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Careers for WOMEN in the BIOLOGICAL SCIENCES

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U.S. DEPARTMENT OF LABOR
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Careers for Women in the BIOLOGICAL SCIENCES

Women's Bureau Bulletin 278

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Foreword

Major economic indicators point to the present and coming decades as periods to be marked by sharp increases in the number of women working outside the home. Now, more than ever before, it is important that women acquire proper and adequate vocational or professional training to equip themselves for expanding job opportunities in the newer fields, as well as the more traditional types of work. The required skill levels are constantly rising in many fields, particularly in the technical and scientific areas.

It is widely recognized that technology and science characterize our civilization. Myriads of anonymous "explorers" and unseen hands contribute to our scientific achievements. Present-day scientists are utilizing the knowledge accumulated over the centuries and are building upon this knowledge at a breathtaking pace. Sharing in this intensification of scientific endeavor are the countless biological scientists who are arraying themselves into a continually broadening spectrum of specialties. Consequently, greater training-in-depth is becoming more and more necessary.

Within the biological sciences, there has been notable acceptance and utilization of women as technicians and as scientists. The indications are manifold that women with advanced training and highly developed skills will occupy still larger numbers of responsible positions in this field.

Although this bulletin was planned and executed during the term of office of my predecessor, Mrs. Alice K. Leopold, I am pleased to have a part in launching it. By assembling information on current developments in the diverse biological sciences and on trends in training for the different kinds of work, the Women's Bureau hopes to provide young women who have a scientific bent with a basis for considering this field as a career. The bulletin also provides material which parents, friends, teachers, or professional vocational guidance personnel will find useful in advising young women about their occupational choices.

ESTHER PETERSON,
Director, Women's Bureau.

Acknowledgments

This bulletin was prepared by Mary C. Murphy and Evelyn S. Spiro, with the assistance of Caroline C. Cherrix, under the general direction of Stella P. Manor, Chief of Program Planning, Analysis, and Reports in the Women's Bureau of the U.S. Department of Labor. It supersedes an earlier bulletin entitled "The Outlook for Women in the Biological Sciences" (1948), and is a companion piece to the one entitled "Careers for Women in the Physical Sciences" (1959). Additional information about jobs in the health occupations, mathematics, programming, statistics, and the social sciences, may be found in the Occupational Outlook Handbook, published by the U.S. Department of Labor's Bureau of Labor Statistics.

The Women's Bureau wishes to acknowledge with sincere appreciation the cooperation of the many organizations and individuals who gave generously of their time to provide information upon which this report is based. Included are persons affiliated with professional societies, colleges and universities, Federal Government agencies, State health departments, private industry establishments, and nonprofit organizations.

Special acknowledgment is due the outstanding women scientists whose careers are described in the biographical briefs which are interspersed throughout the report.

For the photographs which appear in this bulletin, the Women's Bureau is indebted to the following:

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U.S. Department of Agriculture (pp. 28, 42).

Food and Drug Administration, U.S. Department of Health, Education, and Welfare (cover).

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Introduction

Since the beginning of time, human beings have been fascinated by the questions: What is life? and How can life be prolonged? In pursuit of answers to these questions, present-day biologists are concerned with all living organisms—from the simple one-celled plant called algae to the complex being called man. Because there are countless types of living species, the categories of specialist studying them are legion.

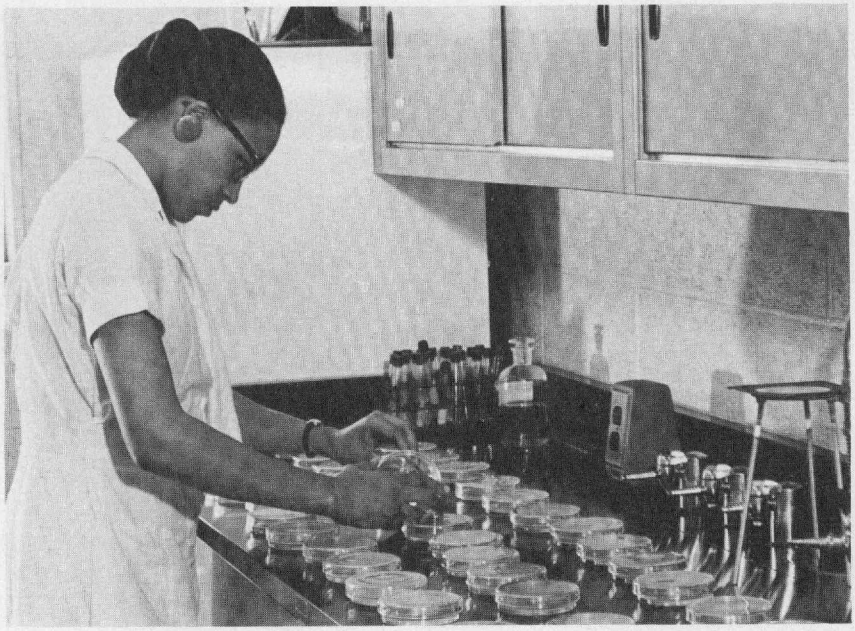
MAJOR BIOLOGY DIVISIONS

Biology is the study of the structure and life cycle of living organisms. This science covers so many diverse areas that biologists are usually classified according to their specialization. In the past, biology was divided into two major branches: *Zoology*—which deals with the study of animal life, including man, and *botany*—which deals with the study of plants. Today, *microbiology* (including bacteriology)—which deals with bacteria, viruses, molds, and other microscopic organisms—is recognized as a third broad classification.

Biology teachers and a few others, whose work cuts across several of the major subdivisions, simply term themselves biologists. Most of the others, however, describe their occupation in terms of their particular subspecialty.

The most familiar system of classifying biological work is by type of organism. *Animal scientists* may specialize in invertebrates (lower forms of life) or vertebrates. Those who specialize in invertebrates, and the forms of life that they study, are: Entomologists (insects), protozoologists (protozoa), helminthologists (worms), and arachnidologists (spiders). Among the specialists in vertebrates, and their subjects of study, are: Icthyologists (fish), ornithologists (birds), herpetologists (amphibians and reptiles), and mammalogists (mammals).

Plant scientists include not only general botanists concerned with fundamental knowledge of all plants, but also specialists who work



A technician checking cultures in a battery of trays as one step in an experiment.

with seed plants (physiologists, anatomists, ecologists, or pathologists), mosses (bryologists), algae (algologists), fungi (mycologists), and ferns (pteridologists).

As the name implies, *microbiologists* are concerned with microscopic and submicroscopic organisms. Some of these organisms are beneficial to the various living species whereas others are harmful. Although the term "bacteriologist" is sometimes used to describe this broad group of scientists, it applies particularly to those specializing in bacteria, just as the term "virologist" refers to those studying viruses. Persons who specialize in methods of immunizing animals and humans against diseases by means of vaccines, toxoids, and other biological products are called "immunologists." Those who test body fluids of patients for indication of specific infections are known as "serologists." Other subspecialties are designated by the particular field of microbiology or bacteriology concerned. A public health bacteriologist tests milk, water, or food to control and prevent contagious disease. A dairy bacteriologist may study the micro-organisms involved in producing cheese and fermented milk. These are but a few of the subspecialties in the growing field of microbiology.

Many specialties exist among biologists which are related to their broad areas of work, such as ecology, genetics, and morphology. These specialties and several others are described briefly in Appendix D.

RELATIONSHIP TO OTHER FIELDS

Several specializations reflect a particular *method* of scientific investigation. Biometricians and biostatisticians, for example, measure biological events by the use of mathematics and statistics. Computer analysts or programmers are becoming increasingly popular in dealing with large masses of data or in planning and designing experiments for precise results.

Biophysicists apply the principles of physics to living beings in order to study processes such as muscular action or the effects of radiation. Biochemists link biology with chemistry to seek answers to questions such as: What regulates certain chemical reactions in tissues? or What chemical changes occur when an organism becomes diseased?

COVERAGE AND SCOPE

As noted in the foreword, this bulletin was prepared primarily for the use of young women who wish to consider the biological sciences as a career, and for their vocational counselors. It was not feasible within the scope of this report, to cover all of the growing number of job possibilities in this occupational field. Rather, emphasis was placed on those segments in which women are well established or in which there is reason to believe they may be in the near future.

Thus, little mention is made of jobs in which persons utilize training in the biological sciences directly in the fields of agriculture and forestry. Also excluded are the jobs of those who utilize this training in the *practice* of medicine or veterinary science. On the other hand, this bulletin does contain information about the occupations of persons who utilize this type of training *primarily* in laboratory research on agricultural or medical or veterinary problems, or in the teaching of subjects related to these fields.[1]

Most of the material in this bulletin relates to job opportunities for women in occupations which require a minimum of a bachelor's degree in biology or one of its specialties. Some attention is given, however, to jobs which have been characterized as subprofessional or technical in nature.

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[1] See Appendix C for a list of Women's Bureau bulletins and pamphlets pertaining to careers for women in the medical and health services.

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Unlike some of the other science fields, a sizable number of women are employed in biology. However, relatively few of this fairly large group have prepared themselves to be "full-fledged" biological scientists. They are better represented in the ranks of research assistants and biology technicians and in the somewhat related occupations of X-ray technician and medical technologist. Since the number of jobs as research assistant and biology technician is quite large, women do, in fact, represent a significant proportion of the total number of workers in the overall biological sciences field. Furthermore, in many places, turnover is relatively high so that a number of well-trained persons are needed to replace those who leave the field as well as to staff new jobs.

Although teaching and laboratory work seem to be the most popular types of assignment for women biologists and biological technicians, women are employed in many other kinds of jobs such as technical writing, editing, library work, scientific illustration, administration, production, and museum lecturing or exhibiting. In fact, women are often preferred as supporting personnel to higher level scientists because of their careful handling of detail and their patience, dexterity, and reliability.

NUMBER EMPLOYED IN THE FIELD

It would be difficult or perhaps impossible to estimate precisely the number of persons employed in the biological sciences. Even arriving at a definition of what we wish to measure poses a major problem. Some persons consider only those educated at the Ph. D. level in biology to be biological scientists. Others include in their definition all supporting technical workers and aids at all levels of education down to those with only a high school education or less.

Regardless of definition, we know that biology is a large occupational field and one in which women already play an important role. There is much to indicate that this role can become even more prominent in the future if enough capable young women choose the biological sciences as a career and obtain sufficient training and education for the field.

Most of the estimates of the total number of professional persons (those with a minimum of a bachelor's degree or its equivalent) employed in the biological sciences range between 50,000 and 85,000. Estimates of the proportion that women comprise of this field likewise vary markedly, ranging from about 10 to 20 percent.

The National Science Foundation in cooperation with several professional societies maintains the National Register of Scientific and

Technical Personnel, which is brought up to date periodically. The numbers of all biological scientists and of women scientists on the Register in the 1956–58 period are shown in Appendix A (see p. 75 of this bulletin), along with brief analyses of women scientists by place of employment, work activity, educational attainment, salary level, age, and educational major.

A bacteriologist working with a multitude of specimens in a drug house laboratory experiment.

2

Who Are the Employers?

A very large proportion of all the women in the biological sciences are employed by educational institutions, government agencies, private industry establishments, or nonprofit organizations. Work performed for these four major groups of employers is described briefly in this chapter.

EDUCATIONAL INSTITUTIONS

Perhaps half of all the college-trained men and women working in the field of biology are teachers. A majority are employed by colleges and universities which, for the most part, utilize persons who have attained the master's or Ph. D. educational level. The remainder teach in secondary and preparatory schools and usually have a bachelor's or a master's degree.

Women comprise a relatively small proportion of the biological sciences faculties of colleges and universities—perhaps 15 to 20 percent—although the ratio appears to be growing gradually, according to National Education Association surveys.

On the other hand, about half of all secondary school teachers are women and about half of all the biology teachers in these schools are women.

▶ One distinguished scientist and educator was recently appointed as president of a women's college in the East, where she plans to continue some teaching and research along with her administrative responsibilities. She successfully combined her professional career with that of being a wife and the mother of four children.

Starting her academic attainment with a bachelor's degree in physics, she took her master's and Ph. D. degrees in agricultural bacteriology and chemistry—with the aid of two fellowships. Some of her earlier papers are considered pioneer studies in microbial genetics.

Participation in community activities, particularly those related to educational affairs, was an important factor leading to her appointment as a college dean, a post she held immediately prior to her present position.

▶ One scientist with a doctorate in zoology is professor of human genetics at a leading university of Canada and director of the genetics department of a large children's hospital. In the latter post, she counsels people with certain hereditary backgrounds on the advisability of marriage and the possibility of transmitting abnormalities to their children. She is perhaps best known for her studies on twins and the development of a method used in the diagnosing of mongoloid children. Her research and writing involve much travel, in which she is often accompanied by her distinguished scientist husband (who is also a zoologist).

▶ A woman who is an authority in the field of embryology combined her work as a researcher with being a full professor and writer. Both her doctorate and Guggenheim award contributed to her studies on differentiation to learn why and how a certain part of the embryo develops into a specialized organ of the animal. Such experiments involve the transplantation of one part of an embryo to another embryo, or tissue culture, where bits of embryonic material are kept alive and growing in nutrient fluids, outside the body.

▶ The application of a biological sciences background to the field of home economics is exemplified by one woman biologist who was president of the American Home Economics Association and for 27 years dean of the College of Home Economics at a midwestern State university. In addition to teaching, she has engaged in research on nutritional problems, such as basal metabolism, metabolism of obesity and of preschool children, and the relation between vitamin A and the utilization of other nutrients.

GOVERNMENT

The next largest employer of persons with training in the biological sciences is government. An estimated two-thirds of this group work for the Federal Government and the remainder for State and local (county and municipal) governments.

Among the Federal agencies which employ large numbers of workers in the biological sciences are the Departments of Agriculture; Interior; Defense (Army, Navy, Air Force); Health, Education, and Welfare; and the Veterans Administration. Many of the jobs in these agencies are in laboratory research and related activities and are currently filled by women.

Some of the jobs with the Agriculture and Interior Departments, however, include administration, soil conservation, forestry, park ranger, range management and conservation—most of which are not attractive to women.

Jobs with State and local government agencies are concentrated in two general areas—those with public health units (especially laboratories) and those with fish and wildlife commissions. Women currently hold a large proportion of jobs in State and local health

department laboratories. Although few women have sought jobs with fish and wildlife agencies, a number of these positions—particularly those in research and biometrics—are considered suitable for women.

▶ Notable achievements have been scored by women scientists on the staffs of State government agencies. A two-woman team consisting of a mycologist and a biochemist in a State health department has produced an antibiotic which is reported to be effective against certain fungus diseases of the skin and of the mouth, intestines, and other mucous membranes. This antibiotic is now being manufactured by a national pharmaceutical company and used in the treatment of the sick.

▶ A distinguished scientist who took advanced degrees in nutrition and chemistry has directed her talents in research and administration to the field of nutrition. After early careers as a teacher and as a research biochemist, she became associated with the U.S. Department of Agriculture in Washington—which she has served for 30 years, in the later years in an executive capacity. During her long and brilliant career, she has been honored by many institutions and organizations—both in this country and abroad. She is the only woman among the 15 persons who to date (1960) have received the President's Award for Distinguished Federal Civilian Service since it was established in 1957 to honor persons "for exceptional achievements of unusual benefit to the Nation."

Among her outstanding achievements has been the development of techniques for applying knowledge about nutritional requirements, chemistry and composition of food, and food consumption to problems of adequate feeding—both under wartime emergency conditions and during peacetime. Her concern and influence extends beyond our national boundaries to sharing actively in attacking the feeding problems of the world and, as a result, she has been called on to serve on numerous United Nations and Inter-American commissions and delegations engaged in meeting these problems.

▶ One of the outstanding women biochemists of our time studied and planned to practice medicine before deciding that she preferred laboratory research. Years of work seeking a pure tuberculin finally led to the development of a formula that is being used nationally for skin tests as a mass means of detecting tuberculosis. Among the many awards and honors bestowed upon her was a Guggenheim fellowship for study in Sweden.

She recently "retired" from her duties as a full professor at an eastern university but continues active in research work, both in her own laboratory and in the laboratories of a Federal Government agency to which she is a special consultant.

▶ A creative woman biologist with a master's degree displays talent in writing as well as in the scientific field. While working for the Federal Government as a marine biologist, she became editor of publications for the Fish and Wildlife Service. She has written books and articles for popular as well as scientific periodicals. Among her works is a best-selling nonfiction book describing the sea in its historical, geographical, chemical, and biological aspects. Honors bestowed on her for this book, which has been translated into 24 languages, include the National Book Award and the Gold Medal of the New York Zoological Society. A Guggenheim fellowship

enabled her to do field research for her third book, which explores the intricacies of animal and plant life at the seashore.

