


AN ABSTRACT OF THE THESIS OF

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Abstract Approved: 

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This thesis proposes a biology course of study for the high schools of this state. It discusses the teaching conditions that are found and points out that the average school has a small enrollment and teaching staff. The findings of several works and a tabular analysis of the state school directory are offered to support this contention. This condition offers problems of teacher training and teacher efficiency.

This proposed course is divided into seven units. Each is a ready-to-use plan with practical aids and consists of a plan, objectives, outline of the unit, suggested activities, reference books, visual aids, and free and inexpensive reference material.

The plan is offered as a suggested time-table, a list of materials and their time of preparation, demonstrations, techniques, and suggestions for improvising equipment. The data included in the outline of the unit were selected by examining the contents of biology books of recent copyright date and supplementing them with material adapted to local needs and conditions. The time suggested for each unit is based on a study made of the percentage of the contents of five recent secondary textbooks that is devoted to the concepts covered by the unit. In several instances the time factor has been modified to increase the instructional value of the unit.

The suggested activities offer a list of activities and projects that aid in the development of the unit. A large number is included to facilitate the efforts of the teacher to adapt the work to the individual needs. The list of reference books includes general biological as well as specific works. It was compiled by examining bibliographies of recent secondary textbooks, the Oregon State Library list, personal libraries, and proven lists of secondary reference books. A special effort was directed toward material pertaining to this area.

The list of visual aids includes posters, charts, silent and sound films, film strips, and slides. The charts include those that are in general use in the schools. The films and slides are those that are available at Oregon State College, the University of California, and other reliable film libraries in this area.

The thesis also points out that present conditions indicate that a heavy turnover in biology teachers is to be expected. This fact and others developed in this thesis indicates the need of a course of study adapted to the Oregon situation to serve as a basis for textbook selection and as a practical aid to the biology teacher.

OLD RELIABLE BOND

FOR CONTENT

A PROPOSED BIOLOGY COURSE
FOR OREGON'S HIGH SCHOOLS

by

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A THESIS

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A PROPOSED BIOLOGY COURSE FOR OREGON'S HIGH SCHOOLS

CHAPTER I INTRODUCTION

The laws of the State of Oregon provide that the supervision of the elementary and secondary schools of the state shall be vested in the office of the Superintendent of Public Instruction. One of the duties of that office is to supervise the preparation of courses of study. Normally this work is done by a committee of representative school men for the state department. The law also provides for the formation of a textbook commission to adopt the necessary textbooks for each course for a period of six years.

This fall the textbook commission selects a textbook for biology. With this selection a new course of study in biology will be worked out. It is desirable and logical to have a course of study fitted to Oregon as a basis for selection of the best text.

One purpose of this thesis is to submit suggestions that might be helpful to the textbook commission and the committee that will be appointed to revise the biology course of study. Other purposes are to organize a course that is adaptable to conditions that actually exist in the state and to collect and assemble a variety of

material that will be useful to the biology instructor in the teaching of this, or any, biology course.

Factors That Should Influence the Content
of a Course of Study for Oregon

Some factors peculiar to this state that should influence the selection of a biology course are the abundance of live material, the industries of the state, and the shortage of suitable reference material. There is a universal agreement among science educators that one of the goals of science is the better interpretation of the environment. There is a need for knowledge of the life about us. The majority of the schools in Oregon are located in an area rich with plant and animal life. Live materials should play an important role in the teaching of biology in these schools. Bates (1:1) says, "The teachers of biology are employing more and more the study of living forms. It is only logical that this very decided trend should become evident since biology is the study of living things."

The people living in Oregon are dependent for their existence on three major industries: lumbering, agriculture, and fishing. Since all three of these have a biological make-up, a thorough understanding of their problems and their conservation should be an important

consideration in the training of the future citizens of this state.

An examination of the courses of study in use in this state at the present time and those that were used in past years reveals that there has been a decided trend toward having them based on but a single text. A biology course of study that is based on but one of the textbooks that is in general use today is likely to be inadequately suited to our needs. An examination of the authors of fifteen secondary biology books fails to reveal a single one who is a resident of the Pacific Northwest. It is improbable that one would find a textbook written primarily for this area as the population distribution would make any attempt at one a doubtful financial venture.

Stevenson (50:21) points out, "Most of our texts and guides are written by Eastern men who draw upon the illustrative materials of that section." This condition necessitates having the biology instructor collect a variety of unassembled materials. This takes time and ingenuity and often imposes a burden on an already over-worked teacher.

