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Report on the 10th International Biology Olympiad in Uppsala, Sweden

"In the footsteps of Linnaes"

July 4 to 11, 1999

Edited by
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The Scientific Committee
The Organization Committee
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The guides
The members of the Association of Biology Teachers

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1. Introduction

In Sweden, the responsibility for the National Biology Olympiad as well as for the IBO has been delegated from the Ministry of Education to the Biology Teachers' Organisation, a non-governmental voluntary organisation with ca 1200 members. Sweden has taken part in the International Biology Olympiads since the first IBO in 1990, first as observer and then since 1992 with a competing team. In 1997, the Ministry of Education agreed that Sweden would be the host country of the 10th IBO in 1999. A great deal of the work in preparing and carrying out the IBO was done by biology teachers, students, and other volunteers, in their leisure time.

In our view, the prime purpose of the IBO must be to stimulate the interest in biology among young people. From that perspective, the social atmosphere among the competitors and the positive experience of a foreign country and its nature are just as important as the competition itself. Therefore, in this report we will put as much emphasis on the program and practical arrangements as on the competition. Our hope is that this report may give both inspiration and some useful practical suggestions for IBO organisers in the future.

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2. Organisation

2.1. Organising Committee

In March 1998, the annual meeting of the Biology Teachers' Organisation appointed an Organising Committee with 10 persons: Andreas Ehn, Birgitta Berggren, Christina Broman, Susanne Fabricius, Monica Fernholm, Christina Polgren, Tony Rohnér, Astrid Rödén, Monica Svensson, and Rolf Ödén. Rolf Ödén withdraw from the Committee at an early stage, and was replaced by Elsa Wicklund and Vega Otterland, so the Organising Committee effectively consisted of 11 persons.

Already in late 1997, Astrid Rödén, Elsa Wicklund and Vega Otterland had got a special responsibility for raising sponsor money for the IBO. Except for this, for a long time there was no clear division of fields of responsibility within the Organising Committee, but the Organising Committee functioned mainly as a reference and decision group. In retrospect, we think it could have been an advantage to make a division of responsibilities much earlier.

2.2. Employed staff

The Organising Committee employed Torbjörn Nilsson as Organising Secretary of the IBO, officially halftime from June 1998 to April 1999 and fulltime from May to August 1999. The actual working time turned out to be less than halftime in the autumn of 1998, fulltime in April 1999 and more than fulltime in the following months. In May 1999, we realised that there was more work than we could manage without employing someone more. Luckily enough we could employ a very competent Assistant Secretary, Cecilia Andersson, halftime in June and July.

We also hired professionals for some specific tasks during the IBO: for cooking the meals, for helping us with the computers at Katedralskolan, for the disco and for setting up the party tents on Friday night. The big buses were hired with professional drivers, as were also the boats used on the archipelago excursion and the trip to Skokloster, and the University Hall was hired with a sound technician.

For assisting the Scientific Task Committee in practically preparing and overlooking the practical tests, we employed for a few days five persons with special competencies, suggested by the Task Committe. We also employed Olga Poluljach to help us with translations into Russian before and during the IBO for a moderate salary, as well as an experienced statistician to help us with statistical analysis of the test results.

2.3. Scientific Task Committe

The Scientific Task Committee consisted of five persons: Prof. Staffan Ulfstrand (animal ecology), who was also the president of the IBO and the Chairman of the international Jury, Prof. Lena Clapham (genetics), Prof. Gunnar Fridborg (plant physiology), Prof. Lennart Olsson (animal morphology), and Prof. Karin Svensson (microbiology). The committee was recruited and appointed in 1998. From November 1998 and till the start of the IBO, the Scientific Task Committee held 16 meetings. Andreas Ehn and Torbjörn Nilsson took part in these meetings to advise the committee about the form and difficulty level of the tasks.

2.4. Student guides

For most competitor teams, there was a student guide that knew the native language of the team and that joined them at leisure time during the IBO week. For some teams, however, we did not succeed to find a guide that knew the language and that could take part the whole week. Therefore, a few teams got two guides during different parts of the week, of which at least one knew the language of the team. Some of the teams of former Soviet republics got guides that knew Russian but not the native language of their country. For the Belgian team, we could not find a guide speaking both Dutch and French, so they got one guide for each language. Hence, altogether we had 41 student guides for the 34 teams.

2.5. Other voluntary staff

Except for the organising committee, the task committee, and the student guides, 65 persons were involved as voluntary staff in arranging the IBO. All voluntary staff was offered payment for their costs of participation, plus a symbolic sum of 124 SEK per day (approximately an average 1-hour salary). Many persons had different tasks on different days. The number of persons helping voluntarily in various activities were as follows:

Persons with a certain responsibility during the whole IBO week:
Head of transport: Jan Borg
Permanent driver: Brage Lindkvist
Head of opening and closing ceremonies: Christina Broman
Head of copying: Monica Svensson
Heads of student guides and running business at Wik: Ingvar Andersson and Monica Hartwig
Head of test correcting: Christina Polgren
Head of jury coffee room: Birgitta Berggren
Localities at Katedralskolan and press contact: Sven Jonsson
IBO Sentinel: Pernilla Lundmark, Michaela Lidström and Lisa Bringegård
Website manager (also before and after the IBO): Jörgen Stenlund

Pre-testing the tests in May:
Pre-testing part of the tests day 1: 7 persons
Pre-testing part of the tests, day 2: 6 persons

Just before the IBO week:
Packing the rucksacks to be given to the participants: 4 persons

Arrival:
Receiving delegations at Arlanda Airport: 2 persons
Receiving delegations at Uppsala railway station: 2 persons
Transportation: 8 drivers, 1 transport organiser
Receiving coordinators and observers at the hotel: 1 person
Receiving competitors and student guides at Wik: 2 persons
Information for student guides in the afternoon and for competitors and guides together in the evening: 2 persons (+ Wik employees)

Opening ceremony:
Preparing the University Hall before the opening ceremony (on the day of arrival), including training the entrance procedure with the guides: 6 persons
Practical help at the opening ceremony: 8 persons
Translation: 1 person

Jury sessions:
Secretaries: 4-5 persons (2 Russian-speaking)
Translators: 3 persons (including Olga Poluljach)
Coffee and snacks for the jury: 2-3 persons at the short jury sessions, 4-7 persons at the long jury sessions
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Copying:
Copying the practical test: 5 persons
Copying the theoretical test: 8 persons
Other copying: 1 person

Practical test:
Preparations the day before the test: the Scientific Task Committee, their 5 special assistants, plus 10 persons
Preparations the same morning and overlooking the test: the Scientific Task Committee, their 5 special assistants, plus 18 persons (5 Russian-speaking)
Guiding the competitors from one laboratory to the next waiting room and the next laboratory: 4 persons

Theoretical test:
Preparing and overlooking the theoretical test: 5 persons (1 Russian-speaking)

Test results:
Correcting the practical test, checking corrections, typing results into computer, and checking computer file: 11 persons plus 2 members of the Scientific Task Committee
Correcting the theoretical test, checking corrections, typing results into computer, and checking computer file: 15 persons
Statistical analysis: 1 person

Excursions etc:
Linnaeus excursion: 10 persons
Archipelago excursion: 9 persons
Stockholm excursion: 15 persons
Boat trip to Skokloster: 2 persons

Closing ceremony:
Preparing and practical help at the closing ceremony: 6 persons
Translation: 1 person

Departure:
Transport: 8 drivers plus one organiser

3. Program and practical arrangements

3.1. General time schedule

The general time schedule was outlined in the autumn of 1998. We chose to stick strictly to the suggestions in the IBO guide. From our experiences of the previous IBO in Kiel, we drew three conclusions regarding the general time schedule:

a) Having an arranged excursion for the jury on Tuesday morning, and then free time later in the day, was not really optimal; since the jury is working late on Monday night, it is better to give them free time on Tuesday morning and arrange something later in the day.

b) It was very good to start early on Wednesday morning with jury session 3, so the jury could use the whole day working through the theoretical test and have some chance to get some sleep in the night.

c) Correction of the theoretical test should not start before the jury has approved the answer key for the test; hence, the jury must work through the answer key on Thursday morning, while the competitors are performing the test.

Initially, we intended to have an additional arranged excursion on Thursday afternoon. However, those members of the Organising Committee that had been to previous IBOs suggested that many jury members might prefer to have some more free time. By omitting that excursion, we also gained some "buffer" time for the case the jury would need more time than appreciated for working on the answer key for the theoretical test.

3.2. Invitations, applications, information, and visa

When preparing and distributing the official invitations, some errors occurred in the communication between us, the Ministry of Education, and the Ministry of Foreign Affairs, leading to some countries receiving the invitation in due time but with some erroneous wordings in it, and other countries receiving the invitation somewhat late. However, in most countries, the official invitation had reached the relevant Ministry in December or January, while in a few countries it did not do so, for what reason we do not know. When we heard from the Official IBO Coordinators of some countries that their Governments had not received the invitation, we asked the Swedish Ministry of Education to send the invitation again by fax. After some further problems with fax transmission to some countries during some weeks, the invitation had finally reached all invited countries

Information to the IBO Coordinators of the invited countries was sent by post to all countries, and also by e-mail to those who had e-mail addresses, in late November and in early April. Along with this information we also sent some different application forms: one for announcing that the country will send a team, which we wanted to know before February 15; separate forms for details about Coordinators and Observers, which we wanted to know before March 31; and a separate form for details about the Competitors, which we wanted to know before June 10. In these forms, we asked whether the participants had some requirements concerning the food, which is important to know when planning and ordering the meals. We also asked specifically for the sex of all persons, to be able to plan their accommodation, and regarding Coordinators and Observers we also asked whether some of

them required single rooms. Most countries sent the required information in the right time or just a little bit later.

For participants from many countries, visa are required for visiting Sweden (or other countries within the European Union). When applying for visa, invitation letters with the name of each invited person are required. Hence, we spent some time on writing personal invitation letters for the participants from different countries. In those instances when the names of all participants were known well in advance and / or fax transmission worked properly, this was no problem. However, when the persons were decided (or exchanged) shortly before the IBO, and fax transmission only worked occasionally and unpredictably, then desperate situations arose and trying to fax invitation letters took much more time than we had anticipated.

Considerably stressing for us as organisers was when we found out (at a late date) that Olga Poluljach, although living and working in Germany but because of being a Russian citizen, needed a working permit from the Swedish immigration authority before the Swedish Embassy would give her a visum. It took many desperate phone calls to the Swedish immigration authority, and to some other authorities as well, to make sure that she got her visum in time.

3.3. Accommodation

Already in 1997, Andreas Ehn booked Hotel Linné and Wik for accommodation of adults and competitors, respectively.

Wik was the only suitable place in the county that could house so many young people, so having booked Wik was more or less a requisite for us being able to arrange the IBO. In many ways, we think Wik was a perfect place for accommodation of the competitors, beautifully situated in the countryside by Lake Mälaren, with 20 minutes driving distance to the town. There was one shortage that the student guides pointed out for us during the IBO week, and that was the lack of a place where the competitors naturally would gather during leisure time. Because the competitors were spread out in four separate buildings, and because there was no obvious gathering place, those who wanted to socialise did not know where to go. This is something we think important for future organisers to consider.

From the Swedish participants in the previous IBO in Kiel, we heard that they appreciated much being mixed with other nationalities in the same room at the place where they were accommodated. However, they found it difficult with room mates that could not speak English at all. Based on this experience, we planned the accommodation of the competitors as far as possible so that different nationalities were mixed; but also so that those with Russian as their first or second language would share with someone speaking Russian, and those with English as their first or second language would share with someone speaking English. We had some little problem with competitors of one country not wanting to share room with competitors from other countries. Since promoting friendly contact between young people from different countries is one of the main aims of the IBO, we think it important that all IBO coordinators make clear to their competitors that they will share room with competitors of other nationalities, and that there is nothing strange in this. We recommend future organisers to stress this in the information sent in advance to the coordinators.

Some time before the IBO, we realised that there were not rooms enough at Hotel Linné to house all coordinators, observers, and staff from outside Uppsala. Hence, we booked some

rooms in another hotel as well, primarily for some of our voluntary staff. This was both more expensive and somewhat impractical. For future organisers, we therefore suggest to consider setting a maximum number of observers that any country is allowed to send.

Although we had asked coordinators to mark in the application forms if they or their observers need single rooms, it turned out on the day of arrival that the coordinators and observers of one country refused to sleep in double rooms, although this was not indicated in their application form. This we think is a completely unacceptable behaviour from adult people. By sheer luck, we managed to find some available single rooms at another hotel, at a higher cost for us. For future organisers, we recommend to write very clearly in the information sent out that those who for some reason need single rooms must indicate this beforehand.

3.4. Localities for tests, jury sessions, and opening and closing ceremonies

The high school Katedralskolan was booked for the jury sessions already in 1997. In summer 1998, after considering whether it would be possible to have the practical test in the new Evolutionary Biology Centre which was just being built, we decided that it would be safer and wiser to book localities that were already in order. Therefore, we booked part of the BioMedical Centre for the practical test. The BioMedical Centre is used for many research conferences and similar activities, so we were lucky that these localities were not booked for something else a year ahead.

When the contents of the practical test were decided and divided inte four parts for different laboratories, we made the detailed planning of what part should be done in which rooms, and

how the competitors should move between the laboratories. To give the competitors a chance to rest between the laboratories, we thought it important to have four different waiting rooms where they could sit down and have some food or snacks, without getting in contact with others that had done other parts of the test.

Planning the use of various rooms at Katedralskolan for various activities was also done in spring 1999. Our considerations in this context were that the office and the jury coffee room should be easily available from the jury session hall, while the room for correcting the tests should be in a more undisturbed part of the building.

In Uppsala, there are several big halls that can be used for theoretical exams, and these are not used very much in summertime, so the hall at Polacksbacken where the theoretical test was performed was booked in early 1999.

3.5. Excursions and sightseeing

From the beginning, we had many ideas about various aspects of Sweden's rich nature that we wanted to show. Successively, however, we realised that time was too limited. We also considered offering, on one day, various alternative excursions, but eventually we found out that this would not be practically feasible.

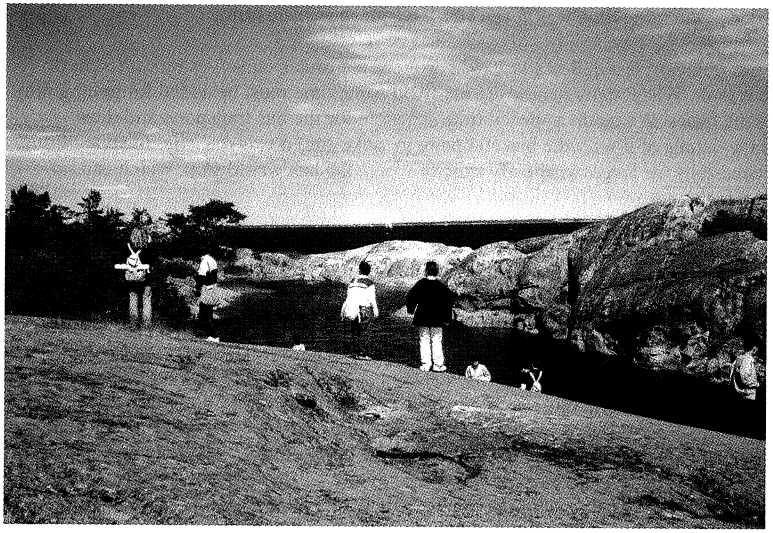
A general strife was to avoid spending too much time on getting here and there by bus. We tried to plan all excursions so that the time spent watching and experiencing things would dominate over the time of sheer transportation.

We assumed that people coming to Uppsala for the first time first of all want to see the town. Hence on Monday afternoon, while the jury was working on the practical test, we let the competitor teams go sightseeing in central Uppsala with their student guides. Thus, each team could decide what they wanted to see and in what order, and they did not have to go in big groups. The guides were instructed to suggest watching the Cathedral, the science museum Gustavianum, and the Royal Castle. For the jury, the time for free sightseeing was on Tuesday morning, while the competitors were doing the practical test. For those jury members that wanted, we offered guided walks, with guides speaking either English or Russian, after lunch on Tuesday.

After the practical test, there were some hours available for an arranged excursion, and this was just enough for seeing the places where Linnaeus lived and worked: the Linnaeus Garden in Uppsala and Linnaeus' place Hammarby outside town. Originally, we intended to show the old viking graves north of the town as well. This would have been desirable also to reduce the size of the groups coming at the same time. However, we found out that transportation would take too much time if a third place were to be included.

On Tuesday evening we heard that many of the student guides felt uncertain what they could suggest the competitors to do on Thursday afternoon, when there was more time to spend freely in Uppsala. We realised that many of the competitors had seen all the main tourist attractions on Monday, and that it might have been wise to arrange something else for them on Thursday afternoon. Fortunately, we could arrange so that those who wanted could go to the Adventure Swimming House at that time, which was much appreciated.

Among various ideas for nice field excursions, we decided to give priority to the archipelago along the Baltic Coast, a geologically remarkable area with hundreds of islands, situated in the world's largest brackish water, the Baltic Sea. Hence, we hired a boat big enough so that all the competitors, their student guides, and a few more IBO staff could go out in the archipelago on Wednesday. As an attempt to stimulate the interest in field biology among the participants, we brought three active members (two of them Russian-speaking) of the Swedish youth organisation for field biology, and some binoculars, to help those interested to watch birds. The boat went out through the inner and middle zones of the archipelago, where most of the islands are forested, and just reached the outer zone where the trees vanish, and stopped there to let the participants spend a few hours at the island Bullerö.



Since the Swedish capital Stockholm is rather close to Uppsala, and since Stockholm is often said to be one of the most beautiful capitals in the world, we supposed many participants would like to go there for an excursion, so we decided to use Friday for this. To let everybody see the most important things, we started by going round town by bus and then visiting Skansen, a combined zoo and open air museum, where many of the wild animals of Sweden as well as houses from all over the country are shown. The competitors and their student guides had time to stay longer than the jury, so they could also go to the Wasa Ship Museum, to the Old Town, or to other places worth seeing, after their own choice. Rather than planning exactly where everybody should go, we let the student guides bring some money for food and entrance fees and let the teams decide for themselves what they wanted to see. Because some of the student guides did not know Stockholm very well, we also engaged some additional young persons this day to come along as "Stockholm guides". Yet, one group of competitors lost their way in Stockholm and had to take a taxi back to the meeting point, suggesting that we should have had some more "Stockholm guides".

3.6. Leisure time activities for the competitors

During leisure time at Wik, the competitors could bathe in Lake Mälaren, go out in the countryside, borrow bicycles, and play football, badminton, and table tennis. We considered hiring some canoes for them as well, but we decided not to do so, due to the risk that someone who could not swim might go out at deep water and turn around with the canoe. In the evenings, those who wanted were shown the old castle, in groups of up to 20 persons. Later one night we also offered listening to bats with an ultra-sound detector, an activity that was joined by ca 25 persons.

3.7. Transport

For bus transport, we made a deal with the biggest local bus company, Gamla Uppsalabuss, who had enough capacity to take care of all our transport needs. The maximum number of buses needed at the same time was seven (for the Linnaeus excursion).

Planning bus transport is a delicate task. We drove some routes ourselves by car to check what time it took. When many people are involved some time must be added for getting into and out of the buses. We made a special time schedule for the bus transports and then discussed the details of it with the bus company to make sure it was realistic. In spite of this, for some occasions we forgot to specify exactly where the bus would stop, which caused some minor problems.

On the day of arrival, because different delegations were coming on different times throughout the day, using the bus company would have either been very expensive or caused long waiting times for the delegations at Arlanda airport. Therefore, we relied on voluntary drivers in stead. We hired seven cabs, so-called mini-buses, taking up to eight passengers, for which only an ordinary driving license is required. This worked well, partly because a third of the delegations had come earlier (when we had no possibility to arrange meeting them at the airport). For the day of departure, our plan was to rely again solely on voluntary drivers and the same number of mini-buses, but we realised during the IBO that this was not feasible, because too many delegations had to get to the airport during a too short time. Fortunately, we could hire a big bus to go to the airport at the time of day when most delegations needed to get there, and take care of the rest of the delegations with mini-buses.

3.8. Telecommunication

For many of the competitors, it is important to be able to phone their parents some times during the IBO week. We learned in Kiel that having only one telephone available for such calls would cause long queues and a little distress among the competitors. Luckily, at Wik their were three telephones to which parents could phone to speak with the competitors.

We had some problems with telecommunications among our staff, which we had not anticipated, and which may be worth to know and think of for future organisers. From our German colleagues, we learned about the great value of providing staff with mobile phones. In order to save money, we managed to borrow a dozen of mobile phones, so that for instance each driver could have a mobile phone on the days of arrival and departure. These phones, however, turned out to be of too poor quality, and some of them quickly became useless. Hence some staff used their own personal mobile phones, some used the poor quality ones we had borrowed, and some did not have any mobile phone. In retrospect, we think it would have been worth the cost to hire better mobile phones, and also to hire them some days in advance to be able to check their performance beforehand.

At Wik, where the competitors stayed, using mobile phones was almost impossible, due to a combination of topography and distance to the city. Of course, this was an advantage from the point of preventing potential attempts at cheating, but it also meant that our staff at Wik was largely dependent on using ordinary phones for communication with staff in Uppsala. We had an agreement that they could use a certain telephone for such calls, but unfortunately it turned out that this phone was only available at office hours, because it was in a building that was locked when the employed staff at Wik were not working. Therefore, contact between staff in Uppsala and staff at Wik was not as tight and easy as would have been desirable.

3.9. Copying

Copying the tests, during the night between the jury session and the day of the test, is a demanding task, which absolutely must work. Katedralskolan had a very large and efficient copying machine, but it was placed in a room that was that was far too small this intensive work. Furthermore, we considered absolutely necessary to have one copying machine as backup in case the one used would stop functioning during the night. Hence, we hired a high capacity copying machine and placed it in a classroom, which we used as copying room. In this room we also placed a smaller copying machine, to be able to do minor copying tasks at the same time as the big machine was copying tests.

Embarrassingly enough, we forgot to calculate beforehand how much copying paper would be required. As a result, we were nearly running out of paper one night, which caused some problems, although we could send a car to borrow copying paper from a university department.

After the copying of the tests for the team of one country, there is an important safety procedure to take place: the national Coordinator checks that all pages are present and properly copied, puts the tests in envelopes, labels the envelopes, hands them to the copying staff for sealing, and after sealing signs the envelopes. An experience we made was that it would have been advantageous if the copying room had had two entrances: one for handing in test originals for copying, and another one for the checking and sealing procedure.