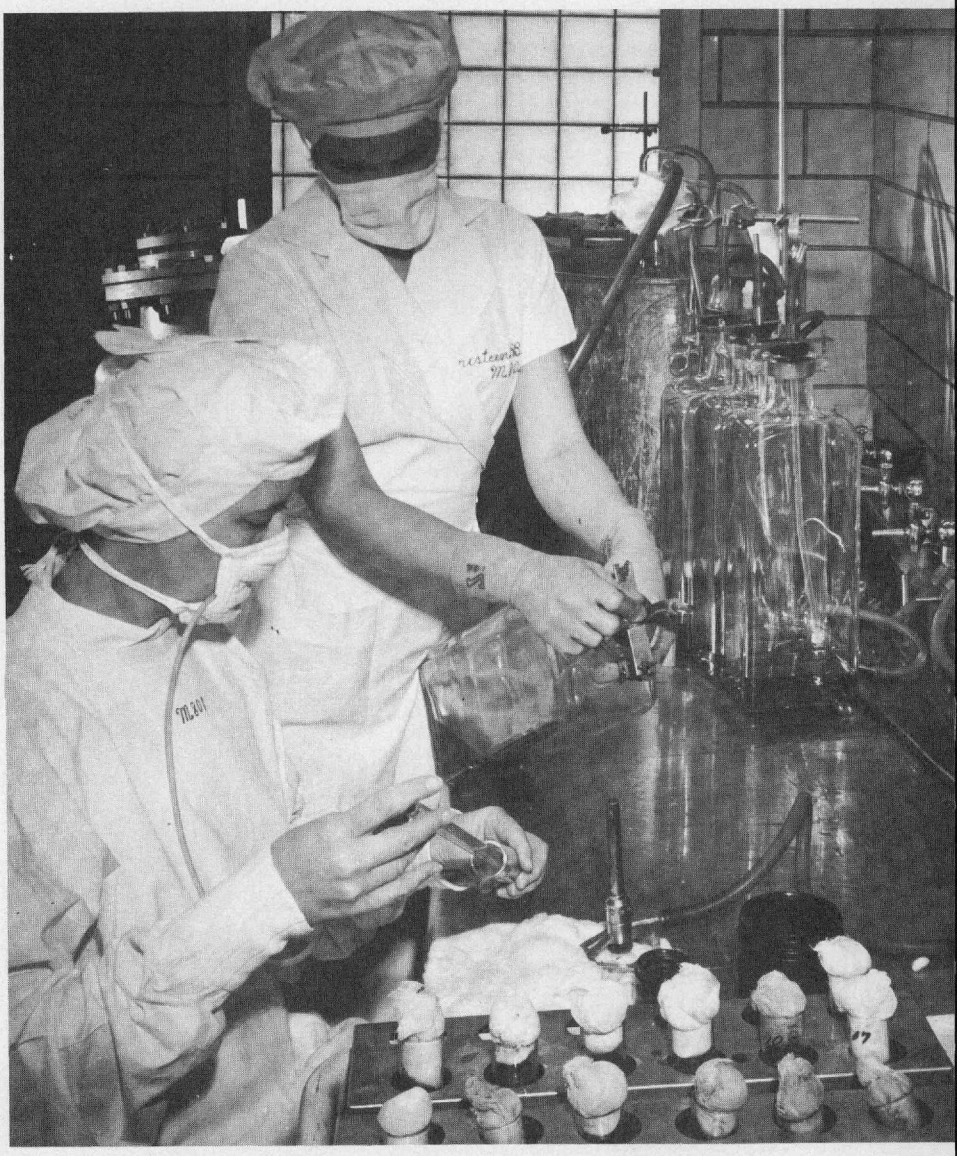
Her childhood interest in nature was revived when she took a college course in biology which caused her to change her major from English to zoology. This author-scientist is a member of the National Institute of Arts and Letters and a Fellow of the Royal Society of Literature. She has been on the staff of two universities.

PRIVATE INDUSTRY

There are a host of industries which employ persons with education and/or experience in the biological sciences. Many of these industries employ relatively few biologists and many individual companies employ only one or two. Nevertheless, when all these jobs are added together, the total is quite large.

Pharmaceutical (or drug) companies as a group comprise one of the largest employers of persons trained in the biological sciences.

A scientist prepares to use a spectrophotometer to determine rate of excretion and absorption of a new sulfa drug.



Laboratory technicians working in polio vaccine production.

Many of these companies, especially the smaller ones which have a less-specialized staff, require their biologists to have considerable knowledge of chemistry. One segment of the pharmaceutical industry produces and distributes items such as vaccines, antitoxins, serums, and blood products.

Other employers in private industry include seed houses and establishments developing and/or manufacturing insecticides and pesticides. Virtually all of the large manufacturers of food products, as well as distilleries and breweries, maintain laboratories for quality control of current products and the development of new or improved lines of goods.

Women biologists are employed by many industrial and business concerns, especially in laboratory activities, but their representation is believed to be smaller in this employer segment than in education and government.

Although activities which are normally considered part of the medical field are not covered in this report, it should be remembered that many hospital laboratories utilize persons with backgrounds in biology. The training required for these jobs may differ in some respects from that for workers in "regular" biological research laboratories. Nevertheless, jobseekers may wish to investigate employment opportunities at hospitals and at private laboratories which serve physicians and dentists.

▶ Marriage to a fellow botanist helped shape the course of one woman's scientific career. She continued her graduate studies and research work while accompanying her husband in his travels from job to job. In addition to raising a family, she became so involved in his field of professional interest that she was considered the only person capable of taking over her husband's university lectures after his death. Later, she was given a grant to continue their previously joint research on root hairs of plants. This study shed light on the similar growth process of cotton—knowledge which proved invaluable to the Department of Agriculture and also led to her discovery of the origin of cellulose. An incidental distinction was that of being named director of a cellulose laboratory of a chemical foundation from which she is now "retired." She has since established her own laboratories where she continues her research activities; she also serves as an associate professor of botany at a New England university.

▶ After acquiring a Ph. D. degree, one woman worked as a plant breeder for a seed company. She later became a full professor at a western university, specializing in the structure of vascular tissues with regard to the movement of food materials and behavior of viruses in plants. She is the author of two books on plant anatomy as well as of many articles in scientific journals.

NONPROFIT ORGANIZATIONS

A number of philanthropic foundations and other nonprofit organizations are active in the biological sciences. Many of them administer comprehensive programs of basic or applied research or both. Examples of those active in the biological-medical field are the Rockefeller Foundation, which sponsors education and research

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projects around the world, and the Sloan-Kettering Institute for Cancer Research which operates primarily from its headquarters facilities in New York City. All of these organizations employ women biological scientists directly, or support their research through grants or fellowships.

- A woman who is now a specialist in cytology began her work experience as a secretary while majoring in languages at a university evening school. Later she was interpreter to an anthropoid expedition to Cuba and at an International Zoological Congress in Uruguay. Language and secretarial training enabled her to support herself while studying for a Ph. D. degree in zoology. Her current research involves evaluation of destructive effects of various agents on mammalian cancer cells, at an outstanding institute for cancer research. She is also editor of one of the biological journals.

- After serving as a teacher and research assistant at a half-dozen colleges and universities, one Ph. D., still in her early 40's, is now an associate professor of microbiology at a major eastern medical college and simultaneously holds a high administrative post at an outstanding nonprofit research institute. Among her recent research projects have been investigations into the application of antibiotics in the treatment of tuberculosis; and mechanisms of resistance to anticancer drugs in bacteria and mouse leukemia and their relationship to human leukemia.

3

Types of Work Activity

Work performed by persons in the biological sciences field can be divided into several broad areas of activity. The vast majority of women in this field, however, are engaged either in teaching or research.

TEACHING

In colleges, teachers of biology or some of its specialties are concerned primarily with classroom teaching of undergraduates and supervision of laboratories. In universities, professors often teach some classes, spend a considerable amount of time working with graduate students, and perhaps supervise or conduct one or more research projects. In a typical high school, a teacher is usually responsible for several classes in biology and one or two other courses, one of which may be general science.[2]

- A woman scientist with a Ph. D. in psychology, but whose work is similar to that of certain biologists, designed and directs her own research project at an institute of animal behavior at a well-known eastern university where she also teaches. Her current study involves observing and photographing comparative reproductive and parental behavior patterns of various species of doves.
- One Ph. D. became a botany teacher at the same women's college where she had obtained her baccalaureate degree. Distinguished as a Fulbright lecturer in Australia and Peru, she has specialized in the genetics of maize, cell physiology, and plant-growth hormones.

RESEARCH

For the most part, jobs in *basic* research (that segment of the field concerned with the discovery of biological facts or relationships for which there may be no immediate application) are found in the

[2] For more information on teaching jobs, see "Occupational Outlook Handbook" 1959 Edition, published by the Bureau of Labor Statistics, U.S. Department of Labor (pp. 40–50).

Federal Government, universities, and nonprofit institutions or foundations. Increasingly, however, private concerns are allocating a portion of their facilities to fundamental research, either from their own funds or under government contract.

Jobs in *applied* research (that segment of the field concerned with the application of known facts to an immediate problem) are found in hospitals (both private and public) public health laboratories, commercial research firms, and industrial manufacturing establishments.

QUALITY CONTROL

A small group of workers—primarily in the technical and aid occupational categories—are engaged in what might be termed quality control activities. Persons engaged in this function—vital to the operation of many types of industrial establishments such as drug houses and food and beverage plants—insure, by continuous testing, that laws or standards set for potency and purity of manufactured products are adhered to.

MUSEUM WORK

There are a few interesting jobs in museums and zoological parks, although the overall volume of employment in this field is relatively small. Some of these institutions are run by government agencies and some by private (usually nonprofit) organizations.

▶ While studying for her Ph. D. degree, one woman worked at the National Museum of the Smithsonian Institution and is now curator of the Division of Reptiles and Amphibians, where she does extensive classification and oversees a collection of 150,000 specimens. An authority on frogs, her research has taken her to South America. She has numerous published materials to her credit including "The Herpetology of Hispaniola," "Frogs of Southeastern Brazil," and "Typical Reptiles and Amphibians in the U.S. National Museum." She also illustrated many of her articles.

▶ One woman, who in her early undergraduate days briefly considered majoring in botany and chemistry, went on to earn her Ph. D. in zoology. She subsequently did research and writing at a prominent midwestern university. She later became affiliated with the American Museum of Natural History in New York to facilitate her research on what was to become a project of many years' duration—the compilation of material and the writing of a treatise on invertebrate zoology. Five volumes of this series have been published and a sixth is now underway. The outstanding character of these works has won her acclaim both in this country and abroad; she was recently honored by election to membership in The National Academy of Sciences. Among her other honors are three honorary Sc. D.'s, and gold medals from the National Academy, and the Linnaean Society in London.

A botanist in a commercial seed firm examines results of an experiment.

RELATED FIELDS

Medical and biological illustrators prepare drawings, paintings, photographs, exhibits, charts, television visuals, motion picture adjuncts for classrooms, publications, and educational programs. This work may be performed for hospitals or medical schools, physicians, scientists, publishing houses, manufacturers of pharmaceuticals, or advertising agencies.

Librarians who are trained in the biological sciences are employed by various Federal Government agencies (Agriculture; Health, Education, and Welfare; Interior; Defense; Veterans Administration), by large public libraries which have specialized departments, by medical schools, by medical and/or biological societies or organizations, and by some of the larger pharmaceutical firms.

Writers and editors are in considerable demand to prepare television and radio scripts, for work with science magazines or magazines with science departments, and to cover science developments

for newspapers. Technical writers are in demand for company publications and for journals of professional societies and other scientific organizations.

Statisticians are employed in growing numbers—especially by Federal and State governments, nonprofit organizations, and hospitals—in all segments of work connected with the biological sciences. Those who have had training in biology or one of its specialties are most in demand. They collect and analyze information on many types of activity, and most often are engaged in correlating data and measurements relating specifically to scientific studies and experiments. Statisticians frequently find that training in biology is useful in dealing with such factors as expenditures, personnel, and program activities.

4

Nature of the Jobs

The preceding section discussed briefly the major types of work activity in which biological sciences personnel are engaged. This section describes more specifically the content of a number of typical jobs, some types of projects in which biological sciences workers are employed, and notes some of the agencies in which certain types of jobs are found.

TEACHING

By far the largest group of men and women trained in the biological sciences—roughly half of the estimated total—are engaged in teaching. The largest proportion of these teachers are employed by colleges and universities with most of the remainder in secondary schools.

Colleges and universities usually require that their teachers have either a master's or a doctor's degree. Most new faculty members are hired as instructors or assistant professors, depending on their level of education and/or the amount of their experience. They usually are engaged full time in classroom teaching and in supervising laboratory activities for undergraduates, predominantly students in the freshman and sophomore classes.

As teachers advance up the academic scale to the associate professor and professor levels, they may (a) teach advanced courses to upperclassmen and graduate students, (b) have smaller classes, (c) have a lighter teaching load (fewer hours spent in the classroom each week), (d) engage in one or more research projects, (e) spend proportionately more time in counseling and working with graduate students, and (f) assume a number of administrative duties.

Teachers at all academic levels must spend a considerable amount of time developing lectures and other instructional materials, preparing and grading tests, and reading professional journals, new

textbooks, and the like to keep up with latest developments in the various scientific fields. Sometimes they have the assistance of both graduate and undergraduate students in the performance of these activities.

In a number of institutions, a major factor considered in promoting faculty members is the quality and quantity of papers published in scientific journals or delivered before professional societies. For the most part, these papers describe the findings of the author relating to research activities.

In order to draw some conclusions on the degree to which women are represented on the faculties of the biological sciences departments of colleges and universities, the Women's Bureau examined the staffing pattern from a sample of 100 schools (including at least 1 from each State). This sampling showed that in the 1959–60 school year 13 percent of biological sciences faculty members were women. The proportion of women among faculty members of women's colleges and universities, however, was 59 percent.

Of the women faculty members counted in the 100-school sample, 20 percent were full professors, 21 percent were associate professors, 26 percent were assistant professors, and 33 percent instructors. A few of the professors also served as department chairman or head.

Generally, only a bachelor's degree is required for high school teaching whereas a master's degree is often a requisite for advancement. In a few places, however, a master's degree is required even for beginning teaching in high school. The duties of high school biology teachers vary markedly from place to place and depend on a number of factors, such as the organizational structure of the school, the size of the student body, and the curriculum. In a very large school, a teacher may teach only biology. But in most places, she also teaches one or more other science subjects, such as general science, mathematics, or chemistry, or perhaps one or more subjects unrelated to science.

Like her college and university counterpart, the high school teacher must spend considerable time in preparing material to be presented during class periods or outlining experiments to be undertaken in laboratory exercises. She must devise and grade tests and maintain a number of administrative records. Most high school teachers are responsible for at least one extracurricula activity which may bear directly on school programs or may be only school-related.

The line of promotion for a high school biology teacher may be progressively from head of the science department to assistant principal, principal, or superintendent of schools. At each suc-

A technologist making a sedimentation rate test.

ceeding level of responsibility, she is expected to assume an increasingly heavy load of administrative duties and to perform fewer activities normally associated with classroom teaching.

RESEARCH

Scientists and their helpers who are engaged in basic research in the biological sciences are seeking to add to the world's fund of scientific knowledge by discovering new truths or by utilizing old truths in new ways. The objective of these efforts is to improve the health and well-being of mankind.

Of perhaps equal importance is the application of known scientific facts to bring about better health and well-being for our present generation. Some facets of applied research are carried on in public

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health service laboratories and others in hospital laboratories and in those maintained by private individuals or commercial groups.

Since the beginning of World War II there has been an enormous upsurge of interest in basic research. This has resulted in expanded laboratory facilities and in a marked increase in the number of persons engaged in research activities—a trend that has accelerated in the past few years.

Traditionally, such basic research has been conducted in thousands of small laboratories in widely dispersed locations. Frequently, it is conducted as an auxiliary function at places where the major portion of staff time is devoted to applied research. For example, in hospitals and public health services, where most workers are engaged in the identification of organisms, necessary for diagnosis of disease, some workers are engaged in theoretical study and experimentation.

The growing recognition of the importance of basic medical research to the achievement of a higher standard of living for all its citizens has prompted the Federal Government to play an increasingly important role in this work.

For example, in 1940, the entire Federal budget for medical and health related research was only $3 million. In 1959, the appropriation for such work administered by the National Institutes of Health alone (including the cost of new construction) was estimated at $210 million—accounting for almost three-fourths of the total Federal medical research budget. Most of these NIH funds were for grants to agencies and persons outside government to conduct research studies, for research training, or for construction and modernization of research facilities. These grants were awarded primarily to educational institutions, but also to individuals (who are usually attached to an educational institution), to other government agencies, and (in recent years) to private industrial concerns. Only about one-fifth of the total NIH medical research expenditure was used in direct research at the Institutes' major research center at Bethesda, Md.

During this same fiscal year (1959), the National Science Foundation made 967 grants for a total of nearly $20.5 million for biological and medical research. This represented about two-fifths of its total grants ($49.1 million) in 1959.

Although the Federal Government contributes the largest single share of money to the total medical research program in this country, funds from private industry, philanthropic organizations, and endowment funds also play an important role. Of an estimated $330 million spent on all medical research in 1957, one-half went into projects conducted at universities, medical schools, and other

nonprofit laboratories; a little over one-fourth was used by industry; and the remainder was utilized by government installations.

Colleges and Universities

The largest amount of money being channeled into basic biological research today is being utilized at colleges and universities.

For many years, some of these educational institutions have placed considerable emphasis on basic research and many of them have well-equipped facilities. With the greater recognition given to this type of work in recent years, schools which pioneered in this field have expanded their staff and facilities. At the same time, additional institutions embarked upon such programs. This has been possible largely through the increased availability of funds from the Federal Government and from philanthropic organizations (foundations, etc.).

A few of the 9,000 research projects for which NIH funds were granted in fiscal year 1959 to educational institutions are as follows:

Role of nutrition in animal cancerogenesis
Application of electron microscopy to renal anatomy
Carbohydrates in normal and pathologic tissues
Tissue culture investigations in rheumatoid arthritis
Mechanisms of gene transfer in bacteria
The biological synthesis of protein
Studies with measles virus grown in tissue culture
Localization of radioactive compounds in tumors
Growth, structure, and genetic functions of viruses
Serologic studies on the agent of human leprosy
Dietary fats, plasma lipids and blood coagulation
Acute nonbacterial gastroenteritis of man
Respiration of plants infected by obligate parasites
Production of malignant tumors by plastic materials
Relationship of virus infection to tumor growth
Interepidemic survival of influenza virus

In some colleges and universities, faculty members are relieved of all teaching responsibilities and spend full time planning and carrying out research projects. They may have several full-time research workers to assist them. Sometimes they are able to draw upon the services of graduate students in the field in which they are working.

In other institutions, faculty members combine research activities with teaching duties. Again, they may employ full-time assistants to carry on some of the routine aspects of their projects and/or utilize the services of graduate students.

Federal Government Agencies

The largest geographic concentration of Federal jobs in basic biological research is in the Washington, D.C., area. A very large proportion of these jobs and many of those situated throughout the country are filled from registers of the U. S. Civil Service Commission. Following is a partial listing of biological sciences occupations for which the Civil Service Commission recruits workers and in which women may be particularly interested:

Biology
Microbiology
Pharmacology
Zoology
Parasitology
Physiology
Entomology
Nematology
Microanalysis
Bacteriology
Botany
Mycology
Genetics
Plant taxonomy
Plant pathology
Plant physiology
Systematic zoology
Fishery research biology
Wildlife research biology
Plant disease and insect control
Biological aid
Laboratory animal caretaking
Medical biology technician

Two Federal Government scientists have reported extensive studies of an agent known as the SE Polyoma virus which induces tumors in certain small animals. They have also worked out an immunizing technique against this virus.

More than 1,000 women were employed in 1959 in the occupational groups listed above, according to a Civil Service Commission survey; nearly 450 worked in the Washington, D.C., metropolitan area. Among professional job categories, by far the largest number of women were classified as bacteriologists and the next largest number, biologists. Well over one-third (37 percent) of all women in these groups were medical biology technicians.

