The major changes in the teaching of biology 1930-1955

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The University of Montana
THE MAJOR CHANGES IN THE TEACHING
OF BIOLOGY, 1930-1955

by

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CHAPTER I

THE PROBLEM AND PROCEDURE

Ever since the dawn of civilization man has examined the living things with which he came in contact. He has observed the plants and animals carefully in the hope of learning how they might become more useful to him. Man has always depended on science to help him solve his problems of living. While the study of life is older than civilization itself, biology as an organized science is a newcomer on the educational scene.

It was not until 1802 that the word first appeared in the English language when it was coined from two Greek words: "bios" meaning life and "logos" meaning the study of. Biology is then the study of life, or more specifically, the study of living organisms. Although man had been formally studying living things long before 1802, educationally, he studied plants in botany and animals in zoology. Biology as a unified study of living organisms is one of the newer additions to modern education. Today, the majority of high schools and colleges throughout our country offer courses in this science.

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Before biology was scholastically accepted as a distinct science many important questions arose, such as: Should it be entirely composed of detailed facts of special classification or should it also include the broader principles of life? Would it sufficiently contribute to family living to merit it a place in our high school curriculums? Which particular objectives should be stressed? Does it seek to fulfill the needs of youth? What appreciations, understandings or solutions of life problems might be expected as a result of class-room activities?

These and many other important questions were raised and discussed before biology, as a science, came into its own.

THE PROBLEM

Statement of the problem. This study attempts to bring forth for consideration an investigation of the major changes in the teaching of biology during the period of years between 1930 and 1955, as this subject has been developed and is being taught in the high schools of the United States. Actually, an effort is being made to show the general tendency of these changes and the manner in which they concern the objectives, subject matter and scope in the growth and development of this particular science.

Importance of the study. In the latter half of the nineteenth century and the first half of the twentieth, advances in scientific discovery and application have affected human life more than during any previous period of several centuries.

Science has given direction to education by linking it with the modern way of life. In order that, as adults they may participate more fully in the benefits of science, and contribute to its further advancement, young people must be given training far beyond that
needed a generation ago. Special and lengthy preparation is necessary so that youth may appreciate some of the future developments of science and gain an insight into the social implications of scientific change.

At present biological knowledge has influenced our way of thinking not only scientifically but socially and politically as well. Consequently biology has earned a well-deserved place as a science in the high school curriculums. Whereas, the subject matter and procedure in chemistry and physics has been established for more than 50 years; the content in biology varied between emphasis on separate fields of botany and zoology to problems of social significance in broad areas of human experience.

As subject matter became more intimately associated with the many problems of modern living, there arose the need to satisfy the increasing public interest in this particular science. Since less than 15 per cent of high school graduates continue their education in college, the providing of the requirements necessary for a better way of living and a more complete family life are placed on the high school teachers. This study will endeavor to show the major changes which have taken place in the teaching of biology during the last twenty-five years.

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METHOD OF PROCEDURE

The method used in writing this thesis best adapted itself to the normative survey approach in that the data is based upon: (1) a discussion of the biology textbooks which were written during the last twenty-five years, (2) a summary of the courses of study developed during this period, and (3) the finding of the research studies made on science teaching which have appeared in the leading educational periodicals.

The study is divided into four major problems: (1) the changes in the objectives of teaching biology as reflected in educational literature, (2) changes in the content of biology textbooks and courses of study for high schools, (3) the changes in the method and procedure in teaching biology, and (4) the analysis of the position of biology in the present day social philosophies.

ORGANIZATION OF THE THESIS

In order to make an earnest and careful examination of the major changes taking place within a given period, an authentic background knowledge of the whole field of biology is necessary. Chapter II will then handle the reviews of the various research studies and the opinions of the writers in this field. Chapter III will contain a description of the changes as shown in educational literature and biology textbooks. The changes in the content and organization of biology courses as proposed by Yearbooks, courses of study and textbooks will be dealt with in Chapter IV. Chapter V will present the newer methods, procedures and techniques which became necessary as a result of the change in objectives. Chapter VI will describe the effects of these major changes on teaching biology in Montana. Chapter VII will analyze the social and economic implications of biology.
Chapter VIII will summarize the results obtained and synthesize the findings. Conclusions and recommendations are suggested for the establishment of the proper understanding and appreciation of biology in the light of the present emphasis on the social and economic consequences involved.
CHAPTER II

REVIEW OF LITERATURE

The question, "Does science actually merit a place in our educational system today?" can be best answered as follows: During the past two decades there has been a great change in the attitude of the masses toward science and scientific procedure. This is due mostly to the many contributions which science has made in our daily lives. Dissemination of scientific information through schools and press has greatly increased the tendency of people to accept educational subjects and behavior based on scientific knowledge. Because science touches, influences, and molds the lives of every living thing, science teachers have a great opportunity and responsibility to make a real contribution to the welfare and advancement of humanity. It is a great social force as well as a method of investigation. Understanding and accepting these facts and this point of view and putting them into practice will, more than anything else, make science teaching what it can and should be.

People today are in fact becoming worshippers of science. While replacing superstition it retains its suggestion of black magic. Those who have for sale medicines, foods, and many

other types of merchandise, stress their scientific preparation. Their advertisements are artificially and profusely filled with references to laboratories, doctors and professors, and with pictures of physicians, test tubes, and other chemical apparatus. This condition of maladjustment of popular knowledge to scientific progress calls for an adaptation of the program of learning for youth.  

It was not until the "Committee of Ten" proposed that science courses be added to the high school curriculum that it ceased to be regarded as the field only of the specialist. Immediately following that announcement, many scientific studies were launched to determine the place of biology in the high school curriculum, authorities began to determine the objectives, syllabi were compiled and innumerable textbooks on this subject were written.

The first published report was Trafton's research investigation of science teaching which was printed in a local publication in Passaic, New Jersey, in 1904 and has been reprinted many times since. In 1910 the first investigation of learning methods of science appeared when Gilbert published his report on the relative merits of two approaches to teaching zoology in the secondary schools. These reports were followed by a few monographs and essays in the educational journals prior to 1920. Between 1920 and 1925 sixty reports and studies on science teaching and curricular studies had been published. Since

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5 Ibid., p. 119
that time literally hundreds of such studies have appeared in educational magazines, research bulletins, as well as in dissertations for higher degrees. From this wealth of material only the most representative could be selected for this study.

AIMS OF SCIENCE EDUCATION

In studying the many articles on science education published during the past two decades one finds a great many research reports based on problem-solving objectives. Some of these writers endeavored to cope with the specific elements of problem-solving behavior, while others concerned themselves with experimentation in methodology in regard to developing skills. Downing believes that in order to make the elements of problem-solving behavior a major goal of science education proper, learning experiences and situations must be provided. That problem-solving behavior as an objective of science teaching is absolutely necessary if science is to be helpful to the citizen in solving his problems is the opinion of Watkins. After the Thirty-first Yearbook issued a report which stressed the value of fundamental generalization in the field of science, considerable change and improvement in science courses resulted. A bulletin from the U. S. Office of Edu-


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culation shows that there has been a steady decline in the specialized sciences during the past 44 years; while another bulletin provides further evidence that astronomy, geology, botany, zoology and physical geography have almost been eliminated from the high school science programs, although Carleton believes that a counter-trend is indicated. Riddle reports that there has been increases in the percentages of enrollments in the general biology courses in high schools. Courses in botany and zoology are much less likely to place the emphasis on fundamental principles than is a course in general biology. Hunter and Spore assure us that the unified course in the biological sciences in the secondary schools is an absolute certainty. More recent findings show that biology is the most common science course in our high schools today.

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16 Forty-sixth Yearbook, op. cit., p. 223


That changes in behavior accompany learning was reported by Urban. A correlation between literature and biology and also between biology and art was Nixon's suggestion. When the principles of human growth relations is stressed in the study of biology, a change in racial attitude is effected is the finding of Subarsky. Martin made an important contribution to the investigations with his report on the purpose of stating and evaluating the principles of biology of value for general education.

These are only a very few of the recent research studies made in the field of biology and they are noteworthy in that the investigators agree with the viewpoints expressed by the National Society for the Study of Education in the Thirty-First and the Forty-Sixth Yearbooks.

METHODS USED IN SCIENCE EDUCATION

In no subject field in secondary education are changes and additions to knowledge and skills growing as they are in science. If bi-

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ology is to become more effective and meaningful and keep abreast with the advances in science which constantly affect our outlook on life, a biology teacher must be ever ready to change or add to his methods of teaching and use many techniques for the attack upon our problems.

There are many books which give helpful ideas and specific directions for experiences in biology. The biology textbooks of thirty years ago placed great emphasis on morphology and taxonomy, or, on structure and classification of organisms. The newer textbooks are far superior to the older ones in both subject matter and illustrations; much of their content is devoted to problems growing out of the relationship of living things to the environment. Much more attention than formerly is being given to genetics, eugenics, health, sanitation, prevention and elimination of diseases, and to the social aspects of biology.

The lack of sufficient equipment for large classes or poorly equipped laboratories has resulted, in most instances, with the lecture-demonstration method replacing the individual-laboratory method. Experimental investigation of lecture-demonstration versus individual-laboratory approach has revealed that for immediate retention of factual material in science the lecture-demonstration method is adequate.

28 Ibid., p. 128
While both Mallenson and Curtis favor the individual-laboratory method, they feel that the manner in which these laboratory exercises are carried out determine the effectiveness of the teaching. Fitzpatrick reports that the demonstration method of providing laboratory experience has come to be a common instructional device and the classroom tends more and more to become a laboratory. That motion picture films can be valuable in helping to attain the major goals of science instruction was reported by Ford while the Committee of Publishers recent study showed that science teachers were more prone to criticize films and had more difficulty in using them effectively.

