13TH INTERNATIONAL BIOLOGY OLYMPIAD

REPORT

7th - 14th July 2002
Riga - Jurmala
LATVIA

1. Introduction

In Latvia, the Center for the Curriculum Development and Examination of the Ministry of Education and Science organizes all the National Olympiads and participates in the International Olympiads. We have a long experience in organizing Olympiads for secondary school students. The biology Olympiads have been taking place in Latvia since 1972. Latvia started to participate in the IBO in 1995.

In 2002, the Ministry of Education and Science and the Government of Latvia organized the 13th International Biology Olympiad in Latvia. The organizers of this enterprise were the Ministry of Education and Science, University of Latvia (Faculty of Biology), and the Biology Teachers Association. The 13th IBO was organized in Riga, the capital of Latvia, and the resort city Jurmala.

2. Organization

Organizing Committee

In 13th July 2001, the Cabinet of Ministers of the Republic of Latvia acknowledged the Organizing Committee of the 13th IBO.

Chairman: Karlis GREISKALNS, Minister of Education and Science

Vice-chairman: Ivars LACIS, Rector of the University of Latvia

Jury Chairman: Indrikis MUIZNIEKS, Vice-rector of the University of Latvia

Executive Director: Uldis KONDRATOVICS, Dean of the Faculty of Biology, University of Latvia

Members:

Maris KRASTINS, Ministry of Education and Science, Head of the Center for Curriculum Development and Examination

Inara AKMENE, Organizer of Olympiads in the Center for the Curriculum Development and Examination

Astrida JAKOBSONE, Financier of the Ministry of Education and Science

Daina KEIDANE, Riga School Council, Chief Expert

Vesma REINKAITE, Head of Jurmala School Board

Mudite KALNINA, National Youth Initiative Center, Head of the Department of the Ministry of Education and Science, Environmental Education and Technics

Maruta KUSINA, Leader of the Biology Teacher's Association

Uldis BINDERS, Central Board of Order Police, Inspector

Andris LAPINS, Center of Catastrophe Medicine, Head of Operative Medicine Service

Computing, Logistics and Preparation

Karlis KALVISKIS, Head of the Computing Laboratory, Faculty of Biology, University of Latvia – *Computers, Local Area Network and Copying*

Liga MAKULE and Tamara ZITCERE, members of the Biology Teacher`s Association – *Souvenirs, meeting teams at the airport*

Valdis BALODIS, Amanda DAMBE, Faculty of Biology, University of Latvia – *Data Presentations*

Gunta KARNITE, clerk of the Faculty of Biology, University of Latvia - *Transport*

Nikolajs PETERSONS, clerk of the Faculty of Biology, University of Latvia – *Materials and Equipment*

Janis LIEPINS, Janis PUDULIS, Dace KUSINA, students – *Guides, excursions*

Girts DEJUS, Indra TOMSONE, Maris ROZENBLATS, students, University of Latvia – *Input of Data, Statistics*

The Organizing Committee took the responsibility about all the organization of the 13th IBO. They had 8 meetings during which all the accomplished tasks were discussed and new commissions were confided.

Scientific Task Committee

The Scientific Task Committee was represented by the staff of the University of Latvia, Riga Stradins University and Biology Teachers Association.

Leader: Assoc. Prof. Dr. Uldis KONDRATOVICS, Dean of Faculty of Biology, University of Latvia

Members:

Prof. Dr. Indrikis MUIZNIEKS, Chairman of the International Jury and Vice-rector of the University of Latvia

Prof. Dr. Gederts IEVINS, Faculty of Biology, University of Latvia

Assoc. Prof. Dr. Uldis KALNENIEKS, Faculty of Biology, University of Latvia

Doc. Dr. Liga OZOLINA-MOLL, Faculty of Biology, University of Latvia

Doc. Dr. Erika NAGLE, Riga Stradins University

Assoc. Prof. Dr. Voldemars SPUNGIS, Faculty of Biology, University of Latvia

Prof. Dr. Valdis BALODIS, Faculty of Biology, University of Latvia

Prof. Dr. Viesturs BAUMANIS, Faculty of Biology, University of Latvia

M. biol. Maruta KUSINA, Head of Biology Teachers Association

Assoc. Prof. Dr. Galina POSPELOVA, Faculty of Biology, University of Latvia

Assoc. Prof. Dr. Tatjana ZORENKO, Faculty of Biology, University of Latvia

Researcher, Dr. Turs SELGA, Faculty of Biology, University of Latvia

Assoc. Prof. Dr. Guntis BRUMELIS, Faculty of Biology, University of Latvia

Lecturer Maris LAZDINS, Faculty of Biology, University of Latvia

Researcher Guntis TABORS, Faculty of Biology, University of Latvia

The Scientific task Committee had 12 meetings from May 2001. During those meetings the discussions about the form of the tasks and difficulty level of tasks took place.

The Scientific task Committee thanks all the countries who sent task proposals for theoretical part of the competition.

Thanks to:

- Argentina
- Belarus
- Belgium
- Czech Republic
- People Republic of China
- Estonia
- Finland
- Germany
- India
- Islam Republic of Iran
- Mexico
- The Netherlands
- Romania
- Russian Federation
- Slovenia
- Thailand
- Turkey
- Turkmenistan
- United Kingdom
- Vietnam

Special thanks for interesting tasks to India and Belarus.

Student guides

Our students were the guides of all the teams. Most of them were previous members of Latvian team of the IBO. All guides were volunteers. The guides of some teams, for example, the team of Thailand and that of India, were their native language speakers.

Other voluntary staff

Except the Organizing Committee, the Scientific Task Committee and student guides many more people were involved as voluntary staff in arranging the 13th IBO.

- 16 people from the Faculty of Biology, University of Latvia, staff took part in the administration of practical tasks;
- 9 biology teachers took part in scoring the results of students in theoretical tasks;
- 4 students of informatics were involved in input the results in computers;
- 9 people (mainly family members of the Organizing Committee) helped to copy and to distribute all the tasks.

More were involved in putting up the posters, making musical events, providing traffic and solving other organization problems.

The Organizing Committee is highlighting the role of students of the University of Latvia and other universities of Latvia in providing the 13th IBO.

Localities for the 13th IBO

The opening ceremony took place in the Latvian Society House in Riga. At first it was decided to organize the opening ceremony in the Hall of the University of Latvia, but it was impossible because of the NATO conference and the entrance exams.
Jury sessions took place in the cinema hall of the hotel "Daina" which was specially adapted for IBO jury sessions.
Students did their practical tasks in the labs of the Faculty of Biology and the Faculty of Chemistry, University of Latvia. They did the theoretical tasks in the auditoriums of the Riga Stradins University.

Accommodation and transport

The hotels were reserved 1.5 years before the 13th IBO. Jurmala is the resort and the hotels are busy during the summer time. Students lived in the hotel "Baltija" in Dzintari, but Jury members and observers where accommodated in the hotel "Daina" in Melluzi.
Transport was ensured by the traffic company "Imanta" as well as by the Jurmala School board, the University of Latvia and the Center of Curriculum Development and Examination, Republic of Latvia.

3. Programme

Students		Jury members & observers	
Time	Activity	Time	Activity
Sunday, 7th July 2002			
	Arrival at the hotel "Baltija"		Arrival at the hotel "Daina"
8.00 a.m. – 8.30 a.m.	Breakfast (Hotel "Baltija")	8.00 a.m. - 8.30 a.m.	Breakfast (Hotel " Daina")
1.00 p.m. – 2.00 p.m.	Dinner (Hotel "Baltija")	12.30 p.m. – 1.00 p.m.	Dinner (Hotel "Daina")
7.00 p.m. – 8.00 p.m.	Supper (Hotel "Baltija")	7.00 p.m. – 7.30 p.m.	Supper (Hotel "Daina")
Monday, 8th July 2002			
8.00 a.m. – 8.30 a.m.	Breakfast (Hotel "Baltija")	8.00 a.m. - 8.30 a.m.	Breakfast (Hotel " Daina")
10.00 a.m. – 11.30 a.m.	Opening ceremony (Latvian Society House)	10.00 a.m. – 11.30 a.m.	Opening Ceremony (Latvian Society House)
1.00 p.m. – 2.00 p.m.	Dinner (Hotel "Baltija")	12.30 p.m. – 1.00 p.m.	Dinner (Hotel "Daina")
2.00 p.m. – 11.00 p.m.	Free time	1.00 p.m. - ...	Evaluation and translation of practical tests
7.00 p.m. – 8.00 p.m.	Supper (Hotel "Baltija")	7.00 p.m. – 7.30 p.m.	Supper (Hotel "Daina")

Students		**Jury members & observers**	
Time	Activity	Time	Activity
Tuesday, 9th July 2002			
7.30 a.m. – 8.00 a.m.	Breakfast (Hotel "Baltija")	9.00 a.m. – 9.30 a.m.	Breakfast (Hotel " Daina")
8.15 a.m.	Departure to Riga groups A1 - A4 (University of Latvia: Faculty of Biology; Faculty of Chemistry)	10.00 a.m. – 1.30 p.m.	Excursion to Old Riga
9.00 a.m. – 2.10 p.m. 1120 a.m. -12.00 p.m.	Practical tests for groups A1-A4 (University of Latvia: Faculty of Biology; Faculty of Chemistry) Change of place Free time for groups B1 – B4		
3.00 p.m. – 3.30 p.m. 3.00 p.m. – 3.30 p.m.	Dinner for groups A1-A4 Dinner for groups B1-B4 (Hotel " Baltija")	2.00 p.m. –2.30 p.m.	Dinner (Hotel "Daina") Free time
2.15 p.m.	Departure to Riga groups B1 – B4 (University of Latvia: Faculty of Biology; Faculty of Chemistry)		
2.45 p.m. – 7.50 p.m. 5.10 p.m. – 5.40 p.m.	Practical tests for groups B1- B4 (University of Latvia: Faculty of Biology; Faculty of Chemistry) Free time for A groups Change of place		
8.30 p.m. – 9.00 p.m.	Supper (Hotel "Baltija")	7.00 p.m. – 7.30 p.m.	Supper (Hotel "Daina")

Students		Jury members & observers	
Time	Activity	Time	Activity
Wednesday, 10th July 2002			
Students		Jury members & observers	
Time	Activity	Time	Activity
9.00 a.m. – 9.30 a.m.	Breakfast (Hotel "Baltija")	9.00 a.m. - 9.30 a.m.	Breakfast (Hotel " Daina")
10.00 a.m. – 1.30 a.m.	Excursion to Kemeri National Park	9.30 a.m. - ...	Evaluation and translation of theoretical tests (hotel "Daina" Cinema hall)
2.00 p.m. – 2.30 p.m. 7.00 p.m. – 7.30 p.m.	Dinner Free time Supper (hotel" Baltija")	1.00 p.m. – 1.30 p.m. 7.00 p.m. – 7.30 p.m.	Dinner Supper
Thursday, 11th July 2002			
8.00 a.m. – 8.30 a.m.	Breakfast (Hotel "Baltija")	9.00 a.m. - 9.30 a.m.	Breakfast (Hotel " Daina")
9.00 a.m.	Departure to Riga Stradins University (Jurmala – Riga)		
10.00 a.m. –2.30 p.m.	Theoretical test. Part A and B (Riga Stradins University)	10.00 a.m. – 11.50 a.m.	IBO Coordinator Meeting
2.30 p.m. – 3.00 p.m. 3.15 p.m. – 5.15 p.m.	Dinner (in bus) Excursion to Old Riga	12.00 p.m. – 12.30 p.m.	Dinner (Hotel "Daina")
		1.00 p.m. – 4.00 p.m.	Excursion to Kemeri National Park
6.00 p.m. -6.30 p.m.	Meeting with team leaders	6.00 p.m. – 6.30 p.m.	Meeting with team leaders
6.30 p.m. – 7.00 p.m.	Supper (Hotel "Baltija")	7.00 p.m. – 7.30 p.m.	Supper (Hotel "Daina")
7.00 p.m. – 10.30 p.m.	Discotheque (Majori Primary School)	7.40 p.m. – 11.00 p.m.	Checking the marking process of theoretical part and the results of practical tests. (Hotel "Baltija" cinema hall)

Students		Jury members & observers	
Time	Activity	Time	Activity
Friday, 12th July 2002			
8.00 a.m. – 8.30 a.m.	Breakfast (Hotel "Baltija")	8.00 a.m. - 8.30 a.m.	Breakfast (Hotel " Daina")
9.00 a.m. - 6.00 p.m.	Excursion to Rundale Palace and Tervete Nature Park	9.00 a.m. – 6.00 p.m.	Excursion to Gauja National Park and Turaida Palace
7.00 p.m. – 7.30 p.m.	Supper (Hotel "Baltija")	7.00 p.m. –7.30 p.m.	Supper (Hotel "Daina")
		7.40 p.m. – 11.00 p.m.	Statistic evaluation of the results of theoretical tests and competition results, drinking beer etc. (Hotel "Daina")
Saturday, 13th July 2002			
9.00 a.m. – 9.30 a.m.	Breakfast (Hotel "Baltija")	9.00 a.m. - 9.30 a.m.	Breakfast (Hotel" Daina")
12.00 p.m. –2.30 p.m.	Closing ceremony (Bulduri Horticultural School)	12.00 p.m. – 2.30 p.m.	Closing ceremony
3.30 p.m. –10.30 p.m.	Farewell Party and dinner in "Krasta Lido"	3.30 p.m. – 10.30 p.m.	Farewell Party and dinner in "Krasta Lido"
Sunday, 14th July 2002			
Departure			

4. Tasks

4.1. Practical tasks

Laboratory 1 "Animal Systematics and Morphology" was prepared by Voldemars Spungis. His students helped to collect the samples and to arrange the laboratory facilities.

Laboratory 2 "Plant Systematics, Anatomy and Physiology" was prepared by Uldis Kondratovics and Valdis Balodis. The staff assistants spent a lot of time on preparing this task.

Laboratory 3 "Molecular Biology" was prepared by Maris Lazdins, Uldis Kalnenieks and technicians helped a lot.

Laboratory 4 "Dendroecology" was prepared by Guntis Brumelis and Guntis Tabors. The Latvia University of Agriculture helped to prepare the materials (tree discs) for this task.

4.1.1. Laboratory I - Animal Systematics and Morphology

Length of the practical test – 60 minutes; 40 points
Tools and Equipments
Microscope, microscopic slides, cover slips, preparation needle, forceps, 10 Petri Dishes, labelled **A** to **J**, permanent marker. There are specimens of one species in each vial.

Introduction
Scientists have investigated the fauna of a freshwater lake. Samples of benthos, plankton and surface dwelling animals were taken to characterise the fauna of aquatic animals and relationships among them. The samples were sorted, then preserved in formaldehyde and finally transferred to a 70% solution of ethyl alcohol, or stored alive.

Tasks
Q. 1. Fill in the answer code of the phylum for the specimens in each vial in the answer sheet.
The jury will check only the answers in the answer sheet! ***(5 points)***

Answer codes:
01 Arthropoda
02 Annelida
03 Porifera
04 Platyhelminthes
05 Mollusca

Vial	A	B	C	D	E	F	G	H	I	J
Phylum										

Q. 2. Fill in the answer code of the taxonomic units for specimens in each vial in the answer sheet. ***(5 points)***

Vial	A	B	C	D	E	F	G	H	I	J
Taxon										

Answer codes:
01 Crustacea
02 Diptera
03 Heteroptera
04 Hirudinea
05 Turbellaria
06 Odonata
07 Coleoptera
08 Lamellibranchiata
09 Euspongia

Q. 3. Mark with crosses in the table in the answer sheet the observed characters for the species for specimens in each vial.

Characteristics	**Vials**									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
K. Laterally flattened body										
L. Abdomen covered by elytrae										
M. Body naked										
N. Labium with hooks										
O. Piercing-sucking mouth parts										
P. Swimming bristles on body										
R. Eyes absent										
S. Eyes rudimentary										
T. Eyes well developed										

(10 points)

Q. 4 A. Prepare 2 whole-mount microscope slides (I and II) for two specimens with the characteristics mentioned below. Use the provided materials. Mount the specimens in glycerine. You will get 1 point for choosing the correct specimen and 1 point for a well-prepared slide.
Please raise your hand when you have prepared both slides!
Slide I
Specimen with clearly visible head capsule, spiracles for breathing of atmospheric air and swimming bristles on the body.
Slide II
Specimen with antenna and antennula, laterally flattened body and compound eyes, planktonic.

(4 points)

Q. 4 B. Select the common characteristic for both animals and write the answer code in the space provided .

Answer codes:
01 Free swimming **02** Attached to plants **03** Benthic

(1 point)

Q. 5. Fill in the answer sheet with the appropriate code of gas exchange for the specimens in each vial.

Vial	A	B	C	D	E	F	G	H	I	J

Answer codes:
01 Spiracles and tracheae **02** Surface of body **03** Gills or rectal gills

Codes										

(5 points)

Q. 6. Based on each pair of characteristics provided, complete the diagrammatic dichotomous key in the answer list by filling in the letters of specimens (A-J) in the appropriate empty spaces in the boxes.

(10 points)

Answer codes:

01 Legs present
02 No legs

03 Six legs
04 More than six legs

05 Planktonic animal
06 Benthic animal

07 Adult, no gills
08 Larva, rectal gills present

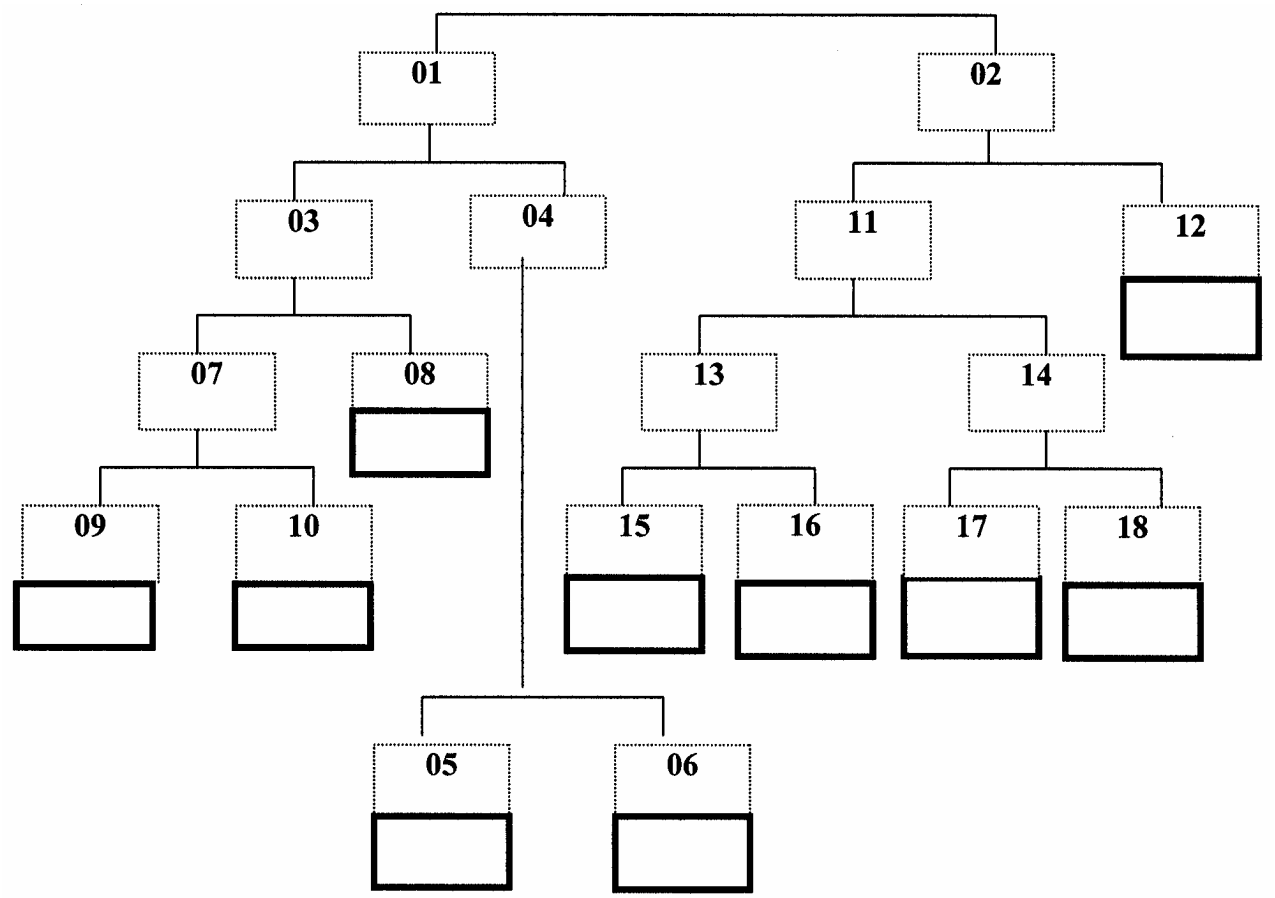
09 Swimming legs, live in the water
10 Running legs, live on the water surface

11 Definite shaped body
12 Indefinite shaped body

13 Body segmented
14 Body without segmentation

15 Head capsule developed
16 No developed head capsule

17 Body naked
18 Body covered by shell



4.1.2. Laboratory II - Plant Systematics, Anatomy and Physiology

Length of the practical test - 60 minutes; 40 points
In the laboratory you must solve 3 tasks

Task 1 – Plant Systematics
Task 2 – Plant Anatomy
Task 3 – Plant Physiology

Task 1 – Plant Systematics

Materials and instruments
You will use the instrument set that you received upon registering for the 13th IBO!
You will also use other instruments and materials: samples No. 1-8, magnifying glass
You have 8 plants (samples 1-8) which can belong to the following plant families (A-J)

In the code table:
Code Table

A. *Apiaceae*	E. *Fabaceae*	H. *Poaceae*
B. *Asteraceae*	F. *Geraniaceae*	I. *Ranunculaceae*
C. *Brassicaceae*	G. *Lamiaceae*	J. *Rosaceae*
D. *Araceae*		

By morphological characteristics, determine the respective families (from those given in the code table), for the samples (1-8)!

Q1. Identify each sample in the dichotomous identification key below. Enter the sample number in the provided windows in the answer sheet. ***(8 points)***
Write the family codes (A-J) in the windows provided beside the appropriate sample numbers! ***(8 points)***

(continued on next page)

Identification key

Thesis Nr.		Sample Nr. (1-8)	Family code (A-J)
1.	Flowers without perianth. Venation parallel … **2.**		
–	Flowers with calyx and corolla. Venation netted … **3.**		
2.	Inflorescence spike		
–	Inflorescence panicle as a dense cylinder		
3.	Inflorescence head		
–	Flowers single or in an inflorescence, that is not a head … **4.**		
4.	Flowers actinomorphic … **5.**		
–	Flowers zygomorphic … **7.**		
5.	Leaves entire or lobed… **6.**		
–	Leaves separated. Inflorescence of compound umbels. $G_{(2)}$		
6.	$Ca_5\ Co_5\ A_5+5G_{(5)}$		
–	$Ca_2+2Co_2+2A_2+4\ G_{(2)}$		
7.	Leaves opposite, entire; fruit – nutlet		
–	Leaves alternate, compound; fruit – legume		

Task 2 – Plant Anatomy

Materials and instruments:

You will use the instrument set that you received upon registering for the 13th IBO!
You will also use other instruments and materials: sample No. 9, pith of black elderberry (for fixing in task 2), microscope, stain mixture, Petri Dish with water, distilled water, microscope, slides and coverslips, razor blade, filter paper, cloth material.

Cut the pith of black elderberry *(Sambucus nigra)* lengthwise in half with a razor blade. Holding with hands, secure sample No. 9 lengthwize between the halves (Figure 1. A-D). The black elderberry pith is used only for fixing. Holding the black elderberry pith in one hand and the razor blade in the other, prepare cross-sections of sample No. 9 (Figure1E) and place them in the water in the Petri Dish! Choose the three best cross-sections (without the black elderberry pith) and place them on the microscope slide. Add a drop of Astra blue (stains cellulose) and safranin (stains lignin) mixture. After 0.5 minutes, remove the stain with the filterpaper, and add a drop of distilled water, and remove them with the filter paper. Twice repeat rinsing with water. Add a drop of water and place the coverslip over the cross-sections.
The quality of the cross-section and the preparation will be assessed!

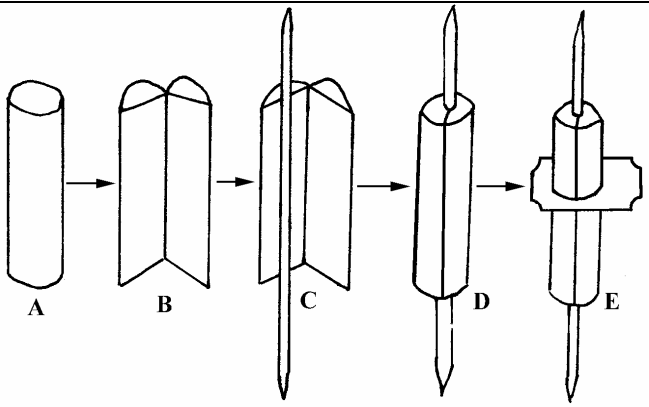


Figure 1. Preparation of cross-section of sample No. 9
A – Black elderberry pith
B – Cut black elderberry pith
C – Sample placed between cut black elderberry pith
D – Ready for cutting
E – Preparation of cross-section

Q 2 A. When the preparation is ready, using the low power x10 objective, find the best cross-section. Raise the card showing "2A", and the assistant of the laboratory task will assess the quality of the cross-section and preparation, and write the assessment points in the answer sheet!

(2 points)

Q 2 B. Using the microscope (objective x10 and x40), study the preparations. Compare the cross-section seen under the microscope with that in Figure 2. and with its fragments [A (Figure 3), B (Figure 4), C (Figure 5), D (Figure 6)].

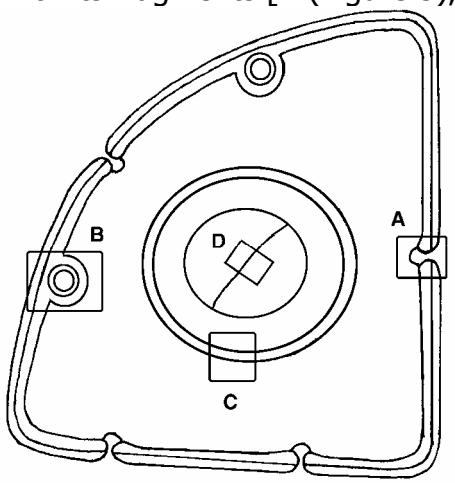


Figure 2. Cross-section of sample No. 9.

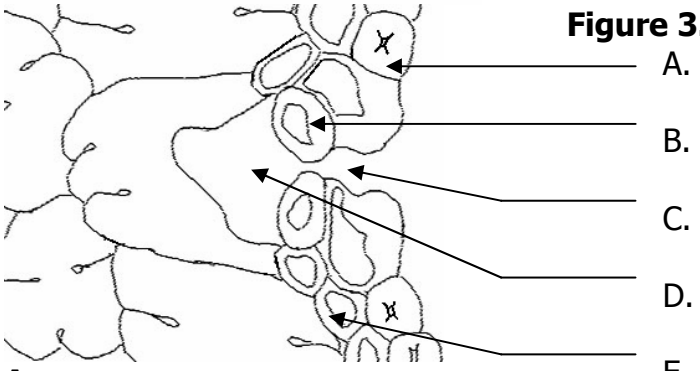


Figure 3. Sample No. 9 cross-section fragment A.

A.

