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Biological Olympiads in the USSR

Vjacheslav M. Dushenkov

Biological olympiads are the sort of intellectual competition widely spread nowadays, especially among high school students. Olympiads, often an integral part of the curriculum, stimulate the pupils' interest in acquiring knowledge and help to evaluate the level of their knowledge. Biological olympiads in this country differ greatly from the science olympiad in the USA. First of all they include only biological material and can be compared only with USA Science Olympiad events such as "A Is for Anatomy," "Bio-Process Lab," "Designer Genes" or "Don't Bug Me." Secondly, it is a personal competition with no official teams. Current olympiads start at the school level and the winners take part in local and then federal olympiads.

From "The Festivals of Young Naturalists" to Biological Olympiads

In Russia, competitions represent one of the most popular form of out-of-school activities in the field of biology education. The roots of the present-day biological olympiads are found in the young naturalists' movement of the 30s. The first olympiads made the work of the naturalists more lively, stimulating the pupils in biology. They summed up the work of various naturalist clubs and showed achievements in cultivating plants and breeding animals. Often held as a part of summer naturalists tournaments, the activities of olympiads were not closely linked to structured learning activities within the school. The participation of only naturalist club members and the organization of competitions in summertime limited the effectiveness of this work.

The "new era" in the history of biological olympiads began in 1951 with the introduction of a new tradition by the biological faculty of Moscow University. Since that time biological olympiads have been held each spring as a real competition of pupils. By 1960, district and city olympiads comprising various biological branches (botany, zoology, cell biology, genetics, etc.) were held not only in Moscow but also in Kazan, Kiev and Leningrad. However, often this did not go beyond the district level. Finally, in 1975, the students of the biological-chemical faculty of Moscow Pedagogical State University initiated the first All-Russian School Children Olympiad. A well-known biologist, academician M. S. Gylarov, headed the organization committee and students from all parts of Russia had a chance to compete at an agro-biological station not far from Moscow. Later on, such olympiads came into regular practice and were sponsored by the Russian Federation Ministry of Education. In March, 1991, 252 high school students came to Rostov-on-the-Don from all regions of Russia to participate in the Seventh All-Russian Biological Olympiad.

The next logical step in this direction was the organization of the All-Union Olympiad—the highest level of the intellectual competition on

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biology. In spite of our present-day difficulties, pupils from almost all Union republics came to Batumi (Georgia) in April 1990 for the first All-Union Biological Olympiad. In the same year students from six European countries participated in the First International Biological Olympiad in Olomouz (Czechoslovakia). Last year the Second All-Union Biological Olympiad met in Chelyabinsk (Ural region). And, in 1991 high school students from Belgium, Bulgaria, Czechoslovakia, Germany, Greece, Holland, Poland, Thailand and the USSR participated in the second International Biological Olympiad in Makhachkala (Russia). There were observers from China, Sweden and the USA (Robert J. Olds, Rahway High School, New Jersey).

Now we have an interconnected system of biological olympiads at different levels. Large numbers of students take part and gradually the best ones are selected. Today, 2 million students from grades 6–11 participate in school olympiads, the bottom of this "olympic pyramid." About 250,000 students from grades 7–11 go on to the district level. More than 13,000 pupils (grades 8–11) competed in regional tournaments, and 1500 pupils (grades 9–11) were at the republic level competition. One hundred thirty-eight students of grades 9–11 came to the Second All-Union Biological Olympiad in Chelyabinsk, and four of them (grade 11) represented the USSR at the International Biological Olympiad.

Why do we need olympiads? Typically, when some establishment of higher education organizes such competitions, it wants, above all, to advertise itself and to find potentially gifted students. This approach is quite understandable and deserves support. But what about students and olympiads at different levels? We think that their objectives are to:

1. Promote the formation of systematic biological and ecological (environmental) thinking.
2. Promote acquiring deeper biological knowledge.
3. Develop interest in biology.
4. Develop creativity and intellect.
5. Bring up responsibility for nature.
6. Look for pupil aptitude for scientific work.
7. Widen the network of various biological clubs and make their work more interesting.
8. Encourage students in career experiences.

The organization of olympiads at different levels helps teachers to share their experiences as well. So, such competitions acquire the role of methodological centers which partly determine the standards of knowledge and the requirements for habits and skills.

The very participation in the olympiad, the communication with the peers from other parts of the country and of different nationalities, has an educational impact. It is important to use this type of

out-of-school activity to acquaint our students with the leading biological colleges and institutions and with biologists.

How Olympiads Should Be Held

Like many activities, everything should be well-prepared—especially olympiads. There is no exaggeration in saying that olympiad organization stresses preparation. Everybody is engaged in the preparatory work: teachers, pupils and the members of the board of adjudicators.

There are six main stages of the olympic cycle:

- a. Forming the organizational committee
- b. Deciding upon the time and the place of the olympiad
- c. Determining the tasks and the forms of their implementation
- d. Selecting the board of adjudicators
- e. The competition itself
- f. Summing up and rewarding.

