Biology Olympiad programme in India

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In July 2000, India participated for the first time in the 11th International Biology Olympiad and each of the four students constituting the Indian team won a medal. Biology (read science) Olympiad is an exciting event for students, teachers and for the organizers. It also exposes students to what science is, how it is done and opens up a new world of science, especially biology in India, about which students have little awareness. Science Olympiads have the potential of motivating students into basic science careers. This movement has important ramifications for biology education, too, in the country.

In July 2000, India participated for the first time in the 11th International Biology Olympiad (IBO) held at Antalya, Turkey. The first IBO was held in July 1990 at Czechoslovakia with six countries participating – Belgium, Bulgaria, Czechoslovakia, German Democratic Republic, Poland and the Soviet Union. Since then, IBOs have been held every July in different countries. The 12th IBO will be held during 8–15 July 2001 at Belgium.

Each of the four students constituting the Indian team won a medal at IBO-2000: Sahajal Dhuria of St. Xavier Senior Secondary School, Jaipur, won a silver medal, while Pallavi Torka of D.A.V. Jawahar Vidya Mandir, Ranchi, S. Ashok of P. S. Sr. Secondary School, Chennai and Swati Pandey of Atomic Energy Central School, Rawatbhatta, won bronze medals each. Bharat Chattoo of M. S. University, Baroda, was the delegation leader of the Indian team at IBO-2000.

Thirty-eight countries participated in this IBO, with the majority being from Europe, especially the erstwhile Soviet Union. In recent years, East Asian countries have made an impressive entry into the IBO movement, winning a large number of gold and silver medals. India's participation in the three science olympiads – physics, chemistry and biology – with Homi Bhabha Centre for Science Education (HBCSE), Mumbai as the nodal agency, is now an annual event, eagerly looked forward to by the student and teaching community in the country. Science olympiads are an exhilarating and uplifting movement, both for students and the organizers. As the academic co-ordinator of the Indian Biology Olympiad programme (INBO), let me recount my experiences.

In February 1999, India decided to participate in the IBO, closely following our participation in physics and chemistry olympiads. Since there was no time for organizing a qualifying test, we tapped the pool of students selected under the National Talent Scheme of NCERT and organized the INBO-99 at ten centres in the country. This was followed by a training camp at HBCSE for 25 students selected on the basis of INBO. Following this, for the year 1999–2000, a *modus operandum* was established to select the top four students in the country who could best represent India at the international level (Box 1). Only four students who are the winners of the respective national competitions can participate in the IBO.

Scientific content of the IBO

The IBO is targetted at senior secondary students; IX/X standard students may also appear for the international event if they have passed the national examinations, i.e. the National Science Examination in Biology (NSEB) and the INBO. (Logistic problems due to large number of students have constrained us to allow students of XI and XII standards only to appear at the NSEB examination. In future, students from standards VIII to X could be considered.) Skills in tackling problems in biology are tested in both theory and practical examinations, each often exceeding four hours. Keen interest in biology, inventiveness, critical analysis, creativity and perseverance are necessary to tackle the tasks in the olympiad. Often, the tasks are extremely challenging going well beyond the Indian B Sc curriculum.

The host country prepares the theory and practical papers. However, an international jury consisting of two scientific co-ordinators from each country closely checks these tasks for scientific validity and difficulty level of all questions. Co-ordinators of non-English speaking countries have the onerous responsibility of translating the tasks in their respective languages.

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Box 1. Modus operandum of selection for the IBO.

The National Science Examination in Biology (NSEB) consists of a theory paper. NSEB is conducted in 600 schools/colleges all over India in November every year. Thousands of students appear at this examination/test.

Two hundred and fifty students selected from the above examination appear for the Indian National Biology Olympiad examination/test in 12 centres in the country. This exam closely follows the international pattern in both theory and laboratory components.

The top 30 students from INBO examination attend a training camp at HBCSE for two weeks, where they go through lectures, laboratory sessions and tests.

Four finalists from this batch participate in the IBO.

Theory paper

The theory paper with 100 and odd objective type of questions, consists of parts A and B, and sometimes part C also. While questions in part A are relatively simple, those in parts B and C are complex and analytical. Parts A, B, and C cover all branches of biology: cell biology (25%), plant and animal sciences and biosystematics (40%), ecology (15%), genetics and evolution (15%) and ethology (5%). Having nearly 40% of questions in plant and animal sciences may appear to be disproportionate, but they have an evolutionary perspective and are challenging. Questions in cell biology, encompassing molecular biology, biochemistry, cell organelles, etc. are stimulating and often demand students to be aware of recent advances in the subject. Conceding that there is no getting away from information-based questions in biology, attempts are being made by different co-ordinators to increase questions which test the capacity of students for logical thinking and problem solving.