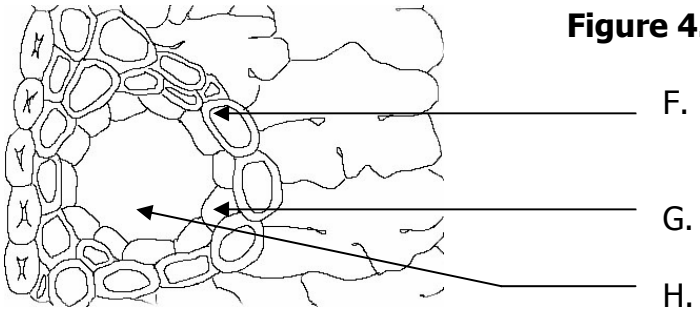


Figure 4. Sample No. 9 cross-section fragment B

B.

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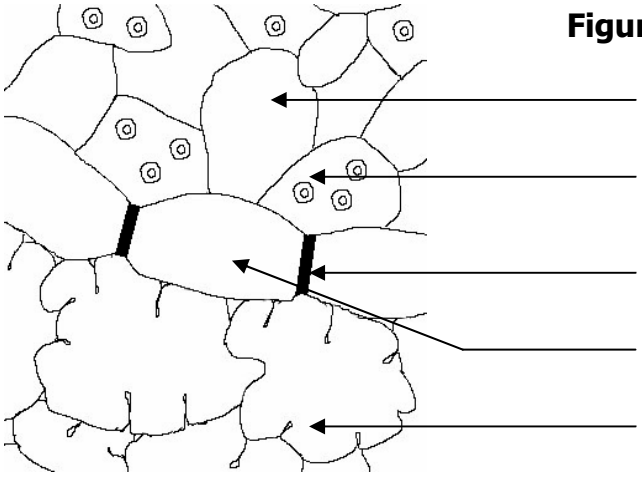


Figure 5. Sample No. 9 cross-section fragment C

C.

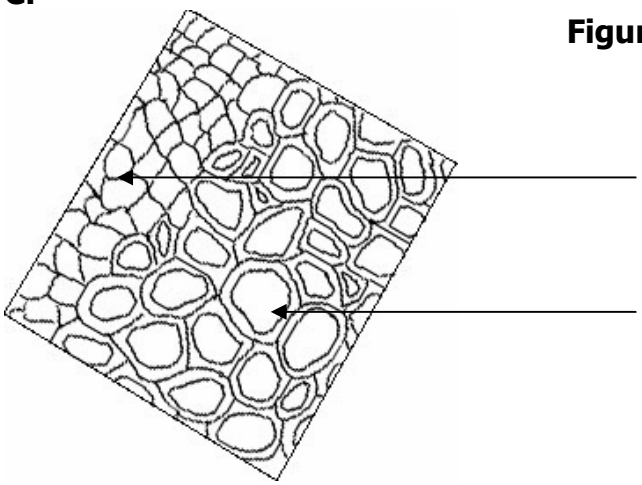


Figure 6. Sample No. 9 cross-section fragment D

D.

Code Table

No.	Part	No.	Part
1.	Pericycle	**13.**	Phloem
2.	Cystolith	**14.**	Transfusion tracheid
3.	Transfusion parenhima	**15.**	Palisade parenchyma
4.	Hypodermis	**16.**	Spongy parenhyma
5.	Casparian strip	**17.**	Guard cell
6.	Endodermis	**18.**	Sclerenchyma sheath
7.	Back cavity	**19.**	Raphide
8.	Trichome	**20.**	Angular collenchyma
9.	Epidermis	**21.**	Front cavity
10.	Druse	**22.**	Lobed parenchyma
11.	Resin duct	**23.**	Xylem
12.	Epithelial cells	**24.**	Pith

In the answer sheet beside the letters A-O of parts seen on Figures 3-6, write the codes of the correct names of these parts!

(15 points)

Q 2 C. Choose the correct plant taxon observed, and enter an "x" beside the respective code in the answer sheet.

Code table:

A.	Bryophyta
B.	Equisetophyta
C.	Pinophyta
D.	Magnoliophyta

(1 point)

Q 2 D. Choose the correct ecological group of the plant observed, and enter an "x" beside the respective code in the answer sheet.
Code table:

A.	hydrophyte
B.	hygrophyte
C.	mesophyte
D.	xerophyte

(1 point)

Task 3. Plant Physiology

Materials and instruments:
You will use the instrument set that you received upon registering for the 13th IBO!
You will also use other instruments and materials: sample No.10 – onion fragment, microscope, $Ca(NO_3)_2$ solution, distilled water, microscope slides and coverslips, razor blade, filter paper, cloth material.

A characteristic stem modification (bulb) fragment from a representative of the Liliaceae is supplied. Separate from the bulb fragment one fleshy inner scale leaf, using the instrument set!

Q 3 A. Determine on which side of the fleshy inner scale leaf can be found the lower epidermis. Lift the card with sign **"3A",** the assistant of the laboratory task will arrive, and you will show him the lower epidermis. His assessment will be entered in the answer page! ***(1 point)***

Q 3 B. Make a preparation**:** using a razor blade, shave a thin (~5 x 5 mm) section of the lower epidermis and place it on the microscope slide. Add one drop of the $Ca(NO_3)_2$ solution, place a coverslip over the section, and begin observation of the process occurring immediately under the x10 objective. Raise the card "**3B",** and the assistant of the laboratory task will arrive. His assessment of the preparation quality will be entered in the answer page! ***(1 point)***

Q 3 C. What is the name of the process seen under the microscope? In the answer sheet, enter an "x" beside the code of the correct process.
Code table:

A.	Hemolysis
B.	Dissociation
C.	Association
D.	Plasmolysis
E.	Deplasmolysis
F.	Hemophosphorylation

(1 point)

Q 3 D. Which of the below concentrations of $Ca(NO_3)_2$ solution could have caused the process observed? Enter an "x" beside the correct codes of the possible concentrations in the answer sheet.
Code table:

A.	1 M
B.	0.5 M
C.	0.1 M
D.	0.05 M
E.	0.01 M

(2 points)

4.1.3. Laboratory III – Molecular Biology

Length of the practical test - 60 minutes; 40 points

Task: Electrophoretic separation of plasmid pX DNA fragments in an agarose gel and construction of a restriction map of the pX plasmid.

The lab assistants will give **5 points** for strict following the lab safety regulations and accurate sample loading:

A - wearing the lab gloves during laboratory experiment – ***1 point***;
B - addressing the assistant before usage of the power supply and correct usage of UV transilluminator – ***1 point***;
C - proper use of pipette – ***1 point,***
D - loading the whole amount of the sample in the well - ***1 point***;
E - not damaging the gel – ***1 point***.

Note: One power supply is used by 3 - 4 – students, one UV transilluminator is used by 2 students!

Please wear the gloves during laboratory experiment !

Managing of power supplies is the priority of laboratory assistants !

Technical explanation

Theory

Electrophoresis is a widely used analytical method for separation of molecules by their charge, molecular weight and size. Frequently electrophoretical separation is performed in gel media where molecules with similar charges are separated according to their molecular weight and size. The substance, which forms the gel, has to be dissolved in the buffer solution.

Mapping of plasmid DNA

Plasmids are circular extrachromosomal double-stranded DNA molecules, which are found in many bacterial species. Restriction enzymes are nucleases, which cleave DNA at the sites where specific 4 – 6 nucleotide (base) pair (bp) sequences are found; e.g. enzyme called *Hae*III cuts the double stranded DNA at sequence (site) GGCC, but enzyme called *Eco*RI cuts the double stranded DNA at sequence (site) GAATTC.

Plasmid DNA mapping is placing of the restriction enzyme cleavage sites relative to each other on the circular scheme of the plasmid molecule. For this purpose we have to determine the length of DNA fragments produced by cleavage of the plasmid with different restriction enzymes. Plasmid molecules can be cut by one or by multiple restriction enzymes simultaneously. DNA fragments produced at cutting migrate as compact bands, which can be visualised in the gel by staining with specific dyes. The distance, which DNA fragment migrates in the gel during electrophoresis (cm from the start point of the migration till the front edge of the fragment band), is inversely correlated to the logarithm of the length of the fragment as measured in bp. One of the most common gel substances for electrophoresis is agarose. Pores of the agarose gel are large enough for separation of molecules with molecular mass over 100 000 Da.

Equipment

Agarose gel electrophoresis tank

(4, Fig.1). contains two electrodes - cathode (5) and anode (6), respectively. Before electrophoresis the gel is overlaid with buffer solution (7). Samples, which contain the mixture of molecules to be analysed, are loaded in the wells (1), which are formed by special comb during the preparation of the gel (2) on the gel support (3). Before connecting to the power supply the electrophoresis tank is closed with a cover (8).

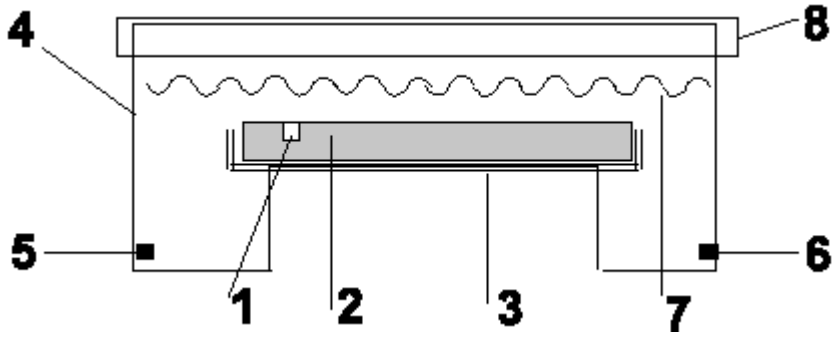


Fig 1. Electrophoresis tank with a gel.

Adjustable volume pipettes are used for handling of liquids (Fig.2).

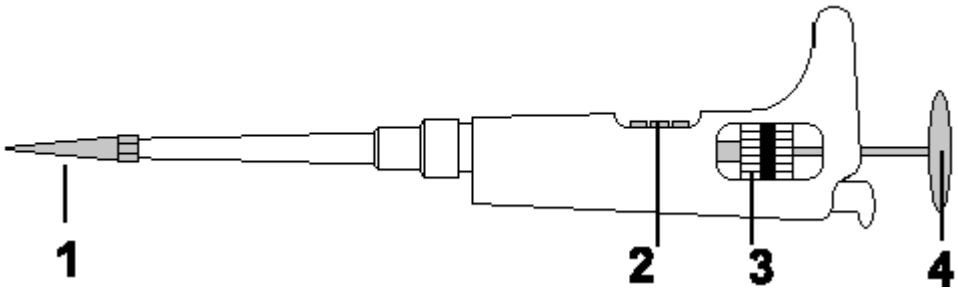


Fig 2. Adjustable volume pipette.

Use of the pipette:

1. By turning of adjustment ring (3) and controlling the volume monitor (2) set the appropriate volume! In this experiment you need to handle two volumes – 5 µl and 10 µl. Correct setting of these volumes on the monitor is shown in Fig. 3.

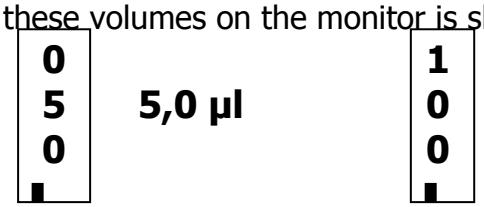


Fig. 3. Correct setting of 5 µl and 10 µl volumes on the monitor of the pipette.

2. Place the yellow tip (1, Fig.2) on the shaft of the pipette.

Do not handle liquid without a tip!

3. Press the button (4,Fig.2) smoothly to the first stop and put the tip in liquid (sample), (Fig.4,A).
4. Slowly release the button to aspirate the sample (Fig. 4 B).
5. Take the tip with the liquid to the target (other drop of liquid or well in the gel) and press the button until collected liquid is completely out of the tip (Fig. 4 C).

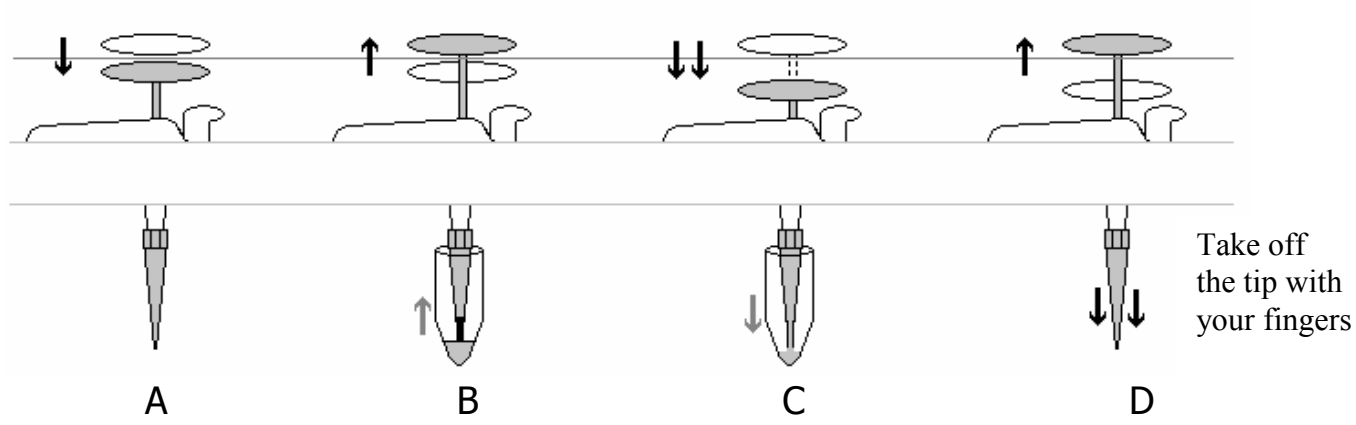
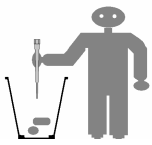


Fig. 4. Steps of liquid handling.

6. Take out pipette from the liquid, release the button (Fig. 4 D) and displace the used tip in the trash, labelled as:



For each solution or sample use a fresh tip!

You can make some trial pipetting attempts with one tip and buffer solution in the tank before starting to handle DNA samples.

Reagents and materials

1. Ready for use 0,8% agarose gel, prepared in 0,5x TAE buffer.
2. Electrophoresis unit, filled with 0,5x TAE buffer (20 mM Tris-acetate, 0,5 mM EDTA, pH=8,0).
3. 2x **GLB** - gel loading buffer, containing 0,05% bromophenol blue in 10% glycerol.
4. **St** - DNA size standard, premixed with loading buffer (more detailed explanation below)
5. **B+C** and **B+D** - 5 µl of plasmid pX DNA each, cleaved with restriction enzymes B + C ; B + D, respectively (detailed explanation see in **"Q2"** below).

To DNA samples fluorescent DNA dye Vistra Green in dilution of 1:10 000 is already added.
For all cleavages DNA of plasmid pX is used. The length of plasmid pX is 4 360 bp.

Experiment (first phase)

Sample loading

1. Load on the gel in each of the wells No.2 and No.5 (Fig. 5) 10 µl of DNA size standard **St.**

2. Add 5 µl of 2x **GLB** to each of cleaved plasmid DNA samples (**B+C** and **B+D**) and load the mix (10 µl) on the gel (**B+C** in the well No.3 and **B+D** in the well No.4, respectively).

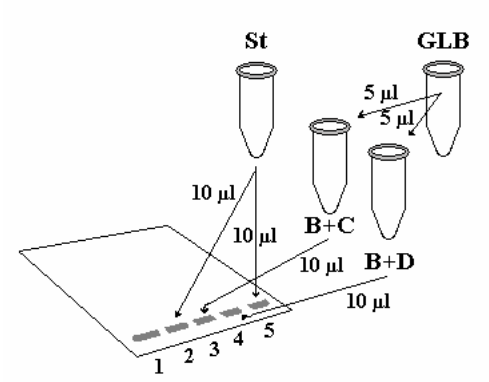


Fig. 5. Sample loading.

3. Close the cover of the electrophoresis unit. **Call the assistant by raising the hand!**

Do not manage power supply; this is the priority of laboratory assistants !

Let the samples run for 20 min. Mind the time, otherwise you lose DNA fragments! Use this time to prepare the answers to the questions below!

Questions (first set, to be answered while the gel runs)

Q1. It is known that in the electrophoresis buffer with pH 8,0 DNA molecules are migrating from cathode to anode.

Give the answers by marking the appropriate boxes **Q1** in the answer list.

- What is the charge of DNA molecules?

A. negative
B. neutral
C. positive
D. Impossible to determine

- Which of the mentioned components is the major determinant of the charge of DNA molecules?

E. purines
F. pyrimidines
G. deoxyriboses
H. phosphate groups
I. hydrogen bonds between the both DNA strands
J. No one of the mentioned

(2 points)

Q2. DNA fragment calculations

Given:

1. The picture of the gel showing electrophoretic separation of DNA size standards and DNA fragments produced by cutting of the plasmid pX with the restriction enzymes A, B, C, D (Fig. 6).
2. Size of the plasmid pX is 4 360 bp (base pairs) and each restriction enzyme (A, B, C, D), cuts the pX DNA at one site (one time) only.
3. The restriction site of enzyme A is taken as the starting point for restriction map of this plasmid.
4. In a combined cleavage with enzymes A and B DNA is cut in two fragments, shorter of which is 380 bp long (see Fig. 7).
5. Length of the DNA fragments in the bands of the DNA size standard (Lane 1, Fig. 6.):
   3 000; 2 000; 1 500; 1 200; 1 031; 900; 800; 700; 600; 500; 400; 300; 200; 100 (in bp)
   Band of 500 bp fragments has elevated width (is darker) in respect to neighbour bands.
   Bands of short DNA fragments (under 500 bp) may be weak or lost from the gel.

Estimate

Q2A. What is the size (bp) DNA fragments marked with the Roman numerals (I-VI) in the DNA size standard Lane 1, Fig.6.? Put the answers in the appropriate cells (I-VI) of the table Q2A in the answer list.

(3 points)

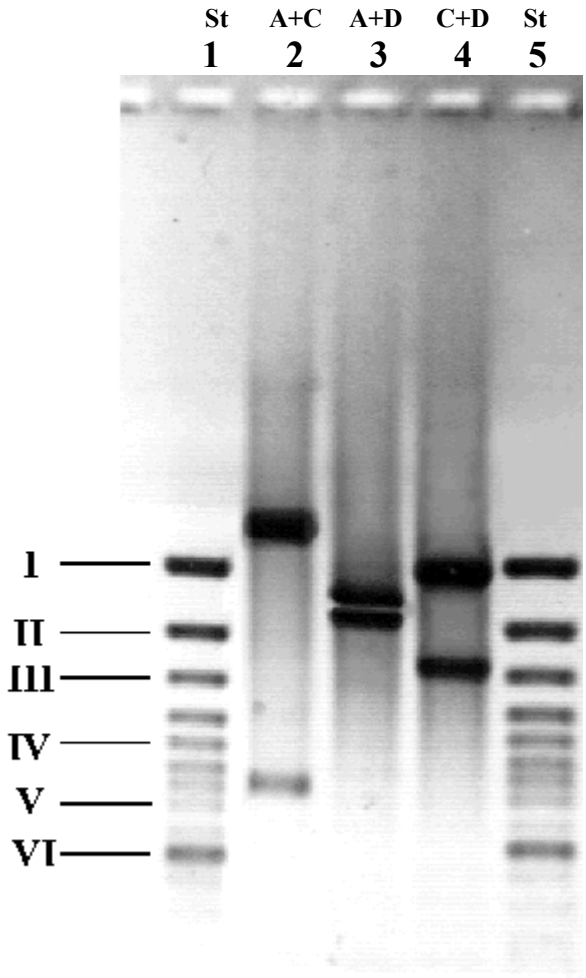


Fig. 6. Electrophoretic separation of plasmid pX cleavage fragments.
Lanes are numbered under the gel, the wells are seen in the upper part.
Lane 1 – DNA fragment length standard
Lane 2 cleavage of plasmid pX with enzymes A + C
Lane 3 cleavage of plasmid pX with enzymes A + D
Lane 4 cleavage of plasmid pX with enzymes C + D
Lane 5 – DNA fragment length standard

Q2B. Plot the distance (cm) migrated by the DNA fragment length standard bands marked with Roman numerals in Fig.6 versus the length of DNA fragments (bp) as determined in your answer Q2A in the co-ordinates Q2B in your answer list. Make the graph using the plotted points
On the X-axis - distance from the well to the front (distant) edge of the band (cm); on the Y axis – length of the DNA fragments (bp). ***(4 points)***

Q2C. Using the graph constructed in paragraph Q2B determine the size (bp) of DNA fragments presented in lanes 2, 3 and 4, Fig.6. Put the answers in the columns 2, 3 and 4 of the table Q2C in the answer list, corresponding the gel lanes 2, 3 and 4, respectively. (Allowed accuracy ±10% of exact value). ***(6 points)***

Q2D. In the sample A+C (Lane 2, Fig.6) after mixing with gel loading buffer DNA concentration was 150 ng/μl (nanograms per microliter), 10 μl were loaded on the gel.

How much DNA (in ng) was loaded on the gel? Put the answers in the column 1 of the table Q2D in the answer list.

How much DNA (in ng) is contained in each of the bands in the lane 2, Fig.6 (A+C) (assuming that all the loaded DNA is distributed between the two bands)? Put the answers in the column 2 (for the band of the largest DNA fragment) and column 3 (for the band of the smallest DNA fragment) of the table Question 2D in the answer list. (Allowed accuracy ±10%). ***(6 points)***

If you still have time until the gel is ready, you can start considering the possible location of cutting sites for the restriction enzymes C and D in the plasmid map (Fig. 7). Use the results from the answer to Q2C!

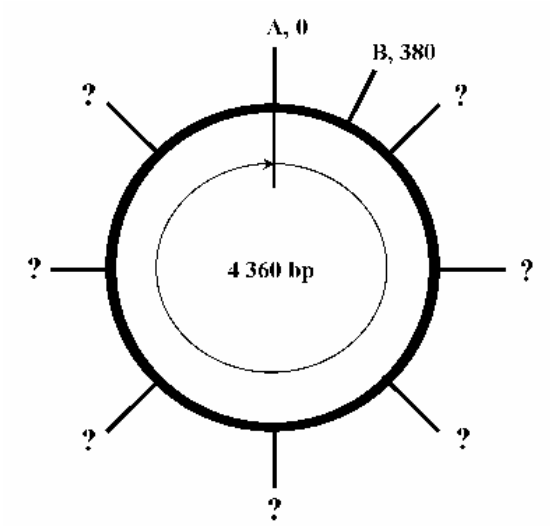


Fig. 7

Experiment (second phase)

20 minutes after the beginning of electrophoresis the assistant will disconnect your electrophoresis tank from the power supply. Do not hesitate to remind the time to the lab assistant!

Thereafter:

1. Place the gel together with the gel support in a tray and take them to the UV transilluminator, the number of which is indicated at your working place.
2. Pick up the protecting shield of the transilluminator.
3. Place the gel on the UV table.
4. Close the protecting shield and switch on UV light.

Do not switch on the UV transilluminator, while the protecting shield is open !

Do not lift the protecting shield while the UV light is on !

5. Observe the image of DNA bands and draw the pattern of bands in the frame given in the answer list **Q3**. DNA bands in your picture must be positioned relative to the DNA size standard precisely as in your gel!
(4 points)

6. Switch off the UV light and leave the gel together with gel support at the transilluminator.

7. Clean the hands with paper towel and continue preparing your answers.

Questions (second set, to be answered after the recording the fragment separation in the gel)

Q 4 A. Determine the approximate fragment length of cut DNA, comparing the position of the bands of samples with the bands of DNA size standard. Put the answers in the answer list; table Q4A, columns 3 and 4, corresponding the lanes 3 and 4, respectively. (Allowed accuracy ±20%).
(4 points)

Q 4 B. Considering the analysis of the gel depicted in Fig.6 and the data obtained from your own gel, determine the approximate positions of the cutting sites of the enzymes C and D at the plasmid map (Q4B, answer list) by writing the letters (C, D) in appropriate boxes. ***(6 points)***

4.1.4. Laboratory IV – Dendroecology

Growth of aspen (*Populus tremula*) invading a clear cut (previously spruce) by seed.
Length of the practical test – 60 minutes; 40 points

Materials and instruments

You will need the instrument set that you received upon registering for the 13th IBO!
Other materials:
A data sheet. The data sheet is identical to the answer sheet with tables, only with some of the columns (Table 1) and rows (Table 2) filled in. THIS DATA SHOULD BE COPIED ONTO THE ANSWER SHEETS. DO NOT WRITE ON THE DATA SHEETS.
10 labelled discs of aspen. DO NOT MAKE ANY MARKS ON THE DISCS
one measuring tape
one ruler
one magnifying glass

Introduction

Aspen has invaded an open area created by a clear cut harvest of a spruce forest. Not all of the trees established in the same year, but over a 8-year period. Now, 18 years after the start of development of the new forest stand, the vertical and radial growth of aspen will be investigated by retrospective analysis. Tree rings can be used to measure the tree stem diameter at different tree ages.

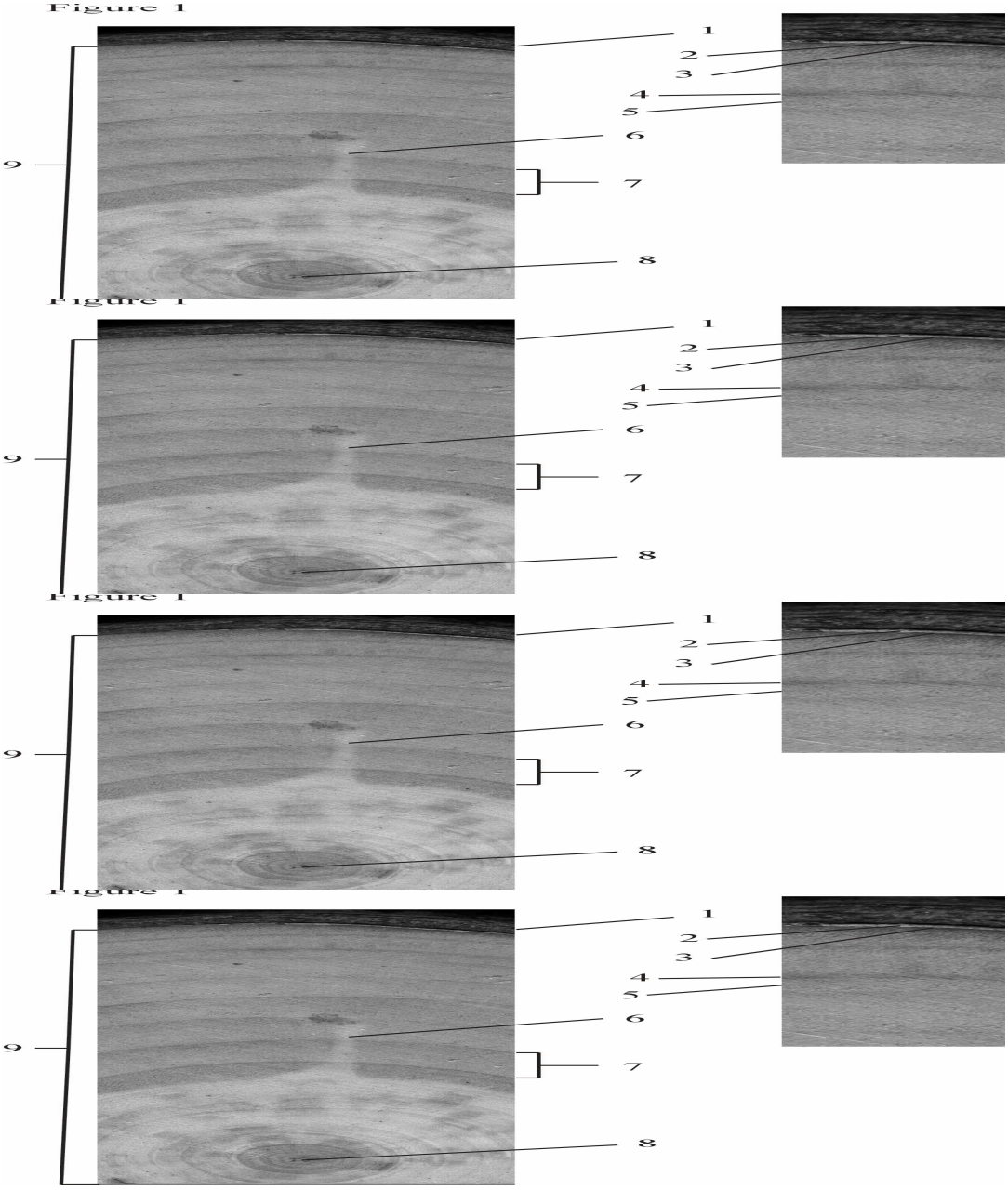
Q1. In the following photograph (Figure 1) of a cross-section of an aspen stem, identify the following, by writing the respective number from the Figure in the answer sheet!