The Unity of Theory & Practice

Our experience shows that competition works best when we have both theoretical and practical levels. Written work, which usually takes four hours, comprises the first stage of the competition. During this stage we examine theoretical erudition of the students. At the second stage, participants demonstrate their ability to recognize various biological objects and their skill with biological research methods. Usually the second part is carried out during an interview with scientists. The organization of the practical stage takes much time and effort and explains why the number of the participants is limited. The score on the first stage usually determines participation in the second.

To Create the Atmosphere of Festivity

If the olympiad does not differ from an ordinary school test, it will fail. As we want pupils to work in a joyful, positive atmosphere, the organizers carefully select the emblems, pins, booklets, parties and even humorous competitions. They think over everything connected with the psychological comfort of the participants and present all with small souvenirs. The best receive deserved rewards. No one fails; the best merely go further in the competition.

Publicity & Support

First, you must find financial sources and attract good specialists from the scientific and pedagogical world. From the very beginning, the organizers seek support of sponsors and try to arouse the teachers'

A. True or false statements.

1. Crossing-over is an essential element of meiosis.
2. Mosquito bites cause malaria.

B. Multiple Choice

1. The sporophyte of a dicotyledonous plant is diploid (2nd). In this case the endosperm will be:
 - a. n
 - b. 2n
 - c. 3n
 - d. 4n
2. Everything enumerated below refers to bacteria with the exception of:
 - a. They are seen with a light microscope.
 - b. They have cell structure.
 - c. They have ribosomes.
 - d. They are diploid.

C. Matching.

1. Draw arrows from the names of plants to distributors of their seeds and fruits.

PLANTS	DISTRIBUTORS	PLANTS
Rowan tree	Birds	Dandelion
Burdock	Ants	Poplar
Marigold	Bears	Celandine
Lime tree	Squirrels	Raspberry
Squirting cucumber	Wind	Birch tree
Sonchus	Water	Maple tree
Oak tree	Dogs	Ash tree
Feather grass	Plant itself	Wild celandine

Figure 1. Some examples of olympiad tasks.

interest. Teachers must be involved and concerned since they carry out schools' olympiads, prepare students and play an active role in olympiads of high levels. The very best school biology teachers take part in carrying out the All-Russian Olympiad and some of them are members of the adjudicators board. As a result, teachers look at their own knowledge and teaching. And, biological olympiads encourage ecological (environmental) awareness. Mass media, beginning with the school newspaper and including federal radio and TV, help immensely here.

Equal Conditions & Freedom of Choice

Competitions with equal conditions for all participants form the bulk of any olympiad. This point leads to working out typical and equivalent tasks. At the same time we must not restrict participants in demonstrating their individual abilities. Variability of tasks allows pupils to select several obligatory tasks out of many. During the second stage we offer optional stations, allowing for student interest. During the All-Union Olympiad, each student participated in just five out of 11 functioning specialized stations. The pupils should have freedom of choice at the theoretical stage, too. For example, they have to answer five out of six questions at All-Russian Olympiads. But, within this freedom we try to insure equality of tasks.

1. A permanent change in cell's DNA. 2. The absorption by cells of nutrients and macromolecules. 3. Any eukaryotic chromosome that is not a sex chromosome. 4. A major interacting system that involves both organisms and their environment. 5. Structures that are similar in function but different in evolutionary origin. 6. An organelle in the cells of plants. 7. An opening in the integuments through which the pollen tube usually enters. 8. The part of earth containing living organisms. 9. A protein that is capable of speeding up specific chemical reactions.

Figure 2. Biological crossword.

The Tasks Given at the Olympiads

The specificity of the tasks depends mainly on the peculiarity of biology, which is not so formalized as mathematics, physics or chemistry. In Russia, most biological material is taught as empirical generalizations. So, the organizers of biological olympiads who work out the tasks are limited by the number of facts on the one hand and by the level of theoretical biology on the other hand. At the same time these tasks take into account school curriculum and age of participant.

The Tasks of the Theoretical Stage

These tasks are worked out as a compromise between the opportunity to demonstrate one's abilities and the necessity to obtain a short and easily scored answer. In the 1950s there were many tasks on enumeration. For example, at the first stage, Moscow University offered such questions as: "What are sponges and wasps made of?" "Enumerate kitchen-garden plants of Rosacea family." "Enumerate poisonous plants of Moscow region." "Who sleeps upside down?" "Name the biggest lizard in the world." "Name the viviparous plants." Now such tasks are seldom used at the high-level olympiads.

Tests represent another special type of task. Here, pupil answers are highly formalized and facilitate checking and comparison of results. These tests may include true-false, multiple choice, matching or short answer questions (Figure 1). Students may also be asked to solve biological crossword (Figure 2) and

1. A symbiotic relationship that is beneficial to both organisms.
2. A jellylike material separating the two cell layers in cnidarians.
3. A compound that stores the energy needed for all cellular activities.
4. A filamentous stage that develops into the gametophyte in mosses.
5. An organism that can manufacture its own food from simple inorganic substance.
6. The central portion of an older woody stem that no longer conducts water.
7. A finely divided branch of a neuron that carries impulses toward the cell body.
8. A plant that lives supported by the boughs of a tree.
9. The outer layer of cells in an embryo or mature animal.

