Thesis Approved

BY

Lee R. Kennedy, M.A., Major Adviser

Dean
THE IMPROVEMENT OF INSTRUCTION IN HIGH SCHOOL GENERAL BIOLOGY

BY

JAMES F. MANNING

A THESIS

Submitted to the Faculty of the Graduate School of the Creighton University in Partial Fulfillment of the Requirements for the Degree of Master of Arts in the Department of Education

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CHAPTER I

Introduction

The purpose of this study is, primarily, to develop an outline in General Biology suitable to the instructional situation at the Norfolk Senior High School, Norfolk, Nebraska, but it is hoped that it may be of some service to teachers and students of biology in other high schools. Various community demands, location, and needs will dictate to a great extent the use of this outline in a particular locality.

The writer first became interested in the present study four years ago. It was at this time that former Norfolk High School students who had taken biology began enrolling in the general biology classes at the Norfolk Junior College. This made possible an opportunity for comparison of the students who had taken biology in other schools with those from Norfolk. It was found in several instances that the students from Norfolk were superior to those of other schools in some achievement areas and inferior in other areas. Some of the reasons for these differences will be presented later. However, the recognition of the difference did serve as a motivation for the desire to improve the instruction of biology. In this thesis the writer will bring together various techniques, data, and experiences which he hopes will
make for the improvement of biology teaching not only in Norfolk High School, but also in other schools.

Since it is a universally accepted truth that education is the development of the whole child, one must at the outset consider the following questions: What is biology? In what ways does it fulfill the needs of the child? How has it as a subject in the curriculum developed?

The name biology is made up of two Greek words, bios, meaning "life," and logos meaning "knowledge or study." Therefore one might say biology means "life science" or the "study of life." In one sense biology is the oldest branch of science, but in the interpretation of biology as an organized science, it is much more recent.

Biology deals with every kind of organism that lives or has lived on the earth, from a one-hundred-and-fifty-ton whale to a virus too small to be seen except with an electron microscope. Biology includes not only the things that are recognized as being clearly plants or animals, but also certain ones that are "border-line" creatures. These are so-called because they possess characteristics of both plants and animals. Biology is, therefore, broader in scope than most people realize. It makes up a great portion of a person's daily life both of the mental and physical side, as well as many of the vocations by which he may earn a livelihood.
Even though biology began with the Greeks, its development from that time to the present has been neither gradual nor steady. Much of the knowledge of living things has been acquired since the seventeenth century. And although during the past three hundred years biology has developed rapidly, during the past twenty-five years it has made almost unbelievable progress.

According to Moon, Mann, and Otto, in their text, Modern Biology, the history of biology covers four principal eras.

These eras are not just periods of time necessary to build our knowledge of science. Rather, they are steps in the development of the methods and attitudes of science.

1. Primitive man and the era of magic and superstition.
2. Greek medicine and the dawn of biology.
3. The dark ages of science.
4. The rebirth of science.

The first courses in biology as a separate subject are traceable to around the year 1850. Earlier courses in natural history were, primarily, botany and zoology; however, as time went on, a need was felt by some that a combined course might be more acceptable and might more adequately suit the needs of students in general. The courses in botany and zoology were retained, primarily for those people interested in agriculture, medicine, and the like.

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In an article, *Trends in High School Biology*, Fred Fitzpatrick states:

Thomas Huxley had introduced a course in biology in the middle of the nineteenth century, and one of his former pupils established a similar offering at the Johns Hopkins University. In the latter quarter of the century, biology courses were added to the curriculums of various American colleges, and, at the same time, the trend was represented by experimental offerings in some secondary schools. So when the Committee on College Entrance Requirements looked with favor upon the proposal for a high-school biology course, and when a New York syllabus in biology appeared (1905), the great change was under way. This change was ultimately to be of great significance, because later on it paved the way for converting the high-school biology course to the purposes of general education.\(^2\)

Many of the early high-school biology courses were nothing more than a fusion of botany, zoology, and physiology. Later, however, other areas of natural science were included, such as psychology, anthropology, and geology. Other trends in high-school biology are discussed in an article in the *Forty-sixth Yearbook* by J. Gordon Manzer.

As the high-school population became less selective, significant modifications of the biology course were instituted. From necessity, the subject matter has become less technical, more practical, and the trend has been toward a unified course, with increasing emphasis on its functional values. For example, the *Thirty-first Yearbook* called attention to the value of fundamental generalizations in the field of science. It was suggested that experiences of all relevant kinds should be made to contribute to the understanding of the generalizations, which might then be expected to make other experiences.

meaningful and to determine appropriate action in problem situations.

The kind of thinking that is represented in the Thirty-first Yearbook has resulted in considerable change and improvement in science courses. However, it is quite possible to "teach" even a major generalization without making it functional. Pupils may be able to state a principle correctly and to answer questions about it, but if they do not use it in ordinary life situations, they do not truly learn it.3

During the past thirty years, biology has changed considerably. One might say its content has been quite "fluid," especially, since so many educators have urged various changes in educational systems. Significant gains in offerings and pupil enrollments have taken place even since World War II. The Forty-sixth Yearbook committee comments that "...the trend has been toward focusing attention less on the organization of the subject matter and more on the results in the lives of the learners."4

The study of biology is fascinating because it is never static; fresh discoveries are constantly being made.

The biology teacher who can forget that he is an instructor and adopt the inquisitive, searching spirit of his class will best use his opportunity of shaping their normal curiosity into a serious interest in this exciting subject.5

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5Dodge, Ruth A., Teachers' Manual for Elements of Biology, Allyn and Bacon, 1948, p. iii.
Often the minds of high-school students are filled with questions about their world—its animals, its plants, and their own bodies and how they function. The high-school biology course should not only answer these questions but also stimulate the students to ask for more information pertaining to these desired inquiries.

The Problem

As was stated at the beginning of this thesis, the purpose is to develop an outline in general biology suitable to the instructional situation in the Norfolk Senior High School. This involved an evaluation of the objectives, content, methods, and techniques of the course as it has been taught during the past six years. It also involves an evaluation of some of the current trends in biology instruction. On the basis of the foregoing analysis an instructional plan for teaching biology in the Norfolk Senior High School has been developed.

The Materials

In addition to the above mentioned activities, nine biology textbooks were compared. Two of the texts were published in 1924, one in 1932, the remaining six, more recent, within the last six or seven years. These nine textbooks were chosen because of their varying ages to show the changes of content that have taken place.

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6See Appendix A.
since 1924 so that the writer could show the current
trends in the subject matter and its organization.

The Procedure

First, a comparison was made of the previously
mentioned textbooks of general biology. These data are
included in Tables I and II. Subject matter was counted
in lines, based on fifteen words per line of the single
column page. Although some of the texts were of the
double column pages, the words were counted so as to
indicate a fifteen-word line across the page. The sub­
ject matter headings of the columns of Tables were taken
from the more recent texts.

Secondly, an evaluation was made of the biology
instructional set-up and the instruction in the Norfolk
High School, based on material from Evaluative Criteria. Also evaluated, were the types of courses of certain
other schools, which appeared in the available literature.

Thirdly, a set of objectives were developed
which are applicable to the situation in Norfolk High
School. Some of these objectives are used by biology
instructors throughout the country, however, others may
be somewhat restrictive to Norfolk or other localities.

Fourthly, the outline was developed so as to

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7Cooperative Study of Secondary-School Standards,
include the materials that would make for a more complete course in high-school general biology as the writer views it on the basis of the present investigation.
CHAPTER II

Comparison of the Textbooks

The writer's decision to compare texts is traceable to the selection of the topic for this thesis. However, he has been interested in the subject matter content of high-school biology texts for a good many years. It is interesting to note the changes that have taken place since 1924, the year of publication of two of the texts compared.

Since each biology instructor has his or her own objectives and methods which will determine the choice of texts, the writer will not include techniques of choosing textbooks. As was mentioned previously in this thesis, the local situation will play an important part in the type of course taught and will automatically influence the choice of text. For example, in the opinion of the writer, the text which had been in use in the Norfolk High School prior to the advent of the writer, did not contain sufficient material with regard to soil conservation. Since soil erosion is a problem in the Norfolk area, he used soil conservation as one of the criterion in selecting a text suitable for the biology classes of Norfolk High School.