Positions under the Federal merit system are filled through competitive examinations.

For appointment to positions such as aid and technician, a college degree is not required but it is given appropriate credit in rating the qualifications of applicants. Normally, high school graduation with courses in appropriate subjects such as biology, chemistry, and physics is sufficient. *To qualify for most entrance level professional positions* applicants must have a bachelor's degree and pass a written test of general abilities. If she has been a superior student, an applicant may be appointed at two grades higher than a graduate with an average college record. *The top level professional positions*, particularly in research, are filled by experienced scientists, many of whom have the Ph. D. degree.

Health, Education, and Welfare Department

Although biologists are employed in a number of Health, Education, and Welfare organizational units, they are concentrated in two—the National Institutes of Health and the Food and Drug Administration.

The NIH, the research arm of the Public Health Service, which has its center of operations in the Washington, D.C., area at Bethesda, Md., conducts and supports medical research. This institution is primarily concerned with the extension of knowledge regarding the major killing and crippling diseases. The scope of its work is indicated by the names of its seven Institutes: Allergy and Infectious Diseases, Arthritis and Metabolic Diseases, Cancer, Dental Research, Heart, Mental Health, and Neurological Diseases and Blindness.

Other important components concerned with research at NIH include the Clinical Center—a research hospital, the Division of General Medical Sciences, the Division of Research Grants, and the Division of Biologics Standards. The Division of Biologics Standards administers the provisions of the Public Health Service Act which requires the licensing of establishments and specified biological products in interstate or international commerce. These products include vaccines, serums, toxins, antitoxins, and analogous products

(such as human blood and its derivatives) applicable to the prevention or treatment of diseases of man.

NIH employs a sizable number of women who are classified as biologists, bacteriologists, physiologists, pharmacologists, parasitologists, medical biology technicians, and laboratory animal caretakers.

It is not possible to describe the job duties of a typical biologist or biological specialist working at NIH. Duties vary markedly from laboratory to laboratory, depending on the worker's degree of education and experience, on the level of responsibility at which she is working, and, of course, the nature of the research in which she is engaged. A few actual jobs, chosen at random, are summarized briefly in the paragraphs which follow to give some insight into the nature of the work.

A *biologist* at the entry level might perform various immunologic, chemical, or biologic tests to evaluate commercial preparations as to potency and safety prior to their licensing or release for sale. She might also conduct tests required in preparing standards for biological products including diagnostic reagents and therapeutic blood products.

Another *biologist*, at a much higher job level which involves supervisory duties, may have responsibility for choosing areas deemed most significant for research attack and independently plan, organize, and direct such original research projects. She would select, develop, and validate the techniques, methods, and procedures used. Two examples of such projects are (1) to develop clones of cells for study of cell transformations in test tubes, particularly those involving changes from normal tissue cells to tumor-producing cells; and (2) to study physiologic and nutritional requirements, growth properties, structural differences and biochemical characteristics between lines of cells derived in the test tube from a single cell that differ in their tumor-producing capacity. In connection with such experiments, a scientist may develop new, or modify existing, methods of procedure or equipment.

A *physiologist* at the entry level may be responsible for the conduct of assigned portions of experiments such as using baby chicks to determine the content of gland-stimulating substances found in tissue extracts, or to determine the amount of iodine that chicks use up after being given graded doses. This junior scientist may also make counts of radioactivity in the thyroids of chicks.

A *physiologist* at the senior scientist level might have responsibility for planning and executing experiments concerned with the relationship between availability of oxygen and the metabolic rate in insects, the mechanism of gas transfer into and within the respiratory system, and related physiological processes. In carrying out this broad phase of research, the scientist might undertake specific projects, such as (a) measuring the metabolic rate of various insects in relation to age, nutritional condition, temperature, and respiratory system in general; and (b) analyzing the effects of various narcotics in relation to the effects on activity, basal respiration, and the mechanism and persistence of narcosis.

The Food and Drug Administration enforces the Federal Food, Drug, and Cosmetic Act (the national "pure food" law). It maintains a program of constant testing and surveillance of food additives, ingredients used in drugs and cosmetics, food packaging

components, pesticides, and processing and preserving methods. For example, scientists are concerned with the toxicity of coloring and dyes added to oranges and lipstick, of pesticides sprayed on cranberries and other agricultural products, of hormones and other growth-inducing chemicals injected into or fed to poultry and cattle.

Among other activities, FDA personnel perform and interpret assays as a basis for the certification for safety and efficacy of batches of a number of antibiotics and antibiotic products as required by the Food, Drug, and Cosmetic Act. These assays are used also for the purposes of developing fundamental information as to the action of antibiotics; the development of working regulations or specifications governing their identity, strength, purity, and safety; and the development of methods of assay for new antibiotic products.

A recent function added to FDA's responsibilities is the study of the effects of radioactivity on food. The biochemists, biophysicists, and other biologists engaged on this project are currently measuring the amount of fallout and devising methods of cleansing

Scientists inject chick embryos with tissue extracts from mice treated with a tumor-damaging drug as a means of detecting the drug and mapping its metabolic fats.

radiated food. An expanded staff may subsequently be needed to work on associated problems such as establishing maximum permissible levels of radiation in foods or discovering the nature and extent of radiation injuries to man.

Examples of specific types of jobs being carried on in the FDA are cited below.

A *pharmacologist* may conduct research on the reactions of animals to drugs or chemical substances to determine whether there would be harmful effects on man. Depending on the level of responsibility, she would either originate, plan, supervise, or conduct the experiments which form the basis for such legal action or administrative decisions as might be found necessary to protect the Nation's health. After studying available literature she might select the approach and develop or adapt techniques suitable to the best performance of the test or bioassay. She may make statistical analyses of the results, interpret and publish the findings, and sometimes testify at court proceedings.

A *medical biology technician* usually works under the direction of a professional pharmacologist or biologist. Her duties might entail the selection of experimental animals, such as rats, mice, chicks, dogs, pigeons, and rabbits which have specific characteristics; controlling their care and feeding; preparing them for surgery by choosing and applying a proper anesthetic; performing simple surgery; preparing the chemical being studied; determining the dose levels, schedules, and manner of administration (by diet or injection); and/or recording, measuring, and computing the data from such observations as food intake, growth, abnormal symptoms, and autopsies. The technician is usually expected to recognize any variation from the normal or expected course of an experiment. She should understand animal anatomy and be able to mix and measure chemicals or test diet constituents, conduct routine chemical or biological tests, handle a stomach tube, extract and prepare blood samples, operate instruments and other recording equipment, and use various laboratory glassware and apparatus.

A *histopathology technician* is considered the "hands" of a pathologist and assists such scientists by processing fixed tissues for microscopic examination. This involves either freezing the tissue or embedding it in paraffin preparatory to cutting and making up reagent solutions. She may also be called upon to perform autopsies on all types of laboratory animals, which requires a careful removal of organs and tissues. Other duties include making records of observations and perhaps writing simple descriptive reports for the pathologist.

Agriculture Department

Another significant employer of persons in the biological sciences is the Agricultural Research Service (an agency of the Department, located in the Washington, D.C., area at Beltsville, Md.). The Service conducts fundamental, applied, and developmental research relating to the production and utilization of agricultural products, and conducts those control and regulatory programs of the Department which involve the enforcement of plant and animal quarantines, meat inspection, the control and eradication of diseases and

insect pests of animals and plants, and related work. It also carries out the Department's physical, chemical, and biological sciences research in the fields of crops, farms and land management, livestock, and home economics, and conducts utilization research to develop new and expanded uses for farm commodities. Some of the specialty fields in which its women research workers are engaged are plant pathology, nematology, genetics, mycology, nutrition, plant taxonomy, entomology, and parasitology.

Special ARS pioneering research groups explore beyond the present limits of knowledge in the agricultural sciences. Utilizing outstanding scientists, these groups conduct long-range searches for new scientific data to provide a solid foundation for the future development of agriculture.

Present developments in experimental nutrition differ considerably from past trends. For example, early studies of this nature emphasized growth, whereas the concentration now appears to be on tissue changes in plant, animal, and man. Also, although the approach today is on normal nutrition, researchers in the future will try to prevent pathological conditions of nutrition.

An important segment of the work done by the Agricultural Research Service is carried out in the laboratories at Beltsville, Md., and, as indicated earlier, a number of these jobs are filled by women. Many of its jobs, however, involve "field" work which requires persons to spend a great deal of time out of doors in all kinds of weather and to use considerable physical strength. For these and other reasons, few women are currently employed in field jobs, either in Beltsville or in the many stations located throughout the United States and foreign countries.

Following are descriptions of a few of the jobs being carried on at ARS.

A *parasitologist* at an intermediate level of responsibility might identify and classify parasites. She may be concerned with studies of the structure and identification of worms affecting wild animals which can be transmitted to domestic animals; recover, identify, record, and preserve parasites for future study; investigate the structural and biological relationship and classification of adult and larval worms and culture the immature or free-living status of nematodes to obtain adults which may be more easily differentiated from closely related species; assist in the identification of parasites which may be detrimental to the livestock industry (when these parasites are submitted to the laboratory by border quarantine stations); and assemble, analyze, evaluate, and interpret results of research and prepare material for publication in a journal and/or reports for administrative use.

A *plant pathologist* may, for example, assist in the planning and conduct of investigations into the nature and control of virus, fungus, and bacterial diseases of certain vegetables. Investigations might be undertaken to identify viruses associated with disease of certain crops, to develop methods of inoculation with

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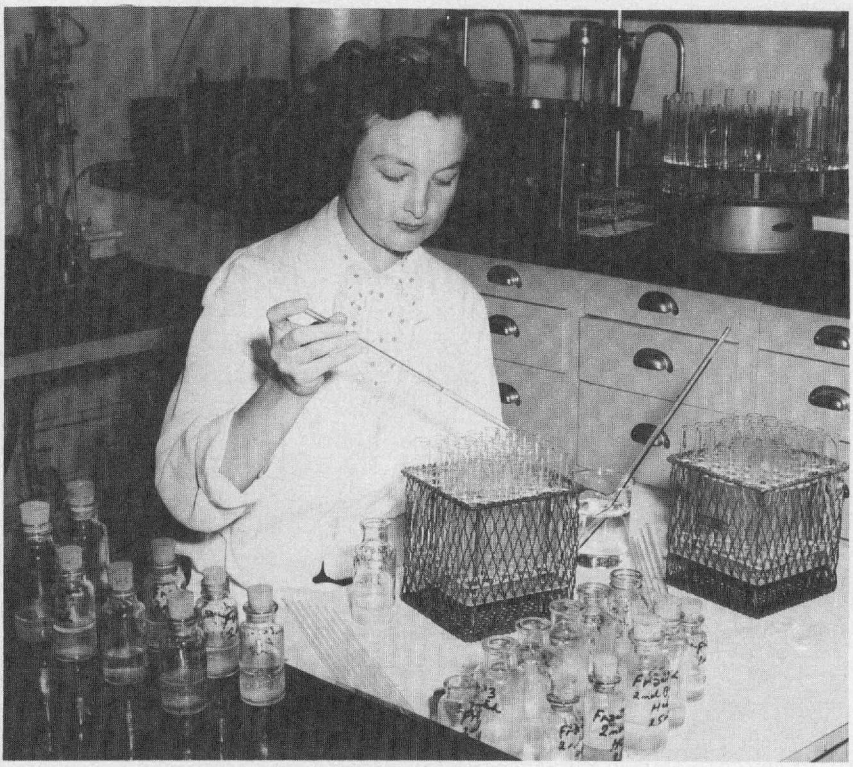


A biologist using the microbiological assay technique to find unindentified poultry growth factor in fish oil solubles.

viruses or to improve techniques to ascertain the pathogenicity of organisms, or to determine virus resistance in selected plant varieties or progenies. The plant pathologist would then analyze, interpret, and evaluate the results of such an investigation and prepare reports for publication, presentation at meetings, or for administrative use.

A *histologist* doing research in the nutritional aspect of biology may study how the quality and use of foods are affected by different methods of cooking or processing or by production and marketing factors. One of the commercial aims of such an investigation would be to aid plant breeders in the development and selection of food varieties with improved qualities for marketing, processing, and preparation for the table. The study would involve an analysis of the structural characteristics of vegetable, fruit, and cereal tissues to learn normal and abnormal variations in structure and their relation to a particular problem.

Other Federal Government Agencies

A great deal of biological research is carried on in hospitals and related facilities maintained by various agencies of the Federal Government. Within the Defense Department, for example, is the complex of several hundred Army, Navy, and Air Force hospitals.

These hospitals range in size from small station hospitals to very large general hospitals. Virtually all have some sort of laboratory facilities. Personnel in the small hospitals may perform only the most elementary and routine laboratory tests. Conversely, some of the largest hospitals have the finest and most modern equipment and are staffed by eminent scientists capable of performing the most complex laboratory analyses.

For the most part, these installations are staffed by military personnel. However, in many establishments, the military staff is supplemented by a sizable complement of civilian employees. This is especially true in the larger hospitals where a sufficient number of military personnel are not available for such assignment or where such personnel lack the needed specialized training or experience. Civilians hired for these jobs are usually selected from civil service registers; many of these jobs are available to women.

In addition to the hospitals, there are a number of other Defense Department installations engaged in various types of biological research. In the Washington, D.C., area alone are the Walter Reed Army Institute of Research, the Armed Forces Institute of Pathology, and the Naval Medical Research Institute. Other specialized research units, scattered around the country, and indeed throughout the world, carry out both basic and applied research. Almost all employ civilian workers—both men and women—for scientific and technical research.

In early 1960, the Veterans Administration had a total of 127 hospitals and clinics with 1 or more facilities located in every State. Within these facilities, more than 140 separate laboratories are in operation, all staffed by civilian workers.

The U.S. Public Health Service operates 15 hospitals, of which several are quite large. Almost all are located in port cities since their primary function is to serve merchant seamen and members of the Coast Guard. Virtually all personnel in these hospitals are civilians.

Much of the laboratory work at these three groups of hospitals—military, Veterans Administration, and Public Health—is carried out as an integral function of the hospital. Laboratory personnel of these installations are, therefore, concerned with the more or less routine identification of various elements of materials examined (tissue, blood, spinal fluid, urine, etc.) and of disease germs. In a great many of the laboratories, however, personnel are also engaged either regularly or intermittently in carrying out more complex biological analyses and in performing more far-reaching, basic research projects.

Almost all of the civilian jobs in these hospitals and in other research facilities are filled by workers recruited through the U.S. Civil Service Commission central and regional offices. These jobs range from aids and technicians to top-level scientists, and virtually all are available to women.

State and Local Public Health Organizations

Although occasionally a State or local public health service conducts what may be considered basic research, the major activity of these organizations is in the realm of applied research. Workers in public health services therefore have two major functions:

1. They are responsible for providing the scientific evidence necessary to enforce public health statutes with regard to (for example) quality and cleanliness of food, milk, and drug products in order to help prevent illness and to help maintain standards of quality.
2. When illnesses do occur, they assist the medical profession in making diagnoses and health officials in the prevention and control of human disease by determining the causative agents of infectious diseases and by making biochemical, cytological, and other tests for the diagnosis of such noninfectious diseases as cancer, diabetes, and heart disease.

Virtually every State government has a central laboratory which performs biological research for its health department. In addition, many States have branch laboratories in local areas which perform most of the routine tests done in a central laboratory. Much valuable time can be saved in those instances where specimens can be processed in a nearby branch rather than being sent to a central laboratory. Some States maintain county laboratories (rather than local branch laboratories) which are operated by county health officers.

State public health central laboratories range in size from those with only a few workers to those with nearly 150. The average number of employees in 1958 was about 35, according to a U.S. Public Health Service survey made late in that year. The work carried out by these laboratories is primarily in the fields of microbiology and chemistry.

Women comprise a significant proportion of the work force in State public health laboratories. In some places, almost all the technician jobs and a substantial number of the higher level bacteriologist and chemist jobs are filled by women.

A typical State public health laboratory may employ bacteriologists and biochemists as well as laboratory technicians and laboratory assistants. Both the bacteriologists and technicians may work in specialized fields such as serology, virology, cytology, mycology, and parasitology.

Harvesting fluid from the amniotic cavity for isolation of influenza virus.

Each State civil service board is responsible for establishing its own requirements for filling jobs in the laboratories and for setting pay scales. Job titles of the laboratory workers vary markedly and the number of persons in each job classification likewise varies from State to State.

A bachelor's degree is usually the minimum education required to qualify as a laboratory scientist (bacteriologist or biochemist). Appointment or advancement to supervisory jobs may require a master's degree. The director of a State laboratory often has an M.D. or Ph. D. degree (or both) and one of these degrees is sometimes required of persons who head major divisions.

Some subprofessional jobs such as laboratory assistant or technician require a bachelor's degree; others may require only 2 years

of college work and experience in the field. Usually laboratory aids need only be high school graduates, preferably those who have had courses in biology, chemistry, and physics.

Examples of some of the job duties which persons in State public health service laboratories may perform follow.

Laboratory (or science) aids do routine work incidental to setting up and making laboratory tests and they may also prepare routine reports of the tests. They may be required to handle supplies, operate simple equipment, and, if no other workers are employed for this purpose, be responsible for the cleaning of glassware and equipment.

Laboratory technicians or *medical technicians* may perform several or all of the following duties (and perhaps others): Make media, stain and make microscopic examination of smears of blood, urine, spinal fluid, etc. Prepare smears and/or cultures of tissue specimens. Prepare reagents used in serological examination and read and record results of such tests. Perform procedures such as blood screening and glucose tolerance tests. Make red and white blood cell counts. Make tests for hemoglobin, sedimentation rate, and coagulation time. Perform venipunctures.

A *bacteriologist trainee* (entry professional level job) needs a good academic background in the biological and chemical sciences to learn the standard laboratory procedures for examination of water, milk, and food. Other job duties may require making bacteriological analyses by means of cultural reactions, pigment production, blood coagulation, and gelatin liquefaction; determining bacteria count for such diverse items as dairy products, restaurant pans, and water from swimming pools and conducting serological tests for the diagnosis of communicable diseases. In addition, such a trainee might conduct tests to determine the feasibility of utilizing new methods or procedures in laboratories.

As a junior scientist gains greater knowledge (some of which may be obtained through additional education) and experience, she may be promoted to successively higher jobs which utilize this training in the performance of more complex technical duties and those requiring use of administrative judgments.