3.10. Recruiting and preparing student guides

Among all IBO staff, the student guides are the ones that have the most direct and personal contact with the competitors, and therefore also potentially the ones that are most important for making the IBO a pleasant and stimulating experience for the competitors. Hence, recruiting suitable student guides and preparing them for their task is of crucial importance for making a good IBO.

Student guides were recruited in many different ways, after we had taken the decision about the economical conditions for student guides and other voluntary staff. In the autumn of -98, we made an announcement in the journal of the Biology Teachers' Organisation, which is being sent to all the members of the organisation, where we asked all readers to search for young persons speaking some of the various languages of the countries involved. We also sent a letter to former Swedish IBO participants, asking them to help, either as student guides or as other staff. Later on, we contacted different language departments at Uppsala University, to get addresses to their students, and we contacted the administrators of student exchange at Uppsala University and at the Agricultural University, to get addresses of foreign students that had spent some time in Uppsala. Then we sent letters directly to a considerable number of students that could speak different languages. Furthermore, we spoke with or sent letters to some exchange researchers and some immigrant organisations to find suitable guides for different countries. We also got good help from Hans Morelis, who knew that one of Netherlands' former IBO participants was now an exchange student in Sweden, so he helped us to get in contact with her.

When searching for student guides, we did not request particular knowledge of biology, but our requirements were that they would have some knowledge of the language of the competitor team, some knowledge of Sweden and Swedish, and an enthusiastic attitude to meeting new people from a foreign country.

Torbjörn Nilsson spoke personally with each of the student guides, going through the time schedule of the IBO week and the roles of the student guides, before they signed the contract to be guides. Shortly before the IBO, a letter was sent to each student guide with some complementing information, for instance the names of the competitors in his / her team.

We were quite successful in recruiting nice young persons with a wide variety of language skills. However, we could have been even more successful in this, if only letters to language students, exchange students, immigrant organisations, etc, had been sent already in the autumn of –98, well before most young people had planned their summer activities. Then we would also have had much more time to prepare the student guides for their task.

During the IBO, we got an impression that some of the student guides felt a bit left aside because the person that they had talked with before did not have very much contact with them during the IBO. This might have a psychological importance that we had not thought of. A suggestion for future organisers is that the person recruiting student guides should also be one of the persons responsible for helping the guides during the IBO.

3.11. Recruiting and preparing other voluntary staff

Other voluntary staff was recruited via repeated announcements in the journal of the Biology Teachers' Organisation, and by talking about the IBO at the national meetings of the

organisation. During the winter preceding the IBO, a considerable number of volunteers sent messages that they wanted to take part.

It would have been desirable to contact each person immediately to discuss how he or she would help. Torbjörn Nilsson had this task, but did not really get started with it until late April, mainly because before then we had not specified enough how many persons would be needed for different tasks on different days. In a few instances, this turned out to be too late, because by then the person had already planned to do something else in early July. During April, May and June, Torbjörn Nilsson phoned the volunteers and made an agreement with each person what days he or she would help, and what main task he or she would have each day. This was written in a contract, which was sent to the volunteer for signing and returning. As far as possible, we planned so that a person working late one night would not have to work early the following morning.

It would have been wise to ask each volunteer to also inform us about his or her exact times of arrival to and departure from Uppsala. Because we did not think of asking everybody for this information, we got some extra difficulties in planning accommodation and meals.

There were two categories of staff that we feel we should have had, but failed to find: some medically trained, in case somebody got ill or hurt, and someone used to organising sports tournaments and similar, to promote activities making the competitors from different countries coming together during leisure time. We followed the example from Germany by asking the local Red Cross if they could hire us some medically trained persons during the IBO, but we asked them too late, so most of their active members were already engaged for another big event the same week.

Besides this, it also turned out that we had too few people for correcting the tests. One reason for correcting taking more time than anticipated was the need to check individual statistical calculations in the practical test. When correcting was not finished the night after the test was done, the problem became acute because most of the staff correcting the tests were then planned to work with other things the following day. Hence the correcting staff had to work very hard, and we also had to call in some extra persons to help with correcting. It would have been wise to have some more correcting staff free of other responsibilities the day after each test, in case correcting would have to continue the following day.

3.12. Meals

Serving a meal to a hundred or several hundred persons, in a reasonable amount of time, is a demanding task. When booking a restaurant for such a meal, it is wise to ask not only how many people they can have seated, but also how many they are used to serve at the same time. We think this worked rather well at all the meals during the 10^{th} IBO.

For planning the meals, it is crucially important to know what restrictions some participants have on what they can eat, so that special food can be ordered for some participants when needed. Therefore we asked the coordinators to inform us beforehand, in the application forms, if their delegation or some of the participants had some restrictions about the food. This worked relatively well. However, we heard that at the lunch during the practical test, when the lunch was brought as individual portions, there was a lack of vegetarian food, indicating that some more competitors were vegetarians than we had been informed. If the coordinators want their teams to do well in the competition, it is important that they take

seriously the task of informing the organisers about specific food requirements of their competitors.

3.13. Sentinel

The IBO Sentinel, i.e. the daily newsletter about the IBO, was produced as a kind of exam project by three high school students, studying at a high school specialising on graphics and related subjects. As input for their ideas, we showed them the sentinel of the previous IBO in Kiel, and then the students did the whole work of planning, writing, interviewing, photography, layout, etc. Due to some communication failures between us, their teacher, and the computer staff at Katedralskolan, they got quite a tough start, having to learn using other software than they were used to. Ideally, they should have been very mobile, but they had some problems with transportation because none of them had a driving license. In spite of these problems, they managed to produce a very appreciated IBO Sentinel. In retrospect, we think we could have given some more thought to planning their working conditions (computer software, transportation, etc). Also the distribution of the IBO Sentinel to the competitors could have been better planned and organised - now we heard that some issue of the sentinel was missed by many of the competitors.

3.14. Website

The website of the 10th IBO is found at http://teacher.ru.orebro.se/ibo. In preparing the website, our first consideration was that it should be readable also for those with relatively old computers and software. We also tried to present the most important information, without making texts too long, and including suitable links for finding more information. Especially, we tried to provide good information and links about Linnaeus and about the places to be visited during the IBO, because we thought excursions and sightseeing will be most granting if participants have some knowledge beforehand.

The website was organised as a starting page with links to seven other pages, where information was organised under the headings "Getting in contact", "Program", "Competition", "Where to stay and what to do", "About Linnaeus", "More about Sweden" and "Russian summary ". There was also a link to the general IBO website. We think this structure was suitable for making it easy to navigate within the website and find the kind of information sought for. Our main problem was that the texts for the website were written at a too late stage, which was especially true for the Russian summary, which appeared only shortly before the IBO.

After the IBO, we added "Results" and "Pictures from the competition" to the website, and the Russian summary was replaced by a link to the full program in Russian.

4. Tests

Biology is a broad subject, requiring many different competencies. Therefore, a competition in biology cannot aim at measuring a single ability with utmost precision, but must aim at measuring many kinds of knowledge and talents and weighing them together in a reasonably fair way. This is reflected in the IBO rules, which regulate how the scores in the competition should be divided between the practical and the theoretical tests, and also within the theoretical test between various sub-disciplines of biology.

4.1. Composition of the Scientific Task Comittee

The Scientific Task Committee consisted of university teachers and researchers in animal ecology, genetics, plant physiology, animal morphology, and microbiology. In addition, Andreas Ehn and Torbjörn Nilsson took part in the work of the Scientific Task Committee, mainly to advise the Committee regarding the form and level of the tasks.

Initially, we intended to have a few more persons, representing some other sub-disciplines, in the Committee, but at its second meeting, in December 1998, the Committee concluded that is was not necessary to search for more Committee members. Most of our Committee members were actively teaching at the basic university level, thereby keeping updated with a somewhat broader field than if they only had been doing research and/or teaching at the most specialised university level. We think this played some role in enabling them to produce good tasks over the whole range of the subject of biology.

Another important advantage was that all Committee members were living and working in Uppsala, which made it possible for the Committee to gather at short intervals when necessary.

4.2. Clearness, difficulty and specialisation level of tasks

High priority was given to producing questions that could be corrected in an objective way, with all given alternative answers being clearly either right or wrong. For the sake of objectivity, such tasks were avoided where some practical skill of a competitor would be judged and scored during the very competition, and also such tasks where the competitor would draw something and the drawing be judged and scored.

As a guideline for the difficulty and specialisation level of the tasks, we used a principle recommended by the IBO Advisory Board Meeting in autumn -98, that tasks should only require knowledge of such facts that could be found in some general text book on biology. When uncertainty arose whether a task was too specialised or not, we checked whether the topic was covered by Campbell's widespread textbook "Biology".

4.3. Testing understanding and scientific thinking

It is important to strive for testing not only factual knowledge, but also ability of understanding and of scientific thinking. Constructing tasks for this aim is, however, inherently difficult, and the restriction to use only multiple choice questions and other questions that can be quickly and objectively corrected makes this even more difficult, also for teachers that have much experience in formulating exams.

One way that we used in some tasks was to provide some biological information in the task, and then put questions that would test whether the competitor could understand the given information. We heard some comments that these tasks were too laborious for the jury to translate, but we still think it is necessary to include some tasks of this type, to get beyond the sheer measuring of factual knowledge.

Another way, that we tried in some parts of the practical test, was to ask the competitors to choose between alternative designs of an experiment, before they got the whole instruction, and also to ask them to interpret their own experimental results correctly. The statistics over the test results showed that these questions were relatively simple and could not discriminate so well between the very best competitors and the intermediate ones. In spite of this, we think it is very important to include this type of questions, to give those competitors that have the understanding of scientific thinking some advantage relative to those that are mainly good at memorising facts.

Of course, when asking the competitors to perform a behavioural experiment with living animals (as we did with guppy fish), it is important that the scoring is not dependent on how the animals happen to behave, but is based only on whether the competitor interpret the results correctly.

4.4. Language

The Scientific Task Committee was instructed to formulate the tasks in English from the very beginning. We think this is a good way to avoid finding out at a late stage that a task that seemed very clear in our own language could not be translated properly without becoming dubious. Before the IBO, we also let a biologist who is a native Englishman read through the tasks to check them for errors and ambiguities.

For the translation from English to Russian, we relied comfortably on Olga Poluljach, whose help was invaluable.

4.5. Making practical and theoretical tests weigh equally

The IBO rules state that the practical and the theoretical tests should weigh equally. The relative weight of these two tests depend on how many tasks are excluded during the jury treatment before the tests, but also on the distributions of the test results within the two tests. Our statistician, professor Bengt Ramund, showed how these things could be accounted for by calculating so-called equal-weighted T-scores, and the International Jury chose to base the awarding of medals on these T-scores.

After the IBO, we found out that this procedure had led to that some competitors with the same raw scores had got different medals, due to very minor differences in their equal-weighted T-scores. After discussing this matter with the IBO Coordination Centre, and recapitulating the discussion in the jury session, we concluded that this could not have been the intention of the International Jury, and that the most appropriate solution must be to award a few more medals, retrospectively, which we also did.

In retrospect, we think adjusting the relative weight of the practical and the theoretical tests scores should only be done if it turns out that their weight is very unequal, for instance if one

of the tests is at least 20% more influential than the other on the total score. Otherwise, it is better to stick to the raw scores, since these are easily understandable to all participants.

5. Some recommendations for future IBOs

Our most important suggestions for future IBO organisers can be summarised as follows:

* Try to do most things further in advance than we did.

* Appoint one and a half year ahead people responsible for the following functions:
jury chairman, copying of the tests, correction of the tests, transport, opening & closing ceremonies, student guides & leisure time activities, excursions.

* Let these responsible persons, or as many as possible of them, visit an IBO as coordinators and/or observers.

* Excursions: don't travel too far, give more time to being at the destination and experiencing things than to transport.

* Scientific Task Committee: include mainly professors that are active in teaching at the basic university level.

* When composing the test, someone with secondary school experience must be involved. We attempted to design three levels of questions; a level consisting ofeasy quesions; a primary level containing good secondary school questions; and a final level of basic university questions.

Programme of the ceremonious opening of the 10th International Biology Olympiad (IBO 99) in Uppsala University Hall

Monday, July 5, 1999
9.30-12.00

Moderation:
Dr Andreas Ehn.
Cermonious marching in of the international students' delegations.

Opening:
President of the IBO 99 and Chairman of the Scientific Committee of the IBO 99. **Prof. em. Staffan Ulfstrand.**

Words of welcome:
Undersecretary of State at the Swedish Ministry for Education and Science, **Carl Lindberg.**

Swedish folk music:
Tresmak.

Words of welcome:
Rector of Uppsala University, **Prof. Bo Sundqvist.**

Swedish folk dance

Words of welcome:
Vice-chairman of Uppsala local goverment, **Prof. Lars Bäcklund.**
Father of Biligical Taxonomi, **Prof. em. Carl von Linné.**
Chairman of the IBO Coordinators, **Dr Hans Morelis.**
IBO Coordinating Centre, **Dr Tomas Soukup.**

Words of vow:
Song: **Gaudeamus Igitur.**

President of the IBO 99
Prof. Staffan Ulfstrand

Dear Colleagues and Students,
Delegates and Competitors,
Fellow Biologists,

It is a great privilege to address you all at this moment and, on behalf of all your hosts, the organizers of the International Biology Olympiad, the scientific Olympic committee members and the University of Uppsala, to welcome all of you, who having travelled from afar have come to the beautiful and historic city of Uppsala, where I hope we shall spend together a week of mutual inspiration and shared new experiences that will make this week in Linnaeus's city a lifelong memory for all of us.

This is the 10th International Biology Olympiad. Thus, there is particular cause for commemoration and stock-taking. I shall permit myself to let my congratulations take the form of a message of great respect and admiration to those farsighted and responsible scientists, who first conceived of the brilliant idea of calling upon young biologists from all corners of the world to come together for peaceful competition in the noble sport of biological eminence. Such a convention of young biologists inevitably will promote feelings of international understanding and facilitate cooperation in years to come, and it will contribute to a confirmation in the minds of every young biologist of the primacy of biology among all scientific endeavours. More simply, there is no real alternative to being a biologist.

Let us not be diffident. Biology encompasses all life on Earth, human or otherwise, which means everything of fascination, complexity and deep significance. Furthermore, to the best of our considerable knowledge, we are alone in the Universe, and what we do is therefore by definition a unique enterprise.

Biology thus is both general in the sense of covering all life, and special in the sense that it cannot be pursued anywhere else. Biology only applies to the Earth - but to everything on Earth.

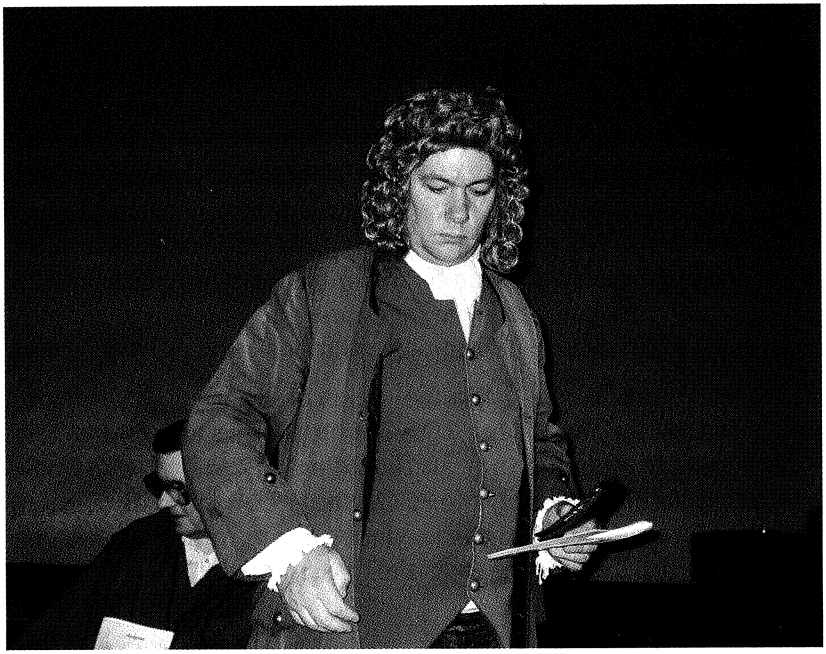
Ever since Darwin, biology has the power of answering all the deep philosophical questions that are taken lightly by no person. Biology is the enemy of superstition and prejudice founded in dark history. Equally importantly, biology is probably the only program with a substantial potential of alleviating human misery through its many practical applications and of raising the dignity of all people on Earth through its insistence that differences and variation are assets of the greatest value, not problems to overcome or - even worse - impossible to overcome. It is only too obvious that human beings can be each others' worst enemies and treat each other with horrible cruelty. Biology, however, can disclose human nature and offer suggestions how humans may make life easier for one another, rather than the opposite.

However, for biology to be capable of providing these benefits for the peoples of the Earth, there is no way around the provision that it be granted freedom to pursue its research avenues and not forced to travel along dark alleys towards trivial goals. It is easy to think of examples where ill-informed and reactionary decision makers have forced biological research into directions that have meant disappointment and sometimes disaster. Biological research can be metaphorically described as an evolutionary process: let it run its course, and beautiful adaptations may arise; dictate its course, and monstrosities may result.

This, then, is No. 10 in the series of Biology Olympiads, and it is also the last in the 20th century. Time is running full speed towards the millenium shift, and next time biologists will be getting together for a Biology Olympiad we shall have entered the 21st century. There is no doubt in my mind that the coming century, even more than the past, will be a Century of

Biology. It is an important task for those of us, who have been around some time, to help paving the way for young people about to begin their career as biologists, and one way of doing this is to arrange Biology Olympiads. May one be allowed a whiff of envy when considering all the revolutionary scientific breakthroughs that today's young biologists will experience in the next century. Certainly more than envy, however, today's young biologists deserve warm wishes for success in their important role as pilots of mankind in the sea to time.

With these words I now open the 10th International Biology Olympiad, and welcome everybody, young or old, in whatever capacity you have come to this venue, and from wherever in the world, to Uppsala and Sweden. Let us give one another a rewarding and pleasant week in the sign of Biology.



Prof. Lars Bäcklund

As a representative of the city of Uppsala I wish you all heartly welcome to this International Biological Olympiad in Uppsala. First of all my greetings go to all of you who take part in the competition, and I hope you will get exciting and stimulating problems to solve. But I hope too that you will find Uppsala a pleasant place full of variety. My greetings also go to all coordiators and observers who are present here. Your tasks at the olympiad are important and necessary for the competions.

It is a great honour for Uppsala to be the place where the 10th Olympiad is held. It is true that for hundreds of years Uppsala has been a place for learning and the education of young students as well as for research. But for a competiton like this to be held, a competent and internationally respected executive organisation is also necessary. We have such a leading group here and, on behalf of the council of Uppsala, I wish to express our great appreciation for the work you have done to make this olympiad possible.

The town that you all, guests and participants, have cme to is the site of the oldest university in Scandinavia, founded in the year 1477. In addition to that we have a young agricultural university with an important profile in environmental research. Uppsala is a very old city, so old that it is impossible to give an exact date for its beginnings, but it is probably almos 2000 years old. Long ago, a few kilometers north of this place, there was a small kingdom, which gradually was to get more and more important and which became the nucleus of what today we call Sweden. The central parts of the present-day town grew out of a port and merchant town 800 years ago, and the building of our cathdral, which is the oldest church in Sweden, started in the 13th century. The cathedral became the coronation and burial church for Swedish kings in the 16th century, before our present capital, Stockholm, became dominant.

The province where Uppsala is stituated is a rich district. For a long time past the soil has given rich harvests and mines have yielded high quality iron ore for centuries. Good means of communication have always contributed to making the district successful in terms of trade. A network of waterways constituted excellent sailing routes for our famous Viking ships, and in modern times we have Sweden´s largest airport, Arlanda in our vicinity. As a matter of fact, Arlanda is closer to Uppsala than to our capital, Stockholm.

When you take part in the coming sightseeing trips, you will certainly ask yourselves, where are these waterways that I just mentioned. But, as I am sure many of you already know, for thousands of years, Sweden, together with large parts of Northern Europe, was covered by thick inland ice, which, when the ice finally melted, had pressed the ground down below the level of the sea. When the ice was gone, the land began to rise, and that process goes on even today. That is why we don´t see much of the waterways the Vikings´long ships used about a thousand year ago. This elevation of the land is getting slower today, but is still about 5 millimeters per year. Today shipping to Uppsala is fairly unimportant, unless you go as a tourist – which is what you will do while you are here. Then you will see a small part of what is the fourth largest lake in Sweden, Mälaren. On that lake there is still quite extensive shipping between different towns. That type of transport is cheaper than lorries and much more harmless to the environment.

Those of us who live in Uppsala think that this town has everything: a great historic past, living traditions of learning and culture, a youthful profile with all the students of the two universities, education and research of the highest standard, and last but not least, good contacts with the rest of the world both intellectually through science and other types of culture, and physically through good communications.

I sincerely hope you will have the opportunity to see and experience parts of all this. I also hope that everything will be to your satisfaction during your stay here, and that the competition will be the good and inspiring fight that everybody wishes it to be. I also hope you feel how heartily welcome you are – today, as well as in the future, perhaps to study or to do research at one of our universities.

Dr Hans Morelis

Ladies and gentlemen, colleagues and of course: dear competitors.

The International Biology Olympiad is a competition, but a very special one, because the main purposes are to stimulate young gifted students interested in biology and to focus on biology as a wonderfull science to study.

Biology not only is wonderful, it is important as well. It is clear that biology is the basis of all life sciences and that you need biologists to solve problems connected with quality of life and environment. Therefore it is necessary to reflect on education in biology and I'm glad that we have gathered together in this olympiad so many experts in biology education from so many countries.

I can assure from experience that our discussions during successive olympiads are in favour of the quality of biology education in my country and I presume that this counts for all other countries present here as well.

Besides this the olympiad brings together a lot of experts of different institutes like Government, Ministry of education, Universities, Teacher Associations, sponsors from industry. These contacts stimulate mutual knowledge and understanding for everyone's activities in the field of biology. So what I like to stress is that the impact of the olympiad is really high.

But for the moment the focus of course is on our competitors and I'm glad that so many young students from all over the world are involved in this 10 th IBO. A special welcome applies for the newcomers: competitors from Iran, Chines Taipeh and Mexico.

Ten years ago in 1990 we started with only 6 countries and

I remember in that time no copying machines were available for us so we translated and wrote the tasks for our students completely by hand. Now 10 years later we have 36 countries, which is 6 times more and we have to our disposal excellent facilities supplied by our sympathic Swedish organizers.