The topics for comparison were taken from the more recent books, since it is from these that the teachers are going to be organizing their courses. This selection
includes topics that most people of today should know something about in order to live a more healthful and enjoyable life. Also included, are topics rather typical to the average high school biology class of today. It may be noted in Table I, that there is a good deal of agreement among the authors as to the content of their books, although the amount of this material does vary considerably in the different books.

As the writer interprets the general objectives of education in biology, they include the acquisition of functional information and functional understandings of principles, the development of instrumental and problem solving skills, and the development of better attitudes, appreciations and interests. The problem that develops from these concepts is to select wisely the material without being too concerned with the so-called "traditional content" of biology at the various points in the course.

It is with some of these concepts in mind, that the writer examined the textbooks and proceeded with the comparison of them. In this study it was found, for example, that six or approximately sixty-six per cent of the books, contained material on the topic of "Periods of Geologic Time;" five or approximately fifty-five per cent, had some material regarding "Radio-active carbons" with reference to their use in biology. Three of the remaining four were written before the "Atomic Age" began; the fourth, although written in 1947, did not include any
material on atomic developments. A recent edition of
this book, does however, contain considerable informa-
tion on atomic developments in the field of biology.

All of the texts made considerable reference to
thirteen of the topic headings indicating some agreement
among the authors as to the content of a general biology
course. Some of the books, however, do show a great deal
more than others in certain areas of study. For example,
four of them contain much more material on conservation
of natural resources than any of the other topics com-
pared. This no doubt is due to the national trend
toward the increased interest and study in the conserv-
ation of the various types of wildlife and so-called
natural resources of the United States. The text which
contains the least on conservation is the most recent
of the texts compared. It was written by two instructors
in the New York City Schools, where the study of conserv-
vation might not be considered as pressing as it is in
other parts of the United States.

Table II shows the breakdown of the three topic
areas mentioned in the two preceding paragraphs. The
breakdown is done, showing the total lines of the topics
and the percentages of these areas with regard to the
total subject matter content of each of the texts.

It is significant to note the general increase
in subject matter content of the three areas which were
chosen arbitrarily for this comparison. Considerable emphasis has been given to these topics in recent years, thus, there has been increased amounts of material given to them in the newer texts.

The area of taxonomy, or that phase of biology which is devoted to classification of plants and animals, has not generally increased as some of the other areas. As a matter of fact, it has dropped significantly if it is compared with conservation, disease, or even evolution. The reason for the drop is that less emphasis is now being given to taxonomy as such. At the present time and many years ago, prior to biology as a course, taxonomy is and was an integral part of botany and zoology. Today there are still the systematists and some systematic studies included in the grouping of the plants and animals, but not so much in biology.

In the text, Everyday Problems in Biology by Pieper, Beauchamp, and Frank, nearly four times as many lines were devoted to taxonomy as in any of the other texts except, Exploring Biology by Ella Thea Smith.

In order that the writer might more thoroughly reorganize the course that he was teaching it was necessary to recognize some of the changes that have taken

\[\text{See Appendix A}\]

\[\text{Ibid}\]
place since the development of biology as a course. The only methods by which this could be done, was to compare texts, various syllabi, or courses of study which might be available. The former, the comparison of texts method, was chosen. The technique of comparison was given in Chapter I, the results in Tables I and II in this chapter.

Tables I and II show the trends, or at least, the attempts of the authors to meet the trends and the demands of the biology instructors in the past and present.

When the New York syllabus in biology was developed in 1905, a great change began as compared with the earlier types of biological science instruction. This change was of considerable significance, because it later on paved the way for converting the high-school biology course to the purposes of general education.

Many of the early secondary-school biology courses represented little more than a telescoping of pre-existing botany, zoology, and physiology courses so that they comprised a single offering. But early in the 20th century, college biologists instituted another controversy as to the respective merits of the "traditional type" and the new "principles" courses, which was duly followed by repercussions on the secondary-school level. Fused courses began to appear in the secondary-schools.

One of the initial advantages of the fused courses was that they had no previous existence, it was a case of
starting with a clean page and selecting appropriate materials of instruction wherever they might be found.

It was not until 1920, that biology became a tenth grade course. Prior to 1920, biology was a ninth grade course along with general science after 1910. As this change came about, some of the problems of planning a curriculum in a school were solved, thus making possible the remaining two years of high school available to other science courses if they were so needed.

As was stated earlier in this thesis, the status of biology has been quite "fluid" the past thirty years. Such data as is available on the post-World War II period indicates that biology in general education is making significant gains in offerings and pupil enrollments. These gains in offerings and enrollment have also taken place in the Norfolk High School.

Some suggestions for the use of the subject matter and organization of a biology course, which the writer hopes has been indicated by the present trends in biology instruction, have been brought out in Chapter IV.
### Table I

**Comparison of High School Biology Textbook Subject Matter Content Based on 15 words per line**

<table>
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<tr>
<th>Author</th>
<th>Title</th>
<th>Publisher</th>
<th>Year</th>
<th>One-celled Organisms</th>
<th>Foods and Vitamins</th>
<th>Photosynthesis</th>
<th>Circulatory System</th>
<th>Excretory System</th>
<th>Endocrine System</th>
<th>Nervous System</th>
<th>Respiratory System</th>
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<td>Biology and Human Welfare</td>
<td>The Macmillan Company</td>
<td>1924</td>
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<td>Smallwood, Reveley, and Bailey</td>
<td>New Biology</td>
<td>Allyn and Bacon</td>
<td>1924</td>
<td>130</td>
<td>336</td>
<td>84</td>
<td>140</td>
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<td>Pieper, Beauchamp, and Frank</td>
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<td>Scott, Foreman and Co.</td>
<td>1932</td>
<td>86</td>
<td>387</td>
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<td>42</td>
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<td>Moon, Marn, and Otto</td>
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<td>Henry Holt and Co.</td>
<td>1947</td>
<td>554</td>
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<td>Curtis and Urban</td>
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<td>Ella Thea Smith</td>
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<td>Alexander A. Fried</td>
<td>High Points in Biology</td>
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<td>Eisman and Tanzer</td>
<td>Biology and Human Progress</td>
<td>Prentice-Hall, Inc.</td>
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CHAPTER III

An Evaluation of Biology Teaching on the High School Level

Before the author could proceed to any great extent in re-organizing the biology course at Norfolk High School, it was necessary to evaluate the course as it was currently being taught.

The evaluative material was taken from Evaluative Criteria, made by the Cooperative Study of Secondary-School Standards Committee, 1950 Edition. The explanations of the checklists and evaluations have been shortened somewhat to save space and time, however, they are essentially the same as the originals. There has been a general substitution of the word "biology" for the word "science" throughout this evaluation.

The Checklists:

✓ provision or condition is made extensively
✓ provision or condition is made to some extent
X provision or condition is very limited
M provision or condition is missing but needed
N provision or condition is not desirable or does not apply

The Evaluations:

5 Excellent
4 Very Good
3 Good
2 Fair
1 Poor
M Missing, if present, they would be helpful
N Does not apply
Statement of Guiding Principles

The biology course consists of those activities, and units of instruction which are designed to meet pupil needs related to science. Major emphasis in the course is upon (1) the understanding and application of major biological principles; (2) the development of competence in the use of the scientific method; and (3) the development of desirable attitudes, interests, and appreciation related to biology and its applications.

The course provides opportunities for all pupils to participate in biological activities to meet their common needs and interests. Provision is also made for additional offerings to meet the special needs, usually vocational or technical in nature, of some pupils.

The learning activities are conducted in a classroom-laboratory situation providing opportunity for group instruction and individual and group investigation and experimentation. Pupils also participate in field activities providing opportunity to study and apply scientific principles outside the classroom. During the learning activities the teacher acts as a guide, keeping a proper balance between pupil-exploration and teacher direction.

Keeping the above mentioned principles or objectives in mind, the writer proceeded with the evaluation of the teaching of biology in the Norfolk Senior High School.
I. Organization

Checklist

(I) 1. General biology courses are required of all pupils. (Grade—10)

(X) 2. A unified biological-science course (general biology) is available to all pupils.