A *principal bacteriologist* or *senior biologist* may head a major organizational segment of the laboratory and in this capacity assist the director in determining administrative and technical policy. She might initiate plans for major new projects or programs and, if approved, direct such investigations; be responsible for continuing critical analysis and appraisal of the functions and performance of the laboratory with a view toward bringing about a more efficient and more effective operation; occasionally (or as necessary), engage in highly complex laboratory testing procedures; and be responsible for the selection and training of new staff.

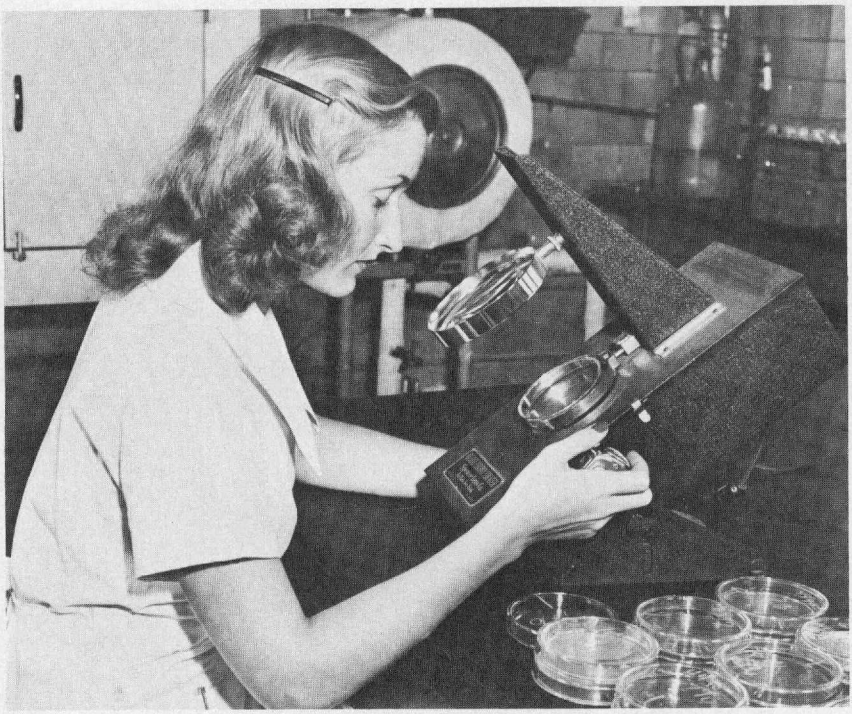
Private Industry

The biological research procedures carried out by private firms are much the same as those carried out under other auspices except that these activities are, of course, directed primarily to the discovery or creation of new commercial products. Nevertheless, some of the activity of such establishments is necessarily directed to basic biological exploration.

The pharmaceutical companies, for example, are concerned primarily with the development of new drugs or medicines or the adaptation of old drugs to combat newly identified types of disease. These activities, in some ways, parallel those of certain government agencies and nonprofit organizations devoted to research in a single disease or group of diseases.

The work of seed houses and of insecticide and pesticide firms is directed primarily toward securing better quality and quantity of agricultural products through development of strains which are more resistant to plant diseases, and the development of chemical sprays and other products which secure like results. Biological sciences personnel employed by food and beverage establishments seek to develop new or better commercial products.

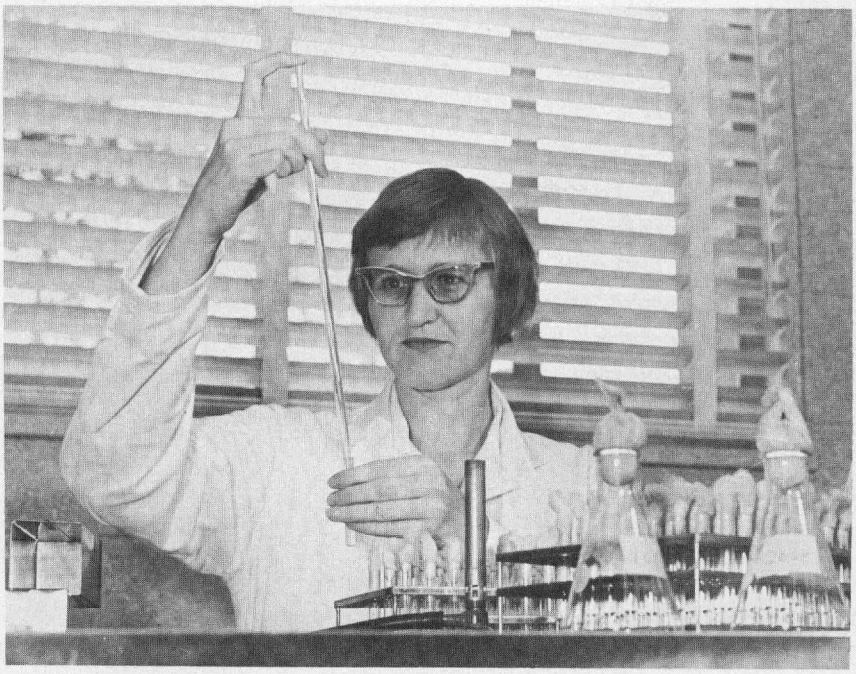
A biochemist assisting in the isolation and purification of antifungal antibiotics.



Bacteriological research in a food products plant.

The job duties which persons trained in the biological sciences perform in private industry are similar to those performed by their counterparts in laboratories run by government agencies, educational institutions, and nonprofit organizations. The education and training required to acquaint workers with fundamental biology laboratory techniques and equipment is the same as for other workers at a comparable level of responsibility.

As previously indicated (p. 9), the largest number of biological sciences workers in private industry are probably in the employ of pharmaceutical houses. Some of the larger companies have several major laboratories located throughout the country. Others are concentrated in a single location and employ several hundred biological scientists and supporting personnel in their research laboratories. In general, relatively smaller numbers of persons work in other types of private industry such as biological supply houses, seed houses, food and beverage manufacturing, processors, and firms manufacturing insecticides and pesticides. The hiring of women, both at the scientist and at the supporting level, has long been a practice in most laboratories operated by private industry.



A technical assistant setting up a cancer research project.

Laboratories run by private industry utilize the skills of persons possessing a wide range of biological specialties or subfields, including bacteriology, endocrinology, entomology, enzymology, genetics, microbiology, nutrition, parasitology, pathology, pharmacology, physiology, virology, and zoology. Persons with these specialties have one or more degrees—a bachelor's, master's, doctor of philosophy (Ph. D.), doctor of medicine (M.D.), or doctor of veterinary medicine (D.V.M.).

In addition to the professionally trained personnel, all companies employ workers with less training and experience to fill supporting jobs. Each firm has its own nomenclature for its supporting personnel but the job titles include: technician, technical assistant, laboratory technician, laboratory helper, glassware washer, animal caretaker, laboratory assistant, technical aid, and research aid. In some places, technicians are required to have a bachelor's degree; in others, to have some college training; and in others, only a high school education.

Women with a college background (usually a major or a minor) in biology or one of its specialties are also employed in a number

of nonlaboratory jobs in private industry establishments. Among the most common of these types of jobs are those concerned with (a) the writing and editing of journals, manuals of instruction, and technical papers and (b) library services (abstractor or librarian).

Among laboratories in private industry, there is considerable variation in working arrangements—depending on the size and function of an organizational unit, and more particularly on the specific problem at hand. In one place, a biologist may work alone on a project, and in another she may have the assistance of other biologists, technicians, or aids. Or, biologists may be engaged in solving a problem which requires cooperating with persons trained in other fields, such as physics, chemistry, medicine, or veterinary science. Such a team may be comprised of one or more biologists (perhaps including one or more Ph. D's), an M.D., and/or a D.V.M.

OCEANOGRAPHY

Reaching for the moon is but one of the many ways of probing space. Plumbing the depths is yet another dimension—one that also promises rewarding discoveries for the 1960 decade. Although nearly three-fourths of the earth's surface is covered by water, little study of sea life has been made in comparison with many other scientific areas. However, basic research activity in the marine sciences should at least double during this decade if the recommendations of the Committee on Oceanography of the National Academy of Sciences—National Research Council are followed.

In general, the Committee recommended an extensive program of oceanwide surveys [3] and extensive investigations of marine resources and radioactivity, among other applied marine sciences. Of special interest to persons who have training in the biological sciences are recommendations that the following specific studies be carried out:

- The genetic effects of radiation on marine organisms
- Possible improvement of stocks by selective breeding and hybridization
- The effects of living organisms on the distribution of radioactive elements introduced into the sea
- Characteristics and behavior of fish under controlled conditions
- Population fluctuations, locations, migrations, and survival requirements of commercial fish stocks
- Transplantation of useful organisms from one region of the sea to another
- Feasibility of adding trace elements to the sea to increase productivity of marine organisms

[3] Our knowledge in this field is reported to be now limited largely to water 100 miles from shore, and is deemed inadequate for even this modest area.

Diseases and other toxic effects in the marine environment
Precise definition of species, and other basic studies

There are many positions in research laboratories, offices, and aquariums which represent suitable opportunities for women. The solution to theoretical and statistical problems need not require even occasional field excursions aboard a vessel or to distant waters. Nevertheless, more and more marine stations are providing adequate facilities for women scientists who wish to spend time at sea. It may be expected, therefore, that more women will prepare themselves for careers in marine biology.

Some jobs related to marine biology are available in private firms such as power companies, oil companies, and those engaged in commercial fishing or fish-processing. Other sources of job opportunities are commercial research laboratories, nonprofit organizations, universities, and private consulting firms. Some of the well-known research organizations include the Woods Hole Oceanographic Institution at Woods Hole, Mass.; Scripps Institution of Oceanography, La Jolla, Calif.; Lamont Geological Observatory, Columbia University, Palisades, N.Y.; Marine Laboratory of the University of Miami, Miami, Fla.; and Bingham Oceanographic Laboratory, Yale University, New Haven, Conn.

A number of government agencies are vitally concerned with the problems of fish and animal life. Every State has a fish and wildlife department, board, commission, or division engaged in the control and care of fish and animals found within its borders. Foremost among the Federal agencies is the Fish and Wildlife Service of the U.S. Department of the Interior. In 1959, this agency employed 375 fishery research biologists. In addition, the Navy Department maintains several small laboratories.

A few examples of the kinds of work conducted by the Fish and Wildlife Service follow:

A *fishery research biologist* (*marine*) who acts as a project supervisor may plan, develop, and direct investigations into the characteristics, fertility, life history, ecology, migrations, and other factors in the biology of certain species of commercial fishes. The objective might be to understand the causes of fluctuations in availability and abundance of the fish in order to predict such changes and plan successful fishing operations.

Another *fishery research biologist* may conduct a survey of a river basin to determine the fish resources and to analyze the effects of proposed water-development projects (power, flood control, irrigation, etc.) on such resources. For some of the field work, aqua-lungs and underwater television are among the diving equipment used.

A *microbiologist* may study the culturing of algae for feeding oysters and clams, the removal of bacteria, and the search for a better food.

A *biometrician* may design a sampling system to obtain reliable and representative data for measuring or estimating various characteristics of fish populations or for establishing a trend for observable relationships, such as the death rate of a school of fish and the amount of bacteria found in the waters. Other biometricians develop suitable statistical procedures and techniques or analyze and interpret the information for significance and then make a written report of their findings.

A *fishery aid* assists scientists in classification and may help to identify and maintain research collections of fishes, prepare research results for publication, and assist in the preliminary reporting of findings. She may compile records and prepare illustrative figures, separate the groups of fishes under study from the large collections of unidentified species, identify them from the scattered and frequently obscure literature in ichthyology, adequately preserve and label specimens, make scientific illustrations, record information in catalogs, assist in the preparation of maps showing fishing locations, maintain laboratory equipment in serviceable condition, and answer inquiries about research in progress.

Scientists with Ph. D.'s outnumber master's degree holders in university laboratories, whereas the federally operated laboratories employ only a small proportion of scientists with Ph. D.'s. However, government-owned and smaller fishery laboratories are relatively good sources of employment for junior scientists and technicians. Of 60 laboratories of various sizes, 5 of the largest currently account for more than half of the junior scientists and technicians.

If the research program in oceanography as recommended by the Committee is carried through, the number of oceanographers at the Ph. D. level would need to be doubled during the next 10 years and an even greater rate of increase would be needed in supporting personnel. At present, an estimated 520 professionally trained scientists are engaged in this field in the United States. Only about a dozen universities offer the doctorate in oceanography and probably no more than a score of persons have received their doctoral degree each year to date. Graduate education at a lower level is provided by three additional universities.

▶ An ichthyologist at the American Museum of Natural History in New York received her doctorate in zoology and won a Fulbright scholarship to do research work in Egypt. Her investigations in undersea life have been conducted in many parts of the world, where she has often gone deep-sea diving with spear, mask, or net to collect specimens of rare and poisonous fish.

Raising a family of four with her surgeon husband did not signal retirement, for during this time she wrote a popular book on her experiences with skindiving. This led to her appointment as the director of a newly

established marine laboratory in Florida where she is studying the behavior of sharks.

▶ Immediately after earning her Ph. D. degree, a woman teacher began her professional career at a far western university and is now associate professor of zoology there. A few years ago she was awarded a Guggenheim fellowship which enabled her to do further study and to visit marine biological stations in northern Europe and Scandinavia. Subsequently, she worked at the famous zoological station in Naples. More recently she was responsible for the material presented in an educational television series entitled "Animals of the Seashore" which consisted of 15 half-hour programs. She is now serving on the Committee on Oceanography of the National Academy of Sciences–National Research Council, which drafted the 10-year action program for the United States as described on page 36. In Copenhagen in July 1960, she participated in the planning for the 10-year international program of surveying the oceans of the world.

MUSEUM WORK

Museums, usually operated by government or nonprofit private organizations, are located throughout the country; most are in major metropolitan centers but some are in smaller places. In the aggregate, the number of jobs in this field is relatively small.

One of the most coveted museum jobs is that of curator. Large museums or zoological or botanical parks usually maintain a staff of curators ranging from assistant to head curator. A specialist in some group of plants or animals, each curator is responsible for the collection, maintenance, study, and exhibition of specimens in his field of knowledge. Those who demonstrate outstanding ability in public relations and administration may advance to a directorship. The total number of curator posts throughout the country, however, is fairly limited. Consequently, it is advisable for those interested in this career to prepare themselves for teaching as well as research so as to insure a wider choice of job possibilities. Museum curators generally hold a Ph. D. degree. Many have taken their graduate training in one of a number of areas of specialization.

Growing public interest in scientific and technical fields will create some expansion in the demand for persons to carry on educational services offered by museums, which will provide some good job opportunities for women biologists. Today, women with a bachelor's degree in biology are filling public information posts as lecturers or hostesses to school and other groups and many help to plan museum exhibits.

A high school education is usually considered sufficient training for museum workers called "exhibits technicians." To be successful in this work, a woman should be artistically inclined since she must

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become proficient in such diverse techniques as coloring, wiring, and making plastic molds of plants or animals. Accuracy is an essential work characteristic for preparing materials for exhibit, such as artificial flowers, leaves, and other accessories. Since many women have a high degree of manual dexterity, they have proved particularly adaptable to this kind of work. Although it is occasionally necessary to handle heavy objects, custodial workers are usually available to assist in this lifting.

"Zoological or botanical illustrators" must, of course, be able to make accurate sketches. There is little room, however, for imaginative artistry in their work since they must be meticulous in reproducing the detail of the animal or plant. Training in biology is not required but is considered helpful.

Although job opportunities are expected to expand in the future, museum employment will probably never constitute more than a small proportion of the total number of men and women working in the biological field. In 1959, the Federal Government employed only about 125 professional workers in museums, of whom many were in disciplines other than biology, and about 85 aids. One museum official estimated that at the technician level only about 1 job in 15 was filled by a woman. Another official estimated that, nationally, the number of full-time positions in taxonomic botany is less than 35. However, a somewhat larger number of biologists are engaged in taxonomic research on a part-time basis.

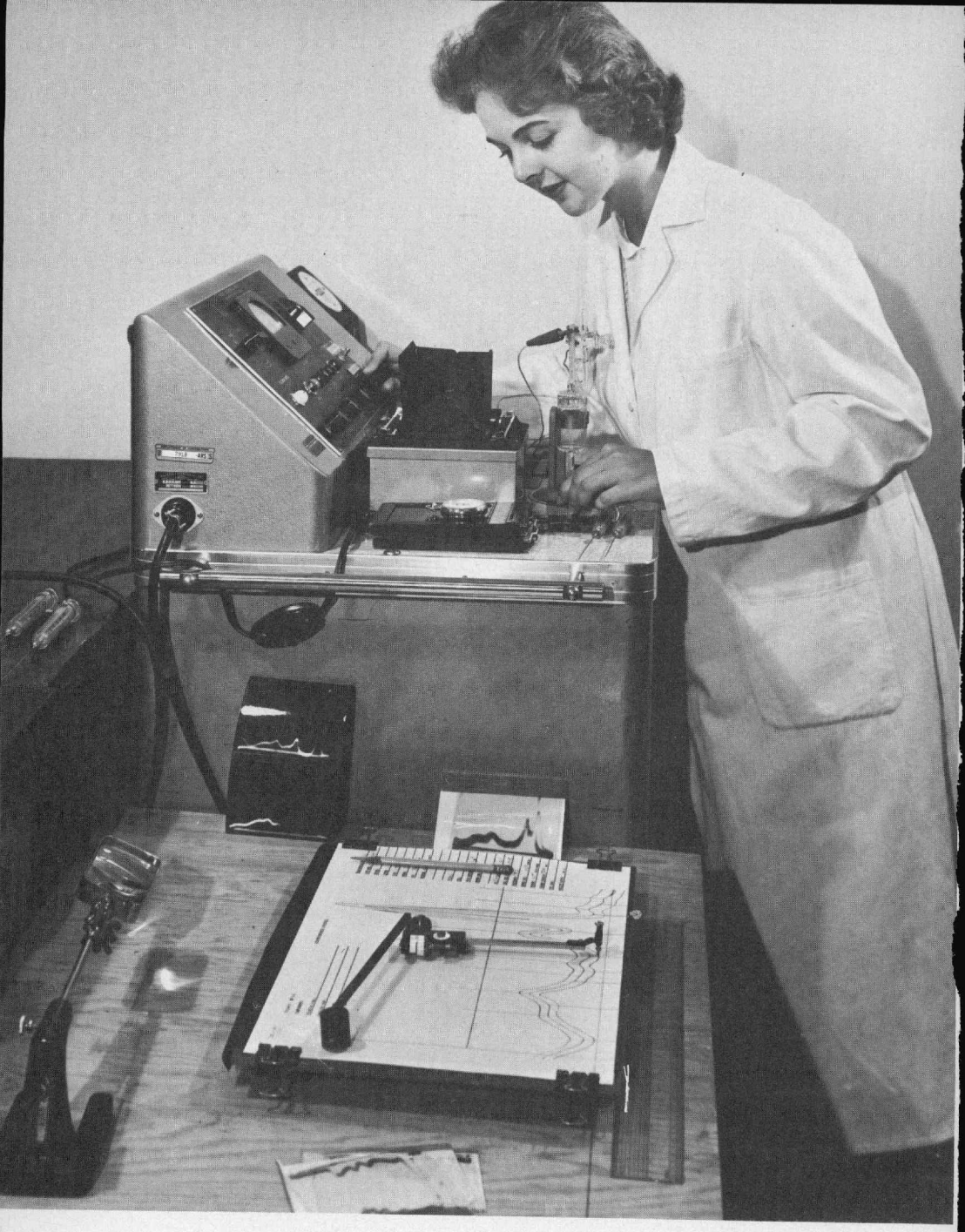
Some universities have a herbarium where taxonomic work is combined with the primary duties of teaching. Unlike those jobs requiring considerable field work, for which there has been a preference to employ men, herbarium positions can easily be filled by women.