Code Table

A.	bark
B.	pith
C.	latewood
D.	earlywood
E.	meristem
F.	annual ring
G.	branch
H.	vascular cambium
I.	phloem cells
J.	xylem cells
K.	cork cells

(11 points)

Figure 1



The growth of aspen stems in the area will be used to determine response to possible intraspecific competition. It is assumed that the effect of competition increases with time, because tree density increases and the trees increase in size.

Q2. For a tree species, not necessarily aspen, what are the **possible** effects of intraspecific competition for light resources:
1. increased mortality rate over time,
2. decreased yearly growth increment in height of stems
3. increased variability among stems of yearly growth increment in height
4. decreased yearly growth increment in diameter of stems
5. increased variability among stems in yearly growth increment in diameter
6. accelerated yearly growth increment in height of stems in response to shading by neighbours

Which of the following is the correct combination of correct answers? Enter your choice in the answer sheet!
A. 1, 2, 4
B. 1, 3, 5
C. 1, 2, 4, 6
D. all of the above
E. 1, 2, 3, 4, 5

(1 point)

The purpose of this practical work is to determine whether radial and/or vertical growth of aspen is related to time of invasion of aspen individuals. In other words, since the time of invasion can be determined by estimating the age of stems, does the growth depend on the age of the individual?

Methods and Results
Within a forest plot (20mX20m), all trees growing were cut at tree base, labelled and stem height was measured. Each student is supplied with 10 segments cut at stem base, which were randomly sampled in the plots. Each stem is labelled, and the height of these stems in metres is provided beside the appropriate tree ring code in **Table 1** of the data sheets. **Copy the codes and the heights onto the answer sheets.**

T1. **Fill in the** Table 1**!**

- Count the number of tree rings of each segment, and enter this data in Table 1 of the answer sheets! ***(2 points)***

NOTE: Since determination of the first few tree rings is difficult due to rot, the first five tree rings developed have been determined under a dissecting microscope, and the position marking the end of five years is marked on each stem. Therefore, you need only to count the rings developed after this mark, and then add 5 years.

- As none of the cut segments are perfectly round (the radial growth differs depending on compass direction), the mean diameter will be estimated by calculation from the perimeter. Using the cloth tape provided, measure the perimeter of each stem, and enter this data in **Table 1** of the answer sheet! ***(2 points)***
- Using the appropriate formula, use the perimeter measurements to calculate the mean diameter, and enter this data in **Table 1** of the answer sheet! ***(1 point)***

- Using the ruler provided, measure the total width of the first five tree rings (from the centre to the mark on the segment) and enter this data in **Table 1** of the answer sheet! ***(1 point)***

- Using the ruler provided, measure the last five tree rings (at the location of the maximum diameter (marked by the line), and enter this data in **Table 1** of the answer sheet! ***(1 point)***

G1. Using the graph paper supplied in the answer sheet, produce scatter plot for **Graph 1.** - Stem age versus height ***(2 points)***

G2. Using the graph paper supplied in the answer sheet, produce scatter plot for **Graph 2.** - Stem tree age versus diameter ***(2 points)***

G3. Using the graph paper supplied in the answer sheet, produce scatter plot for **Graph 3.** - Stem age versus width of first produced five tree rings ***(2 points)***

G4. Using the graph paper supplied in the answer sheet, produce scatter plot for **Graph 4.** - Stem age versus width of the last five produced tree rings. ***(2 points)***
Remember to label the axes with the appropriate scales.

G5. As the graph of stem age versus height appears to indicate a linear relationship, calculate the linear regression equation (best-fit line through the points) using the Tables provided (**Table 1** and **Table 2**) and draw the calculated best-fit line on the appropriate graph ***(1 point)***

NOTE: **In the data sheet supplied, you have been given the correct values of the sum of squared ages (ΣXi^2) and the value of the sum of age times**

height (ΣXi*Yi). Therefore, you do not need to calculate these. ENTER THESE FROM THE DATA SHEET ONTO THE ANSWER SHEET.

T2. Completely fill in **Table 2** on the answer sheets ***(8 points)***

Check that **Table 1** is completely filled in.

Discussion

Q3. The **Graphs** that you have produced suggest that intraspecific competition has resulted in:

1. reduced height of shaded individuals
2. reduced diameter of shaded individuals
3. reduced stem structural support of shaded individuals
4. increased variability in height of individuals of the same age
5. Increased variability in diameter of individuals of the same age

Which of the following is the correct combination of correct answers?

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

(1 point)

Q4. Which of the following comments are suggested by the **Graphs** that you have produced?

1. The reduced growth of individuals invading the clear cut later suggests that aspen has a stress-tolerant growth strategy.
2. The **Graphs** suggest a certain competitive ability, because late-coming stems are able to maintain the same growth rate in height as the stems which arrived earlier, indicated by the linear relationship between age and height.
3. In combination, the **Graphs** suggest that there will be potentially increased mortality of the individuals invading the stand later.
4. The **Graph 4** suggests that the growth strategy of aspen appears to be a ruderal strategy: rapid growth early in succession, taking advantage of available resources

Which of the following is the correct combination of correct answers?

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

(1 point)

Q5. Which of the following comments are suggested by **Graphs 3 and 4**?

1. The **Graphs** show that the effect of competition increases with time after clearcut.
2. Only the trees arriving on the site during the first few years (but not necessarily all of these individuals) have been able to support a high radial growth rate during the last few years prior to cutting.
3. Differences in the amount of shading in the occupied patches may be a reason for the high variability in **Graph 3**.
4. Graphs 3 and 4 probably reflect linear relationships that are hidden by high variability.

Which of the following is the correct combination of correct answers?

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

(1 point)

Q6. Which of the following problems clearly need to be considered, as they can affect the results shown in the **Graphs**?

1. The annual growth increment in tree ring width is related to the current stem diameter. For this reason, calculation of the relative growth rate (RGR) would have less bias.
2. Differences in the growth of the different stems should also be assessed in relation to differences in meteorological conditions during the years after the clear cut.
3. Biotic factors such as herbivory (insects, deer, moose which do occur in the area) and disease may have caused death or damage to a particular age class of stems, biasing the results.
4. The sample size is too low for conclusive results.

Which of the following is the correct combination of correct answers?
A. None of the comments are true
B. All of the comments are true
C. Only 1 and 4 are true
D. Only 2, 3, and 4 are true
E. Only 2 and 3 are true

(1 point)

4.2. Theoretical tasks

We want to thank all the countries, which sent the proposal tasks for the 13th IBO on time. The local Scientific Task Committee especially liked the tasks sent by India, Belarus and Vietnam. It was a pity that we got some tasks too late and some countries didn't send tasks at all. Local specialists made changes in some questions, too.

During the coordinating meeting in Prague, we were asked to make Theoretical Part A shorter and to prepare as questions as possible for Theoretical Part B. This is because the multiple choice questions apparently better test the knowledge of students. We tried to do this. The total number of questions in Part A and maximum possible score was 75. We prepared 42 questions for part B. The total score for Part B was 119. During the Jury sessions, we had long discussions on Part B, especially about the correct answers. For some questions, additional possible correct answers were allowed.

Some questions where skipped. They were mostly the same about which the local jury had long discussions already before the 13th IBO.

Theoretical test

YOU HAVE FOUR HOURS TO ANSWER ALL THE QUESTIONS

Questions in part A **have only one correct answer which should be shown by marking (blacking out) the appropriate field in the answer list.**

You' ll get one point for every correct answer in part **A**
For questions in part **B** you'll have to fill in the correct answers in the appropriate fields,
build graphs, etc.
The number of points you'll get for the part **B** questions varies, depending on the complexity of the question

GOOD LUCK !

4.2.1. Theoretical test Part A

Find the one correct answer in each task and mark it **in the answer sheet** in this way:

The jury will check only the answer sheet! 

Cell Biology

A1. In which processes microtubules could be involved?

	Beating of cilia and flagella	**Movements of chromatids**	**Osmoregulation**	**Movement of organelles in living cells**
A.	+	+	+	-
B.	+	-	-	-
C.	+	+	-	+
D.	-	-	+	-
E.	-	+	+	+

A2. Which of the following is an example of microfilament motion in nonmuscular animal cells?

A. Rigor mortis
B. Flagellar movement
C. Cytokinesis
D. Chromosome movement during meiosis
E. Beating of cilia

A3. When or where it is possible to observe nucleolus?

A. During meiosis
B. In senescent plant cells
C. During apoptosis
D. In senescent animal cells
E. During the elongation of plant cells

A5. Which statement about actin microfilaments is correct?

A. They are found only in animal muscle cells and involved in the contractions of sacromeres
B. They are involved in the formation of the cell cleavage furrow in plant and animal cells
C. They are found only in plant cells and involved in the movement of chloroplasts
D. They are found in plant and animal cells and involved in the movement of vesicles
E. They are found in all eukaryotic cells and involved in the movement of pyruvate from cytosol to mitochondrial matrix

A6. Which statement about genetic material is **incorrect**?
A. There are viruses possessing genomes, built of RNA
B. There are cell organelles possessing their own RNA genomes
C. In the cells of bacteria genetic material may persist in extrachromosomal form
D. Genetic material of eukaryotes is made of DNA
E. Admission of foreign DNA in a cell is not necessarily lethal for the cell, especially in the case of eukaryotic cell

A7. Which of the following is **not** the metabolic role of tricarboxylic acid (TCA) cycle?
A. Completion of carbohydrates oxidation
B. Supply of metabolic precursors for biosynthesis of some amino acids
C. Supply NADH for the respiratory chain
D. Supply NADPH for biosynthetic reactions
E. Production ATP or GTP

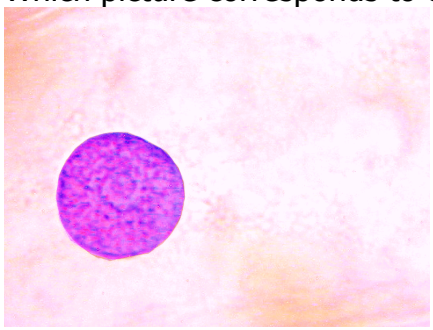
A8. Which statement about the chemiosmotic theory is **not** correct?
A. While electrons in the electron transport chain are passing through the transporters located on the inner membrane of mitochondria, protons are pumped out of the matrix by the respiratory complexes I, III and IV
B. This theory explains coupling between oxidation and phosphorylation
C. The protons return to the mitochondrial matrix through the proton-dependent ATP synthase
D. This theory is valid for forming of ATP in photosynthetic electron transport chains
E. The respiratory proton transport is driven by conformational oscillations of the energy-coupling membrane bilayer

A9. Which three amino acids can be formed directly in one step from the following metabolic intermediates: pyruvate, oxaloacetate and α-ketoglutarate ?

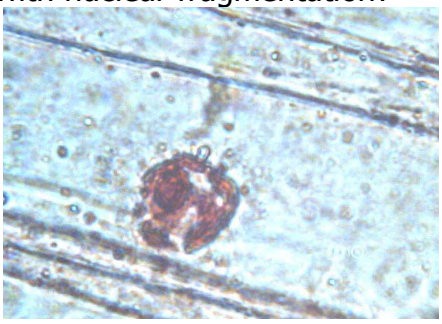
	Pyruvate	**Oxaloacetate**	**α-ketoglutarate**
A.	Alanine	Aspartate	Glutamate
B.	Lysine	Asparagine	Glutamine
C.	Serine	Arginine	Tyrosine
D.	Threonine	Glycine	Tryptophan
E.	Histidine	Proline	Leucine

A 10. How many different primary structures approximately may represent a 10 residues long polypeptide, which is a random combination of 20 naturally occurring amino acids?
A. 10
B. 200
C. 40 00
D. 10 000 000 000 000
E. 100 000 000 000 000 000 000

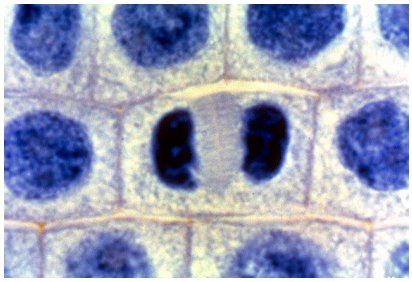
A 11. Apoptotic cell undergoes a series of changes including membrane blebbing, fragmentation of DNA creating a vacuolar nucleus and following fragmentation of nucleus forming micronuclei. Researchers used onion cells to study the cell death. Which picture corresponds to cell with nuclear fragmentation?



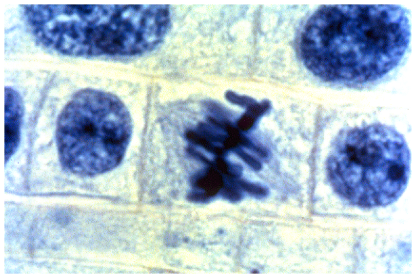
A



B



C



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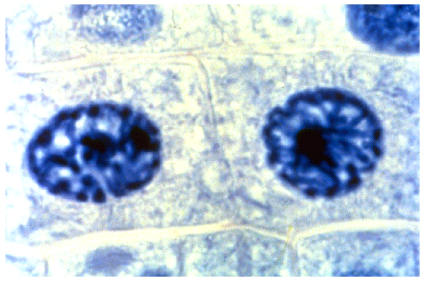


E

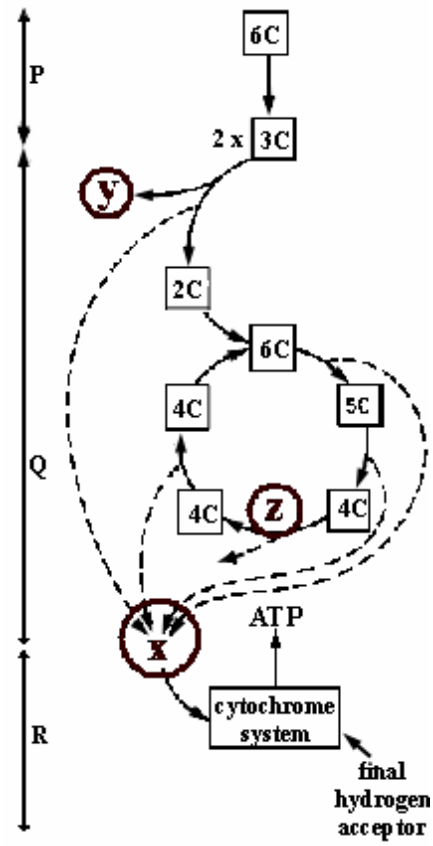
A 12. What is the correct sequence of events during immunological responses to viral infection?

Code

1. Natural killer cell activation
2. Antibody production
3. Cytotoxic T cell activation
4. Virus invasion

Time →

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



A 13. The diagram shows a simplified scheme of three stages (P, Q and R) of aerobic respiration. What substances are X, Y, Z?

	X	**Y**	**Z**
A.	Acetyl CoA	$NADH_2$	Lactic acid
B.	Water	CO_2	Dehydrogenase
C.	$NADH_2$	CO_2	Dehydrogenase
D.	$NADH_2$	Water	Peroxidase
E.	Pyruvate	CO_2	$NADH_2$

A 14. Some genes in the genome of bacteria are organised in operons. Which statement about such operons is correct?

A. Genes of the operon are arranged in mosaic structures of introns and exons
B. Translation of all genes of one operon starts at the same initiation codon
C. All genes of the same operon are not expressed simultaneously
D. Proteins encoded in the genes of the same operon are translated from one common mRNA molecule
E. Translation of all genes from the same operon is terminated at the same common STOP codon

A 15. Which of the given components is **not** needed for DNA replication *in vivo*?

A. Single stranded DNA template
B. Deoxy-nucleoside monophosphates (dAMP, dCMP, dGMP, dTMP)
C. RNA polymerase – primase
D. Single-strand DNA binding proteins
E. DNA polymerase

A 16. For numerous groups of organisms genes are split in exons and introns. Which statement about gene expression is correct?
A. The genetic information of only some introns is used for synthesis of proteins
B. A separate promoter induces the transcription of each exon
C. During RNA processing the sequences of introns are removed as a result of splicing of the pre-mRNA
D. Translation of each exon starts with its own initiation codon (AUG)
E. During the translation ribosomes are jumping over the intronic part of mRNA

A 17. Human hormone insulin is synthesised as pre-protein and modified before secretion in extracellular space. It contains two polypeptide chains. Which statement about these chains is correct?
A. They are synthesised on cytosolic ribosomes and modified in Golgi apparatus
B. They are synthesised on ER ribosomes and modified in Golgi apparatus
C. One chain is synthesised on cytosolic ribosomes, another on ER ribosomes and modified in cytosol and Golgi apparatus
D. They are synthesised on cytosolic ribosomes and modified in the lumen of lysosomes
E. They are synthesised on cytosolic ribosomes and modified in cytosol

A 18. Which statement regarding the amount of genomic DNA per cell (M) during the cell cycle is correct?
A. $M_{DNA}[G_1] = M_{DNA}[_{\text{meiosis prophase II}}]$
B. $M_{DNA}[_{\text{meiosis prophase II}}] = 2 \times M_{DNA[\text{meiosis prophase I}}]$
C. $M_{DNA}[G_1] = M_{DNA}[G_2]$
D. $M_{DNA}[G_{2\ \text{after mitosis}}] < M_{DNA}[G_{2\ \text{after meiosis}}]$
E. $M_{DNA}[_{\text{telophase of mitosis}}] > M_{DNA[\text{telophase I of meiosis}}]$

Plant Anatomy and Physiology

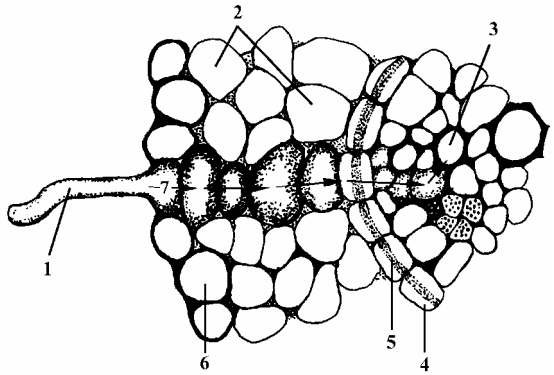
A 19. Which of the following is closer to the centre of a woody stem?
A. Vascular cambium
B. Primary phloem
C. Secondary phloem
D. Secondary xylem
E. Primary xylem

A 20. Carnivorous plants trap insects. What do they obtain from the insects? What do they primarily use this substance for?
A. They obtain water, because they live in a dry environment
B. They obtain nitrogen to make sugar
C. They obtain phosphorus to make protein
D. They obtain sugars, because they can't produce enough in photosynthesis
E. They obtain nitrogen to make protein

A 21. The diameter of woody stems is continually increasing. What structure ensures that there is always enough bark to cover the outside of the stem?

A. Vascular cambium
B. Epidermis
C. Phellogen
D. Endodermis
E. Pericycle

A 22. The drawing shows s cross - section of a plant root. The lines (1-6) indicate parts and the arrow (7) indicates a pathway in the root. Which of the statements (A-E) provides a correct explanation of the drawing?



A. 1 – trichome, 2 – cortex, 3 – phloem, 4 – pericycle, 5 – endodermis, 6 – epidermis,
7– pathway of water and sugars
B. 1 - root hair, 2 – cortex, 3 – xylem, 4 – endodermis, 5 – Casparian strip, 6 - epidermis,
7 – pathway of water and minerals
C. 1 - root hair, 2 – cortex, 3 – xylem, 4 – Casparian strip, 5 -pericycle, 6 – epidermis,
7 – pathway of water and minerals
D. 1 – root hair, 2 – periderm, 3 – phloem, 4 – endodermis, 5 – Casparian strip,
6 – epidermis, 7 – pathway of phytohormones
E. 1 – root hair, 2 – endodermis, 3 – xylem, 4 – epidermis, 5 – Casparian strip, 6 - periderm, 7 – pathway of water and minerals

A 23. Which cell is **incorrectly** paired with its tissue?
A. Root hair – dermal tissue
B. Palisade parenchyma – ground tissue
C. Guard cell – dermal tissue
D. Companion cell – excretory tissue
E. Tracheid – vascular tissue

A 25. A plant biochemist received a specimen from a fellow scientist who noticed that the plant's stomates are closed during the day. The biochemist observed that radioactive carbon in the form of carbon dioxide, fed to the plant at night, was first found in organic acids that accumulate in the vacuole. During the day it moved to sugars being manufactured in the chloroplast. What was the conclusion of the biochemist?
A. The plant fixes carbon by crassulacean acid metabolism (CAM)
B. The plant is a C4 plant
C. The plant is a C3 plant
D. The plant is using mitochondria as chloroplasts
E. The carbon fixation reactions occur in different cells

A 26. Red algae grow at depths beyond those to which red and blue light can penetrate in the ocean. What could account for this?
A. Red algae have accessory pigments that absorb wavelengths of light available at these depths
B. Red algae use infrared energy to power photosynthesis
C. Red algae have a more efficient light-absorbing system for red and blue light
D. Red algae are heterotroph organisms
E. The "red algae" must be identified incorrectly

A. 27. Sections are cut from a willow branch and planted in pots of soil in a greenhouse with the shoot end of the section exposed and the root end in the soil. Roots sprout from the root end and shoots sprout from the shoot end. Which statement about the sections is true?
A. The sections lacks the property of polarity
B. The concentration of auxin in the sections is the same in all their length
C. The root end will produce shoots
D. Dedifferentiation will be the first step in the process of root and shoot formation
E. The root end has special structures forming roots which the shoot ends lack

A 28. Plants have developed many adaptations to maximize the benefits of available water. Which of the following is one of these adaptations?
A. Reorientation of leaves in order to increase leaf temperature
B. Decreasing the amount of water lost for each gram of fixed carbon
C. Increasing the leaf surface area
D. Decreasing the thickness of the cuticle
E. Growing more leaves during drought

A 29. You need pears for a large party after three days but they are not ripe enough to use. What is the best way to hasten the ripening process?
A. To place the pears in the dark
B. To place the pears in a refrigerator
C. To place the pears on the windowsill
D. To place the pears in brown paper bags together with ripe apples

Animal Anatomy and Physiology

A 30. Which statements concerning human respiratory muscles are true?
1. During inspiration, the external intercostal muscles contract and the diaphragm moves downwards
2. Internal and external intercostal muscles act in inspiration, and the diaphragm acts only in expiration
3. During inspiration, only the internal intercostal muscles contract and the diaphragm moves downwards
4. During expiration external intercostal muscles contract and the diaphragm moves downwards
5. During gentle expiration, the thorax passively contracts, and then deep expiration can be finished by contraction of the internal intercostal muscles
6. During inspiration, the internal intercostal muscles contracts and then strong inspiration can be finished when the diaphragm moves upwards

A. 2 and 4
B. 1 and 5
C. 4 and 6
D. 3 and 5
E. 2 is the only correct answer

A 31. Which of the following are characteristics for animals with an open circulatory system?
A. Haemoglobin, haemocoel, lymph
B. Haemocyanin, haemocoel, haemolymph
C. Haemoglobin, absence of haemocoel, haemolymph
D. Haemocyanin, absence of haemocoel, lymph
E. Haemocyanin, haemocoel, lymph

A 32. Which metabolic changes in the cytoplasm of skeletal muscle cells are characteristic of skeletal muscle fatigue?
1. Increase of creatine phosphate concentration
2. Decrease in the amount of glycogen
3. Increase of H+ - ion concentration
4. Increase of ATP concentration
5. Decrease in lactate concentration

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

A 33. Which of the following is characteristic for a physically trained person in comparison with an untrained person?
A. The heart rate can reach a higher level
B. Stroke volume is greater
C. The activity of vagus nerve (*nervus vagus*) is lower
D. Mechanical resistance of blood vessels is higher
E. Left ventricular and diastolic volume is smaller

A 34. Which statements regarding the differences of a compound eye compared with a vertebrate's eye is **not** correct?
1. Has chromatic aberration
2. The absorption of ultra-violet radiation is lesser
3. Acuity of vision (visus) is lesser
4. The ability to detect movement is lesser
5. The visual field is wider

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

A 35. Which statement concerning a laboratory animal (white mouse) that lacks a thymus gland congenitally is true?
A. Cellular immunity does not develop and the antibody synthesis is impaired
B. Only humoral immunity does not develop
C. Only cellular immunity does not develop
D. The immune system is not affected
E. This animal is resistant to viral infections but sensitive to bacterial infections

A 36. The numbers in the first column correspond to human, elephant, bat, mouse and carp. Which number indicates each organism?