I'm sure we all in the next days will experience a very interesting olympiad and we especially are looking forward for the practical tasks with interesting topics like DNA fingerprinting and behaviour of aquarium fishes. And besides this interesting places like Stockholm and the Baltic Sea are waiting for us, but probably more exciting is Uppsala. Because everybody interested in biology should visit once in his or her life Uppsala, the place where Linnaeus, the famous scientist and creator of our systematical nomenclature, lived.

Dear participants, colleagues, distinguished guests and last but not least dear organizers.

It is nice to be here in Uppsala, further to the North than the IBO has ever been. But I am sure that you feel warm from the excitement before the competition.

When I met a group of observers 10 years ago in Olomouc in former Czechoslovakia during the first IBO, I did not realize that so many of them will play an important role, even as organizers, in future IBOs. Let me mention at least three of them.

Firstly it is Hans Morelis, who not only played a decisive role in organization of the fourth IBO in Utrecht, but who also devoted a much of his time to IBO in general, as he has been working as the President of Coordinators for the last six years.

Secondly, it is prof. Erwin Zabel, who was the chairman of the scientific committee during the last IBO in Kiel.

And last but not least it is prof. Andreas Ehn. We all remember his comparison made in his speech in 1991 in Machackala and which he repeated for us last year in Kiel. He described a young swallow during its first flights, how it tries to fly and suddenly after great efforts, it raises high to the sky. He compared it with the IBO, which had at the time of the second IBO only 9 competing teams. He wished IBO to fly high and to become a widespread international competition. His wish has come true. IBO is now an internationally acknowledged biological competition. Last year, there were 33 teams that took part in the competition, this year it is even 36 countries from five continents and other from observing countries.

This year we meet at the IBO competition for the tenth time. The IBO Coordinating Centre in Prague would like to ex-

press, on this occasion, its thanks to all organizers of previous IBOs, especially Jan Stoklasa for the first IBO, B.I.Sivoglazov for the second, Pavol Elias and Jan Stoklasa for the third, Hans Morelis and Peter Voogt for the fourth, Vasil Golemansky for the fifth, Sumonta Promboon for the sixth, Stanislav Strashko and Lidiya Vaschenko for the seventh, Olga Nazarova and Nuri Bayramov for the eighth, Eckhard Lucius and Erwin Zabel for the ninth and Andreas Ehn and Torbjorn Nilsson for the present IBO. However, besides the main organizers, we have to thank the many collaborators and unknown volunteers who helped to prepare and run each IBO competition.

Nevertheless, the 10th is always supposed to be an anniversary. The IBO Coordinating Centre therefore would like to present a small cup remembering all the places of previous ten IBOs. We hope that the next ten IBOs will be as successful as the first ten and we wish the IBO competition to fly high in quality and importance for the education of biology and for creating friendly relations among all participants. In paraphrase to the above comparison of Andreas Ehn, we wish IBO to soar high as an eagle, to stay firmly established among biological competitions as an elephant on the ground, to live as long as a tortoise and to be as widespread as spiders, the beloved creatures of Andreas Ehn.

Dear participants, I would like to wish you good luck in the competition and a pleasant time during your stay at the 10th IBO in Sweden.

Uppsala University – in Brief

With its eight faculties of Theology, Laws, Medicine, Pharmacy, History and Philosophy, Languages, Social Sciences, and Science and Technology, and its Teacher Educatiion Programs, Uppsala University offers a broad spectrum of educational and research opportunities. Moreover, there is a new virtual IT-Faculty to coordinate the extensive activities in the field of information at the University.

SOME 36,000 STUDENTS from all over Sweden choose among offerings of more than 40 programs of study and neatly 1,200 independent courses. Programs in the Social Sciences and in Science and Technology attract the largest nümber of students. Nearly two thirds of the students are under 25 years of age.

Graduate education is constantly growing and developing. Today there are about 2,500 active graduate students. Of these, 44% are women. Each year some 270 doctorates are awarded and nearly 70 licentiate degrees.

An interdisciplinary, holistic approach is a cardinal principle at Uppsala University. The large campus ares gather researchers and students from various disciplines. At some 50 thematic centers and network organizations researchers work across traditional subject boundaries.

Uppsala University was founded in 1477 and is the oldest university in teh Nordic countries. Today the University is one of Uppsalas largest workplaces, with more than 5,000 employees. Close to 2,000 of these are researchers and teachers.

Research and Education

BASIC RESEARCH IN COMBINATION with goal-directed, business-community-related research is the point of departure for research at Uppsala University. This in turn forms the basis for multidisciplinary research. To facilitate collaboration and establish creative research environments, the University strives to develop multidisciplinary centers and campus milicus.

Research and education are pursued in close cooperation with the surrounding society and the business community and with intensive contacts with other universities in Sweden and abroad. International cooperation continues at high rates in both research and education, and high international standards are the objective in all areas. Aggregate funds for research continued to rise in 1998. Uppsala University has done well in the competition for external funding, and outside grants have increased.

In recent years national consoria and strategic reseach centers and centers of excellence have become vital meeting places for researchers and representatives of the business community. The University´s contributions to the development of new companies are extensive. The most recent campaign is Campus Uppsala. This is a joint initiative on the part of Uppsala University, the Swedish University of Agricultural Sciences, and the municipality of Uppsala, among others, to pronote mew businesses and establishments in Uppsala.

Many other initiatives are taken to improve and strengthen communication with the surrounding community, including "open house" efforts and popular lecture series. The

University's museums also play a key role in this connection. The Botanical Garden, the Linnæan Garden, the art collection at the Castle, and the new Museum Gustavianum attract many visitors and at the same time serve as a resource for education and research.

Uppsala University is deliberately and strategically striving to develop multidisciplinary collaboration.

10th International Biology Olympiad (IBO 99)

Programme

Sunday 4 July

Competitors		Coordinators & Observers
	At arrival transfer to Wik	At arrival transfer to Hotel Linné
19.00 - 20.00	Dinner	
20.00	Welcoming assembly in the gymnasium at Wik	

Monday 5 July

Competitors		Coordinators & Observers	
7.00 - 8.00	Breakfast	8.00	Breakfast
8.30	Transfer to the University Hall	9.00	Joint walk to the University Hall
9.30	Opening Ceremony at the University Hall		
12.00	Joint walk to Katedralskolan	12.00	Welcoming reception
12.30	Lunch at Katedralskolan, then sightseeing in Uppsala	12.30	Joint walk to Katedralskolan
		13.00	Lunch at Katedralskolan
		14.00	1st Jury session: approval and translation of the practical tests, at Katedralskolan
18.30	Transfer to Wik	18.00	Dinner
19.00	Dinner at Wik, then leisure time	19.00	1st Jury session, continued

Tuesday 6 July

Competitors		Coordinators & Observers	
6.15 - 7.15	Breakfast	9.00	Breakfast
7.30	Transfer to Bio Medical Centre (BMC)	10.00	Leisure time for sightseeing in Uppsala
8.00 - 14.30	Practical Tests at BMC Lunch is served between the tests	12.00	Lunch
		13.00	Guided tour in central Uppsala
15.00	Excursions to the Linnaeus Garden and Linnaeus' summer residency Hammarby		
19.15	Transfer to Wik	19.00	Return to Hotel Linné
20.00	Dinner and leisure time	19.30	Dinner and leisure time

Wednesday 7 July

Competitors		Coordinators & Observers	
6.45	Departure for excursion	8.00	Breakfast
8.00	Excursion by boat in the archipelago along the Baltic coast	9.00	2nd Jury session: approval and translation of the theoretical test
	Route: from Stockholm 8.00 - - Bullerö 12.00, from Bullerö 14.30 - Vaxholm 17.10	12.30	Lunch
	Breakfast and lunch will be served during the trip	13.30	2nd Jury session, continued
18.45	Return to Wik	18.00	Dinner
19.30	Dinner and leisure time	19.00	2nd Jury session, continued

Thursday 8 July

Competitors		Coordinators & Observers	
6.15 - 7.15	Breakfast	7.00	Breakfast
7.30	Transfer to Polacksbacken		
8.00 - 12.30	Theoretical Test at Polacksbacken	8.00	3rd Jury session: checking of practical test results, approval of the answer key of the theoretical test
12.45	Transfer to Katedralskolan		
13.00	Lunch		
14.00	Sightseeing in Uppsala		
18.00	Transfer to Wik	19.00	Dinner
19.00	Dinner at Wik, thereafter leisure time	20.00	Meeting for Coordinators, thereafter leisure time

Friday 9 July

Competitors		Coordinators & Observers	
6.30 - 7.30	Breakfast	7.00	Breakfast
7.45	Departure for Stockholm	8.00	Departure for Stockholm
9.00	Guided bus tour in Stockholm	9.00	Guided bus tour in Stockholm
10.00	Skansen		
Lunch and sightseeing in Stockholm		12.30	Lunch at Soliden
		14.00	Return to Uppsala
17.30	Return to Wik	15.30 - 18.00	4th Jury session: checking of theoretical test results
18.30	Arrival at Wik	18.30	Transfer to Wik
19.00	Barbecue and disco at Wik		
		Wik's Castle will be shown for Coordinators and Observers	
		Buses go to Uppsala at various times from 21.00 til 24.00	

Saturday 10 July

Competitors		Coordinators & Observers	
9.00 - 10.00	Breakfast	8.00	Breakfast
	Leisure time at Wik	9.00	Jury-meeting 5 at Katedralskolan, final checking of the test results and commitment of medals
12.00-13.00	Lunch at Wik	12.00	Lunch
13.30	Transfer to the University Hall		
14.30-17.00	Closing Ceremony and presentation of medals and trophies		
17.30	Departure by boat to Skokloster		
19.30	Joint final dinner at Skokloster's Värdshus		
24.00	Return by bus		

Sunday 11 July

Competitors		Coordinators & Observers	
7.00 - 10.00	Breakfast	7 - 10.00	Breakfast
Transfer to the relevant departure points			

10th International Biology Olympiad

Practical test 1999-07-06

Laboratory 1: Microbiology

Question (1)

Surname _____

First name _____

Country _____

Code number _____

General remarks about the practical tests

In the practical tests you are expected to demonstrate that you know some basic methods, processes and techniques of biology and that you are able to use them for experimental purposes. This will be tested in a series of tests, organized in four different laboratories:

Laboratory 1: Microbiology

Laboratory 2: Genetics and histology

Laboratory 3: Morphology and physiology

Laboratory 4: Behaviour

You have 70 minutes in each laboratory. You can score 26 - 50 points at a maximum in each laboratory, which means a total amount of 150 points for the practical test. If at some task you mark some incorrect alternative(-s) as well as some correct ones, you will get a lower score at that particular task than if you only mark the correct answers.

Introductory remarks to laboratory 1: Microbiology

In this laboratory you will be given two different tasks. First you will examine the contents of the two jars in front of you (jar 1 and jar 2) to find out how they differ from each other, and find an explanation for how these differences may have come about (questions (1) - (5)). Then you will estimate the concentration of a yeast suspension (jar 3), and find out whether this concentration is significantly different from the concentration of another suspension (questions (6) - (9)). You may call for assistance concerning the phase contrast adjustment of the microscopes. You will find information on how to use the calculator, and carry out statistical tests, at the end of this instruction.

Before you start your experiment you should answer question 1. Give your answer to an assistant, who will then give you the remaining questions.

(1) Jar 1 and jar 2 contain mixtures of shredded cabbage (*Brassica oleracea*) and onion (*Allium cepa*), with a little salt (NaCl) added. The two jars have been kept under different conditions, and the differences betweeen them are due to microorganisms. Which of the listed tools are suitable to examine the contents of the jars to find out the microbiological reason why they differ? Mark with an X the most suitable alternatives for an immediate investigation.

(3p)

_____ A. Microscope

_____ B. Autoclave

_____ C. pH-paper

_____ D. Scissors

_____ E. Balance

_____ F. Your own senses

_____ G. Tape measure

_____ H. Scalpel

Now give your answer to question (1) to the assistants, who will hand you the remaining questions, and then you can start your investigation.

10th International Biology Olympiad

Practical test 1999-07-06

Laboratory 1: Microbiology

Questions (2) - (10)

Surname _____

First name _____

Country _____

Code number _____

(2) Examine the smell and pH of the contents of the two jars. When investigating pH, use a pasteur pipette to extract some liquid and place it on the pH-paper. Mark with X in the appropriate boxes those alternatives which agree with your observations.

(4p)

		Jar 1	Jar 2
smell:	fresh		
	strong or pungent		
	chocolate		
PH:	9		
	7		
	5		

(3) Examine a drop of the liquid from each jar under the microscope, using 10x magnifying oculars and 40x magnifying objectives for a total magnification of 400x. The microscopes are already set up, do not change the objective. You may call for assistance concerning the phase contrast adjustment of the microscopes. In which jar do you find most microorganisms?

(2p)

Most microorganisms are found . . . (mark with an X)

_____ A. . . . in jar 1.

_____ B. . . . in jar 2.

(4) Compare the microorganisms you can see in the liquid from the jars with the pictures attached. Note that the two sheets of pictures show the organisms at different magnifications. Which organisms are abundant in the liquid from the jar with most microorganisms? Mark the abundant organisms with an X.

(6p)

_____ A. *Staphylococcus*

_____ B. *Anabaena*

_____ C. *Lactobacillus*

_____ D. *Saccharomyces*

_____ E. *Streptomyces*

_____ F. *Micrococcus*

_____ G. *Escherichia*

(5) Which explanation(s) for the differences between jar 1 and jar 2 are plausible? Mark those with an X.

(6p)

_____ A. The vegetables in one of the jars have been contaminated by bacteria.

_____ B. The vegetables in one of the jars are fermented.

_____C. One of the jars has been kept warm (25°C) for about 2 weeks, while the other has been refrigerated at between about +4°C and +8°C.

_____ D. Microorganisms have arisen in one of the jars but not in the other.

_____ E. Microorganisms already present on the vegetables have grown in one of the jars but not in the other.

_____ F. From the beginning there was more water in one of the jars than in the other, and therefore there are more bacteria in it.

Now turn to the yeast suspension in jar 3. You will estimate the concentration of yeast cells with the aid of a counting chamber. The counting chamber is described below.

The counting chamber and its use

Before using the chamber you should clean it, first with water, then with alcohol, and dry it carefully using absorbent paper. Put the cover slip in place. Note that there is a special cover slip to be used with this chamber. Fill the chamber with your liquid sample from the side, as shown in Fig. a (next page), so that the liquid seeps in below the cover slip. Put the chamber underneath the microscope.

In the counting chamber the two areas marked "grid" in Fig. b each contain a 9 mm^2 grid divided in larger and smaller fields. Fig. c shows an A-square (1 mm^2), framed by three lines, and the smaller areas it contains: C, 0.01 mm^2; D, 0.0025 mm^2; E, 0.04 mm^2, and F, 0.005 mm^2. At 400x total magnification, the D-area is most convenient for counting, since its whole area can be seen at one time (Fig. d).

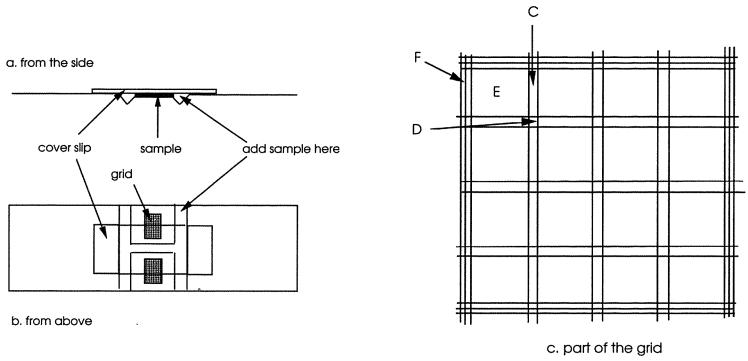


Fig. a. - c. The Bürker counting chamber

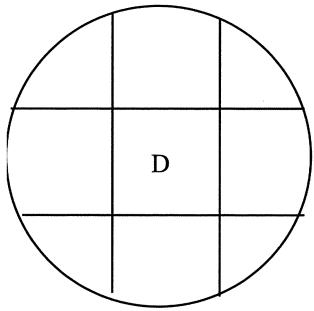


Fig. d. The D area viewed at 400 x total magnification

You will count the number of cells in a number of D-areas (actually, in a number of volumes the basis of which are D-areas). The depth of the chamber is 0.1 mm.

While counting, you have to consider in how many D-areas you need to count the cells to get a reliable measure of the cell concentration.

(6) Count the number of cells in an appropriate number of D-areas. For each D-area in which you have counted the cells, write down the number of cells that you have counted below. Then calculate the average (arithmetic mean) of those values. Write the number of D-areas counted as well as the mean number of cells per D-area on the lines at the bottom of the page.

Number of cells in each D-area counted:

Number of D-areas counted: ..... (2p)

Mean number of cells per D-area:..... (4p)

(7) From the mean number you calculated in question (6), calculate the concentration of the suspension in cells/ml.

(3p)

Concentration: _____ cells/ml

(8) On the following pages you find descriptions of the t-test and the χ^2-test, and of how to use the calculator. Which of these tests is/are appropriate to determine whether the cell concentration you have found is significantly larger or smaller than 2.0×10^7 cells/ml? Mark the correct answer with an X.

(2p)

_____ A. The t-test.

_____ B. The χ^2-test.

_____ C. Both tests are suitable.

(9) Perform the relevant calculations to determine if your estimate is significantly different from 2.0 x 10^7 cells/ml. Write the numerical value of the statistic(-s) you calculate in the appropriete box(-es).

(3p)

t	
χ^2	

(10) Using $\alpha<0.05$ as the level of significance, is your result significantly different from a concentration of 2.0 x 10^7 cells/ml? You will get a score for your answer here only if it agrees with your calculation in response to question 9. Mark the correct answer with an X.

(2p)

_____ A. Yes.

_____ B. No.

10th International Biology Olympiad

Statistics and how to use the calculator

The χ^2-distribution and χ^2-test

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$$

The χ^2-test is useful when you want to compare an observed distribution of frequencies (O_i) with expected frequencies (E_i). O_i and E_i in the formula above are absolute frequencies = numbers of e.g. individuals.

Suppose you want to test the goodness of fit between observed frequencies of different phenotypes in an offspring and the expected frequencies according to your hypothetical, genetic model. The expected absolute frequencies (E_i) are calculated from the relative frequencies according to your hypothesis. The number of classes (k in the formula above) is, in this case, the number of different phenotypes.

The χ^2-distribution, just like the t-distribution described below, is a probability density function. The values of χ^2 range from zero to positive infinity. See figure in the lower right

corner of the attached χ^2-table. Just as for t, the χ^2-distribution varies with the number of degrees of freedom (ν). In the simplest case, the number of degrees of freedom (ν) is one less than the number of classes (k).

$$\nu = k - 1$$

Tabulated χ^2-distributions show the degrees of freedom (ν) down, the probabilities (α) across and their corresponding χ^2-values. See attached table of χ^2-distributions.

As the χ^2-distribution is a probability density function, it follows that α is the probability of χ^2 being as great or greater than the table value, under the null hypothesis (H_0), i.e. if H_0 is true. Example: What is the probability for $\chi^2(\nu = 5) \geq 1.234$? The answer is: 0.90 - 0.975.

The threshold for rejection of the null hypothesis (H_0) is usually set at $\alpha = 0.05$. An investigator is then said to accept the 0.05 (or 5%) level of significance. This means that if the computed χ^2-value exceeds the critical χ^2-value, the hypothesis is rejected.

Suppose that the computed $\chi^2 = 4.666$ and $\nu = 2$. At $\alpha = 0.05$, the critical $\chi^2(\nu = 2) = 5.991$. As the computed χ^2 is less than the critical χ^2, the null hypothesis (H_0) is not rejected.

The *t*-distribution and *t*-test

The *t*-distribution was first described by W.S. Gossett using the pen name "student", and so is often referred to as "student's distribution". The difference between the sample arithmetic

mean (m) and the true mean (μ) divided by the standard error of the sample mean (s_m) follows the t-distribution:

$$t = \frac{m - \mu}{s_m}$$

The standard error of the sample mean (s_m) is defined as

$$s_m = \sqrt{\frac{s^2}{n}}$$

where (s) is the standard deviation and (n) the number of observations.

The shape of the t-distribution depends on the number of degrees of freedom (ν).

$$\nu = n - 1$$

The t-table is arranged with degrees of freedom (ν) going down, and probabilities (α) going across. These probabilities correspond to the areas under the curve of the t-distribution that fall outside the chosen critical values of t - see figure at the lower right of the attached t table. Note that the table shows only the absolute value of t; since the curve is symmetric around 0. Note also that there are two tails each contributing half the value of α.

The value of α is chosen depending on the level of significance you want; the corresponding t-value is called the critical value of t. For $\alpha = 0.05$ and $\nu = 5$, we find $t = 2.571$. The null hypothesis (H_0) is that the sample mean is not significantly different from the true mean. If the absolute value of the observed t-statistic is smaller than the critical t, the null hypothesis is not rejected.

How to obtain the statistical data on your calculator:

To put your calculator into the statistical mode, press the following keys, in this order:

2ndF

on/c

The word STAT will show in the upper right corner of your display, and the designations in red or blue (different on different calculators) apply to the individual keys on the right side of your calculator.

Now enter your values one by one, pressing the key M+ (which now means DATA) after each number entered. As you go through this, the display will indicate the number of values entered, i.e. n. You then obtain the remaining statistics by pressing the appropriate keys:

$\bar{x}$ for the mean (*m*), s for the standard deviation (*s*).

You get out of the statistic mode of your calculator by pressing the on/c key again. You are now ready to perform the rest of the calculations needed to compute the values necessary for comparison with tabulated values.

10th International Biology Olympiad

Practical test 1999-07-06

Laboratory 2: Genetics and histology

Surname _____

First name _____

Country _____

Code number _____

General remarks about the practical tests

In the practical tests you are expected to demonstrate that you know some basic methods, processes and techniques of biology and that you are able to use them for experimental purposes. This will be tested in a series of tests, organized in four different laboratories:

Laboratory 1: Microbiology

Laboratory 2: Genetics and histology

Laboratory 3: Morphology and physiology

Laboratory 4: Behaviour

You have 70 minutes in each laboratory. You can score a maximum of 26 - 50 points in each laboratory, which means a total of 150 points for the practical test. If at some task you mark some incorrect alternative(-s) as well as some correct ones, you will get a lower score at that particular task than if you only mark the correct answers.

Introductory remarks to laboratory 2: Genetics and histology

In this laboratory, the focus is on genes and cells: questions (1) - (10) deal with mendelian inheritance, (11) - (13) are about making chromosome preparations, and in questions (14) - (16) you study microslides of various plant and animal tissues and their cells. You will find information on how to carry out statistical tests and how to use the calculator at the end of this instruction.