Many other types of audio-visual aids have been investigated also. Brechbill compared the use of the microscope with that of the microprojector. Carpenter reported on the value of using re-

31 Francis D. Curtis, "Individual Laboratory Work Must Be Retained," Science Teacher, 17:63-64, April, 1950.
corded science lessons. The effectiveness of the opaque projector as an aid to science instruction was demonstrated by Stickler. For a better understanding of our environment and what shall be found there Hunter, Mann and Bruce advocate that field trips become a "must" in science education. Fitzpatrick feels that field study is recognized as a normal and desirable feature of secondary school sciences today. Henderson and Armacost stress the many possibilities of the use of radio in science classes. Draper believes that television, if wisely handled, can be a very effective tool both to direct science teaching and to provide wider background materials.

Most of the research investigations have been made on the basis that the major objectives of science teaching are the functional understanding of the principles of science which are valuable for general education, namely: the development of proper attitudes, and the training in skills of the scientific method. The increased interest in investigating the means of making science courses more practical has resulted in improving the quality of the investigations. It has placed greater stress on the procedures for determining student needs and on the procedures for filling such needs, thus enriching the biology program.

38 George W. Hunter, Paul B. Mann, Guy V. Bruce, "Biological Field Trips as an Integral Part of Science Education," The American Biology Teacher, 4:5-11, October, 1941.
40 Ibid. p. 146
41 Ibid, p. 149
CHAPTER III

OBJECTIVES OF BIOLOGY TEACHING

In the past hundreds of notable statements of what individuals or groups of individuals have professed to believe were the aims of education have been proclaimed. Most of these have been in terms of abilities of the individual to think clearly, to speak forcefully, and to get along with others. In more recent years the more notable statements have been formulated in terms of the functioning of the individual in certain stated areas of activity in which all or almost all individuals are certain to be called upon to function, thus serving the welfare both of the individual and society.

It will be observed that these statements are very similar to that of Spencer, who almost a half-century ago defined education as preparation for "complete living" which included activities of five principal categories in the following order of importance: (1) self-preservation, (2) rearing and discipline of offspring, (3) economic life, (4) social and political relations, and (5) leisure.

According to Whitehead education is the acquisition of the art of the utilization of knowledge and the best education is to be found in gaining the utmost information from the simplest apparatus.

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OBJECTIVES DEVELOPED
BY EDUCATIONAL ASSOCIATIONS

The category of aims of secondary education most widely accepted is the one announced by the Commission on the Reorganization of Secondary Education. These seven objectives, so often called "The Seven Cardinal Principles of Secondary Education," set forth by that group are: (1) health, (2) command of the fundamental processes, (3) worthy home membership, (4) vocation, (5) citizenship, (6) worthy use of leisure time, and (7) ethical character.

A report on the reorganization of science in the secondary schools was issued by a subcommittee of the aforementioned Commission. This report was the first comprehensive document to deal exclusively with the teaching of science in the secondary schools.

This report sought to show how science instruction could contribute to the cardinal principles of secondary education set up as objectives by the Commission; to bring some order to the science offerings of the high school; and to give practical help on the selection and organization of materials and on the teaching of science in the high schools. It had the beneficial effects of giving impetus to an emerging science sequence in the high schools, as well as pointing science instruction toward larger social goals than had been true previously. Some critics believed that the report tended to overemphasize immediate and practical goals to the exclusion of certain of the larger influences that the ac-

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cumulation of science knowledge had on our present civilization.

Inglis believed that there are three important groups of activities which require the participation of the individual and establish three fundamental aims for secondary education, as for all education, in America. Those three groups of activities are distinguished accordingly as they involve primarily: (1) participation in the duties of citizenship and in the not-directly economic relations of cooperative group life; (2) participation in the production and distribution of economic utilities; (3) the life of the individual as a relatively free and independent personality. Thus, according to him, the three fundamental aims of secondary education are: (1) the preparation of the individual as a prospective citizen and cooperating member of society—the Social-Civic Aim; (2) the preparation of the individual as a prospective worker and producer—the Economic-Vocational Aim; (3) the preparation of the individual for those activities which, while primarily involving individual action, the utilization of leisure, and the development of personality, are of great importance to society—the Individualistic-Avocational Aim.

A committee of the American Association for the Advancement of Science in 1927 issued a report entitled "On The Place of Science in Education." This report emphasized the importance of scientific thinking as an objective of science teaching; recommended that studies of a national scope on science teaching be set up; and urged that a field secretary be provided to assist teachers of science in the study of their problems.

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Douglass approached the problem of aims somewhat differently by listing the general outcomes of teaching and discussing the type of method best productive of each desired outcome. The outcomes of instruction treated in this manner by Douglass are: (1) the acquisition and imparting of information, (2) the retention of information once acquired, and (3) the acquisition of habits, skills, ideals, and attitudes. Although it is almost certain that any given classroom activity will contribute to more than one of the desired outcomes, Douglass makes it clear that in any classroom situation one objective will be dominant and that the types of treatment may be differentiated to satisfy the needs of the given situation.

After a careful study of printed addresses, articles in periodicals, and other written sources containing viewpoints on the purposes of secondary education which yielded a total of twenty-one objectives, Koos summarized them as follows: (1) civic-social-moral responsibility, (2) recreational and aesthetic participation and appreciation, (3) occupational efficiency and (4) physical efficiency.

Another influential report in science education was issued in 1932 by the Thirty-first Yearbook of the National Society for the Study of Education. It listed thirty-eight principles as guides in the selection of specific objectives for science teaching.

In the fall of 1932 the National Education Association appointed a

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committee to select the desired Social-Economic Goals for America. After careful study and consideration they selected the following ten: (1) hereditary strength, (2) physical security, (3) participation in an evolving culture, (4) an active flexible personality, (5) suitable occupation, (6) economic security, (7) mental security, (8) equality of opportunity, (9) freedom, and (10) fair play.

Umstattd chose the following as desirable objectives: (1) Physical health, (2) mental health, (3) fundamentals of learning, (4) development of special interests and abilities, (5) vocational efficiency, (6) wholesome recreation, (7) a sense of values, (8) good citizenship, (9) social efficiency, (10) a progressive social outlook.

The trend of teaching science for purposes of general education was further emphasized by a report published in 1944 entitled "Education for All American Youth."

OBJECTIVES DEVELOPED FOR SCIENCE TEACHING

Science must include the broad objectives of education. The general objectives of science teaching may be listed as: (1) to impart factual information, (2) to develop interests, (3) to meet immediate and future needs, (4) to develop skills and habits, (5) to develop knowledge and understandings, and (6) to develop attitudes and appreciations

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in the field of science.

In 1932, a bulletin entitled "Instruction in Science" was published as a part of the National Survey of Secondary Education. This report was based on observations in 14 cities over the United States and upon evidence obtained from the analysis of a large number of courses of study in each of the four high school sciences. This investigation showed a great lack of agreement in objectives, content, and method, among the science educators and the teachers of science. It also revealed that general science and biology were well established in the high school curriculum and were more progressive both in objectives and methods than the older sciences of chemistry and physics.

A report entitled "Science in General Education" was issued by the Commission on Secondary School Curriculum of the Progressive Education Association in 1938. This report advocated that science in the secondary school be taught around broad areas of living such as (1) personal living, (2) immediate personal-social relationships, (3) social-civic relationships, (4) economic relationships, (5) the disposition and ability to use reflective thinking in the solution of problems. This report traced the implications for science teaching in each of these proposed areas of living.

The National Committee on Science Teaching of the Department of Science of the National Education Association, after three years of study, issued a series of reports in 1942. Two of these reports were concerned with the changed emphasis in the teaching of science in Amer-

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These were entitled "Science Teaching for Better Living" and "Redirecting Science Teaching in the Light of Personal-Social Needs." These reports were important because they were prepared by Committees of Science Teachers and were participated in by many other science teachers over the country. The reports advocated somewhat the same point of view as that of the Progressive Education Association report mentioned previously, however, they went farther in suggesting that pupils have science needs in such areas of living as safety, conservation, health, and vocation.

In 1947 the National Society for the Study of Education published its Forty-Sixth Yearbook entitled "Science Education in American Schools." This report stresses the importance of science taught for its functional value in aiding the adjustment of individuals and set the major objectives of high school biology as: (1) to develop functional understandings of biological principles, (2) to develop scientific attitudes, and (3) to develop an understanding of the importance of the scientific method, and facility in its use.

In a recent survey, Watson and Cohen found that four objectives

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are stated repeatedly. They may be summarized briefly as follows: 
(1) to acquaint the student with the scientific habit of thought and to encourage his using it in attacking problems of everyday living; (2) to give an understanding and appreciation of the development of science as one of man's great intellectual and cultural achievements; (3) to impart sufficient knowledge of man's physical and biological environment to enable the student to function intelligently in relation to it; (4) to disclose the impact of science and technology on contemporary life and to interpret some aspects of the social problems that arise from it.

OBJECTIVES DEVELOPED
BY AUTHORS OF BIOLOGY TEXTBOOKS

Objectives of secondary education and the objectives for science teaching can be applied to the teaching of biology.

The following objectives listed by several of the better known authors of biology textbooks show that they have followed the suggestions and recommendations set forth by the literature, surveys, reports, and authoritative committees which has been published in recent years.

