Name: Donald Ray Caskey Date of Degree: August 8, 1964

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: TOPICS INCLUDED IN HIGH SCHOOL BIOLOGY

Pages in Study: 31 Candidate for Degree of Master of Science

Major Field: Natural Science

Scope and Method of Study: This report describes what various authors have written about topics in high school biology. Included is an analysis of nine high school biology text books; comparing the topics covered and the amount of emphasis placed on each topic.

Findings and Conclusions: It was found that the nine high school biology text books covered about the same topics with a variance in emphasis in each text. In the conclusion the author includes a list of topics that should be included in any high school biology course.

ADVISER'S APPROVAL L. Herbert Bruneau

TOPICS INCLUDED IN HIGH SCHOOL BIOLOGY

By

DONALD RAY CASKEY

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1959

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
August, 1964

TOPICS INCLUDED IN HIGH SCHOOL BIOLOGY

Report Approved:

L. Hubert Bruneau.

Report Adviser

Robert C. Zite

Robert MacVicar

Dean of the Graduate School

PREFACE

In this report a study is made of the subject matter or topics covered in high school biology. After teaching four years in a small Oklahoma high school, it is apparent to the author that there is a wide range of possible topics in a high school biology course. This report attempts to answer the questions: What topics should be covered? How much time should be spent on each topic?

Methods of teaching high school biology are not studied in detail in this report, but are mentioned. A brief history of the development of the curriculum of high school biology is included. Along with the history are the ideas and work of different authors on the subject of high school biology. Next a study of topics included in nine high school biology text books is given. The last part of the report is a list of topics which the author of the report would include in a high school biology course.

Indebtedness is acknowledged to Dr. Robert C. Fite and the National Science Foundation for making possible a full year of advanced study.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The following remarks were made in February, 1939, by Dr. K. A. Sarafian (18) who is neither a biology teacher nor a member of the Biological Science Curriculum Study: "Emphasize life in teaching rather than description and morphology of life. Make the laboratory a genuine center of student investigation. Try to make students discoverers rather than imitators."

During the intervening years much work, including that of the Biological Science Curriculum Study, has been done in getting biology teachers to follow the methods described by Dr. Sarafian.

In 1954 a conference was held at which the following objectives for a high school course were laid down: (22)

(1) Understanding basic principles of biology.
   - (A) Photosynthesis.
   - (B) Living processes.
   - (C) Evolution.
   - (D) Inheritance with change.
   - (E) Ecological relationships.

(2) Understanding the human cycle.

(3) Understanding community relationships.

(4) How biology can be used in later life.

(5) Understanding of the scientific method.

(6) A positive approach to physical and mental health.

(7) A vocational interest and appreciation related to living things.

Prior to the development of the Biological Science Curriculum Study text-book material, the American Institute of Biological Science produced a series of films that helped enrich the biological curriculum. Burr Roney (17), who helped in the production of these films, made some interesting observations. First, he described the average tenth grade biology student. "He has reached the age of fifteen or sixteen and has finished ten years of schooling without any predictable amount of science in his background."

In speaking about subject matter in high school biology, Roney made the following points: "Biology includes a diversity of material as great as that of all the physical sciences put together. Second, the biology course is given the same length of time to be taught. Therefore, the biology teacher must decide on the most important ideas and facts."

Roney says that we should teach the facts about biology as we know them today without leading the student through all the misconception of the past. When the content of biology is accurately described and pruned of historical misinformation, its fundamentals are easier to understand since there are fewer mysteries about organisms than there formerly were.

The Biology Teacher's Handbook describes the development of the biology text book. (19) The text books of the period 1890-1929 set the model for the conventional science text book. They consisted of a mass of disconnected facts and elementary generalizations. Authors who selected these facts were working scientists. They knew the facts of

biology at that time. From 1929 till 1959 material in text books was emphasized or omitted on the basis of what could be most readily taught. Other material was modified to conform to theories of teaching and learning no matter how much it distorted the view of the subject as known by the scientists.

One of the factors which greatly influenced the methods used, if not the subject matter, were the seven cardinal principles of education. (21) The principles are good and are still used today. The principles are: health, command of fundamental processes, worthy home membership, vocation, civic education, worthy use of leisure, and ethical character. All subject matter should accomplish one or more of these principles or goals.

The first Biological Science Curriculum Study text book was written in the summer of 1960. The authors included high school biology teachers and university research biologists. The materials were tested in high schools and were revised in 1961 and 1962.