Preparation of Biology Teachers in Oregon

Another factor which should be considered in the selection of a biology course for state-wide use is the ability of the teacher who is going to use it. Investiga-

tions during the last ten years reveal that the preparation of the average biology teacher indicates much to be desired.

Masson (18:34) found that seven per cent of the biology teachers in Oregon have had no undergraduate training in biology. Twenty-six per cent have had but ten or fewer term credit hours preparation and fifty-two per cent have had but fifteen or fewer term credit hours preparation. The results of this study could be interpreted to indicate that in many cases the preparation of the biology teacher consists of the one year of laboratory science required by the institution from which he graduated. This often means but a year's work in botany or zoology, seldom both.

Masson (18:35) also found that but "...eleven per cent of all teachers have thirty-three term credit hours of undergraduate college preparation in biological sciences." The 1941-42 Oregon State College Catalog lists 36 term hours as the requirement for a major norm in Biological Science and 24 term hours for a minor. The national survey of biology teachers by the Committee on the Teaching of Biology (40:28) found that 618 individuals out of 2,931 reporting or twenty-one per cent "...noted specifically that they had not (*italics in original quotation*) prepared to teach biology."

There is a notable lack of practical courses and special methods in the preparation of biology teachers. ✓ According to Stevenson (50:21) "The teacher must set himself to the task of becoming acquainted with the common plants and animals of the region in which he is teaching. This requires more initiative and research than the average biology teacher possesses."

Conditions Affecting Teacher Efficiency

A contributing factor to the status of the biology teacher in this state is the population scarcity. According to the survey of Public Higher Education in Oregon (45:85) "Oregon ranks fortieth in density of population among the states of the union." This condition along with the reluctance of some districts to consolidate results in numerous small schools with small teaching staffs. Table I indicates the condition for the school year 1941-42.

A study made by Nelson (6) found that in 1939 "...the median Oregon high school had 5.5 teachers and an enrollment of 93.6 pupils, while the mean high school contains 9.2 teachers and an enrollment of 214 pupils." Table I and the Nelson study indicate that the majority of biology teachers in this state are teaching in a school employing six or fewer teachers. A further exam-

Table I
Size of Teaching Staff and
Number of High Schools in Oregon

Size of Teaching Staff	Schools
Two-teacher school.....	31
Three-teacher school.....	31
Four-teacher school.....	41
Five-teacher school.....	33
Six-teacher school.....	25
Seven-teacher school.....	11
Over seven-teacher school.....	86
Total.....	258

Table compiled by making a tabular analysis of the teaching staffs of the schools listed in 1941-42 Oregon State Teachers' Directory. The table reads: During the school year 1941-42 there were 31 two-teacher high schools in Oregon. It reads the same for each other group.

ination of the Oregon State Teacher's Directory for 1941-42 reveals that in some of the schools the teacher who teaches biology has as many as five daily preparations. A study of teacher load by Luebke (16:19) shows that thirty-seven per cent of the science teachers of Oregon in 1933 taught science and one other field. This condition of having to make numerous daily preparations is bound to reflect in lowered efficiency of even the good biology teacher.

The findings in the above-mentioned studies also indicate that the size of the majority of the secondary schools in Oregon tends to prohibit the employing of a teacher adequately prepared in the field of biology. A small teaching staff presenting the courses prescribed by the State Department of Education emphasizes the necessity of employing teachers with a background in many courses. On the basis of the data in Table I an undergraduate engaged in teacher training would be unwise to become a specialist only in the field of the biological sciences.

The present state of emergency is tending to drain the secondary schools of men teachers. Of the 227 science teachers investigated by Leubke (16:16) 158 or 70 per cent of them were men. Stevenson (43:15) found that of the 169 science teachers outside the city of

Portland, 135 were men and 34 were women. These facts would indicate that a large turnover in biology teachers is to be expected.

Organization of the Proposed Biology Course

This proposed course has been organized into seven major spheres or units. It is generally accepted that some form of unit organization is more popular than other techniques. There is much disagreement concerning the merits of particular forms. Whether the individual biology teacher cares to employ Bruner's (29) "Theme or Generalization" unit, or the "Curriculum Units" suggested by Woods (48), rests entirely with him and his experiences. The proposed course of study will make the task of the biology teacher easier in any consequential reorganization or revision which he undertakes. Woods (48:14) has stated, "Planning the materials for a single unit may require fifty to a hundred hours..."