Mendelian inheritance:

statistical test of a hypothetical genetic model

In front of you is a box with seedlings of barley (*Hordeum vulgare*). At this stage of development each seedling has only one leaf. The phenotype of a seedling is either green, yellow (*xantha*) or white (*albina*).

Yellow leaf colour shows monohybrid and recessive inheritance to normal green. Thus, the genotype of a yellow (*xantha*) plant can be designated *xx*. Accordingly the genotype of a green plant is *XX* or *Xx*. White leaf colour, also, shows recessive inheritance. Thus, the genotype of a white (*albina*) plant can be designated *aa*. The genotype of a green plant is either *AA* or *Aa*. The *xantha*-locus and the *albina*-locus are not linked.

The yellow and white plants cannot photosynthesise so they will die at the seedling stage. Only green plants survive and produce offspring.

A gardener at the Genetic Centre in Uppsala started this experiment with plants having genotype *Aa Xx* (generation number 0 = G_0). As barley breeds by selfing, the offspring of such a plant is the same as if you make the cross *Aa Xx* x *Aa Xx*. The offspring (offspring generation number 1 = G_1) was grown in a field.

(1) What proportion of the plants in G_1 is expected to survive and produce offspring?

(2 p)

Answer: .....

The box in front of you contains 9 spikes (ears) from 9 different plants in G_1. The seedlings are the offspring generation number 2 = G_2.

The seedlings from one spike belong to one of these four categories:

1) all green, 2) green and yellow, 3) green and white, 4) green, yellow and white.

(2) Write the theoretically expected ratio of spikes producing seedlings that are

(2p)

all green .....

green and yellow .....

green and white .....

green, yellow and white .....

(3) In one of the spikes only 8 seeds germinated and produced 7 green seedlings and 1 white. What is the probability of this outcome, if the parent had the genotype *Aa XX* ?

(2p)

Answer: .....

(4) Now focus your attention on the spikes with seedlings of all three colours: green, yellow and white. (These seedlings give an example of dihybrid segregation.) You need to respond to (4a) and (4b) to solve the remaining questions, but in this question you only score points at (4c).

(4a) Count the total number of seedlings from these spikes with green, yellow and white colour respectively. (The number of such spikes will of course vary by chance from one box to another.)

Spike	Number of seedlings that are		
no	green	yellow	white
1	.....	.....	.....
2	.....	.....	.....
3	.....	.....	.....
4	.....	.....	.....
5	.....	.....	.....
6	.....	.....	.....
Total	.....	.....	.....

(4b) In the introduction no information is given about the phenotype of plants with genotype *aa xx*. What is your hypothesis? Mark with an X.

_____ A. Yellow.

_____ B. White.

_____ C. Do not germinate.

(4c) Which one of the following ratios of the three different phenotypes in generation G_2 is expected according to your hypothesis? Mark the correct answer with an X. (You will get a score only if your answers to 4b and 4c are consistent.)

(2p)

	green	yellow	white
_____ A.	2/4	1/4	1/4
_____ B.	9/15	3/15	3/15
_____ C.	10/16	3/16	3/16
_____ D.	9/16	3/16	4/16
_____ E.	9/16	4/16	3/16

From these hypothetical relative frequencies (i.e. from your null hypothesis = H_0) you can now compute the expected number (E_i) of each of the three phenotypes. At the end of this instruction, you will find information about χ^2.

(5) From your answers in (4a) and (4c), fill in the table below.

(2p)

	Green	yellow	White
O_i			
H_0			
E_i			

(6) Calculate χ^2 from your data.

(3p)

Answer: χ^2 is .....

(7) What is the number of degrees of freedom (ν) in your test?

(2p)

Answer: .....

(8) At the significance level (α) = 0.05, what is the critical value of χ^2?

(2p)

Answer: .....

(9) At the significance level (α) = 0.05, do you have reason to reject your hypothesis?

(2p)

_____ A. Yes.

_____ B. No.

(10) Suppose you calculate χ^2 from the data from another box. If your hypothesis is true, what is the probability of getting a χ^2-value as great or greater than the value you calculated in (6)?

(2p)

Answer: .....

Making and analysing mitotic chromosome squash preparations

On your desk you will find this material:

Roots, some of which have been pre-treated with a drug. All roots have been macerated in a mixture of HAc (acetic acid) and HCl (hydrochloric acid).

Slides, coverslips, acetic-orcein, forceps, mounted needles, plexi-glass rods, blotting paper and plastic gloves are also provided.

Make squash preparations of roots pre-treated with the drug as well as preparations of untreated, normal roots. Analyse your preparations by light microscopy. You have to examine many cells, at different stages of mitosis, in order to solve questions (11) - (13).

(11) Which **five** of the following statements (A-K) are correct? Mark each correct statement with an X. If at this task you mark more than five alternatives, you will get a lower score.

(10p)

_____ A. The drug causes the chromosomes, at the stage corresponding to prometaphase-metaphase, to spread all over the cytoplasm, instead of being gathered with their centromeres in the middle (equator) of the spindle. (This indicates that the drug causes the microtubules to break down.)

_____ B. The drug causes the mitotic spindle to rotate 90° in the cell, so that the metaphase plate can easily be seen in polar view.

_____ C. Centrioles are present in the normal material, but absent from the drug-treated material.

_____ D. The drug causes the chromosomes to become more contracted than normally.

_____ E. The drug causes the chromosomes to become more slender than normally.

_____ F. The drug prevents the sister chromatids from being seen individually.

(11, continued)

_____ G. At prophase-prometaphase the sister chromatids are closely associated (aligned) all along their length. This statement applies to the normal as well as to the drug-treated material.

_____ H. At metaphase, sister chromatids are held together only in the centromere region. A metacentric chromosome then looks like the letter X. This statement applies to the normal as well as to the drug-treated material.

_____ J. In normal material the sister chromatids are closely associated (aligned) all along their length until the onset of anaphase. However, the drug may cause a metacentric chromosome to look like the letter X.

_____ K. The drug prevents normal anaphase movement of daughter chromosomes towards opposite spindle poles.

(12) What is the chromosome number (2n) of the plant?

(2p)

Answer: .....

(13) How many of these 2n chromosomes are acrocentric? (An acrocentric chromosome has one relatively long chromosome arm and, on the other side of the centromere, a relatively very short arm.)

(2p)

Answer: .....

Histological microslides of plant and animal tissues

(14) In microslide 1 you can see a transverse section of a part of a plant. From which part of the plant is this transverse section?

(2p)

_____ A. Root

_____ B. Stem

_____ C. Needle

_____ D. Carpel

(15) The drawing below shows the same transverse section as microslide 1. Five arrows (1-5) point at different types of cell. What is each type of cell? The drawing merely indicates the locations of the cells, so to find out what cell types they are you must observe them in microslide 1. Write the number of each of the arrows on the appropriate line.

(5p)

(fig.)

_____ Fiber

_____ Vessel element

_____ Cambial cell

_____ Endodermis cell

_____ Collenchyma cell

_____ Sieve tube element

_____ Parenchyma cell

(16) In microslides 2 - 5 there are sections of different internal organs and tissues from mammals. What organ or tissue type is represented by each of slides 2-5? Mark the correct alternatives with an X in the appropriate boxes.

(8p)

	Slide 2	Slide 3	Slide 4	Slide 5
Skin epithelium				
Striated muscle				
Smooth muscle				
Heart muscle				
Lung				
Liver				
Testis				
Pancreas				
Ovary				
Bone				
Cartilage				

10th International Biology Olympiad

Statistics and how to use the calculator

The χ^2-distribution and χ^2-test

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The χ^2-distribution, just like the *t*-distribution described below, is a probability density function. The values of χ^2 range from zero to positive infinity. See figure in the lower right corner of the attached χ^2-table. Just as for *t*, the χ^2-distribution varies with the number of degrees of freedom (ν). In the simplest case, the number of degrees of freedom (ν) is one less than the number of classes (k).

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The *t*-distribution and *t*-test

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The standard error of the sample mean (s_m) is defined as

$$s_m = \sqrt{\frac{s^2}{n}}$$

where (s) is the standard deviation and (n) the number of observations.

The shape of the *t*-distribution depends on the number of degrees of freedom (ν).

$$\nu = n - 1$$

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$\bar{x}$ for the mean (*m*), s for the standard deviation (*s*).

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10th International Biology Olympiad

Practical test 1999-07-06

Laboratory 3: Morphology and physiology

Surname _____

First name _____

Country _____

Code number _____

General remarks about the practical tests

In the practical tests you are expected to demonstrate that you know some basic methods, processes and techniques of biology and that you are able to use them for experimental purposes. This will be tested in a series of tests, organized in four different laboratories:

Laboratory 1: Microbiology

Laboratory 2: Genetics and histology

Laboratory 3: Morphology and physiology

Laboratory 4: Behaviour

You have 70 minutes in each laboratory. You can score a maximum of 26 - 50 points in each laboratory, which means a total of 150 points for the practical test. If at some task you mark some incorrect alternative(-s) as well as some correct ones, you will get a lower score at that particular task than if you only mark the correct answers.

Introductory remarks to laboratory 3: Morphology and physiology

In this laboratory, you will examine several types of biological material: questions (1) - (2) relate to plants and plant tissues that have been exposed to different treatments, questions (3) - (5) relate to skeletal bones of mammals, while questions (6) and (7) relate to the use and construction of dichotomous identification keys.

(1) T1 - T4 are plants or seeds of four different species, each of which has been grown or **left** to germinate, respectively, in deficiency or absence of some necessary environmental factor. A number of such factors are included in the list below. For comparison there are also control plants and seeds of the same species (numbered C1 - C4) grown under favourable conditions. The maize plants have been grown in a water culture. What factor has been missing during growth / germination of T1 - T4? For each plant, write the letter corresponding to the most probable deficiency / absence on the lines at the bottom of this sheet.

(8p)

Factors:

A. Boron	B. Calcium	C. Chlorine	D. Iodine	E. Lead
F. Light	G. Magnesium	H. Mycorrhiza	I. Oxygen	
K. Phosphorus	L. Sulfur dioxide	M. Water		

Plant T1 (maize, *Zea mays*) has been lacking _____

Plant T2 (garden cress, *Lepidium*) has been lacking _____

Plant T3 (*Coleus blumei*) has been lacking _____

Plant T4 (seeds of wheat, *Triticum*) has been lacking _____

(2) Look at the four pairs of plants or plant tissues that are numbered 5a, 5b - 8a, 8b. In each pair one plant has been treated with a plant hormone or other substance. Your task is to tell which plant in each pair was treated, and with what it was treated. Choose one substance for each treated plant from the list below. In the table below, write the appropriate letter (A - F) in the box corresponding to the treated plant (a or b) in each pair.

(4p)

In pair 6a, 6b there could be some doubt as to which of the plants was treated, and therefore the untreated plant in this pair is marked with an X in the table.

Substances:

A. Auxin B. Gibberellic acid C. Abscisic acid

D. Ethylene E. Cytokinin F. Lactic acid

	a)	b)
5) *Arabidopsis*, dwarf mutant		
6) Cutting of *Pelargonium*		X
7) *Coleus*		
8) Tobacco leaf tissue		

(3) Now examine the two different skulls of mammals in front of you. Skull anatomy provides much information concerning the lifestyle of animals, especially their food habits. What are the food habits of the two mammalian species represented by these skulls?

Mark with an X for each skull what food habit it represents.

(4p)

	Skull 1	Skull 2
carnivorous		
herbivorous		
piscivorous		
omnivorous		

(4) The appendicular skeleton is the skeleton of the limbs. You have in front of you an example of homologous bones, numbered 1 and 2, from two different mammals with different specializations in their appendicular skeletons. From which part of the animals do these bones come? Mark the correct answer with an X.

(2p)

_____ A. The upper forelimb (humerus)

_____ B. Part of the lower forelimb (ulna)

_____ C. The upper hindlimb (femur)

_____ D. Part of the lower hindlimb (tibia)

_____ E. A digit (phalanx)

(5) Look at the shape of the bones 1 and 2. For what kinds of movement are these bones primarily adapted? Mark the correct alternative for each bone with an X.

(4p)

	Bone 1	Bone 2
Digging		
Running		
Swimming		
Flying		

(6) The three beetles (Coleoptera), numbered 1 - 3, belong to three different genera. The task is to identify which beetle belongs to which genus. To identify the beetles, use the identification key on page 8 and the pictures on page 9. Fig. 1 shows what some parts of a beetle are called, and figs. 2-14 are explained in the identification key. To study a beetle under the stereo microscope, lift the beetle by its needle and hold both ends of the needle with your fingers.

Write the number of each beetle (1, 2, 3) in front of the name of its genus.

(9p)

___ *Acanthocinus*	_____ *Agathidium*	_____ *Calathus*
___ *Cassida*	_____ *Dascillus*	_____ *Dryophtorus*
___ *Eledonoprius*	_____ *Hylobius*	_____ *Mycetochara*
___ *Oceoptoma*	_____ *Carabus*	_____ *Tenebrio*
___ *Xylita*		

Identification key:

1a The outermost 3-5 segments of the antennae distinctly thicker than the other segments (fig. 2 & 3) => 2

1b The outermost 3-5 segments of the antennae of approximately the same thickness as the other segments (fig. 4 & 5) => 5

2a The 1st segment (closest to the head) of the antennae several times longer than the other segments => 3

2b The 1st segment (closest to the head) of the antennae of approximately the same length as the other segments => 4

3a Antennae with 11 segments: 1 very long, 7 normal and 3 thick => *Hylobius*

3b Antennae with 8 segments: 1 very long, 4 normal and 3 thick => *Dryophtorus*

4a All feet 5-segmented (fig. 6 & 7) => *Oceoptoma*

4b Hind feet 4-segmented (fig. 8 & 9) => *Agathidium*

5a All feet 5-segmented (fig. 6 & 7) => 6

5b Hind feet 4-segmented (fig. 8 & 9) => 8

6a Pronotum more than twice as broad as long => *Dascillus*

6b Breadth of pronotum less than twice its length =>7

7a Claws with distinct teeth on the inner side (fig. 10) => *Calathus*

7b Claws with inner side smooth (fig. 11) => *Carabus*

8a All feet 4-segmented => 9

8b Fore and middle feet 5-segmented =>10

9a Antennae longer than total body length => *Acanthocinus*

9b Antennae shorter than total body length => *Cassida*

10a Claws with distinct teeth on the inner side (fig. 10) => *Mycetochara*

10b Claws with inner side smooth (fig. 11) => 11

11a Head with protracting edge in front of the eyes, antennae inserted under this edge (fig. 12) => 12

11b Head without protracting edge in front of the eyes => *Xylita*

12a Sides of pronotum toothed (fig. 13) => *Eledonoprius*

12b Sides of pronotum smooth (fig. 14) => *Tenebrio*

(pictures)

(7) Now look at plants 9 - 13. These plants belong to the following species:

9: *Achillea millefolium*

10: *Artemisia vulgaris*

11: *Lamium purpureum*

12: *Potentilla reptans*

13: *Veronica chamaedrys*

On the next page you will find an identification key leading to these five plant species and four others. In the key, nine characters are missing. Choose among the ten characters labelled A - J below. In each place where a character is missing in the key, write one of the letters A - J to indicate which of these characters fits into the key in that place.

(6p)

Characters:

A. Stalk with alternate leaves

B. Stalk with hair in two rows

C. Flowers small, gathered in a capitulum

D. Flowers larger, not gathered in a capitulum

E. Capitula small, in long panicles

F. Two stamens

G. Three stamens

H. Four stamens

I. At least four stamens

J. Two stamens longer and two shorter

Identification key:

1a _____ => 2

1b _____ => 4

2a _____ => *Artemisia vulgaris*

2b Capitula larger, not in long panicles => 3

3a Stalk with opposite leaves => *Bidens tripartita*

3b _____ => *Achillea millefolium*

4a _____ => 5

4b _____ => 6

5a Stalk with hair evenly spread all around => *Veronica montana*

5b _____ => *Veronica chamaedrys*

6a _____ => 7

6b More than four stamens => 8

7a Stamens of equal length => *Brassica rapa*

7b _____ => *Lamium purpureum*

8a Leaves silvery downy underneath => *Potentilla argentea*

8b Leaves not downy underneath => *Potentilla reptans*

10th International Biology Olympiad

Practical test 1999-07-06

Laboratory 4: Behaviour

Questions (1) - (4)

Surname _____

First name _____

Country _____

Code number _____

General remarks about the practical tests

In the practical tests you are expected to demonstrate that you know some basic methods, processes and techniques of biology and that you are able to use them for experimental purposes. This will be tested in a series of tests, organized in four different laboratories:

Laboratory 1: Microbiology

Laboratory 2: Genetics and histology

Laboratory 3: Morphology and physiology

Laboratory 4: Behaviour

You have 70 minutes in each laboratory. You can score a maximum of 26 - 50 points in each laboratory, which means a total of 150 points for the practical test. If at some task you mark some incorrect alternative(-s) as well as some correct ones, you will get a lower score at that particular task than if you only mark the correct answers.

Introductory remarks to laboratory 4: Behaviour

In laboratory 4 you will plan, perform and analyse an experiment with guppies *(Poecilia reticulata)* concerning sexual selection. There are two major types of sexual selection:

	Definition	Common consequence
Intersexual selection	individuals of one sex (usually females) choose their partner non-randomly among individuals of the other sex	may lead to the evolution of conspicuous ornaments in males, which are used to attract females
Intrasexual selection	individuals of one sex (usually males) fight over the opportunity to mate, while the other sex has no choice but to mate with the winner	may lead to the evolution of fighting ability and weapons in males, and also of signals used to scare off competitors

In many varieties of guppies, the males have a large and colourful tail-fin. This trait has been exaggerated through human breeding, but the basis for this breeding is the natural variation among wild guppies. Comparing guppies with extraordinarily large tail-fins with those with smaller tail-fins may help us to understand in what way a large tail-fin may be advantageous in the context of sexual selection.

A large tail-fin could be

- an ornament functioning as a signal to attract females
- a signal of fighting ability used to scare off males

or both, or neither.

The task here is to design, perform and analyse an experiment, which will test the hypothesis that **inter**sexual selection may explain why some males have a large tail-fin.

Waiting for actual copulations to occur would be too time-consuming, but one can use a short-cut often used by behavioural researchers, namely to assume that an individual will spend more time close to an individual with whom it would prefer to mate and less time near a less preferred individual. At your disposal you have female guppies, male guppies with smaller tail-fins, male guppies with larger tail-fins, and an aquarium divided by lines in the bottom into three sections of equal size, each containing one beaker.

In this laboratory, you will answer all questions by marking the correct alternative (or the appropriate boxes) with a cross (X).

You should answer questions (1) - (4) **before** starting with the practical work. When you have answered these questions, give your answers to an assistant. The assistant will then give you the remaining questions, and thereafter you start the experiment.

(1) Which of the following predictions is correct?

(2p)

If **inter**sexual selection makes it advantageous for males to have a large tail-fin, then . . .

_____ A. . . . females will prefer to mate with a male with a small tail-fin.

_____ B. . . . females will prefer to mate with a male with a large tail-fin.

_____ C. . . . females will show no preference for males with either large or small tail-fins.

(2) Which of the experimental designs (A - H) on pages 6-7 would be most appropriate to test the hypothesis that **inter**sexual selection makes it advantageous for males to have a large tail-fin? Each design is described by a sketch of the aquarium from above. To test any one of the designs the behavior of the fish should be recorded after 2,3,4 and 5 minutes.

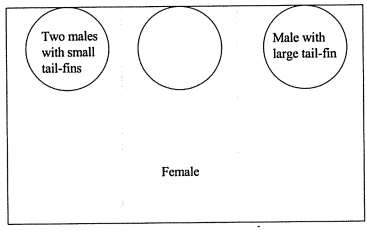
(6p)

_____ Design A _____ Design B _____ Design C

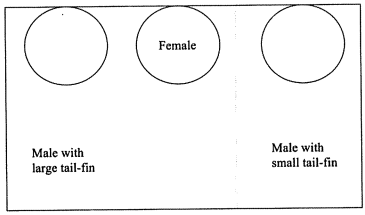
_____ Design D _____ Design E _____ Design F

_____ Design G _____ Design H

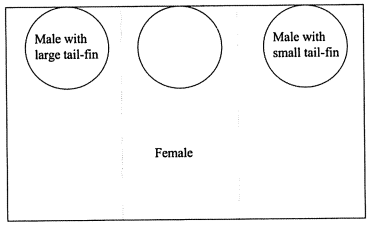
Design A:



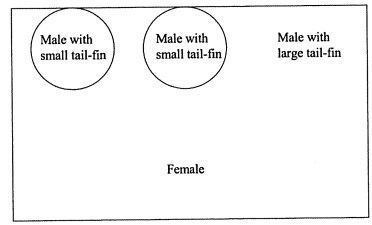
Design B:



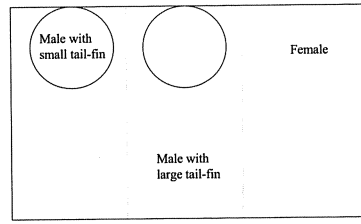
Design C:



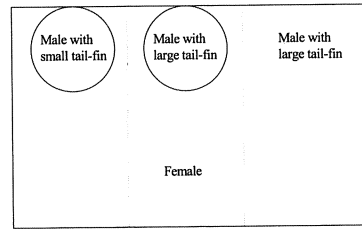
Design D:



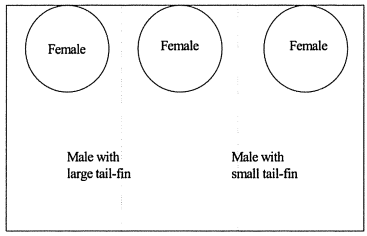
Design E:



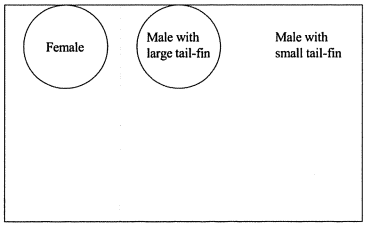
Design F:



Design G:



Design H:



(3) Some previous studies have suggested that female guppies prefer males with much red and orange in their colouration. If this is so, can it affect the interpretation of your results?

(3p)

_____ A. Yes, if males with small tail-fins have more red and orange in their colouration, then it may be difficult to tell whether large tail-fins or red / orange colour is the character that makes the females prefer some males.

_____ B. Yes, if males with large tail-fins have more red and orange in their colouration, then it may be difficult to tell whether large tail-fins or red / orange colour is the character that makes the females prefer some males.

_____ C. Yes, if females have more red and orange in their colouration than males, then it may be difficult to tell whether large tail-fins or red / orange colour is the character that makes the females prefer some males.