(X) 3. Biology courses are allotted a sufficient number of periods per week. (The number of periods per week is ___.)

( ) 4. Biology class periods are of sufficient length. (The period length is __ minutes.)

( ) 5. Provisions are made for some pupils to use the science facilities outside of regularly allotted class time.

( ) 6. Teachers are allowed time in their assigned duties to prepare for laboratory and demonstration experiments.

( ) 7. Consideration is given to such factors as type of activities, facilities available, and safety of pupils in determining class size.

Evaluations

(2) a. To what degree are general biology courses or activities provided for all pupils?

(4) b. To what extent do time allotments of the biology courses meet science instruction needs satisfactorily?

(1) c. To what degree are specialized biology courses or activities available to pupils with a specialized science needs?

(4) d. To what extent do the enrollments in biology courses show that the needs of all pupils for instruction in biology are being met? (Below is shown the enrollment for two previous years, with the number of sections of biology. Also shown is the number of registrants for 1954-55 and the addition of another section to be taught by the physical science instructor.)

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Pupils</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1917-18</td>
<td>49</td>
<td>2</td>
</tr>
<tr>
<td>1953-54</td>
<td>74</td>
<td>2</td>
</tr>
<tr>
<td>1954-55</td>
<td>110</td>
<td>3</td>
</tr>
</tbody>
</table>
II. Nature of Offering

Checklist

The biology course includes experiences

1. That develop knowledge, understanding, and appreciation of important principles of biology.

2. That provide practice in applying important scientific principles in laboratory situations.

3. That develop an understanding of the contributions of biology to daily life.

4. That require manipulation of scientific equipment and measurement with scientific instruments.

5. That provide opportunity for pupils to design and construct technical or semitechnical apparatus and equipment.

6. In reading and interpreting various types of scientific publications.

7. That develop an understanding of the elements of the scientific method.

8. That encourage the development of a variety of scientific interests.

9. That provide opportunity to study problems involving biology in the home and local community.

10. That develop an understanding of the place of biology in the conservation of natural and human resources.

11. That emphasize recent scientific developments (e.g., atomic energy, sulfa drugs, penicillin).

12. That aid pupils in developing desirable scientific attitudes.

13. That include experiences with community resources through field trips.

Evaluations

(a) To what extent does the variety of offerings meet the various needs of the pupils?

(b) To what extent does the content of offerings meet the needs of the pupils?

(c) To what degree do the experiences stimulate pupils to apply methods of scientific growth?

(d) To what extent do the offerings provide for study and discussion of recent scientific development?

(e) To what extent are the science offerings related to life problems of pupils?
III. Physical Facilities

Checklist

(JJ) 1. Biology room is of sufficient size to accommodate largest class without crowding.
(M) 2. A work area, set apart from regular biology classroom, is provided for activities by individuals and small groups.
(JJ) 3. A fully equipped demonstration area or table is provided which is easily visible to all members of the class.
(JJ) 4. Biology room is equipped for use of audio-visual equipment.
(JJ) 5. Audio-visual projection equipment is available.
(M) 6. Ventilation is provided to free instructional area of dangerous or unpleasant gases.
(JJ) 7. Laboratory tables are provided for individual and small-group work.
(M) 8. Acid-resistant sinks are provided.
(JJ) 9. Cabinets or cases are available for display of materials.
(JJ) 10. Storage space is provided for laboratory supplies and equipment.
(JJ) 11. Biology materials and equipment are provided for class use.
(JJ) 12. Demonstration equipment is readily available.
(JJ) 13. First-aid kits, neutralizing solutions, and water are readily accessible to the pupils.
(JJ) 14. Gas and electricity are available for pupil use.
(JJ) 15. An aquarium is provided for the biology classroom.
(JJ) 16. A terrarium is provided for the biology classroom.
(JJ) 17. A system of record-keeping for equipment and supplies is used.

Evaluations

(4) a. How adequate are the space provisions for biology instruction?
(4) b. How adequate is the equipment to meet enrollment and curricular needs of pupils?
(4) c. How adequate are materials and supplies?
(4) d. How adequate are storage facilities for equipment and supplies?
(3) e. To what extent is equipment maintained in good condition?
(4) f. How effectively is teacher using the facilities?
IV. Direction of Learning

A. Instructional Staff

Checklist

All members of the science staff

(M) 1. Have had preparation in biological sciences.
(M) 2. Have had preparation in physical sciences.
(M) 3. Have had preparation in social sciences.
(V) 4. Have had intensive preparation in the science area in which they are now teaching.
(V) 5. Have had preparation in methods of teaching science.
(M) 6. Have had preparation in mathematics.
(V) 7. Are acquainted with recent scientific developments and their educational implications.
(V) 8. Are acquainted with recent developments in the teaching of science.
(N) 9. Have participated in science activities in industry or business.
(V) 10. Are familiar with resources of community.
(V) 11. Are continuing their in-service education.
(V) 12. Assist the librarian in the selection of science reading materials.

Evaluations

(l) a. How satisfactory is the preparation of the staff in science subject matter?
(l) b. How satisfactory is the preparation of the staff in methods of teaching science?
(l) c. To what extent is the science staff carrying on in-service training activities?
(l) d. How well are staff members prepared to make practical applications of scientific principles?

B. Instructional Activities

Checklist

(V) 1. Instruction in biology contributes to the school's objectives.
(V) 2. Instruction is directed toward clearly formulated, comprehensive objectives in science.
(V) 3. Specific instructional activities contribute to the comprehensive objectives of the science program.
( =) 4. There is evidence of careful planning and preparation of the instructional activities.
( V) 5. Flexible or differentiated assignments are used to provide for individual pupils.
6. Scientific resources of the community and environment are used.

7. Science activities of varying degrees of difficulty are provided.

8. Pupils are encouraged to raise and define scientific problems.

9. Particular emphasis is placed on experiments.

10. Models, charts, and specimens are used in the instructional activities.

11. Effective use is made of audio-visual aids in the instructional activities.

12. Field trips are conducted.

Evaluations

(3) a. How adequately does teacher plan for the instructional activities?

(3) b. How well are instructional activities adapted to needs of individual pupils?

(4) c. To what extent are effective teaching methods practiced?

(3) d. To what degree are activities integrated with out-of-school experiences of pupils?

(3) e. How effectively are field activities used?

C. Instructional Materials

Checklist

1. A variety of textbooks and reference materials is available.

2. Reading materials are available which provide for differences in the reading abilities and science backgrounds of pupils.

3. Science pamphlets and nontextbook materials are available.

4. Biological magazines are available.

5. Well-edited booklists are available.

6. Teacher-prepared materials are available.

7. Films, filmstrips, and slides are available.

8. Microprojection apparatus is available.

9. Models and specimens are provided.

10. Charts, maps, and similar visual aids are provided.

11. Audio-aids are available for classroom use.

Evaluations

(5) a. How adequate is the variety of instructional materials?

(5) b. How adequate is the content of the instructional materials?
How well are pupils guided in the effective use of instructional materials?

D. Methods of Evaluation

1. Evaluation is an integral part of the instructional activities.

2. Evaluation activities place emphasis upon the growth of the individual toward appropriate objectives in biology.

3. A variety of testing techniques is used.

4. Diagrams, charts, and pictures are used in tests and evaluation.

5. Objective evaluation is made of the laboratory activities of the pupils.

6. Evaluation is made of pupil reports of their own laboratory investigations.

7. Evaluation is made of pupil ability to apply the elements of scientific method.

8. Evaluation is made of pupil science projects which are conducted out of school.

9. Pupils participate in the evaluation of their own progress in the learning activities.

10. Both teacher and pupils recognize that tests should be used to reveal strengths and to point out areas for improvement.

Evaluations

a. How comprehensive are the evaluation activities in biology?

b. To what extent does teacher use evaluation results in analyzing the effectiveness of his teaching?

c. To what extent do evaluation procedures help the pupil understand the nature of his growth in biology?

d. To what extent do evaluation procedures measure pupil ability to make practical application of biological principles?

e. To what extent do evaluation procedures identify pupils of unusual promise in the field of biology?