Cox (7) gave the importance of Biological Science Curriculum Study program to subject matter. Biology embraces such a wide range of disciplinary approaches that biologists simply cannot agree on one single best way of teaching biology. BSCS, Biological Science Curriculum Study, has developed the laboratory block, and three versions of the text book. Despite the difference in approach about 70 per cent of the total material is common to all three versions. The three versions are:

Blue version -- molecular biology.

Green version -- ecological and behavioral aspects.

Yellow version -- cellular biology.

In the BSCS program working in a "cookbook" type laboratory and learning a long list of scientific names is giving way to experiments that include out-of-class investigations by gifted science students.

Dr. Arnold B. Grobman (9) describes the laboratory block program. The laboratory blocks are designed to serve the investigatory function of teaching laboratory work. A six-week block of time is required for the student's investigation, hence the name. At present the following laboratory blocks have been prepared:

1. Plant growth.
2. Microbes.
3. Animal growth and development.
4. Interdependence of structure and function.
5. Regulation in plant by hormones.
6. Animal behavior.
7. Ecology of land animals and plants.

What is the effect of the BSCS program on the topics taught in high school biology? It will be some time before all schools will completely change to BSCS. As pointed out by Rudolph Janu, (11) the cost, extra equipment, special training of teachers, time and space requirements will prevent some schools from participating completely in the program. The statement, "All old text books are obsolete and must be replaced", made by Janu is not completely true. As pointed out in the research of this report the approach and methods of BSCS are quite different from conventional text books, but the subject matter and degree of coverage by a good conventional text is not different. A good teacher could adapt BSCS methods to a standard text although it would be easier if the teacher has a BSCS textbook.

With the coming of BSCS, a struggle is occurring between classical biology and molecular biology. Ban Commoner (6) describes the viewpoint of both schools of thought. Classical biology is built upon observations and experiments with actually living organisms, organs, and cells. It assumes that life is inherently associated with the complexity of at least the cell. Molecular biology, on the other hand, assumes that chemical constituents separated from the cell and studied with sufficient detail will be found to possess some life-like properties. It permits the notion of a "living molecule". The outcome of this struggle will determine which of the two streams of biological science will survive and form the main stream of our future understanding of life.

Two special groups of students provide problems in planning topics to be taught in high school biology. They are the low achiever or disadvantaged pupil and the high achiever or advanced student. Most high schools have only a few pupils in each group, but they do present problems.

Most topics and the length of time spent on a topic are geared to the average student. The low achiever can become lost if the correct methods of teaching are not used to include him. BSCS is currently working on the premise that the disadvantaged youngster needs a program which explores important basic concepts in modern biology. (14) The BSCS holds to the conviction that these students will find more interesting adventure in their school experience through traveling new roads related to up-dated concepts in biology, than by retraveling the byways of health, disease, and nutrition. In the summer of 1963, three experimental units were prepared; ideas in genetics, ecology, and cellular biology.

The advanced student provides a different problem to the biology teacher. He can usually grasp the material quickly and needs extra work in order to use his abilities to the highest degree. In most high schools an advanced course is needed for the better students. This advanced course would be given in the eleventh or twelth grades. At Oak Park and River Forest High Schools in Oak Park, Illinois, a study was made of the subject matter in an advanced biology course. (8) The following major units were found to be successful:

(1) Physical and chemical nature of protoplasm.

(2) Microbiology.

(3) Vertebrate physiology.

(4) Genetics and evolution.

(5) Plant physiology.

What does the future hold for biology? What changes will occur in the subject matter taught in the future? What principles and concepts will be taught in high school biology in the future? The knowledge about biology is dynamic. It is constantly evolving. Ideas we hold today about the mechanism of cell reproduction, the chemistry of the cell, evolution, or plant growth may not be incorrect, but it is certain that we shall have a better understanding of their functions and importance in the future. New subjects will be added to the biology curriclum. For example, plant pathology which is not taught extensively in high school biology illustrates the disease concept in biology. (3) The disease concept holds that the irritation of cells and tissue by some agent results in injury and death. Plants provide a quick, cheap, and safe method of studying disease. In the future with an ever increasing population the control of plant disease will be an important

factor in saving mankind's food supply.

Kastrinos (12) points out that the most important aim of science education now, and in the future, is that of improving the ability to think critically. Leake (15) points out that advances in the next decade in biology will employ teamwork in the greater understanding of the chemistry of the body, human behavior, and disease. Important areas of the biology of the future are listed by Klinge (13) as follows:

(1) Other forms of life.

(2) Directed evolution.

(3) Chemistry of genetics.