JOBS OVERSEAS

The demand for all types of scientific personnel to provide technical assistance to other nations has opened up a number of opportunities for persons trained in the biological sciences and will undoubtedly continue to do so in the foreseeable future. In addition, there are some projects being conducted by and for the United States abroad which offer jobs to women biological scientists and technical workers.

In 1959, 84 persons trained in the biological sciences occupational series (see p. 22) were working for the United States Government

in foreign countries. Other persons with such training were employed by the United Nations, the World Health Organization, the Rockefeller Foundation, private industry, church groups, and other organizations. Many of these biological sciences personnel were engaged in rendering advisory services to schools and colleges, to public and private health services, and to various kinds of research organizations of foreign governments to help solve agricultural and health problems.



A biologist analyzing blood proteins in studies involving human nutrition.

5

Preparation for a Career

ADVANCED OR GRADUATE DEGREE

Persons who wish to become full-fledged scientists in the biological field should, if at all possible, work toward the attainment of a doctor's degree (M.D. or Ph. D.). Employers point out that those with less than a doctor's degree seldom have sufficient knowledge or experience in the field to initiate plans for a research project, determine methodology or develop techniques for the conduct of a study, analyze the results, or prepare a report of the findings for a professional journal or for internal administrative use.

Although in the past a number of people with less than a doctor's degree have made names for themselves in biological research, today's trend in biology—as well as in many other fields—is toward raising the academic requirements for workers. It is generally considered advisable to continue working toward an advanced degree unencumbered by the simultaneous holding of a full-time job. However, if this cannot be arranged, a dual work-school schedule can be followed fairly satisfactorily if courses are stretched over a longer period than would be necessary if studying full time.

The course of study of a candidate for an advanced degree in the biological sciences, like that in other fields, will be determined largely by three factors:

1. The ultimate occupational goal of the student (if this is known),
2. The requirements established by the educational institution for the degree sought, and
3. The breadth and depth of individual courses offered by the college or university.

Many authorities agree that it is highly desirable for a student to get the broadest possible foundation in the humanities, the scientific field in general, and in the fundamentals of biology during undergraduate years, and to begin her specialization at the graduate level. The more one knows about her intended career goal, the

better she can plan the area in which she wishes to specialize. Once an area of specialization is determined, a student is in a better position to select the school which provides a good program in her chosen area of work.

An advanced degree is almost always required for college or university teaching. A teacher's certificate is required to teach in public junior colleges in some States (including California, Illinois, Florida, New Jersey, and Michigan). To qualify for such a certificate, one must usually have a master's degree and have completed specific courses in education.

THE BACHELOR'S DEGREE

Persons who have been unable to continue their formal education beyond the level of a bachelor's degree nevertheless play an important role in today's biological sciences research team. These people hold jobs as research associates or research assistants and are the eyes and hands of the higher level scientists who are usually project leaders. Under the supervision of these leaders, research assistants perform the many activities necessary to push a project toward its completion—usually by designated, fairly standard laboratory techniques.

At the entry level, research assistants perform a variety of routine tests. As these workers gain experience, they are generally given increasingly important assignments involving the use of more complex procedures. The research project leader is usually responsible for the final analysis of test results and for reports of results for publication in scientific journals or for official use, but experienced research assistants or associates often write initial drafts or make major contributions to the preparation of such reports.

The required course of study for obtaining the bachelor of science degree with a major in biology varies markedly from school to school. Some schools offer a wide range of electives in the biological sciences whereas others have a high percentage of required courses. In order to gain some insight into current practices, the Women's Bureau examined the 1959–60 curriculum offerings in 100 schools (at least 1 in each State). Sixty-eight of the schools offer a major in *biology*. At these schools, in addition to general biology, the courses most frequently required of a biology major are botany, genetics and heredity, anatomy, and physiology.

Among the 36 colleges offering a *botany* major, the courses most frequently required (other than botany) include physiology, anatomy, morphology, ecology, genetics and heredity, and general biology. The 32 institutions which offer a major in *zoology* most often require that students take courses in anatomy, botany, embryology, physiology,

genetics, and general biology. A large proportion also require a senior seminar. Considerably fewer of the 100 universities (14) offer a major in *microbiology* or *bacteriology*. Among those which do, courses required most frequently outside the immediate major field are immunology, genetics and heredity, and physiology.

Other courses which were either required or deemed highly desirable for majors in biology or its specialties are taxonomy, histology, entomology, evolution, pathology, mycology, parasitology, virology, and cytology.

In addition to specific courses in biology, many schools require mathematics, chemistry, physics, and a foreign language—most frequently German or French. These courses do not count toward the major but are necessary for a degree in the biological sciences.

With the growing interdependence of all of the scientific disciplines, it is increasingly imperative that biology majors also study chemistry and physics. Taking these courses during undergraduate years is highly desirable; for a graduate degree in biology, they are usually a firm requirement.

Foreign languages are extremely helpful, especially in working toward a higher academic degree. Much of the world's scientific literature is published in either German or French and although there is a growing utilization of persons to translate and abstract this material, many scientists find it a great advantage to be able to read papers in the original language. With the widening of activity by the Russian nation in the scientific fields, the study of their language is also becoming increasingly popular among scientific students.

The importance of the mastery of the English language—both in writing and in speaking—cannot be emphasized too strongly. No matter how brilliant a scientist may be, if she cannot communicate her findings to others her own progress and that of the scientific world are deterred. For this reason, many science students find it advantageous to take undergraduate courses in expository writing, report writing, and public speaking. Or if this is not feasible, participation in such extracurricular activities as debating or dramatic clubs or in literary or journalism societies may provide valuable experience.

PREPARATION FOR HIGH SCHOOL TEACHING

A young woman who plans to teach in high school will want to ascertain early in her college career the requirements for obtaining a certificate or license in the State in which she intends to work.

The usual educational requirement for a State certificate is a bachelor's degree, with the equivalent of at least one-half year of education courses, including student teaching, and specialization in one or more subjects commonly taught in secondary schools. Arizona, California, New York, and the District of Columbia grant secondary certificates only to applicants with a year of graduate work. Many school systems, especially in large cities, have requirements beyond those needed for State certification.

College students preparing for secondary school teaching usually devote from one-fourth to one-third of the 4-year course to their major, which may be a single subject or a group of related subjects. About one-fifth of the time is spent in education courses and the remainder is devoted to general or liberal education.

Although certification requirements vary among the States, the person who is well prepared for secondary school teaching in one State usually has little trouble meeting requirements in another. A well-qualified teacher can ordinarily obtain temporary certification in a State while she prepares to meet any unusual requirements.

DEGREES GRANTED TO WOMEN

There has been a recent resurgence of interest by women in the study of the biological sciences, as shown by the number of college degrees granted in this field. Some 4,000 such degrees—bachelor's, master's and doctor's—were awarded in the school year 1958–59, compared with only 2,900 in 1955–56. The uptrend that began in 1956–57 was sharply accelerated in 1957–58, and was followed by about the same rate of increase (about 15 percent) in 1958–59. This group, however, represented only 2.6 percent of total degrees in all fields granted to women in the most recent year for which information is available—1958–59. Nevertheless, the rate of increase in the number of degrees awarded in the biological sciences over the 3-year period ending in 1958–59 (38 percent) was more than double the rate of advance in total degrees awarded in all fields during this period (16 percent).

Year-by-year information on degrees granted to women in all fields and in the biological sciences since 1948 is shown in table 1.

Eighty-six percent of the degrees granted to women in the biological sciences in the academic year 1958–59 were bachelor's, 11 percent were master's, and 3 percent were doctorates. These proportions were about the same as in the 3 previous years. The distribution was somewhat different for biology degrees granted to men in the

Table 1.—Degrees Granted to Women, 1947–48 Through 1958–59

[All levels]

Academic year	All fields		Biological sciences [1]	
	Total degrees	Percent change from previous year	Total degrees	Percent change from previous year
1958–59	153, 448	+6	[3] 4, 001	+15
1957–58	145, 126	+4	[3] 3, 481	+14
1956–57	139, 171	+5	[3] 3, 065	+6
1955–56	132, 509	+7	[3] 2, 901	−4
1954–55	124, 089	−1	3, 015	−1
1953–54	124, 871	(2)	3, 035	−5
1952–53	124, 863	−1	3, 208	−6
1951–52	125, 605	+1	3, 404	−7
1950–51	124, 584	+3	3, 644	−7
1949–50	121, 540	+3	3, 917	−1
1948–49	118, 537	+8	3, 949	−11
1947–48	110, 168	----------	4, 456	----------

[1] Certain classification changes have been made since 1947–48 when the U.S. Office of Education began publishing its annual reports on earned degrees. Limited data on earned degrees published prior to that time are not comparable with annual data for the past 10 years. In particular, the 1955–56 survey expanded the definition of "education" to include science education as well as art, business, and nursing education. As a result, beginning in 1956, some recipients of degrees previously classified as science majors were classified as education majors.

[2] Less than 1 percent.

[3] Excludes degrees granted in premedical, predental, preveterinary sciences, and optometry (preprofessional).

Source: U.S. Department of Health, Education, and Welfare, Office of Education. Annual reports for the academic years 1947–48 through 1958–59, Earned Degrees Conferred by Higher Educational Institutions.

Table 2.—Degrees Granted in the Biological Sciences 1958–59

Selected subfield	Total				Women				Men			
	Total	Bachelor's	Master's	Doctoral	Total	Bachelor's	Master's	Doctoral	Total	Bachelor's	Master's	Doctoral
All subfields [1]	14, 320	11, 297	1, 981	1, 042	4, 001	3, 432	457	112	10, 319	7, 865	1, 524	930
Anatomy and histology	234	138	59	37	39	25	9	5	195	113	50	32
Bacteriology [2]	833	504	204	125	333	257	60	16	500	247	144	109
Biology, general	8, 218	7, 534	537	147	2, 536	2, 357	150	29	5, 682	5, 177	387	118
Botany, general	630	347	177	106	174	119	44	11	456	228	133	95
Entomology	353	147	136	70	16	8	8	------	337	139	128	70
Genetics	80	3	35	42	8	------	6	2	72	3	29	40
Pathology	163	16	83	64	8	------	6	2	155	16	77	62
Pharmacology (excluding pharmacy)	65	------	33	32	12	------	9	3	53	------	24	29
Physiology	272	89	102	81	79	45	24	10	193	44	78	71
Zoology	2, 641	2, 127	370	144	680	576	91	13	1, 961	1, 551	279	131
Biochemistry	402	146	117	139	79	23	38	18	323	123	79	121
Biophysics	31	10	4	17	------	------	------	------	31	10	4	17
Other [3]	398	236	124	38	37	22	12	3	361	214	112	35

[1] Excludes degrees granted in premedical, predental, and preveterinary sciences, and in optometry.

[2] Often called microbiology, includes mycology, parasitology, and virology.

[3] Includes subfields such as cytology, embryology, morphology, marine biology, and ecology.

Source: U.S. Department of Health, Education, and Welfare, Office of Education. Annual report for the academic year 1958–59, Earned Degrees Conferred by Higher Educational Institutions.

1958–59 academic year—76 percent received bachelor's; 15 percent, master's; and 9 percent, doctorates.

Of all the women who earned degrees in the biological sciences during 1958–59, a majority (63 percent) majored in general biology. The next largest proportion (17 percent) was in general zoology. Bacteriology and botany accounted for relatively smaller groups—8 and 4 percent, respectively, and the remainder represented a wide variety of categories within the biological sciences field.

The numbers of degrees in individual biological specialties that were granted to men and women during the school year 1958–59 are shown in table 2. In most of the categories, the number of degrees received by women exceeded that for the preceding academic year.

PREPARATORY COURSES IN HIGH SCHOOL

The course of study in high school will be much the same whether a young woman plans to go on to college and major in the biological sciences or plans to seek a job in this field immediately upon high school graduation. She will want to take as much general science, biology, chemistry, and physics as her schedule will permit. If advanced courses in the latter three subjects are offered, they should be scheduled if at all possible. A thorough grounding in English, particularly grammar, and in mathematics is essential, and 2 years of a foreign language will be extremely helpful.

Slight increases have occurred in the proportion of high school students enrolled in biology, chemistry, and physics courses in the grades in which these subjects are usually offered, according to surveys conducted by the Office of Education of the Department of Health, Education, and Welfare. These studies have been made at 2-year intervals, starting in 1954. The 1958 survey also found that about 3 out of every 4 pupils enrolled in the 10th grade were taking biology—by far the largest proportion of any science group in the respective grade where the subject is usually taught.

The ratio of girls to all pupils taking biology declined slowly but steadily during the 10-year period 1949–58—from 53 percent in 1949 to 49 percent in 1958.

EXTRACURRICULAR ACTIVITIES

There are a multitude of professional scientific societies in the biology field, each of which establishes its own membership requirements. Membership in some societies is open to college students at

either the undergraduate or graduate level. In others, membership is restricted to highly trained and experienced scientists who have engaged in original research projects and who have had their papers on such projects published in appropriate journals.

Most professional societies are national or international in scope and have chapters located throughout the country on a local area or regional basis. Meetings are usually held monthly (some for only 9 or 10 months each year) and are devoted at various times to business matters of the organization. For the most part, however, they are devoted to the reading and discussion of research. College students who belong to professional societies usually pay a considerably lower membership fee than regular members.

There are many advantages to such membership, especially for persons who are interested in a career in the biological science field. A listing of some of the well-known societies to which persons trained in the biological sciences may belong appears in Appendix E.

A number of study programs for high school science students are offered by universities and other organizations during the summer months. For example, one university schedules a 2-weeks' summer session for 80 high school pupils from the 9th through the 12th grades. Students take part in laboratory and field activities in the natural sciences. Another program provides for a 10-weeks' summer session limited to 25 promising students who have had at least one course in biology. Research techniques and methods are taught. Cooperative work-training and apprentice activities for students are provided by some local community groups during the summer months.

Among other activities of interest to science students are science clubs, bird or wild life study, scientific journals or books, and visits with scientists. In addition, prospective scientists often visit laboratories, State extension stations, and museums of natural history and technology.

A high school girl who is interested in science may become a member of one of the Science Clubs of America, affiliated with Science Service, Inc. In 1959, there were nearly 25,000 such clubs. If none is available in the community, a club can be organized by a sponsor or teacher in any grade who requests material from headquarters. Information about such organizations can be obtained from the Science Clubs of America, 1719 N Street NW., Washington 6, D.C. Science Service, Inc., is a nonprofit association that sponsors science fairs for high school students. College scholarships, prizes, and trips are awarded to project winners. A Science Talent Search is also open each year to high school seniors. Winners are awarded college

scholarships. Any high school principal or teacher may request information by writing to Science Talent Search at the address given above.

Another activity for junior and senior high school students interested in science is the contest held annually by the Future Scientists of America Foundation (of the National Science Teachers Association). This contest, now known as the Future Scientists of America Awards Program, is open to science students all over the country, and some 40,000 girls and boys entered in 1960.

A judging team of science teachers and scientists chose the 194 regional winners, who were awarded United States savings bonds. That girls as well as boys are successful in this program is indicated by the fact that one-third of the winners were girls. Reports of the projects are written by the students themselves, and many are published in a magazine entitled "Tomorrow's Scientists."

Information about this awards program can be obtained from the national headquarters of the sponsoring organization, which is located at 1201 Sixteenth Street NW., Washington 6, D.C.

VACATION WORK FOR STUDENTS

Many high school and college students are able to utilize the summer months to earn money and gain work experience. Interested students who have good academic records are employed either on a part-time or full-time basis during the summer by a number of educational institutions and business or industrial firms. Although many of these jobs involve the performance of rather routine duties, they often give the student an insight into the entire operation as well as bring her into contact with professional scientists who may help her determine whether she desires a lifetime career in this field.

Some of the jobs are clerical and require making simple computations or keeping various kinds of records or reports. In a research laboratory or research center, a summer helper might have charge of certain supplies or equipment, assist workers of a higher grade in performing simple laboratory procedures, help with glasswashing, or assist in the care and feeding of animals used in experiments.

Many Federal Government agencies hire *student assistants* for temporary, part-time, or intermittent jobs without requiring a civil service examination. They are assigned to aid scientific, professional, and technical personnel and cannot be appointed to routine clerical positions. Persons appointed must be high school or college students pursuing courses related to the field in which they are employed. A number of agencies employ only those students who are at least col-

lege juniors. Work is limited to a maximum of 130 days a year; maximum total pay for this period is $1,785.

Under another program, college students who are recruited as *student trainees* are required to pass a civil service examination. They receive on-the-job training in Federal offices and research laboratories under the guidance of experienced professional personnel. A trainee has a chance to observe and participate in the work of an agency and to decide whether she would like to join it on a permanent basis. One who does good work may be given leave of absence without pay to return to school. She may then return the following vacation to work in the same agency without taking another examination. After receiving her degree, she can be promoted from subprofessional to professional work without taking another examination.

Vacation jobs open to student trainees which may be of interest to biological sciences majors are in the following fields: biological and plant sciences (agronomy, biology, botany, genetics, horticulture, plant pathology, plant physiology) entomology; oceanography; and plant pest control. Information and application forms can be obtained from most post offices, U.S. Civil Service Commission regional offices, or the U.S. Civil Service Commission, Washington 25, D.C.