V. Outcomes

(No checklist items are prepared for this division since they would largely be repetitions of the checklist items in preceding divisions)
Evaluations

(3) a. To what degree do pupils exhibit and understanding of biological principles?

(2) b. To what degree do pupils possess skill in interpreting biological information and literature?

(4) c. To what degree do pupils possess skill in using scientific apparatus?

(3) d. To what degree do pupils exhibit ability to apply the elements of scientific methods in solving problems?

(3) e. To what degree do pupils exhibit an interest in biology as shown by their leisure and hobby activities?

(3) f. To what degree are pupils acquiring scientific knowledges and skills to prepare them for work or further education?

(3) g. To what degree do pupils possess a knowledge of vocational opportunities open to them in the field of biology?

VI. Special Characteristics of Biology

1. In what respects is the biology instruction most satisfactory and commendable?

   a. The laboratory facilities and equipment are adequate and have been used to good advantage.

   b. The utilization of charts, models, and specimens have been something for the pupils to "get their hands on", especially since most high school students need something tangible in their science studies.

   c. The use of sound projected films and filmstrips have been of great benefit to the instructor in classroom procedure.

   d. The enrollment has increased considerably over the past seven years.

2. In what respects is there greatest need for improving biology instruction?

   a. The area needing the most improvement is that part devoted to making lesson plans and the preparation of other materials for class recitation.

   b. Some improvement of some of the laboratory exercises is needed.

   c. The size of the classes should be reduced from an average of about 35 to 28; to make for better use of the facilities.
d. More adequate utilization of field trips should be made. This might be done by taking more trips and smaller groups.

e. General biology should be required of all Norfolk High School students.

f. More student evaluative procedures should be used. There average has been one test per week and one written daily paper a week.

g. The time allotment for each class should be increased to 60 minutes. This, of course, is an administrative problem and should be done for all classes in the Norfolk High School.

h. There should be added to the staff, one more biology instructor. At present, one teacher handles all the natural science classes in the Norfolk High School and the Junior College.

Evaluation of Certain Other School's Biology Instruction

Carrying the evaluation of current trends in biology instruction to a few other schools as found in the literature, the writer summarized some of the courses and evaluated them separately. This evaluation was done in brief paragraph form, rather than the outline form, as in the case of the Norfolk High School. Since the material was secured by research it was impossible to evaluate it in the same manner as the Norfolk course.

An account of the biology course at the Glens Falls, New York High School was given in New Directions in Science Teaching by Laton and Powers. A portion of that account is quoted on the following page.
The tenth-grade biology course at Glens Falls was originally planned for students who did not intend to go to college. As a matter of fact, many of them would not finish high school. Almost all the work of one semester was based on the concept of the human life span. This concept was used as an organizing framework for a wide variety of facts.

The introduction consisted of a general overview of plant and animal life. Life-cycles of plants, protozoans, insects, and frogs formed the background for the questions: Do human beings live through a life cycle? Do they go through changes as these other living things do?

The class listed stages in the human life span from birth to death but omitted any mention of the prenatal stage. When this omission was pointed out by the teacher, more questions were asked about this first stage of life than about all of the others.10

From the material quoted above in the last paragraph, the class and instructor in the Glens Falls school proceeded with what appeared to be a very good study of the human life span. There is no doubt in the mind of this writer that the pupils in that class learned much about life in a well directed manner. Pupil participation in the planning of a course can be good only if well directed by a competent instructor. Since there was considerable activity on the part of the students in this case, plenty of guidance from the teacher was necessary. From the account of the course, the results must have been good.

The point this author would like to make is that a type of a course set up like the one in Glens Falls...
Falls, might have been all right for Glens Falls but not Merna, Nebraska. The location of the school, the type of people served, and the objectives of the instructor will determine whether or not the "Glens Falls" course would be adaptable to a particular school.

EVALUATION—Good, especially in an area where the education of many of the young people will terminate with the completion of high school, if not before. The type of course might also be used in other situations depending on the circumstances.

A course in general biology, sponsored by the departments of zoology and botany at Arsenal Technical Schools, Indianapolis, Indiana, was developed experimentally in 1940-1941. Students desiring to take a course in biological science were placed in biology if they had averaged C or below in the last semester of English. Otherwise, they were assigned to botany or zoology, according to their interests.

The content of the biology course was made up chiefly of material on conservation, health, and recreation. Emphasis was on (1) world problems of distribution and (2) food and health habits to build strong bodies, for peace, war, and other emergencies.

From the information available, the chief problem was the large number of absences and withdrawals. This
was believed to be due to the low scholastic records.

EVALUATION—The evaluation of this course was made by the teachers of the course. Quoting from Laton and Powers:

At the end of three years it seemed proved beyond a doubt that the biology course had a definite place in the science curriculum. Some teachers even questioned the desirability of offering it to the slower students only. However, it was true that the botany and zoology classes now contained only those students who were definitely interested in, and able to cope with, those subjects on a college-preparatory level.11

In 1940, the faculty of the New Trier High School, in Winnetka, Illinois, felt that a portion of the student body, namely, the non-college-preparatory students were being inadequately served in the area of biology.

A plan was so devised to place the non-college-preparatory group in special classes in biology. The course was so planned to include only material that the students could apply in understanding and facilitating their own development, in developing their own philosophies, or in understanding the society in which they live and its problems.

Needless to say, the students participated in planning the course, since this school has been classified as a progressive school. Student committees were

11 Ibid., pp. 43-44.
assigned to give special reports and demonstrations to the class as a whole. Observers were impressed by the work of the committees and how they accepted their responsibility of educating their fellow students.

EVALUATION--In the opinion of this writer, the course without a doubt, did much for many of the students, especially those who participated on the committees. However, such a plan needs careful direction and may be usable only in certain situations, depending upon the philosophy of the school.

Summarizing the evaluation of the biology course as taught in Norfolk and those of certain other schools, it is the opinion of the writer, that the courses in the other schools were applicable in their situations, but that the course as it was being taught in Norfolk, needed revision.
CHAPTER IV
Proposed General Biology Course

The course in general biology as proposed for the Norfolk High School and certain other schools, whose instructors may find the course outline helpful, has been developed on the following basis:

1. Based on certain principles, following a basic text.
2. Specialized treatment of botany, zoology, physiology, and environmental factors.
3. Problems of daily living, particularly, human everyday living.

The text which has been used, was *Biology in Daily Life*, by Curtis and Urban. This text and its authors have emphasized the following objectives as the most important in a general biology course:

1. To develop functional understandings of scientific (biological) principles.
2. To develop scientific attitudes.
3. To develop a clear understanding of the nature and importance of the scientific method and a facility in its use.

The authors of *Biology in Daily Life*, state that "the understanding of a principle becomes functional when the pupil has mastered its meaning to such an extent that he can apply it in interpreting new observations and experiences in everyday life." The student who can do this has learned a principle, not to the extent that he knows it as a fact from memory, but as something applicable to his own life.

The development of a scientific attitude has to be brought about by teaching specifically and repeatedly those things which tend to eliminate such ideas as superstition, race prejudice, gullibility, and intolerance.

The development of an understanding of the scientific method has received a great deal of emphasis the past twenty-five years. Perhaps too much for many of the general biology courses as they have been taught. Not all of the students in general biology become scientists, therefore, the emphasis need not be so great as some instructors and authors have expressed that it should be stressed. Certain logical reasoning should be a part of all learning situations, but may not necessarily be set down step by step, as in the scientific method. True, in many cases, a scientific approach would be necessary. For example, in following the directions for certain experiments, the necessity of setting up the problem with a control should be done, otherwise, no comparison could be made. Likewise, the other steps of the scientific method should be followed.

The construction of the outline for the Norfolk High School biology course was also based, on the fact that no laboratory workbook was to be used. Laboratory work exercises have been made by the writer over a period of years, with various substitutions and deletions being made as the case might have warranted. The laboratory
exercises, as a whole, have not been included in the outline. The principal reason being, that since many instructors do use a workbook or have their own exercises, the writer's exercises might not be particularly helpful.