(4) Control of the cell.

(5) Application of ecology.

Michael Walsh (23) shows the importance of the biology teacher emphasizing the career opportunities in biology and states that the teacher should attempt to show the student the importance and opportunities of biology instead of giving only the usual group of facts about the subject.

CHAPTER II

SURVEY OF NINE HIGH SCHOOL BIOLOGY TEXT BOOKS

In this report nine high school text books which have been used in the last twenty years were surveyed. Table I gives a list of subjects covered in the nine text books. It was difficult in some cases to distinguish between topics. The various cycles such as water cycle, nitrogen cycle, and carbon cycle are covered in one chapter in some books. In other texts the cycles are covered in separate chapters. Conservation of resources is interwoven into the subject material of the BSCS text book while most conventional text books cover conservation in a distinct chapter. It was a problem to decide if a particular subject was covered even though not in the same manner as in the BSCS text.

After making a list of the topics covered by the text books each one was summarized and compared with the BSCS text book. In Table II the major topics covered in the BSCS text were used. These are: ecology, animal classification, plant classification, microorganism, functioning of plants, functioning of animals, evolution, and heredity. All topics in high school biology could be covered under these headings. Ecology would include cycles in nature, biogeography, balance in nature, and food webs. Plant and animal classification would include a description of the major phyla and characteristics and habits of representative species. Microorganisms covers protozoa and algae description along with description of disease causing bacteria. Under microorganisms

would also be a discussion of disease and its effects. The subject functioning of plants would include photosynthesis, reproduction, cell function, and the processes or functions of roots, stems, and leaves. Animal functioning includes cell functions, organ functions, and reproduction. Under the topic evolution there would be included evidence of evolution, the theory proposed by Darwin, and the modern concept of evolution. The topic heredity covers the work of Mendel, genes, chromosomes, DNA molecules, and knowledge of the heredity of different characteristics of animals and plants today.

After establishment of the eight major topics an evaluation scale was set up. Because the BSCS text book is considered to be the best or most modern type of high school biology text book it was used as the basis for the following rating scale. A score of <u>one</u> indicates the topic was not as extensively covered in the conventional text as in the BSCS text. <u>Two</u> indicates approximately equal treatment in the two books. And <u>three</u> means that the material or topic was covered in more detail in the conventional text book. The results of rating the text is shown in Table II.

TABLE I

TOPICS COVERED BY NINE HIGH SCHOOL BIOLOGY TEXTS[1]

	1	2	3	4	5	6	7	8	9
Balance in nature	x	x	x			x		x	x
Scientific method	x	x	x	x		x		x	x
Carbon cycle	x	x	x				x	x	x
Water cycle	x						x	x	
Food webs	x	x	x				x		
Biosphere	x							x	x
Population characteristics	x							x	
Environmental factors	x	x	x			x			
Communities	x						x		
Classification	x	x	x	x		x		x	x
Animal kingdom	x	x	x	x		x	x	x	x
Plant kingdom	x	x	x	x	x	x	x	x	x
Microorganisms	x	x	x	x	x	x		x	x
Components of soil	x	x	x	x				x	
Nitrogen cycle	x	x	x	x		x	x	x	x
Health and disease	x	x	x	x				x	x
Distribution of land organisms	x								x

[1]Numbers used in this table correspond to the following text books:

1. High School Biology, BSCS Green Version. (5)
2. Biology a Basic Science, Second Edition. (10)
3. Biology a Basic Science, First Edition. (10)
4. The Biological World. (24)
5. Your Biology. (20)
6. Modern Biology. (16)
7. Biology. (4)
8. Biology for Better Living. (2)
9. Dynamic Biology. (1)

TABLE I (Continued)

	1	2	3	4	5	6	7	8	9
Aquatic environments	x								x
Evolution	x	x	x	x		x	x	x	x
Distribution of organisms	x					x			x
Cell	x	x	x	x	x	x	x	x	x
Photosynthesis	x	x	x	x		x	x	x	x
Leaf	x	x	x	x	x	x	x	x	x
Roots	x	x	x	x		x	x	x	x
Stem	x	x	x	x		x	x	x	x
Digestion	x	x	x	x	x	x	x	x	x
Respiration	x	x	x	x	x	x	x	x	x
Circulation	x	x	x	x		x	x	x	x
Blood	x	x	x	x	x	x	x	x	x
Excretion	x	x	x	x	x	x	x	x	x
Endocrine system	x	x	x	x	x	x	x	x	x
Nervous system	x	x	x	x	x	x	x	x	x
Muscles	x	x	x	x	x	x	x	x	x
Skeletal system	x	x	x	x	x	x	x	x	x
Reproduction	x	x	x	x	x	x	x	x	x
Heredity	x	x	x	x	x	x	x	x	x
Origin of species	x			x	x		x		x
Behavior	x	x	x		x		x	x	x
Man and the biosphere	x	x	x					x	
Living and non-living		x	x	x		x		x	
The microscope		x	x	x	x	x		x	x
Structures of animal detail		x	x	x		x	x	x	