The following sequence and time are suggested:

Unit 1. Distribution of Organisms	2-4 weeks
Unit 2. Food and Organisms	5-8 weeks
Unit 3. Behavior of Organisms	3-5 weeks
Unit 4. Relationship among Organisms	5-7 weeks
Unit 5. Change and Organisms	4-6 weeks

Unit 6. Perpetuating Organisms 4-8 weeks

Unit 7. Grouping of Organisms 4-6 weeks

The above arrangement and time factor may be adjusted to suit local needs, the amount of equipment that is available, and the experiences of the instructor. This sequence of units need not necessarily be followed. However, if there is a rearrangement, there should be a corresponding adjustment in the accompanying plans. This arrangement has proved to be satisfactory for use in Southwestern Oregon. The time for the various units has been arrived at as the result of studying Table II and making several adjustments in keeping with the peculiar needs of Oregon as indicated by a study of the occupational and recreational needs of the pupils and the preparation, load, and time of the average teacher. The proposed course of study has been made out using the mean time indicated for each unit.

On the basis of the findings in Table II, Unit 6 should have a time allotment of but three weeks. This is not enough time in view of the importance of the concept and the abundance of material that is available for its development. Two weeks have been taken from Unit 4 and added to Unit 6 to make the necessary adjustment.

Table II
Relative Emphasis Given the Subject Matter
Included in the Units of This Work

Unit	Textbooks					Mean	No. of Weeks
	1	2	3	4	5		
1	5.4	5.0	14.5	5.4	10.2	8.1	2.8
2	17.4	28.2	13.3	29.7	17.7	21.3	7.5
3	12.9	12.4	17.2	6.4	5.9	10.9	3.8
4	14.1	12.5	26.3	30.6	35.4	23.8	8.3
5	13.8	22.6	12.0	5.7	13.8	13.6	4.8
6	8.0	11.6	4.9	7.1	5.9	7.5	2.6
7	28.4	7.7	11.8	15.1	11.1	14.8	5.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	35.0

Textbooks used in the analysis: (1) Ritchie, John W., Biology and Human Affairs, 1941. (2) Benedict, Ralph C., Warren W. Knox, and George K. Stone, Life Science, 1941. (3) Kinsey, Alfred C., New Introduction to Biology, 1938. (4) Hunter, George W., Problems in Biology, 1939. (5) Hunter, George W., Life Science, 1941. The table reads: Textbook No. 1 devoted 5.4 per cent of its contents to a discussion of the subject matter included in Unit 1 of this work. The mean for all the books was 8.1 per cent which represents 2.8 weeks of a school year of 35 weeks. It reads the same for each other group.

Each unit of the proposed course is organized as follows:

Plan

Objectives

Outline of the Unit

Suggested Activities

Reference Books

Visual Aids

Free and Inexpensive Reference Materials

The Plan is offered as a suggested time-table, a list of materials and their time of preparation, demonstrations, techniques, and suggestions for improvising equipment. It is submitted in far greater detail than is necessary for most teachers. Its use does not eliminate the possibility of a pupil-planned classroom technique should the ability and the training of the pupils and the teacher make such an undertaking an effective teaching method. Its make-up should prove helpful to the experienced as well as the inexperienced, regardless of the classroom method they employ.

The Objectives are the desirable accomplishments from the pupil's participation in the unit and should be included in the duplicated material handed to the pupils.

The Outline of the Unit should be duplicated and distributed immediately after the presentation (see the Plan for Unit 1). This outline can serve as a study guide for the pupils. They should check the unfamiliar items by looking them up in the indexes of their reference books. The pupils should be encouraged to refer to several books as a check on the authenticity of the information. Miller and Blaydes (21:116) thinks that the pupil "... gets different points of view from different writers and finds it necessary to become critical and discriminating."

The Suggested Activities are varied to the extent that they should be adaptable to any range of interest and individual difference that will be encountered in the classroom. They are numerous enough to be useful for a variety of techniques and practices. The instructor may assign certain ones or allow them to be selected on the basis of individual interests of the pupils. They should prove useful, at least as a suggestion, for teacher-planned activities.

A list of Reference Books accompanies each unit. These have been selected from the Oregon State Library list, bibliographies found in the newer secondary textbooks, bibliographies prepared for biology-teaching

works, examination of the card catalogue of the Oregon State College library, recommended reading lists (13) and titles that have been suggested by individuals.