_____ D. No, the interpretation of my results regarding the effects of male tail-fin size on female choice cannot be affected by other characters preferred by the females.

(4) When you have finished the experiment with one set of fish, should you put the fish back in their boxes and let them mix with the others, or should you put them in other boxes to keep fish that have been tried already separate from those that have not?

(2p)

_____ A. Put them back and let them mix with the others, so that each replicate is done with a random combination of the fish available.

_____ B. Keep fish that already have been tried separate and use new fish in each replicate, so that each replicate is an independent observation.

_____ C. Put the female back and let her mix with the other females, but keep males that already have been tried separate and use new males in each replicate.

Now, before doing the experiment, give your answers to an assistant, who will then give you the remaining questions.

10th International Biology Olympiad

Practical test 1999-07-06

Laboratory 4: Behaviour

Test protocol and questions (5) - (9)

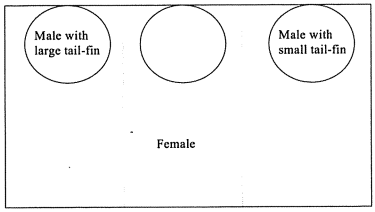
Surname _____

First name _____

Country _____

Code number _____

Now you are ready for the experiment. The experiment should be performed as follows: (Fill in the results in the test protocol on the next page. Mark with a cross (X) in the appropriate boxes)



* Put a female in the test aquarium, a male with a small tail-fin in the beaker on one side, and a male with a large tail-fin in the beaker on the other side. The middle beaker is left empty.
* Watch the fish and after 2, 3, 4 and 5 minutes, record whether the female is in the same section as either of the males or in the middle section with the empty beaker.
* Note also which of the two males has most red and orange in his colouration.
* Put the fish already tested in separate boxes and repeat the experiment with fish that have not been used.
* When you repeat the experiment, alternate having the male with large tail-fin to the left and to the right compartment.
* Because of the limited time, you will only make five trials.
* Fill in the results in the test protocol on the next page. Mark with a cross (X) in the appropriate boxes.

Test protocol:

Replicate nr	Male	Which male has the most red & orange	Placed in Beaker		Position of female (section of aquarium)											
					after 2 minutes			after 3 minutes			after 4 minutes			after 5 minutes		
			left	right	left	mid	right	left	mid	right	left	mid	right	left	mid	right
1	large tail-fin															
	small tail-fin															
2	large tail-fin															
	small tail-fin															
3	large tail-fin															
	small tail-fin															
4	large tail-fin															
	small tail-fin															
5	large tail-fin															
	small tail-fin															

After completing the five trials, proceed with questions (5) - (9).

In this laboratory, instead of calculating statistics, you will interpret what the trend in the results suggests, that is, what would be the conclusion if you had done many more trials and the results were the same. When you have completed five trials, procede with questions (5) - (9).

(5) Did the females prefer males with small or large tail-fins?

(2p)

_____ A. Large tail-fins.

_____ B. No, neither.

_____ C. Small tail-fins.

(6) Did the females prefer the male with more red and orange than the one with less of these colours, or vice versa?

(2p)

_____ A. The females preferred the male with more red / orange.

_____ B. There was no indication of any preference for males with more or less red and orange in their colouration.

_____ C. The females preferred the male with less red / orange.

(7) If the trends you observed were statistically significant, what would your conclusion then be?

(3p)

_____ A. The result would support the hypothesis that a large tail-fin makes a male more attractive.

_____ B. The result would support the hypothesis that red and orange colour makes a male more attractive.

_____ C. The result would support the hypothesis that either tail-fin size or red / orange colour, or both, makes a male attractive, but would not show which of these traits is important.

_____ D. The result would not support any of these hypotheses.

(8) In this experiment you used several males and several females. The number of guppies needed could have been reduced by using the same two males in all trials, and only change the female between trials. How would this have affected your interpretation of the results?

(3p)

_____ A. It is inconceivable that most females would show a preference for one and the same of the two males, so no conclusion could be drawn from such an experiment.

_____ B. It could happen that most females would show a preference for one of the males, but it would be impossible to tell whether this was because of his tail-fin size or because of something else.

_____ C. It could happen that most females would show a preference for the male with the larger tail-fin. This would mean that tail-fin size is an important character when the females choose their partner. However, I would have to give each female much more time to choose before I checked which male she preferred.

_____ D. It would not affect the results or the interpretation of the experiment at all.

(9) As you may remember from the begining of the instruction, **inter**sexual selection is when individuals of one sex choose their partner among individuals of the other sex, and **intra**sexual selection is when individuals of one sex fight or scare off each other to get the opportunity to mate with individuals of the other sex. Today's experiment was designed to test whether tail-fin size is important in **inter**sexual selection. If instead you wanted to make an experiment to test whether **intra**sexual selection may explain why some guppy males have a large tail-fin, which of the following experiment designs would be the most appropriate?

(3p)

_____ A. Put two female guppies in an aquarium. At one short side of the aquarium, let the females see a film of two male guppies, one with a large and the other with a small tail-fin. Check which of the females is closest to the film projection of the males.

_____ B. Put two males with different tail-fin size in an aquarium. At one short side of the aquarium, let the males see a film of a female guppy. Check which of the males is closest to the film projection of the female.

_____ C. Put two female guppies in an aquarium. At one short side of the aquarium, let the females see a film of two male guppies, one with a large and the other with a small tail-fin. Check which of the males on the film projection that the females are closest to.

_____ D. Put a single female guppy in an aquarium. At one short side of the aquarium, let the female see a film of two male guppies, one with a large and the other with a small tail-fin. Check which of the males on the film projection that the female is closest to.

10th International Biology Olympiad

Theoretical test 1999-07-08

The theoretical test is composed of three parts:

In part A, all questions are multiple choice questions with one and only one correct answer. You always mark the correct answer with a cross (X) on the line in front of it.

In part B, all questions are multiple choice questions, but in each question any number among the answers may be correct. Thus, there may be only one correct answer, or several, or all answers may be correct. You must mark exactly and only those answers that are correct. You always mark the correct answers with a cross (X) on the lines in front of them.

In part C, the questions are constructed in various ways, and you have to read for each question how the answer is to be given. Often you answer by writing one or a few digits or characters, and then these must be distinct and legible, otherwise your answer will not be judged as correct.

Surname _____ First name _____

Country _____ Code number _____

10th International Biology Olympiad

Theoretical test 1999-07-08

Part A

In this part, all questions are multiple choice questions with one and only one correct answer.

You always mark the correct answer with a cross (X) on the line in front of it.

Cell Biology, Microbiology & Biotechnology

1. Almost all cells in an animal contain the same genes. The cells are different in structure and function because they synthesize different . . .

(1p)

_____ A. . . . tRNA molecules.

_____ B. . . . mRNA molecules.

_____ C. . . . histones.

_____ D. . . . ribosomes.

2. Vesicles from the smooth endoplasmatic reticulum most likely are on their way to the . . .

(1p)

_____ A. . . . rough endoplasmatic reticulum.

_____ B. . . . lysosomes.

_____ C. . . . Golgi apparatus.

_____ D. . . . plant cell vacuole.

3. In the thylakoid membranes of the chloroplast there are two photosystems, PS I and PS II.

3a. Are both of these photosystems associated with light harvesting pigments?

(1p)

_____ A. Yes both.

_____ B. Only PS I.

_____ C. Only PS II.

3b. The splitting of water results in three products: oxygen, protons and electrons. Which of these are used in the photosynthetic light reaction?

(1p)

_____ A. All three of them.

_____ B. Oxygen and protons.

_____ C. Protons and electrons.

_____ D. Oxygen and electrons.

_____ E. Only electrons.

3c. Some photosynthetic and anaerobic bacteria do not split water but another compound instead. Which compound?

(1p)

_____ A. Hydrogen sulfide, H_2S.

_____ B. Methane, CH_4.

_____ C. Sodium sulfate, Na_2SO_4.

_____ D. Ethylene, C_2H_4.

4. What is cytokinesis?

(1p)

_____ A. Mitosis.

_____ B. Division of the cytoplasm.

_____ C. Cytoplasmic streaming during interphase.

_____ D. Cell crawling.

_____ E. Flagellar locomotion of a sperm.

5. In which order do the following processes take place during mitosis in animals and plants?

(1p)

I The nuclear envelope breaks down.

II The chromosomes move to the middle ("equator") of the spindle.

III Microtubules attach to kinetochores.

IV Daughter chromosomes move apart.

_____ A: I, II, III, IV

_____ B: II, III, I, IV

_____ C: I, III, II, IV

_____ D: IV, III, II, I

6. In which order do the following events take place during meiosis in animals and plants?

(1p)

I Formation of synaptonemal complex (SC) and pairing of homologous chromosome regions.

II Crossing over, i.e. exchange of nonsister chromatid regions.

III Cessation of pairing of homologous chromosome regions.

IV Cessation of association between sister chromatid regions. However, association between sister chromatid regions in the centromere region still prevails.

V Formation of chiasmata.

_____ A: I, II, III, IV, V

_____ B: I, II, III, V, IV

_____ C: I, V, II, III, IV

_____ D: I, III, IV, V, II

7. Myxobacteria are said to be "social" bacteria, because they can aggregate to form multicellular structures. To form these multicellular structures, the bacteria communicate with each other using chemical signals, one of which is cyclic AMP (cAMP). A scientist is cultivating myxobacteria on a semi-solid surface where the bacteria can move. He is applying a gradient of cAMP to the culture vessel, so that the concentration of this compound is much higher at one end of the vessel than at the oppposite. Where does he find the bacteria in the vessel?

(1p)

_____ A. At the end where the cAMP concentration is highest.

_____ B. At the end where the cAMP concentration is lowest.

_____ C. At the middle, where the cAMP concentration is intermediate.

_____ D. Evenly dispersed all over the vessel.

8. Human superoxide dismutase (hSOD, an enzyme converting the superoxide radical, O_2^-, to peroxide, O_2^{2-}) is a remarkable enzyme: heat resistant, and stable to proteases and detergents. It is of considerable medical interest for its potential in treating various human syndromes caused by oxidation damage. You have access to cDNA encoding this enzyme, and want to clone it for large-scale production. Which of the following vectors (DNA molecule into which to clone your hSOD gene) is the most suitable choice for cloning this gene?

(1p)

_____ A. A bacterial plasmid providing the cloned gene with a signal sequence causing its export out of the cell.

_____ B. A bacterial virus that replicates to produce a high number of new virions, and then lyses the cell.

_____ C. A eukaryotic high-copy-number plasmid (high copy number = the plasmid is present in a very high number in each cell that harbors it).

_____ D. A eukaryotic plasmid providing the cloned gene with a signal sequence causing its export out of the cell.

Plant Anatomy & Physiology

9. What is the primary cause of the inability of non-halophyte plants to grow in soils of high salt concentration?

(1p)

_____ A. Mineral ions are poisonous to the plants.

_____ B. The water potential of the soil is too low.

_____ C. The oxygen content of the soil is too low.

_____ D. Salt-loving nematodes feed on the root hairs.

_____ E. A crust of salt close to the soil surface makes it difficult for young seedlings to penetrate the soil.

_____ F. Salt crystals form in the stomata and stop the gas exchange.

10. From which layer in a young tree stem do aphids (the insect family Aphididae) obtain their nutrition?

(1p)

_____ A. The cambium.

_____ B. The layer outside the cambium.

_____ C. The layer inside the cambium.

_____ D. Different layers depending on the age of the plant.

_____ E. Different layers depending on the aphid's age and stage of development.

11a. What is the plant diplophase called?

(1p)

_____ A. Mesophyte.

_____ B. Gametophyte.

_____ C. Endospermatophyte.

_____ D. Allelophyte.

_____ E. Sporophyte.

_____ F. Zygotophyte.

_____ G. Cormophyte.

_____ H. Chrocophyte.

_____ I. Diplophyte.

11b. What is the plant haplophase called?

(1p)

_____ A. Mesophyte.

_____ B. Gametophyte.

_____ C. Endospermatophyte.

_____ D. Chrocophyte.

_____ E. Cormophyte.

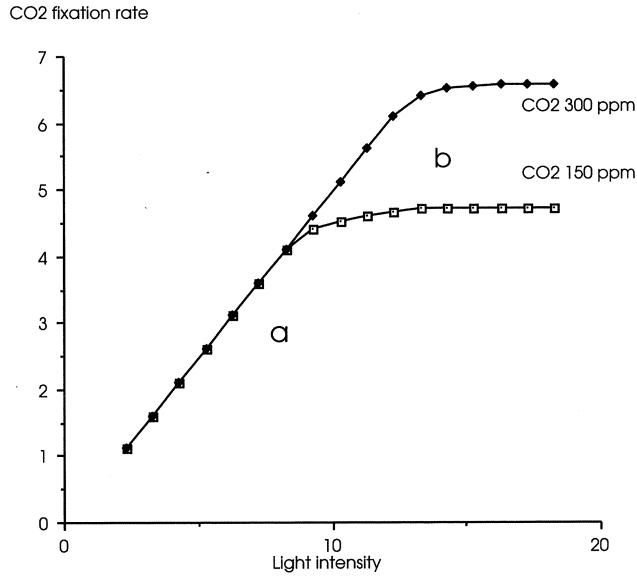
_____ F. Haplophyte.

_____ G. Sporophyte.

_____ H. Allelophyte.

_____ I. Egg-plant.

12. This graph shows how the CO_2 fixation rate of a plant varies with light intensity and different CO_2 concentrations in the air:



Which of the following interpretations of the linear portion (a) of the curve is correct? It represents the part where CO_2 fixation rate is limited by . . .

(1p)

_____ A. . . . CO_2.

_____ B. . . . light.

_____ C. . . . CO_2 and light.

_____ D. . . . temperature.

13. The carrot *(Daucus carota)* belongs to a group of plants we call rosette plants, because they grow into a rosette of leaves in the first year and build up a supply of food in their roots. If such a plant is left in the field over the winter, the root and the stem tip will survive, and in the next summer it will grow into a long stem with leaves and flowers and then develop fruits and seeds. Then it will die.

However, it is possible to keep it alive and growing for several years without flowering. What treatment is appropriate?

(1p)

_____ A. Spray with gibberellin every second month.

_____ B. Keep it in a glasshouse with a constant temperature of 20 °C.

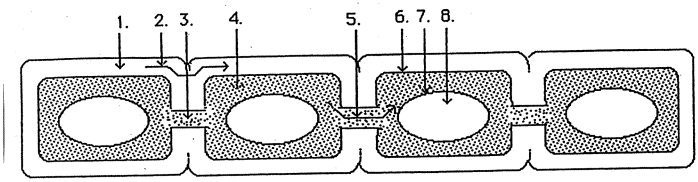
_____ C. Plant it in a very poor soil.

_____ D. Dig it up every autumn and place it in a refrigerator during the winter.

_____ E. Cut off the leaves before they wilt after the summer.

14. The drawing shows some leaf cells. The arrows (1-8) mark parts of the cells and pathways where water can pass. Which of the statements (A-D) provides a correct explanation of the drawing?

(1p)



_____ A. 1 = symplast, 2 = symplastic pathway, 3 = plasmodesma, 4 = apoplast, 5 = apoplastic pathway, 6 = plasma membrane, 7 = vacuole membrane, 8 = stoma

_____ B. 1 = apoplast, 2 = apoplastic pathway, 3 = plasmodesm, 4 = symplast, 5 = symplastic pathway, 6 = vacuole membrane, 7 = plasma membrane, 8 = vacuole

_____ C. 1 = symplast, 2 = apoplastic pathway, 3 = cytoplasm, 4 = cell wall, 5 = symplastic pathway, 6 = vacuole membrane, 7 = plasma membrane, 8 = stoma

_____ D. 1 = apoplast, 2 = apoplastic pathway, 3 = plasmodesm, 4 = symplast, 5 = symplastic pathway, 6 = plasma membrane, 7 = vacuole membrane, 8 = vacuole

Animal Anatomy & Physiology

15. The taste quality detected by taste buds located on the posterior third of the human tongue is . . .

(1p)

_____ A. . . . sweet.

_____ B. . . . sour.

_____ C. . . . bitter.

_____ D. . . . salty.

16. An antidiuretic hormone . . .

(1p)

_____ A. . . . increases plasma osmolality (solute potential).

_____ B. . . . decreases sodium reabsorption from the ascending limb of the loop of Henle.

_____ C. . . . decreases plasma glucose after meals.

_____ D. . . . decreases urea reabsorption.

_____ E. . . . increases free-water transfer from the distal tubule and collecting duct to the capillary blood.

17. Hyperthyroidism is characterized by . . .

(1p)

_____ A. . . . increased metabolic rate, increased heart rate, weight gain.

_____ B. . . . increased metabolic rate, increased heat production, weight loss.

_____ C. . . . increased heat production, increased oxygen consumption, weight gain.

_____ D. . . . increased heart rate, weight loss, sleepiness.

18. At what stage does implantation into the uterus of a woman occur?

(1p)

_____ A. Zygote.

_____ B. Unfertilized egg cell.

_____ C. Gastrula.

_____ D. Blastocyst.

19. Deleted

Plant Anatomy & Physiology

20. The spectrum of light reaching the ground under a canopy in a forest differs from the light reaching the ground in an open field.

20a. This difference is mostly due to a certain plant molecule. Which?

(1p)

_____ A. Rubisco.

_____ B. Chlorophyll.

_____ C. Phytochrome.

_____ D. Cellulose.

_____ E. Tabasco.

20b. In what respect does the light under a canopy differ from the light in an open field?

(1p)

_____ A. The ratio of blue to green light is higher.

_____ B. The ratio of red to far red light is higher.

_____ C. The ratio of red to green light is higher.

_____ D. The ratio of far red to red light is higher.

20. (continued)

20c. Plants respond to the composition of light through the action of a certain compound. Which compound?

(1p)

_____ A. Gibberellin.

_____ B. Cytokinin.

_____ C. Phytochrome.

_____ D. Rhodopsin.

_____ E. Cytochrome.

20d. In which of the following respects do the plants under a canopy differ from plants of the same species in an open field?

(1p)

_____ A. They have longer internodes.

_____ B. They have shorter internodes.

_____ C. They have thicker stems.

_____ D. Their anthocyanin content is higher.

Ethology

21. In the picture you can see a moving toy followed by three goslings (young domestic geese). What is the most likely explanation for the behaviour of the young birds?

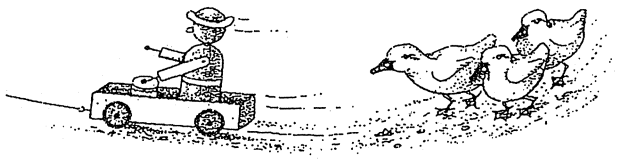
(1p)

_____ A. It is a displacement activity resulting from the absence of their parents.

_____ B. Imprinting, i.e. the toy was the first moving object they saw after hatching, and as a result they react to it as if it were their parent.

_____ C. They have been trained by their keeper to follow this particular object.

_____ D. Goslings have an innate tendency or instinct to follow any moving object they see.



22. Deleted

23. In certain animal species, such as ants and bees, many or even most individuals abstain from their own reproduction and devote all their energy to nursing and protecting the offspring of other individuals. This may appear paradoxical, since natural selection implies unequal reproductive success and generates organisms maximizing their reproductive output. What is the evolutionary explanation of the presence of large numbers of sterile individuals in an ant colony?

(1p)

_____ A. Reduced reproductive output guarantees that the demand for food can perpetually be satisfied locally and thus the ant colony safeguards its own long-term persistence by reproductive restraint.

_____ B. All the ants in the colony are closely related genetically and therefore accrue fitness through the reproductive success of their close kin.

_____ C. The sex ratio among new-born ants is greatly skewed such that most females do not find males to mate with and therefore inevitably live a sterile life.

_____ D. Ants reproduce exclusively parthenogenetically.

24. In the practical test, you investigated **if** female guppies prefer some males over others. A more complicated question is **why** female guppies show such preferences.

24a. For simplicity, assume that most females already have evolved a preference for males with large tail-fins. In that case, what advantage may an individual female get by mating preferentially with males having large tail-fins, instead of mating randomly with any male?

(1p)

_____ A. By copulating preferentially with males having large tail-fins, a female will experience less competition (from other females) over mating opportunities.

_____ B. A male with a large tailfin is likely to produce sons with large tailfins as well, and as a result a female which preferentially copulates with such a male will get sons that are attractive to other females, and therefore she is likely to get many grandchildren.

_____ C. A male with a large tailfin is likely to produce sons with small tailfins, so the sons will not be very attractive to other females, and consequently they have to copulate with their mother and she will get many more offspring.

_____ D. A male with a large tail-fin is less likely to have copulated with many other females, and therefore a female copulating preferentially with such males has a lower risk of getting infected by venereal diseases.

24. (continued)

24b. Not only females may be choosy about whom to mate with. In a number of species males prefer certain females and ignore or reject others. In some species males are in fact more choosy than females. An alternative experiment therefore could have been to investigate the mating preferences of male guppies, for instance, whether they prefer big or small females.

Suppose you know that males prefer big females. Suppose also that the males on each copulation event deliver a number of sperm that is many times the number needed to fertilize all the ripe eggs carried by the female, while there is a limit to how frequently a male can copulate. What could then be the advantage to the male of being choosy about whom to mate with instead of mating randomly with any female?

(1p)

_____ A. Larger females produce more eggs, so a male that copulates preferentially with larger females is likely to sire a larger number of offspring.

_____ B. Larger males produce more sperm, and therefore a male that copulates preferentially with larger females is likely to sire a larger number of offspring.

_____ C. Larger females use more energy and nutrients for body growth and less for producing young, and therefore a male that copulates preferentially with larger females is likely to sire a smaller number of offspring.

_____ D. Larger females copulate with a higher number of different males, and therefore the offspring of each male is more genetically diverse if the mother is large than if the mother is small. This increased genetic diversity leads to higher fitness of the offspring, and therefore a male sires more grandchildren if he copulates preferentially with large females.

Genetics & Evolution

25. Tay Sach's disease (TSD) in humans is caused by the inability to synthesize hexosaminidase. This enzyme contributes to the breakdown and turnover of lipids in brain cells. TSD shows monohybrid, autosomal and recessive inheritance. The genotype of an individual with TSD may thus be denoted *aa*. What is the most likely explanation for an *Aa*-individual being just as healthy as an *AA*-individual?

(1p)

_____ A. The dominant allele *A* is a transposon. In a heterozygous individual it detaches from its normal position and moves on to the recessive allele *a*, thus preventing the transcription of *a*.

_____ B. The recessive mutant allele is expressed as an inhibitor protein that prevents the transcription of the normal allele *A*.