TABLE I (Continued)

	1	2	3	4	5	6	7	8	9
Fats, carbohydrates, and protein		x	x	x	x	x		x	
Tobacco and smoking		x	x	x	x	x		x	
Mental health		x	x					x	
Conservation		x	x	x	x	x	x	x	
First aid				x				x	

TABLE II

EMPHASIS VARIOUS TEXT BOOKS MAKE ON DIFFERENT BIOLOGICAL TOPICS[2]

Topics	1	2	3	4	5	6	7	8	9
1. Ecology	2	1	1	1	2	1	2	2	3
2. Animal classification	2	2	2	3	2	3	3	2	1
3. Plant classification	2	2	2	3	2	3	3	2	1
4. Microorganisms	2	1	1	1	1	2	2	2	2
5. Functioning of plants	2	1	1	1	1	2	1	2	1
6. Functioning of animals	2	2	2	2	3	3	2	3	1
7. Evolution	2	1	1	1	1	1	2	1	1
8. Heredity	2	1	1	1	2	1	2	1	1
Total Rating	16	11	11	13	14	16	17	15	11

[2]The number at the top of each column corresponds to the text books of Table I.

CHAPTER III

SUMMARIES OF NINE HIGH SCHOOL BIOLOGY TEXT BOOKS

1. High School Biology BSCS green version. (5)

The BSCS come close to meeting the needs of high school students since it combines the ideas and work of both teachers and research biologists. The BSCS green version can be used as a guide for teaching high school biology for many years if the teacher will constantly keep informed on new ideas and methods of teaching. The subject matter in the BSCS text book is about the saem as that in the conventional texts, but the emphasis and method of teaching is revolutionary.

Due to the fact that all of the subject matter in the other eight text books is compared with the BSCS green version a more detailed description is given for this text than for the others.

Chapter I, "The World About Us", emphasizes how the biological world is interrelated. It includes a discussion of interdependence of plants, animals, and protists in the transfer of energy and in the cycling of matter as well as the interdependence of living systems and the physical envoronment.

Chapter II describes the composition of population. Then the third chapter gives a brief description of a community so as to provide a basis for developing some ideas concerning kinds of community interrelationships.

Chapters IV, V, and VI deal with "Diversity in the Biosphere."

Chapter IV starts by discussing mammals. Later in the chapter there is a discussion of the less familiar forms. The emphasis in this chapter is on the diversity of form within the animal kingdom. The complementarity of form and function, and the idea of adaptation with a minimum of evolutionary implication is brought out.

Chapter V deals with plants in the same manner as animals were in the preceding one. In this chapter there is a discussion of nomenclature for plants.

Chapter VI deals with microorganisms and fungi which are placed in the kingdom Protists.

In the next section of the book, living things of the world are examined. The three bases on which patterns of distribution in the world can be made are ecological, historical, and biogeographical. Each of these bases is covered in the unit, "Patterns in the Biosphere".

Chapter VII, titled "Patterns of Life in the Microscopic World", begins with ecological groupings of microorganisms. Patterns of microorganisms are essentially independent of the pattern schemes developed in the other chapters.

Chapter VIII, "Patterns of Life on Land", introduces a discussion of climate which is an extension of the principle that organisms cannot be understood withoug an understanding of their environment.

Chapter IX, "Patterns of Life in Waters", is an extension of the principles of ecological distribution studied in chapter VIII.

"The History of Life" is the title of chapter X. In this chapter, an idea of the sweep of events through time and of the continuity of living processes and ecological relations is given.

Chapter XI, "The Geography of Life", describes how certain animals

become distributed over the earth.

The next section of the text has five chapters dealing with the "inner physiology" of organisms.

Chapter XII deals with the cell. It is a long chapter and provides the student with the basis of cellular structure and function which is needed to interpret later chapters. Some attention is given to energy release and storage in the cell.

Chapter XIII covers "The Functioning Plant". Focus of the chapter is placed on the process of photosynthesis. The biochemistry of photosynthesis is developed to a great extent. The remainder of the chapter concerns the basic structure and function of those plants with which most students make frequent contact, the vascular plants.