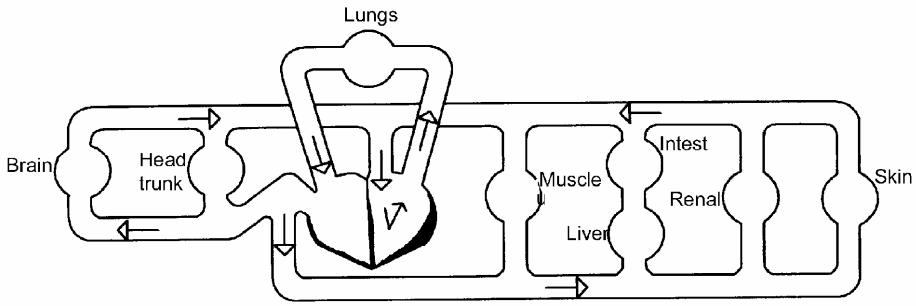
	Body	**Heart rate**	**Maximal speed**

Number	temperature (°C)	(beats/min)	of locomotion (m/s)
1	1-30	30-40	1.5
2	38	450-550	3.5
3	31	500-660	14
4	36.2	22-28	11
5	36.6	60-90	10

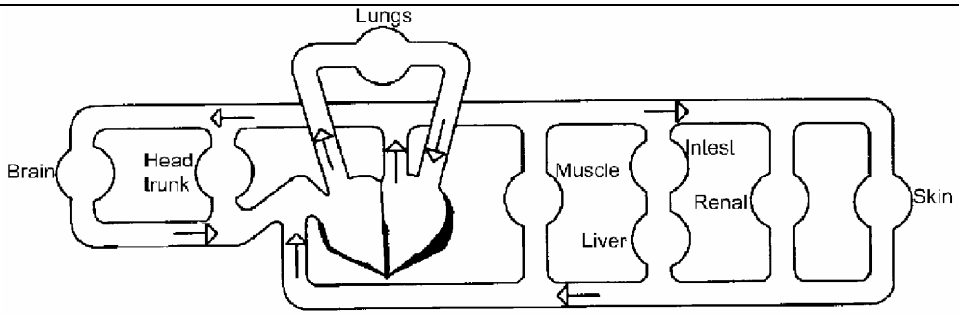
	1	2	3	4	5
A.	Human	Elephant	Bat	Mouse	Carp
B.	Mouse	Bat	Elephant	Human	Carp
C.	Carp	Mouse	Bat	Elephant	Human
D.	Carp	Mouse	Elephant	Bat	Human
E.	Bat	Mouse	Carp	Human	Elephant

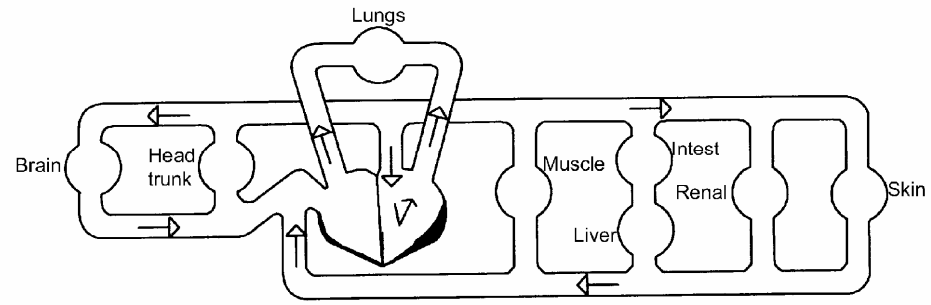
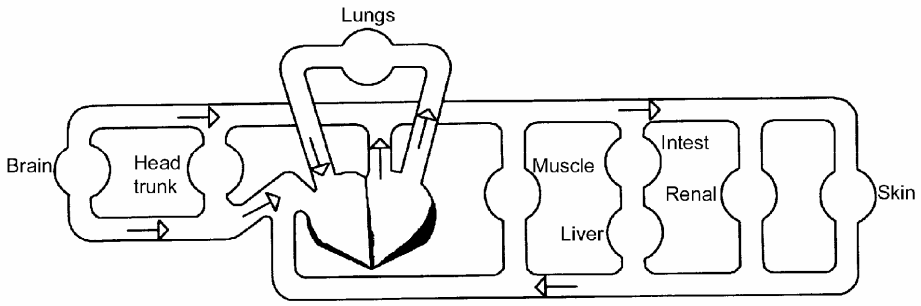
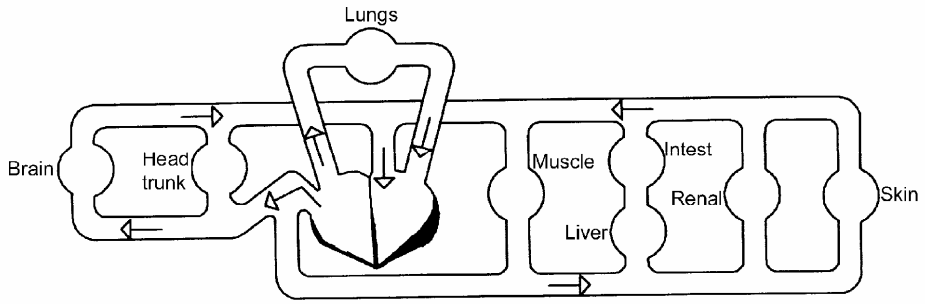
A 38. Which figure shows the correct blood flow direction in a human?

A.

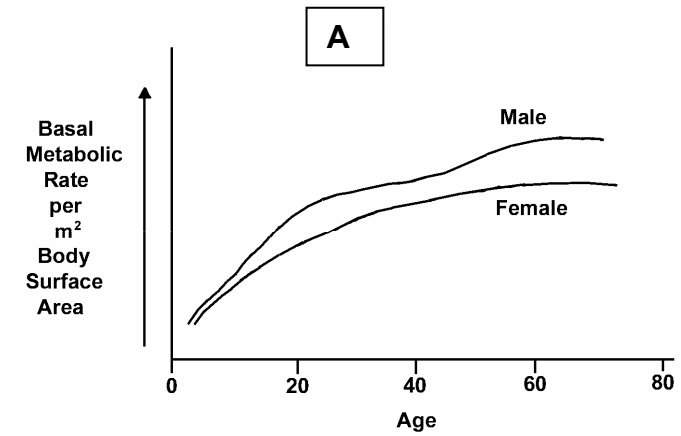


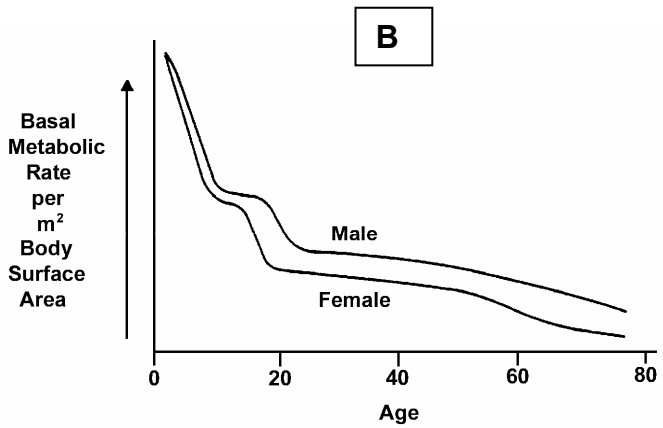
B.

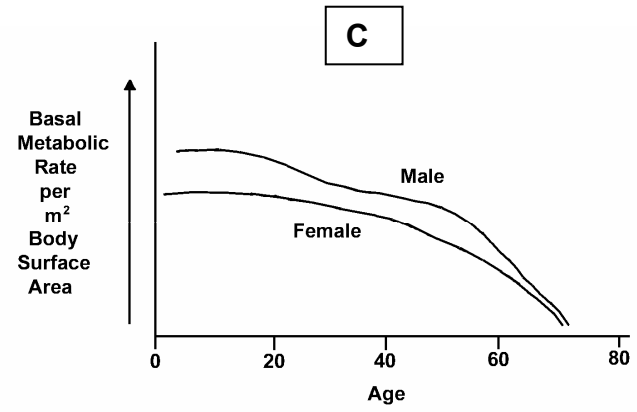


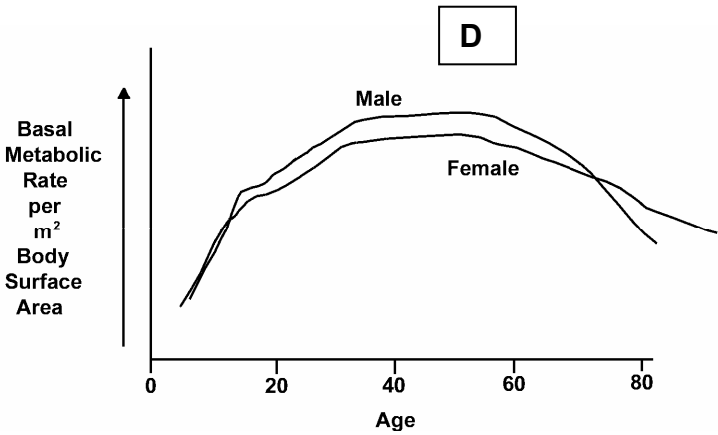
C.	 Lungs Brain Head trunk Muscle Intest Renal Liver Skin
D.	 Lungs Brain Head trunk Muscle Intest Renal Liver Skin
E.	 Lungs Brain Head trunk Muscle Intest Renal Liver Skin

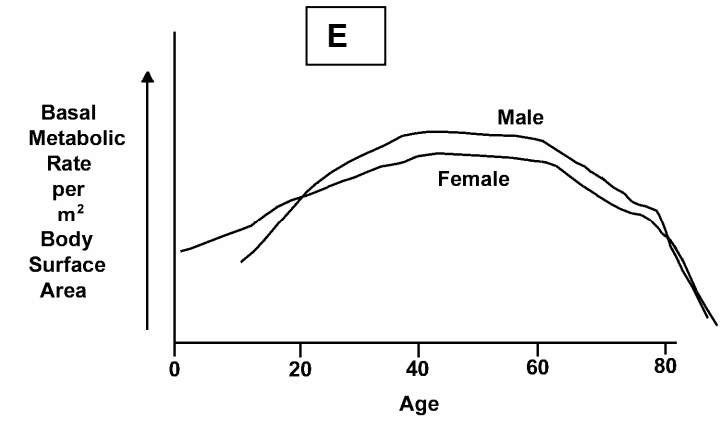
A 39. Which of the figures shows the correct relations between basal metabolic rate per m^2 body surface area and age (in years) of human male and females?



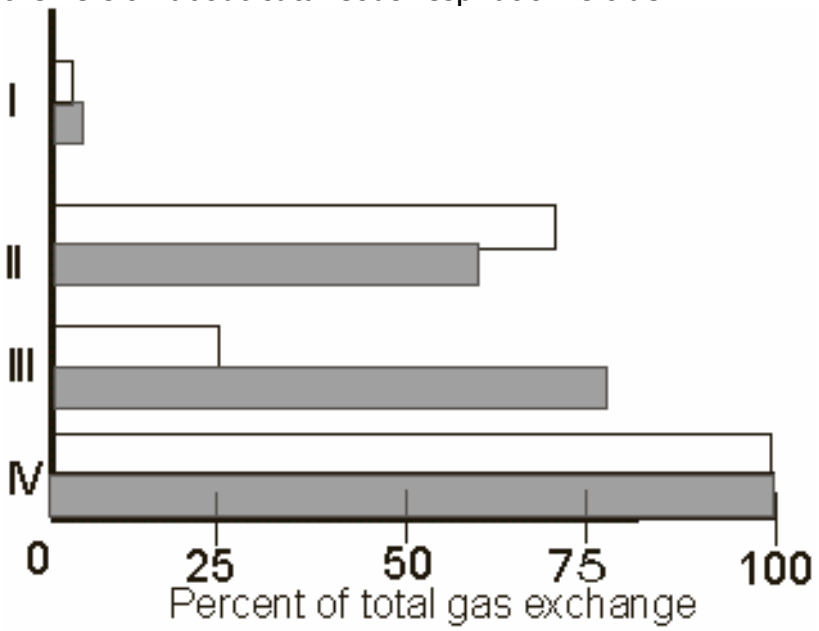








A 40. The Figure shows cutaneous respiration among different vertebrates: excretion of carbon dioxide (solid bars) and uptake of oxygen (open bars). Which of the version about cutaneous respiration is true?



Bullfrog (larva)
Rana catesbeiana

Bullfrog (adult)
Rana catesbeiana

Lungless salamander
Ensatina eschscholtzii

Human
Homo sapiens

	I	II	III	IV
A.	Bullfrog (larva)	Bullfrog (adult)	Lungless salamander	Human
B.	Human	Bullfrog (adult)	Bullfrog (larva)	Lungless salamander
C.	Lungless salamander	Bullfrog (larva)	Bullfrog (adult)	Human
D.	Bullfrog (adult)	Bullfrog (larva)	Lungless salamander	Human
E.	Bullfrog (adult)	Human	Bullfrog (larva)	Lungless salamander

Ethology

A 41. Fixed action patterns (FAPs) are important components of behaviour. Which statement about the fixed action patterns is **not** true?
A. They are highly stereotypical, instinctive behaviours
B. FAPs are triggered by sign stimuli in the environment, and once begun, are continued to completion
C. A supernormal stimulus often produces a stronger response
D. FAPs diminish the adaptive significance of behaviour
E. FAPs are often released by one or two simple cues associated with the relevant object in an organism

A 42. Which feature correctly describes the return of salmon to their native stream to spawn?
A. Insight
B. Olfactory imprinting
C. Habituation
D. Classic conditioning
E. Positive taxis

A 43. Why did psychologists fail in teaching chimpanzees to talk like humans?
A. Chimpanzees have a different location and structure of larynx
B. They have weakly developed cerebrum
C. They have thin tongue
D. They have too large teeth
E. They have bad memory

A 44. Why do territorial birds, which are territory owners tend to win when they meet intruder birds?
A. They are more aggressive and better fighters
B. They have more to gain from a fight and so they are prepared to fight harder. The higher benefit associated with territory, the harder they fight for it
C. Ownership is simply a conventional settlement
D. Owners always have a larger body size
E. Both A and D are correct answers

Genetics and evolution

A 45. What is the probability for exactly three children to have a dominant phenotype in a family with four children of heterozygous parents (Aa x Aa)?
A. 42%
B. 56%
C. 36%
D. 44%
E. 60%

A 46. Mouse hair colour is determined by two unlinked loci – **C** and **B**. Mice with genotype **CC** or **Cc** are agouti, and with genotype **cc**-albino because pigment production in hair is blocked. At the second locus, the **B** allele is dominant to the **b,** and the **B** allele determines black agouti coat colour, but **b** - brown agouti coat colour.
A mouse with a black agouti coat is mated with an albino mouse of genotype **bbcc**. Half of the offspring were albino, one quarter - black agouti, and one quarter were brown agouti. What was the genotype of the black parent?

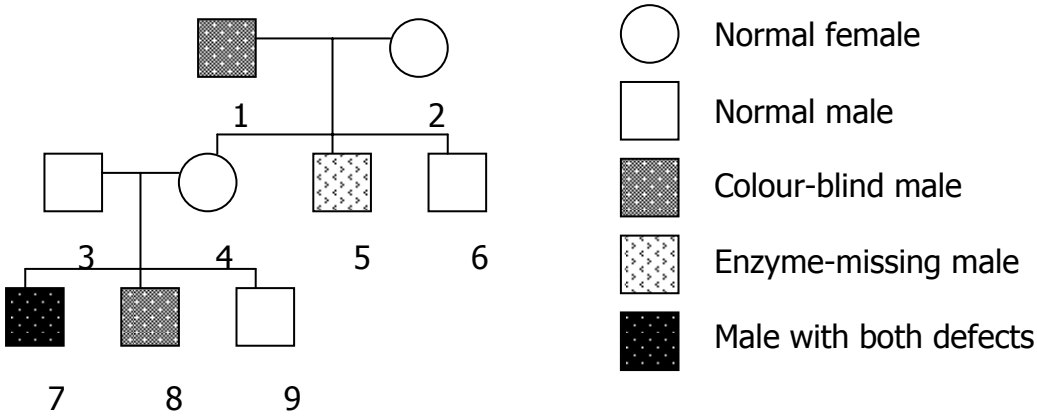
A. BBCC
B. BbCc
C. BbCC
D. Bbcc
E. BBcc

A 47. After graduation, you and 19 friends (sex ratio close 1:1) build a raft, sail to a deserted island, and start a new population, totally isolated from the world. Two of your friends carry (that is, are heterozygous for) the recessive **c** allele, which in homozygotes causes cystic fibrosis.
What will be the incidence of cystic fibrosis on your island, if you assume that the frequency of this allele does not change during the growth of population?
A. 0.05 %
B. 0.0025 %
C. 0.25 %
D. 0.5 %
E. 0.10 %

A 48. Suppose that allele **b** is sex-linked (located on X chromosome), recessive and lethal. It kills the zygote or embryo. A man marries a woman who is heterozygous for this gene. What would be the predicted sex ratio of the children of this couple if they have many children?

	Girls		**Boys**
A.	1	:	1
B.	2	:	0
C.	3	:	1
D.	3	:	2
E.	2	:	1

A 49. Two X-linked genetic defects have been studied by genealogical method (family history): colour blindness and deficiency of certain enzyme in red blood cells. The pedigree shows the results.



Which individual (-s) show (-s) that crossing over has occurred?

A. 8 and 9
B. 1
C. 7 and 8
D. 7 and 9
E. 5

A 50. Which statement about the meiotic behaviour of chromosomes in a translocation
heterozygote is true?

A. Only adjacent chromosomal segregations yield viable gametes
B. Chromosomes form a cross-shaped structure during prophase I
C. All gametes produced by a translocation heterozygote are non-viable
D. All gametes produced by a translocation heterozygote contain either duplications or deletions
E. The correct answers are A and D

A 51. Dihybrid crosses between tall, spherical seeded plants and short, dented-seeded plants in the F_1 generation produced only tall, spherical seeded plants. A testcross of F_1 hybrids with short, dented-seeded plants produced many more tall, spherical seeded plants and short, dented-seeded plants than tall, dented-seeded and short spherical –seeded plants. Which is the right conclusion?

A. Genes for tallness and seed shape are located in different chromosomes

B. Genes for tallness and seed shape are located in the same chromosome, and are completely linked

C. Genes for tallness and seed shape show incomplete linkage

D. Traits for tall, dented-seeded plants are dominant

E. Traits for short, spherical seeded plants are recessive

A 52. Which part in the given DNA sequence corresponds to the translating sequence of this gene?

Promoter

-10 0

5`- TATCTTATGT**T**CTCAATCTT**G**AGGAGGAGGTACGCTATGAAGTCTCACGAATGGCTTAATAGTAG-3`

A.	**ATG**TTCTCAATCTTGAGGAGGAGGTACGCTATGAAGTCTCACGAATGGCTTAATAGTAG
B.	**ATG**AAGTCTCACGAATGGCTTAATAGTAG
C.	**ATG**GCTTAATAGTAG
D.	TATCTTATGTTCTCAATCTTGAGGAGGAG**GTA**
E.	TATCTTATGTTCTCAATCTTGAGGAGGAGGTACGCT**ATG**

A 53. What is the key difference between heterochromatin and euchromatin?

A. Heterochromatin is found only near the centromeres; euchromatin is found near the ends of chromosomes

B. Euchromatin is "true" chromatin; heterochromatin is a DNA-protein complex

C. The X chromosome is made up of euchromatin; heterochromatin is found in the Y chromosome

D. Heterochromatin is found in prokaryotic DNA; euchromatin is found only in eucaryotic DNA

E. Heterochromatin is transcriptionaly silent, while euchromatin is often transcriptionaly active

A 54. In crossing true-bred yellow and grey fruit flies *Drosophila*, the following results were obtained:

Parents	**Progeny**
Grey female x yellow male	All grey
Yellow female x grey male	All males – yellow All females - grey

Which statement is correct?

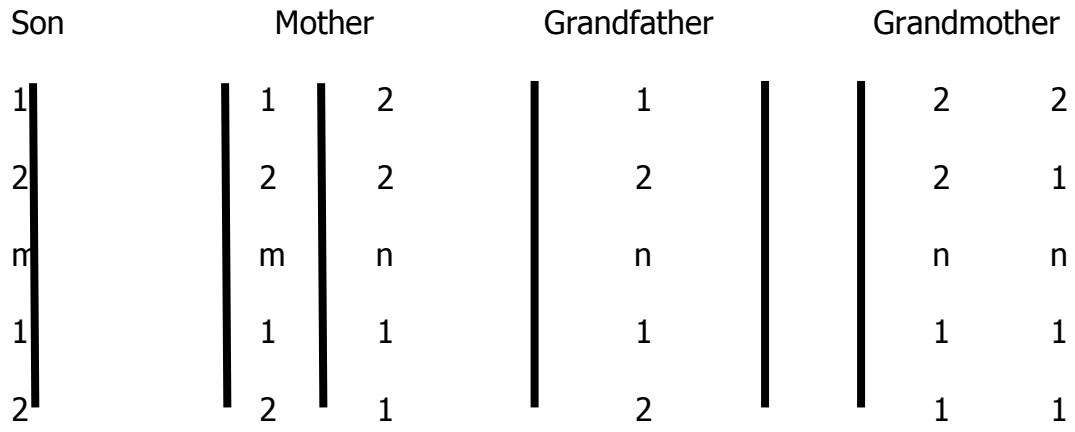
A. Alleles for grey and yellow body colour are codominant

B. The allele for grey body colour is X-linked recessive

C. The allele for yellow body colour is X-linked dominantThe allele for grey body colour is X-linked dominant

D. The allele for yellow body colour is autosomal recessive

A 55. In the figure, each column represents a hypothetical haplotype for four RFLP
(restriction fragment length polymorphism) loci, each with two alleles (indicated by **1** or **2**), and the disease locus, where **n** indicates normal allele and **m** the mutant allele for a X-linked locus.



Presence or absence of the mutant allele can be detected by some direct molecular assay. The data that the mutation is present in the mother but absent in both her parents does not tell us which of the parents was the source of the mutant gamete. The problem is solved by haplotype analysis using closely linked polymorphic loci. Where did the mutation, received by the son occur?

A. In mother's germ cells
B. In grandmother's germ cells
C. In grandfather's germ cells
D. In both grandfather's and grandmother's germ cells
E. There is insufficient information to solve this problem

Ecology

A 56. Which statement (-s) is (are) correct?
1. Food chains usually have at least 7 levels
2. Food chains are limited in length by energy losses, for example in respiration
3. Most of the world terrestrial above-ground production is utilized directly by detritivores
4. Gross energy production is the remaining assimilated energy after respiration

A. 2, 3 and 4
C. Only 2
C. Only 1
D. 1 and 3
E. 2 and 3

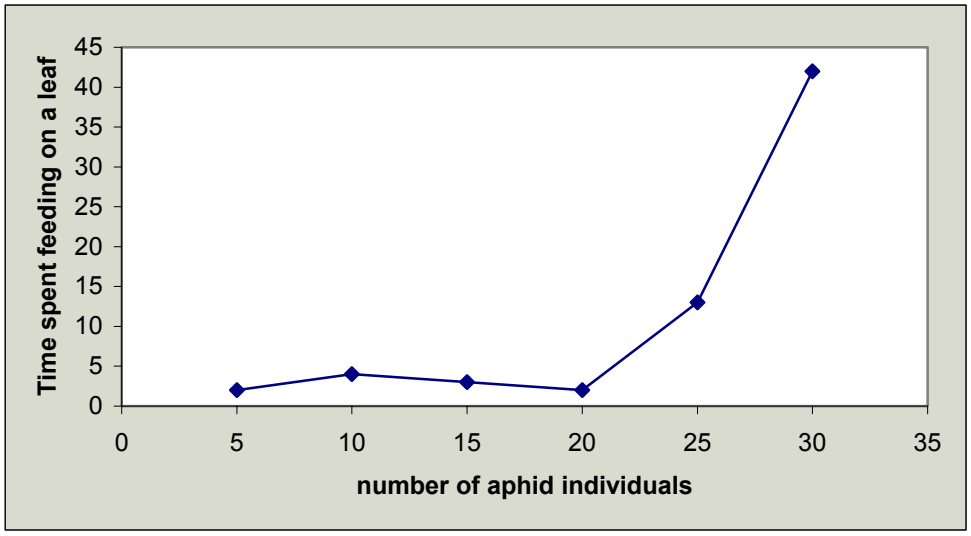
A 57. Which statements are correct?
1. Some autotrophic bacteria obtain energy oxidizing NH_4^+ to NO_2^- or NO_2^- to NO_3^-
2. Some autotrophic bacteria obtain energy reducing NO_2^- or NO_3^-
3. Nitrogen-fixing cyanobacteria can utilize atmospheric nitrogen (N_2)
4. The ocean serves as a buffer, stabilizing the atmospheric CO_2 concentration
5. Coral reefs are very productive ecosystems, but they contain a minor portion of the global amount of assimilated C

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

A 60. Which statement (-s) is (are) correct?
1. Succession after forest logging is an example of secondary succession
2. Succession after forest fire is an example of secondary succession
3. Generally, fire is a very important ecological process, as many ecosystems depend on fire for their renewal
4. In climax forests, most of the under storey species will have high competitive ability.
5. In climax forests, most of the under storey species are stress-tolerant species

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

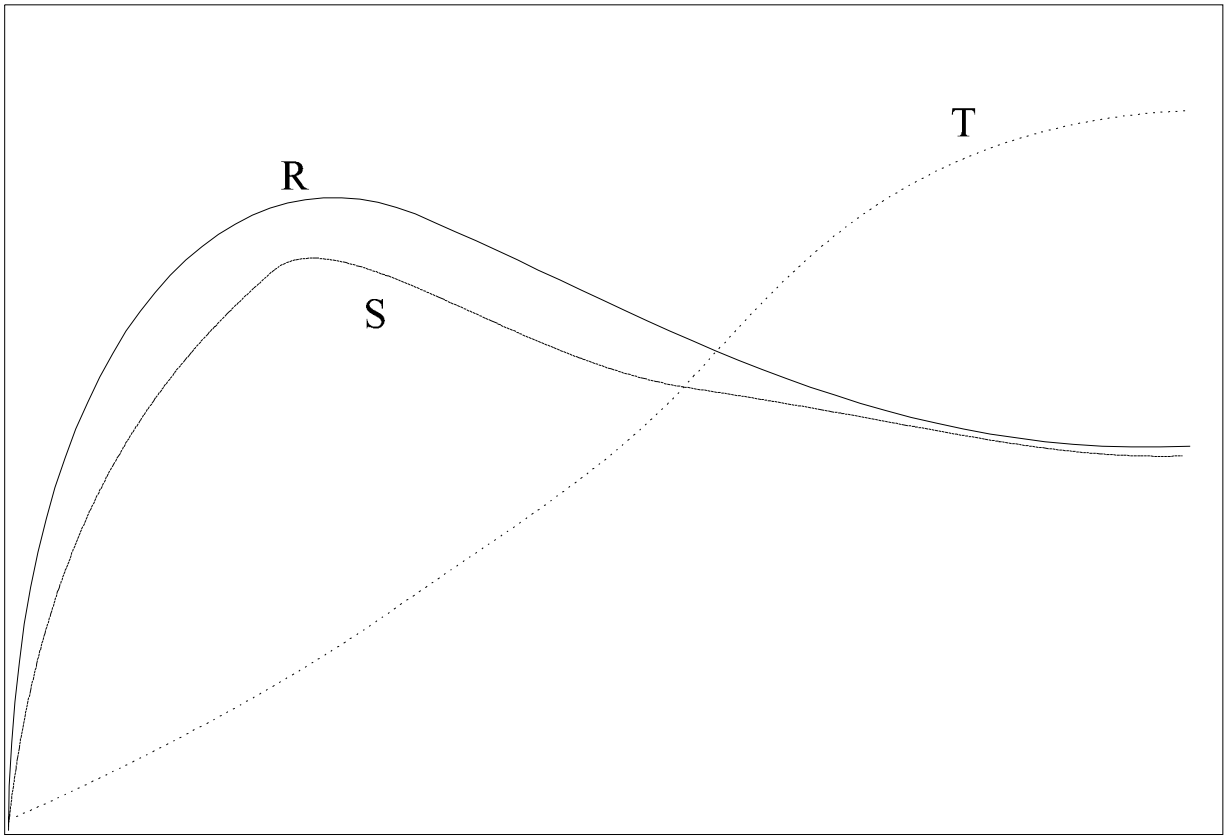
A 61. Aphids are common prey for ladybird beetles. The figure shows the amount of time spent feeding on a leaf by ladybird beetles. What does the figure indicate?



1. Ladybird beetles become confused when stationary prey is abundant, and have to spend a longer time capturing an individual
2. The size of the ladybird population is dependent on the number of aphids available
3. Ladybirds do not waste energy searching for aphids when they are in short supply
4. Ladybird beetles have a better chance of spotting from afar a leaf with many aphids as compared to a leaf with few aphids
5. Ladybird beetles spend more time on leaves where there are more aphids, because their net energy gain is maximum due to fewer losses from searching

A. Only 1
B. Only 2
C. Only 3
D. 3 and 5
E. All the answers are correct.

A 62. Changes that occur in a forest developing on abandoned farmland are represented in the graph below. What do the curves R, S and T indicate?