Practicals

For practical examination, every year four major areas are announced well in advance. For the 12th IBO to be held in Belgium, the different areas in practicals are as follows:

Laboratory 1: Plant anatomy, morphology and taxonomy

This task requires skills on making sections of plant materials and staining them, using dissecting tools, identifying plant structures and organs (leaves, stems, roots, flowers, fruits, etc.), discriminating major plant groups (e.g., algae, mosses, ferns, and spermatophytes), the characteristics, taxonomy and life cycle of vascular plants, including mosses, flower anatomy, characteristics of common flowering plant families.

Laboratory 2: Animal anatomy, morphology

The students must be able to make dissections of an invertebrate (Ph. Annelida, Arthropoda, or Mollusca) and identify the main macroscopic organs.

Laboratory 3: Plant pigment analysis

This task requires knowledge of thin layer chromatography and result interpretation and demands skills on making extracts, sample manipulation and laying.

Laboratory 4: Ethology

Students should be able to observe and interpret animal behaviour (using video sequences prepared by the organizers).

Obviously, practical exams demand a variety of skills spanning from dissection of common invertebrates to flower structures, pipetting, separation techniques and statistics. Practical exams in ethology and ecology are new for the Indian students, wherein they have to either carry out tasks as instructed, or observe and analyse the given situation. These tasks, often intuitive and analytical in nature, emphasize the importance of biology at behavioural and environmental levels. The use and making of graphs, tables and figures is an important component of practicals.

A few surprises are not to be ruled out at the practical level. For instance, at the 11th IBO, in laboratory 3, students were required to load the given DNA samples – human genomic DNA and plasmid DNA – along with five organic and one marker stain, for gel electrophoresis with a micropipette and observe and analyse the separation after 20 minutes. This experiment initially took the members of the international jury by surprise but its inclusion was assured since the task was analytical and demanded good understanding of certain aspects of DNA structure.

Indian students are uncomfortable with laboratory work. During the training camp at HBCSE, it was observed that nearly all students were unaware of the use of even an optical microscope; use of 1 ml pipette or a burette was even more difficult. Quantitative and analytical thinking, combined with endurance, are brought to the fore in the practical tasks, often spanning five hours.

Cascading effects of olympiads

The Science Olympiad movement is not merely aimed at getting medals. It has a cascading effect in different directions:

Box 2. Olympiad movement and basic sciences.

All countries are facing a major problem of bright students not opting for careers in basic sciences. This is not true to some extent for biology courses, at least in the USA. The Graduate Record Exam scores, as researched recently by the Commission on Professionals in Science and Technology (CPST) reveal that except in biology, the trend of students avoiding science and engineering programmes at the graduate schools is sharply negative. Hence the lack of inclination among Indian students for research careers in biology is surprising, more so since good work in biological research is going on in several laboratories in the country. Biology olympiads are expected to push at least some students towards basic biology.

Indian students are blissfully unaware about the excitement going on in biological sciences. Even the top four students selected for the IBO this year were ignorant about the human genome project, when its first draft was announced on 26 June 2000. Further, students are surprised when they hear Indian biologists talk about their work. This was best expressed by Ankita Patel, one of the students from Anand during the training camp-2000 who said, 'To' think that all this work in plant genome project is going on in my neighbourhood at the MS University in Baroda!!! Wish I had known it earlier'. This is not an isolated reaction. The toppers of INBO-99, who are currently studying medicine, had similar comments to make when they heard about the work going on at the Bhabha Atomic Research Centre and Tata Institute of Fundamental Research, both in Mumbai, and at the Banaras Hindu University. Listening to the details in molecular biology, either at microbial, plant or animal levels, makes them immediately realize the fast-changing nature of biology and medical sciences.

This shows that there is a big communication gap among our scientists, teachers and students on one hand, and between scientists and the media on the other. Some hard thinking about how best to inform our students about the excitements in biological sciences is the need of the hour.

(a) New friendships are forged. These friendships can result in fruitful collaborations and exchange visits. Despite cynical views voiced often in the media, Indian scientists and science students are regarded highly and sought after outside the country.