In his book, *New Introduction to Biology*, Kinsey[20] lists four objectives: (1) to create an interest in the living world, (2) to give the student an idea of the unit of the life processes in plants and in animals, (3) to teach the scientific method, and (4) to have respect for observation.

George Hunter,[21] in his book *Problems in Biology*, advocates:

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(1) a better understanding of our health, (2) conservation of our natural resources, (3) the acquiring of vocational knowledge, (4) a more worthy use of leisure time, (5) an understanding of the laws of heredity, and (6) developing character.

Baker and Mills, in their text, Dynamic Biology, have as their objectives: (1) to learn that life forms are greatly affected by the environment, (2) to get a general picture of the distribution of life forms upon the earth, (3) to learn important definitions and to understand the relationship of biology to other fields of learning.

The interest concept, a type of pioneering in biology textbooks, was developed by Bush, Dickie, and Runkle in A Biology of Familiar Things. They stress two major objectives: (1) to acquaint the student with the study of life, growth, and improvement, and (2) to show the interdependence of plants, animals, and human beings.

In Biology and Human Affairs, Ritchie lists his objectives as: (1) to understand our place in nature and how to live in harmony with nature, (2) to control our environment and to make the world a better place in which to live, and (3) to serve as an approach to the problems of human relationships in a scientific spirit and to see these problems in a scientific light.

Smallwood, Reveley, Bailey and Dodge stress practicality,
simplicity and interest in their book, *Elements of Biology*, their objectives being: (1) to make biology a vital, human subject, (2) to focus on the everyday interests of young people in the everyday world, and (3) to give the pupil a conception of science as a living subject highly important to human welfare.

Curtis and Urban in their book, *Biology in Daily Life*, have set their objectives as: (1) to develop functional understandings of biological principles, (2) to develop scientific attitudes, and (3) to develop an understanding of the importance of the scientific method, and facility in its use.

Kroeber and Wolff in their book, *Adventures with Animals and Plants*, list their objectives as: (1) to stress the importance of studying living things, (2) to make it possible for us to avoid many diseases, (3) to provide more and better food, and (4) to help us to understand ourselves better.

Moon, Mann and Otto in their book, *Modern Biology*, lay stress on the following objectives: (1) to become familiar with living things, (2) to understand the basic principles of life, (3) to acquire scientific methods, (4) to appreciate conservation of natural resources, (5) to improve general health standards, (6) to provide opportunity for recreation, (7) to acquaint the student with some of the outstanding biologists, and (8) to acquaint the student with biological occupations.

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In Exploring Biology, Smith sets her objectives as: (1) to help the student master the few big principles of biology instead of the facts of botany and zoology, (2) to show the importance of these principles in the everyday problems of living a healthy, well-rounded, useful life.

As has been previously stated, the objectives of secondary education are many and varied; the same is true of science in general and biology in particular. In the past the primary interest was in the subject matter being taught not the students, but changes in the objectives show a definite trend away from the stressing of subject matter to a more practical point of view with emphasis on the social and economic aspects of human welfare. Since objectives serve the purpose of defining the goals of biology, they cannot be accomplished by the subject matter of biology, itself, but rather through the manner in which that subject matter is taught. The foregoing objectives show a definite effort is being made to provide experiences selected to meet pupils' needs and to further enrich the biology course by helping it to keep pace with the changes in modern life.

CHAPTER IV

CONTENT AND ORGANIZATION OF
THE BIOLOGY COURSE

Content of the biology course should be based on the objectives of biology. The selection and organization of the content should depend on the objectives. Since subject matter is no longer the primary goal of the biology course then variation and sequence is the core of the problem.

In 1905, New York issued a syllabi for high schools which contained a unified course in biology, upon which most of the earlier biology textbooks were based. These particular textbooks had a tripartite organization of units of botany, zoology and human physiology. The content was solely college preparatory and it was assumed that subject matter acquired, irrespective of the method of learning it, was of the utmost importance.¹

George Hunter published the first biology textbook in the United States.²

General biology came into the science curriculum at about the beginning of this century. It developed chiefly in response for an introductory course which would make possible an integration of materials selected from various biological courses. It was hoped that such

a course would afford a satisfactory orientation in the field of the biological sciences, a purpose which the introductory courses in botany, zoology, physiology and hygiene had failed to fulfill. It was vigorously opposed by many administrators and subject-matter specialists in high schools, and especially in universities and colleges. It has thrived because of a growing conviction of its merits and now has firmly established its place in the science curriculum.

CONTENT SUGGESTED IN YEARBOOKS

The content of the course in biology is less clearly defined than that of any other course in the science curriculum for the secondary school. 3

An investigation by Finley 4 showed that when botany, zoology and physiology were taught in place of biology, the major emphasis was placed upon the anatomy, morphology, and classification of plants and animals because they lent themselves so well to laboratory work. But since the aim of biology teaching in our secondary schools has changed from "biology for the sake of biology" to "biology in relation to human welfare," the stress is now placed upon the practical, ecological, economic and human welfare aspects of biology.

It is very fortunate that the choice of the subject matter of high school biology has not been standardized and crystallized in the same manner as the subject matter and content of physics and chemistry courses. 5 This allows plenty of opportunity for freedom in the selec-


5 Thirty-first Yearbook, op. cit., p. 239.
tion of elements and materials with which to effect the accomplishment of the major goals of teaching biology.

In 1932 the Committee on the Teaching of Science listed the following principles as a selection of the knowledge content of the biology curriculum based on objective evidence of the life needs of the average person:

I. Energy cannot be created or destroyed, but merely transformed from one form to another.

II. The ultimate source of the energy of all living things is sunlight.

III. Micro-organisms are the immediate cause of some diseases.

IV. All organisms must be adjusted to the environmental factors in order to survive in the struggle for existence.

V. All life comes from previously existing life and reproduces its own kind.

VI. Animals and plants are not distributed at random or uniformly over the surface of the earth, but are found in definite zones and in local societies.

VII. Food, oxygen, certain optimal conditions of temperature, moisture, and light are essential to the life of most living things.

VIII. The cell is the structural and physiological unit in all organisms.

IX. The more complex organisms have been derived by natural processes from simpler ones, these in turn from still simpler, and so on back to the first living forms.

These principles may be regarded, then, as a series of more immediate or specific objectives under the major objective, knowledge. Instructional units may well be formulated that will afford such a mastery of one principle or of a group of closely related principles as will insure their use in solving life's problems when the need shall arise.

The Committee suggested that the biology course be based on (1) an understanding of most, or if possible all, of the foregoing prin-

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6 Thirty-first Yearbook, op. cit., p. 224.
7 Ibid., p. 229.
ciples so that the student will be able to apply them to the solution of such problems of a biological nature as will arise in his life; (2) an appreciation of some of the scientific attitudes exemplified in the work of great biologists and a sense of the lawfulness of nature and of every man's obligation to obey such laws and other similar emotionalized standards; and (3) a reasonable degree of skill in the use of the scientific method of thinking on matters biological, so that the student will not go astray in his attempt to think through to a logical conclusion the biological problems with which he will certainly be faced.

The Committee also suggested that the work of biology be organized into definite teaching units. A unit is a relatively small part of learning material, so selected and organized as (1) to clarify a principle and afford abundant drill in its application to life problems, (2) to contribute to the attainment of scientific attitudes, and (3) to give abundant practice in the use of the elements and safeguards of scientific thinking.

These suggestions of the Thirty-first Yearbook resulted in considerable change and improvement in biology courses. However, it is very possible to "teach" a major generalization without making it functional. A student may be able to state a principle correctly and to answer questions about it, but if he does not use it in life situations, then he has not really learned it. The present state of personal and community health and the amount of prejudice and intolerance in the world today show the inadequacy of the materials taught and learned in

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8 Thirty-first Yearbook, op. cit. p. 238.

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biology classes.

Since 1936 the trend has been toward focusing less attention on the content and organization of subject matter and placing more emphasis on the results in the lives of the learners. With this type of thinking in mind, the Forty-sixth Yearbook suggests that biology courses include materials related to:

1. Health (personal and public, including physical fitness, food and nutrition, disease, safety, mental health, etc.).

2. Reproduction, heredity, and the effect of the environment (as related to personal and social problems, individual and group differences, improvement of living organisms, etc.).

3. The conservation of living things.

4. The structure and functions of living things, especially of the human body.

5. The conditions necessary to support life, and adaptations of living things.

6. Living things of the past, and the changes that have occurred.

7. Relations between individuals, between groups, and among living things in general.

The above items certainly do not exhaust the possibilities and are far too general to serve as a guide to the teaching of subject matter. If we are to assume that all learning should contribute to scientific attitudes, the use of the scientific method, and in developing a philosophy of life, then these items may suggest some of the problems and situations in which biology may help.

As has been previously stated, the selection and organization of content for a course in high school biology should be the means of achieving the major objectives of biology teaching. Since the logical develop-

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10 Ibid.
11 Ibid.
12 Ibid.
ment and mastery of the subject matter of biology is not of itself a primary goal, and since in any event the field is too broad to be covered adequately in the time provided in school, then it follows that considerable variation in topics covered and in the order of topics will be legitimate and desirable, as circumstances vary.  

CONTENT FOUND IN COURSES OF STUDY

The following is a summary of the Washington State Course of Study for Biology.

The objectives of this course of study are: (1) to help the student develop an imaginative and observing mind, (2) to develop unprejudiced habits and attitudes, (3) to furnish a background of knowledge that will help him in the recognition of and solution of his own physical, mental and social environmental problems, (4) to foster an appreciation of plant and animal life, and (5) to supply him with experiences enabling him to make wiser choices in vocational and recreational pursuits.