It must be remembered that biology is such a broad field of study, that no one individual could learn all that is known about it in a lifetime, therefore, it be possible that some will feel that certain areas need more emphasis than others. Much of the student's knowledge of biology must be gained from reading, discussion, laboratory and field study. The completion of a course in biology has to be brought about by certain objectives. The course in Norfolk has been based upon the following goals or objectives in biology:

**Objectives**

1. To become familiar with living things.
2. To develop, through the study of organisms, an understanding of the basic principles of life.
3. To develop, through understanding, an attitude of respect for living things.
4. To develop in every individual a cooperation attitude toward conservation programs.
5. To acquire, through practice, the scientific method of observing and reasoning.
6. To improve general standards of health through a better understanding of ourselves and the problems of disease.
7. To acquaint the students with some of the outstanding contributors to biological knowledge.
8. To improve the students knowledge of biological occupations.
9. To make biology a vital, human subject.
10. To develop an appreciation of nature.
Content

The material covered in the outline was based upon the content of the text used in Norfolk, *Biology in Daily Life*, by Francis D. Curtis and John Urban. Supplementary readings in other texts and scientific literature should be made by the instructor as the course progresses.

Methods

The writer has suggested that the local situation has control over the type of course that is offered. This is, the administration to a great extent, could advise the instructor as to the techniques, plans, and discipline that is expected of the instructor. The following methods, however, have proved to be useful in many situations. Perhaps, a combination of all or some of them would prove to be acceptable in a majority of biology classes.

1. The textbook-recitation method.
2. The laboratory method.
3. The demonstration-lecture method.
4. The problem-project method.
5. The principles method.

Pupil Evaluation

While everyone who has gone to school is familiar with the words, "test" and "examination," it is hoped that the term "evaluation" will carry a significance which will not become synonymous with these better known words. Evaluation is intended to do a great deal more than "test". An evaluation program should, (1) measure in every sense
that which tests and examinations are supposed to measure. 

(2) It should motivate, guide, and inspire the student 
and the instructor to do better work. (3) It should 
point out the strength and the weakness to both the 
teacher and student.

The types of pupil examination or evaluation should be varied so that both the teacher and pupils can determine whether or not the course objectives, as well as special objectives, have been accomplished. Therefore, both objective and subjective tests should be used in the evaluation program. Whether standardized tests should be used or not, often is an administrative problem. In the opinion of the writer, these tests have proved to be helpful, not only in the evaluation program, but also as an aid in promoting good public relations with the school patrons.

Further evaluation of the students in Norfolk has been possible through the requirement of this writer, that all students conduct a worthwhile project outside of their regular biology class and laboratory periods. Many very useful projects have resulted. For example, on display in the laboratory, is a set of chicken embryos which two students prepared from eggs secured from the local hatchery. It is optional to the students as to whether they keep the project or leave it in the school as a momento of their efforts.
CHAPTER V

Outline of the Proposed Course in General Biology

I. Introduction.
   A. Getting acquainted with biology.
      1. What biology is, by way of definition.
      2. What biology includes. The materials studied.
      3. Vocational values of biology.
      4. Everyday values of biology.

II. Problems and characteristics of living things.
   A. The changing populations of living things.
      1. Where living things are found.
         a. Life is distributed in space.
         b. Life is distributed in latitude.
         c. Life is distributed in time.
         e. Life is distributed in altitude.
   B. Why do populations of plants and animals change?
      1. Factors affecting the abundance of life.
         a. The available food supply.
         b. Temperature conditions.
         c. The abundance of water.
         d. The condition of the water.
         e. The amount of oxygen present.
         f. The amount of light.
         g. The presence of natural barriers.
h. The addition of a plant or an animal to a society or the elimination of a plant or an animal from it.

i. Diseases.

2. Balance of nature.

a. Every plant-and-animal society tends to establish and maintain a balance of nature.

b. A change in the membership, changes the balance of nature.

C. Biological principles applicable to parts A and B.

a. All life exists on or within a few miles of the surface of the earth.

b. As time passes, there is a biological succession; that is, there are changes in the kinds of plants and animals which populate any particular part of the earth.

c. Living things affect the environment, and the environment affects living things.

d. Living things tend to spread from their native habitats to new places.

e. Matter is changed from one form to another, but it can neither be created nor be destroyed.

f. Living things depend on one another in various ways.

g. Whenever a new kind of living thing settles in a habitat, it upsets to some extent the balance of life existing there.

h. All living things are constantly engaged in a struggle for existence.

D. Characteristics of all living things.

1. What are living things like?

a. Cells, the units of which all living things are composed.

b. Protoplasm, the "basis" of life.

c. Cell structures.

d. Combinations of cells; tissues, organs, and systems.
e. Division of labor.

f. Successful organisms.

2. Differences between plants and animals.

a. Plants, partly or wholly green. The green plants being independent; the others, partially or wholly dependent.

b. Most animals have locomotion.

c. Most plant cells have walls made chiefly of cellulose. No animal cells have walls composed of cellulose.

d. No plants have muscles and nerves. Most animals, except the very simple ones, have true muscular and nervous systems.

3. How living things are grouped and named.

a. Need for scientific names.

(1) For convenience in research throughout the world.

(2) For ease in classification.

b. The Linnaean System.

(1) The two-name system, or

(2) The Binomial System of Nomenclature.

c. A universal language through the use of "keys" and Latin.

4. Biological principles applicable to part D.

a. Living things vary in size from those too small to be seen, even with a microscope, to those as large as whales and large trees.

b. All living things are made up of one or more cells.

c. Cells are about the same size in both large and small living things.
d. All living things are composed of protoplasm, which differs in different kinds of living things and in different parts of the same organism.

e. Cells are organized into tissues, tissues into organs, and organs into systems.

f. Those kinds of living things are most likely to continue to exist which are best adapted to their habitats.

III. Kinds of Life (Unit Eight in Curtis and Urban (this "jump" from the first of the book to the last comes as a part of the course revision)).

A. The invertebrates, or animals without backbones.

1. Important facts about the one-celled animals.
   a. Where are the protozoans found? How do they live? On what do they live?
   b. Protozoa and man.

2. Animals with porous bodies, the sponges.
   a. Type of skeleton.
   b. Bodies composed of two layers of cells.
   c. Free-living, and aquatic.
   d. Sponges and man; of little importance since man's discovery of making cellulose sponges.

3. Animals with bag-like bodies.
   a. Coral animals, coral reefs and islands in many parts of the world.
   b. The Hydra.
   c. The Jellyfish, Portuguese man-of-war.
   d. Economic importance.

4. The Flatworms.
   a. The tapeworms.
   b. Liver flukes.
5. The roundworms.
   a. Trichinosis parasite.
   b. The pinworm.
   c. Various nematodes found in the soil.
6. The segmented worms or annelids.
   a. The earthworm.
   b. "Night-crawlers".
7. The spiny-skinned animals.
   a. The starfish.
   b. Sea urchin.
   c. Sea cucumber.
   d. Sand dollar.
8. The Mollusks.
   a. Clams.
   b. Oysters.
   c. Snails.
   d. Squids and Octopus.
   e. Mollusks and man.
9. The highest invertebrates, the Arthropods.
   a. The insects.
   b. The crustaceans.
   c. The spiders or Arachnids.
   d. The arthropods and man. The largest of all
groups or phyla of animals. In the group
are found some of the most useful and some
of the most harmful animals to man.
   e. Economic importance ranks high in the study
of the arthropods. The Class Insecta, perhaps
is the group most important to the economic
status of man.
B. The highest group of living things. The animals with the spinal cords, the chordates.

1. Animals with back bones, the vertebrates.
   a. The fishes, the perch.
   b. The amphibians, the frog.
   c. The reptiles, snakes and lizards.
   d. The birds, the sparrow.
   e. The mammals, the cat or rabbit as example.
   f. Examples and specimens of all the above groups of vertebrates should be studied in the classroom and laboratory, not only with regard to their makeup, but also as to how they affect man.

C. Biological principles for parts A and B of III.

1. From lower to higher forms of life there is an increasing complexity of structure, and this is accomplished by an increasing amount of division of labor.

