

## EDUCATIONAL OPPORTUNITIES AT THE BIOLOGY DIVISION, ORNL

ALEXANDER HOLLAENDER

*Director, Biology Division, Oak Ridge National Laboratory\**

Now in its fifteenth year, the Biology Division continues to explore new ways of cooperation with southern colleges and universities in the dissemination of scientific knowledge and in the development of research-oriented talent. We are one of 25 divisions of Oak Ridge National Laboratory many of which have similar programs of educational opportunities.

The Oak Ridge National Laboratory is operated by Union Carbide Nuclear Company for the Atomic Energy Commission. UCNC is a division of Union Carbide Corporation.

Although our full range of activities extends from participation in educational television for junior high school students to serving on occasion as faculty members for courses at large universities, we have retained a particular interest in the problems of small colleges and schools.

Some of our educational programs, established for several years, are administered in cooperation with the Oak Ridge Institute of Nuclear Studies, an association comprised of 38 southern schools. Among these are the Research Participation, Traveling Lecture, Predoctoral Fellowship, and Student Trainee plans. Other programs are arranged entirely by the division or, as in the case of federal training grants, require that the initiative be taken by the school.

We consider these educational activities a major function of the division and one of its necessary sources of strength. One valuable asset has been the rich interchange of thinking between ourselves and scientists abroad. The postdoctoral program, for example, permits recent PHD's from other countries (as well as our own) to spend a year or more at Oak Ridge working on independent research problems. Inspired by these associations, our biologists have in turn applied for and received fellowships for teaching and research abroad. This past year found six of our senior staff members on fellowships in Italy, France, Israel, the Netherlands, Brazil, and Argentina.

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All educational programs, however, must relate to and yet be subordinate to the major activity of the Biology Division. This is research in fundamental biology and biochemistry with emphasis on cytogenetic effects and the biochemical, biophysical, pathological, and physiological changes produced by radiation. Much of our research is oriented toward radiation biology but the importance of fundamental research on other biological problems is not made secondary to studies of radiation effects.

A number of Tennessee schools have participated in Biology Division educational plans, and we invite others to do so. We are pleased to have two University of Tennessee graduate students now at the laboratory, Paul Urso, an ORINS fellow, and Rhoda Grell, one of our consultants. Other consultants are faculty members at Tennessee schools: Gordon Carlson and Brooke Webber, University of Tennessee; Carl Tabb Bahner, Carson-Newman College, and Stanfield Rogers, University of Tennessee Research Hospital.

Sixteen representatives from colleges and universities in Tennessee attended the Small-College Conference at Oak Ridge in 1958, 1959, and 1960. Represented were Austin Peay State College, Union University, David Lipscomb College, Millsap College, King College, Milligan College, Tusculum College, Carson-Newman College, Knoxville College, Lincoln Memorial University, Maryville College, Tennessee Polytechnic Institute, The University of the South, and Southwestern at Memphis.

As many readers know, an important purpose of the Small College Conference is to stimulate interest in the Traveling Lecture program, in the Student Trainee plan, and in the Research Participant opportunity for faculty members. Inasmuch as a number of Tennessee schools did not attend the conferences, we are summarizing here these three activities along with a review of other programs, including mention of the cooperation we can offer schools seeking the Graduate Training Grants offered by the Public Health Service of the U. S. Department of Health, Education, and Welfare.

*Student Trainee Program* — For the fourth consecutive year, temporary summer appointments have been offered to a limited number of college juniors who are majoring in the sciences and will be seniors in the school year 1961-1962. The program is primarily for students from small colleges in the southern region who possess the potential for a successful career in science. It was specifically designed to give students with three years of college education the experience of working in a laboratory devoted to full-time basic research.

Students are selected on the basis of scholastic achievement, aptitude, graduate school potential, and interest in research by a committee composed of ORNL and ORINS personnel. There is

no formal application blank. A nomination must be sent by the faculty adviser, along with two letters of recommendation, a transcript of credits, and a statement from the student outlining his current and long-range plans for a career in science to the Oak Ridge Institute of Nuclear Studies by January 15 of the year he wishes an appointment. The latter is for 10 weeks, includes a weekly stipend, and a travel allowance.

Thirteen of the 46 student trainees in 1960 were biology students making a total of 33 attending since the program was inaugurated in 1958.

Students are assigned to groups whose work is closely related to their individual interests.