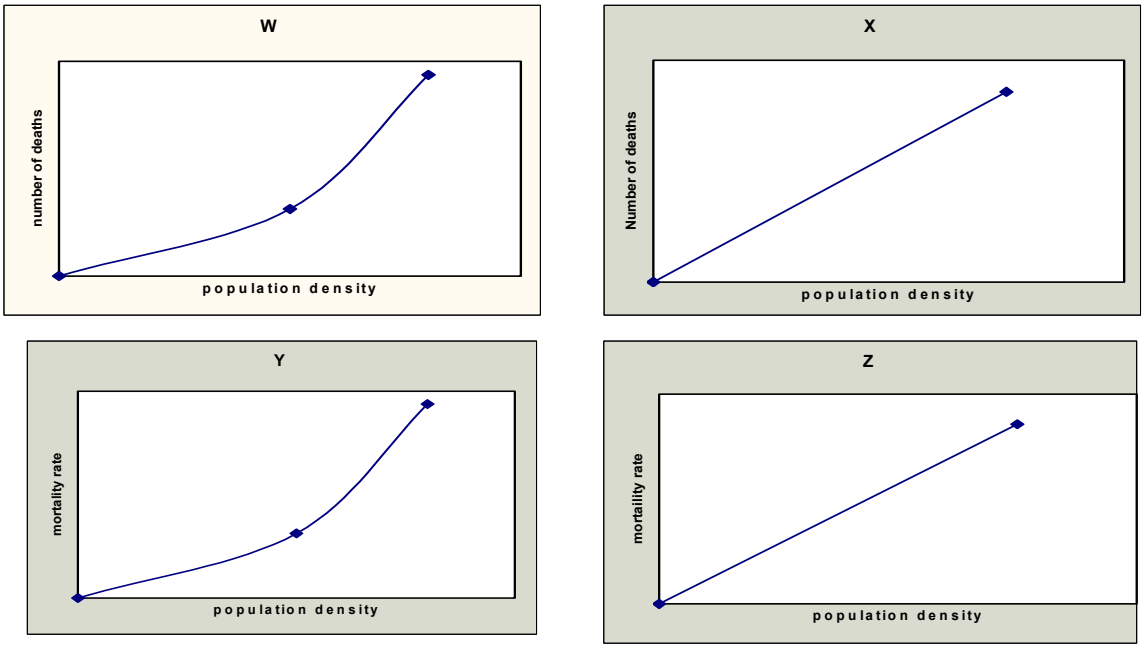


	Curve R	**Curve S**	**Curve T**
A.	Net productivity	Respiration	Succession
B.	Gross productivity	Net productivity	Heterotrophy
C.	Gross productivity	Respiration	Total biomass
D.	Community respiration	Total biomass	Net productivity
E.	Respiration	Total biomass	Gross productivity

A 64. In a Latvian pond, a random sample of carp fish consisted of 120 individuals. All individuals were permanently marked and released without injuring them. On the next day, 150 individuals were captured, of which 50 were marked. Assuming no change in the total population size between the two days, what is the size of the population in the pond?

A. 3600
B. 6000
C. 170
D. 360
F. 50

A 65. Which of the figures below show density-dependent mortality that could play a role in regulation of population size?



A. W, X, Y and Z
B. Y and Z
C. W and X
D. Only Y
E. W, Y and Z

A 66. In an experiment to determine the proportion as a percent of cabbage leaf material eaten by a caterpillar that was converted to biomass, it was observed that the caterpillar ate 2 cm^2 of leaf per day . In order to make an estimate of the conversion several measurements were done.
W. Average dry mass per cm^2 of leaf similar to that eaten
X. Total mass of caterpillar faeces per day
Y. Dry mass of caterpillar faeces per day
Z. Mass of carbon dioxide produced per day
Which of the given equations for estimating B, the mass of cabbage leaf converted into caterpillar biomass per day, is correct?
A. B = 2W-Y-Z
B. B = W-Y-Z
C. B = (2W-Y-Z)/2W
D. B = 2W-X-Z
E. B = W-X-Z

Biosystematics

A 68. What do **all Angiosperms** have that all Gymnosperms lack?
A. vascular cambium
B. secondary xylem
C. pericarp
D. cotyledons
E. seeds

A 70. Which of the following **is false** about the life cycle of mosses?
A. Gametophytes arise from a protonema
B. External water is required for fertilization
C. Gametes are produced by meiosis
D. Antheridia and archegonium are produced by the gametophytes
E. Sperms have flagella

A 71. Many benthic marine invertebrates have free-living planktonic larvae. Which of the following invertebrates all have planktonic larvae?
A. Nematoda, Echinodermata, Polychaeta, Turbellaria
B. Polychaeta, Turbellaria, Echinodermata, Corallium
C. Decapoda, Echinodermata, Corallium
D. Bivalvia, Turbellaria, Porifera, Nematoda
E. Cephalopoda, Gastropoda, Bivalvia, Echinodermata

A 72. Which statement regarding the systematics of following taxa is correct?
A. Phylum Platyhelminthes includes Hirudinea, Turbellaria and Cestoda
B. Phylum Arthropoda includes Chilopoda, Polychaeta, Crustacea
C. Phylum Platyhelminthes includes all the parasitic worms
D. Phylum Arthropoda includes water insects and water mites
E. Phylum Echinodermata and phylum Cnidaria are close relatives, as they possess a radial symmetric body

A 73. A biology student made some comments after examining Turbellaria, tapeworm (*Taenia* sp.) and trematoda (*Fasciola hepatica*). Which of his comments is **not** true?
A. Reduction in digestive system evolved in conjunction with passing to the parasitic life style
B. With passing to the parasitic life style, the reproduction capacity has increased
C. The total disappearance of the digestive system in the parasitic species did not cause any additional change in the body
D. The excretory systems of these animals basically resemble each other
E. The parasitic life style did not cause any change in the basic structural plan of the nervous system

A 74. Parasites are adapted to the host and its life cycle. Which of the following statements about parasitic species is correct?
A. Numerous Nematoda, Turbellaria and Cestoda are endoparasites in the intestine of fishes
B. Fleas, lice and most female mosquitoes are ectoparasites of warm-blooded animals
C. Cyclops are the intermediate hosts of Trematoda and Cestoda
D. The parasitic Nematoda and Turbellaria develop directly without an intermediate host
E. Trematodes and Turbellaria are endoparasites of cold-blooded animals

A75. Heterothermy is the ability to reduce body temperature during hibernation until it gets close to the environmental temperature. Which of the following animal groups include heterothermal organisms?
A. Rodentia, Chiroptera, Insectivora
B. Only Carnivora
C. Carnivora, Chiroptera
D. Penguins
E. All mammals living in burrows

4.2.2. Theoretical test Part B

Please read carefully all the instructions!
For questions with multiple correct answers, you will be penalised for additional incorrect responses.
Only the calculators which were provided with the Olympiad materials are permitted.
Mark all the correct answers in the answer sheet! **The jury will check only the answer sheet!**

Cell Biology

B 1. The dependence of the initial reaction rate on substrate concentration for 3 different enzymes (**X, Y and Z**) is given in the table:

Substrate concentration **(arbitrary units)**	**Initial rate (arbitrary units)**		
	X	Y	Z
1	0.92	0.91	0.032
2	1.67	1.67	0.176
4	2. 85	2.86	0.919
6	3.75	3.75	2.180
8	4.40	4.44	3.640
10	4.90	5.00	5.000
15	5.80	6.00	7.337
20	6.23	6.67	8.498
30	6.80	7.50	9.397
50	6.00	8.33	9.824
100	4.20	9.09	9.968

1. Plot the initial rates versus substrate concentrations on the answer sheet! ***(1 point)***
2. Which enzyme (X, Y or Z) is a regulatory enzyme with a co-operative behaviour? ***(1 point)***
3. Which of the enzymes (X, Y or Z) is inhibited by its own substrate? ***(1 point)***

B 2. For an exponentially growing culture of microorganisms the specific growth rate (μ) is a parameter, that gives the cell biomass (g) synthesized per gram of existing cell biomass per unit of time (usually, per hour). This rate (μ**)** is inversely related to the doubling time of the culture, t_d: $\mu = \ln 2/t_d \approx \mathbf{0.7/t_d}$. Hence, the shorter the doubling time of cells, the higher is the specific growth rate of the culture.
Two microorganisms, A and B, were inoculated each in a fresh growth medium with an initial optical density (OD) of 0.1. A lag phase of 1 hr duration was observed for both cultures. Three hours after inoculation, the OD of culture A was 0.4, while that of the culture B was 1.6.

1. Estimate the specific growth rate for culture A
2. Estimate the specific growth rate for culture B

(2 points)

B 3. Calculate the intracellular millimolar (mM) concentration of potassium in *Escherichia coli*, if the measured potassium content is 7.8 micrograms per milligram of dry cell mass. Assume all potassium ions are free in the cytosol (not bound to macromolecules), and that the intracellular volume is 2 microlitres per milligram of dry cell mass. The atomic weight of potassium is 39 Daltons.

(1 point)

B 4. A species of fungus can dissimilate glucose and produce ATP in two ways.
Aerobically: $C_6H_{12}O_6 + 6O_2 = 6\ CO_2 + 6\ H_2O$,
Anaerobically: $C_6H_{12}O_6 = 2\ C_2H_5OH + 2\ CO_2$
This fungus is cultivated in a glucose-containing medium. Half of the total ATP production is anaerobic.

1. What is the ratio between the rates of aerobic and anaerobic catabolism of glucose?
2. What is the expected oxygen consumption (moles per mole of consumed glucose)?
3. What is the expected CO_2 evolution (moles per mole of consumed glucose)?

For calculations, assume that glucose is fermented via the usual Embden-Meyerhof-Parnas glycolytic pathway, and that oxidative phosphorylation proceeds with maximum efficiency. ***(3 points)***

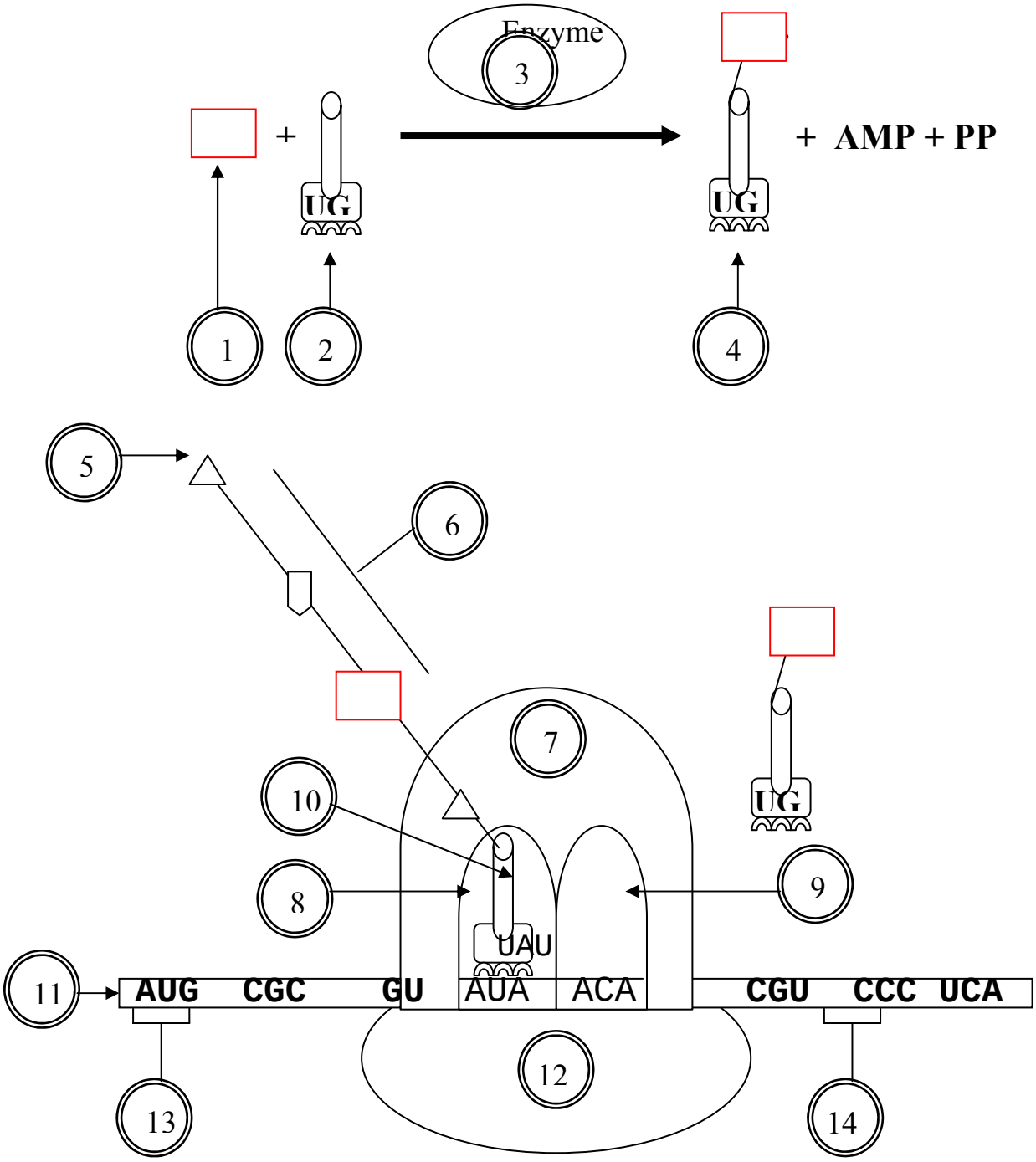
B 5. For the bacteria *Bacillus subtilis*, several auxotrophic mutants have been obtained which need addition of aspartate, threonine or methionine to the growth medium.

Mutant	Amino acid precursors that are not synthesized by the mutant	Amino acid needed for growth	Metabolite, accumulating in the medium
aspA		**4.** Aspartate	**7.** Fumarate
metA	**1.** Homocystein	**5.** Methionine	**3.** Homoserine
metH		**5.** Methionine	**1.** Homocystein
thrC		**6.** Threonine	**2.** Homoserinephosphate
thrB	**2.** Homoserinephosphate	**6.** Threonine	**3.** Homoserine
thrA	**3.** Homoserine **2.** Homoserinephosphate **1.** Homocystein	**6.** Threonine **5.** Methionine	**4.** Aspartate

1. What is the biosynthetic pathway for methionine biosynthesis?
2. What is the biosynthetic pathway for aspartate biosynthesis?
3. What is the biosynthetic pathway for threonine biosynthesis?
Indicate the pathway with appropriate numbers from the table (1-7) and arrows in the answer sheet! ***(3 points)***

B6. Before a lecture, an assistant noticed that comments on an important diagram are lost. He found many of terms in a textbook, including some which were unrelated to this diagram.

1. Please help the assistant to locate the correct terms for this diagram and to place the appropriate numeric labels in the table in the answer sheet.



(*Continuation see on the next page*)

	Term	Number		**Term**	**Number**
A-1	Amino acid		**A-2**	Growing polypeptide	
B-1	Pentose		**B-2**	Growing DNA strand	
C-1	Fatty acid		**C-2**	Growing RNA strand	
D-1	Small ribosomal subunit		**D-2**	Alpha subunit of RNA polymerase	
E-1	tRNA		**E-2**	Nuclear pore	
F-1	IgG		**F-2**	P site	
G-1	Receptor		**G-2**	Centriole	
H-1	Aminoacyl-tRNA synthetase		**H-2**	Large ribosomal subunit	
I-1	Protein kinase		**I-2**	A-site	
J-1	Glucokinase		**J-2**	Z-site	
K-1	Aminoacyl-tRNA		**K-2**	Peptidyl-tRNA	
L-1	Inductor		**L-2**	DNA polymerase	
M-1	Operator		**M-2**	Spliceosome	
N-1	N - end		**N-2**	Adenylate cyclase	
O-1	C - end		**O-2**	Capsomer	
P-1	5` - end		**P-2**	Single stranded DNA	
R-1	3` - end		**R-2**	Codon	
S-1	Nucleotide		**S-2**	Initiation codon	
T-1	Lysosome		**T-2**	Gene	
U-1	Sigma subunit of RNA polymerase		**U-2**	Terminal transferase	

2. Which component of this diagram has (give the number) peptidyl transferase activity? ***(5 points)***

B 7. The growth of bacteria is studied. For a period of exactly one duplication, the sample is moved from an environment with a light nitrogen isotope (^{14}N) to an environment with heavy nitrogen isotope (^{15}N). After this the sample is again transferred to the environment with light nitrogen for a period of two duplications.

1. What is the composition of double-stranded DNA (in %) of light and heavy nitrogen isotopes after the experiment?

A. Only light	**B.** In between	**C.** Only heavy

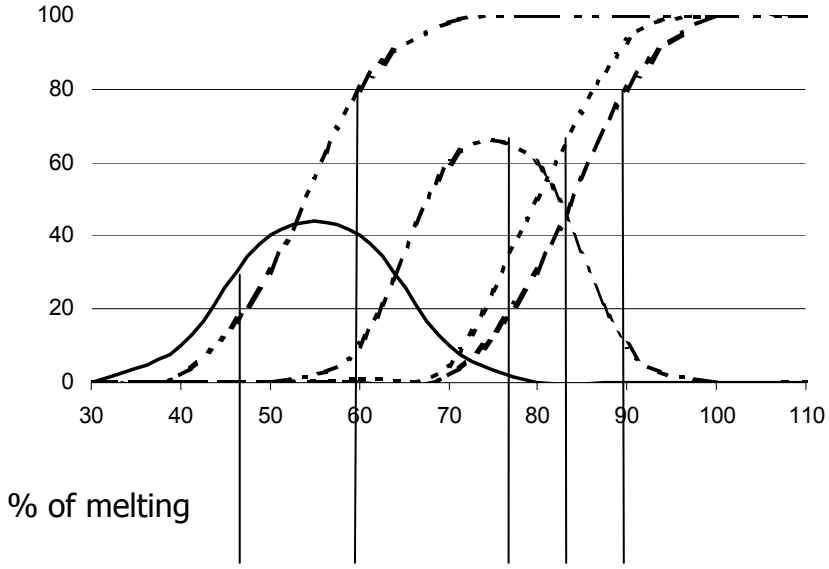
From these cells two types of mRNA {mRNA (*A*) and mRNA (*B*), respectively, expressed from two different genes} were isolated. Both mRNAs were found to contain an identical number of nucleotides. The nucleotide composition of each mRNA was estimated as (see the table).

mRNA	**A %**	**C %**	**G %**	**T %**	**U %**
A	17	28	32	0	23
B	27	13	27	0	33

2. What is the nucleotide composition of double-stranded genomic DNA in the coding part of the genes A and B, respectively.

dsDNA	A %	C %	G %	T %	U %
A					
B					

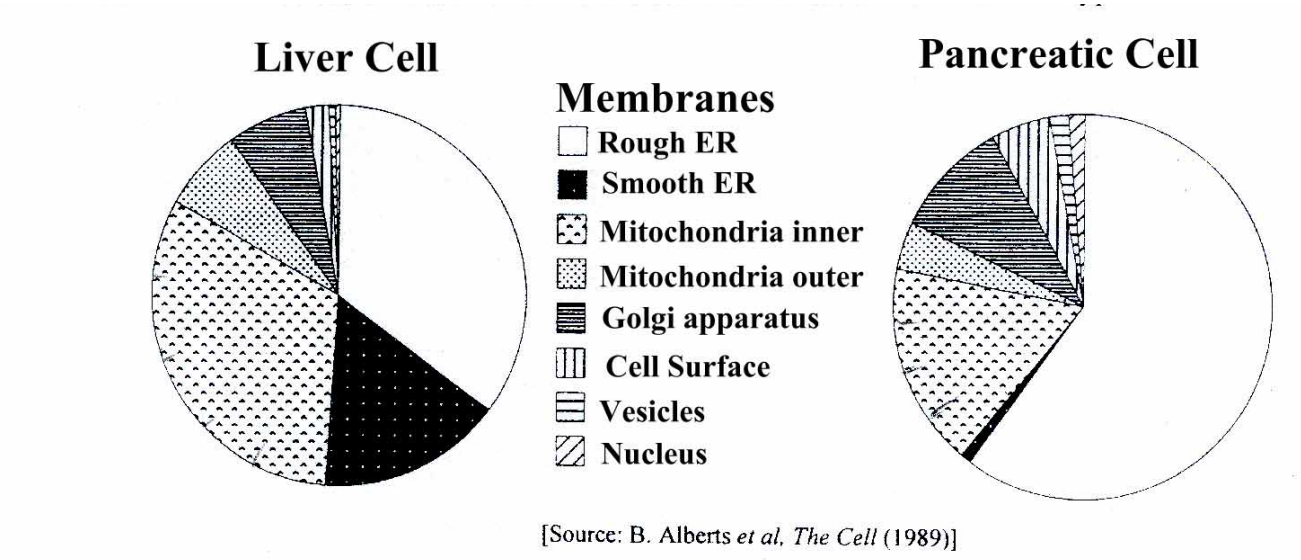
3. What curve in the plot below represents the DNA melting profile of the coding part of genes A and B, respectively?



Curve **1** **2** **3** **4** **5**

(3 points)

B 8.

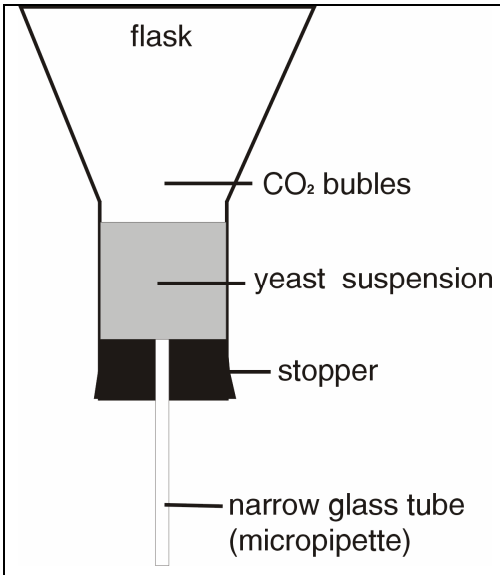


[Source: B. Alberts *et al, The Cell* (1989)]

The pie charts show the relative amounts of types of membrane found in two types of cells.
Suggest, why liver cells (answer **1**) possess significantly more smooth ER, while pancreatic cells (answer **2**) have more rough ER. Chose the correct statements (**A to E**) from the left column and pair them with the appropriate numbers **(1 to 5)** from the right column.

	Process	Structure	**Number**
A.	Higher synthesis of lipids	In nuclear membrane of pancreatic cells	**1**
B.	Higher proteolytic activity	In glycogen particles of liver cells	**2**
C.	Higher lipolytic activity	In endoplasmic reticulum of pancreatic cells	**3**
D.	Higher protein-secretory activity	In mitochondria of liver cells	**4**
E.	Hihger ATP-synthesizing activity	In endoplasmic reticulum of liver cells	**5**

(2 points)



B9. The diagram shows an apparatus made by a student to investigate the effect of temperature on the activity of ethanol fermentation of yeast. The conical flask contains 2.5 g yeast suspended in 2% sucrose solution. The meniscus moves down the glass tube (5ml micropippete) during fermentation.

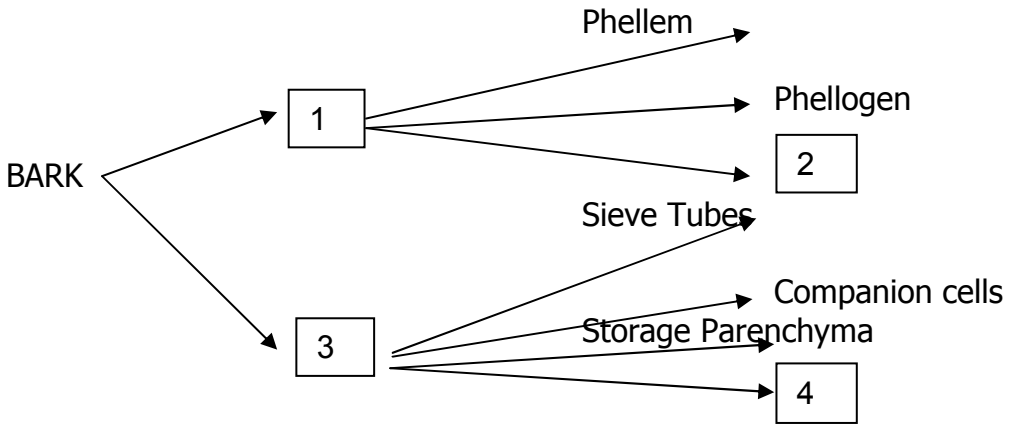
The table shows the amount of suspension (ml) pushed in the glass tube due to CO_2 accumulation at regular time intervals.

Time (min.)	**4^0 C**	**10^0 C**	**20^0 C**	**35^0 C**	**55^0 C**
1	0	0.2	0.4	0.7	0
2	0	1.0	1.3	1.2	0.1
3	0.1	1.9	2.2	2.8	0.2
4	0.2	3.1	3.3	4.4	0.3
5	0.3	4.0	NO RESULT	NO RESULT	0.4

1. Plot the data on CO_2 accumulation at different temperatures.
2. Estimate the average rate of CO_2 production (ml CO_2/min) for the yeast suspension at 20^0 C using the values obtained in the period between 2 and 4 minutes.
3. Estimate the specific rate of CO_2 generation (millimoles CO_2/(min g)) at 20^0 C.
4. What would be the specific rate of ethanol accumulation (millimoles ethanol /(min g)), if the fermentation follows the equation? $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2\ CO_2$ ***(4 points)***

Plant Anatomy and Physiology

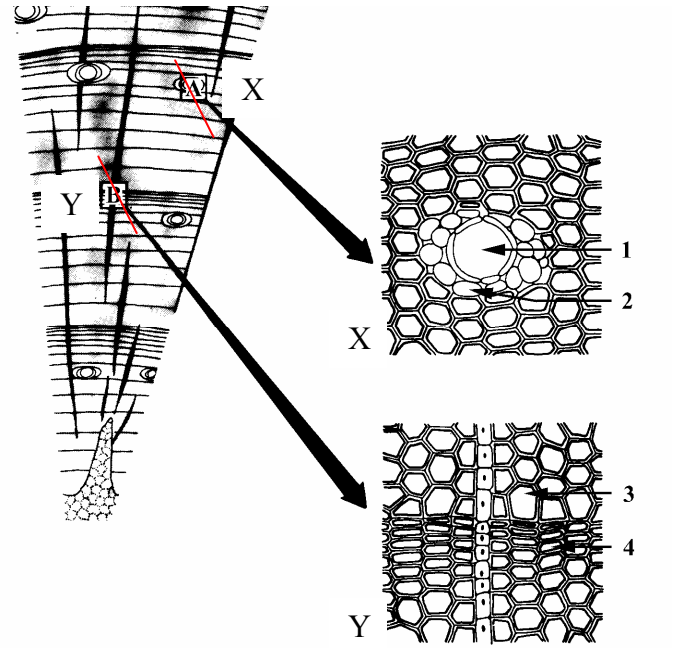
B 10. Write the numbers (each number can be used only once) of the unnamed structures in the appropriate boxes in the table in the answer sheet.



	Structures	Number
A.	Periderm	
B.	Primary phloem	
C.	Phloem fibers	
D.	Phelloblast	
E.	Phelloderm	
F.	Secondary phloem	
G.	Tracheids	

(2 points)

B 11. The figure shows a cross section of gymnosperm stem wood. Write in the table in the answer sheet the appropriate numbers (each number can be used only once) of corresponding plant structures.