A large list has been included with the hope that a few would be found in any library. See Bibliography A.

The list of Visual Aids was compiled from examination of charts actually in use in school, by suggestion included in other works, and by reviewing information from the manufacturers of certain ones. As a result of the present war, schools will be dependent on American-made charts after the present foreign-made supply is exhausted. Numerous charts and aids are submitted as there are many types in use. The purpose here is not to suggest what one to purchase but what chart out of the available set to use with each particular unit. The list of films, film slides, and glass slides was compiled with the two-fold purpose of complete coverage and availability. Schools of this state have the facilities of the film libraries of the Oregon State College and the University of California accessible to them. Dependence on sources other than the regular film libraries has proved to be undependable and no doubt will be more so under present conditions.

The material listed under Free and Inexpensive Reference Materials has been collected, in most cases,

by requesting material by the "penny post card" method. The list of government publications was compiled, for the most part, from catalogues. Most of the Farmer's Bulletins and many of several other publications will be found in the Smith-Hughes departments of the schools. Bibliographies may be secured from the Extension Service, Oregon State College, upon request. Additional material can be obtained from a list found in Heiss (10:273), Modern Methods and Materials for Teaching Science, and from a list secured from Bruce Miller, Principal, Ontario Junior High School, Ontario, California.

An evaluation program should be developed by each teacher using this course of study. The extensiveness of the program and the type that they employ will be determined, to a large extent, by their experiences. Valuable assistance can be obtained by referring to Miller and Blaydes (21:168), Hunter (11:122), and the Progressive Education Association, Science in General Education (38:388-439).

In the light of the aforementioned deficiencies and problems a course of study for state-wide use should be a useful tool in the planning of the techniques to be used in the teaching of the course. It must be practical in relation to the experiences of the teacher. It is with these considerations in mind that certain techniques

have been included in this proposed course of study. Those likely to be beyond the capacity of the teacher to utilize have been omitted. Utility and practicability have been two criteria by which all the contributions to this work have been evaluated.

Contents of the Proposed Biology Course

The subject matter included in this proposed biology course has been assembled after an examination of the contents of the secondary biology textbooks listed in Table III.

The data was carefully examined for content and revised by checking it item by item with the indexes and reviewing the material referred to in each of the above-mentioned texts. The criterion for acceptance in most cases was the appearance of a satisfactory discussion in at least five of the texts. There seems to be a common agreement among most of the biology textbooks concerning the material to be included. Each item has been expanded, whenever possible, by the inclusion of materials and examples common to this area. Particular emphasis has been directed toward adjustment of the material to the occupational and recreational demands of the state and the preparation of the biology teachers.

Table III
High School Biology Textbooks

Author	Textbook	Copyright Date
Baker-Mills	Dynamic Biology	1938
Benedict-Knox-Stone	Life Science	1941
Ritchie	Biology and Human Affairs	1941
Hunter	Problems in Biology	1939
Hunter	Life Science	1941
Kinsey	New Introduction to Biology	1938
Pieper-Beauchamp-Frank	Everyday Problems in Biology	1936
Smith	Exploring Biology	1938
Smallwood-Reveley-Bailey	New Biology	1937
Wood-Carpenter	Our Environment	1938
Curtis-Caldwell-Sherman	Everyday Biology	1940

This course presents full coverage of the material in this field but does not propose to establish minimum or maximum limits. These should be influenced by such factors as the location of the school, size of the class, ability of the class, available material, and the amount of equipment.

The concepts of this proposed course serve as a continuation and culminating activity of the biology presented in the present elementary and junior high basic science program (33). In this course the pupil will encounter a broadened and expanded mass of data as well as a survey feature that is new to him. An effort has been directed at providing orientation for future work and the development of new interests.

Summary to Chapter I

The first chapter points out that this fall the state textbook commission is to select a text for biology. This proposed course of study offers suggestions that might be helpful to the commission and to the committee that will revise the biology course of study. The needs of Oregon are discussed. These are influenced by a population, for the most part, dependent on lumbering, agriculture, and fishing for its livelihood, by an

area rich in live material, and by an absence of suitable reference material. It is also pointed out that the population distribution creates a condition that increases the difficulty of giving prospective teachers a specialized biological background during their undergraduate work. Several studies have been discussed to show that many biology teachers in Oregon lack adequate preparation. This condition was also noted in a national study. Other studies are discussed to show that the biology teacher is overloaded.