Figure 3. Biological chinaword.

chinaword (word maze) puzzles (Figure 3).

Drawing questions constitutes a special group of tasks. Originally a participant was asked to draw a diagram or a scheme. The usual type of question was: "Draw a squirrel's footprint and indicate by an arrow the direction of its movement." Now we usually make a drawing the basis for a question: "Who or what is it?" On the basis of recognizing an object we construct questions with which we can check the student's knowledge of biological regularities. An example of such a task is given in Figure 4. Genetic problems are also widely used at biological olympiads. Other types of problems include:

Water plants and snails are living together in an aquarium exposed to light. During a week, snails consume 0.40 mol of glucose and the water plants use 0.36 mol. During the same period of time the water plants produce 0.84 mol of glucose. What will be the net weekly production of oxygen in this aquarium?

Questions with a preliminary introduction of factual material represent a traditional form of olympic task. For example:

1. One can often see crocodiles and frogs lying in water with only a bit of their muzzles above it. Why is the frog's mouth always shut in this case while the crocodile's mouth may be partly opened?
2. For several years scientists completely cleared away the litter in a broad-leaved forest. What changes do you think they found in that forest? Explain the reasons for those changes.

Quite naturally, these tasks do not represent all the olympic tasks of the theoretical stage. Each of the variations has its merits and shortcomings. The organizers choose the most appropriate types and combinations of tasks.

Tasks for the Practical Stage

During the second stage, or practical stage, biological objects form the basis for questions. Each participant visits his/her choice of several stations where he/she has an interview with scientists.

A system of question cards is usually used here. At every station there are 30 cards, each with two questions. The questions embrace all possible themes

Figure 4. Write the proper cell chromosome number on the arrows: n , $n+n$, $2n$, $3n$, $4n$.

of the branch and are practically oriented. The answers envisage the use of laboratory equipment. The following stations function at All-Union Olympiads:

General Biology

1. Cytology and genetics
2. The theory of evolution
3. Ecology and environmental protection
4. Man and his health

Zoology

1. Invertebrates
2. Fish, amphibians, reptiles
3. Birds
4. Mammals

Botany

1. Bacteria, algae, lichens, fungi
2. Plants
3. Cultivated plants.

This choice may vary, depending on material available. Each student should visit five stations.

Practical work is another aspect of the second stage. The participants carry out one or several practical works, and organizers evaluate such skills as observing, obtaining and analyzing the results, and reporting on their work. This type of work requires much effort and can be done only if the number of participants is relatively small. It is used at school olympiads sometimes and at the practical stage of the international olympiad, where the number of participants is not large.

One of the variants of practical work at the first International Biological Olympiad was the zoology tasks.

Example: Study the contents of the food of barred owls (Strix varia). Study the contents of an owl pellet and divide it into the parts belonging to the various organisms which have constituted the owl's food. With the help of the book, determine some groups of animals on the basis of the remains of their skeletons; determine the contents of the food.

The organizers of the olympiad may choose any other task type for the second stage or offer their own variants based on their opportunities.

Evaluation

Students are scored. It is important to make the number of possible points the same at both stages as it will increase the objectivity of the general result. There is usually no difficulty in evaluating the written tasks, especially those which require only one possi-

The level of knowledge	The score criteria	Points Value
0	No answer or an answer is completely wrong.	0
Low	Only a general idea is presented or bad mistakes have been made.	1
Satisfactory	An answer is right but incomplete. A participant has not demonstrated skills to apply knowledge in practice.	2
Medium	An answer is right but a participant either can't apply knowledge in practice or doesn't know popular scientific literature.	3
High	A right and detailed answer. A participant has demonstrated good knowledge of school material, popular scientific literature, and can apply knowledge practically.	4
Very high	A very full and detailed answer in which a participant has demonstrated broad biological erudition, knowledge broader than envisaged by school curriculum.	5

Figure 5. Evaluation levels.

ble answer. For evaluating practical and problem tasks we often use a six-point system (Figure 5).

Some Problems & Perspectives

Young participants of biological olympiads constitute the gold intellectual fund of the olympic movement. Nowadays, many well-known Russian scientists participated in this movement in their youth. Rectors of universities make no mistake when they enroll the olympiad prize-winners without entrance exams. But, we still have many problems with the olympic movement. The first, lack of money, reflects the difficulties in our state economy and its effect on the educational system and out-of-school activity. We have now organized a nongovernment Russian Association of Biology Teachers which will be able to coordinate and support the system of biological olympiads on different levels. While disintegration of the Soviet Union caused the end of the All-Union Olympiads, we hope that its place will be taken by a Biological Olympiad of the Commonwealth or something similar.

We would be pleased to correspond with teachers in other countries with an interest in biology olympiads as we prepare to expand the biological olympiad to become a truly international endeavor.