Radiation Science in a Two-Year College

By EVELYN M. HURLBURT

Radiation has made startling contributions to industrial and scientific progress during the past few decades. Many recent advances in biology, medicine, and environmental research would not have been possible without the use of radionuclides. Yet opportunities have been rare for students in the first two years of college to understand the role of radiation in the world today and to sample the excitement of using radiation-science techniques.

The purpose of this article is twofold: (i) to summarize some of the things that have happened in radiation-science studies in a two-year college, and thereby to encourage two-year-college biologists everywhere to launch radiation-science programs; and (ii) to awaken two-year-college biologists to the educational potential and the variety of options unfolded by these programs.

Pioneering Steps at Montgomery College

At Montgomery College (formerly Montgomery Junior College), Takoma Park, Md., the biology department felt it was imperative to offer first- and second-year college students the option of using the concepts and skills of radiation science for answering questions in biology. Our intentions were communicated to the Division of Biology and Medicine of the U.S. Atomic Energy Commission, and in 1961 Montgomery College became the first two-year college in the country to be awarded a grant from this division of the AEC for instruction in the life sciences. The $10,000 was used to purchase four basic Geiger–Mueller systems for beta counting, a well-type scintillation system for gamma counting, a laboratory monitor-ratemeter, and a gas-flow system for counting low-energy betas, such as ^{45}Ca, ^{35}S, and ^{14}C. Additional purchases included a six-foot radiochemical hood, lead bricks, portable survey equipment, direct-reading dosimeters with charger, film badge service, sets of absorbers, and standard sources.

During the academic year 1962-63, students in general biology, zoology, anatomy–physiology, and microbiology participated in a program that included lectures and films on the nature of radioactivity and laboratory instruction in the basics of radiation measurement. During this initial period it became evident that existing materials were inadequate for teaching radiation techniques in biology to undergraduates. The AEC's Division of Nuclear Education and Training then supported a literature search to identify resource materials for instruction in radioisotope techniques in biology and for developing a series of laboratory studies using radiotracers in the biology courses at a two-year college. Results of these studies, described by E. M. Hurlburt, have been published by AEC's Division of Technical Information, Oak Ridge, Tenn.: *Radioisotope Techniques for Instruction in the Biological Sciences* (1966) and *Tracing Life Processes with Radioisotopes* (1967).

Student Projects

Students in existing biology courses engaged in active investigation and assumed the role of research scientists (fig. 1, 6). Surprising vigor was in-

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Fig. 1. Students measuring ^{131}I uptake in a rat.

jected into zoology and botany courses when selected students studied relative uptake and distribution of ^{32}P, ^{22}Na, ^{65}Zn, ^{131}I, ^{45}Ca, and ^{59}Fe in plants (*Elodea,* ragweed) and animals (clams, rabbits). Emphasis was placed on autoradiography, since it is cheap and easy yet very effective (fig. 2, 3). Transport of materials across cell membranes became meaningful for groups of students in general biology when they explored the effects of formaldehyde and phenylhydrazine on absorption of ^{32}P by yeast cells.

Teams of students in anatomy–physiology undertook independent projects. One team devised a microtechnique for determining the turnover rate of radioiron in rabbit plasma and erythrocytes; another group determined total volume of blood in the rat by labeling erythrocytes with ^{51}Cr; and still another team studied iodine metabolism in the rat, estimating thyroxin by labeling with ^{131}I.

Selected students in microbiology not only traced the uptake of radioactive materials from the medium into bacterial cells but also followed the incorporation of ^{32}P into nucleic acids, proteins, and lipids in *Escherichia coli* by fractionating ratioactive cells (fig. 4). Other students studied the metabolism of ^{14}C glucose in *E. coli* cells or examined the effects of the antibiotic chloramphenicol on protein synthesis by tracing the incorporation of ^{35}S into *E. coli* proteins.

With AEC support a statistical study of the effectiveness of using radiotracers in microbiology instruction was carried out. A randomized group of students engaged in a direct, intensive search into biochemical processes in bacterial cells. Students in the experimental group not only experienced the excitement of finding new information, but the use of radiation techniques measurably enhanced their achievement of content objectives and science process skills (E. M. Hurlburt, 1968: *Dissertation Abstracts* 28:7).

The investigative projects described here have tremendous value for stimulating the potential biologist. Several students have become interested in research problems in radiation science as independent-study projects in our college honors program. One student under the writer's direction devoted part of the spring semester and the entire summer session, 1970, to an honors project in which he used ^{32}P, ^{22}Na, ^{45}Ca, and ^{131}I to gather information about biochemical processes in the Chesapeake Bay jellyfish (fig. 5). Last year this student presented a paper, "A Radiotracer Study of Encystment in *Chrysaora quinquecirrha,*" at the 21st annual AIBS meeting.