Chapter XIV deals with "The Function Animal". The theme of this chapter is the variety of ways in which fundamental problems of animal organization are approached in different animal groups.

Chapter XV, "Reproduction and Development", deals with reproduction as a process unlike the other physiological processes discussed in previous chapters.

The topic of chapter XVI is "Heredity". It is treated by developing some of the research that produced it. Mathematics is used in this chapter.

The next two chapters deal with adaptation. Chapter XVII is a summary of the evidence for evolution. Darwin is regarded as one who provided an explanation of how evolution works and not as the originator of evolution as a concept.

Chapter XVIII deals with "Behavior: Individual Adaptation". In this chapter such topics as instinct, learning, and tropism are covered.

The last section in the BSCS green version has two chapters on "Man and the Biosphere". Chapter nineteen, "The Human Animal", brings out some of the ways in which man contrasts anatomically and physiologically with his fellow organisms. But since much of man's distinctiveness is behavioral rather than physiological or anatomical a great deal is written involving the borderline between anthropology and biology. The last chapter deals with topics with relevant biological information, but also with topics which will concern the student in the future as a citizen.

(2) Biology, A Basic Science, Heiss and Lape, First Edition. (10)

Each chapter in this text is prefaced by a problem to be solved. More than one problem is given for each unit. The following is a list of problems taken from some of the units:

(A) What conditions are necessary for life?

(B) How are living things classified?

(C) How do leaves manufacture food?

(D) What nutrients are present in foods?

(E) How do we digest food?

(F) What are the types of blood?

(G) How do animals with lungs respire?

(H) How do plants respond to stimuli?

(I) How are habits formed?

(J) What kinds of microorganisms cause disease?

The emphasis in the entire book is on the whole animal, organs, and tissue. One half page is devoted to the molecule and one chapter to the balance in nature. This is a good book and could be used with the BSCS method. It gives an undue proportion of descriptive material

on plants and animals.

(3) Biology, A Basic Science, Heiss and Lape, Second Edition. (10)

The second edition of Biology, A Basic Science did not have a great change from the first edition.

(4) The Biological World, Wideman and Gehlen. (24)

Three hundred and sixty one pages of the six hundred and seventeen of this book deal with descriptions of plant and animal phyla. Each of the body functions of the animals is taken up separately. The book emphasizes facts not principles. Very little is said about ecology or community life in the book.

(5) Your Biology, Smith and Lisbonbee. (20)

The greatest fault of this book as a text is that it is to simple. No topic is covered in much detail. The activities in the book are of the "cookbook" type; they do not require the use of the scientific method in most cases. There is an overemphasis on tissue, organ, animal, and plant terminology. Most high school students might find this book interesting but not challenging.

(6) Modern Biology, Moon, Mann, and Otto. (16)

Only in the first chapter is much said about the life processes as a whole. The second unit deals briefly with ecology. It includes the factors of environment, balance in nature, classification, and the community. None of the topics are covered as thoroughtly as they are in the BSCS green version.

The next five units give a detailed description of plant parts, plant and animal phyla, and the structure of the human body. The unit on disease and heredity is not covered as thoroughly as the corresponding material in BSCS green version. The last unit is on conservation. This

is a textbook which would make a good reference book, but it has too much detailed description to be adapted to modern methods of biology.

(7) Biology, Brown. (4)

This book includes a great amount of terminology. The material as it is presented would not be suitable for high school students even though the subject matter covered is similar to the BSCS topics.

(8) Biology for Better Living, Boyles and Burnett. (2)

The theme throughout the book is how to improve the conditions of human living. A portion of one chapter of this book is devoted to mental illness, a subject not covered in many high school biology text books. This is an important area since nearly one fourth of the sickness today is mental disorders of various types. Its greatest drawback as a text is the lack of illustrative material. There is no emphasis on molecular biology in the book.

(9) Dynamic Biology, Baker and Mills. (1)

Each unit in this book has a preview study. At the start of the unit on "Conquering Dangerous Microbes" is the story of the microbe detectives. The emphasis of this book is ecology. A whole unit is devoted to the haunts and habits of fish, birds, fur-bearing animals, and wild flowers. The interdependence that exists between green plants and animals is discussed. There is a unit on the changing forms of living things. The book lacks any emphasis on molecular biology which is the major drawback along with the fact that it lacks pictures.