Training consists of work on a specific problem, attendance at division seminars, observation, and informal discussion. The student's work is evaluated on the basis of an oral report given before the other students and their advisers and a written scientific manuscript. We consider the writing of a paper of primary importance in teaching students one of the essential obligations of a scientist. Several Biology Student trainees have seen their names as co-authors on papers published even before graduation, which we believe provides excellent incentive for future effort in research.

Projects engaged in by 1960 Biology Division students were as follows:

Effect of Gibberellin on Wheat Seedlings in the Absence of Photosynthesis

The Cytological Detection of Reciprocal Translocations in Mice

Passive Anaphylaxis in One- to Two-Week-Old Chickens

A Cytogenetic Study of Mutation Using Tissue Culture Technique

Carotenoid Pigments in *Rhodospseudomonas spheroides*

The Synthesis of RNA Isolated Nuclei

Study of Lymphatic Tissue as a Site for Foreign Antigen Transplantation

Radiosensitivity of *E. coli*

Immune Response of Mice to an Enzyme Antigen

A Medium for the Isolating of Tetrahymena Nuclei

Studies on Gel Filtration

Electrophoretic Study of the Components of Rat Serum

Although the Student Trainee plan was originally conceived for small southern schools, an interesting development has been the number of applications that come from schools outside this region. Some of these were accepted and the 1960 group included young people from Wisconsin, Oregon, Minnesota, and Puerto Rico.

*Teaching Activities* — The division engages in two continuing lecture activities—the Traveling Lecture Program and the