In recognition of these factors this thesis presents a proposed biology course of study divided into seven units. Each is a ready-to-use plan with practical aids.

CHAPTER II

UNIT I

DISTRIBUTION OF ORGANISMS

BIOLOGY

Unit 1.

Time: 15 days.

DISTRIBUTION OF ORGANISMS

PLAN

DayMethod

-
- 1 Introduce the course by means of an exploration field trip or an unusual experiment. Attempt to use a psychological approach rather than the traditional logical introduction. Make the course as interesting as life really is.

Distribute the Socio-Economic Rating questionnaire to be used in the guidance program. Call attention to the fact that these may be filled out with the assistance of the parents if necessary and returned at the next meeting of the class.

Have a protozoa culture started at least two weeks before this day in order for the population to be numerous enough for pupil examination at the end of another two weeks. Pure cultures of protozoa may be obtained from any of the supply houses. A mixed culture may be started by soaking some grass, hay preferably, that has grown along ditches or depression that sometimes becomes submerged. This should be allowed to stand in a warm place out of the direct light.

2 Pretest for Unit 1.

This test should include subject matter that is likely to be known by the pupils as well as samples of the material to be covered in the unit. The test should be fairly long and objective so it can be scored immediately. The result of this test should give information concerning the members of the class that will be valuable in determining emphasis on the topics and the individualization of the work.

Presentation.

Introduce the unit by some form of motivation technique. This may be in the form of a short lecture, a demonstration, viewing some of the visual material, or reading aloud the introduction to the unit. The method used should vary from unit to unit and may be followed by a short discussion period answering the spontaneous remarks by the members of the class.

Collect the Socio-Economic Rating questionnaire.

Distribute the duplicated copies of the Outline of the Unit and Suggested Activities

- 3 Appoint committees for such classroom projects as maintaining bulletin boards, making cages suitable for keeping animals in the classroom, and making classroom exhibits and displays. The membership on these committees should be rotated.

The bulletin board committee should clip and display articles and illustrative material from current sources. These should be arranged in an attractive manner and be replaced frequently. All material should be filed for future reference.

Supervised study.

Examine the Outline of the Unit and use it as a guide for surveying the data included

in this unit.

Check equipment and route for the field trip to be taken at the next meeting of the class.

4 Field Trip.

Purpose: To observe and collect specimens of the fauna and the flora of this vicinity and to locate areas for group examination at later dates.

Take the class on a tour of the neighborhood visiting a freshwater stream or pond. Pupils should take collecting equipment such as: dip nets, collecting jars, battery jars, and cans in which to get rock and sand for the aquarium. Material for the terrarium can also be gathered at this time.

Each pupil should take notes on his observations and turn them in at the end of the trip.

On returning to the classroom the material collected should be examined and put into temporary containers. Battery jars, fruit jars, empty mayonnaise and salad dressing jars, or pans will be useful for this.

Collect the reports on the field trip.

See that rats are ready at the next meeting of the class to start feeding diet deficient in vitamin A. (See the Plan for Unit 2, 16th day).

5 Supervised study.

Continue with the examination of the outline and surveying the data included in the unit.

Check over the materials brought in from the field trip and those on hand to establish the aquarium. These should include the

receptacle to be used, enough washed sand to fill the container to a depth of two inches, washed rock or gravel, rooting aquatic plants such as: vallisneria, sagittaria, and ludwigia, purchased from the supply houses or common native plants such as: arrowhead, spike rush, water buttercups, hornwort, duck-weed, and watercress, non-rooting forms such as: elodea, cabomba, and myriophyllum, and the animals such as: diving beetles (Dytiscidae), back swimmers (Notonectidae), giant water-bugs (Belostomatidae), larvae of May flies, caddiceflies, midges, and stone flies, minnows, salamanders, and frogs.

Start feeding of experimental and control rats to show the effects of a diet deficient in vitamin A. (See the Plan for Unit 2, 16th day).

6 Class discussion.

Purpose: To establish an aquarium to observe aquatic life.

Discuss the establishment of an aquarium for the classroom. Demonstrate how it is assembled. Pupil comment should be encouraged concerning the necessity for the materials placed in the aquarium. The teacher should balance the aquarium; however, this need not be stressed at this time.