CHAPTER IV

FACTORS INVOLVED IN DECIDING WHAT TOPICS TO TEACH IN HIGH SCHOOL BIOLOGY

What conclusions can be drawn from the analysis of nine high school biology text books? First, a wide variety of subjects can be taught in high school biology. Second, all high school biology text books cover about the same material with varying emphasis on the different subjects. Third, the specific topics taught will depend upon the school system, the teacher, and the community.

In deciding what subjects to include in a high school course in biology a teacher must take into consideration the following: time, facilities, purpose for teaching, and type of students involved.

Most high school teachers have about 180 teaching days. Taking out five days for unexpected occurrences leaves 175 days to cover the subject matter of biology. The teacher must divide the time so as to emphasize the important subjects but at the same time to give the students a good overview of biology. Another consideration involving the time factor is when to teach a particular subject. A discussion of plants in the middle of winter is not as appropriate as in the early fall or spring when plants are abundant. All of the BSCS text books use the winter months to cover such subjects as reproduction, heredity, organ system, and evolution.

Facilities available can be a limiting factor on subject matter

in high school biology unless the teacher is willing to improvise. A detailed study of ecology of plants will not be successful if the high school is located far from natural habitat of plants. This does not mean that ecology should not be taught in a large city high school, but the teacher will have to collect and bring the plants to the class. A microscope for every two students is a necessity for teaching such subjects as microorganisms, cell structure, and bacteriology. Attempting to have more than two high school students per microscope will result in poor learning, waste of time, and discipline problems. One method of partially solving the problem of not enough microscopes is the use of a microprojector. The amount of chemicals a teacher has available will determine how much of the chemistry of living things he can cover properly. Biology can and has been taught from a text book in a classroom with nothing but a teacher's desk and thirty pupil chairs. It is questionable, however, if this type of biology teaching would be of much value even if all the subject matter in the BSCS green version were covered. To be taught effectively good facilities are necessary no matter what subject matter is covered.

The purpose to be fulfilled in teaching high school biology is the key factor in determining what will be taught. What knowledge of living things and what attitudes and skills relevant to biology would contribute most to the personal lives of the students and to the execution of their responsibilities as citizens.

The following paragraphs discuss six areas in which the high school biology teacher can contribute to the lives of students and to their duties as citizens.

(1) Ability to make a living.

One of the basic things that any course can give a student is knowledge of the ability to survive. Anything the teacher can cover that will help the student in deciding what he will do for a living will be valuable. To accomplish this any course in high school biology should indicate the opportunities of work in the biological field. Information should be given throughout the course about possible vocational opportunities in the various areas of study in biology. All students should have an understanding of what is involved in the following studies: embryology, genetics, classification, natural history, histology, morphology, ecology, parasitology, physiology and microbiology. None of these topics would be covered at one specific time. For example, two days would not be set aside for the study of parasitology because very few students in a high school biology class would be interested in that particular field of study. In almost any discussion of diseases parasites would be mentioned, and at this time a brief discussion of parasitology would be appropriate. If a particular student shows an interest in the subject of parasitology the teacher should always be prepared to help him find information on the subject.

(2) Interest in the living world.

All biology courses should develop an interest and curiosity on the part of the students in the living world. One of the objectives of a teacher should be to make students familiar with the plants and animals that live in his community. If a student already knows the common names of the plants around him, he will become curious when a plant is found that he does not know. The writer feels that teaching names of plants and animals to high school students is worthwhile because this is an important factor in helping the student to gain an appreciation of the

world around him. Most of the general concepts of heredity, evolution, diversity in nature, and ecology can best be understood when the students have concrete examples of these concepts in the community in which they live. A study of ecology will develop an appreciation of nature. The green version of the BSCS text stresses the ecological approach. This is the reason the writer feels that it is best of the three BSCS versions. Ecology is an area of biology which all students, no matter what they do later in life, will find interesting. Ecology and classification of plants and animals will add considerably to the student's appreciation of life. In fact, if the proper methods of teaching are used, almost every subject taught in biology can add to appreciation of life.

(3) Ability to find information.

One area that will add to the personal life of a student is the ability to find information. If a student is trained to use the Biological Abstracts, Readers' Guide, and other bibliographical material, he will know how to find the latest information on a subject. The ability to find information can be taught along with other subjects.

(4) Science as enquiry.

The main emphasis of BSCS biology has been the expressed goal of conveying and understanding of the processes of biological science as well as of its products. The phrase "science as enquiry" is used to designate these processes. This too is one thing that cannot be taught separately, but the whole idea of the modern biology course should be to get the student to investigate and to find out why. This attitude of enquiry will be useful no matter what the student's occupation.