	Plant structure	**Number**
A	Early wood	
B	Sieve tube	
C	Late wood	
D	Resin duct	
E	Companion cell	
F	Xylem parenchyma	

(2 points)

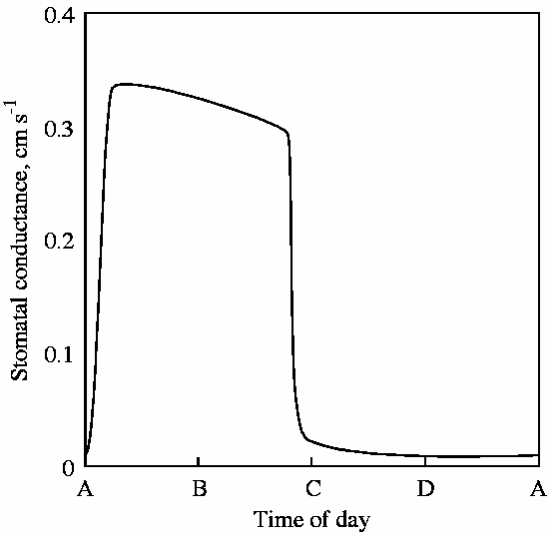
B 12. The following features pertain to specific structures and processes in plants. Write the number that corresponds to appropriate structure in the table in the answer sheet!

1. Regulates the inward flow of ions into the roots
2. A plastid which develops in a plant when it is kept in the dark
3. A cell type which provides the main support in gymnosperm wood
4. Provides water movement horizontally across the stem

	Plant structure	**Number**
A.	Tracheids	
B.	Epidermis	
C.	Endodermis	
D.	Resin duct	
E.	Rays	
F.	Leucoplast	
G.	Etioplast	

(2 points)

B 14. The diurnal curve indicates the stomatal opening for a typical C3 plant.

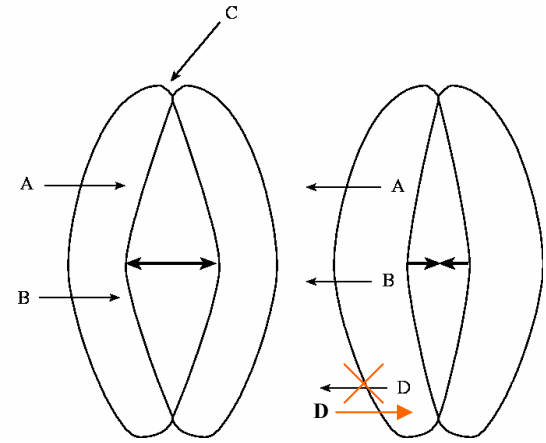


Stomatal conductance is an indication of the capacity for diffusion through stomata and an indirect measurement of stomatal opening. A stomatal conductance of zero indicates that stomata are closed (i.e., there is no transpiration).

1. Indicate the times of day in the diagram and mark them on the answer sheet, using the codes:

1. Midnight **2.** Noon **3.** 6:00 a.m. **4.** 6:00 p.m

A	
B	
C	
D	



Stomatal opening vs. closure is regulated through several internal and external factors.

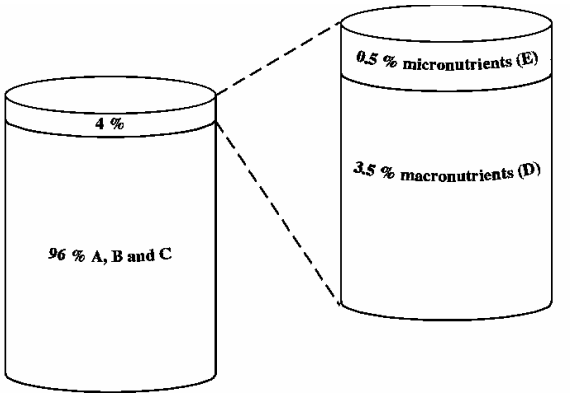
2. Indicate and mark in the answer sheet, which of the following corresponds to the factors depicted in the picture. Use the given code:

1. CO_2 **2.** Light **3.** Ca^{2+} **4.** Abscisic acid **5.** K^+ **6.** H_2O

A and B	
C	
D	

(4 points)

B 15. Plants require 16 essential elements - boron (**1**), calcium (**2**), carbon (**3**), chlorine (**4**), copper (**5**), hydrogen (**6**), iron (**7**), magnesium (**8**), manganese (**9**), molybdenum (**10**), nitrogen (**11**), oxygen (**12**), phosphorus (**13**), potassium (**14**), sulfur (**15**), zinc (**16**). The proportional masses of various elements in plants are shown.



1. Indicate the numbers in the answer sheet, corresponding to each element in the table.

A, B, C	
D	
E	

(3 points)

Animal Anatomy and Physiology

B 16. The Figure shows the overall fluid balance in the human gastrointestinal tract. Calculate three volumes (**X, Y** and **Z**) and write them in the answer sheet.

Volume of fluids absorbed in the gastrointestinal tract or excreated during 24 hours.

.....

Small intestine absorbs X ml

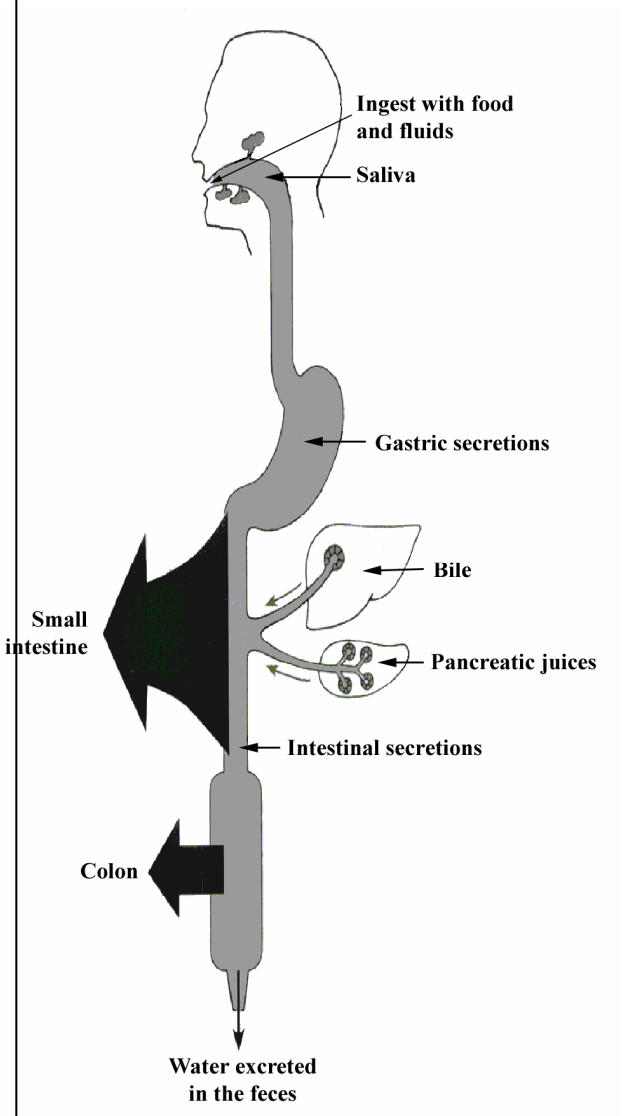
.....

.....Colon absorbs 1 000 ml

.....

Water excreation in the faeces 100 ml

Sum: Y ml



Volume of fluids entering the gastro-intestinal tract during 24 hours.

.....

Ingested with food and fluids 2 000 ml

.....

Saliva 1 500 ml

.....

Gastric secretion 2 000 ml

.....

Bile 500 ml

.....

Pancreatic juice Z ml

.....

Intestinal secretion 1 500 ml

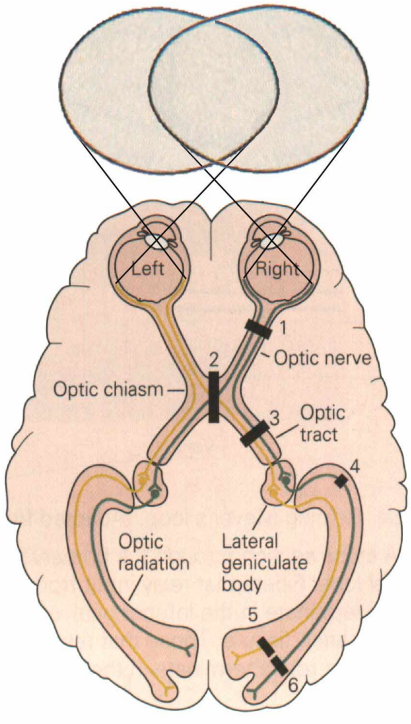
.....

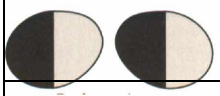
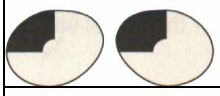
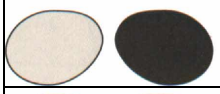
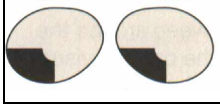
Sum: 9 000 ml

(1 point)

B 17. Lesions in various points in the visual pathway produce deficitsat the visual field. The level of a lesion can be determined by the specific deficit in the visual field. In the diagram of the cortex the numbers along the visual pathway indicate the sites of lesions. The deficits that result from lesions are shown as black areas in the visual field maps on the right.

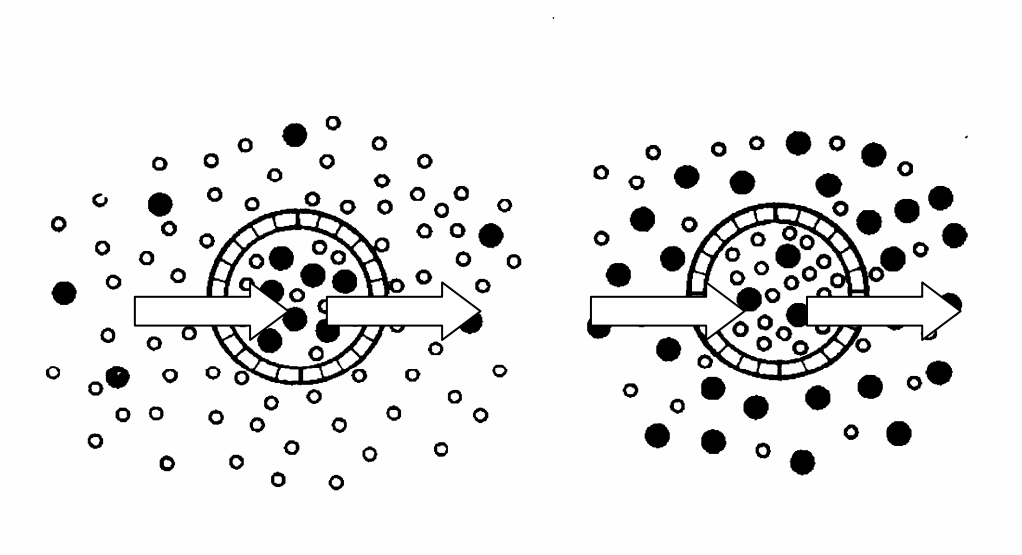
Choose the corresponding deficits that result from lesions at each site and write the numbers of the lesion sites in table in the answer sheet!



Defects in visual field of Left eye Right eye		**Number of lesion site**
	**A.**	
		
		
	**D.**	
	**E.**	
		

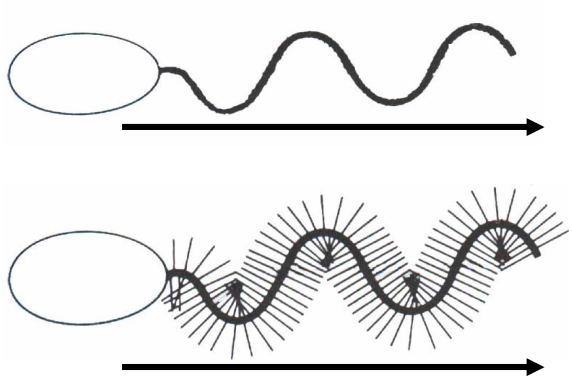
(3 points)

B 18. Please color the arrows in the answer sheet that indicate the direction of the water flow through the cell membrane of an erythrocyte. Light circles in the figure show the water molecules, dark circles show the molecules of the dissolved substances.



(1 point)

B 19. Please indicate the direction of the locomotion of protozoan (A) and (B) by arrows in the boxes in the answer sheet. Arrows in the figure indicate the direction of wave caused by ciliary's movement.



A.

B.

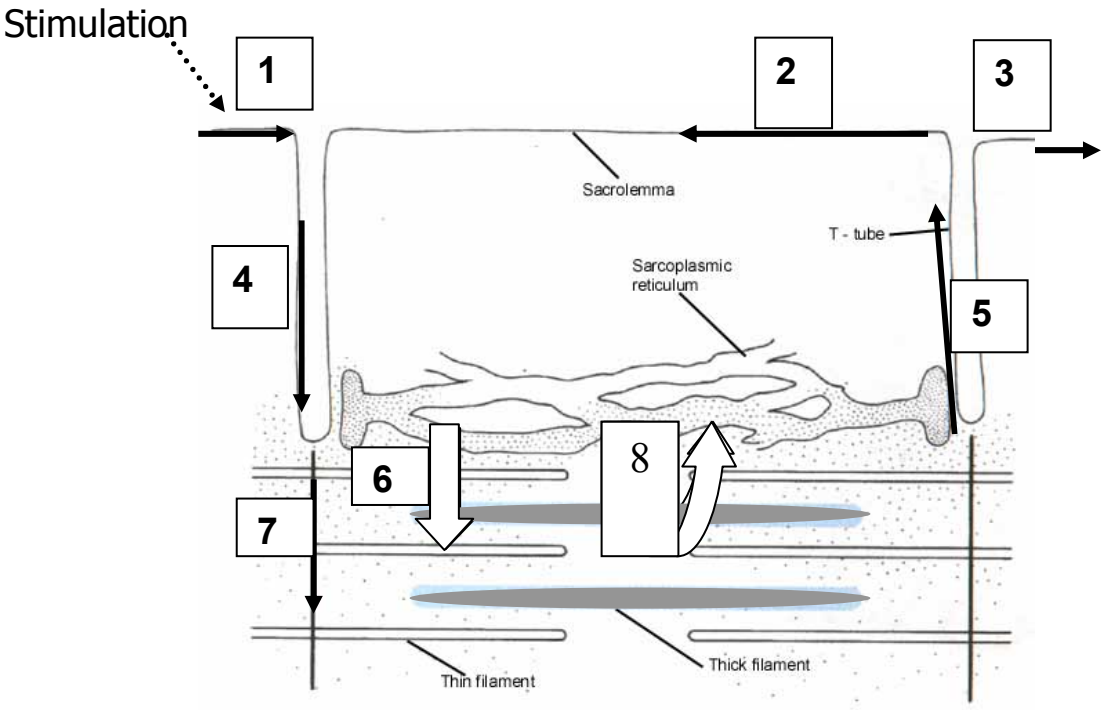
(1 point)

B 20. Please mark with crosses in the table in the answer sheet the locations where filtration, reabsorbtion and secretion take place in the mammal nephron (more than one correct answer per process possible)!

Process	1. Renal corpuscle	2. Proximal convoluted tubule	3. Henle loop	4. Distal convolu-ted tubule	5. Late distal tubule and collecting duct
A. Filtration of fluid that is isotonic to blood					
B. Reabsorption of water, Na^+, K^+, glucose, amino acids, Cl^-, HCO^-_3, urea					
C. Reabsorption of water, Na^+, K^+ and Cl^-					
D. Reabsorption of water, Na^+ and Cl^-					
E. Reabsorption of water, Na^+ HCO^-_3 and urea					
F. Secretion of H^+ and K^+					
G. Secretion of H^+, NH_4^+, urea and creatinine					
H. Secretion of urea					

(5 points)

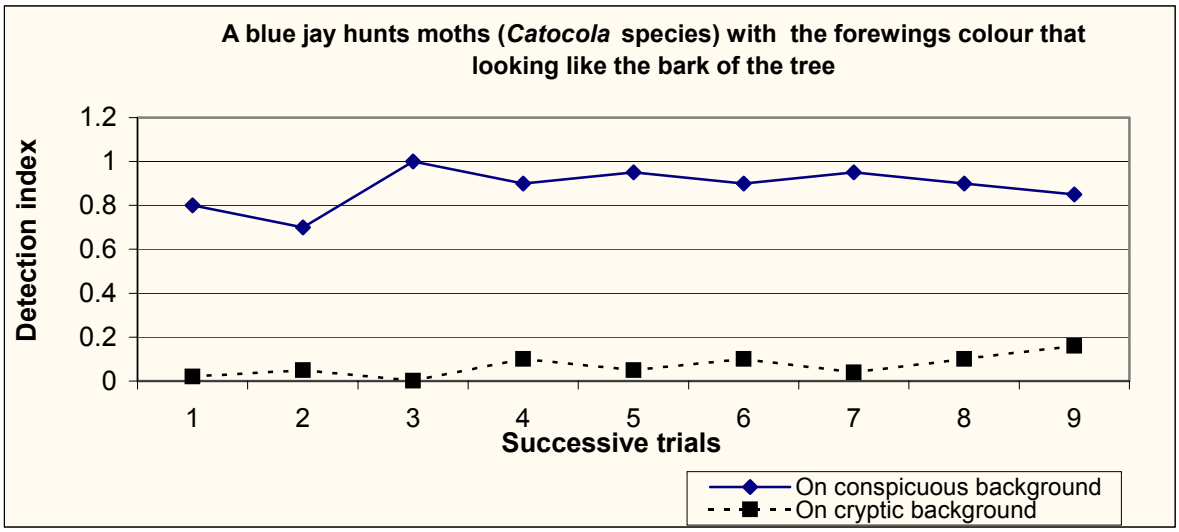
B 22. Arrange in the answer sheet in the correct sequence the arrows (choose from 1-8) that characterize the sequence of events in stimulation and contraction of muscle. The black arrows indicate propagation of excitation (action potential) in the membranes; the white arrows – depolarization - induced Ca^{2+} propagation in the sarcoplasma.



(1 point)

Ethology

B 25. A blue jay actively hunts on different moths (*Catocala*). The hindwings of the moths are often strikingly coloured yellow, orange, red or other color, but the forewings of the moths appear cryptic, looking very much like the bark of the trees on which the moths rest. In other words moths on a cryptic background appears like background. The forewings cover the hindwings, but when they are distrurbed, the hindwings are suddenly exposed. On a uniform background the moths are easily seen.
The detection index estimates the ability to spot a moth.



Which statements regarding wing coloration are true? Mark them with crosses in the answer sheet.

A. The forewings are coloured to decrease detection of moths by a predator

B. The hindwings are brightly coloured without any significance, it is a random feature

C. The hindwings' colour may have a "startle" effect on a bird, causing the bird to stop momentarily and thus giving the moth time to escape

D. The forewings' cryptic colour does not defend moths completely, because jays learn to see moths on a cryptic background

E. Brightly coloured hindwings promote sexual partner recognition

F. A predator does not discriminate colours

(3 points)

Genetics and evolution

B 26. In fruit fly *Drosophila melanogaster*, there is a dominant gene **(b+)** for grey body colour and another dominant gene **(c+)** for normal wings. The recessive alleles **(b, c)** of these two genes result in black body colour and curved wings respectively. Two students Ada and Donald made crosses to determine the distance between these two genes. Flies with a grey body and normal wings were crossed with flies that had black bodies and curved wings. The results obtained in Ada's and Donald's experiments are shown in the table.

	Grey body, normal wings	Black body, curved wings	Grey body, curved wings	Black body, normal wings
Ada`s experiment	236	253	50	61
Donald's experiment	55	56	241	248

1. What is the distance (in map units) between these two loci? Mark in the answer sheet.

2. What was the genotype of flies with a dominant phenotype in Ada`s **(A.)** and Donald`s **(B.)** experiment? Give the genotypes and show the linkage phase of genes **b** and **c** in the answer sheet!

A. (Adas's flies)
B. (Donald's flies)

(3 points)

B 27. Several mutations (A, B, C, D) have been found in the coding sequence of a gene.

Codon	1	2	3	4	5	6	7	8	9	10	11	12
Wt	ATG	TGC	CCC	CGA	GTC	GAG	GAC	CTG	AGC	CTG	ACG	AGC
A.	---	-C-	---	---	---	---	---	---	---	---	---	---
B.	---	---	---	A--	---	---	---	---	---	---	---	---
C.	---	---	---	---	A--	---	---	---	---	---	---	---
D.	---	---	---	---	---	---	---	*--	---	---	---	---

* Deletion of 1 nucleotide

1. Please translate codons of variants of the given sequence (Wt, A, B, C, D) in one letter codes of amino acids (use table of genetic codes) and place the answers in the table in the answer sheet. **Note:** write ST instead of STOP

	Codon											
Wt	1	2	3	4	5	6	7	8	9	10	11	12
A.												
B.												
C.												
D.												

First base	Second base U		Second base C		Second base A		Second base G		Third base
U	**UUU**	F (Phe)	**UCU**	S (Ser)	**UAU**	Y (Tyr)	**UGU**	C (Cys)	U
	UUC	F (Phe)	**UCC**	S (Ser)	**UAC**	Y (Tyr)	**UGC**	C (Cys)	**C**
	UUA	L (Leu)	**UCA**	S (Ser)	**UAA**	STOP	**UGA**	STOP	**A**
	UUG	L (Leu)	**UCG**	S (Ser)	**UAG**	STOP	**UGG**	W (Trp)	**G**
C	**CUU**	L (Leu)	**CCU**	P (Pro)	**CAU**	H (His)	**CGU**	R (Arg)	**U**
	CUC	L (Leu)	**CCC**	P (Pro)	**CAC**	H (His)	**CGC**	R (Arg)	**C**
	CUA	L (Leu)	**CCA**	P (Pro)	**CAA**	Q (Gln)	**CGA**	R (Arg)	**A**
	CUG	L (Leu)	**CCG**	P (Pro)	**CAG**	Q (Gln)	**CGG**	R (Arg)	**G**
A	**AUU**	I (Ile)	**ACU**	T (Thr)	**AAU**	N (Asn)	**AGU**	S (Ser)	**U**
	AUC	I (Ile)	**ACC**	T (Thr)	**AAC**	N (Asn)	**AGC**	S (Ser)	**C**
	AUA	I (Ile)	**ACA**	T (Thr)	**AAA**	K (Lys)	**AGA**	R (Arg)	**A**
	AUG	M (Met)	**ACG**	T (Thr)	**AAG**	K (Lys)	**AGG**	R (Arg)	**G**
G	**GUU**	V (Val)	**GCU**	A (Ala)	**GAU**	D (asp)	**GGU**	G (Gly)	**U**
	GUC	V (Val)	**GCC**	A (Ala)	**GAC**	D (asp)	**GGC**	G (Gly)	**C**
	GUA	V (Val)	**GCA**	A (Ala)	**GAA**	E (Glu)	**GGA**	G (Gly)	**A**
	GUG	V (Val)	**GCG**	A (Ala)	**GAG**	E (Glu)	**GGG**	G (Gly)	**G**

2. Please arrange in the answer sheet the mutations (A-D) in an order, which shows their influence on protein functions starting from the most deleterious mutation.

(4 points)

B 28. A river has two populations of snails; a large population just off the left bank (main population), and a much smaller one downstream near an island (island population). Consider a locus that has two alleles, **G** ang **g**, in the island population, but is fixed for the **G** allele in the main population. Let *p* be the frequency of the **G** allele in the island population.

Because of river flow, migration occurs from the large population to the island, but not the reverse. Assume p= 0.6 before migration. After migration 12% of the islands snails originated from the main population.

1. Calculate *p* after the migration!

Following the wave of migration, the island snails reproduce. For some reason, the island snails, including the new immigrants, have a much higher mutation rate than the main population. The mutation rate of **G** $\rightarrow$ **g** in the island population is 0.003, and there is essentially no reverse mutation (mutation in the main population is rare, and can also be ignored).

2. Calculate *p* in the next generation of island snails?

(2 points)

B 29. In a specific population, genotype frequencies have been estimated before and after selection.

	a_1a_1	**a_1a_2**	**a_2a_2**
Frequency before selection (generation F_0)	0.25	0.50	0.25
Frequency after selection (generation F_1)	0.35	0.48	0.17

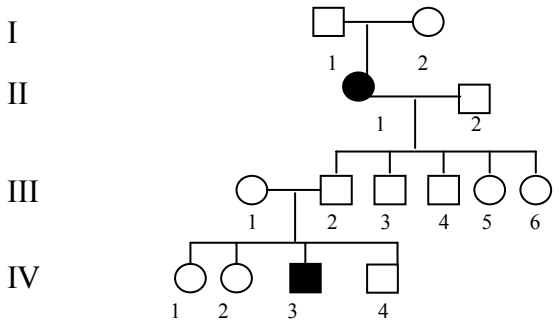
1. Calculate the selection coefficient of each genotype (a_1a_1, a_1a_2, a_2a_2) and write the answer in the answer sheet!

2. Against which genotype is selection the strongest? Write the answer in the answer sheet! ***(2 points)***

B 30. Expression of some autosomal genes depends on whether that gene came from male or female parent. These are so called imprinted genes (imprinted genes

are expressed in a parent - specific manner). Imprinting of these genes happens during spermatogenesis or oogenesis, and may silence the allele coming from one parent.

Problem 1. Imprinted genes can account for many cases of incomplete penetrance. The pedigree shows the incomplete penetrance of an autosomal dominant gene resulting from imprinting during oogenesis. A woman II_1 is heterozygote for this gene. Analysis of DNA reveals that III_2 and III_5 have received the mutant gene from their mother.



1. What is the probability of II_1 and II_2 having an affected child? Mark the answer in the answer sheet!

2. What is the probability of III_1 and III_2 having an affected child? Mark the answer in the answer sheet!

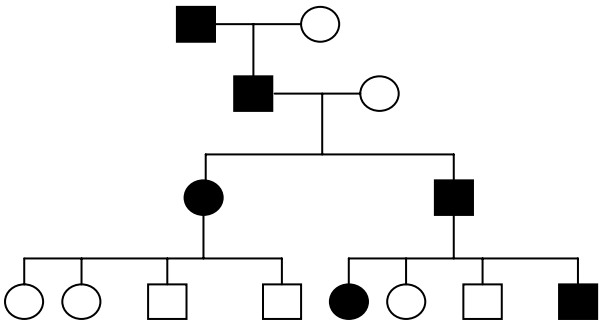
3. What is the probability of III_4 and III_5 having an affected child? Mark the answer in the answer sheet!

Problem 2. Parental imprinting gives a deviation from Mendelian patterns of inheritance, because the same allele may be differently expressed depending on whether it is inherited from the mother or the father.

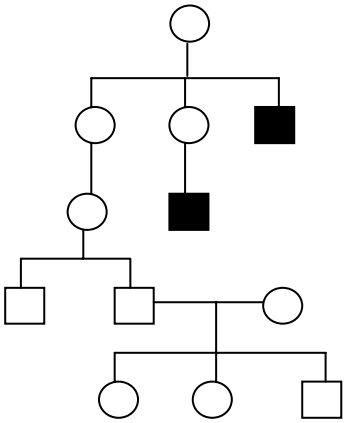
(Continuation see on the next page)

Determine which pedigree show maternal (**1**) and which paternal (**2**) imprinting (choose from pedigrees A,B,C,D).