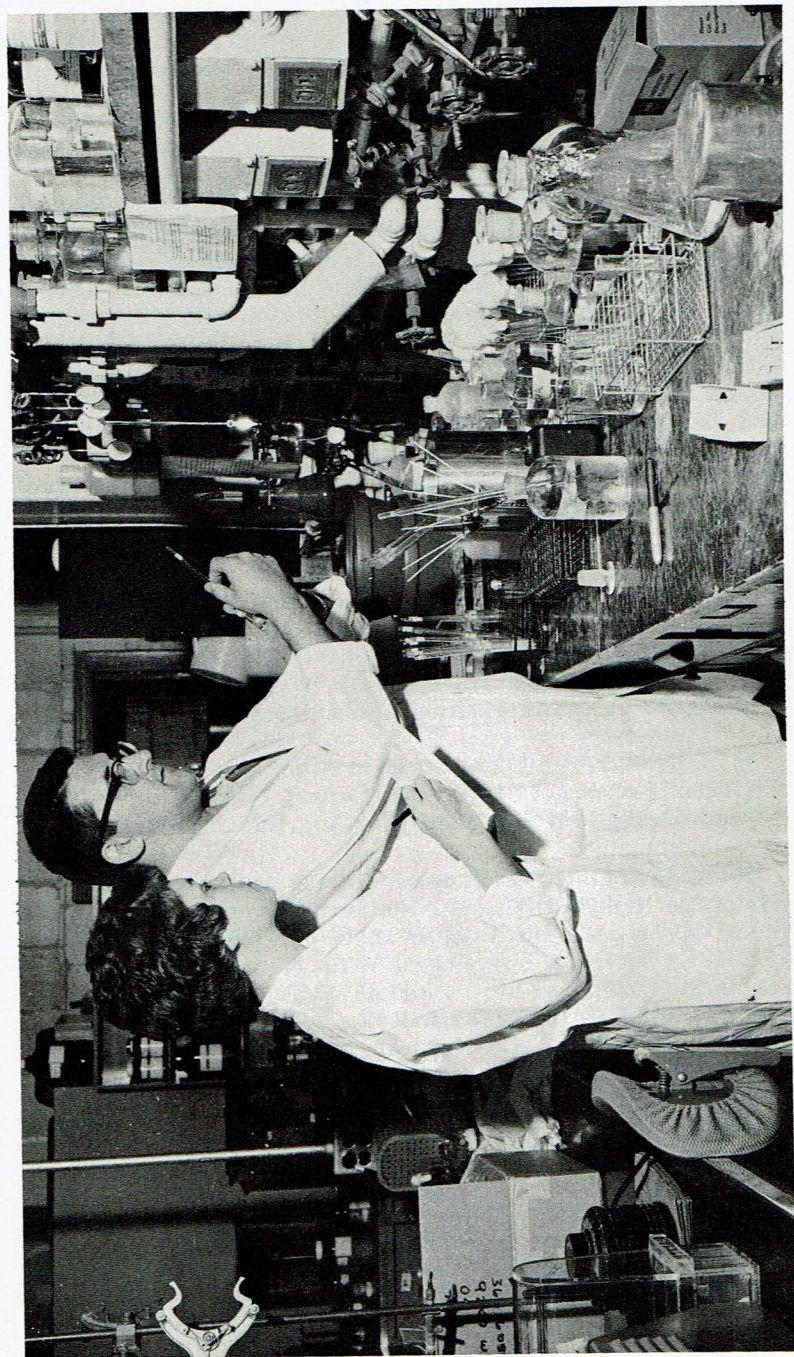


Fig. 1. Student Trainee Sara L. Page instructed by Carl J. Wust as they determine incorporation of radio-active amino acids into proteins in cell-free systems.

Small College Lecture Plan. The Traveling Lecture is part of the Atomic Energy Commission's program for exchange of scientific and technical information with colleges and universities, particularly in the South. In 1960 members of the Biology Division gave approximately 100 lectures at institutions in southeastern, midwestern, and eastern United States.

The Small College Lecture Plan was set up by the Biology Division to meet requests for lectures specifically on the undergraduate level. Under this plan, a staff member spends a week in a given area. The school that presented the original request for a speaker makes arrangements for him to visit at least three colleges in one trip. Chosen for their ability to lecture effectively to undergraduates, staff members have developed talks to inspire discussion. They are available for small groups as well as large ones, for intimate club sessions, or for classroom discussions. At the informal sessions, students may ask anything they wish, for example, details of a given research project, kinds of problems tackled at Oak Ridge, job opportunities for scientists, or the meaning of basic research. Examples of lecture titles in this program are as follows:

The Study of Lethal Effects of Radiation on Bacteria  
Photosynthesis  
Chemical Approaches to Genetics  
Enzymes, the Biological Catalyst  
Biochemical Transformation of Food Stuff to Living  
Protoplasm  
Hazards of Ionizing Radiation to Animals and Man  
General Aspects of Sex Determination  
Methods for Preventing and Treating Radiation Damage in  
Mammals

A number of other teaching activities are engaged in by members of the Biology Division. Nine lectures were given last year under the Summer Institute, arranged for high school science teachers by ORINS and supported by the National Science Foundation. Staff members are invited to speak at courses and conferences conducted by the Oak Ridge School of Reactor Technology and the Oak Ridge Institute of Nuclear Studies. Recent ORINS talks were given at the Radioisotopes School, to the Medical and Training Division, and at the Twelfth Annual Nuclear Science Seminar.

The Biology Division has a program under which its members are given leaves of absence to teach one-or-two-semester courses in their special fields at universities. Under this plan graduate courses have been taught at Duke University, the University of North Carolina, Vanderbilt University, and Florida State University.

Under a cooperative agreement between the University of Tennessee and Oak Ridge National Laboratory, our scientists

give lectures at the university's Institute of Radiation Biology. Six division members are included on the faculty of the institute. The same agreement makes it possible for thesis research to be carried on in the division by institute students.

In the summer of 1961, an institute in radiation biology again will be conducted by the Oak Ridge Institute of Nuclear Studies, July 24-September 1, for 24 college biologists under the sponsorship of the National Science Foundation in cooperation with the Atomic Energy Commission. The last two weeks will be concerned with lectures, laboratories, and demonstrations on the effects of radiation on biological systems such as bacteria, yeasts, seeds, and laboratory animals; use of a kilocurie cobalt-60 radiation source and X radiation; and studies of dosimetry using chemical and glass dosimetric techniques.

Members of the Biology Division in 1960 presented 122 papers before 38 professional societies and congresses in the United States, Venezuela, Sweden, Italy, Germany, Australia, Denmark, Russia, Japan, and Poland.

*Research Participation Program*—This program, administered by the Oak Ridge Institute of Nuclear Studies, permits faculty members of universities to spend from 3 to 15 months in the Biology Division working on research projects. Since the program was started in 1948, 91 participants from 56 different institutions have done research in our laboratory. About 85 percent of these participants have been from southern schools; 15 of them were from Tennessee. Vanderbilt University and the University of Tennessee (Memphis) send one or more research participants nearly every year. Other interested schools are Meharry Medical College, Maryville College, and the University of Tennessee (Knoxville).