(5) Personal health.

Starting with the first grade the student is told about his body

functions and how to take care of his body. The purpose of a high school biology class should not be to review monotonously all the ideas and principles covered in previous years. High school biology should indicate to the student the frontiers of knowledge that scientists have established in the field of health. One area that should be stressed is mental health. An understanding of the causes, treatment and research on mental illness should be obtained by every high school student. The realtive importance of this area of study is pointed up by the fact that nearly one of every four cases of illness is mental.

(6) General knowledge of life.

The topics which are taught to give a student a general knowledge of life will depend a great deal upon the teacher. The nine unifying themes of BSCS give a good general framework for deciding what should be covered to achieve the aim of general knowledge of life. (19)

The nine unifying themes of BSCS biology are the following:

(A) Change of living things through time.

(B) Diversity of type and unity of pattern in living things.

(C) The genetic continuity of life.

(D) The complementarity of organism and environment.

(E) The biological roots of behavior.

(F) The complementarity of structure and function.

(G) Regulation and homeostasis; preservation of life in face of change.

(H) Science as inquiry.

(I) The history of biological conceptions.

By careful use of these nine unifying themes a good general knowledge of biology can be obtained. The following paragraphs give a brief

description of those subjects which might be covered by the themes.

Evolution is the first of these and the most basic of the nine BSCS themes. Good sense and order of the similarities and differences among living things can only be made by reference to their evolution. The relations of living things to the particular environment in which they live, their distribution over the surface of the earth, the comings and goings of their parts during development, even the chemistry by which they obtain energy and exchange it--all such matters find illumination and explanation, in whole or in part, from the history of life on earth.

Two areas are covered by the second theme, "Diversity of Type and Unity of Pattern in Living Things". First the extraordinary diversity of living forms and their adaptation to widely diverse environmental conditions are striking characteristics of life entirely apart from their connection with evolution. The second area illustrated by this theme is the well-known similarity of pattern among such diverse parts as the limbs of different vertebrates. There is also the virtually universal role of ATP as the vehicle for energy transfer among all living things.

The complementarity of organism and environment is part of the theme of evolution, especially where it concerns the environment of the whole organism. Topics covering the theme would emphasize the interplay of organism and environment. This theme would also bring out the reciprocal relation of living unit and environment. Reciprocity is seen most vividly in what man has done to and with his environment in creating the need for and the possibility of conservation.

The theme, the genetic continuity of life, is a part of evolution. This theme is dealt with most by the subject of heredity.

The next theme is "The Biological Roots of Behavior". It is important that the student understands that there are limits to what he can do, limits imposed by his biology. Behavior should be taught as rising from the experience of the individual, but also from the experience of his forebears, that is the stored experience arising from variation and selection in evolution.

To understand the ways by which an organ is made sensitive and responsive to demand put on it by changing conditions of environment is the meaning of the theme "Regulation and Homeostatis".

The last factor, the type of student, affects the methods of teaching more than the topics covered. A slow student can be taught ecology the same as an advanced student. The difference between the two groups is the greater amount of depth and detail that can be covered with an advanced student. Every student is an individual and a teacher must always be aware of this, and take advantage of the various interests of the students.

The purpose for teaching determines what topics a teacher will cover. Time, facilities, and the type of students will determine how much detail a teacher will go into on a particular topic.

CHAPTER V

SUMMARY AND CONCLUSION

This report is summarized in Table III. In Table III the writer has given a list of subjects, length of time devoted to each topic, and order of each as he would teach them in a high school biology class.

It is concluded that the subject matter taught in most high school biology classes is practically the same. The greatest difference as demonstrated by BSCS is the approach or method of teaching by inquiry.

What topics should be included in high school biology? It does not matter as long as the topic is up to date, accurate, and accomplishes or develops one of these six objectives: ability to make a living, interest in the living world, ability to find information, science as inquiry, personal health, and general knowledge of life.

TABLE III

SUGGESTED TOPICS IN HIGH SCHOOL BIOLOGY

Days	Subject
5	Balance in nature Biosphere Scientist's viewpoint Energy, matter Food webs
25	Individuals and populations Communities and ecosystems Principles of classification Animals and plants
10	Protists
5	Ecology of microorganisms
15	Distribution of land organisms
5	Aquatic environments
10	Patterns of life in the past
10	The Cell
5	Photosynthesis
10	Roots Stems Leaves
20	Digestion Respiration Circulation Blood Excretion

TABLE III (Continued)

Days	Subject
	Endocrine, glands
	Nervous system
	Muscles and skeletons
10	Reproduction
	Heredity
15	
	Adaptation
	Behavior
15	
	Mental Health
10	Man and the biosphere

LITERATURE CITED

(1) Baker, Arthur O. and Mills, Lewis H., Dynamic Biology, New York: Rand McNally, 1938.