FINANCIAL ASSISTANCE

There are many ways in which a high school graduate with an outstanding academic record but limited financial resources can obtain a college education. Many sources of information on the types of scholarships are available. A student should talk with her school counselor, preferably before graduation, and with the librarian at both her school and public library. She might also write to the college or university of her choice, telling them of her school record and work experience (if any) and the field in which she wishes to specialize and ask them to send her information on scholarships for which she might be eligible.

Title II of the National Defense Education Act of 1958 provides for the establishment of loan funds in American colleges and universities from which a student may borrow up to $5,000. The law requires each borrower to be a full-time student, be in need of the amount of the loan to pursue her courses of study and be capable, in the opinion of the institution, of maintaining good standing in chosen courses of study. Special consideration is given to students with superior academic backgrounds who intend to teach in elementary or secondary school or whose background indicates a superior capacity or preparation in science, mathematics, engineering, or a modern

foreign language. These loans are interest-free during the years of study and 1 year thereafter, when they become repayable at 3 percent interest on a long-term basis.

The same Act, under Title IV, authorizes university fellowships for as much as 3 years of full-time graduate study with a maximum stipend of $6,600 plus dependency allowances. Although the applicant who indicates an interest in college teaching is given preference, she is under no obligation to teach or render any services either during or after her course of study. Fellowships, some of which require the performance of duties in exchange, are also available under the sponsorship of private companies, universities, service organizations, and philanthropic individuals.

Almost every college and university has funds for scholarships or loans to help the undergraduate student. Graduate students are often able to defray their costs of study through teaching assistantships.

An increasing number of college alumni groups and local clubs and fraternal orders affiliated with national or international organizations provide assistance to promising local students.

A 1957 survey of business firms revealed that one-third of the companies employing more than 1,000 workers and one-seventh of those employing 1,000 or fewer workers award one or more scholarships annually. Fewer than half of the firms restrict the awards to employees or their children. Awards range from $300 to $1,000 a year. Several are renewable if the student's grades are satisfactory. Many of these firms have tuition-aid programs for employees attending school on their own time.

Further suggestions as to ways of obtaining financial aid have been issued by the U.S. Department of Health, Education, and Welfare. The following publications, which were selected by its Office of Education as helpful to prospective college and graduate students, may be found in college libraries and in public libraries of larger cities.

Rich, Wilmer Shields. *American Foundations and Their Fields.* 1949–55. American Foundations Information Service. 860 Broadway, New York 3, N.Y. 784 p. $35.

Feingold, S. Norman. *Scholarships, Fellowships and Loans.* 1955. Bellman Publishing Co., Box 172, Cambridge 38, Mass. v.1—$6; v.2—$5; v.3—$10. 3v. set $20.

Lovejoy, Clarence E. and Jones, Theodore S. *College Scholarship Guide.* 1957. Simon and Schuster, Inc., Publishers, 630 5th Avenue, New York 20, N.Y. $3.95 cloth; $1.95 paper.

Wilkins, Theresa Birch. *Financial Aid for College Students: Undergraduate.* 1957. Department of Health, Education, and Welfare, Office of Education. 1957 series, no. 18. Government Printing Office, Washington, D.C. 23 p. $1.

Mattingly, Richard C. *Financial Aid for College Students: Graduate.* 1957. Department of Health, Education, and Welfare, Office of Education. 1957 series, no. 17. Government Printing Office, Washington, D.C. 50 cents.

Craig, William Bradford. *How to Finance a College Education.* 1959. Henry Holt & Co., New York 17, N.Y. 79 p. $1.95 paper.

Potter, Virginia Bosch. *Fellowships in the Arts and Sciences, 1960–61.* 3d. ed. 1959. The Association of American Colleges, Washington, D.C. 220 p. $3.75.

Babbidge, Homer D. *Student Financial Aid; Manual for Colleges and Universities.* 1960. American College Personnel Association, Washington, D.C. 56 p. $1.50.

UNESCO. *Study Abroad: International Handbook, Fellowships, Scholarships, Educational Exchange, XI, 1959–60.* 1959. UNESCO Publications Center, 801 Third Avenue, New York 22, N.Y. or Columbia University Press, 2960 Broadway, New York 27, N.Y.

6

Earnings and Other Work Factors

SALARIES

The earnings of persons working in the biological sciences are roughly comparable with those of other professionally trained personnel with similar educational backgrounds.

Federal Employment

The pay scale for Federal workers is based on the degree of difficulty and responsibility of individual jobs. On the basis of these factors, 18 pay grades have been established (see Appendix B).

Persons with a bachelor's degree in biology or one of the biological specialties but no work experience, who pass the required written test, may be appointed at grade 5, $4,345 a year. Those who have a superior academic record or who have successfully completed 1 year of graduate study in the appropriate specialty may be hired at grade 7, $5,355. Those who have successfully completed 2 years of graduate study beyond the bachelor degree may be hired at grade 9, $6,435 a year. The Ph. D. graduate without experience may start at grade 11, $7,560.

Most persons who continue in Federal Government service are advanced to successively higher grade levels commensurate with their education, skill, and experience. A few biologists now hold positions at the GS–17 level under the Classification Act, and a few are in positions for which Congress has made special provisions and for which the salary may go as high as $19,000. In 1959, however, the highest grade held by women biologists in Federal employment was GS–14. Nearly half of all women in the supervisory level jobs (GS–11, 12, 13, 14) were bacteriologists.

Persons with at least a high school education but less than a bachelor's degree may enter the biological sciences field in the Federal service in such jobs as Medical Biology Technician, Biological Aid, or Laboratory Animal Caretaker. Technician and aid jobs range

from GS–1 ($3,185) through GS–7 ($5,355), with the exact entry classification dependent on education and/or experience.

Average annual salaries of professional men and women working for the Federal Government in selected occupational fields in 1958 are shown in the following tabulation.

Selected occupational series	*Average annual salary of Federal employees, 1959*
Bacteriology	$7, 397
Biology	8, 064
Botany	7, 609
Entomology	7, 791
Fishery research biology	7, 079
Genetics	8, 153
Microanalysis	7, 468
Microbiology	8, 689
Mycology	8, 187
Nematology	7, 006
Parasitology	7, 887
Pharmacology	9, 413
Physiology	8, 867
Plant pathology	8, 111
Plant physiology	8, 115
Plant taxonomy	8, 400
Systematic zoology	8, 824
Wildlife research biology	7, 618
Zoology	8, 206

SOURCE: U.S. Civil Service Commission, Occupations of Federal White-Collar Workers, October 31, 1959.

In 1959, medical biology technicians in the Federal Government had an average salary of $4,328; biology aids, $4,299; and laboratory animal caretakers, $3,588.

Among the supplemental benefits enjoyed by Federal Government employees are the rather liberal allowances for vacation and sick leave, low-cost group life insurance, group medical-hospitalization benefits, and a retirement system to which the employer makes substantial contribution.

State and Local Employment

According to the latest (August 1958) salary survey of State health workers conducted by the U.S. Public Health Service, salaries of 1,334 professional laboratory employees ranged from $2,142 to $13,321. The average (median) salary was $5,208 for this group.

More than half of the State laboratory workers covered by the PHS survey earned between $4,000 and $6,000. Roughly one-seventh earned less than $4,000, one-seventh between $6,000 and $7,000, and one-sixth $7,000 and over. Most of those people who earned $9,000 or

over were in the Middle Atlantic States (New York, New Jersey, Pennsylvania) and in the East North Central States (Ohio, Illinois, Indiana, Michigan, Wisconsin).

The PHS survey noted a marked rise in the median salaries of State workers in all health occupational categories between 1956 and 1958. In the 11-year span 1947–58, however, there was a smaller percentage increase for the laboratory personnel group than for each of the other five groups surveyed (medical personnel, sanitary engineers, sanitary personnel, supervisory and consultant public health nurses, and nutritionists).

The Public Health Service also made a survey in August 1958 of the salaries of local public health workers. This study covered 904 professional laboratory workers—those having at least a bachelor's degree in the biological sciences. More than 60 percent of these workers earned between $4,000 and $6,000 a year, with a median salary of $4,963. Another 16 percent earned less than $4,000; 13 percent, between $6,000 and $7,000; and 9 percent, $7,000 and over.

Colleges and Universities

The salary level of teachers and researchers in colleges and universities generally reflects the level of academic training and the length of experience. However, it may vary between women's colleges and coeducational institutions, by geographic region, by sex, between public and nonpublic institutions, and between colleges and universities.

According to the National Education Association's 1959–60 salary survey, the median salary of women who had attained the rank of full professor was $7,899 (based on a 9-month term). Three out of four of the women professors made between $6,680 and $9,190. The salary for full professors ranged as high as $16,000.

Associate professors (women) had a median salary of $6,790. The salaries of associate professors ranged from $2,000 to as high as $12,000. Three-fourths of these women made more than $5,900.

As might be expected, the median salary for women assistant professors was somewhat lower—$5,875. The lowest salary reported for assistant professors was under $2,000 and the highest was between $12,500 and $13,000. Three-fourths of these women earned about $5,200.

Three out of four of the women instructors made about $4,400, with a median of $4,855. Salaries for women instructors ranged from less than $2,000 to between $14,500 and $15,000.

The median salary of teachers in junior colleges was slightly below the median of those employed in 4-year schools.

Women teaching in colleges and universities in the Far West had the highest median salary ($6,815), according to the NEA survey. The median salary was a little lower for women who taught in the New England States—$6,241—and in the Middle Atlantic States—$6,208. Lowest salaries were reported for the Southeastern States, with a median of $5,094.

The type of educational institution appeared to bear an important relationship to the salaries paid to college and university faculty surveyed. Although municipal universities had fewer faculty members than any other type of educational institution, the median salary for women of all ranks in these schools was by far the highest recorded—$8,089. In fact, this salary level was $55 higher than the median salary paid men at these same institutions. Women in teachers colleges had the next highest (median) salary ($6,418) followed by those in State universities ($6,152) and State colleges ($6,115). Median salaries for women at landgrant colleges and nonpublic universities were slightly lower—$5,908 and $5,825, respectively.

The lowest median salaries for women were reported in the nonpublic colleges. Moreover, the smaller the student body in the nonpublic colleges, the lower the median salary for women faculty members. Among those colleges with 1,000 or more students, women faculty members had a median salary of $5,457; those with between 500 and 999 students, $5,055; and those with fewer than 500 students, $4,506.

Some differences occur in salaries for teaching in summer sessions. More than 80 percent of the colleges and universities responding to the NEA survey have summer sessions. Of those which hold summer sessions, half employ almost 50 percent of their full-time, academic-year teachers. More than half of the summer session teachers are paid the same salary rate as during the academic year, about 45 percent are paid a lower rate, and 3 percent are paid a higher rate.

Secondary Schools

The average annual salary of all secondary school classroom teachers (men and women) for academic year 1959–60 was estimated by the NEA to be $5,334. Only about 13 percent of these teachers had salaries below $3,500; 30 percent were between $3,500 and $4,499; 29 percent between $4,500 and $5,499; 17 percent between $5,500 and $6,499; and 11 percent made $6,500 or more. The largest proportion of persons in the $6,500-and-over salary bracket were in California, Alaska, New York, and New Jersey.

An earlier NEA survey (1958–59), showed that the median minimum salary for classroom teachers in large urban school districts

(population of 30,000 and over) was $4,000 for those who had a bachelor's degree, and between $4,200 and $4,300 for those who had a master's degree. In the smallest districts (population between 2,500 and 4,999), the median minimum salaries were somewhat lower—$3,831 for teachers with a bachelor's degree and $4,039 for those with a master's degree.

The same 1958–59 survey indicated that the medians of maximum salaries for classroom teachers in the large urban districts ranged between $6,000 and $6,500 for teachers with a bachelor's degree, between $6,502 and $6,850 for those with a master's degree, and between $7,176 and $7,200 for those with a Ph.D. degree.

In a 1955–56 study, the NEA reported that, on the average, women secondary school teachers earned about 4 percent less a year than men.

Private Industry

The salaries paid biological sciences personnel in private industry are affected by factors such as occupational category, geographical area, extent of training and experience, and the supply-demand situation of the job market. In early summer 1960, the Women's Bureau studied the salaries paid by a few representative firms located in various parts of the United States, with the following results.

The most common entry salary reported for men and women filling jobs which required only high school graduation or some college work but less than a bachelor's degree was $3,300 or $3,400 a year. Some of these jobs commanded a salary closer to $3,550. Still other workers, classified in somewhat more responsible subprofessional or technician classifications, had beginning salaries of $3,800.

Entry salaries for persons who held a bachelor's degree ranged from $4,050 to $6,500 a year. For persons with a master's degree, the range was from about $5,400 to $7,150 a year with almost $6,100 the most common salary.

In some private industry establishments, the beginning rate for all occupational categories is a little lower for women than for men with the same qualifications. At the doctoral level, however, the rate in all reporting establishments was uniform for both sexes. Entrance salaries for Ph. D.'s and M.D.'s ranged from $6,000 to $9,350, with the most common annual salary close to $8,250.

INDUSTRY PRACTICES

An indication of the type of supplementary benefits which scientific personnel are enjoying today is gleaned from a survey of 22 selected industrial firms leading in research and development activities throughout the United States. The Stanford University study, entitled "Motivation of Scientists and Engineers," published in 1959, reported that these employees generally receive some form of overtime pay and, in most cases, share in the company's success through participation in profit-sharing, bonus, or stock-purchase plans. In addition, all the corporations interviewed offer in-company training and opportunities for graduate study.

About three-fourths of the firms adopted a parallel line of promotion for their scientific personnel, thus enabling them to advance through progressively higher technical responsibilities rather than through increased administrative duties. Moreover, technical competence was the criterion stressed by most of the firms canvassed in selecting their research supervisors.

JOB-RELATED TRAINING

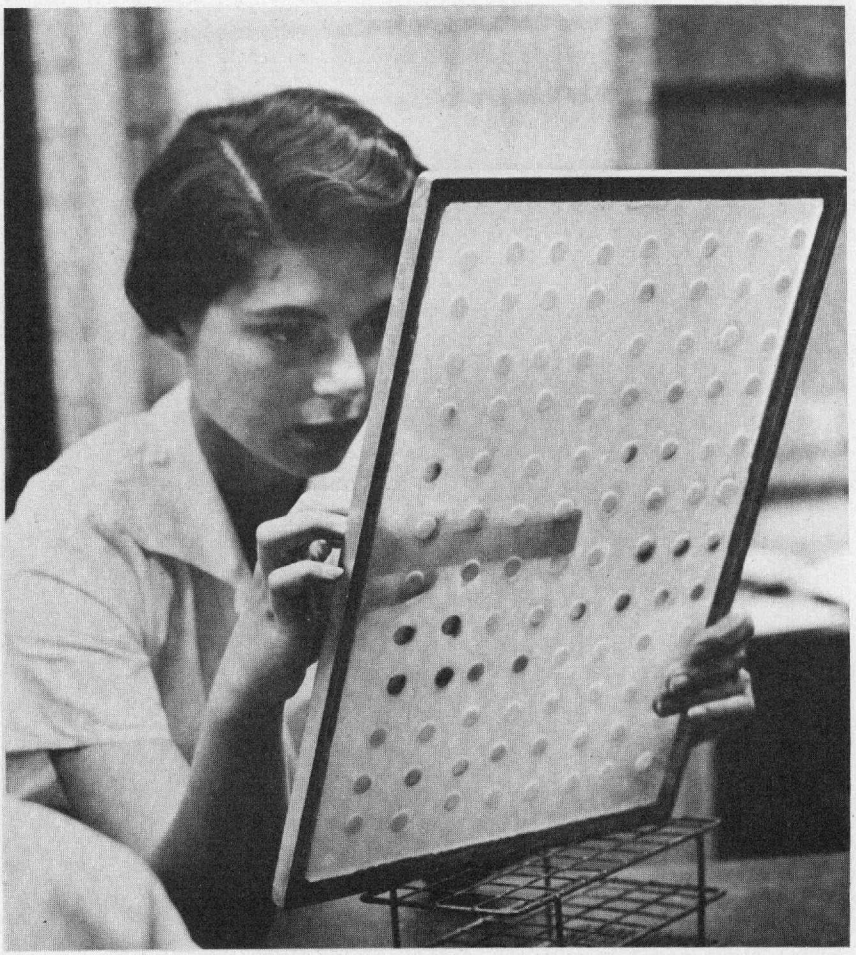
Government agencies (Federal, State, and local), nonprofit research organizations, and many private industry establishments engaged in activities in the biological sciences field have had a continuing interest in giving their employees on-the-job training or in providing the opportunity for off-the-job instruction.

A number of Federal Government agencies have availed themselves of the opportunity, afforded by the Government Employees Training Act (Public Law 85–507) of July 1958, of authorizing selected employees to attend various kinds of training courses. This training is authorized in order that these employees may develop maximum proficiency in the performance of their official duties. Some of these courses are of short duration and teach only one specific phase of work; others have broad application to work situations.

From time to time, the U.S. Public Health Service conducts special training programs open to members of the laboratory staff of State and local public health services. These may be conducted at the National Institutes of Health in the Washington, D.C., area or at a Public Health Service field station—such as the one for communicable diseases, in Atlanta; or the Sanitary Engineering Center (Taft Memorial Laboratory), in Cincinnati. These courses may be conducted so that participants can "brush up" on fundamentals of certain types of laboratory analysis, or for the purpose of teaching either a new technique or the use of new equipment or machinery.

Professional associations and other groups occasionally hold seminars or symposiums which laboratory workers may attend to broaden their knowledge or perspective.

College and university teachers are ordinarily given sabbatical leave to study, do research, or travel in order to become qualified for advancement. High school teachers are usually encouraged or required to attend annual or semiannual conferences or conventions of up to a week's duration to discuss literature and the use of equipment and to exchange experiences in classroom techniques.



An associate microbiologist measuring the activity of antibiotic-producing cultures.

Up until a few years ago, the biological scientist engaged in laboratory research could seldom advance beyond the median salary level and still remain primarily in research. Before such a scientist could advance further, it was generally necessary to assume administrative duties—which occupied a large proportion of the workday. But there was a growing recognition by both public and private establishments of the obvious advantages of retaining scientists directly on research throughout their work life, rather than allowing their time and energies to be channelled into other activities. This recognition has led many employers to the divorcing of pure research from administrative duties. As a result, it is now possible for a scientist as she gains greater experience, carries more research responsibilities, prepares more research documents, and achieves professional recognition in a specialty field, to advance to the top of the salary scale as a laboratory worker.