Functions of organisms should be stressed rather than structure and as many practical applications should be introduced as can be completed satisfactorily. Field work in the local community, experiments and demonstrations are all important phases. It is especially important that health instruction in biology be coordinated with that taught in other classes in the high school.

The following are the general topics to be stressed wherever appropriate applications can be made throughout the course: (1) physical and mental well being, (2) economic and recreational biology, and

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13 Ibid.
(3) conservation of human and natural resources.

The body of the course is divided into six large unit topics, each with many subtopics which allow for complete coverage and variations.

UNIT I
Cells: Units of Structure and Function in Living Things
   I. Cell Structure.
   II. General Functions of All Cells.
   III. Kinds of Cells.

UNIT II
Nutrition and Health of Living Things
   I. Plants as Food Factories.
   II. Animals as Food Consumers.

UNIT III
Growth and Reproduction of Living Things
   I. Plants.
   II. Animals.

UNIT IV
Behavior of Living Things
   I. Responses of Plants and Lower Animals.
   II. Animals with Central Nervous Systems.

UNIT V
Heredity and the Improvement of Living Things
   I. Agricultural Advancement.
   II. Laws of Heredity.
   III. Human Applications.
   IV. Disease Prevention and Control.

UNIT VI
Interrelations of Living Things and Their Environment
I. Relation to Physical Surroundings.
II. Interdependence of Plants and Animals.
III. Balance of Nature.
IV. Conservation of Natural Resources.

The following is a summary of the Oregon State course of study for biology.

The objectives of the biology course are listed as: (1) to develop an increasing sense of personal responsibility for the student's own health and the health of his community, (2) to develop an interest and an appreciation of their natural surroundings, (3) to develop an appreciation of the contributions of biology to modern life, (4) to develop an understanding of those biological principles which are necessary for effective social adjustment, (5) to discover the vocational possibilities of biology, (6) to develop skills in observing and interpreting biological phenomena, and (7) to develop those activities which will promote worthy use of leisure time.

The course is divided into seven units. Each unit is built about a major generalization of science and are so arranged that the teacher may follow the order of units best suited to the particular situation rather than the order in which they are listed.

Unit 1. Exploring the World of Life.
Unit 2. Living Food Factories.
Unit 3. Living Chemical Laboratories.
Unit 4. Why Living Things Behave as They Do.
Unit 5. How Life Goes On and On.

Unit 6. You and Heredity.

Unit 7. Conservation of Life.

It is suggested that this biology course be developed around the practical aspects of daily living and that the teacher: (1) use live materials, (2) use familiar organisms---local flora and fauna, (3) avoid emphasis on technical terms, (4) use varied methods, techniques, and content, (5) explore and experiment with students, (6) use seasonal materials, (7) emphasize the consumer aspects of life, (8) emphasize health when it comes naturally in the content being studied, (9) keep in mind the nature of the learner and use the psychological approach, (10) seek to develop an understanding of the major principles of life, and (11) strive to realize the objectives of science instruction.

In reviewing the content found in these courses of study, it is to be noted that they have followed the suggestions of the Thirty-first \(^{16}\) and Forty-sixth \(^{17}\) Yearbooks in the stressing of the practical, ecological, economic and human welfare aspects of biology. Both courses allow the teacher freedom of choice in selecting the particular unit, materials and methods to be used in teaching it.

CONTENT FOUND IN TEXTBOOK

TABLE OF CONTENTS

The following is a listing of the contents of two of the more widely used of the biology textbooks:

BIOLOGY IN DAILY LIFE


\(^{16}\) Thirty-first Yearbook, op. cit., pp. 114, 224, 229, 234.

\(^{17}\) Forty-sixth Yearbook, op. cit., p. 184.
UNIT SEVEN - LIFE CONTINUES FROM AGE TO AGE

16. Types of Reproduction 428
17. Life---Past, Present, and Future 465

UNIT EIGHT - KINDS OF LIFE

18. The Invertebrates, or Animals Without Backbones 513
19. The Highest Group of Living Things 537
20. The Four Great Groups that Make Up the Plant Kingdom 554

AS SCIENTISTS WORK: ELEMENTS OF SCIENTIFIC METHOD 570
AS SCIENTISTS THINK: SCIENTIFIC ATTITUDES 571
GLOSSARY 573
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Biology in Daily Life was selected because its authors Francis D. Curtis and John Urban have had many years of teaching, supervising high-school classes in biology, and of working with teachers of the subject. Mr. Curtis is Head of the Department of Science at University High School, Ann Arbor, Michigan, and Professor of the Teaching of Science, University of Michigan, and also a member of the National Society for the Study of Education. Mr. Urban is Professor of Science at New York State College for Teachers, Buffalo, New York. Both these men realized that a modern course of biology must serve the needs of two important groups of pupils: those whose formal education will terminate before or upon the completion of their high-school work, and those who will continue their schooling through college.

The biological materials of greatest interest and value to the members of the first group are likely to be of optimal appeal and worth, also, to those of the second group. The latter group, however, must
secure, in addition, a foundation of biological knowledge sufficiently broad and complete to enable them to continue, without handicaps, their study of biology in college.

The content of their book and its organization and methods of presentation are planned to serve the needs of both these groups of pupils. In selecting the content, the authors state that they have taken care to ensure that the requirements of various state and city syllabuses are adequately met.

The authors of this text believe that in order to attain the major objectives of high-school biology, as announced by authoritative committees, the materials must be specially designed to effect them and must be taught directly.

In their book, therefore, such materials are presented definitely, persistently, and diversely.

MODERN BIOLOGY


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Modern Biology was chosen because it is a text for the beginner. It is designed for the pupil of secondary school level who has had no previous experience in the scientific study of plants, animals, and man. It combines the best features of type, systematic, and principles courses. Organisms presented as types provide the pupil an opportunity to study a complete plant or animal and the interrelations of its organs and life activities. In this way, the pupil deals with the unit of life. Systematic study of plant and animal groups shows the relationship of living things, the development of life through various stages of complexity, and the wide variety of organisms which compose the living world.

The study of principles is accomplished largely by the inductive approach. The pupil determines facts relating to the structure, functions, behavior, and adaptations of living things. These facts lead him, through generalization, to an understanding of principles. The authors do not center the course on the study of principles and reduce the study of plants and animals to broad illustration of these principles. Nor do they expect the pupil to generalize in the abstract comparison of life forms from an assumed background of knowledge which he rarely pos-
sesses. Rather, the pupil pursues his study of biology as a science and in the way in which he would learn in the out-of-doors. There, plants and animals are obvious; biological principles are hidden.

The pupil begins his study with a brief history of biology and the development of the scientific method. Modern Biology thoroughly discusses the basic characteristics of living things, the life processes, and the chemical and physical basis of life before any specific organisms are considered. Likewise, the pupil studies the interrelation of all living things before he deals with any particular life forms. This sequence provides a biological background for the study of various plant and animal groups. The units dealing with disease, genetics, and conservation are placed after those which deal specifically with plants, animals, and man. Thus, the pupil enters these more advanced phases of biology with an extensive background of the life forms involved.

Recognizing the reading problems of many high-school pupils, the authors have simplified the vocabulary wherever possible. The sentences and paragraphs are short. Words having important scientific meaning are printed in boldface type.

From the findings it is concluded that the content found in yearbooks, courses of study and textbooks show that the subject matter of the biology course is not so standardized as to offer any great limitations but allows freedom to cope with the everyday problems that arise from time to time. No longer is the emphasis placed upon anatomy, morphology and classification of plants and animals but rather on increased interest in meeting pupil’s needs in the social and economic problems of human welfare.
CHAPTER V

MODERN METHODS AND PROCEDURES IN TEACHING BIOLOGY

Methods and procedures are guided by the principles of educational psychology. These principles must be adapted to all teaching in general and to biology in particular. It is questionable whether or not the content of a course can be separated from the teaching methods employed or whether the changes in the method of teaching have brought about changes in the curriculum. The newer methods tend to guide the science experience of students more directly toward the objectives of science instruction.

The fundamental point of view regarding secondary education in a democratic society has evolved slowly and concomitantly with the evolution of the common man; the curriculum for the attainment of this ideal is still in the process of development.¹ Our heritage of secondary education should aid us in finding solutions to our curriculum problems and should guide us in making decisions that involve important principles of action which have been tested through centuries of experience.

TEXTBOOK METHOD

There are widely divergent points of view on the place that textbooks should hold in education, but today there is hardly any secondary-school situation in which textbooks are not used. In many schools,


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there is no influence that does more to determine what is taught. This situation has long existed and still continues in general practice. Lampkin's study asserted the influence of the textbook: "Textbooks powerfully influence the scope, sequence, and methods of instruction."

Caswell and Campbell found that the scope of work in American schools is determined by the content and organization of textbooks.

A recent report from publishers stated that textbooks are the most universally used teaching aid and are taken almost too much for granted.

Observation indicates that textbooks provide the most common method of teaching biology. Large numbers of teachers are influenced by the teaching procedures suggested in the textbook prefaces and Chapter-end exercises. Workbooks, laboratory manuals, printed subject matter tests, and teacher's manuals that accompany textbooks also provide inservice teacher education. In many cases today, the textbook and its accompanying publications constitute the most important source of inservice training in methods of teaching. Therefore, it may be expected that textbooks which recognize persistent life situations should influence practice in the direction of more attention to the objectives of biology teaching.