Toward Careers in Radiation Science

In 1961 a program called Radiation Technology was instituted at Montgomery College under the sponsorship of the U.S. Public Health Service. This program was designed to prepare students for

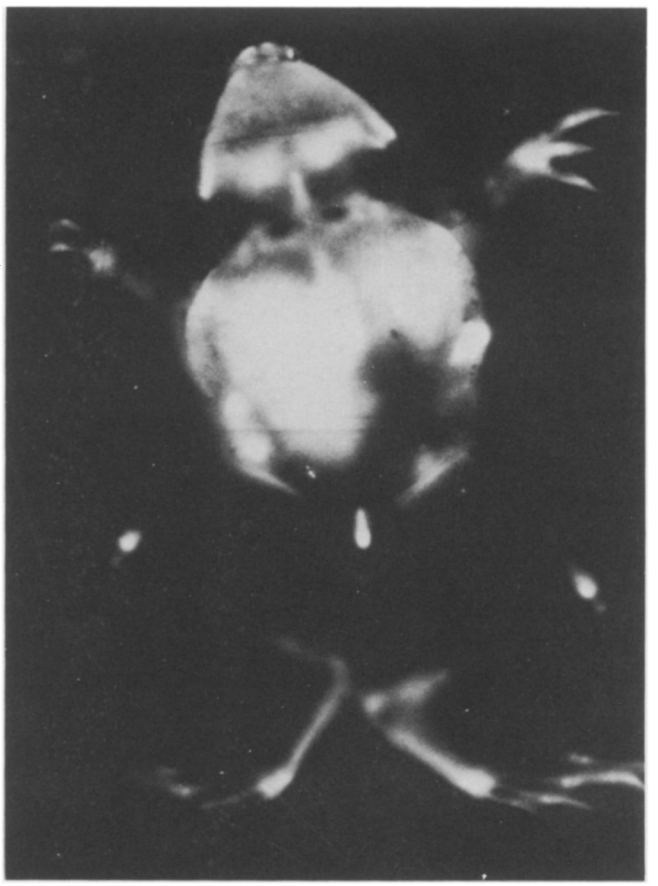

Fig. 2. Autoradiogram of a frog injected with 2 μ Ci ^{32}P and exposed to x-ray film for 12 hours. This and the other autoradiograms were prepared by students.

careers as radiation health-technicians or nuclear-science aides (fig. 6). The program includes specialized courses in fundamentals of nuclear physics, radiation instrumentation, biologic effects of radiation, radiochemistry, and radiation control, along with supporting courses in liberal arts and sciences. The original program has evolved into the current curriculum in Radiation Science, which provides considerable elective choice: students may plan for immediate employment as technicians or they may select courses for transfer into four-year programs in radiation physics, radiochemistry, or radiation biology.

PHS funds have enabled enlargement of the space and expansion of the equipment in the original radiation facility. The programs supported by PHS and AEC have continued to complement each other as Montgomery College has ventured further into new arenas.

Radiation-Biology Institutes

During the summer of 1969, AEC supported a six-week Radiation Biology Institute for Secondary School Teachers, in which a portion of the instruction was offered at Montgomery College and part of the program was conducted at American University, Washington, D.C. 18 high school teachers from the Washington region participated and were granted six hours of graduate credit at American University.

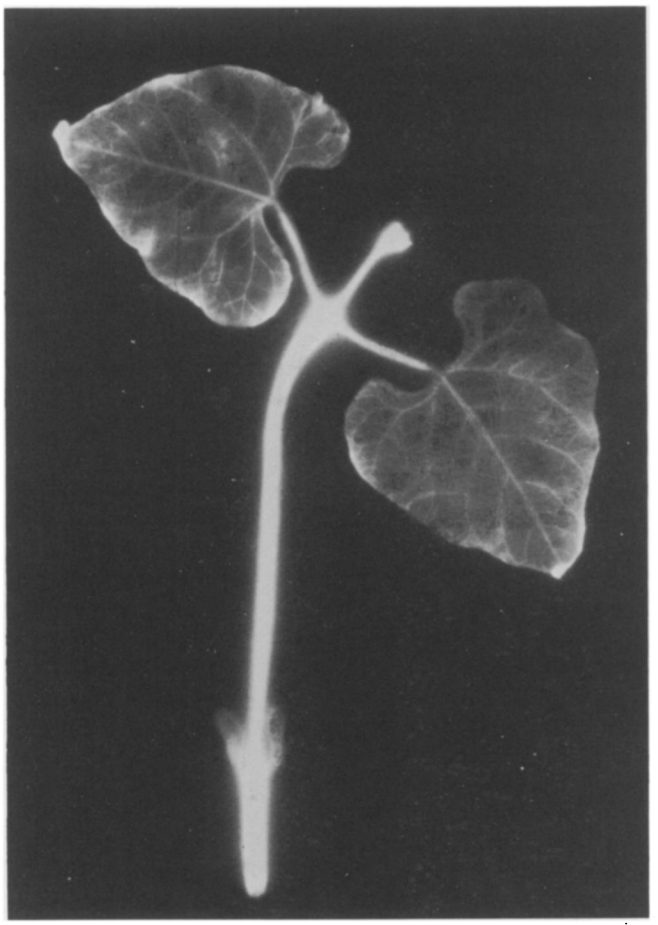

Fig. 3. Autoradiogram of leaves from a bean plant whose roots were immersed in 5 μ Ci ^{32}P for three hours; leaves exposed to x-ray film for 100 hours.