The new "open-door" policy of advancement via progressively higher research channels rather than through administrative posts, is a particularly favorable development for those who demonstrate technical proficiency. This does not mean that scientists at the upper echelons will have no administrative assignments. Rather, it means that such duties will not normally constitute a significant portion of her activities. At the same time, the way remains open for the biological scientist who enjoys the management aspects of this field to advance via the more usual route to the top—the administrative "chain of command."

To the extent that education shapes a person's native ability, imagination, resourcefulness, and the like, training-in-depth may be considered the most important single factor affecting her advancement. Of course, a thorough education alone is no guarantee that a scientist will succeed. Indeed, at the junior and intermediate levels, some supervisors prefer to work with individuals who are intelligent and proficient in their jobs but who have only a modest academic background. However, it is generally recognized that a solid education is the cornerstone for a successful career, particularly at the professional level, where a Ph. D. and/or a substantial number of published papers are deemed indispensable for achieving prestige and status.

The usual line of advancement for persons in the teaching field was discussed earlier (see pp. 17–18) but is summarized briefly here.

Customarily, persons beginning their teaching careers at colleges or universities are hired as instructors. In most places, the work

performance of members of the teaching staff is evaluated periodically and those who meet established criteria are given a salary increment while retaining the same job title, or are promoted to the next highest rank, usually that of assistant professor. As vacancies occur and as junior members of the staff achieve proficiency in their teaching activities and professional recognition from their scientific colleagues, they usually advance to associate professor and then to professor.

Professors who have an interest in and a talent for administrative duties in addition to their demonstrated talents for teaching or research may be promoted to head of a department or perhaps dean of a college.

Promotion at the high school level is somewhat more limited and depends, among other things, upon the size of the school system to which one belongs. In many places there are no gradations for classroom teachers, although there may be periodic salary increases based on length of service. In larger schools, a teacher may become head of the biology department and then head of the science department. In a smaller school, promotion may be directly from classroom teacher to school principal and ultimately to superintendent of schools. A person may hold the post of school principal and continue to do some classroom teaching. To attain the position of superintendent, a teacher must usually hold an advanced degree (often a Ph. D.) and/or demonstrate ability in administration.

7

Finding Employment

The manner in which one locates and obtains a job in the biological sciences depends, among other things, on the extent of academic preparation, the type of position desired, and whether one is seeking a temporary summer job or a regular full-time job. Vacation work was discussed previously (see pp. 50–51), and only full-time jobs will be discussed in this section.

In general, there are a number of things a young job seeker will want to do—no matter in what occupational field she is qualified. She should talk with her school counselor or college placement officer, advising him of her job interest and ascertaining if he knows of job openings for which she is qualified. He may be able to make an appointment for her with government and industry representatives who visit the campus. He may also help her prepare a brief statement of academic qualifications, personal attributes, and work experience (both paid and voluntary) which could be used in lieu of or as a supplement to more formal applications required by some employers.

She undoubtedly will discuss her interest in a job with the head of the science department and her major professor since employers sometimes contact them directly. She will alert her family and friends to be on the lookout for suitable vacancies. She will watch the newspaper "help wanted" advertisements in cities in which she would like to work. She will also scrutinize the "want ads" and notices that appear in the scientific and business journals.

She may wish to talk with the youth counselor at the local office of the State public employment service (affiliated with the United States Employment Service). If she lives in or near a large city, she will want to speak with the professional placement officer of the public employment service to ascertain the local and national job market in her field. There are more than 100 such professional placement centers scattered throughout 44 States and the District of Columbia.

If she knows an establishment where she would particularly like to work—a Federal or State government agency, a pharmaceutical house, a seed house, a food or beverage firm, a hospital, a private research laboratory—she will want to send a résumé of her qualifications, or apply directly, to the personnel office of that establishment.

Other, more specific, suggestions for persons of various educational levels and interests follow.

WITH LESS THAN A COLLEGE DEGREE

Some jobs in Federal Government establishments—such as medical aid, biological aid, medical technician, and medical biology technician—do not require a college degree. These jobs are in research centers and in government hospitals. Examination announcements may be obtained from the central office of the U.S. Civil Service Commission in Washington or from the appropriate regional civil service office.

There are also jobs as laboratory aids in State and local public health laboratories. Notices of examinations can be obtained from the appropriate civil service boards.

In addition, all kinds of establishments conducting biological research—public, private, nonprofit, and others—have a few jobs which may not even require high school graduation. These occupations may involve taking care of animals used in research, or of the glassware and other equipment and supplies in a hospital or laboratory. Application for these jobs may also be through civil service—or directly at the place of employment.

WITH A BACHELOR'S DEGREE

Let us assume that a young woman has a baccalaureate degree with a major in biology or one of the biological specialties. *If she plans to teach in high school*, she would have included in her program of study the courses in education required by the Board of Education in the State in which she plans to teach. She would also have taken the necessary steps to obtain a license or certificate to teach in that particular State (all States require them).[4]

If she is interested in teaching in high school in any particular community, she should write to the locality's school board during her

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[4] Arizona, California, New York, and the District of Columbia require that a high school teacher have a bachelor's degree and have completed 30 additional semester hours' work before a permanent teacher's certificate is issued. Under certain conditions, the District of Columbia and New York will grant temporary certificates to persons with less than this number of college credits.

senior year to inquire whether they expect any vacancies. Since prospective employers often contact college employment offices, the head of the college biology department, or the local public employment office, she should seek their assistance. Her State Board of Education may maintain a list of schools needing teachers in her specialty.

If she is interested in a Federal Government job, she should get the appropriate examination announcements from the U.S. Civil Service Commission in Washington or from the appropriate U.S. Civil Service Regional Office which serves her area. In some cases, she may be able to file for an examination and be placed on a register even before she is graduated (although final appointment will probably not be made until the actual awarding of the degree).

If she is interested in working in the public health service laboratory in a particular State, she should get in touch with the State Civil Service Board or the appropriate Merit System Agency for information about examinations. (All State health departments are covered by a merit system.)

Some counties and municipalities also maintain laboratories to help protect the health and welfare of their citizens, and entry to these jobs is also usually through civil service or merit systems.

In order to answer a number of questions about *post-graduation experience of women awarded their bachelor's degree*, the Women's Bureau, in cooperation with the National Vocational Guidance Association, conducted a survey in 1958.[5] This survey covered almost 88,000 women who received first degrees in June 1957. Employment status 6 months after graduation was reported for an estimated 2,800 women graduates with a major in the biological sciences. Of these, 60 percent were employed; 32 percent—quite a large proportion in relation to graduates with majors in other fields—were continuing their schooling; 2 percent were still seeking work; and 6 percent were not employed, in school, or seeking work.

Among the employed, nearly half were working as biologists or technicians in biological and health-related fields, 26 percent were teaching, 5 percent were engaged as chemists, almost 5 percent were nurses, and the remainder worked in miscellaneous occupations and professions.

Of the nearly 1,935 graduates working as biologists and biological technicians, 38 percent reported that they had found their jobs through direct application to the place of employment. Another

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[5] See "First Jobs of College Women, Report of Women Graduates, Class of 1957," Women's Bureau Bull. 268, U.S. Department of Labor, 1959.

A supervising technologist planting tuberculosis cultures under a protective ultraviolet sterilizing bacteriological hood.

26 percent were guided to their jobs through their college placement bureau or a college professor. Twenty-one percent of those surveyed found employment through the efforts of family or friends, and the remainder through public and private employment agencies or newspaper or magazine advertisements.

WITH AN ADVANCED OR GRADUATE DEGREE

A woman who has an outstanding academic record and a Ph. D. or M.D. degree in one of the biological sciences will find a wide range of job opportunities available to her. She can pursue a career in either basic or applied research in a number of government agencies, universities, hospitals, museums, nonprofit research organizations, or private firms.

If she wishes to teach in high school, she will have taken the courses required to obtain a certificate in the State in which she plans to work. If she wishes to teach at a college or university, her chances of being appointed to the faculty are far greater if she has a Ph. D., particularly for posts above the instructor level. In some colleges, a doctorate is required for teaching posts.

Whatever her choice, the methods of finding a suitable job are much the same as those outlined in the preceding section for persons with a bachelor's degree. In addition, organizations such as the American Institute of Biological Sciences and the Federation of American Societies for Experimental Biology, both located in Washington, D.C., maintain employment exchanges for their members and, in some instances, for nonmembers. Job seekers and hiring personnel often make contact while attending the annual conventions of these organizations as well as through the placement offices maintained by the societies and through their publications which often contain information on job applicants.

PART-TIME EMPLOYMENT

Both biological research and teaching offer opportunities for part-time employment to a growing number of people who are not available for full-time work. The nature of activities carried on in some laboratories makes it possible and often times even desirable to utilize part-time personnel. For example, some types of basic research or experimental work can be conducted as well or better on a 3-or-4-day-a-week schedule or on an abbreviated (4 or 6 hours) workday. Applied research laboratories such as hospitals, public

health service facilities, and commercial laboratories sometimes need extra people at certain hours of the day or at certain times during the month or the year in order to meet peak workloads. Many experiments require around-the-clock observations or testing and can be carried out only if supplementary personnel are available to replace the regular staff when they go off duty for evenings, weekends, or vacations.

A number of junior and senior high schools are meeting their teacher shortages by hiring housewives academically qualified to teach one or more courses each day. Similarly, women who hold a master's or doctor's degree and live in college towns may have an opportunity to do part-time classroom teaching or laboratory supervision. Some colleges and universities conduct night courses and either employ or might be willing to employ qualified persons to teach biological sciences subjects at these evening classes.

In the next decade, with the unprecedented influx of students into high schools and colleges, the number of schools with arrangements for the utilization of part-time personnel can be expected to grow. This development will work to the especial advantage of women who cannot work full time or to those who hold full-time jobs but who wish either to broaden their experience or enhance their income or both.

8

A Look to the Future

BIOLOGY RESEARCH

No one can foresee what monumental discoveries biological scientists engaged in research will make in the years ahead. Hardly a day passes without the announcement of some new development which has in it the potential for a dramatic improvement in the health and well-being of mankind.

For example, within the past 10 to 15 years our knowledge of viruses, the smallest of the "living things," has been growing by leaps and bounds. Scientists are already able to break them apart and put them together again and can cause infection with just that part of the virus known as a nucleic acid. Biologists and biochemists are now trying to synthesize nucleic acids. If they succeed and these nucleic acids can cause infection, the scientists will, in one sense, be on the verge of creating life. Virology is a field which has had a particular appeal for women and a number of them are already making notable contributions to the advancement of this research specialty.

Still other specialists will be engaged in other research projects which have far-reaching implications—such as those who are working to discover or devise an abundant, nourishing, and inexpensive food supply for the exploding world population. But whether the problem solved is tiny or huge in scope, there is every reason to believe that women scientists of the future will continue to display keen interest in and contribute significantly to discoveries in all the specialized fields of research.

RADIATION BIOLOGY

Radiation research is among the fields that have recently emerged in the biological sciences area. A number of pioneering scientists are studying the effects of radiation—including fall-out from atomic

Poplar trees grown under special conditions so that each receives the same nutrition. Plants are subsequently used in experiments related to atomic energy.

weapons tests—upon such biological processes as aging, tumor growth, mutations and other changes in the hereditary mechanism, structural differences in proteins and cells, and sensitivity and tolerance adjustments.

Radiation is also becoming increasingly useful as a tool in medical research and therapy for both diagnosis and treatment of various diseases. Radioactive tracers are used to study physiological processes (both plant and animal), photosynthesis, energy transfer, growth, disease, and healing processes. Future possibilities from radioactive isotope research are foreseen for such projects as producing nicotine-free tobacco and obtaining more efficient production of agricultural products.

Already involved in various aspects of radiological research and application are a number of private companies, universities, and government agencies. Among the latter are several units of the Department of Defense; the Department of Health, Education, and Welfare; the Veterans Administration; State and local health departments; and the Atomic Energy Commission. The AEC was established to promote the use and control of nuclear materials for

A biology technician using a microscope to determine genetic changes in fruit flies, some of which have been exposed to X-rays, and others to neutrons—atomic particles produced by a nuclear reactor.

our national defense and in the interest of health and welfare for mankind everywhere. Its operations are carried out largely by industrial concerns and by private and public institutions under contract with the Commission.

Women represent a fairly sizable proportion—ranging from one-fourth in some installations to more than half in others—of all biologists and biological technicians employed by selected AEC laboratories surveyed by the Women's Bureau in early 1960. Nearly 3 out of 10 women biologists were reported to hold supervisory positions at 1 of the installations, but it should not be inferred that this was a representative picture since comparable data were not furnished by the others. Individual installations stress different aspects of the biology field, but it appears that women are most likely to work in medical technology, general biology, physiology, biochemistry, microbiology, cytology and cytochemistry, genetics, pathology, and enzymology.

All except one of the installations surveyed reported an adequate supply of biologists and technicians. College graduates to work as technicians were most needed at one facility. Another indicated a steady demand for bachelor's and master's degree holders in all fields of biology because of the high turnover of scientists at this level who leave to continue their study toward a Ph. D.

Because of the variety of research activities conducted by these laboratories, both specialists and individuals with broad general training are employed. In the main, the difference between the duties of technicians and scientific personnel is that the latter originate and carry through their own research projects whereas the technicians assist and work under the supervision of a scientist.

On the educational plane, at some places the scientists usually hold advanced degrees, whereas subprofessional workers generally have a bachelor's. In some places, however, technicians need have only a high school education or possibly some college training, depending on the level of job responsibility.

As an example of the levels of remuneration that may be expected by beginning biology personnel today, the following salaries are cited for one of the eastern installations under contract to the AEC. Starting rates in early 1960 ranged from $550 to $650 a month for Ph. D.'s, $475 to $550 for M.S.'s, $300 to $425 for B.S.'s, and $280 to $310 for high school graduates.

SPACE BIOLOGY

Launching a manned satellite, as we already know, is an undertaking of herculean proportions that requires the participation of many types of scientists. Exobiology, space biology, extraterrestrial biology, bioastronautics are all merely esoteric terms which are alternative names for this new and exciting branch of science.

Is there life on Mars? Or, for that matter, is any other planet inhabitable? Can space research open the Pandora's box to the riddle of creation—the origin and evolution of the universe? Will investigation yield discoveries of new organisms that may be of economic benefit or danger to man? What effects would space environments have on humans and other living species and how could they be applied to the medical and biological problems of manned space flights? For example: What would be the basic physiological and psychological reactions of space travelers to factors such as extreme temperature change, weightlessness, acceleration and deceleration, buffeting, noise and vibration, toxicity, radiation, confinement, and isolation? How much tolerance has man to such

stresses and pressures and what methods, precautions, and treatments can be devised by biologists to help these astronauts successfully adapt to voyages through the upper atmosphere? Will man contaminate other planets with organisms from earth?

An illustration of some of the studies being conducted for use in our probe of outer space concerns the age-old problem of sustenance. Until recently, biologists were hopeful that algae (plankton)—a fast-growing form of plant life—could be used as the perfect food. Now, experiments show that these sea weeds are unsatisfactory as a sole or even palatable source of food without further processing. Parallel research is centering on a completely synthetic chemical diet, while similar problems abound in clothing composition and design as well as the other practical aspects of maintaining life and good health aloft in space ships.

If there is any form of life on other planets, it is believed most likely to be microorganisms, both because they are more apt to thrive in marginal environments and to precede in evolutionary sequence the larger organisms. Moreover, according to at least one outstanding scientist, it is considered relatively feasible to collect, cultivate, and analyze microbes under the present experimental techniques of microbial cytochemistry and biochemical genetics which also lend themselves to automation and telemetric recording adaptations.

Since microbes will be such an important source of raw material for biological space study, scientists are extremely interested in avoiding contamination of other planets from the introduction of earth's organisms. Similar concern is being expressed about the risks of infectious diseases and harmful agents that might be carried back to earth by the returning space vehicles.

Although it is thus obvious that microbiologists and biochemists will be in the forefront of exobiology research, virtually all the other branches of biology will also be represented in the long-range studies, especially as the accumulation of data facilitates deeper investigation into the more complex species. Accordingly, this vast spectrum of endeavor ranges from systematic biology, which classifies species, to psychology or human engineering, which studies anxiety, loneliness, performance, and other behavior manifestations.

Some of the areas of work in the life sciences and the types of personnel that will be needed include:

1. Life-support systems for generating breathing oxygen and absorbing carbon dioxide: These projects will require—in addition to scientists of other disciplines—biochemists, biophysicists, bioengineers, and cellular, respiratory, and plant physiologists.

2. Clothing design for the moon, planets, and space: General physiologists and textile engineers.

3. Nutrition: Biochemists, dietitians, physiologists, and bioengineers.

4. Toxicity monitoring and data telemetering: Physiologists, bioengineers, and biochemists.

5. Radiation: Radiobiologists and biophysicists.

6. Basic research for extraterrestrial life and for vehicle decontamination: Experimental zoologists and botanists, physiologists, biochemists, and bacteriologists.

7. Testing, performance, data reduction, and psychological aspects of space flight: Human engineers, human factors specialists, neurophysiologists, psychologists.

8. Physiological stress studies: Physiologists, biochemists, and all types of aeromedical researchers.

Where is the work of basic and applied research in exobiology being conducted? Colleges and universities and a scattering of private companies, generally under government contract, have been conducting a substantial share of the space studies. Government agencies themselves have been playing a vital role in both the planning and development phases of space activity. Among the Federal agencies directly engaged in either carrying out or monitoring space research projects are the National Aeronautics and Space Administration and the Department of Defense.

Relatively few women have had either the training or the opportunity to participate in space biology research. But as activities in this field accelerate, it is anticipated that more and more women will find jobs available to them—especially those occupations which require highly trained scientists to work in laboratories.

APPENDIX A

National Register of Scientific and Technical Personnel

The most authoritative and detailed information on those characteristics of scientists which are related to their work is contained in the National Register of Scientific and Technical Personnel maintained by the National Science Foundation. A number of professional scientific societies mail questionnaires to individual scientists, members and nonmembers alike, to insure the most complete coverage possible. By using a standard National Science Foundation questionnaire, information on each scientist in the Register is brought up to date every 2 years.