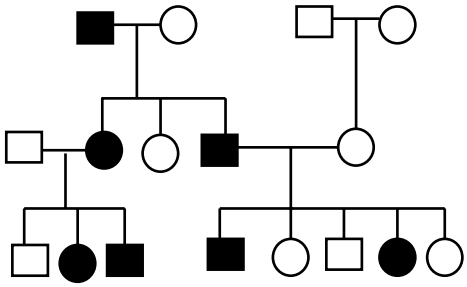
A



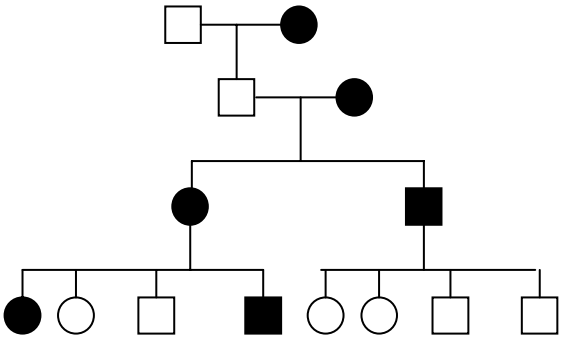
B



C



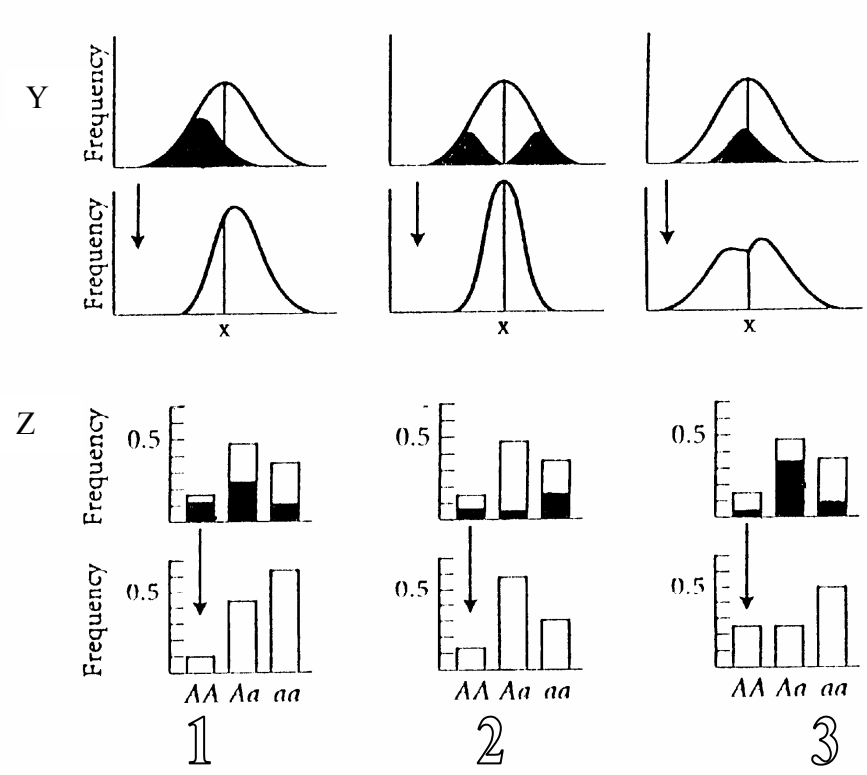
D



1. Maternal	**2.** Paternal

(5 points)

B 31. The figures show modes of selection on **(Y)** a heritable quantitative (continuous) trait and **(Z)** a polymorphism inherited as two alleles at one locus. In both cases, the phenotype was assumed to be inherited additively (i.e. heterozygote intermediate between homozygotes, there is no interaction among loci that contribute variation to the quantitative trait). The vertical axis is the proportion of the population with each phenotype. The upper rows of figures in both **Y** and **Z** show the distribution of phenotypes in one generation, before selection occurs. The shaded portions represent individuals with relative disadvantage (lower reproductive success). The lower rows of figures in both **Y** and **Z** show the distribution of phenotypes in the following generation, after selection among the parents has occurred. **X** marks the mean of the quantitative trait before selection.



A. Directional selection does not alter the means, but may reduce the variation
B. Disruptive or diversifying selection is unlikely to be exactly symmetrical, and thus usually shifts the means
C. Directional selection increases the proportion of genotypes with higher values of the trait
D. Stabilizing selection is unlikely to be exactly symmetrical, and thus usually shifts the means
E. Stabilizing selection does not alter the means, but may reduce the variation

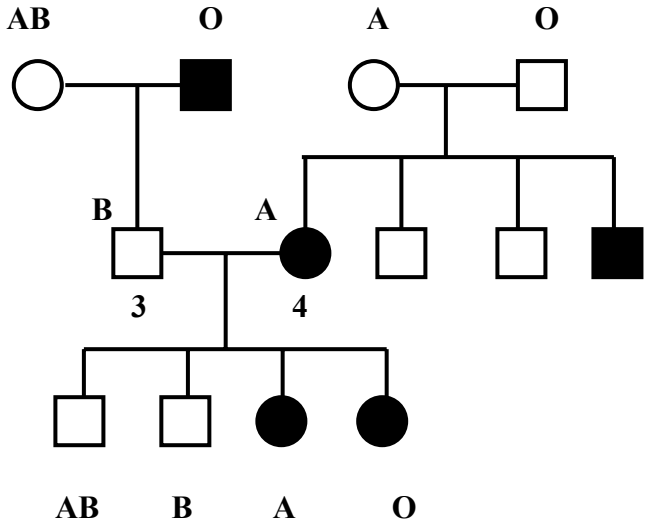
(Continuation see on the next page)

Match in the answer sheet the statements (A – E) with appropriate schemes (1 - 3) Not all the rows in the table have to be filled.

Statements	Number of schemes
A	
B	
C	
D	
E	

(3 points)

B 32. Alkaptonuria is a rare genetic disease. The gene for alkaptonuria (**alk**) is recessive and has been located on chromosome 9. Gene **alk** is linked to the gene **I** encoding the ABO blood types. The distance between the **alk** gene and gene **I** is 11 map units. A pedigree of a family with the alkaptonuria is shown below. Affected individuals are indicated by shaded symbols. In addition, the blood type of family members is given.



1. What are the genotypes of individuals 3 and 4? Give the answer in the answer sheet

2. If individuals 3 and 4 are expecting their fifth child, what is the probability that the child will have alkaptonuria (a physician has determined that foetus has blood type B)? Give the answer in the answer sheet!

(2 points)

Ecology

B 33. The following table shows the commercial fishing catches of smelt and fishing intensity in the Riga Gulf between 1982 and 1985. The fishing intensity during those years was estimated by the total time spent by all fishing boats that were concentrated on this species. The fishing equipment did not change in the investigated time-period.

Year	Catch (tons)	Fishing intensity (relative units)
1982	100	2
1983	150	5
1984	100	5
1985	150	3

Estimate and write in the answer sheet the relative sizes of the smelt population, starting with a relative size of 10 units for the year 1982.

1982 = 10
1983= ……
1984= ……
1985= ……

(3 points)

B 34. Figure 1 shows the number of phytoplankton cells, and P and N (inorganic) concentrations in water samples in a transect along the coast of the Atlantic Ocean around a fish processing factory.

The nitrogen concentrations in the water were very low and close to the detection limit. The closest station to the factory was Station 6. Figure 2 shows the results of a nutrient enrichment study. Water samples taken at the Stations were filtered to remove phytoplankton.

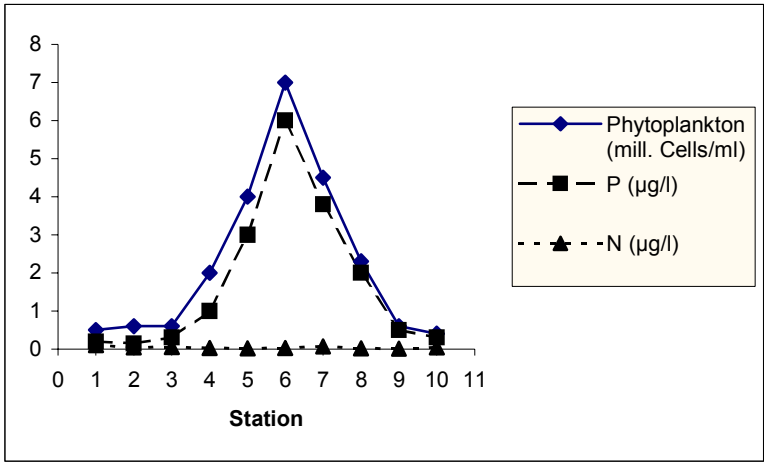
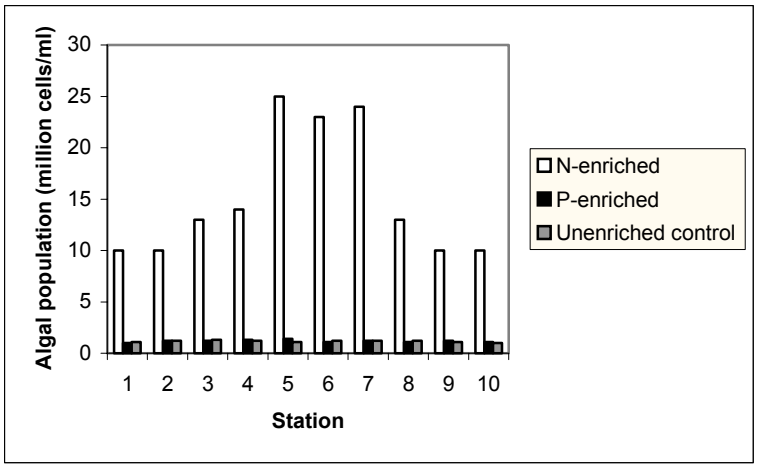


Figure 1

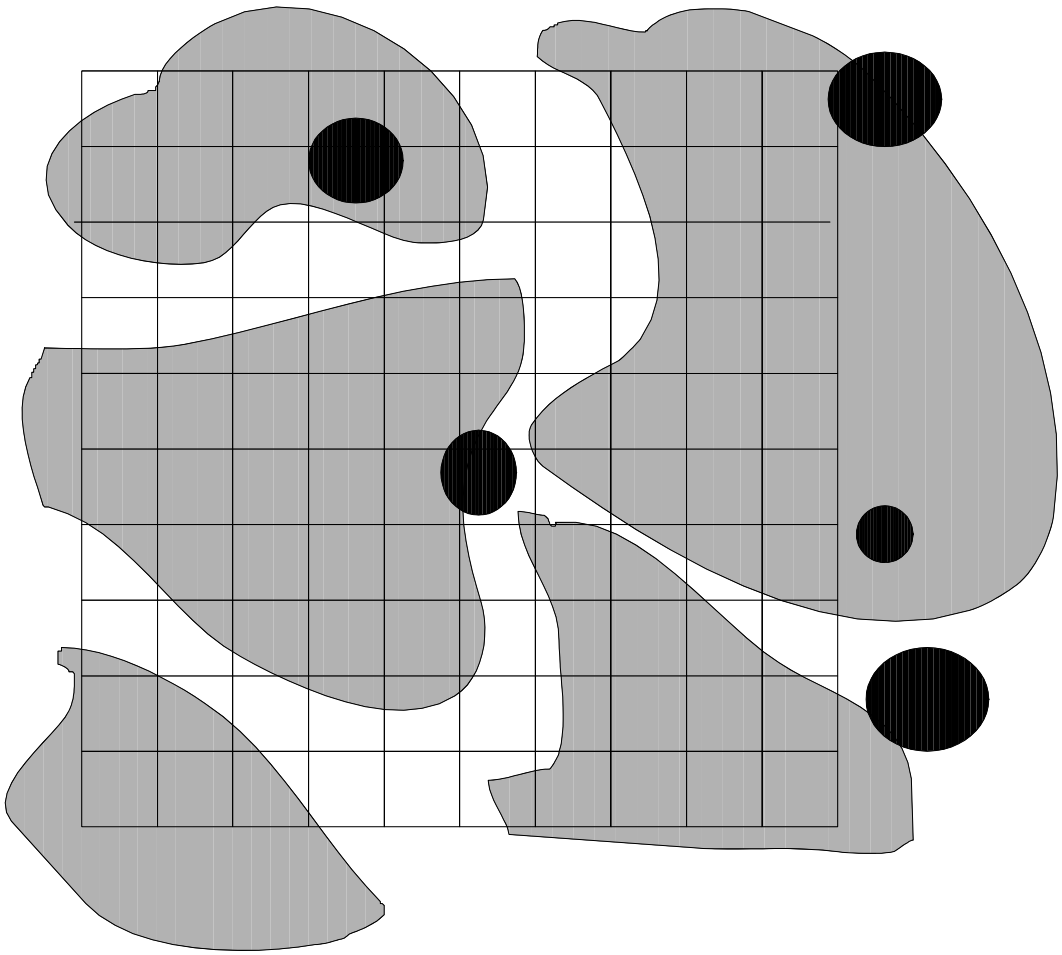
Then standard amounts of phytoplankton were added to the samples, and then they were enriched with only N, only P, or were unenriched, and the number of phytoplankton cells in these enriched or unenriched samples were counted at a later time.Figure 1

Figure 2



1. Which is pollutant or pollutants that factory is emitting? Give the answer in the answer sheet using the appropriate codes.
Codes: X. Phytoplankton **Y.** Zooplankton
Z. Nitrogen **W.** Phosphorus **S.** Organic substances
2. Which is the main limiting nutrient (**A**) in this is case?
Which is the second limiting factor (**B**) in this case?

(3 points)



B 35.

The diagram shows a 10m x 10m plot located in a forest with two main tree species: Species X which is shaded grey, and Species Y which is shaded black. The plot is divided into a grid with step 1m.

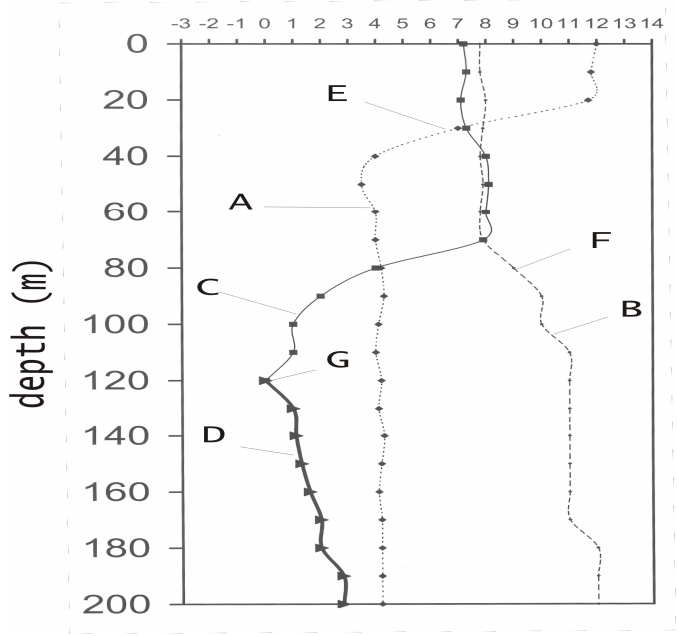
1. What are the percentage frequencies of Species X and Species Y using a quadrate size of 2 m x 2m?

2. What are the percentage frequencies of Species X and Species Y using a quadrate size of 5m x 5m. Write the correct answers in the answer sheet.

		1. Quadrate of size 2m x 2m	**2. Quadrate of size 5m x 5m**
A.	Species X		
B.	Species Y		

(4 points)

B 36. The Baltic Sea is brackish, receiving salt water from the North Sea, and fresh water from rivers. Turnover of water in deep layers is much slower than at surface layers. Stratification of the water column is common in summer. The following figure shows a depth profile (in July) for oxygen concentration (mg/l), hydrogen sulphide concentration (mg/l), salinity (PSU) and temperature (°C) in the water column.



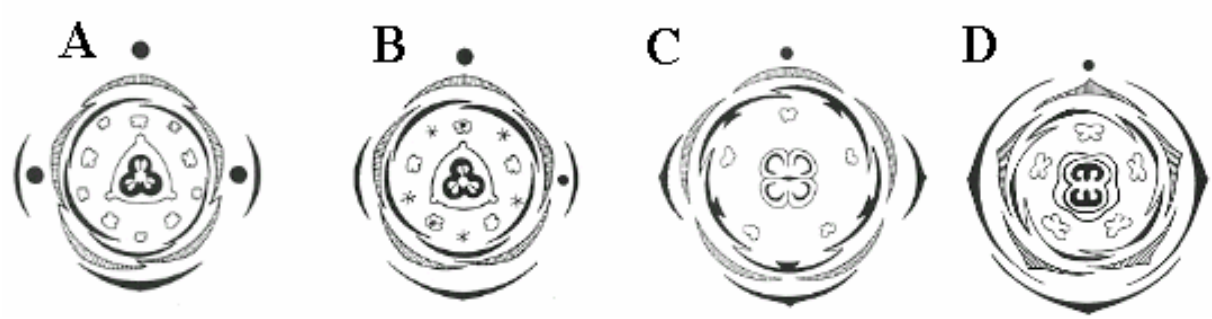
Match in the table in the answer sheet the labels A, B, C, and D with oxygen concentration, hydrogen sulphide concentration, salinity and temperature, and the labels E, F and G with parts of the curves – halocline, redoxycline and thermocline.

1	Oxygen concentration	
2	Hydrogen sulphide concentration	
3	Salinity	
4	Temperature	
5	Halocline	
6	Redoxycline	
7	Thermocline	

(7 points)

Biosystematics

B 37. There are 4 flower diagrams shown:



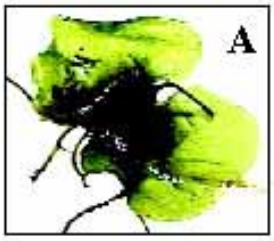
Write the appropriate label (**A-D**) of a diagram in the table in the answer sheet.

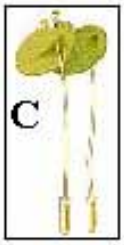
	Flower formulas	**Label**
1	⊕♀♂ $Ca_{(5)}$ Co_5 A_{5+5} $G_{(3)}$	
2	⊕♂ $Ca_{(5)}$ $Co_{(5)}$ $A_{(5)}$	
3	⊕♀♂ Ca_5 Co_5 A_{0+5} $G_{(3)}$	
4	⊕♀♂ Ca_5 $Co_{(5)}$ A_5 $G_{(2)}$	
5	⊕♀♂ Ca_5 $Co_{(5)}$ A_5 $G_{(4)}$	

(2 points)

B 38. The pictures below show a seed **(1)** or a fruit **(2)**. Write the answers **(1 or 2)** in the table in the answer sheet.

(2 points)





(2 points)

B 41. The systematic, morphological, biological and ecological characters of two invertebrate species are presented. Write the appropriate number of an organism in the table in the answer sheet!

A. Protist
No flagellum, no cilia
Complex life cycle
Intracellular parasite
Intermediate host present

……..

B. Arthropod
Secondarily reduced wings
Incomplete metamorphosis
Ectoparasite on mammals
Absence of intermediate host

……..

Code: **1** *Plasmodium* **2** Dysentery amoeba **3** *Paramaecium*
4 *Trypanosoma* **5** Tick **6** Flea **7**. Human louse **8** Spider

(2 points)

B 42. Most birds start to incubate when their clutch is full. There are species which start incubation after the first egg is laid. Their chicks hatch asynchronously, which is characteristic to birds of prey and owls (Falconiformes, Strigiformes).
Mark all the correct statements with crosses in the table in the answer sheet.

A.	Food resources for birds of prey, and therefore the number of chicks they can feed, differ between years significantly	
B.	Younger nestlings are fed more often and they catch up with older ones in the progress of their growth	
C.	Birds of prey feed as many chicks of the brood as the food resources allow in the given year	
D.	During years with scarce food resources, food is given mainly to the oldest nestlings, while the youngest ones starve to death	
E.	Older nestlings help to feed younger ones	
F.	Room in the nest is not sufficient for several big chicks simultaneously, therefore they grow up and fly out of the nest one at a time	
G.	One fledgling that can reach reproduction age is more important for species survival then several but not well developed fledglings	
H.	The number of fledglings and not their fitness is the most important for the species survival	

(2 points)

5. Results and statistical analysis

Theoretical part

The figures 1 – 24 represent statistics summarizing information on the theoretical part A and part B. Results were analyzed by Biology sub-branches.

As it can be seen from the graphs 1 - 9, in part A students showed the best results in Cell Biology, Plant Anatomy and Physiology, and Animal Anatomy and Physiology. In those sub-branches 62 % of students gave the true answers. Good results were achieved also in Genetics and Evolution (61 % true answers) and Systematics (59 % true answers). The most complicated part was Ecology (49 % true answers) and Ethology (54 % true answers).

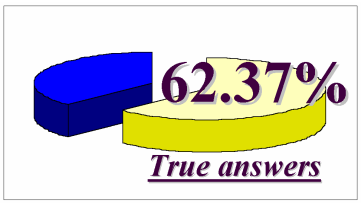


Fig. 1. Cell Biology. (Part A).

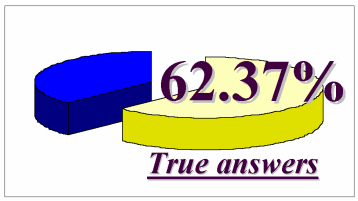


Fig. 2. Plant Anatomy and Physiology. (Part A).

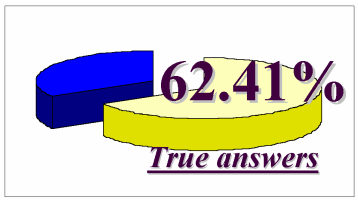


Fig. 3. Animal Anatomy and Physiology. (Part A).

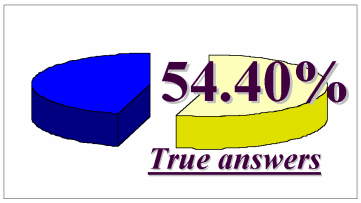


Fig. 4. Ethology. (Part A).

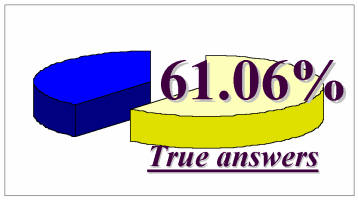


Fig. 5. Genetics and Evolution. (Part A).

Fig. 6. Ecology. (Part A).

Fig. 7. Systematics. (Part A).

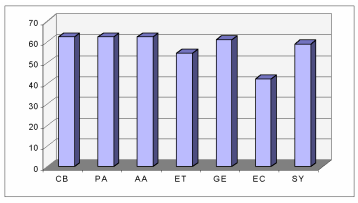


Fig. 8. Part A. True answers (%). CB – Cell Biology; PA – Plant Anatomy and Physiology; AA – Animal Anatomy and Physiology; ET – Ethology; GE – Genetics and Evolution; EC – Ecology; SY - Systematics

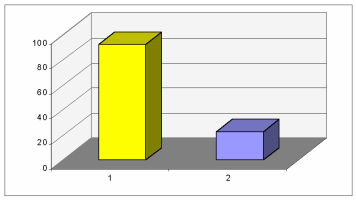


Fig. 9. Difference between excersises (% true answers). The easiest – Q22 (Plant anatomy and Physiology), 91.82 % true answers, and the heaviest –Q56 (Ecology), 22.64 % true answers.

Figures 10 – 24 show the participants density trace as well as the observed minimum, observed maximum and the possible maximum in tasks, Part B, in appropriate biology sub-branches. In total the results of part B correspond to the general curve of distribution (Fig. 23), but in several cases they are different. As many questions of Ethology, Part B, were skipped, there was no possibility to analyse the appropriate results. The column diagram is given in figure 16. The most difficult tasks were prepared in Genetics and Evolution (Fig. 17) and Ecology (Fig. 19), but less complicated tasks were prepared in Systematics (Fig. 21).
The difference between the observed maximum and possible maximum in part B in total is rather great – 41 point (Fig. 24). That means that part B tasks were quite difficult in comparison with tasks of part A.

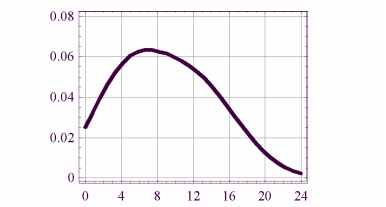


Fig. 10. True answers. Participants density trace. Cell biology. (Part B).

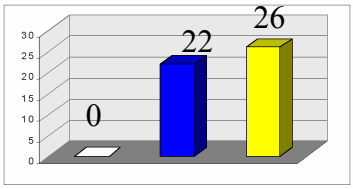


Fig. 11. True answers. Cell biology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

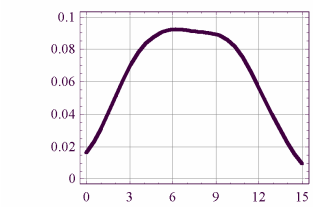


Fig. 12. True answers. Participants density trace. Plant anatomy and physiology. (Part B).

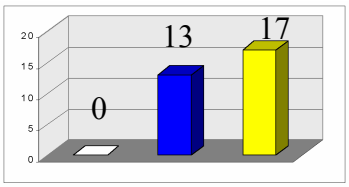


Fig. 13. True answers. Plant Anatomy and Physiology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

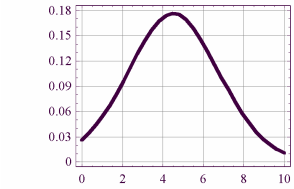


Fig. 14. True answers. Participants density trace. Animal anatomy and physiology. (Part B).

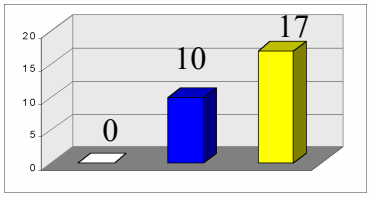


Fig. 15. True answers. Animal Anatomy and Physiology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

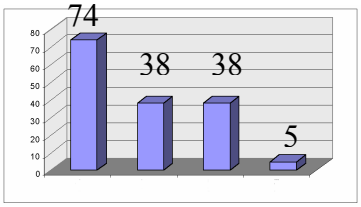


Fig. 16. Points vs. number of the participants. Ethology. (Part B).

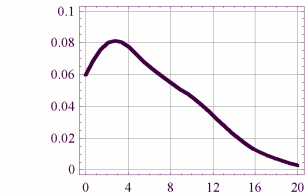


Fig. 17. True answers. Participants density trace. Genetics and Evolution. (Part B).

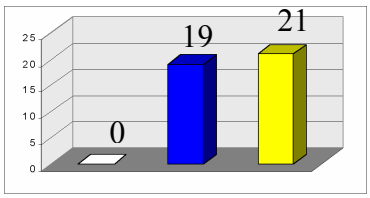


Fig. 18. True answers. Genetics and Evolution. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

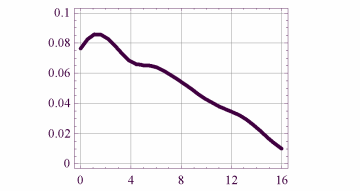


Fig. 19. True answers. Participants density trace. Ecology. (Part B).

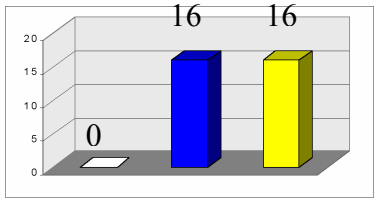


Fig. 20. True answers. Ecology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

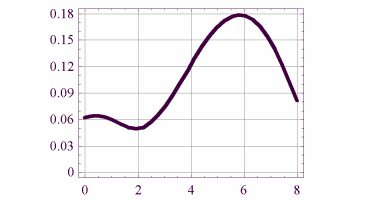


Fig. 21. True answers. Participants density trace. Systematics. (Part B).