It is probably true that even today there are many places where the textbook is the course in biology and where learning consists largely of


5 Ibid., p. 131.
reading the text and reciting its content back to the teacher. Properly used, the textbook may become a very important part of a course in biology. When a single basal text is the only reference source, there is, of course, the danger that the pupils will come to think of the text as the only source of material and will thus have a distorted conception of its true value. In many schools sets of textbooks in biology are being provided and rather than following a single text slavishly, students are encouraged to seek widely in several sources for the information that will help them solve their problems. This plan makes for better learning habits on the part of the pupil.

In spite of the recognized abuses of the textbook method, there is no doubt but that it will continue to be an important method of learning in biology classes for many years to come.

LECTURE METHOD

It has been long recognized that teachers usually teach as they were taught. This tendency introduced the lecture method into the secondary school at an early date. For many years this was practically the only method of teaching biology.

In the use of the lecture method the teacher develops a topic in biology more or less from a logical organization. It is a common practice to supplement this method with demonstration and visual aids or to have the students participate in the lecture either by giving a part of it or by doing experiments and demonstrations from the demonstration table.

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7 Ibid., p. 158.
The chief advantage of the lecture method is that it provides an efficient means of covering the subject matter and more or less insures that the students will receive the material in a concise and logically organized manner. The greatest disadvantage is that the lecturer is usually the only active participant in the process, while the student is a passive recipient of information. In such a situation little responsibility for learning may be assumed by the student.

After much study of this type of teaching method, Preston lists the following points. The strong points are: (1) it is cheap, (2) it requires no special apparatus, (3) it is suited to any size class, (4) it can cover more ground in a given time than any other teaching method, and (5) it usually involves less preparation on the part of the teacher than does other types of work. He lists his weak points as: (1) there is no assurance that the pupils are attentive and are receiving what is given; (2) there is no assurance that what is received is understood; (3) the rate may be too rapid to allow the student to get the necessary connection or thought; (4) students are unskilled as listeners; (5) students are passive recipients, not active participants; (6) there is minimum stimulation to critical evaluation with the emphasis on content retention above everything else.

It should not be inferred from this discussion that the lecture method is essentially obsolete. There are many instances in modern teaching where this method may be used to advantage, such as in opening up a new unit for study or in summarizing principles at the close of a unit. It may also be used for giving information bearing on the solution of problems or where for economy of time it is necessary to cover a given area rapidly.

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Whenever the need for using this teaching method arises, the teacher should make careful plans to see that the materials are interesting and well organized and that the ideas presented are clear cut.

UNIT PLAN OF ORGANIZATION

Many of the experts believe that the unit method of teaching is the best means of individualizing instruction in any class, especially the larger ones.

A unit should be developed around a major concept generally acceptable to biologists. The unit should ask a major question in a deductive manner. The major question will be followed by a number of minor concepts, in question form, called problems, which when answered will contribute greatly to providing the answers to the larger unit question. The "things to do" possibly labeled "topics" will be stated in a positive manner. These will consist of experiments, minor reasoning exercises, reading motivator project suggestions, and drill materials. Many of the topics will be labeled as optional. These might well include such verbal directions as "draw," "collect," "observe the experiment and report your conclusions," "inquire," "visit," etc. and provide opportunities for students with special talents to expand their studies in line with their particular interests.

In attempting to determine the attitude of pupils toward the unit plan of teaching, Billet concluded that boys and girls of all levels of academic intelligence, accomplishment, and application, regardless of the subject, consider the unit plan as a distinct improvement over the

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traditional recitation procedure.

LABORATORY METHOD

Many investigators and writers have set the laboratory technique up as the one in which there is maximum pupil activity and thus where the potentialities for learning are high. It is not a method that may be used exclusively but rather in conjunction with other techniques where it may become a very effective means of collecting evidence in the solution of problems. The laboratory should be a place where a student may take a question or a hypothesis and then test them under controlled conditions. All too often laboratory work degenerates into mere busy work on the part of the students. Laboratory directions are followed slavishly and without thought and there is little evidence of controlled experimentation.

If the laboratory method is to produce its maximum effectiveness it must be planned, directed, and controlled by the teacher with as much care as possible. There are times when the use of laboratory directions may be a greater hindrance than help. Often fruitful laboratory work follows a discussion where likely hypotheses for the solution of a problem are proposed and considered. Here pupils plan cooperatively with the teacher in devising ways of testing a given hypothesis and controlling factors, thus making their own directions.

The Thirty-first Yearbook of the National Society for the Study of Education summarizes the things that laboratory instruction should accomplish as follows:

(1) The development of simple laboratory techniques,
such as weighing, glass bending, microscopic manipulation, etc.

(2) Proving and establishing for the pupil himself principles which have long since been well established and generally accepted.

(3) Using the laboratory as an instrument for object or "thing" teaching, according to the historical concepts of Pestalozzi, Comenius and Basedow.

(4) Using the laboratory for the purpose of developing better understanding and interpretations of the principles of science, as a means of better illustration.

(5) To produce training in the scientific method.

(6) As a means of possible training in the experimental solution of the pupil's own problems.

(7) The use of the laboratory as a workshop for the study of science problems which arise in the science class or in the life of the pupil.

Under proper guidance and supervision the laboratory method can yield much in training for the development of skills and techniques and should produce tested evidence upon which the pupil may base his conclusions.

**INDIVIDUAL METHOD**

Under the impetus of the measurement movement, educators in general have become conscious of individual differences and have sought ways of providing for these in the classroom. Science teachers along with others have been active in devising plans which would permit a student to progress through the work of a course at his own rate. In most of these plans the student has assumed the responsibility of his own learning, and this is a laudable point. However, when the individual plan is used in the extreme, many socializing values of discussion and group work are lost.

Recently this extreme individual plan has been modified in most

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13 *Heiss, op. cit.*, p. 163.
schools, and the trend now seems to be toward the Dalton or small group plan. In this particular plan the teacher opens up a new area of investigation, and the class then organizes into small groups to investigate the various problems which have been defined. Each group selects a group leader who becomes responsible to the teacher for the work of the group. These groups carry on whatever activities seem valuable for the solution of the problem at hand. From time to time the class is assembled by the teacher for general instructions or for hearing progress reports from the various groups. In the use of this plan, basic readings on the entire unit are generally required of all pupils. At the close of the unit the class assembles to hear the group reports, see important demonstrations, moving pictures, slides, etc., and take part in the discussion and organization of the materials. In such a plan the subject matter usually becomes the means to the end of solving problems and many opportunities are presented for instructing the pupils in good techniques of problem solving.

PROJECT METHOD

This method consists chiefly of building a comprehensive unit around an activity which may be carried on in the school room or outside. Some of the projects which may be carried on in the school room may be the hatching of chicks, around which an extensive unit on foods, heat, physiology, and other areas may be built; the construction and maintenance of an aquarium and a terrarium about which the biological and natural principles may be taught; the growing of plants in the seed box, and the like. Projects which may be carried on out-

14 Ibid., p. 164
side the school room may be caring for certain domesticated animals, the growing and maintaining of a garden, a forest nursery including work in reforestation, and maintenance of homes for birds and bird feeders. Projects of this kind serve as vital experiences around which fundamental biological information and concepts may be learned.

A disadvantage in the use of this method is the difficulty in achieving efficient organization of instructional materials which will eliminate confusion and time-wasting on the part of the students. Another disadvantage is the difficulty and inconvenience resulting from the care and maintenance of these projects, especially care of domesticated animals and maintenance of a garden. It often ties down the teacher to the ultimate completion of the projects as students frequently lose interest and neglect to fulfill their responsibilities as the unit develops.

The popularity of this method of teaching was shown in a recent bulletin which reported that 68.3% of our high schools maintained projects in biology classes.

**CONTRACT PLAN**

This method consists chiefly in the preparation of contracts of work on two or more different levels which may vary in quality, quantity, or both. These levels are usually designated as A, B, and C contracts; the A contract referring to the minimum or lowest amount of achievement, the B and C respectively requiring greater amounts of activity and study. The student chooses at the beginning of the unit the

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contract he wishes to complete. This plan obviously helps to care for individual differences in ability and interest on the part of the pupils. 18

One disadvantage attached to this method is that certain pupils tend to align themselves with a certain contract and continue to execute these same levels of contracts even though they have the ability to do the tasks required of more extensive amounts of work. Of course, a teacher can use his influence to encourage pupils to undertake the contracts which are more in keeping with their ability. A second objection to this plan is the lack of flexibility usually attendant with a single contract. When the specified amount of work is done as outlined, provisions are generally made for additional and enriched experiences, and activity ceases upon the completion of the prescribed activities.

DEMONSTRATION METHOD

This method has proven to be very effective as a device for developing understanding in the pupil for facts, concepts, and principles. 19 Used in conjunction with the lecture it may very well become a most efficient method of covering a given section of content in a limited time. It has the advantage of being easily adapted to a logical development of content when the teacher so desires.

The demonstration method has been attacked on the grounds that the pupils are so often passive when it is used rather than active as they would be in the laboratory. 20 But if the teacher assigns demonstrations or part of the demonstration to be done by the pupils, this disadvantage can be overcome to some degree. Pupil participation

20 Hoff, Op. cit., p. 188.
requires that the pupil assemble the materials and try out the demonstration before the class period begins.

This method of instruction need not be one where pupils merely watch and listen. If the teacher uses an inductive approach to the solution of a problem, the demonstration lesson may be so planned that it functions as a controlled experiment. Often much valuable discussion may be directed to the setting up and working of a demonstration experiment.