The Register does not contain a full count of scientists, however. Response to the National Science Foundation questionnaire is on a voluntary basis and a number of scientists fail to respond. Secondly, the National Register defines the term "scientist" as those persons for whom academic training and experience in a scientific field are prerequisites. Normally, persons holding a doctoral degree in a scientific field or persons with a bachelor's degree plus 4 years of professional experience are considered "scientists." The exact definition, however, varies among the scientific disciplines.

The 1956–58 Register includes approximately 140,000 scientists who were employed full time. Of these, more than 8,700, or 6.2 percent, were women. Persons registered in the life sciences—which include the biological sciences, agricultural sciences, and medical sciences—totaled almost 30,000, of whom 8.2 percent were women. Women registered in the life sciences (2,470) ranked third in number behind women working in the fields of psychology and chemistry.

A brief analysis of selected categories of data collected during 1956–58 by the American Institute of Biological Sciences and the Federation of American Societies for Experimental Biology for the National Science Foundation follows.

Place of Employment

By far the greatest number of women life scientists were employed by educational institutions. Three-fifths worked in these institutions; one-fifth worked for government and approximately one-tenth each for nonprofit organizations and private industry. More than

one-third of the women employed by nonprofit organizations were microbiologists and almost two-fifths of those employed by private industry were microbiologists or pharmacologists.

Educational institutions employed 86 percent of the women biologists who specialized in anatomy and 80 percent of those in zoology. Also working in educational institutions were 76 percent of the botanists, 70 percent of the geneticists, 74 percent of the physiologists, 64 percent of the nutritionists, almost 40 percent of the microbiologists, 44 percent of the pathologists, and 35 percent of the pharmacologists. More than two-fifths of the women employed by government agencies were working in the subfield of microbiology; the next largest subfield was nutrition.

Work Activity

More than two-fifths of the women life scientists in the Register were employed in some type of research and fewer than two-fifths were engaged in teaching. The remainder worked in a variety of other activities such as management or administration, inspection, field exploration or clinical practice.

Most of the women whose biological subfield was anatomy, botany, or zoology held teaching posts, whereas the majority of the geneticists, nutritionists, pharmacologists, and physiologists were engaged primarily in research activities. Nearly half of the microbiologists and pathologists were doing research work, and more than one-third were employed in activities other than teaching or research.

Educational Attainment

Eight out of ten of the women life scientists held a graduate degree and over 60 percent of these were doctoral (M.D. or Ph. D.). Analyzed by subfield, the largest numbers of doctoral degrees were held by microbiologists (240) and nutritionists (182). The largest proportion of doctoral degrees was held by geneticists (74 percent), followed closely by anatomists and physiologists (70 per cent), and nutritionists (69 percent). In the subfields of botany, pathology, and pharmacology, roughly half of the women held a doctorate; two-thirds of the pathologists had medical degrees.

Educational Major

More than two-fifths of the women in the life sciences had received their highest degree in the same subfield as that in which they were employed, and one-third received their highest degree in another life science.

The highest proportions of women employed in the subfield in which they had majored were botanists (76 percent), microbiologists (66 percent), and zoologists (62 percent). Conversely, only 6 percent of the pathologists and 20 percent of the anatomists were employed in the subfield in which they had taken their highest degree.

TABLE A–1.—NUMBER OF WOMEN EMPLOYED IN SELECTED LIFE SCIENCES SUBFIELDS WHO REPORTED HIGHEST DEGREE GRANTED AND EDUCATION MAJOR [1]

Life sciences subfield	Highest degree granted [2]					Education major [2]					
	Total	Less than a master's	Master's	Doctoral	M.D.	Total	Same as employment	Other life sciences	Medical and health sciences	Other sciences and mathematics	Non scientific
Total	2,462	502	743	1,037	180	2,453	1,072	815	208	256	102
Anatomy	138	16	25	91	6	138	27	92	8	4	7
Botany	218	16	84	118	0	218	166	41	0	2	9
Genetics	69	5	13	49	2	69	26	39	2	0	2
Microbiology	670	206	224	218	22	668	439	142	33	46	8
Nutrition	265	21	62	178	4	264	125	20	8	105	6
Pathology	96	28	19	17	32	96	6	40	34	12	4
Pharmacology	104	42	11	42	9	104	30	44	11	17	2
Physiology	207	21	41	119	26	205	94	62	27	18	4
Zoology	190	30	84	74	2	189	117	53	1	1	17
Other	505	117	180	131	77	502	42	282	84	51	43

[1] See p. 79 for definition of terms used in this table.
[2] Total represents number of responses to this questionnaire item.

SOURCE: National Register of Scientific and Technical Personnel, 1956–58, National Science Foundation.

TABLE A–2.—NUMBER OF WOMEN EMPLOYED IN SELECTED LIFE SCIENCES SUBFIELDS WHO REPORTED TYPE OF EMPLOYER AND WORK ACTIVITY [1]

Life sciences subfield	Employer [2]					Work activity [2]			
	Total	Educational institution	Government agency	Private industry	Nonprofit organizations and others	Total	Research	Teaching	Other
Total	2,457	1,475	487	268	277	2,438	1,093	881	464
Anatomy	139	120	8	3	8	139	46	86	7
Botany	217	166	31	6	14	217	73	128	16
Genetics	69	48	7	6	8	69	48	19	2
Microbiology	670	269	212	106	83	663	318	121	224
Nutrition	265	169	53	19	24	261	171	56	34
Pathology	96	42	21	12	21	95	46	16	33
Pharmacology	104	36	13	46	9	104	79	10	15
Physiology	206	152	22	11	21	206	127	64	15
Zoology	189	151	24	6	8	188	44	133	11
Other	502	322	96	53	31	496	141	248	107

[1] See p. 79 for definition of terms used in this table.
[2] Total represents number of responses to this questionnaire item.

SOURCE: National Register of Scientific and Technical Personnel, 1956–58, National Science Foundation.

Salaries of Registrants

The median salary for women employed in the life sciences was $5,719. More than two-fifths received $6,000 or over, and only an eighth reported less than $4,000. Women in the subfield of nutrition had by far the highest median salary ($6,886). The next highest was that of pathologists ($5,972), followed by those in pharmacology ($5,848).

Age of Registrants

More than half of the women reported as full-time workers in the life sciences were 40 years of age or older; over half of these were at least 50 years of age. Almost one-third of the registrants were 30 to 39 years of age, and the remainder were under 30.

TABLE A-3.—NUMBER OF WOMEN EMPLOYED IN SELECTED LIFE SCIENCES SUBFIELDS WHO REPORTED SALARY AND AGE

Life sciences subfield	Salary [1]					Age [1]				
	Total	Under $4,000	$4,000–$5,999	$6,000 and over	Median	Total	Under 30	30–39	40–49	50 and over
Total	2,424	301	1,060	1,063	$5,719	2,451	346	783	636	686
Anatomy	138	19	60	59	5,667	137	12	41	34	50
Botany	217	42	92	83	5,446	218	22	56	58	82
Genetics	67	11	35	21	5,286	68	15	24	19	10
Microbiology	663	74	324	265	5,590	666	97	224	178	167
Nutrition	263	10	71	182	6,886	264	34	76	66	88
Pathology	93	11	36	46	5,972	95	16	30	26	23
Pharmacology	101	8	46	47	5,848	104	34	46	17	7
Physiology	201	21	93	87	5,710	205	32	87	43	43
Zoology	186	36	89	61	5,281	190	21	55	47	67
Other	495	69	214	212	--------	504	63	144	148	149

[1] Total represents number of responses to this questionnaire item.

SOURCE: National Register of Scientific and Technical Personnel, 1956–58, National Science Foundation.

Definitions of Terms Used in Tables A–1 and A–2

Less than a master's degree:	Most women in this group have a bachelor's degree; some have more than a bachelor's but less than a master's; a few have less than a bachelor's.
Master's degree:	Includes women with at least a master's degree but less than a doctorate.
Same as employment:	Includes women working in the subfield in which they had majored, i.e., anatomy, botany, etc.
Other life sciences:	Includes women employed in life sciences not shown separately such as entomology, ecology, biophysics, and phytopathology.
Medical and health sciences:	Includes women employed directly in the field of medicine and surgery (cardiology, hematology, radiology, etc.) or dentistry, public health, pharmacy, or veterinary medicine.
Other sciences and mathematics:	Includes women employed in fields such as the earth sciences, meteorology, geography, chemistry, and physics.
Nonscientific:	Includes women employed in fields such as psychology, history, or one of the social sciences (economics, political science, demography, sociology, etc.).
Educational institution:	Includes women employed by colleges, universities, and secondary schools.
Government agency:	Includes women employed by agencies of international, Federal, State, and local governments.
Private industry:	Includes women employed by private industry or business establishments and those who are self-employed.
Research:	Includes women whose primary work activity was in research, without regard to the place of employment.
Other (work activity):	Includes women engaged in a wide variety of activities such as development and design; consulting; technical writing and editing; management or administration; inspection, analysis, testing, process control; production; technical sales, service, marketing, purchasing; field exploration, surveys, and clinical practice.

Canadian Government Register

The Canadian government also has registered personnel engaged in the scientific and professional fields. The educational attainment of persons surveyed in Canada may not be directly comparable with those covered by the NSF Register. It is noteworthy that women constituted a relatively small proportion of the total on the register in each country. However, women biologists in Canada represented a much larger proportion of that field than in the United States.

In order to establish a Technical Personnel Register, the Canadian Department of Labour made a survey (in 1956) of persons who received their bachelor's degree prior to 1952. Women are represented in all 15 of the major professional fields which make up the Register and comprise 23 percent of the nearly 1,500 who work in the field of biology. This was by far the largest proportion of women among the categories of personnel on the Register.

Among the women in biology, 38 percent were employed in research; 47 percent in testing, inspection, and laboratory services; 13 percent in teaching and writing; and 2 percent in other activities. Of the women biologists on the Register who reported by type of employer, almost one-third worked in government, nearly one-third in educational institutions, and the remainder were scattered among other types of employers.

Although coverage of the United States Register differs somewhat from that of the Canadian Register, some comparisons may be made of work activities and places of employment.

A large proportion of women on both registers were engaged in research, with the slightly higher rate in the United States—45 percent compared with 38 percent. But then the pattern deviates sharply. Although 36 percent of the other United States registrants were teachers, less than 13 percent were so engaged in Canada. Nearly half (49 percent) of all Canadian women biologists performed testing, inspection, laboratory, or other miscellaneous services whereas only 17 percent of the United States women engaged in these activities.

When compared by place of employment, the dissimilarity of the two groups of registrants becomes even more apparent. Roughly 60 percent of the United States women biologists were employed by educational institutions compared with about 31 percent in Canada. A higher proportion worked for government agencies in Canada (30 percent) than in the United States (20 percent).

Federal Government Salary Structure

Federal civilian employees are paid under several different pay systems. Virtually all jobs in the biological sciences are covered by the Classification Act; a few are under the jurisdiction of local wage boards. Pay rates for employees under the Classification Act are set by the Congress and are nationwide or broader in coverage.

The Classification Act provides a pay scale called the General Schedule (GS) for employees in professional, administrative, technical, and clerical jobs, and for employees such as guards and messengers. The jobs under the General Schedule are classified and arranged in pay grades according to difficulty of the duties; the responsibilities; and knowledge, experience, or skill required.

Grades in the General Schedule, together with the entrance and maximum salary and the periodic steps for each grade, are listed in the following table.

U.S. Government Classification Pay Scale

[Effective July 10, 1960]

Grade	Rates within grade									
	a	b	c	d	e	f	g	Longevity		
								x	y	z
1	$3,185	$3,290	$3,395	$3,500	$3,605	$3,710	$3,815	$3,920	$4,025	$4,130
2	3,500	3,605	3,710	3,815	3,920	4,025	4,130	4,235	4,340	4,445
3	3,760	3,865	3,970	4,075	4,180	4,285	4,390	4,495	4,600	4,705
4	4,040	4,145	4,250	4,355	4,460	4,565	4,670	4,775	4,880	4,985
5	4,345	4,510	4,675	4,840	5,005	5,170	5,335	5,500	5,665	5,830
6	4,830	4,995	5,160	5,325	5,490	5,655	5,820	5,985	6,150	6,315
7	5,355	5,520	5,685	5,850	6,015	6,180	6,345	6,510	6,675	6,840
8	5,885	6,050	6,215	6,380	6,545	6,710	6,875	7,040	7,205	7,370
9	6,435	6,600	6,765	6,930	7,095	7,260	7,425	7,590	7,755	7,920
10	6,995	7,160	7,325	7,490	7,655	7,820	7,985	8,150	8,315	8,480
11	7,560	7,820	8,080	8,340	8,600	8,860	--------	9,120	9,380	9,640
12	8,955	9,215	9,475	9,735	9,995	10,225	--------	10,515	10,775	11,035
13	10,635	10,895	11,155	11,415	11,675	11,935	--------	12,195	12,455	12,715
14	12,210	12,470	12,730	12,990	13,250	13,510	--------	13,770	14,030	14,290
15	13,730	14,055	14,380	14,705	15,030	--------	--------	15,290	15,550	15,810
16	15,255	15,515	15,775	16,035	16,295	--------	--------	--------	--------	--------
17	16,530	16,790	17,050	17,310	17,570	--------	--------	--------	--------	--------
18	18,500	--------	--------	--------	--------	--------	--------	--------	--------	--------

Employees in all grades except GS–18 receive periodic "step" increases if their job performance is satisfactory. In each of the first 10 grades, the increases occur every 12 months until the maximum

salary is reached. In grades GS–11 through GS–17, they occur every 18 months. Employees in grades GS–1 through GS–15 also get a maximum of three "longevity increases" if they continue to serve in the same grade after they have reached the maximum salary.

Employees are not promoted automatically to a higher grade. Promotions depend upon openings in higher grades and upon the ability and work performance of the individual employee. It is not always necessary for an employee to move to a new job to get a promotion. If his work assignments become more difficult and his responsibilities increase, his job may be reclassified to a higher grade with a corresponding increase in pay.

APPENDIX C

Women's Bureau Publications in the Medical and Health Services Field

Publications marked with an asterisk (*) are out of print, but can be seen in many public libraries and university libraries.

Publications for which prices are quoted may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. Orders for these items should be accompanied by check or money order payable to the Superintendent of Documents.

Bulletin No.	
	The Outlook for Women:
203–1	As Physical Therapists. 51 pp. Rev. 1952. 20¢.
203–2	As Occupational Therapists. 51 pp. Rev. 1952. 20¢.
*203–3	In Professional Nursing Occupations. 80 pp. Rev. 1953.
203–4	As Medical Technologists and Laboratory Technicians. 54 pp. Rev. 1954. 25¢.
203–5	As Practical Nurses and Auxiliary Workers on the Nursing Team. 62 pp. Rev. 1953. 40¢.
*203–6	As Medical Record Librarians. 9 pp. 1945.
*203–7	As Women Physicians. 28 pp. 1945.
203–8	As Medical X-Ray Technicians. 53 pp. Rev. 1954. 25¢.
*203–9	As Women Dentists. 21 pp. 1945.
*203–10	As Dental Hygienists. 17 pp. 1945.
*203–11	As Physicians' and Dentists' Assistants. 15 pp. 1945.
*203–12	Trends and Their Effect Upon the Demand for Women Workers. 55 pp. 1946.
228	The Industrial Nurse and the Woman Worker. 48 pp. 1949. 15¢.

Some of the above subjects are covered also in chapters prepared for the 1959 edition of the Occupational Outlook Handbook—Bureau of Labor Statistics Bulletin 1255. Reprints of these chapters may be had under the following titles:

	Employment Outlook for:
1255–47	Medical X-Ray Technicians, Medical Technologists, Dental Hygienists, and Medical Record Librarians. 15¢.
1255–59	Physical Therapists and Occupational Therapists. 10¢.
1255–74	Registered Professional Nurses and Practical Nurses. 10¢.

APPENDIX D

Glossary of Selected Biological Specialties

Cytologists:	Investigate cells.
Ecologists:	Deal with the relationship between plants and animals and their environment.
Embryologists:	Examine the growth process, from seed or egg to mature organism.
Geneticists:	Study the transmission and variation of hereditary characteristics.
Histologists:	Investigate tissues.
Morphologists:	Study the structure of organisms.
Nutritionists:	Emphasize the effects of food on animals and man, including diet, food processing and preparation; and are concerned with many digestive, circulatory, and excretory functions.
Paleontologists:	Trace the origin and development of species by studying the fossil remains of the past.
Pathologists:	Attack the problems related to the nature, causes, and control of plant and animal diseases.
Physiologists:	Concentrate on functioning of organs to learn how digestive, circulatory, reproductive, and other systems operate.
Taxonomists:	Identify and classify species according to their characteristics and "family tree" relationships.

APPENDIX E

Professional Societies in the Biological Sciences

I. Societies associated with the American Institute of Biological Sciences:

Member Societies

American Academy of Microbiology
American Bryological Society
American Physiological Society
American Phytopathological Society
American Society for Horticultural Science
American Society of Human Genetics
American Society of Ichthyologists and Herpetologists
American Society of Naturalists
American Society of Parasitologists
American Society of Plant Physiologists
American Society of Plant Taxonomists
American Society of Zoologists
Botanical Society of America
Conference of Biological Editors
Ecological Society of America
Entomological Society of America
Genetics Society of America
Mycological Society of America
National Association of Biology Teachers
Poultry Science Association
Phi Sigma Society
Society for Industrial Microbiology
Society of General Physiologists
Society for the Study of Development and Growth

Affiliate Societies

American Association of Anatomists
American Association of Bioanalysts
American Dairy Science Association
American Fern Society
American Fisheries Society
American Genetic Association
American Ornithologists' Union
American Society of Agronomy
American Society of Animal Production

American Society of Limnology and Oceanography
American Society of Mammalogists
Association of Official Seed Analysts
Association of Southeastern Biologists
Biological Photographic Association
International Association of Dental Research
National Pest Control Association
Potato Association of America
Society of American Bacteriologists
Society of American Foresters
Society for Experimental Biology and Medicine
Society of Protozoologists
Society for the Study of Evolution
Society of Systematic Zoology
Wildlife Disease Association

II. Societies associated with the Federation of American Societies for Experimental Biology:

American Physiological Society
American Society of Biological Chemists
American Society for Pharmacology and Experimental Therapeutics
American Society for Experimental Pathology
American Institute of Nutrition
American Association of Immunologists

III. Other Organizations

American Association for the Advancement of Science
New York Academy of Sciences

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