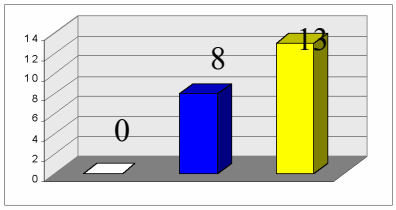


Fig. 22. True answers. Systematics. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

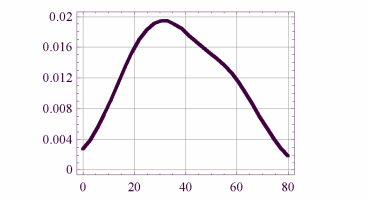


Fig. 23. True answers. Participants density trace. Total. (Part B).

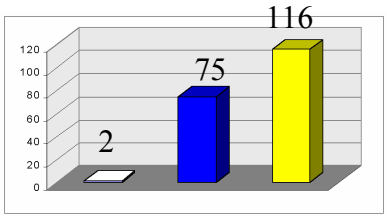


Fig. 24. True answers. Total. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Part B).

Practical part

The figures 25-37 represent statistics summarizing information on practical part. The results of 4 practical tests were analyzed – Zoology, Botany, Molecular biology and Dendroecology.

Figures 25-34 show the participants density trace as well as the observed minimum, observed maximum and the possible maximum in practical tasks in appropriate biology sub-branches. The results of all practical tasks (Fig. 26, 28, 30, 32) as well as total density trace (Fig. 34) correspond to the general curve of distribution.

The students were divided in the morning and afternoon groups. So the results of the morning groups were compared with the results of afternoon groups (Fig. 35 - 36). There was no useful difference between the obtained results of students from these groups.

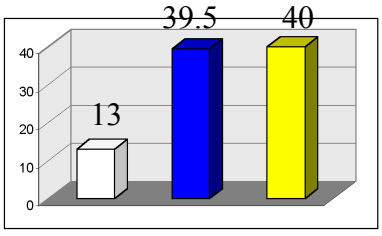


Fig. 25. True answers. Zoology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum (Practical test).

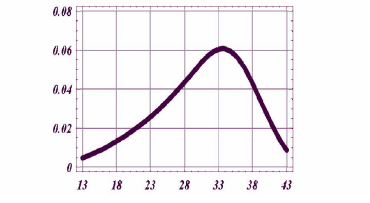


Fig. 26. True answers. Participants density trace. Zoology. (Practical test).

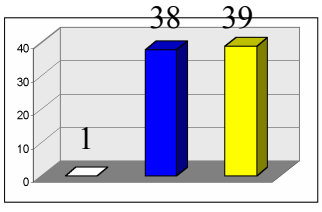


Fig. 27. True answers. Botany. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Practical test).

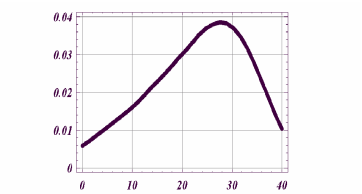


Fig. 28. True answers. Participants density trace. Botany. (Practical test).

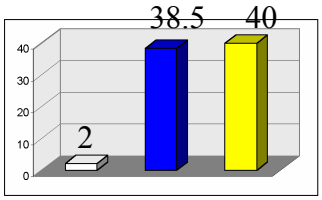


Fig. 29. True answers. Molecular Biology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Practical test).

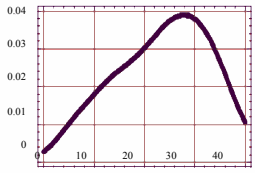


Fig. 30. True answers. Participants density trace. Molecular Biology. (Practical test).

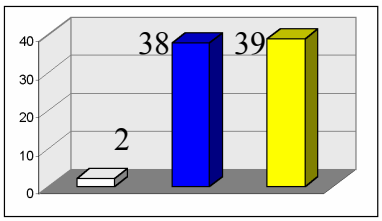


Fig. 31. True answers. Dendroecology. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Practical test).

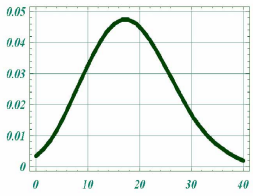


Fig. 32. True answers. Participants density trace. Dendroecology. (Practical test).

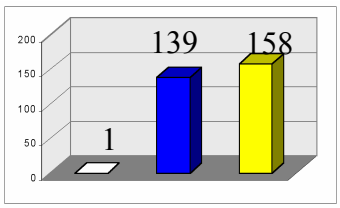


Fig. 33. True answers. Total. 1 – observed minimum; 2 – observed maximum; 3 – possible maximum. (Practical test).

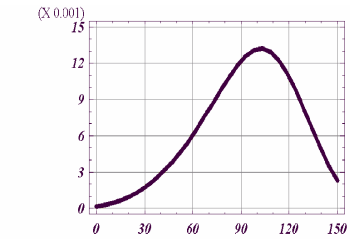


Fig. 34. True answers. Participants density trace. Total. (Practical test).

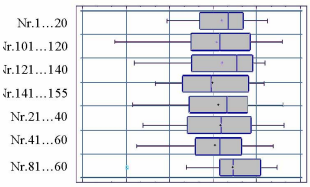


Fig. 35. Box-and-Whisker Plot for participants index number. (Practical test).

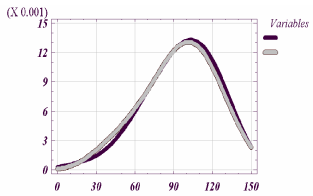


Fig. 36. True answers. Participants density trace. Comparison: Afternoon vs. Morning. (Practical test).

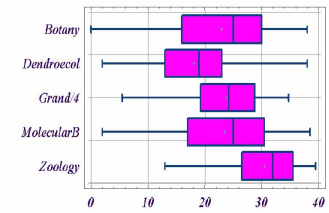


Fig. 37. Box-and-Whisker Plot for branches. (Practical test).

Total results

Figures 38 – 40 shows rank of participants versus t-score. The knowledge for most students are similar both in practical and theoretical part (Fig. 38, 39). Some students were better in practical tasks, but some of them – in theoretical tasks. The curve "Rank vs. Total t-score" (Fig. 40) is S-shaped and that means that the best students (rank 1-5) are best aware, and the worst students (rank 152 – 157) are worst aware both in theoretical and in practical tasks.

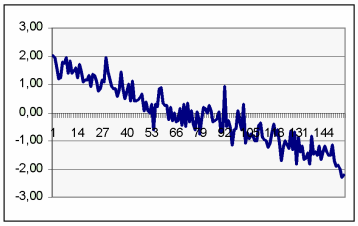


Fig. 38. Rank vs. Theory t-score

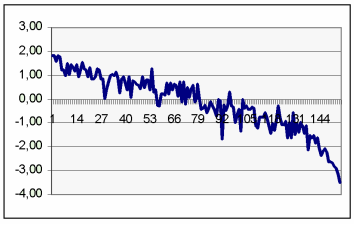


Fig. 39. Rank vs. Practice t-score

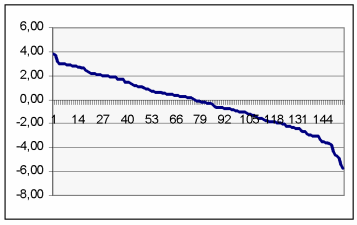


Fig. 40. Rank vs. Total t-score

The results and awarded medals of participants of the 13th IBO are given in the table below.

International Biology Olimpiad 2002 Final Results

	Family name	*First name*	*Country*	*Practice (/158)*	*Theory (/164)*	*Practice + Theory*	*t-Practice*	*t-Theory*	*t-Score*	*cc-Score*	*t-Rank*	*Rank*	*Medals*
1	Chen	Xu	People Republic of China	138,5	133	271,5	1,79	2,01	3,80	67,71	1	1	gold
2	Wyatt	David	United Kingdom	138,5	131	269,5	1,79	1,93	3,72	67,24	2	2	gold
3	Shilov	Evgeny	Russia	134	122,5	256,5	1,59		3,17	64,05	3	3	gold
4	Tsung-Yu	Hou	Taiwan (Chinese Taipei)	139	113	252	1,81	1,19	3,01	63,12	4	5	gold
5	Thompson	Erica	United Kingdom	137,5	114,5	252	1,75	1,25	3,00	63,08	5	4	gold
6	Fu	Hongyu	People Republic of China	125,5	127,5	253	1,20	1,79	2,99	63,01	6	5	gold
7	Cho	Hyun Hee	Korea	125,5	126,5	252	1,20	1,75	2,95	62,77	7	5	gold
8	Moon	Soo Young	Korea	120,5	131,5	252	0,97	1,95	2,92	62,64	8	5	gold
9	Hao-chun	Hsu	Taiwan (Chinese Taipei)	131,5	118	249,5	1,47	1,40	2,87	62,33	9	9	gold
10	Son	Joo Hun	Korea	122	128,5	250,5	1,04	1,83	2,87	62,33	10	10	gold
11	Licheuski	Uladzimir	Belarus	131	117,5	248,5	1,45	1,38	2,83	62,09	11	11	gold
12	Ng	Shuh Chang	Singapore	128,5	120	248,5	1,34	1,48	2,82	62,02	12	11	gold
13	Huang	Mingyan	Singapore	125	123	248	1,18	1,60	2,78	61,81	13	13	gold
14	Yen-po	Lan	Taiwan (Chinese Taipei)	131	114	245	1,45	1,23	2,68	61,26	14	14	gold
15	Ling	Cheng	People Republic of China	120	126	246	0,95	1,73	2,68	61,21	15	15	gold
16	Chaibang	Adisorn	Thailand	126	118,5	244,5	1,22	1,42	2,64	61,01	16	16	gold
17	Banditsaowapak	Rawichot	Thailand	132,5	110,5	243	1,52	1,09	2,61	60,82	17	17	silver
18	Gailīte	Ieva	Latvia	127	112	239	1,27	1,15	2,42	59,74	18	18	silver
19	Preativatanyou	Kanok	Thailand	126	112	238	1,22	1,15	2,38	59,48	19	19	silver
20	Holik	Aliaksei	Belarus	119,5	116	235,5	0,93	1,32	2,24	58,72	20	20	silver
21	Zagidullin	Timur	Russia	127,5	106	233,5	1,29	0,91	2,20	58,45	21	21	silver

International Biology Olimpiad 2002 Final Results *(continuation)*

	Family name	*First name*	*Country*	*Practice (/158)*	*Theory (/164)*	*Practice + Theory*	*t-Practice*	*t-Theory*	*t-Score*	*cc-Score*	*t-Rank*	*Rank*	*Medals*
22	Goodarzi	Hani	Islamic Republic of Iran	117,5	117	234,5	0,84	1,36	2,19	58,43	22	22	silver
23	Misāne	Maija	Latvia	117,5	115,5	233	0,84	1,30	2,13	58,08	23	23	silver
24	Vohra	Rahul	United Kingdom	119,5	111,5	231	0,93	1,13	2,06	57,65	24	24	silver
25	Chen	Guang	Australia	127	103	230	1,27	0,78	2,05	57,61	25	28	silver
26	Liu	Danny	Australia	125,5	104	229,5	1,20	0,82	2,03	57,45	26	30	silver
27	Wei-hsiang	Lin	Taiwan (Chinese Taipei)	118	112	230	0,86	1,15	2,01	57,38	27	26	silver
28	Sanguinetti	Agustin	Argentina	118	110,5	228,5	0,86	1,09	1,95	57,03	28	29	silver
29	Bhattacharya	Hrishikesh	India	99,5	131	230,5	0,02	1,93	1,95	57,02	29	26	silver
30	Najafabadi	Hamed Shateri	Islamic Republic of Iran	109	120	229	0,45	1,48	1,93	56,91	30	25	silver
31	Chia	Wei Zhong Jonathan	Singapore	115	113	228	0,72	1,19	1,92	56,83	31	31	silver
32	Kim	Yong-Woo	Korea	120,5	106,5	227	0,97	0,93	1,90	56,74	32	32	silver
33	de Adelhart Toorop	Reinier	The Netherlands	121,5	104	225,5	1,02	0,82	1,84	56,41	33	33	silver
34	Chia	Sheng Zhi	Singapore	121	104,5	225,5	1,00	0,84	1,84	56,39	34	33	silver
35	Pupov	Danil	Russia	124	98	222	1,13	0,58	1,71	55,64	35	35	silver
36	Sun	Lu	People Republic of China	119	103,5	222,5	0,91	0,80	1,71	55,63	36	36	silver
37	Subsoontorn	Pakpoom	Thailand	104,5	119	223,5	0,25	1,44	1,69	55,50	37	37	silver
38	Luzhynskaya	Aryna	Belarus	117,5	104	221,5	0,84	0,82	1,66	55,36	38	38	silver
39	Tesitel	Jakub	Czech Republic	120	95,5	215,5	0,95	0,48	1,43	54,01	39	39	silver
40	Sarkar	Siddharth	India	114	102	216	0,68	0,74	1,42	53,97	40	41	silver
41	Mok	Vincent	Australia	108	108	216	0,41	0,99	1,39	53,81	41	39	silver
42	Bekakhmetov	Gabit	Kazakhstan	120	93,5	213,5	0,95	0,39	1,35	53,53	42	42	silver
43	Can	Cenik	Turkey	101	111	212	0,09	1,11	1,20	52,69	43	43	silver

International Biology Olimpiad 2002 Final Results *(continuation)*

44	Lytvchenko	Olexandr	Ukraine	115,5	93,5	209	0,75	0,39	1,14	52,35	44	44	silver
45	Gossmann	Toni	Germany	115	93,5	208,5	0,72	0,39	1,12	52,22	45	45	silver
46	Markov	Denis	Russia	113	95	208	0,63	0,46	1,09	52,05	46	46	silver
47	Jappar	I. Aditya	Indonesia	111,5	96,5	208	0,57	0,52	1,08	52,01	47	46	silver
48	Hoell	Reinhard	Germany	108,5	99,5	208	0,43	0,64	1,07	51,94	48	46	silver
49	Fechner	Peter	Germany	120	85	205	0,95	0,05	1,00	51,52	49	49	silver
50	Terletskyy	Bogdan	Ukraine	110	93	203	0,50	0,37	0,87	50,79	50	50	bronze
51	Berezhnoy	Nikolay	Kazakhstan	116,5	85,5	202	0,79	0,07	0,86	50,73	51	51	bronze
52	Koval	Svetlana	Ukraine	117	83,5	200,5	0,82	-0,02	0,80	50,38	52	52	bronze
53	Aivelo	Tuomas	Finland	107,5	91,5	199	0,38	0,31	0,70	49,79	53	53	bronze
54	Van Den Bossche	Hannes	Belgium	127	69,5	196,5	1,27	-0,59	0,68	49,70	54	54	bronze
55	Oktay	Afsin Ahmet	Turkey	106	91	197	0,32	0,29	0,61	49,27	55	57	bronze
56	Sitnik	Katarzyna	Poland	107,5	89	196,5	0,38	0,21	0,59	49,19	56	54	bronze
57	Kalhor	Reza	Islamic Republic of Iran	93,5	104	197,5	-0,25	0,82	0,57	49,07	57	57	bronze
58	Nettelblad	Carl	Sweden	92,5	105	197,5	-0,30	0,87	0,57	49,04	58	56	bronze
59	Mardakheh	Faraz Khosravi	Islamic Republic of Iran	103,5	92	195,5	0,20	0,33	0,53	48,86	59	59	bronze
60	Nguyen	Tuan Anh	Vietnam	104	90,5	194,5	0,22	0,27	0,50	48,63	60	60	bronze
61	Riley	Timothy	United Kingdom	103	90	193	0,18	0,25	0,43	48,25	61	61	bronze
62	Nguyen Van	Nhuong	Vietnam	113,5	78	191,5	0,66	-0,24	0,42	48,17	62	62	bronze
63	Bernasconi	Alejandro	Argentina	104	88	192	0,22	0,17	0,39	48,04	63	63	bronze
64	Makeyenka	Siarhei	Belarus	113,5	77	190,5	0,66	-0,28	0,37	47,93	64	64	bronze
65	Jones	Sarah	Australia	108	83	191	0,41	-0,04	0,37	47,91	65	65	bronze
66	van den Brand	Michiel	The Netherlands	113	76	189	0,63	-0,32	0,31	47,56	66	66	bronze
67	Irša	Lāsma	Latvia	111,5	77	188,5	0,57	-0,28	0,28	47,41	67	66	bronze
68	Baltkalne	Martina	Latvia	102	87	189	0,13	0,13	0,26	47,28	68	68	bronze
69	Sedman	Laura	Estonia	114,5	73	187,5	0,70	-0,45	0,26	47,25	69	69	bronze
70	Aggarwal	Ashish	India	97	91	188	-0,09	0,29	0,20	46,92	70	70	bronze

International Biology Olimpiad 2002 Final Results *(continuation)*

71	Kolar	Filip	Czech Republic	114,5	71,5	186	0,70	-0,51	0,19	46,89	71	71	bronze
72	Serkan	Kir	Turkey	95	92	187	-0,18	0,33	0,15	46,63	72	72	bronze
73	Buryova	Ivana	Slovakia	109,5	75,5	185	0,47	-0,34	0,13	46,53	73	73	bronze
74	Alexandrova	Anastasia	Ukraine	100,5	85	185,5	0,07	0,05	0,11	46,42	74	74	bronze
75	Steblovnik	Klemen	Slovenia	109	73,5	182,5	0,45	-0,42	0,03	45,93	75	75	bronze
76	Kambarov	Yerkebulan	Kazakhstan	112	69	181	0,59	-0,61	-0,02	45,65	76	76	bronze
77	Lach	Radoslaw	Poland	96,5	84	180,5	-0,12	0,01	-0,11	45,13	77	77	bronze
78	Aarts	Anita	The Netherlands	101	78	179	0,09	-0,24	-0,15	44,89	78	78	bronze
79	Rezkova	Katerina	Czech Republic	112,5	65	177,5	0,61	-0,77	-0,16	44,83	79	80	bronze
80	Radomir	Ort	Slovakia	100	78	178	0,04	-0,24	-0,20	44,63	80	80	bronze
81	Verschoor	Arjan	The Netherlands	90	88,5	178,5	-0,41	0,19	-0,22	44,49	81	82	bronze
82	Dagdas	Yasin Fatih	Turkey	90,5	87,5	178	-0,39	0,15	-0,24	44,39	82	79	bronze
83	Septiawan	A. Rendra	Indonesia	93,5	83	176,5	-0,25	-0,04	-0,29	44,11	83	83	bronze
84	Srivastan	Stuti	India	86,2	90	176,2	-0,58	0,25	-0,33	43,85	84	84	bronze
85	Bancerek	Joanna	Poland	90,5	85	175,5	-0,39	0,05	-0,34	43,80	85	85	bronze
86	Lacoretz	Mariela	Argentina	96,5	76	172,5	-0,12	-0,32	-0,44	43,24	86	86	bronze
87	Heer	Sebastian	Switzerland	92,5	76,5	169	-0,30	-0,30	-0,60	42,31	87	87	bronze
88	Cojcariu	Ovidiu Dumitru	Romania	89	78,5	167,5	-0,46	-0,22	-0,68	41,87	88	91	bronze
89	Barrett	Neil	Ireland	83,5	84,5	168	-0,71	0,03	-0,68	41,84	89	89	bronze
90	Dungan	Lara	Ireland	99	67	166	0,00	-0,69	-0,69	41,77	90	91	bronze
91	Kappei	Dennis	Germany	97,5	68,5	166	-0,07	-0,63	-0,70	41,73	91	88	bronze
92	Gubadov	Murad	Azerbaijan	62	106,5	168,5	-1,68	0,93	-0,76	41,41	92	90	bronze
93	Djupfeldt	Emil	Sweden	93,5	71,5	165	-0,25	-0,51	-0,76	41,39	93	93	bronze
94	Kokalj	Borut	Slovenia	88,5	77	165,5	-0,48	-0,28	-0,76	41,38	94	94	bronze
95	Tealdi	Ana Carolina	Argentina	93,5	71	164,5	-0,25	-0,53	-0,78	41,27	95	95	bronze
96	Stano	Matej	Slovakia	105,5	56	161,5	0,29	-1,14	-0,85	40,87	96	98	
97	Monoshev	Rasul	Kyrgyzstan	93	69	162	-0,27	-0,61	-0,88	40,67	97	98	
98	Ivanov	Miroslav	Bulgaria	91,5	70	161,5	-0,34	-0,57	-0,91	40,51	98	96	
99	Artadana	I.B.Made	Indonesia	77	85	162	-1,00	0,05	-0,96	40,26	99	96	
100	Zavera	Emil-Alin	Romania	84,5	75,5	160	-0,66	-0,34	-1,00	39,98	100	100	

International Biology Olimpiad 2002 Final Results *(continuation)*

101	Hakanpaa	Silja	Finland	90	69	159	-0,41	-0,61	-1,02	39,88	101	100	
102	Wozniak	Krzysztof	Poland	69	91	160	-1,37	0,29	-1,07	39,58	102	102	
103	York	Donna	Ireland	98,5	58	156,5	-0,03	-1,06	-1,08	39,51	103	103	
104	Kozubikova	Eva	Czech Republic	90,5	66,5	157	-0,39	-0,71	-1,10	39,42	104	104	
105	Kormann	Urs	Switzerland	93	61,5	154,5	-0,27	-0,92	-1,19	38,90	105	105	
106	Gutierrez	Eva	Mexico	89,5	65	154,5	-0,43	-0,77	-1,21	38,81	106	105	
107	Raemdonk	Cedric	Belgium	89,5	63	152,5	-0,43	-0,85	-1,29	38,34	107	107	
108	Ota	Katja	Slovenia	92	59,5	151,5	-0,32	-1,00	-1,32	38,16	108	108	
109	Aituov	Baurzhan	Kazakhstan	90,5	59	149,5	-0,39	-1,02	-1,41	37,65	109	109	
110	Nguyen Thi	Thuy Duong	Vietnam	74,5	72,5	147	-1,12	-0,47	-1,58	36,65	110	110	
111	Cicanic	Michal	Slovakia	72,5	74,5	147	-1,21	-0,38	-1,59	36,60	111	110	
112	O Toole	Geoffrey	Ireland	83	62	145	-0,73	-0,90	-1,63	36,40	112	112	
113	Jutzi	Michael	Switzerland	83	60,5	143,5	-0,73	-0,96	-1,69	36,04	113	113	
114	Sperber	Henrik	Sweden	82,5	59	141,5	-0,75	-1,02	-1,77	35,56	114	114	
115	Lundman	Emma	Sweden	86,5	53,5	140	-0,57	-1,24	-1,81	35,31	115	116	
116	Escalona	Christian	Mexico	82	58	140	-0,77	-1,06	-1,83	35,19	116	115	
117	Helanto	Ulla	Finland	74	66,5	140,5	-1,14	-0,71	-1,85	35,10	117	117	
118	Handzhiyski	Ivan	Bulgaria	67	74	141	-1,46	-0,40	-1,86	35,04	118	117	
119	Lc Thi	Thu Trang	Vietnam	76	64	140	-1,05	-0,81	-1,86	35,03	119	117	
120	Bevk	Danilo	Slovenia	70	69	139	-1,32	-0,61	-1,93	34,64	120	120	
121	Allakuliyev	Muhammet	Turkmenistan	79,5	57,5	137	-0,89	-1,08	-1,97	34,42	121	121	
122	Heiniger	Jael	Switzerland	92,5	42,5	135	-0,30	-1,69	-1,99	34,28	122	122	
123	Tajonar	Adriana	Mexico	81,5	54	135,5	-0,80	-1,22	-2,02	34,11	123	123	
124	Yaneva	Teodora	Bulgaria	75	59,5	134,5	-1,09	-1,00	-2,09	33,71	124	124	
125	Dotsenko	Dmitriy	Kyrgyzstan	75	57	132	-1,09	-1,10	-2,19	33,12	125	125	
126	Herpigny	Basile	Belgium	78	52,5	130,5	-0,96	-1,28	-2,24	32,84	126	126	
127	Xicotencatl	Gracida	Mexico	63	68,5	131,5	-1,64	-0,63	-2,27	32,69	127	127	
128	Cavadzade	Tural	Azerbaijan	77	52	129	-1,00	-1,31	-2,31	32,46	128	127	
129	Majidov	Anar	Azerbaijan	63	67,5	130,5	-1,64	-0,67	-2,31	32,45	129	129	
130	Capiau	Julie	Belgium	86,5	39,5	126	-0,57	-1,82	-2,39	32,00	130	130	

International Biology Olimpiad 2002 Final Results *(continuation)*

131	Dilion	Denis	Moldova	66	62	128	-1,50	-0,90	-2,40	31,94	131	131	
132	Malvik	Marko	Estonia	76	50	126	-1,05	-1,39	-2,43	31,73	132	131	
133	Wiarta	I.Ketut	Indonesia	68	54,5	122,5	-1,41	-1,20	-2,61	30,69	133	133	
134	Pentson	Martin	Estonia	77	43	120	-1,00	-1,67	-2,68	30,34	134	134	
135	Paljanos	Annamaria	Romania	74,5	44,5	119	-1,12	-1,61	-2,73	30,03	135	135	
136	Kopra	Jaakko	Finland	67,5	49	116,5	-1,43	-1,43	-2,86	29,26	136	136	
137	Akmatbekov	Aybek	Kyrgyzstan	74	39,5	113,5	-1,14	-1,82	-2,96	28,72	137	137	
138	Cafarov	Murad	Azerbaijan	52,5	63	115,5	-2,11	-0,85	-2,97	28,64	138	138	
139	Yuldashev	Abdimomun	Kyrgyzstan	65	48	113	-1,55	-1,47	-3,02	28,37	139	139	
140	Ciobanu	Natalia	Moldova	63	50	113	-1,64	-1,39	-3,02	28,32	140	139	
141	Jarve	Mari	Estonia	65,5	47	112,5	-1,52	-1,51	-3,03	28,27	141	139	
142	Chingotuane	Alaudio Viegas Filipe	Mozambique	58,5	54,5	113	-1,84	-1,20	-3,05	28,20	142	142	
143	Ševchenko	Sabina	Moldova	63,5	43	106,5	-1,61	-1,67	-3,29	26,80	143	143	
144	Andashev	Batyr	Turkmenistan	53	49,5	102,5	-2,09	-1,41	-3,50	25,58	144	144	
145	Oltean	Bogdan Mihai	Romania	47	55	102	-2,36	-1,18	-3,55	25,31	145	145	
146	Hojagyeldiyev	Dayanch	Turkmenistan	51,5	49,5	101	-2,16	-1,41	-3,57	25,19	146	146	
147	Karugi Kaigua	Ruth	Kenya	53	47	100	-2,09	-1,51	-3,60	24,99	147	147	
148	Kitromilis	Andreas	Cyprus	50	47	97	-2,23	-1,51	-3,74	24,21	148	148	
149	Kokkodis	Marios	Cyprus	41,5	55,5	97	-2,61	-1,16	-3,78	23,99	149	148	
150	Tuzo D.K. Mmari	Paschal	Kenya	41	42	83	-2,64	-1,71	-4,35	20,67	150	150	
151	Cambaza	Manuel Edgar	Mozambique	40,5	37	77,5	-2,66	-1,92	-4,58	19,35	151	151	
152	Tsiarli	Maria	Cyprus	37	38	75	-2,82	-1,88	-4,70	18,67	152	152	
153	Savva	Constantinos	Cyprus	35,5	35,5	71	-2,89	-1,98	-4,87	17,69	153	153	
154	Matavele	Raquel Jose	Mozambique	30,5	27,5	58	-3,11	-2,31	-5,42	14,49	154	154	
155	Macuacua	Bachir Carlos	Mozambique	22	29,5	51,5	-3,50	-2,23	-5,73	12,73	155	155	