_____ C. In heterozygous embryos *a* mutates to *A*. Consequently there are no *Aa*-adults.

_____ D. The amount of hexosaminidase produced by an *Aa*-individual is quite enough for normal breakdown of lipids.

26. Independently of Darwin, another person developed the same theory of natural selection as the chief driving force of evolution. When he informed Darwin about his theory, this precipitated Darwin's publication of "On the Origin of Species". What was the name of this person?

(1p)

_____ A. Ernst Haeckel

_____ B. Carl von Linné (Carolus Linnaeus)

_____ C. Alfred Wallace

_____ D. Jean-Baptiste de Lamarck

_____ E. Charles Lyell

_____ F. Gregor Mendel

27. Of which of the following phenomena do Darwin's observations of the Galapagos finches (fam. Geospizidae) provide a classical example?

(1p)

_____ A. Hardy-Weinberg equilibrium.

_____ B. Sympatric speciation.

_____ C. Adaptive radiation.

_____ D. Convergent evolution.

_____ E. Flightlessness.

28. The alleles at the AB0-locus are here denoted I^A, I^B and i, respectively. The genotype of an individual with blood group B is thus either I^BI^B or I^Bi. The allele frequencies in the population are denoted p(I^A), q(I^B) and r(i), respectively.

When you answer the following questions, assume that individuals mate randomly with respect to their genotype at the AB0-locus.

28a. What is the expected frequency of individuals with blood group B?

(1p)

_____ A. $2qr^3$

_____ B. $q^2 + 2qr$

_____ C. $2qr$

_____ D. $q + r$

_____ E. $p + q + r$

In the country Faraway live Eve and Elvis and their two children, Olga and Boris. Eve and Elvis both have blood group B.

28b. What is the probability that Olga has blood group 0?

(1p)

_____ A. r^2

_____ B. $2qr^3$

_____ C. $(2qr)^2 \times 1/4$

_____ D. $(2qr / (q^2 + 2qr))^2 \times 1/4$

_____ E. $1 - 2qr$

28. (continued)

28c. What is the probability that Olga and her brother Boris **both** have blood group 0?

(1p)

_____ A. r^4

_____ B. $(2qr)^2 \times 1/4$

_____ C. $(2qr / (q^2 + 2qr))^2 \times (1/4)^2$

_____ D. $((2qr / (q^2 + 2qr))^2 \times 1/4)^2$

_____ E. $(1 - 2qr)^2$

29. On an isolated island live 5 800 people, of which 2 800 are men. 196 of these men are red-green colour-blind. This type of colour blindness is caused by a recessive allele (*r*) on the X-chromosome. This type of colour blindness does not affect the fitness of an individual.

What is the probability that **at least one** of the **women** on this island is red-green colour-blind?

(1p)

_____ A. 0.00

_____ B. 0.08

_____ C. $1 - 0.9951^{3000}$

_____ D. $1 - 0.9936^{3000}$

_____ E. $3000 \times 0.0056 \times 0.9944^{2999}$

_____ F. 0.0064

_____ G. 1.00

30. In an island population of an annual, diploid plant species the allele frequencies in 1999 are p(*A*) = 0.90 and q(*a*) = 0.10. Suppose that the population consists of 50 plants in the year of 2000. Then, what is the probability that the allele *a* **has been lost** (i.e. p(*A*) = 1), just by chance, between the year 1999 and 2000?

(1p)

_____ A. 0.90^{100}

_____ B. 0.90^{50}

_____ C. 0.90

_____ D. 0.10^{100}

_____ E. 0.10

31. Heterozygosity, i.e. the frequency of individuals that are heterozygous at a certain locus, is a commonly used measure of genetic variation in a population. Assume a population of an annual plant species consisting of about 50 individuals. This year the allele frequencies in one locus are p(*A*) = 0.90 and q(*a*) = 0.10, respectively. Which of the following evolutionary forces might cause an increase of the heterozygosity in the next generation?

(1p)

_____ A. Genetic drift.

_____ B. Inbreeding.

_____ C. Selection against *aa*-plants (*aa* having lower fitness than *AA* and *Aa*).

_____ D. Immigration from a population where p(*A*) = 0.99 and q(*a*) = 0.01.

32. What features of present day bacteria are likely to prevent their direct evolution into multicellular organisms with differentiated organs?

(1p)

_____ A. They are very successful in the niche they occupy, and therefore do not need to evolve to multicellularity.

_____ B. They lack a cytoskeleton, and thus cannot develop good communications to adjacent cells.

_____ C. They have a rigid cell wall, and therefore cannot contact other cells.

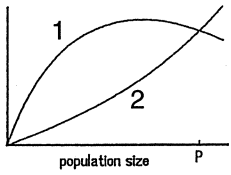
_____ D. Because they have a very versatile metabolism they cannot develop multicellularity.

Ecology

33. In setting harvesting quotas, for instance for whales, graphs are studied that show the relationship between number of births, number of deaths and population size. Inspect the following example:

Induviduals/time unit

Induviduals/time unit



Which line in the graph shows the number of births, and what does the point P represent?

(1p)

_____ A. Line 1 shows the number of births, and P represents the maximum population size.

_____ B. Line 2 shows the number of births, and P represents the maximum population size.

_____ C. Line 1 shows the number of births, and P represents the carrying capacity.

_____ D. Line 2 shows the number of births, and P represents the carrying capacity.

34. The marine pelagial is usually divided into two zones: an upper zone where net primary production takes place, and a lower zone where it does not. What is the critical factor generating this difference?

(1p)

_____ A. In the upper zone the water is warm enough for algae to grow faster than their primary consumers can eat them.

_____ B. In the upper zone there is enough light for photosynthesis to produce a surplus of organic matter.

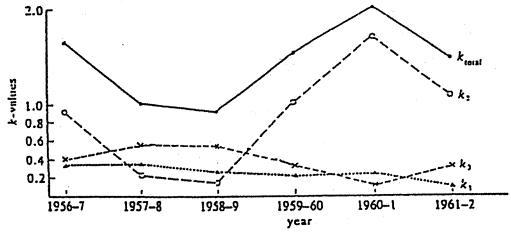
_____ C. In the upper zone the concentration of nutrients is high enough for photosynthesis to produce a surplus of organic matter.

_____ D. In the upper zone the intensive stirring of water near the surface gives the water an oxygen concentration high enough for photosynthesis to take place.

_____ E. In the upper zone the population density of fish is high enough to keep zooplankton at a low density, thereby allowing a high concentration of algae.

35. The population of a particular species of butterfly is affected by three mortality factors (with k-values k_1, k_2, k_3). The graph shows the variation of these over several years together with the variation in k_{total}. As k-values increase, butterfly mortality increases.

Use the graph to help you answer these questions:



35a. What is the relationship between k_1, k_2, k_3 and k_{total} ?

(1p)

_____ A. $k_{total} = k_1 \times k_2 \times k_3$

_____ B. $k_{total} = k_1 \times k_2 / k_3$

_____ C. $k_{total} = k_1 \times k_3 / k_2$

_____ D. $k_{total} = k_1 + k_2 + k_3$

_____ E. $k_{total} = k_1 + k_2 - k_3$

_____ F. $k_{total} = k_1 + k_3 - k_2$

35. (continued)

35b. Which was the main mortality factor in 1960?

(1p)

_____ A. k_1

_____ B. k_2

_____ C. k_3

35c. In which year did most butterflies survive to breed?

(1p)

_____ A. 1956-57

_____ B. 1957-58

_____ C. 1958-59

_____ D. 1959-60

_____ E. 1960-61

_____ F. 1961-62

36. The number of species in a landscape is often divided into two components called α-diversity and β-diversity. α-diversity is the number of species within a certain biotope in the area, while β-diversity is the degree of difference in the number of species composition between different biotopes in the landscape. Study the following table, which shows the species composition in three different biotopes within three different areas.

Area	**1**			**2**			**3**		
Biotope	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
Species									
1	x			x			x		
2				x					
3	x			x			x		
4	x			x			x		
5	x			x			x		
6	x	x		x	x		x		
7	x	x		x	x		x		
8	x	x		x	x		x		
9	x	x		x	x			x	
10	x	x						x	
11		x	x		x			x	
12		x	x		x	x		x	
13		x	x		x			x	
14						x		x	
15		x	x			x			x
16			x			x			x
17			x			x			x
18			x			x			
19			x			x			x
20						x			x

36. (continued)

36a. Which biotope has on the average the highest α-diversity?

(1p)

_____ A. Biotope *1*.

_____ B. Biotope *2*.

_____ C. Biotope *3*.

36b. In which area is the average α-diversity of the three biotopes highest?

(1p)

_____ A. Area **1**.

_____ B. Area **2**.

_____ C. Area **3**.

36c. In which area is the β-diversity highest?

(1p)

_____ A. Area **1**.

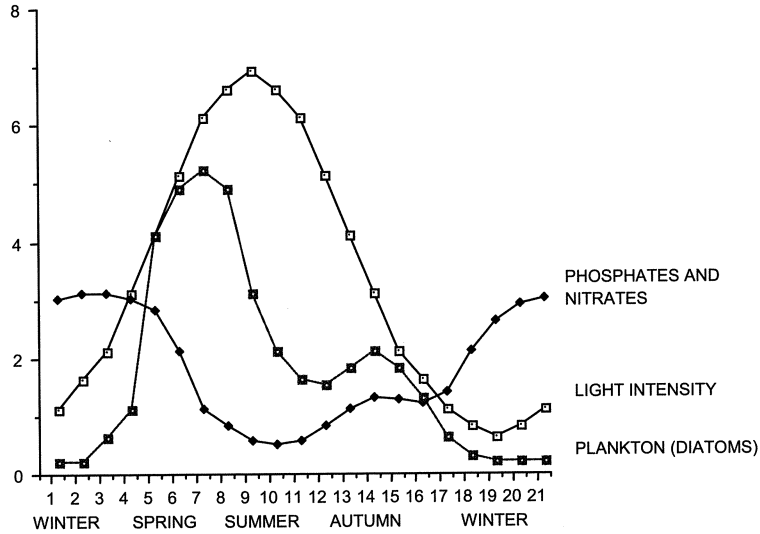
_____ B. Area **2**.

_____ C. Area **3**.

37. Deleted

38. Deleted

39. This graph shows the seasonal changes in diatom plankton number and in some abiotic factors in the upper layers of an ocean in the Northern temperate zone:



Which of the following interpretations of the graph is correct?

(1p)

_____ A. The increasing light intensity destroys diatoms.

_____ B. The increasing amount of diatoms decreases the amount of nutrients.

_____ C. The increasing light intensity creates upwelling which raises the nutrients to the sea surface.

_____ D. The increasing light intensity increases the activity of decomposers and as a result of this the amount of nutrients decreases.

_____ E. The decline of diatoms causes the declines of nutrients.

Systematics

40. In which of the following alternatives (A-D) are the traditional taxonomic categories listed from more inclusive to less inclusive?

(1p)

_____ A. Order, Genus, Class, Family, Species.

_____ B. Class, Order, Family, Genus, Species.

_____ C. Genus, Order, Class, Family, Species.

_____ D. Family, Genus, Order, Class, Species.

41. Which of the following categories includes all the others?

(1p)

_____ A. Chordates.

_____ B. Vertebrates.

_____ C. Amphibians.

_____ D. Mammals.

42. When did Dinosaurs become extinct?

(1p)

_____ A. Ca 2 million years ago.

_____ B. Ca 65 million years ago.

_____ C. Ca 200 million years ago.

_____ D. Ca 400 million years ago.

43. A fish, a dolphin and a penguin have many external features in common, such as a stream-lined body shape. Why?

(1p)

_____ A. They descend from one and the same recent ancestor and still possess many of this ancestor's traits (phylogenetic inertia); thus the body shape is not an adaptive trait.

_____ B. They are all swimming animals and have therefore accumulated features making locomotion in water less energy-demanding (convergent evolution).

_____ C. The similarity between these animals is superficial and reflects neither common history nor evolutionary response to the same environment; in fact, these animals are built along entirely different principles; they live in the same habitat (water) because they have their particular shape, rather than the other way around.

44. The genetic similarities between man and the two chimpanzee species allow us to estimate that the separation of the hominid line and the chimpanzee line occurred:

(1p)

_____ A. Ca 250 000 years ago.

_____ B. Ca 100 000 000 years ago.

_____ C. Ca 6 000 000 years ago.

_____ D. Ca 6 000 years ago.

45. After the separation of the chimpanzee and hominid lines, the first major trait characterizing the hominid line was . . .

(1p)

_____ A. . . . brain enlargement.

_____ B. . . . stereoscopic vision.

_____ C. . . . tool making.

_____ D. . . . bipedalism and erect body posture/walking.

_____ E. . . . homeothermy.

_____ F. . . . increased sexual size dimorphism.

_____ G. . . . carnivory (meat-eating).

Surname _____ First name _____

Country _____ Code number _____

10th International Biology Olympiad

Theoretical test 1999-07-08

Part B

In this part, all questions are multiple choice questions, but in each question any number among the answers may be correct. Thus, there may be only one correct answer, or several, or all answers may be correct. You must mark exactly and only those answers that are correct. You always mark the correct answers with a cross (X) on the lines in front of them.

46. The *lac* genes of *Escherichia coli* are classic; this is where the operon concept was coined, and investigations of how this operon was regulated rendered its investigators a Nobel prize. The *lac* operon of *E. coli* contains three genes:

z, encoding β-galactosidase,

y, encoding β-galactoside permease, and

a, encoding a transacetylase.

Allolactose is an isomer of lactose that is produced by β-galactosidase as an intermediate in the splitting of lactose to galactose and glucose. It is allolactose, not lactose, that is the natural inducer for the *lac* operon. Allolactose binds to the repressor and thereby opens the operon for transcription. Under which of the following conditions will expression of β-galactoside permease be induced?

(2p)

_____ A. Addition of lactose to a z^-y^+ mutant.

_____ B. Addition of allolactose to a z^-y^+ mutant.

_____ C. Addition of lactose to a z^+y^- mutant.

_____ D. Addition of allolactose to a z^+y^- mutant.

47. Cycloheximide is a drug that prevents protein synthesis in eukaryotic cells; chloramphenicol prevents protein synthesis in bacterial cells. Steroid hormones exert their effect by binding to cellular receptors. The hormone-receptor complex then binds to particular regions of DNA, and thereby regulates transcription. A transcriptional co-activator, TC, has been isolated from human cells. This binds to the steroid receptor, and is necessary for full transcriptional activation by a steroid hormone. The cDNA encoding TC has been cloned in a bacterial plasmid. Cultured human cells were transfected with this plasmid in the presence of cycloheximide or chloramphenicol. In both cases full steroid hormone transcription activation took place. The cDNA clone was subsequently mutated, introducing stop codons in all three reading frames. Upon transfection of human cells, full steroid hormone transcription activation took place.

Which of the following explanations are consistent with these data?

(2p)

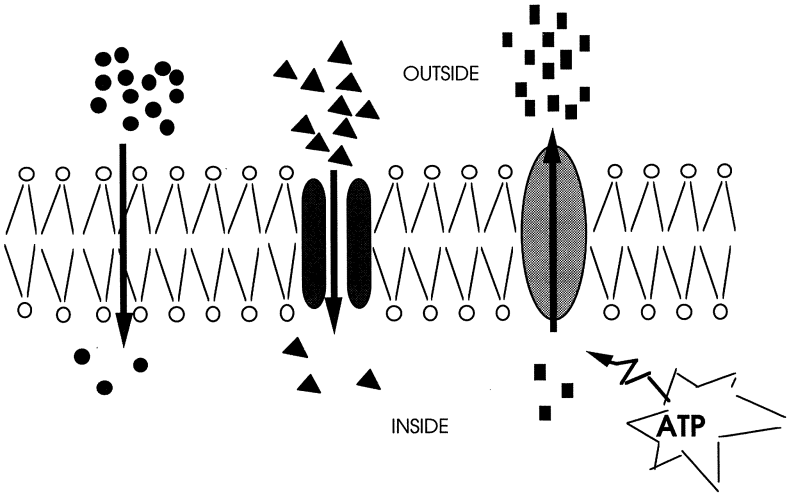
_____ A. The human cells contain translational suppressors that override all the stop codons. Therefore the normal TC product can be made, despite the presence of stop codons in all reading frames.

_____ B. The gene product of TC necessary to activate transcription is an RNA, not a protein.

_____ C. The plasmid contained enough TC protein so that no new TC protein synthesis was needed in the human cell upon transfection for maximal transcription activation.

_____ D. The cDNA itself bound to the steroid receptor and thereby activated transcription.

48. The drawing below shows the transport of different substances through the plasma membrane of a plant cell. The drawing represents a lipid bilayer with a channel protein (middle) and a carrier protein (right). The direction of each transport is shown by an arrow and the number of symbols indicates the concentraton of each substance.



Which statements are correct?

(1p)

_____ A. This substance can be sucrose.

_____ B. This substance can be oxygen.

_____ C. This substance can be chloride ions.

_____ D. This substance can be water.

_____ E. This substance can be protons.

49. One line of cultured mouse lymphoma cells is quite sensitive to cyclic AMP (cAMP). High internal levels of cAMP cause cell death. The intracellular activity of dibuturyl-cAMP (db-cAMP) and cAMP is the same. Resistant cells can be selected by growing the cells in the presence of db-cAMP. Such cells are resistant not only to cAMP, but also to the prostaglandin PGE1 (which kills sensitive cells by raising their intracellular cAMP level).

A student homogenized db-cAMP-sensitive and db-cAMP-resistant cells so that their cell membranes became disrupted, and then removed all particulate matter (fragments of cell membranes, nuclei and internal membrane systems) so that essentially only the protein-containing cytoplasm was left. She prepared three samples for analysis, as shown below. She then added radioactive cAMP, incubated for a while, and subjected the mixture to gel filtration (a technique that separates molecules according to their size). In both cases she found the radioactivity in two peaks: a complex of cAMP with some protein(-s) (fraction A), and free cAMP (fraction B):

	fraction radioactive cAMP	
Cell homogenates	A: in protein complex	B: free
sensitive	0.5	0.5
resistant	0.1	0.9
equal mixture of sensitive and resistant	0.5	0.5

49. (continued)

Which of the following explanations is/are consistent with the data?

(2 p)

_____ A. The transport system for cAMP is defective in resistant cells. cAMP binds to this transport protein in homogenates from sensitive cells, and therefore does not bind to anything in homogenates from resistant cells

_____ B. The regulatory subunit of a protein kinase is defective in resistant cells. cAMP binds to this regulatory subunit in homogenates from sensitive cells, and therefore does not bind to anything in homogenates from resistant cells.

_____ C. Resistant cells contain a new activity that is capable of modifying cAMP so that it no longer can bind to its receptor. The "free cAMP" in homogenates from resistant cells is really modified cAMP that elutes in approximately the same way as cAMP.

50. In eukaryotes, the majority of the RNA made in the nucleus undergoes three modifications before being transported from the nucleus to the cytoplasm. Which of these modifications help protect the RNA from degradation by nucleases?

(1 p)

_____ A. A 7-methyl-guanosine cap is added to its 5' end.

_____ B. A poly-A tail is added to its 3' end.

_____ C. Introns are spliced out.

51. Which of the features below would permit you to determine whether a cell is eukaryotic or prokaryotic?

(1p)

_____ A. The genetic material exists as a complex of nucleic acids and proteins.

_____ B. The genetic material is separated from the rest of the cell by a semipermeable barrier.

_____ C. There is a cell wall.

_____ D. The cell is motile.

_____ E. It can use H_2S as energy source.

52. Which of the following statements is/are true for bacteria?

(1p)

_____ A. Negative control of gene expression is common.

_____ B. The processes of transcription and translation are coupled.

_____ C. Positive control of gene expression is common.

_____ D. Structural genes average 50 000 base pairs.

_____ E. Several genes are transcribed into one mRNA molecule.

53. Respiring cells use the citric acid cycle (Krebs cycle) to oxidize their nutrients completely, and obtain NADH that is subsquently oxidized in mitochondria to gain ATP. Fermenting cells (yeast, for instance, and many bacteria) use part of the citric acid cycle, although they cannot oxidize their nutrients completely, and do not gain ATP from the extra NADH it generates. What do fermenting cells gain by operating part of the citric acid cycle?

(1 p)

_____A. A supply of oxaloacetate, which is a very unstable compound, and therefore needs to be made continuously.

_____B. Supplies of some of the citric acid cycle intermediates, which are essential precursors for cellular biosynthesis.

_____C. A supply of succinate, which is needed for acylation of tRNAs. Without acyl- tRNAs, protein synthesis is inhibited.

_____ D. A supply of malate, which is needed for all ATP synthesis.

54. Deleted

55. Deleted

56. A scientist was growing yeast (*Saccharomyces cerevisiae*) in a simple nutrient solution, using ^{14}C-labelled glucose as its only energy source. She noted that for each mole of glucose that was completely oxidized, the cells consumed 6 moles of O_2, and produced 36 moles of ATP.

56a. The radioactivity of what carbon compound(-s) did she measure to be able to say that the glucose was completely oxidized?

(1p)

_____ A. CO_2

_____ B. CH_4

_____ C. Ethanol

_____ D. Lactate

56b. What is the name of the process that she was studying?

(1p)

_____ A. Respiration.

_____ B. Detoxification.

_____ C. Fermentation.

_____ D. Denitrification.

_____ E. Photosynthesis.

56. (continued)

She then moved her culture to an anaerobic environment, and continued to study what happened to the radioactive glucose. She found that the cells continued to grow, utilizing glucose as energy source. Now, no oxygen was consumed, and the yield of ATP was only 2 moles per mole glucose oxidized.

56c. What is the name of the process that she is now studying?

(1p)

_____ A. Respiration.

_____ B. Detoxification.

_____ C. Fermentation.

_____ D. Denitrification.

_____ E. Photosynthesis.

56d. Which compound(-s) will become labelled by ^{14}C under these conditions?

(1p)

_____ A. CO_2.

_____ B. CH_4.

_____ C. Ethanol.

_____ D. Lactate.

Plant Anatomy & Physiology

57. Seeds of wheat (*Triticum aestivum*, family Poaceae = Graminae) and lupin (*Lupinus polyphyllus*, family Fabaceae = Leguminosae) were used in the following experiment. Both types of seeds had been harvested about 6 months before. Dry seeds of each species were put together in samples of the same weight and treated as follows:

a. Wheat seeds were soaked in water for 24 hours

b. Wheat seeds were soaked in a solution of 1 M mannitol for 24 hours

(mannitol is a sugar alcohol not taken up by plants)

c. Lupin seeds were soaked in water for 24 hours

d. Lupin seeds were dipped in boiling water for a few seconds and then soaked in water for 24 hours.