Many teachers like to use the so-called "silent demonstration" as a means of developing the student's skill in accurate observation, recording data, interpreting data, and formulating conclusions. In this method the teacher or student performs a demonstration and allows no discussion until all the observations have been made. A discussion period then follows which is directed to the recording of observations, the interpretation of the data, the formulation of hypotheses, and perhaps further testing.

As a method of illustrating applications of principles, the demonstration method is excellent. After a certain principle has been studied, as many devices as are available for showing the practical applications of the principle are assembled. Here again students may participate in doing some of the demonstrations.

The principal advantage of the demonstration method is the fact that the teacher is in control of the situation and can see to it that the pupils make all the essential observation. This is often difficult when the laboratory method is used.

There have been innumerable studies which compared the lecture-demonstration method with the individual-laboratory method. Noll

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has made the following summary and conclusions of these studies:

(1) that some time and money can be saved by the lecture demonstrations, although just how much of a saving can be effected has never been carefully established;

(2) it has been shown rather clearly by a few investigations that individual laboratory work produces certain results in the pupil more efficiently and more permanently than the demonstration does;

(3) no careful student of the problem would advocate the discarding of either method on the basis of present evidence;

(4) the choice of which method to use depends on the total situation in which it is to be used.

AUDIO - VISUAL AIDS

Audio-visual materials have had a place in classrooms and instructional techniques for scores of years; some were used in man's earliest efforts at instruction. Scientific developments have greatly increased the number of kinds of teaching tools, and equipment is not so limited as it once was.

Today the purpose of teaching, basically, is to arouse the pupil and to direct his behavior into channels which are desirable, such as the development of proper skills, useful habits, conceptual understandings, acceptable attitudes, personal appreciations, and critical mindedness. The philosophy of audio-visual education accepts this tenet and holds that audio-visual materials validate the principle.

As has been previously stated in Chapter III, many studies have been made on the effectiveness of using audio-visual aids in the teaching of biology.


24 Ibid., p. 143.
Ford reported that motion picture films and slides are invaluable in teaching biology, while Brechbill stressed the use of the microprojector and Carpenter the value of tape recordings. The use of the opaque projector as an aid to biology teaching was demonstrated by Stickler. Charts, graphs, and diagrams may be used as part of a health exhibit in a unit in biology; still pictures, displays, diaramas, models, maps and mock-ups can be used effectively in a unit on conservation of natural resources. Exhibits and museums have great value in attracting students to "look and learn."

Henderson and Armacost found that radio offered many possibilities in teaching biology. It can present science specialists in interviews or panel discussions; or the program might be a dramatization of some highlight of science. There are a great many science programs being broadcast and while they are not always on the air during the biology period or even during school hours, tape recordings


30 Ibid., p. 393.

are available by writing the network where the program originated or to the U. S. Office of Education. With the use of the tape recording the program can be used at the proper time. The use of radio cannot displace the teacher, but it can reinforce, complement and strengthen the teacher's efforts.

Draper\(^{32}\) reports that if wisely handled television can be a very effective tool to direct biology teaching and provide wider background materials. It is admirable suited to "show how" things are done. It can use the "close-up" very effectively and can magnify any of the objects being viewed. Many biological and other laboratory procedures can be well demonstrated to classes by means of television. At the present time there are any number of good science programs being presented on commercial networks and local stations. Several of the producers of these programs make available to teachers, well in advance, a list of the subjects and copies of the script. With this material on hand prior to the telecast, teachers are able to provide pupils with background materials, to stimulate further study, and after the telecast, to conduct question and answer periods.

FIELD TRIPS

A field trip is a school journey to a particular place outside the regular classroom.\(^{33}\) It is an effective technique for teaching if handled skillfully.\(^{34}\) Plans for these trips must be very thorough and definite in order to avoid confusion and waste of time. A field trip should be correlated with the unit the class is studying, and a thorough background for this experience should be prepared before the event takes

\(^{32}\) Ibid., p. 145.
place. It is a good idea to prepare in advance, with the help of the
class, a list of questions or items to be observed. After the field
trip has been completed, a comprehensive discussion should be held
in order to fix and unify the experiences which the students have had.
If possible, this discussion should be conducted during the tour or as
soon as possible afterward. The conduct of the students and their safe
transportation to and from the school is the responsibility of the teac-
cher. For a better understanding of our environment and what shall
be found there Hunter, Mann and Bruce advocate that field trips are
a "must" for biology classes. Fitzpatrick feels that field trips are
recognized as a normal and desirable feature of biology classes.

Dale has worked out a very detailed plan for successful field trips. Hoff has listed the advantages and disadvantages of these excursions. Other important tips can be had by reading Heiss.

BIOLOGY CLUBS

Biology clubs provide an opportunity for pupil activity, training
in leadership, and self-expression. They represent freedom and
expression where the classroom represents conformity and repression.

36 George W. Hunter, Paul B. Mann, Guy W. Bruce, "Biological
Field Trips as an Integral Part of Science Education," The American
Biology Teacher, 4:5-11, October, 1941.
37 The Bulletin of the National Association of Secondary School
42 H. C. McKown, School Clubs, (New York: The MacMillan Co.,
These clubs should be formally organized and must have interesting and varied programs. From the social point of view, the club fosters school spirit and loyalty to the school and the group, develops cooperation and permits the spirit of service. Opportunities for advanced and extended study in various fields may be provided through club organization. Many areas of biology cannot be studied in high school because of the limited abilities and interests of high school pupils. Students often are capable of doing extended study in biological areas which cannot be conveniently studied in the classroom. For those students who are disposed to further study, the club may help to provide this need. This opportunity for pursuing special interests by selected individuals helps care for individual differences in the biology program. Biology clubs make it possible for interested pupils to do considerably more than may usually be accomplished. Also, they help to show the teacher what students can and will do. Data concerning biology clubs showed that they were effective in stimulating the interest of the pupils in all community types and regions. A recent survey on biology clubs reported that 33.5% of our high schools had one or more biology club. The 66.5% having no clubs gave the following reasons: (1) lack of tea-

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45 "The Teaching of Biology in Secondary Schools of the United States," A Report of Results from a Questionnaire, Sponsored and Published by the Committee on the Teaching of Biology of the Union of American Biological Societies, 1942.
cher's time, (2) lack of facilities, (3) lack of pupil interest.

EVALUATION

Evaluation is an integral part of the total instructional process because it provides data by means of which to determine initial status or readiness for learning, progress and difficulties in learning, final attainment, and extent of retention and transfer. 47

Testing and evaluation in high school biology go on at three levels. The first level is the regular succession of marking periods in which the teachers use their own devices in obtaining grades on which to base an estimate of a pupil's rank in a class. If adequate pre-testing has been done, they may also show pupil growth in the acquisition of facts, concepts and skills. 48 Short objective or essay tests, recitations, "papers" done on assigned reading, notebooks or workbooks, and laboratory exercises all contribute to the grade. Few commercial tests are used. 49

The second level of evaluation is typified by the project, enterprise, community research or activity, science fair production, set of visual aids, (as pupil-made slides), or by the solution of a real research problem in biology. 50 All these may take weeks or even a semester. Achievement of this nature is often "figured into" the grades on tests of the first level. Often times the amount of time spent on a long-range enterprise will influence a final grade to some extent: that is, the grade will be partly for effort and persistence as well as for excellence of production. 51

49 Ibid., p. 171.
50 Ibid., p. 170.
Third, some attempt should be made to evaluate the student's intellectual capacity for biology apart from the local situation as has been previously stated. It is here that commercial standardized tests are needed. Consistent high marks on teacher-made tests do not always mean that the pupil is a superior biology student. This is mostly true because teacher-made tests are designed to yield "passing" grades for the greater part of the class, and tests which would really challenge the superior student would be made up of items more than half of which would be too difficult for the rest of the group. Excellent tests are available not only for subject matter but also for abilities, capacities, aptitudes and attitudes.

An evaluation program which would attempt a complete appraisal of a student's growth in biology might well use the various devices listed by the Forty-sixth Yearbook:

1. Evaluation by paper-and-pencil devices:
   (a) Verbal tests, either "objective" or "essay" in form.
   (b) Diagrams, pictures, charts, etc.
   (c) Rating scales and check lists.
2. Analysis of work products according to acceptable criteria (apparatus set-ups, notebooks, student collections, committee reports, etc.).
3. Classroom questioning and discussion.
4. Observation of significant behavior either
   (a) informal, as in day-by-day classroom or laboratory activities, or
   (b) systematic, as in situations specifically planned to elicit known types of behavior.
5. Conferences and interviews with individuals or with

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small groups.

With the shift of emphasis away from logically organized courses in high school biology toward courses where content is organized around problems of pupil adjustment, there may be less demand for instructional tests based on units and chapter of textbooks and an increased demand for teachers who are using a certain problem organization to build their own mastery tests. Such a procedure, of course, will not alter the validity of techniques now being used, but will simply mean a different organization of test items.

With the developing of functional objectives of biology teaching, the trend has been away from the straight lecture method to include all the newer approaches found in teaching. Biology should and can use to even greater advantage the Unit Plan, the Individual Method, the Project Method, the Contract Plan, the Demonstration Method, the various Audio-Visual Aids, the Field Trips and the Biology Clubs. Therefore, one cannot conclude whether biology has contributed the newer methods to education or that the newer methods have made biology more dynamic as a content subject.

CHAPTER VI

THE EFFECTS OF THESE MAJOR CHANGES
ON TEACHING BIOLOGY IN MONTANA

In 1897, the "diploma committee" (an accreditation group) of the State Board of Education plus the President of Montana Colleges prescribed that biology be included in the curriculum of the High Schools of Montana.¹

Biology was included in the Montana State Course of Study in 1912.²

A survey made by Barnes³ showed that during the school year of 1933-1934, 53% of Montana high schools offered a course in biology; 66% of them offered it during 1939-1940 and 71% during 1946-1947.