2. Living things have become adapted to a wide range of physical conditions.

3. Protective adaptations are an aid to survival.

4. The biological functions of color are to conceal, to disguise, or to make conspicuous.

5. Each species of living organism is adapted to live wherever it has become established.

D. The four great groups that make up the plant kingdom.

1. The simplest plants, Algae and Fungi.
   a. The four classes, referring to the Algae.
   b. The Fungi.
   c. The Lichens.
   d. The economic importance of the Thallophytes, the phylum to which the above three groups belong.
2. The Mosses and Liverworts
A relatively small group of plants, quite widely distributed throughout the world. Found most abundantly in moist areas. The group is of little importance in relation to man's welfare.

3. The Ferns, Horsetails, and the Club Mosses.
   a. The ferns, most plentiful many million years ago.
   b. The horsetails, often called "snakegrass", "snakeweed", or "joint-grass".
   c. The club mosses, not true mosses, though they resemble them in several ways.
   d. The principle economic value of the ferns and their relatives, is that the ferns played a very prominent part in the formation of the coal beds of the earth.

4. The Seed-bearing plants.
   a. The gymnosperms, the pines, spruces, and firs.
   b. The angiosperms, the flowering plants.
      (1) Trees, bushes, and shrubs.
      (2) Many perennials, annuals, and biennials.
   c. Independent and dependent flowering plants.
   d. Seed plants and man. Thousands of years ago man first began to control seed plants for his advantage when he learned to raise food crops. Agriculture has been the most important industry ever since.

E. Biological principles for Part D.

1. Plants show an increasing complexity of structure from the algae and fungi to the seed plants.
2. Most plants are independent organisms.
3. Every living thing has its enemies.
4. Species not fitted to their environment will become extinct.
5. In order to survive, some plants and some animals form associations, examples of which are parasitism, commensalism, and symbiosis.

6. From the lower to the higher forms of plant life the body structure becomes more and more complex.

IV. Using our biological resources wisely.

A. Conservation of the Soil.

1. The origin of the soil.
   a. The changing of rock to soil.
   b. The shifting of the soil, wind, water, and glaciers.
   c. Plants reduce erosion by holding the soil in place.
   d. Plants help to make the soil.

2. How the top-soil is eroded away.
   a. Methods of using the land.
   b. Methods of plowing.
   c. Methods of grazing, and types of grazing animals.
   d. Destruction of the forests.
   e. Erosion by running water.
      (1) Sheet erosion, wind and water.
      (2) Gully erosion, by water.
      (3) The Dust Bowl.

3. Checking erosion.
   a. Contour plowing, furrows follow the same level across the field.
   b. Terracing.
   c. Strip cropping, planting alternate strips of different crops.
d. Mulch farming.
e. Rotation of crops.
f. Diversion ditches.
g. Cover crops.
h. Discontinuing the farming of some of the land.

4. Reclaiming the Dust Bowl.

B. Conservation of Needed Materials in the Soil

1. How water is lost from and returned to the soil.
   a. Rapid run-off.
   b. Evaporation.
   c. Transpiration from plants.
   d. Under-ground drainage.
   e. Falling water table.

2. Water conservation methods.
   a. Contouring, terracing, and so forth.
   b. Irrigation.

3. Important minerals in the soil.
   a. Hidden hungers in livestock and man.
   b. Hidden hungers in plants.

4. Restoration of minerals to the soil.
   a. Crop rotation.
   b. Adding fertilizer of one type or another after the soil has been tested.

C. Conservation of Forests.

1. Values of forests.
   a. Provides wood products.
   b. Aid in flood control.
c. Maintaining the water supply.

d. Provides homes for wild life.

2. How forests are destroyed and how may they be conserved?

a. Fires.

b. Some commercial interests.

c. Diseases.

d. Insects.

e. Winds.

f. War.

g. Forest conservation.

(1) By reforestation.

(2) By establishing wood lots and town forests.

(3) By increasing the uses of soft-woods.

(4) Educating the public on fire safety.

D. Conservation of Wild Life.

1. Changing the animal habitats.

a. Hunting.

b. Agriculture.

c. Growth of towns and cities.

d. Plants, dying out or "eaten out."

2. Vanishing wild life.

a. Bison.

b. Passenger pigeon (vanished)

c. Wild ducks.

3. Should hunting be allowed?

a. On a limited schedule or scale.
b. State and Federal regulation.
c. International agreement.

4. How may wild life be conserved?
   a. Protection by law.
   b. Establishing sanctuaries and refuges.
   c. Restoring former habitats.
   d. Improving living conditions.
   e. Raising fur and game animals.

5. Conservation of the fish population.
   a. Providing suitable habitats.
   b. Protecting by laws.
   c. Restoring fish populations.
   d. Planting in new localities.
   e. Establishing private fish ponds.

6. Conservation in the National Parks. All wildlife is protected in the National Parks.

V. The World's Food Supply.

A. The manufacture of food.

1. Green plants or those plants containing chlorophyll.
   a. Processes and structures.
      (1) Diffusion.
      (2) Osmosis.
      (3) Photosynthesis, the food-making process in green plants.
      (4) Leaf structure.
      (5) Securing water through the roots.
      (6) The stems and their structure.
(7) Photosynthesis and respiration compared.

2. Principles for part A of V.
   a. Because only green plants can make food, they make possible all other life.
   
   b. Green plants make food by using water and carbon dioxide as the basic raw materials, sunlight as the source of energy, and chlorophyll as the substance which brings about the formation of sugars.
   
   c. Water and various substances dissolved in it pass through moist plant and animal membranes.

B. Controlling the manufacture of food.
   1. Food storage and plant survival.
   2. The storage of energy foods.
   3. The nature of the energy foods.
   4. Food storage in vegetables.
   5. Annual, biennial, and perennial crop plants.
   6. Helping our plant allies.
      a. To secure minerals.
      b. To secure water.
         (1) Breaking up the soil surface.
         (2) Removing competing plants.
         (3) Irrigating.
      c. To secure sunlight.
      d. Proper planting time.
      e. Varying the garden or field habitat.
      f. Help our plants defend themselves, or aid them directly by destroying their enemies.
         (1) Spray for insects and disease.
(2) Introduce enemies of our plant enemies.
(3) Rotating crops.
(4) Preventing and treating plant diseases.
(5) Developing disease-resistant strains.

7. Biological principles to be learned.

a. Green plants obtain energy and materials for growth from foods which they make by combining certain chemical elements.

b. Many living things prey upon other living things.

c. Many plants and animals exist as parasites, within or upon other living things.

d. All living things must secure energy in the form of food.

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

VI. Food and Life.

A. Foods and diet.

1. Classes of foods.

a. Energy foods.

(1) Carbohydrates.
(2) Fats.
(3) Proteins.

b. Non-energy foods.

(1) Vitamins.
(2) Minerals.
(3) Water.

c. The functions of energy foods.

(1) Maintaining body temperatures.
(2) Building body cells. (For Growth)(For Regeneration)

(3) Carrying on the bodily processes and moving body parts.

d. Values of non-energy foods.

(1) Water
   (a) Dissolves minerals, food substances, and waste materials.

   (b) Carries food materials to all the living cells and carries waste materials away from them.

   (c) Forms part of every body fluid.

(2) Minerals
   (a) Needed for healthy bones, teeth, blood, and other tissues.

   (b) Needed in proper proportions in all living cells because they help to regulate physiological processes.

(3) Vitamins.

   (a) Are body regulators.

   (b) Necessary for normal growth.

   (c) Prevent diseases, certain diseases.

   (d) Cure certain diseases due to vitamin deficiencies.

e. How to determine a proper diet.

(1) Measure food values through knowledge of caloric values of different foods.

(2) Know the meaning of metabolism and basal metabolism.

(3) Know the "basic seven" foods.

(4) Know the true meaning of dieting. Consult family doctor to determine if there is a necessity for going on a certain type diet.

(5) Be able to recognize food adulteration.
f. How food is used by living things.

(1) Digestion.

(a) Chemical and physical changes that take place in digestion.

(b) Enzymes, digestive juices produced in the body of the plant or the animal, which aids in the chemical changes.

(2) Digestion in the higher invertebrates and vertebrates.