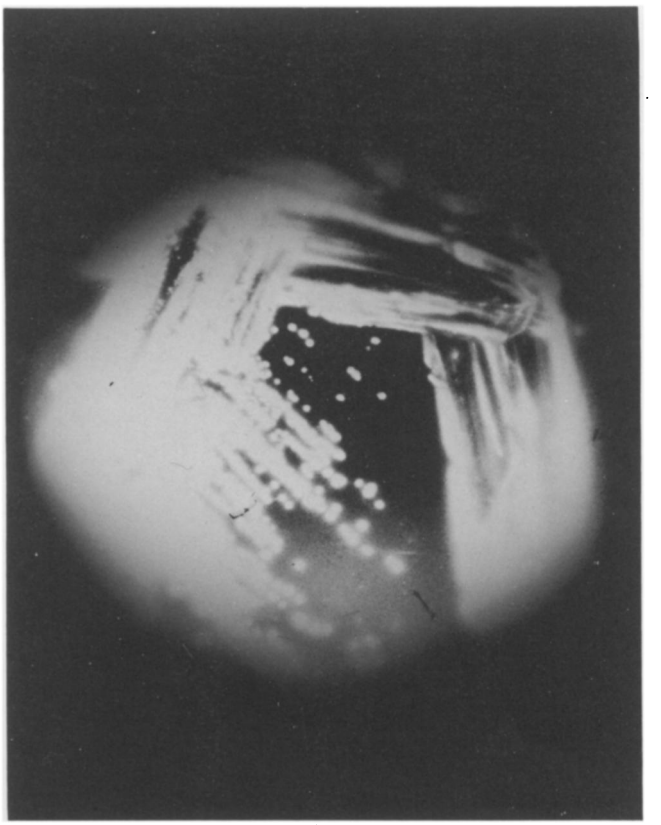

Fig. 4. Autoradiogram showing **E. coli** colonies on an agar plate containing 0.5 μ Ci ^{32}P; surface of plate exposed to x-ray film for 20 hours.

An In-Service Institute in Radiation Biology, similarly sponsored by Montgomery College and American University and supported by AEC, enabled 10 high school teachers to design and carry out radiation-science projects in their classrooms during the academic year 1969-70. These teachers were awarded two hours of graduate credit for independent study in biology at American University. A two-day conference workshop titled "Radiation and the Environment—A Problem or A Challenge?" was held at Montgomery College Nov. 20-21, 1970. This conference, sponsored jointly by Montgomery College and American University, was designed to acquaint Montgomery County high school science teachers with some of the biologic parameters of radiation in our environment. In addition to the 20 teacher participants, many interested members of the community attended the lectures by prominent guest speakers on the ecologic and social implications of man's use of radiation.

The Challenge

Through the encouragement and staunch support of the federal government, Montgomery College has

had broad opportunities for service. We have been able to provide our students with techniques that are indispensable to contemporary biology and that also inject increasing vigor into the study of biology. We have been enabled to work with a four-year college and with the local high school system to stimulate nuclear-science education and to promote public understanding of radiation.

Although the financial climate for biology will be distinctly different in the immediate future from what it has been in the past two decades, the curtailment of support does not portend a major crisis. The challenge of providing quality academic programs at a time of increasing college enrollments must inevitably be met, and it should be understood that radiation-science offerings can be of various dimensions. The incorporation of radiation-science instruction into Montgomery College's total program has been a long-term process taking place in many small steps. However, the success of Montgomery College in developing a variety of activities in radiation science should serve to encourage other two-year colleges. The larger the number of two-year colleges that knock on federal doors with solid proposals in hand, the greater the possibility of some measure of support.

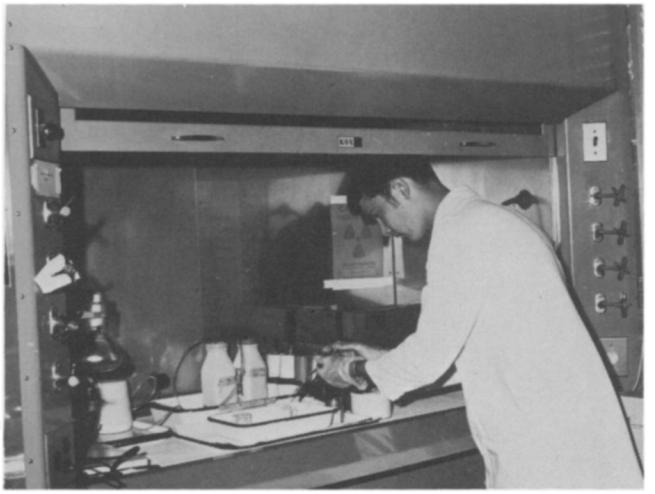

Fig. 5. Student pipetting samples of radioactive medium used for culturing **Chrysaora quinquecirrha.**

Fig. 6. Students studying the effects of neutrons on various elements. Note cautionary label on neutron-activation chamber.