Card⁴ reports that 38% of Montana high schools require biology as a graduation requirement while 32% of the remainder offer it as an elective.

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Jones found that in the small high schools in Montana biology was being taught in out-dated rooms and laboratories not constructed to meet present day needs and that the inventories of equipment of these schools do not meet the standards set forth either by the authorities or the State Department of Education. He further stated that the biology equipment was generally too inadequate to serve their purpose in helping to achieve the objectives set forth for a course in biology. His survey showed that the equipment shortages were most apparent in the following categories: (1) visual aids, (2) classroom utilities such as worktable space and equipped experimentation desks, (3) project activities such as field trips and student experimentation supplies such as preserved and dried specimens, dissection equipment and mounting equipment.

The foregoing conditions are those over which the teacher has little or no control and because of them many progressive procedures and methods are impossible to attain. Demonstrations may fail due to lack of equipment, laboratory work suffers and visual aids are useless. Biology methods, procedures and materials are likely to become more and more of a compromise. However, Keeslar found that the elements of the scientific method can be taught and scientific attitudes inculcated into students by combining short periods of inductive reasoning (usually associated with experimental procedures and problems) into the final metamorphosis of unit understanding with little or no equipment.

Most authorities agree that biology can be taught and learned with

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very little equipment, but it can be learned better and more efficiently with the help of the various aids that are available. 7

The fact that Montana has had no state course of study for biology since 1932, 8 allows the teacher the freedom of choosing the unit and method of teaching it.

When national committees of educational experts make suggestions of methods and procedures to be used in teaching a particular course, the very weight of the experience and fame of the individual members of these committees make it almost imperative for school administrators to see that these suggestions are followed. 9 As this is true in other sections of the country, so was it a fact in Montana. 10

Personal interviews with various biology teachers in Montana high schools revealed that they teach biology from the standpoint of meeting student's needs with emphasis on the functional aspects of the subject and use most of the modern methods and procedures described in Chapter V to help make this subject a "living" one. That this is true is borne out by the increased number of schools offering courses in biology. 11 For a course to grow in popularity, it must have a "real life" purpose.

Because so very little has been published concerning methods of

8 See letter in Appendix.
10 Ibid., p. 136.
teaching in Montana would lead one to believe that Montana teachers were not taking advantage of the newer methods and procedures or following the current trends. However the following articles may help dispell that idea.

A survey made by Thorne of 137 high schools from 51 counties in Montana showed that in more than half of these schools units in conservation were taught in the biology classes, and that motion pictures, radio programs, film strips, various posters and art displays were used in carrying out the unit.

Howard Nelson's biology class in Glasgow high school have carried out the following projects: aquaria, caring for animals in the laboratory, nature photography, nutritional and blood experiments, nature and bird studies, growing and propagating plants. At frequent intervals, Mr. Nelson has doctors, nurses, laboratory technicians and others visit his biology classes and talk on various vocations and professions.

Richard Nelson, science instructor at Kalispell High School, reported that 65 projects were entered in 10 divisions in the Kalispell Science Fair this spring. 16 of these projects were entered at the Inland Empire Science Fair held in Spokane, Washington, where 35 schools from Washington, Oregon, Idaho and Montana competed for prizes.

After having his biology class work on individual projects, Edward Boner, Science Instructor at Nashua High School, is certain that the

project method improves biology teaching and helps meet student's needs.  

The writer would suggest that in schools which lack sufficient biology equipment that attempts be made to make full use of seasonal materials in teaching biology. In every feasible manner students should be aided to see biology functioning in the great outdoor laboratory. The next best thing is to bring the outdoors into the classroom with inexpensive visual aids and collected materials. The biology room and laboratory can and should be a museum, green house, library and visual center rolled into one. This can be accomplished with a small amount of effort and a minimum of expense.

The booklet Biology Projects contains over 100 experiments, observation items and other profitable activities which are well suited for directing the student in "what-to-do" activities. If similar topical or project material were incorporated in a program in which these activities are related to the development of the major concepts in the minds of the students, it is believed that a real understanding and appreciation of biology would ensue.

CHAPTER VII

RECOGNITION OF THE STUDENT'S PHYSICAL, MENTAL AND SOCIAL PROBLEMS

Science is a vital factor in daily living; it has invaded the home, revolutionized our manner of living. Scientific research in medicine and surgery have changed our standards of health and our mode of life. Scientific discovery and development have modified man's material existence and his thinking.

BIOLOGY AND GENERAL EDUCATION

Biology, a life science, should be designed to meet the fundamental needs in general education. These needs may be found in the basic relationship between man and his natural environment.  

Biology instruction should not be a restricted, compartmentalized discipline confined to a classroom or laboratory but should contribute to and make broad applications to significant areas of human experience.

When biology is spoken of in relationship to general education, it is likely to be thought of in terms of "needs" or "problems." 

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The potential contribution of biology is fairly obvious. It includes knowledge that is functional in the sense that it is related to common affairs and concerns and extends to understanding of various concepts or principles and to the development of certain special skills and the genesis of desirable attitudes.  

Much functional biological knowledge has been acquired in very recent times and has not yet been generally utilized as material of instruction. It is evident that the objectives of biology teaching in the schools have not always been clear or well chosen, and that lip service has been given to ideals but there has been a failure to provide materials of instruction that would make a realization of these objectives possible.

In the general educational approach it is clear that the training of the professional biologist is not the aim of the high school biology course. This course, however, may serve to reveal aptitudes and develop interests of pupils who will later engage in specialized training during later phases of their formal educational experience, and from these ranks the biologists of the next generation may well come. That such a turn of events is desirable if not imperative, may be gathered from the Steelman report to the President of the United States in which the statement is made "...that the indispensable resource for progress in science is an ample supply of highly trained scientist and technicians. As a nation, we face serious shortages in this field."

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4 Ibid., p. 238.
Biology being a life science should deal with life situations; interest should center around: public safety, community health, civic beauty, agriculture, conservation of human and natural resources. The more "life-like" the situation the more interest will be displayed.

An article by Shoemaker\(^7\) suggests sources of valuable printed material on conservation projects available to biology teachers which can be adapted to fit local situations. Numerous activities that are suitable for teaching conservation of plants and animals are also described in this article.

Mentzer\(^8\) describes how a biology class might study a unit on wild-life conservation which could include observation and survey of a wild-life community. This would involve observation of animal life in its natural habitat, food, cover, environmental conditions, interdependence, diseases, and the like. This survey could very naturally lead into a study of game laws, economic importance of wild life, methods of protection, and restoration, and perhaps actual participation in the work of conservation.

Craig\(^9\) has written an excellent discussion on the wise use of natural resources. Various resources, including soil, grasslands, forests, water, wild life, mineral deposits, and man himself, are


treated from the standpoint of their importance to the welfare of the human race, both present and future. Many practicable activities are suggested which teachers may engage in with their pupils in learning about natural resources of the community, the nation and the world. Emphasis is placed on the study of effective procedures which may be used to insure wise utilization of natural resources.

The Committee of the American Council of Science Teachers, composed of 260 consultants from 43 states, directed science teaching toward "better living" and the solution of "personal and problems." Biology teachers can demonstrate that: (1) natural resources can be preserved, (2) health and safety can be established, (3) better adjustment can be made to labor-saving devices, (4) more intelligent consumption of goods and services can be attained, and (5) living can be made better.

This same committee guided science teaching toward the problems of everyday living in regard to personal health, problem solving and critical thinking. Many of the practical problems of everyday living are controversial issues, and these issues demand tolerance based on a mature philosophy of life which can be developed by problem solving techniques. The committee listed the following controversial issues as those which have a direct bearing on science and especially on biology teaching: (1) socialized medicine, (2) control of patents, discoveries, resources, (3) freedom of research, (4) natural resources, plant, animal and human, (5) sex education, (6) ownership and control of

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11 Ibid., p. 12.
forces and materials of nature and (7) adjustments to other members of society.

Through such units and activities as have been described, contributions to the functional understanding of biological principles would be realized; growth would be made in habits of careful observation and scientific method; and desirable attitudes, interests, and appreciations would be encouraged and developed.

BIOLOGY AND LIFE ADJUSTMENTS

In January, 1944, the Vocational Division of the U. S. Office of Education began a study on "Vocational Education in the Years Ahead." More than 150 persons participated in this study which covered 16 months. In the final meeting of the Consulting Committee, Dr. Proesser presented the following data: (1) that vocational schools prepared 20% of their pupils for skilled vocations, (2) that the high schools prepared 20% of their students to enter college, and (3) that the remaining 60% are not receiving the life adjustment training they need and to which they are entitled.

The idea of a life adjustment program was discussed at the 5 Regional Meetings which were sponsored by the U. S. Office of Education during 1946. In September, 1947, The Commission on Life Adjustment Education for Youth was formed. 13

Biology can contribute much to a life adjustment program by making the day-to-day learning of the student interesting and by crea-

ting an abiding interest in science that may be followed through life. These interests may play an important role in the vocation of some students while in others they may continue into later life purely in an avocational role. The biology teacher should be certain to point out to the students the possibilities that the field may offer for a career and also to plan his teaching so that the avocational and recreational opportunities are stressed.