(a) The alimentary canal.

(b) The digestive glands.

(3) Digestion in a typical mammal.

(a) The alimentary canal.

(b) The glands and their secretions, the enzymes and their action.

(4) How cells are supplied and their wastes removed.

(a) Human blood.

1) The plasma.

2) The red corpuscles.

3) The white corpuscles.

4) The blood platelets.

(b) Blood Transfusions.

(c) Blood types, A, O, AB, and B.

(d) The Rh factor.

(e) The circulatory system, composed of heart, arteries, capillaries, and veins.

(f) Functions of the liver.

(g) Circulation and tobacco.

(h) Circulation and alcohol.
(i) The respiratory system.
(j) The respiratory structures.
(k) Respiration and flying.
(l) Artificial respiration, various methods.
(m) Respiration and tobacco.
(n) The need for waste removal.
(o) All living cells must get rid of wastes in order to survive.

VII. The conquest of disease.

A. Enemies to health.

1. What are the nature and effects of important germ diseases.
   a. Infectious diseases.
   b. Plant and animal germs.
   c. Parasitic Fungi.
      (a) Bacteria.
      (b) Molds.
   d. Parasitic animals.
      (a) Protozoa.
      (b) Roundworms.
      (c) Flatworms.
   e. "Border-line" germs.
      (a) Viruses.
      (b) Rickettsiae.
   f. How infectious diseases are contracted.
   g. How infectious diseases are spread.

2. What are the nature and effects of important non-germ diseases?
a. Causes of non-germ, or non-infectious, diseases.

(a) Improperly functioning endocrine glands. Each of the major endocrine glands would then be discussed.

(b) A disease caused by growths: cancer. Study the symptoms of cancer, also tumors.

(c) Diseases caused by a lack of essential substances in the diet, vitamins, for example. Study some of the more commonly known vitamin deficiency diseases.

(d) Diseases caused by foods, organic dusts, and other substances: allergies.

(e) Diseases resulting from inorganic dusts, fumes, and other causes.

(f) Organic diseases.

(g) Diseases due to flying.

b. Biological principles.

(a) All living things are subject to disease.

(b) All plants and animals are engaged in a constant struggle for energy.

(c) Each germ disease is caused by a specific organism.

(d) Non-germ diseases are usually, non-infectious.

B. Human conservation through efforts to maintain health.

1. How does the body defend itself against attacks by disease germs?

a. Defenses of the body.

(a) The defenses that repel or expel germs.

1) The skin.

2) The mucous membranes.

3) Hairs and cilia.
4) Sweat and oil glands.
5) Sneezing and coughing.

(b) Defenses that destroy germs or render them harmless.
1) White corpuscles.
2) Tissues that surround germs.
3) Fevers.
4) Certain secretions.

(c) Preventive medicine in human conservation.
1) Getting rid of carriers of disease germs.
2) By improving sanitation.
3) Keeping clean.
4) By observing quarantine.
5) Isolating sick people.
6) By sterilizing the air with germicides or ultra-violet ray lamps.
7) Detecting diseases in their early stages.
8) Giving inoculations or vaccinations.
9) Public health laws.

(d) Curative medicine in human conservation.
1) Inoculating with antitoxins.
2) Giving the patient specifics, penicillin, and the like.
3) Performing surgical operations.
4) Using the X ray.
5) Using radium.
6) Sterilizing wounds.
(d) Human conservation through maintaining good mental health.

1) Use your energy wisely.
2) Finish what you start.
3) Define your goals.
4) Control your wants.
5) Face your problems squarely
6) Avoid feeling too important
7) Look for the humor in life.
8) Learn to control your emotions.
9) Change your activity.
10) Balance your work and play.

(e) Human conservation through reduction of the number of accidents.

1) In the home.
2) In automobiles, trucks, and busses.
3) In industry.
4) On the street, but not in automobiles.

VIII. The behaviors of living things.

A. What are the kinds of behavior?

1. Voluntary.
2. Involuntary.

B. What brings about behavior?

1. Stimuli.
2. Responses, the results of the stimuli, or one might call these responses, the behavior.

C. Factors affecting behavior.
1. Strength of the stimuli.

2. The condition of the organism.

3. Possible responses.

D. Types of involuntary behavior.

1. Tropisms in plants.

2. Reflex actions, in animals and man.

3. Instincts in animals and man.

4. Involuntary behavior, is unlearned behavior.

E. Types of voluntary behavior.

1. Certain behaviors are related to survival.
   a. "Fight or flight".
   b. "Freezing".

2. Behavior associated with life needs.
   a. Securing food.
   b. Securing oxygen.
   c. Maintaining necessary bodily temperatures.
   d. Conserving body fluids.

3. Behaviors associated with continuing the race.
   a. Fighting for leadership in a herd of animals.
   b. Migrating.
   c. Choosing mates.
   d. Providing parental care.
   e. Distracting the attacker.
   f. Social insects; live in communities like bees.
   g. Man, today as in past ages, live together to preserve mankind.
4. Biological principles.
   
a. Plants and animals respond to various kinds of stimuli in their environment.

b. In general, the behaviors of the simpler animals are much less complex than those of the higher ones.

c. Behaviors of living things are adaptations which enable the organisms to survive and to continue their kinds.

d. A reaction is successful if, directly or indirectly, it increases the organism's chances for survival.

F. The structures that are involved in behavior.

1. The nervous system.  
2. The endocrine system.  
3. The muscular system.  
4. The sense organs.  

Each system and the sense organs should be studied carefully and completely.

G. Man's ability to supplement his senses.

1. Hearing aids, for the individual, also radar.

2. Eye-glasses, microscopes, various other types of optical equipment.

3. X-rays.

4. Biology and associated sciences still have some way to go to supplement all the senses.

5. Biology and the knowledge of it was useful during World War II in many branches of the service, right down to the K-9 Corps.

6. Biological principles.

   a. All the bodily functions of the higher animals are controlled by the nervous system.

   b. All but the simpler forms of animal life have sense organs, but these vary in number and keenness.
c. Sense organs are important factors in survival.

H. How learning is effected.

1. Conditioned reactions.

2. Natural and artificial conditioning.

3. Conditioning of human beings. All but the simplest unlearned behaviors of human beings are conditioned responses.

4. Habits, forming and breaking habits.

I. Factors affecting learning.

1. Experience.

2. Pleasure or annoyance.

3. Attention.

4. Human beings are like, rather than unlike, other animals in the ways in which they learn.

5. Biological principles.

   a. The natural behavior of animals can be changed, or conditioned.

   b. Animals with complex nervous systems may be conditioned more readily than those with simpler nervous systems.

   c. The survival of an organism depends largely on how it reacts to stimuli.

IX. Life continues from age to age.

A. Types of Reproduction.

1. Asexual reproduction, one parent reproduction.

   a. Fission, or cell division.

   b. Asexual-spore formation.

   c. Vegetative reproduction.

      1) Budding.

      2) Bulbs.
3) Grafting.

4) Tubers, runners, and rhizomes.

2. Sexual reproduction, two parent organisms.
   a. Conjugation.
   b. Fertilization.
   c. Determiners of sex.
   d. Proportions of males and females.

3. Alternation of sexual and asexual reproduction. 
   Most commonly found in the higher plants.

4. Types of flowers


7. Adaptations for spreading to new habitats.

8. Reproduction from unfertilized eggs.
   a. Natural process.
   b. Artificial process, man induced.

9. Reproduction in the higher animals.


11. Biological principles.
   a. Every cell develops from another cell.
   b. Every embryo begins life as a fertilized egg.
   c. Every living thing is descended from either one or two parents.
   d. Living things die, but life continues from age to age.
   e. In general, living things reproduce asexually in one generation, and sexually in the next, except the chordate animals.
   f. More living things are produced than will survive.
B. Life—past, present, and future.