All samples were kept in darkness for 24 hours and then weighed and placed on wet filter papers in Petri dishes for a germination test. The table below shows the approximate percent increase in weight during the different treatments, and the percent germination.

57. (continued)

Treatment	Percent increase In weight	Percent germinating seeds
a. Wheat soaked in water	98	100
b. Wheat soaked in mannitol solution	12	0
c. Lupin seeds soaked in water	11	0
d. Lupin seed dipped in hot water before soaking	110	80

Which explanations to the results are probable?

(2p)

_____ A. In water-soaked seeds respiration starts so that water can be taken up.

_____ B. The difference in weight between dry seeds and water-soaked seed is due to water uptake.

_____ C. The mannitol enters the cell wall and makes it impermeable to oxygen and water.

_____ D. The mannitol inhibits certain steps in the citric acid cycle (Krebs cycle).

____ E. The high concentration of mannitol hinders the uptake of water.

____ F. Mannitol makes a very tight slime around the wheat seeds which squeezes them so they cannot grow.

_____ G. Fresh lupin seeds have seed coats with a very low permeability to water.

_____ H. When heated the dry lupin seeds are stressed and produce a lot of new proteins so that their weight increases.

_____ I. The heating of lupin seeds makes the seed coat more permeable to water.

_____ J. The heating of lupin seeds destroys the cell membranes so that water goes in.

58. The Calvin cycle . . .

(1p)

_____ A. . . . proceeds during the night.

_____ B. . . . produces phosphoglyceraldehyde.

_____ C. . . . needs ATP.

_____ D. . . . releases carbon dioxide.

59. What are the benefits to the plant of C4 photosynthesis as compared to C3 photosynthesis?

(1p)

_____ A. C4 photosynthesis needs fewer light quanta to fix one mole of CO_2.

_____ B. C4 photosynthesis can proceed at much lower CO_2 concentrations than C3 photosynthesis.

_____ C. Plants with C4 photosynthesis are more economic in water use.

_____ D. Plants with C4 photosynthesis require fewer types of minerals.

Animal Anatomy & Physiology

60. The absorption in the small intestine in humans is impaired if the liver stops producing bile. The absorption of which of the compounds A-E would be severely reduced without bile?

(1p)

_____ A. Dipeptides.

_____ B. Fat-soluble vitamins.

_____ C. Starch.

_____ D. Glucose.

_____ E. Amino acids.

61. Which of the following compounds are transported in intestinal epithelial cells by a sodium ion- (Na^+) dependent cotransport process?

(1p)

_____ A. Glucose.

_____ B. Galactose.

_____ C. Fructose.

_____ D. Amino acids.

_____ E. Dipeptides.

62. Which of the following structures, features and processes are necessary for gas exchange in all animals?

(2p)

_____ A. Hemoglobin or another respiratory pigment.

_____ B. Thin and wet surface.

_____ C. Diffusion.

_____ D. Red blood cells.

_____ E. Lungs or tracheae.

_____ F. Oxygenated water or air.

63. Which of the following compounds normally appear in the glomerular filtrate of mammals?

(1p)

_____ A. Urea.

_____ B. Glucose.

_____ C. Amino acids.

_____ D. Plasma proteins.

_____ E. Mineral salts.

64. Which of the following substance(s) are essential for blood coagulation in the human body?

(1p)

_____ A. Prothrombin.

_____ B Potassium.

_____ C. Heparin.

_____ D. Fibrinogen.

_____ E. Calcium.

65. The following measurements were obtained in a male patient:

Heart rate = 70 beats/min

Pulmonary vein contains 0.24 ml O_2/ml

Pulmonary artery contains 0.16 ml O_2/ml

Whole body O_2 consumption = 500 ml/min

What is the patient's cardiac output?

(2p)

_____ A. 1.65 L/min.

_____ B. 4.55 L/min.

_____ C. 5.0 L/min.

_____ D. 6.25 L/min.

_____ E. 8.0 L /min.

66. Two types of muscle participate in the locomotion of earthworms (*Lumbricus*, Annelida). When moving forward, an earthworm first squeezes the front segments into a long tube (I) and then drags its back part (II). Which muscles are contracted (c) and relaxed (r) in I and II, respectively?

(2p)

	I	II
	Longitudinal muscles/circular muscles	Longitudinal muscles/circular muscles
_____ A.	r/c	r/c
_____ B.	r/c	c/r
_____ C.	c/r	c/r
_____ D.	c/r	r/c
_____ E.	c/c	r/r

Genetics & Evolution

67. The wild type eye colour of the fruit fly *Drosophila melanogaster* is brick red. In such an eye there are two types of pigments: bright red and brown pigments.

A young student has as a hobby to collect mutants of *D. melanogaster* with bright red eyes. He has received some such strains from a Drosophila Stock Centre, e.g. *cinnabar*, *scarlet* and *vermilion*, all of which have bright red eyes. In the compost bucket in his kitchen he was happy to find a mutant with bright red eye colour. From this compost mutant he produced a true-breeding strain with bright red eyes that he calls "Uppsala". His girl-friend has given him "Wik", which is another true-breeding strain with bright red eyes. Crosses between some true-breeding strains gave the results presented in the table below. Each F_1 consisted of hundreds of flies. The number of F_2 individuals are given in the table. Wild type is denoted by "+", and the mutants with bright red eye colour by "m".

67. (continued)

Parent strains (P)			Phenotypes in F_1		Phenotypes in F_2	
Females	x	Males	Females	Males	Females	Males
cinnabar	x	+	+	+	762 + 242 m	757 + 239 m
scarlet	x	+	+	+	312 + 101 m	301 + 99 m
scarlet	x	*cinnabar*	+	+	908 + 699 m	901 + 692 m
vermilion	x	+	+	m	114 + 104 m	111 + 102 m
Uppsala	x	+	+	+	612 + 199 m	601 + 182 m
Uppsala	x	*cinnabar*	m	m	216 m	203 m
Wik	x	+	+	m	160 + 151 m	155 + 149 m
Wik	x	*vermilion*	+	m	203 + 197 m	4 + 396 m

67. (continued)

67a. In which of these strains does mutant bright eye colour show autosomal, monohybrid and recessive inheritance in relation to wild type?

(2p)

_____ A. *cinnabar*

_____ B. *scarlet*

_____ C. *vermilion*

_____ D. Uppsala

_____ E. Wik

67b. Which mutant strains carry mutant genes in linked but separate loci?

(2p)

_____ A. *cinnabar* and *scarlet*

_____ B. *cinnabar* and *vermilion*

_____ C. *vermilion* and Uppsala

_____ D. Uppsala and Wik

_____ E. *vermilion* and Wik

67. (continued)

67c. What is the distance between these two linked loci?

(2p)

_____ A. 1 cM (cM = centimorgan)

_____ B. 2 cM

_____ C. 4 cM

_____ D. 8 cM

_____ E. 10 cM

_____ F. 12 cM

_____ G. 20 cM

_____ H. 80 cM

68. Which of the following cell structures are homologous, i.e. derived from a common ancestor?

(1p)

_____ A. The cell wall of bacteria and the cell wall of plants.

_____ B. The flagellum of a bacterium and the flagellum of an animal cell, e.g. a sperm.

_____ C. The nucleosomes in plants and the nucleosomes in animals.

_____ D. The mitochondria in plants and the mitochondria in animals.

69. Some mutations in mitochondrial DNA can cause a disease in humans called Leber's hereditary optic neuropathy (LHON). This is characterized by a sudden onset of blindness in adults. Which of the following statements are true?

(1 p)

_____ A. Only women (not men) can develop LHON.

_____ B. Both men and women can develop LHON.

_____ C. A person will develop LHON only if both its mother's and its father's mitochondria carry the mutation.

_____ D. A person will develop LHON if its father has the disease but its mother is healthy.

_____ E. A person will develop LHON if its mother has the disease but its father is healthy.

70. Which of the following statements about speciation in animals is/are true?

(2p)

_____ A. Species always arise momentarily as a result of major sudden mutations.

_____ B. The number of species usually multiplies as a result of one population becoming divided into two (or more), which subsequently evolve in divergent directions.

_____ C. A species may undergo changes over time and eventually become different enough to be regarded and named as a new species.

_____ D. Speciation invariably proceeds at a fixed pace. Speciation events can therefore be accurately dated using the molecular clock.

_____ E. According to the biological species definition a species consists of the total set of individual organisms having identical genomes.

_____ F. On inspection of external features, it should be possible to identify each individual in a species. Otherwise the species delimitations are erroneous and have to be revised.

_____ G. All traits distinguishing two species must have evolved by natural selection.

_____ H. Artifical selection can in principle lead to the generation of new species.

Ethology

71. A flock of sparrows is feeding at a bird table in a garden. Suddenly one of the sparrows gives an alarm call, all the birds fly off and hide in nearby bushes, and a second later a hawk flies past. How can the sparrow that first spotted the hawk gain fitness by calling instead of flying off silently?

(2p)

_____ A. By giving the alarm call the caller will attract the attention of the predator in order to sacrifice itself for the benefit of its species.

_____ B. Predators that realize they have lost their chance of a surprise attack often give up hunting, so by giving the alarm call the caller signals to the hawk that it had been discovered, and the caller thereby will reduce its own risk of being attacked.

_____ C. By giving the alarm call the caller will save a number of flock members, many of which are its own relatives. In other words, the habit of giving an alarm call can be explained in terms of kin selection.

_____ D. Alarm calling is an instinctive response always produced in the presence of a predator.

Ecology

72. The reproductive life history of an individual is defined by the number, time distribution and size of its reproductive investments.

Which of the following variables are elements in an individual's reproductive life history as defined above:

(1p)

_____ A. Reproduction several times or only once.

_____ B. Number and size of offspring per litter/clutch.

_____ C. Age at first reproduction.

_____ D. Discontinuation of reproduction beyond a certain age.

_____ E. Aerobic versus anaerobic metabolism.

_____ F. Vulnerability to interspecific competition.

_____ G. Variation in immunocompetence.

73. An ecological pyramid may describe the number of individuals, the biomass, or the rate of energy flow, at different trophic levels within an ecosystem. Usually the values at a higher trophic level are lower than those at a lower level within the same pyramid. Otherwise the pyramid may be called inverted. What circumstances may lead to inverted pyramids?

(1p)

_____ A. A pyramid of biomass, in which the producers have a very short lifecycle compared to the consumers.

_____ B. A pyramid of biomass, in which the consumers have a very short lifecycle compared to the producers.

_____ C. A pyramid of numbers of individuals, in which the individual bodymass of producers is several orders of magnitude larger than the individual bodymass of consumers.

_____ D. A pyramid of numbers of individuals, in which the primary consumer level is strongly dominated by one abundant species.

_____ E. Extremely hot climate promotes inverted pyramids.

_____ F. Extremely cold climate promotes inverted pyramids.

_____ G. Mountainous areas with high UV-radiation have inverted pyramids.

74. Which of the following statements is / are correct in relation to the carrying capacity of an area for a particular species?

(1p)

_____ A. The carrying capacity of an area is determined by the availability of resources.

_____ B. When a population that inhabits an area is larger than its carrying capacity, the population is likely to decrease

_____ C. The carrying capacity of an area can vary as a result of the environmental conditions.

_____ D. The carrying capacity of an area can be zero.

_____ E. The carrying capacity is always the same for all populations of a species throughout its range.

75. Which of the following interactions may plausibly generate coevolutionary change?

(1p)

_____ A. Interspecific competition.

_____ B. Mutualism (Symbiosis).

_____ C. Predation.

_____ D. Commensalism.

_____ E. Parasitism.

76. A metapopulation is a set of local populations, where sometimes a population becomes extinct and sometimes a new population is "born" by emigrants from some population colonizing an empty habitat patch (that is "a population of populations"). In a population, the number of individuals is determined by the balance between birth rate (+ immigration) and death rate (+ emigration). Correspondingly, in a metapopulation the number of populations is determined by the balance between extinction rate and colonization rate. Which of the following statements about metapopulations are correct?

(2p)

_____ A. If there are many habitat patches and colonizations of empty patches occur frequently, then the metapopulation may persist for a very long time even if all local populations are short-lived.

_____ B. If the extinction rate of local populations exceeds a certain rate the whole metapopulation will go extinct.

_____ C. Species that require a habitat that is patchily distributed are more likely to function as metapopulations than species that are habitat generalists.

_____ D. Species in which every individual moves several times per day between different resource patches are more likely to function as metapopulations than species which only seldom make movements between the resource patches.

_____ E. A metapopulation can persist only if some dispersal between the habitat patches is possible.

_____ F. In a metapopulation, no single population persists longer than the lifespan of one individual.

Systematics

77. Which of the following statements is / are true?

(1p)

_____ A. The human species, *Homo sapiens*, is a very old species which has been around since late Cretaceous.

_____ B. Orangutans are the closest relatives of humans.

_____ C. The human species arose in Africa, from where humans spread over the world.

_____ D. The human species is the only species manufacturing tools for defined purposes.

_____ E. The genetic variation among populations in the human species is small compared to that in most species.

78. Deleted

79. Which of the following plants is / are monocotyledons?

(1p)

_____ A. Potato (*Solanum*).

_____ B. Apple (*Malus*).

_____ C. Wheat (*Triticum*).

_____ D. Carrot (*Daucus*).

_____ E. Maize (*Zea*).

_____ F. Onion (*Allium*).

80. Which of the following statements about Carolus Linnaeus (Carl von Linné) are true?

(2p)

_____ A. Linnaeus introduced the concept of hierarchical systematics with ever more exclusive groups from kingdom down to species.

_____ B. Linnaeus invented the binomial system of nomenclature giving each species a genus name and a species name, for example *Homo sapiens* for humans.

_____ C. According to the rules of taxonomy a name given by Linnaeus to a species of animal or plant can never be changed.

_____ D. Darwin explicitly benefited from the Linnean hierarchical systematic system ("clusters within clusters") for the elaboration of his theory of descent with modification.

_____ E. Linnaeus' binomial nomenclature is still used in botany but not in zoology.

_____ F. Linnaeus classified humans as a species belonging to the class of Mammalia and the order of Primates.

_____ G. In his life Linnaeus scientifically defined and described more than 100 000 species of plants and animals.

Surname _____ First name _____

Country _____ Code number _____

10th International Biology Olympiad

Theoretical test 1999-07-08

Part C

In this part, the questions are constructed in various ways, and you have to read for each question how the answer is to be given. Often you answer by writing one or a few digits or characters, and then these must be distinct and legible, otherwise your answer will not be judged as correct. You must use Arabic numerals (1,2,3..).

Cell Biology, Microbiology & Biotechnology

81. It is possible to fuse somatic cells of different origin to each other, producing somatic cell hybrids. The hybrid cells usually retain only some of the chromosomes contributed by each fusion partner, different in each hybrid cell. Cells lacking hypoxanthine-guanine phosphoribosyltransferase (HGPRT) are resistant to 8-azaguanine (8-azaG), while cells lacking thymidine kinase (TK) are resistant to 5-bromodeoxyuridine (BudR). Neither HGPRT nor TK is essential for cell growth under ordinary circumstances. In order to map positions of human genes, a scientist wanted to fuse human cells capable of encoding HGPRT but not TK to mouse cells lacking HGPRT-coding capacity but capable of encoding TK.

81a. What would she need to add to the growth medium to select hybrid cells incapable of making either HGPRT or TK?

(1p)

_____ A. 8-azaG.

_____ B. BudR.

_____ C. Both 8-azaG and BudR.

_____ D. Neither azaG nor BudR.

_____ E. HGPRT.

_____ F. TK.

_____ G. HGPRT and TK.

_____ H. Neither HGPRT nor TK.

81. (continued)

Having obtained the fused cells, she then analyzed the presence (+) or absence (-) of five human enzymes in five different hybrid cell lines. She also tested the presence or absence of four particular human chromosomes in these hybrid cell lines. The results are shown in the table below:

		Hybrid cell lines				
		A	B	C	D	E
Human enzymes	I	-	+	-	+	-
	II	-	-	-	-	-
	III	+	-	-	+	-
	IV	+	+	+	+	+
	V	+	-	-	+	-
Human chromosomes	1	-	+	-	+	-
	3	+	-	-	+	-
	8	-	-	-	+	+
	17	+	+	+	+	+

81b. Write on the dotted line for each chromosome which of the enzymes I-V it encodes.

(1p)

Chromosome 1: .....

Chromosome 3: .....

Chromosome 8: .....

Chromosome 17: .....

82. The chromatin of human cells contains 1.08 mg histone and 0.7 mg non-histone protein per mg of DNA. Assume that a mole of an average gene contains 10^6 g DNA, and that the average molecular weights of histones and non-histone chromatine proteins are 12000 and 17000 daltons, respectively.

82a. How many molecules of chromosomal protein are complexed with an average gene? Write your answers on the dotted lines.

(1p)

No. histone molecules: .....

No. non-histone protein molecules: .....

82b. If an average human cell contains 10^{13} daltons of DNA, how many molecules of chromosomal proteins are complexed with it? Write your answer on the dotted line.

(1p)

..... molecules

82c. According to one model for how eukaryotic gene expression is regulated, certain chromatin proteins functions as activators, turning on large sets of genes. Assume such an activator induces the expression of 1000 genes. If one molecule of activator is required per gene, and the cells are diploid, what percentage of total chromatine proteins would this represent? Write your answer on the dotted line.

(1p)

.....%

83. The following table contains a list of cell constituents in plant and animal cells. Mark with a cross (X) in appropriate boxes of the table the statements that apply to each constituent. Compare only plant and animal cells.

(2p)

Constituent	Only in Plant cells	Only in animal cells	Contains DNA	Forms starch	Is photo-synthetic	Is coloured
Chloroplast						
Ribosome						
Proplastid						
Endoplasmatic reticulum						
Microfilament						
Mitochondrion						
Nucleus						
Cell wall						
Golgi apparatus						

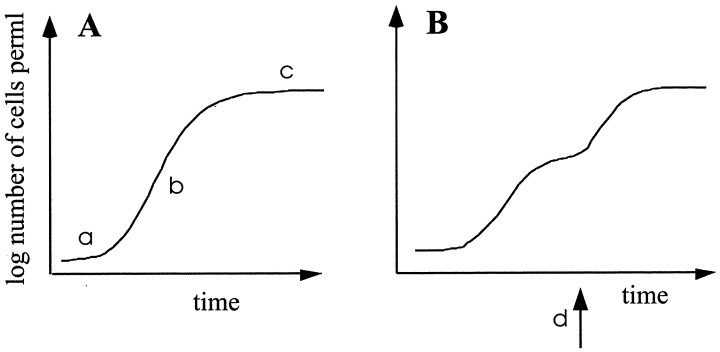
84. Mitochondria are organelles surrunded by membranes. It is possible to prepare pure mitochondria, and treat them in various ways. What happens when you expose purified mitochondria, kept at 37 °C in an isotonic buffer, to the following treatments?

Several treatments may result in the same effect, and some effects are not obtained by any treatment. Mark with a cross (X) in appropriate boxes of the table which effect the different treatments have. Mark only one box for each treatment.

(2p)

	Treatment							
Effect	Temperature raised by 30°	Temperature reduced by 30°	Detergent added	Lysozyme added	Protease added	Cyanide added	ATP added	Pyruvate added
The membranes are destroyed								
The membranes Become more solid								
Electron transport starts running "backwards" so that ATP is consumed								
Electron transport to oxygen is blocked								
The compound is taken up and oxidized								
Nothing happens								

85. The figure below shows two growth curves obtained with *Escherichia coli*. For both, the cells were kept in a simple mineral-salts medium with no nutrients added. For fig A, 0.2 g glucose was added per 100 ml culture at the start of the experiment. For fig B, 0.05 g glucose was added per 100 ml at the start of the experiment.



85a. What are the correct names of the growth phases designated a - c in fig A?

Choose among the names 1-4, and write the number of the correct name on the appropriate line.

(2p)

1 = death phase

2 = exponential phase

3 = lag phase

4 = stationary phase

Phase a is _____

Phase b is _____

Phase c is _____

85. (continued)

85b. In fig. B, which addition(-s) at time d would result in the growth curve illustrated?

(1p)

_____ A. 0.05 g potassium cyanide.

_____ B. 0.05 g glucose.

_____ C. 0.05 g lactose.

_____ D. 0.05 g sodium pyruvate.

_____ E. 0.05 g sodium azide.

86. In which order do the processes A-F take place in a eukaryotic cell?

(2p)

A. Peptidyl transfer

B. Ribosome binding to RNA

C. RNA polymerase binding to DNA

D. Splicing

E. Transcription

F. Folding of the polypeptide chain

Write the letters A-F in the correct order here: .....

87. Suppose you want to clone a human gene that is expressed in liver and is suspected to be involved in a genetic disease.

87a. Which of the following would be the best starting material?

(1p)

_____ A. A human genomic DNA library. __ C. Human cellular DNA

_____ B. A human liver cDNA library. __ D. A human tRNA library

87b. Regardless of your preference in question 87a, you are forced to use a human genomic library, available as phage clones (no other material is available). You have identified a particular phage clone carrying the gene you are interested in, in a stretch of human DNA including at least 10 other genes of no interest to you. What is the logical order of subsequent steps in order to produce a clone that carries just the gene that you are interested in? The procedure outlined will not permit you to identify your clone, just produce it.

A. cleave DNA with a restriction endonuclease

B. treat with DNA ligase

C. extract DNA from starting material

D. transform *Escherichia coli* cells

E. mix library DNA with vector (plasmid) DNA

F. heat mixture to inactivate enzyme

Write here the letters A-F in the order these steps should be performed. You may need to perform one or more steps more than once.

(2p)

Plant Anatomy & Physiology

88. What are the effects of these different plant hormones? Mark the correct alternatives with a cross (X). Mark only one hormone for each effect.

(2p)

	Auxin	Gibberellin	Abscissic acid	Ethylene	Cytokinin
Delays the breakdown of chlorophyll					
Closes stomata					
Is active in phototropic responses					
Can make long-day plant flower during short days					
Makes bananas yellow					

89 Only some of the processes 1-7 below occur in extant plants. Name these processes correctly by writing the number of the process on the appropriate line.

(2 p)

1. DNA → RNA
2. DNA → protein
3. RNA → DNA
4. DNA → DNA
5. RNA → protein
6. Protein → DNA
7. Protein → RNA

Replication is process no. .....

Reverse transcription is process no. .....

Transcription is process no. .....

Translation is process no. .....

Animal Anatomy & Physiology

90. Match each of the following elements, listed below, with its corresponding mass percentage in the human body.

(2p)

elements C - H - N - O - P mass percentages 1 - 3 - 10 - 18 - 65

C ..... %

H ..... %

N ..... %

O ..... %

P ..... %

91. Compare marine fish to freshwater fish with respect to the following statements! Mark with a cross (X) the correct fish type for each statement.