Participants work alone or in collaboration with members of the division on problems of their own selection. In some cases, graduate students of participants have obtained fellowships to work in the division on investigations in which the professor, the student, and the laboratory have an interest. During their stay at Oak Ridge, participants are paid a salary by the laboratory which equals their university base pay.

*Graduate Training Grants*—At the request of the University of Georgia, the Biology Division is cooperating in a United States Public Health Service program. Under this program, funds may be granted at the request of a college or university to "establish, expand, or improve pre- and postdoctoral research and training for students in such basic biological fields as pathology, genetics, cellular biology, pharmacology" and other health-related sciences.

In line with this objective, two Biology Division members have been appointed to the University of Georgia staff as re-

search professors in biochemistry and bacteriology. Predoctoral students will come to the division in the summer months to work on thesis research. Postdoctoral students will spend longer periods in further training at the laboratory.

We believe these Public Health Service training grants tie in naturally with our own Small College Program and we will cooperate fully insofar as our personnel and facilities will permit when asked to do so by colleges or universities, preferably in the south.

*Educational Television*—Always interested in programs to attract more young people to the field of biology, this division—as well as the Physics and Chemistry Division — has been participating since January 1961 in a daily series of television lectures to seventh and eighth grade science students. This program has been arranged by Oak Ridge National Laboratory in cooperation with the Metropolitan TV Council, a group comprised of schools in Knoxville, Knox County, Alcoa, Maryville, and Oak Ridge as well as representatives of the two major networks that are donating the time.

Five of the 20 "General Science" lectures in the winter course were given by members of the Biology Division. Their topics were:

- Enzymes, the Biological Catalysts
- Protein Synthesis
- RNA and DNA
- Cellular Organization
- Environments that Permit Life

Members of the division have also on occasion been invited to present talks in cooperation with the University of Tennessee educational television series.

The television programs are a natural outgrowth of the division's concern with problems that come up when students arrive at college without sufficient training to pursue scientific studies. In our opinion, national laboratories must accept some of the responsibility for improving this situation, and with this goal in mind, we have invited a small group of high school teachers to work with us in the laboratory during the summer whenever funds for such a project are available. The teachers have expressed the opinion that this is an excellent method of broadening and improving the instruction they can offer students.

We have also urged our staff members to accept speaking engagements at summer institutes for high school teachers sponsored by the National Science Foundation. In the past three years we have sent scientists to address such gatherings at Tennessee Polytechnic Institute, the University of Kansas, Columbia College (South Carolina), Tuskegee Normal and Industrial Institute (Alabama), Florida State College for Women, and West-



Fig. 2. Student Trainee Joanne T. Graziani performs experiment with chickens to determine hypersensitivity to protein antigens.



ern Kentucky State College. Again in 1961, ORINS will hold a four-week summer Institute at Oak Ridge for secondary school science teachers, sponsored by the National Science Foundation in cooperation with the Atomic Energy Commission.

Several members of the Biology Division have served on a committee of the Oak Ridge school board to study the improvement not only of science education but of all subjects covered by secondary schools.

Other division investigators regularly serve as advisers to local science students who participate in the National Science Fair competition. Division personnel give demonstration lectures to high school students and frequently contribute articles to the high school newspaper. The Oak Ridge school system is making a serious effort to emphasize science at all grade levels, and the articles, lectures, etc. are an important part of this program.

*Fellowships* — Every year sees an increase in the number of young scientists from this country and abroad coming to work in the Biology Division under fellowships from outside sources such as the National Science Foundation, the Rockefeller Foundation, the International Cooperation Agency, the International Atomic Energy Agency, the National Institutes of Health, the United States Public Health Service, and others.

In the year 1960 alone, 25 scientists from other countries worked in the division under the United States Atomic Energy Commission's Alien Guest Program. The majority of these foreign investigators are associated with universities in their home countries and come to Oak Ridge primarily for experience and training in radiation biology. Among the countries represented recently were Argentina, China, Denmark, Egypt, Germany, Great Britain, Israel, Italy, Japan, Norway, Spain, Turkey, and Viet Nam. Past investigators have been from France, Uruguay, Portugal, Chile, Denmark, and the Netherlands.

The presence of so many scientists from other lands has supplied some of the motivation for our staff members in seeking fellowships abroad. Senior investigators have recently completed or are currently engaged in teaching and research assignments at the University of Pavia, Italy; the Institute of Physical-Chemical Biology in Paris; the University of Sao Paulo, Brazil; the Hebrew University Medical School in Jerusalem; the Medical Biological Laboratory in the Netherlands, and the National University of Buenos Aires.

