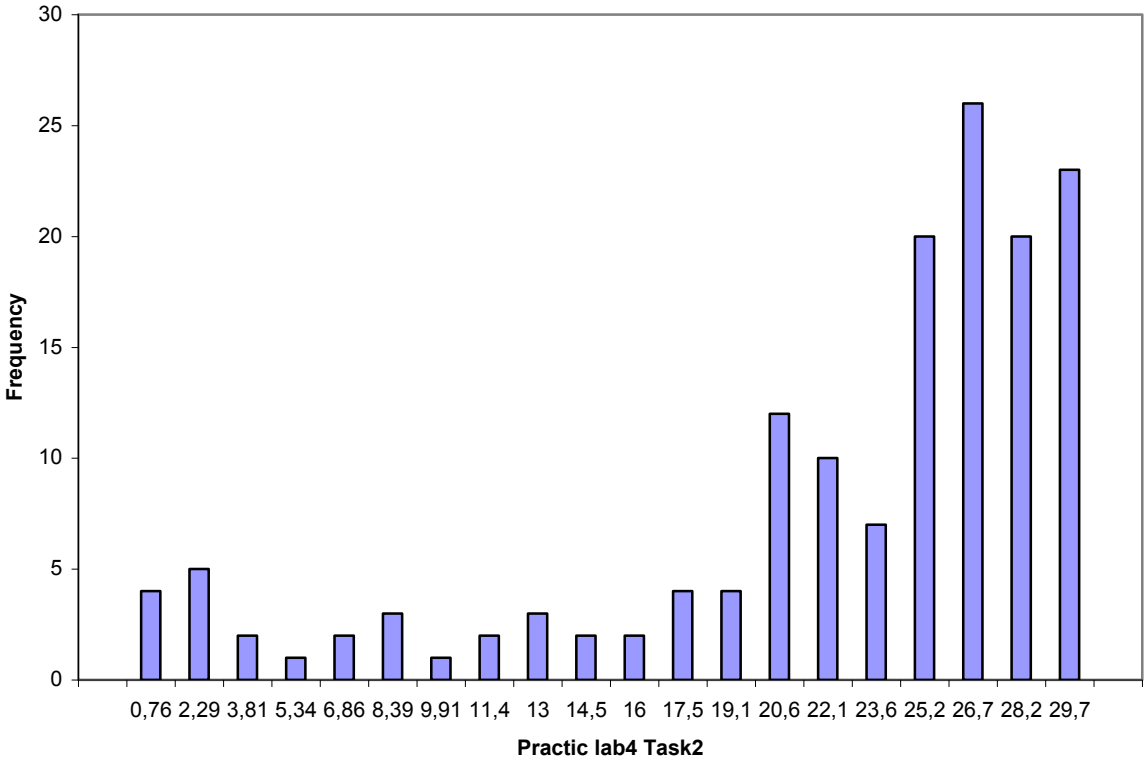

Diagram 20. Distribution of students frequency depending from results of Lab 4 of practical test (task 2).

Distribution of students frequency by others tasks of laboratories of practical test is near to normal distribution.

6. Awarding by medals and closing ceremony.


INTERNATIONAL BIOLOGY OLYMPIAD
МЕЖДУНАРОДНАЯ БИОЛОГИЧЕСКАЯ ОЛИМПИАДА


НАЯ БИОЛОГИЧЕСКАЯ ОЛИМПИА


БИОЛОГИЧЕСКАЯ ОЛИМПИАДА

APPENDIX

Genetic code.

FIRST POSITION (5'-end)	SECOND POSITION				THIRD POSITION (3'-end)
	U	**C**	**A**	**G**	
U	**UUU** Phe	**UCU** Ser	**UAU** Tyr	**UGU** Cys	**U**
	UUC Phe	**UCC** Ser	**UAC** Tyr	**UGC** Cys	**C**
	UUA Leu	**UCA** Ser	**UAA** Stop	**UGA** Stop	**A**
	UUG Leu	**UCG** Ser	**UAG** Stop	**UGG** Trp	**G**
C	**CUU** Leu	**CCU** Pro	**CAU** His	**CGU** Arg	**U**
	CUC Leu	**CCC** Pro	**CAC** His	**CGC** Arg	**C**
	CUA Leu	**CCA** Pro	**CAA** Gln	**CGA** Arg	**A**
	CUG Leu	**CCG** Pro	**CAG** Gln	**CGG** Arg	**G**
A	**AUU** Ile	**ACU** Thr	**AAU** Asn	**AGU** Ser	**U**
	AUC Ile	**ACC** Thr	**AAC** Asn	**AGC** Ser	**C**
	AUA Ile	**ACA** Thr	**AAA** Lys	**AGA** Arg	**A**
	AUG Met	**ACG** Thr	**AAG** Lys	**AGG** Arg	**G**
G	**GUU** Val	**GCU** Ala	**GAU** Asp	**GGU** Gly	**U**
	GUC Val	**GCC** Ala	**GAC** Asp	**GGC** Gly	**C**
	GUA Val	**GCA** Ala	**GAA** Gly	**GGA** Gly	**A**
	GUG Val	**GCG** Ala	**GAG** Gly	**GGG** Gly	**G**