Biological career possibilities can probably best be provided for through individual counseling. The teacher is in an excellent position to select from his classes those young people who, because of special aptitudes, may be well fitted to pursue further study in the field leading to a life work. Interest in biology for such students may be materially enhanced by selecting them for special responsibilities about the laboratory. They can save the busy teacher many hours of work while learning to handle various pieces of equipment. Often times these same students are capable of setting up demonstrations and keeping equipment in repair.

Avocational interests in science may be widely varied throughout all the recognized scientific areas and fields. Such interests can be effectively provided for during the school years by means of science clubs and field trips. These same interests may later develop into some phase of a science career or become a healthy and useful hobby such as gardening, bird study, collecting, growing rare plants or making scientific equipment.

The objectives of biology teaching must be sought in the broad areas of human experience where young people meet their problems of

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15 Ibid., p. 149.

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adjustment. Adjustment to new situations generally means a change in the behavior patterns of the individual. The functional understandings of facts, principles, and concepts, the acquisition of skills, the growth in the use of the scientific method, and the acquisition of scientific attitudes, appreciations, and interests should be the means to end for more effective adjustment.

BIOLOGY AND FAMILY LIFE

Biology can help the family along the four major lines of interest that are distinguished as the: physical, social, mental and spiritual welfare of the individual. The physical includes all that contributes to the fundamental purposes of the organisms survival. The other values are based on a program which seeks to build a sound and efficient body which makes education for family living a very broad field.

Biology or life science offers a good place to deal with the sex aspect of family life education. This type of education must be planned to meet the student's need on the basis of his level of maturity. Biology is an appropriate subject in which we can give to our young people a thorough understanding of their bodies and the facts that they need to know which pertain to sex. They should be taught in this course that sex is a vital part of their personality and that it should not be relegated to complete silence. It is nothing short of criminal to send boys and girls out into the world without a knowledge of sex facts and the relationship of sex behavior to emotional well being, personal hap-

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piness, and social responsibility.

Sex facts are only a part of what should be included in family life education. Marriage is more than mating, more than a biological drive. Care should be taken not to emphasize the biological side of marriage and family life to the exclusion of other factors. Back of many broken homes lie emotional immaturity, inner conflict, and just plain boredom. Marriage is an adult enterprise and boys and girls should be taught that it is.

In some manner the school must teach boys and girls how they mature into adult human beings, how to accept their role in life as a male or a female, how to develop emotional independence and security, and why they must learn to take responsibility and the biology class seems to be the most logical place for them to learn these facts.

BIOLOGY AND THE TEACHER

Biology teachers face a dual responsibility. They must effectively contribute to and promote the general scientific enlightenment of all citizens, and at the same time promote challenge and training for potential scientists. Only through careful and thoughtful planning for both these responsibilities can individual and societal needs be adequately recognized in this age of science and technology.

The responsibilities of general education are often difficult for the teacher to meet because his own high school and college studies were focused on specialized work in science. He did not have the opportunities to study and experience socialized and individualized

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18 Ibid., p. 318.
procedures. The training of talented pupils is made difficult by large numbers of pupils in the classes who need general education rather than specialized education. Meeting the dual responsibilities within the regular biology class requires a variety of materials and procedures which the teacher must learn and perfect on the job and often with little guidance.

Many biology teachers have become quite skillful in meeting individual and societal needs. Through mutual sharing of helpful ideas with other teachers and through printed science materials they can grow in teaching effectiveness.

Biology can be one of the most interesting and worthwhile courses in the high school. There are techniques and materials available that add something extra to the emphasis on reading and talking as sources for the evaluation of ideas.

Because the teacher is the school's most important public relations agent he can put adventure into school work and induce students to talk about biology at school and in the community. He can win approval for additional supplies, equipment, films, slides, and other teaching aids. He can help revise existing courses and plan elective science courses that pupils will appreciate. He can make biology permeate the school and community. These things he can do and these things he needs to do.

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20 The Teaching of Biology in the Secondary Schools of the United States. A Report of Results from a Questionnaire. Sponsored and Published by the Committee on the Teaching of Biology of the Union of American Biological Societies, 1942.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the major changes in the teaching of biology during the years between 1930 and 1955, as this subject had been organized and taught in the high schools of the United States.

The method followed the normative survey approach in that the data were based upon: (1) the research studies of science and biology teaching which have appeared in the educational periodicals during the last 25 years; (2) the courses of study which were developed during that period; and (3) the high school textbooks on biology that had been written between 1930 and 1955.

SUMMARY

Summary of the Objectives of Biology Teaching. Most of the reports and research studies have been carried out upon the assumption that the major objectives of the teaching of biology are the functional understanding of the principles of science which are considered valuable in general education. There is an increased interest in meeting the needs of the students. Textbooks tend toward a more practical point of view with implications of social and economic problems of human welfare and interest.

Summary of the Curriculum in Biology Teaching. There seems to be an increased interest in investigating means to make biology courses more practical and closer to the pupil's needs. Such topics as: health
education, consumer education, conservation education, mental hygiene, social hygiene and family adjustment programs have received varied interest. To be effective in the lives of the students a biology course must be based on human behavior and health. An integration with other subjects is receiving more and more consideration.

Summary of the Methods and Procedures in Teaching Biology. Numerous techniques and methods in teaching have been developed. There appears to be less consideration of method as method, and much more concern with the adequate understanding of scientific principles; however, all the modern teaching aids and methods have come to find an important place in the teaching of biology.

Summary of the Effects of These Major Changes on Teaching Biology in Montana. Although there has been a lack of written reports on methods and procedures used by Montana high school biology teachers, reports available show that the newer methods and procedures are being used and that the trend of shifting the emphasis on subject matter to the more functional aspect of meeting student's needs is being followed.

Summary of the Recognition of the Student's Physical, Mental and Social Problems. Biology has changed from the detailed, morphological subject of the early decades of the 20th century to a place of prominence in the high school curriculum with particular emphasis on the economic and social aspects of human welfare; however, the teacher emerges as the important factor.

CONCLUSIONS

From the findings of this study, it was concluded that:

1. The youth of today must adjust themselves to a much more complex and chaotic world than existed three decades ago. Therefore, to meet the needs of youth, the science course in biology has shifted emphasis on functional understanding of the principles of science that
are used in everyday living.

2. Many courses are being offered in life science or biology on the secondary level. In many cities this is a required course for graduation. For this reason the number of textbooks on the subject is increasing.

3. To meet the needs of the functional curriculum a greater number of approaches have been developed in teaching biology. The biology course has become more practical with emphasis on health and human welfare.

4. That biology in a course makes a rich contribution in solving the problems of family and life adjustment.

Research studies should be inaugurated and developed in:
1. Using community resources in teaching biology.
2. Methods used in teaching through the use of community resources.
3. A scientific investigation of the amount of knowledge attained through the use of visual aids versus teaching without visual aids.
4. A publication survey of films that could be used in relation to hygiene, family life, social and human welfare.
5. Using health education based on the fundamental approach to the teaching of biology.
6. The development of units that could be used in television productions in teaching biology.

RECOMMENDATIONS

A survey of the changes in teaching biology during the past 25 years shows how important the subject has become in meeting the needs of youth in this era of the 20th century. For this reason biology should be a required course in high schools.
Since family living and life adjustment approaches are being emphasized in the present day high schools, further research should be carried out to see what effective considerations could be given to the teaching of biology to meet these curricula changes.

The insufficiency and lack of courses of study for biology suggest further research by individuals or committees to prepare such curricula in keeping with the functional needs of youth. This material should be developed in greater detail to replace the brief outlines which now exist.

Surveys should be made of student and faculty research.

Teachers should encourage students to participate in local and national science displays in the field of biology.
BIBLIOGRAPHY

BOOKS


**PERIODICALS**


Hunter, George, Paul B. Mann, and Guy V. Bruce, "Biological Field Trips as an Integral Part of Science Education," The American Biology Teacher, 4: 5-11, October, 1941.


PUBLICATIONS OF LEARNED ORGANIZATIONS


BULLETINS

Redirecting Science Teaching in the Light of Personal-Social Needs,
American Council of Science Teachers. National Committee of
Science Teaching. Washington: National Educational Association,
1942. 20 pp.

The Biennial Survey of Education, 1926-28. United States Bureau of

The Teaching of Biology in Secondary Schools of the United States,
A Report of Results from a Questionnaire. Sponsored and Published
by the Committee on the Teaching of Biology of the Union of Ame-
rican Biological Societies, 1942.

UNPUBLISHED MATERIALS

Barnes, A. E., "Educational Offerings in Montana High Schools,
1945-47," unpublished Master's Thesis, Montana State University,

Hutchinson, D. W., "Factors Conducive to Curricular Changes in
Montana High Schools," unpublished Master's Thesis, Montana
State University, 1950. 180 pp.

Jones, Layton, "Equipment Needs for Teaching Biology in a small
Montana High School," unpublished Professional Paper, Montana
State University, 1952. 137 pp.

ENCYCLOPEDIAS

A Cyclopedia of Education. Paul Monroe, Editor. New York: The

Encyclopedia of Modern Education. Philosophical Library, Inc.,

COURSES OF STUDY

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Mr. Philip C. Foley  
425 North Excelsior Avenue  
Butte, Montana  

Dear Mr. Foley:  

I regret to inform you that we have had no authorized course of study for Montana high schools in Biology since 1932.  

The legislatures have not seen fit to appropriate funds for the preparation of such courses, and we do not have sufficient staff to spend time in such preparation.  

Thank you for your request.  

Cordially yours,  

MARY M. CONDON  
State Superintendent  

William I. King  
(signed)  
William I. King  
High School Supervisor  

WIK:pla