The Biology Division naturally has a continuing interest in domestic fellows. United States citizens are currently fulfilling United States Public Health Service postdoctoral fellowships, three in enzymology, one in nucleic acid enzymology, one in nucleic acid chemistry, and one in *Drosophila* research.

A predoctoral fellowship program is sponsored by the Oak Ridge Institute of Nuclear Studies. Three graduate students are

now carrying out thesis research — two in the Cell Physiology groups, one in Radiation Immunology.

*Research Associates* — Outstanding graduates recently awarded a doctoral degree may apply to the Biology Division for a temporary appointment of one or two years as a Research Associate. Candidates are selected on the basis of their interest and ability in fundamental research. Information concerning this program is sent each year to department heads of approximately 400 colleges and universities throughout the country. Since the program was initiated in 1954, 32 Research Associates have worked at the laboratory, four from schools in Tennessee. Of these eight have joined the Division staff and nearly all the others have gone to teaching posts in colleges and universities.

*Consultants* — Professional consultants frequently visit the division and carry on a continuous program of consultation with staff scientists. Twenty-six consultants are associated with the division, 9 of them coming only during the summer months.

Several Research Participants have been appointed as consultants after returning to their laboratories. Under their contract, they return from time to time to consult with division members on mutual research problems.

*Seminars* — Scientific personnel of educational institutions in and around Oak Ridge and Knoxville are invited to attend the regular Biology Division seminars each Thursday afternoon. They are attended regularly by faculty members and graduate students from the University of Tennessee and occasionally by faculty members and students from Carson-Newman College in Jefferson City.

The guest speaker is usually a visitor from another laboratory in the United States or abroad. These seminars are an effective supplement to the literature in keeping informed on work in other laboratories. Recent speakers and their subjects indicate the scope of these presentations:

Richard Young, National Aeronautics and Space Administration, Washington, D. C., "Discussion of technical aspects of space vehicles."

Charlotte Auerbach, University of Edinburgh, "Work in progress at the mutation unit in Edinburgh."

H. Fernandez-Moran, Massachusetts General Hospital, "Electron microscopy on biological materials at low temperatures."

Heinrich Gerhartz, Universität Clinic, Berlin, Germany, "Chemical damage to bone marrow."

Hans Ris, University of Wisconsin, "Some speculations on the evolution of the cell."

Additionally, informal luncheon seminars are held daily. All members of the laboratory are invited to attend these seminars to hear investigators report on their work.

Lecture courses at an advanced level are given in the division each year on such subjects as Radiological Physics, Basic Genetics, Biochemistry, Physical Tools in Biological Research, Elementary Biometrical Methods, Physical Chemistry, General Pathology, and Radiobiology.

*Conferences* — Proceedings of research conferences held by the division are published and are available by request in a letter addressed to the director's office. A four-day conference is held annually, customarily in Gatlinburg, Tennessee, on topics of biological interest. The subject of the 1960 conference was "Mammalian Genetics and Reproduction" and the proceedings were published as a monograph supplement to the *Journal of Cellular and Comparative Physiology*. The April 1961 general topic is "Recovery of Cells from Injury." Most of the papers at this conference consider ways in which cells can recover from or repair radiation injury whereas some are on related biochemical and biophysical subjects.

Booklets containing minutes of other small conferences are prepared whenever possible for distribution to interested scientists, faculty, or graduate students. Investigators working in specific fields are invited to meet for a one- or two-day discussion. Several meetings on bone marrow transplantation are held during the year; others have been concerned with photoreactivation and photosynthesis.

*Annual Reprint Selection List* — Members of the Biology Division wrote and had published more than 200 papers and abstracts in 1960. Many of these were published in scientific journals; some in the proceedings of meetings or in symposia of conferences; others in books such as "Radiation Protection and Recovery." These reprints are available to interested investigators on request.

We have tried to bring together in this article the outstanding opportunities for further training and research offered by the Biology Division, particularly to our neighbors, the faculty and students from colleges and universities in the south. In every case, our efforts are always to supplement, and not to supplant, work being done in the schools. We are receptive to the consideration of new areas of cooperation if need is pointed out. We hope to see our educational program grow as the Biology Division grows, each contributing, as in the past, to the intellectual vigor of the other.