1. Records of past life.
   a. Kinds of fossils.
   b. Accounting for the fossils, geologic time.

2. Living things change.
   a. Mutations. (De Vries).
   b. Other variations.
   c. Inheritance.

3. Discoveries in heredity.
   a. Mendel.
      1) His experiments.
      2) The results.
   b. Mendelian principles.
      1) Dominance.
      2) Segregation, or separation.
      3) Independent assortment.
      4) $F_1$ and $F_2$ generations.
      5) Mendelian ratio, 1:2:1.
   c. Sex-linked characters.
      1) Color-blindness.
      2) Secondary sexual characteristics.
   d. The Rh blood factor.
   e. Mutations and genes.

4. Improvement of living things.
      1) Method of inbreeding.
      2) Results of inbreeding.
b. Method of hybridization.
c. Results of modern hybridization.
   1) Immunity to diseases.
   2) Adaptations to different climates.
   3) Increased yield or production.
   4) Unusual size or color, long hair, fragrance, flavor, and so forth.
d. Luther Burbank.
e. Modern crop plants, corn for example.
f. Superior and inferior human stocks.
g. Heredity or environment?
h. Racial differences.
i. Amalgamation.
j. Improving the human population.

5. Biological principles.
   a. In nature, only the fittest survive. (very few exceptions).
   b. The kinds of plants and animals that inhabit the earth change in form over long periods of time.
   c. The changes in organisms from generation to generation may be slight or great.
   d. Plants and animals inherit characteristics according to definite laws.
   e. Every living thing is the product of two inseparable factors, heredity and environment.
   f. Acquired characters are not inherited.
   g. Heredity provides the native capacities of a plant or an animal, and environment determines to a great extent how fully these capacities will be developed.
CHAPTER VI
Summary and Conclusions

In summarizing the material in this investigation, one might say that a number of implications have come to "light".

Firstly, that the available literature is not too plentiful. It was found that no studies have been made in recent years that could be said to be similar in nature to this investigation. During the past year or so, a few articles have appeared in some of the science publications. Most of those articles were not applicable to this study, either.

Secondly, the trend has been to "modernize" biology to the extent that it has become less formal than previously. The tendency recently, has been to get away from so much memory-type learning. Since 1932, the trend has been to make biology functional, that is, applicable to the daily life of the students. For example, in the early part of the 20th century, the vogue in biology instruction was the teaching of many biological terms, definitions, and scientific names. One can hardly say that terminology is lacking in biology today, but there isn't as much as there was.

The writer would at this point, like to list certain conditions which possibly limit the effectiveness
of the instruction in general biology. Some of these conditions, without a doubt, would be the reasons why there was some inferiority in certain achievement areas among the Norfolk graduates and the graduates of some of the other schools in the Norfolk area. These things were mentioned briefly in Chapter I.

1. Inadequate facilities for science instruction.

2. Inadequate equipment and supplies.

3. Classes to large, or pupils in the classes with inadequate background in science.

4. Staff members not trained to teach biology.

5. Inadequate finances for the purchase of equipment or supplies.

6. Community objections to the teaching of certain phases of biology, such as sex education, heredity, and evolution.

7. Teacher overloaded with other classes, or too many other duties.

Below are listed a number of innovations which the writer would suggest as a means of improving, not only the biology instruction and achievement in Norfolk, but also in other schools where biology instruction needs improvement. No order of importance is indicated by their sequence.

1. Increased use of audio-visual aids and biological equipment where available.

2. Changes in course offerings by addition or deletions of certain units or topics.
3. Addition of supplementary pupil activities, such as science clubs, field trips, pupil projects, science fairs, and camping, to the regular program.

4. Improvement in the facilities by equipping existing rooms for use of audio-visual aids or by the addition of a greenhouse, a museum, a projection room, or a laboratory to the existing facilities.

5. Adoption of a new textbook and increased use of references and magazines in the school library.

6. Addition of new courses in health, conservation, or home and family living to the curriculum and making biology a required course for all pupils.

7. Improvement in the teaching by the addition of more techniques or varying the ones the instructor already knows.

8. Increased use of community resources by the biology teachers.

9. If possible, add more individual laboratory work.

10. Eliminate at least half the technical vocabulary.

By using the above mentioned suggestions and following the objectives which were given earlier, the writer hopes to improve his biology instruction. Perhaps others may find this investigation helpful.

A final conclusion concerns evaluation. Evaluation should be continuous, not only the evaluation of pupil achievement, but also the evaluation of the appropriateness and effectiveness of the teaching methods, procedures, and devices employed.
CHAPTER VII
Related Literature

Up to the present time there have been a number of research studies made concerned with the subject of biology. Some of them are in the way of an analyses of textbooks, some on the methods of conducting laboratory exercises, some on the methods of teaching, while others have indicated the trends in textbooks, workbooks, and other materials.

A master's thesis by Sr. M. Maxentia Lobenstein, O.S.F., entitled "A Syllabus for the Teaching of Biology in Secondary Schools," revealed the following information:

Among the analyses of textbooks, attention might be called to the work of Elmer Weltzin at the State University of Iowa, published in July 1933, entitled "The Content of Biology in High School Texts". This research reveals a tendency to eliminate the older material from the books and to put in more material on such topics as insects, mollusks, bones and muscles of man, man's ductless glands, diseases, birds, reptiles, and mammals other than man. New topics such as human reproduction, animals of the past and future, and others have been added according to Mr. Weltzin.

In the master's thesis prepared by George E. Towles, at the University of Iowa in 1939, entitled "Trends in Subject Matter as Indicated by an Analysis of Textbooks," one may go a step farther than was indicated by Mr. Weltzin. Mr. Towles points out that the new subjects which are being included in the textbooks are of extreme importance, value and interest to teachers and students of biology chiefly, because they are topics which are more closely related to the student's everyday life and
with which he comes in constant contact. 13

These findings were in accord with those of this writer as he compared the texts of approximately twenty-five years ago with those of more recent years. Fred Fitzpatrick, in an article entitled "Trends in High School Biology", made the following statements:

Before we attempt to assess the current status of secondary-school biology, it may be well to consider the past, for many things we encounter in the modern world are comprehensible only in historical perspective. Biological offerings of high schools in the United States represent the culmination of a development that has been in progress for over a hundred years. They reflect strongly the influence of modern educational emphases, but they also carry the imprint of some educational theories that have long since been abandoned as over-all guides to instruction. As an example, we reject an outmoded educational theory, but items of so-called subject matter selected according to the tenets of that theory continue to be employed in instruction even though the justification for such employment no longer exists.

Though we, as teachers, may tend to cling to methodologies and materials in instruction which are most familiar to us, the challenge of newer knowledge has proved irresistible to many, and it seems possible that secondary-school biology might have undergone substantial changes even though educational philosophy and aims had remained static. 14


In an article, "Where Are We Now and Where Are We Going in Science Education?" by Herbert S. Zim, the plea is to return to fundamentals. Quoting briefly,

But this is not the same plea as the one you hear from uninformed and misinformed critics of education who vainly hope for a return to the past. The fundamentals of science and education are dynamic, modern methods of working with the world and with young people; to observe and discover, to experience and grow. It is to these fundamentals that science teachers should turn at this critical period in American Education. It is here they will find the ultimate satisfaction one finds in a hard job worth doing and worth doing well. 15

For a final reference, the writer would like to quote in part from an article by J. Gordon Manzer in the Forty-sixth Yearbook.

In the past the course in high-school biology was planned to meet the supposed needs of pupils who expected to pursue the same subject in college. Though it replaced courses in botany and zoology as such, it often kept both those subjects and treated them separately, perhaps adding a section on human physiology.

As the high-school population became less selective, significant modifications of the biology course were instituted. From necessity, the subject matter has become less technical, more practical, and the trend has been toward a unified course, with increasing emphasis of its functional values.

During the past ten years, particularly, the trend has been toward focusing attention less on the organization of subject matter

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15 Zim, Herbert S., Where Are We Now and Where Are We Going in Science Education?, The Science Teacher, NSTA., Sept. 1952, p. 167.
and more on the results in the lives of the learners. It has been demonstrated that changes in behavior can accompany learning.\textsuperscript{16}

In summarizing, it may be said that the literature bears out the findings and conclusions of this writer, that changes in general biology courses have taken place and that teachers are aware of the necessity of the changes. The fact that the biology teachers have been experimenting with the course content, materials, and techniques is a sign that they are aware of the challenge to make their courses better.

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