(2p)

	Marine fish	Freshwater fish
Higher water intake		
Excrete salts across their gills		
Absorb salts through specialized cells in their gills		
Have relatively dilute urine		

92. Deleted

Genetics & Evolution

93. A human disease was shown to be due to a recessive mutant allele, denoted *a*. Children with genotype *aa* all die before the age of 10. *AA*- and *Aa*-individuals have the same fitness. In one generation (generation G_0) of an isolated population, the frequency of the allele *a* was 0.0100 among adults.

93a. If no new mutations arise, what is the frequency of heterozygous carriers (*Aa*) among new-born babies in the next generation (generation G_1)? Give your answer to four places of decimals.

(1p)

Answer: .....

93b. What is the frequency of the allele *a* among adults in the next generation (generation G_1)? Give your answer to four places of decimals.

(1p)

Answer: .....

94. An archaeologist discovered a sample of mammoth flesh frozen in ice in the Siberian taiga. She wanted to test how similar DNA from this flesh was to DNA from present-day Indian elephants. Choose among the following techniques those appropriate for this task, and list the techniques you have chosen, in the correct order of performing the analysis.

A. Carry out DNA electrophoresis.

B. Transform mammoth DNA into elephant cells.

C. Subject the mammoth specimen to amniocentesis.

D. Use the polymerase chain reaction on mammoth and elephant DNA.

E. Carry out restriction enzyme digestion of DNA.

F. Hydrolyze mammoth and elephant DNA with acid.

G. Analyse the karyotype of the mammoth specimen.

Write the letters designating the appropriate techniques in the correct order on the dotted line.

(2p)

Correct order: .....

95. The sex determination system in the insect order Hymenoptera (ants, bees and wasps) is such that males are haploid (n) and females (queens and workers) are diploid (2n).

Microsatellites are short tandem repeats of one to six nucleotides. The number of repeats often varies from one individual to another, and a given number of repeats constitutes an allele of that particular microsatellite locus. Microsatellites are common throughout most eukaryotic genomes.

In an experiment, microsatellite DNA fragments from 10 ant workers (numbered 1-10 below), all from the same mound of *Formica sp.*, were tested. In this species there is only one queen per mound, but she can mate with one or more males.

Two microsatellite loci were amplified separately by means of PCR, using primers complementary to regions outside the microsatellite itself. The amplified DNA was radioactively labelled. The fragments were then separated by means of electrophoresis in a polyacrylamide gel. Under these conditions DNA will move towards the anode, the faster the smaller it is. After concluding the electrophoresis, a photographic film was placed on top of the gel. The film then darkened at places where there were radioactive DNA fragments. The results are shown below.

Individual:	1	2	3	4	5	6	7	8	9	10
Locus 1:	-	-	-		-	-		-	-	-
	-		-	-	-		-	-	-	-

Individual:	1	2	3	4	5	6	7	8	9	10
Locus 2:		-	-			-	-	-		
	-			-	-		-		-	-
	-	-			-	-			-	

95. (continued)

95a. How many alleles are there at each of the two loci?

(1p)

Locus 1: .....

Locus 2: .....

95b. What is the minimum number of males with whom this queen has mated, judging from the results of amplification of locus 1?

(1p)

Answer: .....

95c. What is the minimum number of males with whom this queen has mated, judging from the results of amplification of locus 2?

(1p)

Answer: .....

96. For what pioneering contributions are the geneticists A-F known? (In brackets the year when their respective discovery was presented, at a meeting and / or in a printed publication.) After each of the descriptions I-VI, write the letter (A-F) of the person(s) known for this advance.

(2p)

A Gregor Mendel (1865/1866)

B Thomas H Morgan (1910)

C Herman J Muller (1927)

D Oswald T Avery, Colin M MacLeod & Maclyn McCarty (1944)

E Barbara McClintock (1950)

F James Watson & Frances Crick (1953)

I Studied the X-ray diffraction pattern of DNA and concluded that DNA has a double-stranded and helical structure.

Answer: .....

II Showed that X-rays induce mutations.

Answer: .....

III From studies of unstable loci in maize (*Zea mays*), concluded that some genetic elements, now called transposons, are mobile in the genome.

Answer: .....

96. (continued)

IV From experiments with *Streptococcus* (at that time called *Pneumococcus*) concluded that genes are made of DNA.

Answer: .....

V From experiments with the garden pea (*Pisum sativum*), concluded that the hereditary "factors" are derived in pairs from the parents and are segregated unchanged to the germ cells. The hereditary "factors" do not blend. Coined these terms: dominant and recessive.

Answer: .....

VI Discovered X-linked inheritance in the fruit fly (*Drosophila melanogaster*). One of his students, Calvin Bridges, later demonstrated that genes are contained in the chromosomes. Another of his students, Alfred H Sturtevant ("that young Sturtevant!") was able to interpret experimental data that were due to linkage of genes in a chromosome. Sturtevant used these data for gene mapping.

Answer: .....

Ecology

97. A student wished to estimate the size of a population of woodlice (terrestrial Isopoda) under a log. She captured 40 woodlice, marked and then released them and allowed them to thoroughly mix with the rest of the population. After 24 hours, once again she captured 40 woodlice. Of the newly captured woodlice, only 16 were marked. Assume that no woodlice were born, died, immigrated to or emigrated from the population during the past 24 hours. Estimate the number of woodlice in the population.

(2p)

The number of woodlice in the population is estimated to be .....

98. According to the equilibrium theory of island biogeography, the number of species on an island is determined by the balance between frequency of extinctions on the island and frequency of new species colonizing the island. The theory says that the larger an island is, the more seldom will species go extinct. It also says that the closer an island is to the mainland from which new colonists may come, the more often will colonizers arrive at the island. As a result the number of species will be at or near an equilibrium level where extinctions and colonizations take place equally often. But there will also be a change of the particular species which are found on the island at a given time. This change is called species turnover, and turnover rate is the sum of extinction rate and colonization rate.

Of four islands differing in size and distance to mainland, which will have high and low species number and which will have high and low species turnover rate? Write on the dotted lines the digit (I-IV) of the appropriate description.

(2p)

I. most species, intermediate turnover rate

II. intermediate species number, lowest turnover rate

III. fewest species, intermediate turnover rate

IV. intermediate species number, highest turnover rate

a) A large island close to the mainland has.....

b) A large island far away from the mainland has .....

c) A small island close to the mainland has .....

d) A small island far away from the mainland has .....

Systematics

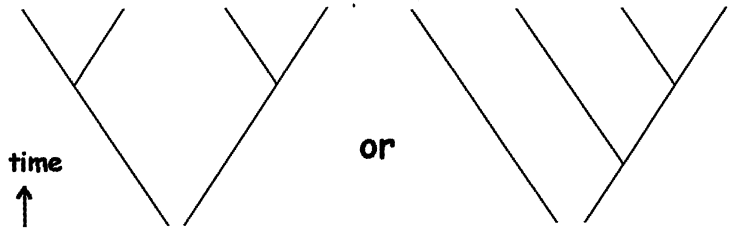
99. Systematists use the so called cladistic method to find evolutionary relationships. Organisms are first described in terms of specific characters, as shown in the table below.

Character		frog (A)	bat (B)	duck (C)	anteater (D)
1	mammary glands	—	+	—	+
2	wings	—	+	+	—
3	fingers and toes	+	+	+	+
4	sticky tongue	+	—	—	+
5	three ear ossicles	—	+	—	+
6	endothermy	—	+	+	+
7	diaphragm	—	+	+	+
8	placenta	—	+	—	+

You will see that some characters are shared by two or more organisms, which indicates that these organisms may be related. However, shared similarities may also be the result of convergent

evolution, and be misleading when we try to reconstruct the evolutionary relationships of a group of organisms. Only similarities that are due to common descent can be true indicators of relationship. Shared similarities may also be the result of common descent from an ancestor having the property in question. Such characters say nothing about the pattern of evolutionary branching from this ancestor. In order to distinguish primitive characters from those that have evolved more recently, cladistic analysis uses a concept called outgroup comparison. An outgroup is a species or group that is relatively closely related to the group studied, but clearly not as closely related as the study-group members are to each other.

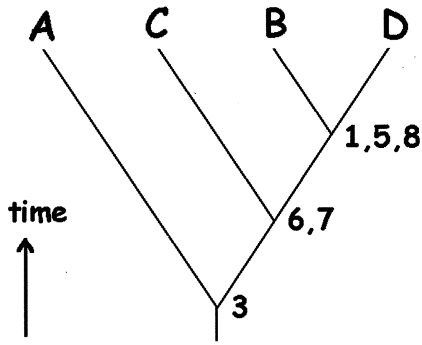
The organisms are then grouped together on simple branched trees called cladograms. With four groups of organisms the shape of the cladogram may be:



The best cladogram is the one in which the pattern of branches most closely reflects the character distribution among the organisms. In most cases, the criterion used is **parsimony**, meaning that the simplest explanation is preferred. This results in a cladogram showing the fewest number of independent changes.

Characters are mapped onto the cladogram at the base of the group of organisms that share that character.

In this case the best cladogram out of 15 possibilities is:



Using this knowledge you have to find the appropriate cladogram that fits to four species indicated by P, Q, R and S, which have the following similarities:

1 only P and Q are abundant in the desert

2 only R and S produce seeds

3 all four have chlorophyll

4 only P and Q have spores

5 all have vascular tissues with the exception of P

6 only R and S produce flowers

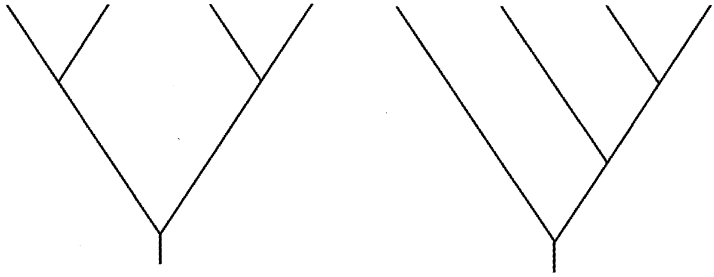
7 only in Q, R and S is the sporophyte the dominant generation

8 only P does not have roots

The task is to choose the cladogram with the correct shape, to fill out P, Q, R and S at the end of the correct branches, and to indicate the correct similarities at the start of the branches.

Now fill out your answer below:

(3p)



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Answer key to the theoretical test

Part A

1. B
2. C
3a. A
3b. C
3c. A
4. B
5. C
6. B
7. A
8. D
9. B
10. B
11a. E
11b. B
12. B
13. B
14. D
15. C
16. E
17. B
18. D
19. (deleted)
20a. B
20b. D
20c. C
20d. A
21. B
22. (deleted)
23. B
24a. B
24b. A
25. D
26. C
27. C
28a. B
28b. D
28c. C
29. C
30. A
31. A
32. (deleted)
33. C
34. B
35a. D
35b. B
35c. C
36a. A
36b. A
36c. C
37. (deleted)
38. (deleted)
39. B
40. B
41. A
42. B
43. B
44. C
45. D

Part B

46. B
47. B
48. B, C, E
49. B
50. A, B
51. B, E
52. A, B, (C), E
53. B
54. (deleted)
55. (deleted)
56a. A
56b. A
56c. C
56d. A, C
57. B, E, G, I
58. B, C
59. B, C
60. B
61. A, D
62. B, C, F

63. A, B, C, E
64. A, D, E
65. D
66. B
67a. A, B, D
67b. E
67c. B
68. C, D
69. B, E
70. B, C, H
71. B, C, (D)
72. A, B, C, D
73. A, C
74. A, B, C, D
75. A, B, C, E
76. A, B, C, E
77. C, E
78. (deleted)
79. C, E, F
80. A, B, D, F

Avdelning C

81a. C **C = 1p , C + an other = 1p**

81b. Chromosome 1: I
Chromosome 3: III, V
Chromosome 8:
Chromosome 17: IV

82a. No. histone molecules: 90
No. non-histone molecules: 41

82b. 1,31 x 10^9

82c. 0,00015%

Constituent	Only in plant cells	Only in animal cells	Contains DNA	Forms Starch	Is photo-synthetic	Is coloured
Chloroplast	x		X	X	x	x
Ribosome						
Proplastid	x		X			
Endoplasmatic Reticulum						
Microfilament						
Mitochondrion			X			
Nucleus			X			
Cell wall	x					
Golgi apparatus						

9-10 R = 2p 5-8 R = 1p 1 – 2 F = -1p Several faults 0

84.

	Treatment							
Effect	Temperature raised by 30°	Temperature reduced by 30°	Detergent Added	Lysozyme Added	Protease added	Cyanide added	ATP added	Pyruvate added
The membranes Are destroyed	x		X					
The membranes Solidify		x						
Electron transport Starts running "backwards" so that ATP is consumed								
Electron transport to Oxygen is blocked						x		
The compound is Taken up and Oxidized								x
Nothing happens				X	x		x	

85a. Phases a is 3
Phases b is 2
Phases c is 4

85b. B, C, D

86. C E D B A F

87a) B

87b). C, E, A, F, B, (F), D

88.

	Auxin	Gibberellin	Abscissic acid	Ethylene	Cytokinin

Delays the breakdown of chlorophyll					x
Closes stomata			x		
Is active in phototropic responses	x				
Can make long-day plant flower During short days		X			
Makes bananas yellow				x	

5R = 2p **3-4 R = 1p**

89. Replication is process nr 4
(Reverse transcription is process nr 3) 3
Transcription is process nr 1
Translation is process nr 5

90. C 18%
H 10%
N 3%
O 65%
P 1%

91.

	Marine fish	Freshwater fish
Higher water intake	X	
Excrete salts across their gills	x	
Absorb salts through specialized cells in their gills		X
Have relatively dilute urine		X

4R = 2p **2 – 3 R = 1p**

92 (deleted)

93a. 0.0198

93b. 0.0099

)

94. D E A **DEA = 2p**

95a. Locus 1: 2
Locus 2: 3 **R = 1p**

95b. 2 **R = 1p**

95c. 3 **R = 1p**

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

6R = 2p **4-5R = 1p**

97. 100
R = 2p

98. a) I
b) II
c) IV
d) III

4R = 2p **2-3R =1p**

99. Exakt svar enligt figuren
Allt R = 3p

General principle:

Guessing and "dubbelgardering" should not be encouraged. Therefore, a marking too much should render a reduction of points equal or similar to the reduction given for a missing marking.

Indiviual results and medals rewarded

Name	Country	Pract	Theor	Sum	Medal
Peng Xiaoyu	China	124	113	237	Gold
Arite Franz	Germany	115	113	228	Gold
Basar Cenik	Turkey	107	116	223	Gold
Pavel Flegontov	Russia	108	115	223	Gold
Fang-Yi Su	Chinese Taipei	117	105	222	Gold
Anna Kajzar	Poland	104	116	220	Gold
Hao-Yun Hung	Chinese Taipei	114	106	220	Gold
Naboon Riddhiraksa	Thailand	115	105	220	Gold
Mu-En Lin	Chinese Taipei	112	105	217	Gold
Kylie Greig	Australia	106	110	216	Gold
Jung-Sang Sunwoo	Korea	107	105	212	Gold
Liu Qinying	China	104	108	212	Gold
Zhang Yanming	China	113	99	212	Gold
Bettina Tonn	Germany	105	106	211	Silver
Claire Bulmer	United Kingdom	120	91	211	Silver
Timothy Wilson Brown	Australia	97,5	113	210,5	Silver
Martin Kostka	Czech Republic	123	87	210	Silver
Se Jong Lee	Korea	111	98	209	Silver
Hossein-Ali Asgharian	Iran	103	105	208	Silver
Yan Yi	China	108,5	99	207,5	Silver
Pastouhov Strahil	Bulgaria	108	99	207	Silver
Pei-Wei Fang	Chinese Taipei	113	94	207	Silver
Bas Janssens	Netherlands	113	93	206	Silver
Seyedmehdi Payab-Vash	Iran	109	94	203	Silver
Magorzata Owczarek	Poland	93	109	202	Silver
Natalja Nikonorkina	Russia	106	96	202	Silver
Till Ischebeck	Germany	94	104	198	Silver
Ahmet Yunus Özdemir	Turkey	91	106	197	Silver
Ji-Youn Chang	Korea	98	98	196	Silver
Fatih Özsolak	Turkey	102	93	195	Silver
Yuliya Syrnikova	Ukraine	94	99	193	Silver
Ilnaz Gazizov	Russia	95	96	191	Silver
Natalie Coltman	United Kingdom	101	90	191	Silver
Zvkasz Kepczynski	Poland	100	91	191	Silver
Aino Lahdenperä	Finland	105	85	190	Silver
Premysl Falt	Czech Republic	103	87	190	Silver
Vladislav Naydenok	Belarus	97	93	190	Silver
Alejandro Loydi	Argentina	90	99	189	Silver
Georgina Catto	Australia	94	95	189	Silver
Tatyana Ovchinnikova	Belarus	101	88	189	Silver
Lalita Kulmala	Thailand	92	94	186	Bronze
Cagri Sakalar	Turkey	89	96	185	Bronze
Pawez Szyld	Poland	97	88	185	Bronze
Catherine Wilson	Australia	95	89	184	Bronze
Olov Wilander	Sweden	87	97	184	Bronze
Serhyi Nikonov	Ukraine	91	93	184	Bronze
Adrian Rea	Ireland	101	82	183	Bronze
Sorcha Ni Dhubhghaill	Ireland	92	90	182	Bronze
Olga Kirjanova	Latvia	105	76	181	Bronze
Prim Plansangkate	Thailand	91	90	181	Bronze
Anette von Vietinghoff	Germany	95	83	178	Bronze
Henry Evans	United Kingdom	88	87	175	Bronze
Robbie Joosten	Netherlands	92	83	175	Bronze
Seyedmohammedmehdi Dastghaib	Iran	92	83	175	Bronze
Alisher Aliev	Uzbekistan	82	92	174	Bronze

Esko Oksanan	Finland	83	91	174	Bronze
Radko Avi	Estonia	93	81	174	Bronze
Krastev Dragomir	Bulgaria	92	81	173	Bronze
Sittiporn Pataradilokrat	Thailand	88	84	172	Bronze
Rob Verlinden	Netherlands	86	85	171	Bronze
Robin Lundén	Sweden	83	85	168	Bronze
Yuri Polikanov	Russia	82	86	168	Bronze
Jin-Guen Rheey	Korea	84	82	166	Bronze
Citalai Pelaez	Argentina	73	92	165	Bronze
Kisembaev Nurbol	Kazakhstan	90	75	165	Bronze
Vera Kudrashova	Belarus	96	69	165	Bronze
Daniele Tauriello	Netherlands	82,5	82	164,5	Bronze
Konstantin Kotlinsky	Belarus	79	85	164	Bronze
Jaime F. Guerrero McManus	Mexico	83	80	163	Bronze
Liana Paschenko	Ukraine	76	87	163	Bronze
Tran Duc Long	Viet Nam	77	85	162	Bronze
Stoimenov Ivaylo	Bulgaria	82	77	159	Bronze
Yuriy Akimov	Ukraine	72	86	158	Bronze
Batchvarova Kalina	Bulgaria	76	81	157	Bronze
Boboilá Cristian	Romania	81	76	157	Bronze
Michelle McCartney	Ireland	77	80	157	Bronze
John Browne	Ireland	82	74	156	Bronze
Leonardo Azuaga	Argentina	74	81	155	Bronze
Nesveldin Anton	Kazakhstan	87	68	155	Bronze
Tristan Martin	United Kingdom	77	77	154	Bronze
Iulian Tsurcanu	Moldova	84	69	153	Bronze
Miroslav Srba	Czech Republic	90	63	153	Bronze
Tomas Balharek	Slovak Republic	83	70	153	Bronze
Kristian Tullhög	Sweden	86	66	152	
Saul Quintanilla Figueroa	Mexico	83	68	151	
Shadmehr Demehri	Iran	73	76	149	
Antoine Berthoud	Switzerland	70	77	147	
Jan Soltes	Slovak Republic	72	75	147	
Mihkel Soon	Estonia	82	65	147	
Tegla Cosmin Adrian	Romania	78	69	147	
Ion Melnic	Moldova	74	71	145	
Maria Jakubovova	Slovak Republic	75	69	144	
Maxime Dechesne	Belgium	81	63	144	
Yergaliyev Kuanysh	Kazakhstan	74	69	143	
Charles Vidondez	Switzerland	73	69	142	
Cassandra Eldelweiss Villava R.	Mexico	73	68	141	
Johanna Kase	Estonia	88	53	141	
Petr Sipek	Czech Republic	69	72	141	
Javor Sacha	Switzerland	60	79	139	
Ion Radu Emanuel	Romania	60	77	137	
Jahangir Turgunov	Uzbekistan	68	69	137	
Nguyen Quoc Trung	Viet Nam	62	75	137	
Tran Cong Tu	Viet Nam	67	70	137	
Artis Apinis	Latvia	61	74	135	
Nguyen Thi Thu Hoai	Viet Nam	54	79	133	
Mikkel Grymer	Sweden	71	61	132	
Michaela Brázdilova	Slovak Republic	70	60	130	
Renoit Naesens	Belgium	69	61	130	
Cara Roxana Romanita	Romania	68	61	129	
Helena Faust	Estonia	78	50	128	
Shavkatjon Hamdamov	Uzbekistan	57	71	128	

Kristina Karhu	Finland	73,5	54	127,5	
Inti Calderon Pineda	Mexico	64	62	126	
Nodirjon Davronov	Uzbekistan	49	76	125	
Máris Ábele	Latvia	57	66	123	
Timo Lahti	Finland	55	67	122	
Algashev Nurlan	Kazakhstan	58	60	118	
Maxim Inglish	Moldova	63	55	118	
Paola Silvina Biancotti	Argentina	64	51	115	
Gert Dekegel	Belgium	67	45	112	
Jánis Pudulis	Latvia	46	66	112	
Yusuf Atayev	Turkmenistan	41	71	112	
Marjorie Vereckt	Belgium	62	43	105	
Guvanc Oyezmuradov	Turkmenistan	54	46	100	
Mariana Ciumash	Moldova	59	38	97	
Buthaynah Alessa	Kuwait	58	37	95	
Cary Corayev	Turkmenistan	47	48	95	
Kerimaliev Askar	Kyrgyzstan	41	47	88	
Shahriar Samiluulu	Kyrgyzstan	42	46	88	
Tirtishnaya Darina	Kyrgyzstan	50	32	82	
Doha Alhomaidah	Kuwait	37	42	79	
Tangadiin Eruult	Mongolia	37	41	78	
Salma Alhouli	Kuwait	41	34	75	
Faiyez Almosharji	Kuwait	29	32	61	