(b) The scientific competitions stimulate students' interest in their respective subjects, which, in turn, may inspire some to pursue scientific careers. To further motivate such students, different countries resort to a variety of strategies. For instance, the German biology team has two ex-IBO students as co-ordinators, besides two senior professors. Switzerland and Estonia also follow this pattern. These students are also involved in the organization of the local biology olympiads.

In India, the Department of Science and Technology has launched a scheme: the Kishore Vaigyanik Protsahan Yojana (KVPY). The top four students in biology who participated in IBO qualify for KVPY fellowship, provided they pursue careers in biology (Box 2).

(c) Olympiads offer a unique opportunity to compare biology syllabi and educational trends among different countries and within a country. This can be an useful exercise in improving curricula of different science subjects.

(d) At the national level, the number of participating and winning students at the INBO and training camps, gives a fair indication about the quality of biology education in a particular state. Only one student from Maharashtra – Pune – could qualify in the 1999 and 2000 training camps. This should make the teachers in the state sit up and take notice and push for changes in the state's senior secondary syllabus and textbooks.

(e) Olympiads can trigger formation of teacher organizations which could work for the improvement of education in different science subjects. Formation of the Indian Association of Biology Teachers on the lines of Indian Association of Physics Teachers (IAPT) can go a long way in enriching biology education. Efforts are on at HBCSE to catalyse the formation of such an association.

(f) Preparations for the NSEB, INBO and training camps are a stimulating experience for teachers and for the organizing scientists. Our constant efforts are to put forward the theory questions and practicals in a challenging manner (today students do not find biology challenging).

Further, our questions in the classical areas of zoology and botany encourage students to think and make connections with an evolutionary perspective, which, in turn, brings out structure–function relationships. This point is emphasized constantly – at the level of organisms, organs, tissues, and cellular and at molecular levels – in all our training sessions. Once tuned to this approach, learning and teaching of biology is never the same again. Students are full of questions, for which often there are no easy answers.

In the training camp held at HBCSE for 12 days, students are exposed to different theory aspects in the morning sessions. Expository and curriculum-based lectures are delivered by scientists and college teachers. The idea is to excite students about modern biology, besides attempts to cover the more difficult and unfamiliar aspects of biology which the students have not learnt in their schools/colleges. For instance, ethology and molecular biology are not covered in our college texts. Three to four theory tests are also given. In the training camp last year, theory tests were given daily to students, exposing them to international level questions.

It is not possible to give details of all practical sessions designed and carried out at HBCSE, but let me recount just one instance. One of the areas specified for the 11th IBO, under the section of zoology – laboratory 2, was 'Interpretation of lifestyles of various animal

species'. Among the many experiments set up, we designed an experiment involving the digestive systems of three invertebrates – a protozoan, an annelid and an arthropod. Students were required to observe the passage of food and the process of digestion in a protozoan (under specific instructions), and also dissect, draw and label the digestive systems of the other two organisms. Modifications in the three digestive systems, e.g. a prominent crop and salivary glands in cockroach, were to be noted and linked to the organism's lifestyle. Several subsequent questions cropped up (e.g. can we link up the modifications as seen in the insect's digestive system to its lifecycle? What is the exact role of the enlarged crop in insects? etc.). These and other such questions are now being examined.

No vertebrate specimens are kept for dissection at the IBO. Dissection and detailed study of an organism, if any, is only on invertebrates.

Conclusion

India faces a challenging task. It will have to find innovative ways to inspire its bright students into science courses. Science olympiads play an important role as they have the potential to excite students about basic sciences. All technologies, including agriculture, medicine and different engineering fields, have a strong foundation in basic sciences. A proud and self-reliant India can ill-afford to ignore its basic sciences or the urgency to produce trained personnel necessary to teach these sciences. To my mind, science olympiads succeed in creating a romance about science, giving students and teachers a whiff of what science is and how it is done. Above all, students come to understand that doing science gives one a tremendous amount of intellectual satisfaction. In the technology-driven world of today where knowledge is power, creation of knowledge by our best minds needs to be nurtured: olympiads are a step in that direction.

ACKNOWLEDGEMENTS. I thank Prof. Arvind Kumar, the national co-ordinator of Science Olympiads and Centre Director, HBCSE, Mumbai for his support, my scientific colleagues in the biology group, teachers and scientists in Mumbai and in the country who assisted as observers and resource persons, and finally, the Indian Association of Physics Teachers, which organized the first round of selection all over the country. The encouragement and financial support from the Department of Science and Technology, Department of Atomic Energy and Ministry of Human Resource Development is gratefully acknowledged.

Received 17 August 2000; revised accepted 20 September 2000