(2) Boyles, Ernest E. and Burnett, Will R., Biology for Better Living, Chicago: Silver Burdett Company, 1944.

(3) Boothroyd, C. W., "The Place of Plant Pathology in High School Biology." Am. Bio. Teacher, Vol. 26, (1964), pp. 114-117.

(4) Brown, Relis B., Biology, Boston: D. C. Heath and Company, 1961.

(5) BSCS Green Version, High School Biology, Chicago: Rand McNally Company, 1963.

(6) Commoner, Ban, "Biology Today", N.E.A. Journal, Vol. 53, (March, 1964), pp. 17-20.

(7) Cox, H. T., "Modern Biology: A Unifying Science" Journal Sec. Ed. Vol. 39, (Jan., 1964), pp. 9-13.

(8) Fordyce, Phillip R., "The Advanced Biology Course", Am. Bio. Teacher, Vol. 21, (May, 1959), pp. 168-170.

(9) Grobman, Arnold B., "High School Biology Course Modernizing", Sci. News Letter, Vol. 80, (Nov., 1961), p. 321.

(10) Heiss, Elwood D. and Lape, Richard H., Biology, A Basic Science, New York: D. Van Nostrand Company, 1958.

(11) Janu, Rudolph, "The New Science Curriculums" Sch. Mgt., Vol. 7, (Jan., 1963), p. 63.

(12) Kastrinos, W., "The Relationship of Two Methods of Teaching to the Development of Critical Thinking by High School Students in Advanced Biology", Sci. Ed., Vol. 48, (Mar., 1964), pp. 187-195.

(13) Klinge, Paul, "Biology Bright Future", Am. Bio. Teacher, Vol. 22, (Oct., 1963), pp. 13-20.

(14) Lisonbee, L., "Teaching Science to the Disadvantaged Pupil", Sci. Teacher, Vol. 30, (Oct., 1963), pp. 18-21.

(15) Morley, F. and Leake, C. D., "Biology Future Predicted", Sci. News Letter, Vol. 83, (Apr. 27, 1963), p. 259.

(16) Moon, Truman J., Mann, Paul B., and Otto, James H., Modern Biology, New York: Henry Holt and Company, 1947.

(17) Roney, Burr, "Problems of Content and Level", Am. Bio. Teacher, Vol. 22, (April, 1960), pp. 199-203.

(18) Sarafian, K. A., "Philosophy of Education for Biology Teachers", Am. Bio. Teacher, Vol. 1, (Feb., 1939), pp. 96-97.

(19) Schwab, Joseph S., Biology Teachers Handbook, New York: John Wiley and Sons Inc., 1963.

(20) Smith, Ella Thea and Lisbonbee, Lorenzo, Your Biology, New York: Harcourt Brace and World Inc., 1962.

(21) Smith, Samuel, Gressman, George R., and Speer, Robert R., Education and Society, New York: The Dryden Press, 1942.

(22) Stickler, Hugh, "Teaching High School Biology", Am. Bio. Teach., Vol. 17, (Jan., 1955), pp. 30-34.

(23) Walsh, Michael P., "Careers in Biology", Am. Bio. Teach., Vol. 16, (Nov., 1954), pp. 176-178.

(24) Wideman, Charles J. and Sister Raphaelis Gehlen, The Biological World, Chicago: Loyola University Press, 1962.

VITA

Donald Ray Caskey

Candidate for the Degree of

Master of Science

Report: TOPICS INCLUDED IN HIGH SCHOOL BIOLOGY

Major Field: Natural Science

Biographical:

Personal Data: Born in Ponca City, Oklahoma, September 24, 1936, the son of Raymond L. and Edna A. Caskey.

Education: Attended grade schools in Enid and Stillwater, Oklahoma; was graduated from Stillwater High School in 1954; received the Bachelor of Science Degree from Oklahoma State University in May, 1959; attended Oklahoma State University as an Academic Year Institute participant in 1963-1964; completed requirements for the Master of Science degree in August, 1964.

Professional experience: Taught biology, chemistry, and general science at Union High School, Broken Arrow, Oklahoma, 1959-1963. A member of National Science Teachers of America and Oklahoma Education Association.