Assemble the aquarium by filling the bottom of the tank to a depth of two inches with the sand. Place the rocks and gravel on top. If the container is large enough to, scoop out depressions and build up an end or side of the bottom. Plant the rooted aquatic plants by spreading the roots out on the sand and covering them to the crown. Fill the aquarium being careful not to disturb the bottom. This may be accomplished by pouring the water onto a sheet of paper or a saucer. Add stalks of the floating

plants. Allow the aquarium to stand several days before adding the animals. If using native plants, sterilize them by placing them for one hour in a solution which has been made by adding four or five crystals of potassium permanganate to one gallon of water. Follow this by a thorough rinsing in clear water.

The aquarium may be housed in any receptacle from the metal and glass tanks in a variety of sizes, purchased from the supply houses, through the glass and wood assortment that can be made locally with a glass cutter and a few tools, to the glass or metal containers that may be purchased inexpensively from secondhand or 5- and 10-cent stores. Any container that is of sufficient size and will hold water can serve as an aquarium tank.

Supervised study.

Spend the balance of the period working on the activities.

Check the materials available for establishment of the terrarium.

7 Class discussion.

Purpose: To establish a terrarium in the classroom that will keep plants and animals in more-or-less natural surroundings for ecological study and provide living material for observation.

Discuss the various types of terraria, i.e., field, bog, swamp, desert, and woodland and the arrangement of the materials. Allow the pupils to construct the classroom terrarium under the supervision of the teacher.

The best container for the terrarium is a rectangular aquarium tank. An improvised tank may be made by standing four sheets of window glass twelve inches high against each side and on the inside of a box sixteen by twenty by three inches deep. Two of these sheets are cut to the inside length

and two to the inside width minus two thicknesses of the glass. The top is bound around with adhesive tape. The terrarium should be equipped with a glass top to prevent the escape of the animals and to regulate the humidity.

Several different types of terraria should be constructed for the biology room. Possibly the first, and certainly the easiest is the woodland terrarium. To make this type clean the tank thoroughly and cover the bottom to a depth of two inches with washed, coarse sand or crushed gravel. This bottom layer should be elevated at one end forming a hill. Cover the whole surface with one and a half inches of soil and leaf mold from the woods. Have a definite viewpoint in mind so that the plants can be arranged with the taller in the rear. Run enough water down the sides of the tank to saturate the sand or gravel layer and make the layer of soil damp. Cover the terrarium with the glass to control the humidity and place it in a light place.

After the plants have been established terrestrial snails and insects, newts, and a tree frog may be added.

Supervised study.

Spend the balance of the period working on the activities.

8 Supervised study.

Work on the activities.

Pupil-demonstration of the mastery of microscopic technique.

Purpose: To demonstrate to the teacher the mastery by the individual pupil of the fundamentals of microscopic technique.

Each pupil will demonstrate his ability to clean the microscope, regulate the light, bring objects into focus under both the low and high power, carry the microscope, prepare simple slides, and name the important parts and their uses.

Place the animals in the aquarium.

9 Supervised study.

Work on the activities.

Evaluation.

Prepare a short objective self-test on microscopic technique. This self-test should be duplicated and taken by the pupil when he feels that he has mastered the fundamentals of the use and care of the microscope.

Feed the animals in the aquarium and the terrarium. The common tendency is to feed too often and too much. A schedule that calls for feeding on Mondays and Thursdays is well suited to school conditions. The natural food should be fed whenever possible. In many cases this can be raised in the laboratory. Regularity in the feeding practices is rewarded with interesting responses from the animals. All food that is not eaten in a short time should be removed.

Review the film to be shown at the next meeting of the class.

10 Demonstrate with the microscopes or the microprojector the organisms found in the protozoa culture.

Show one of the films included in the list at the end of this unit.

Supervised study.

Use the balance of the period to work on the activities.

11 Supervised study.

Work on the activities.

Feed the animals in the aquarium and the terrarium.

Pupil examination of the protozoa cultures using the laboratory microscopes.

Purpose: To provide a supervised practice period for development of the skills necessary for microscopic work, to develop initiative in the pupils, and to increase the pupil's knowledge concerning the protozoa.

This work can be extended over more than one period depending upon the number of microscopes that are available to the class. While the remainder of the class is working on the activities, pupils equal to the number of microscopes available may be examining the cultures. Schools without microscopes often can rent them from other schools for short periods of time. Occasionally they can be rented or borrowed from private individuals such as doctors or scientists. Many schools overlook the possibility of purchasing good used ones from the instrument houses. The purchase of two used microscopes is a better investment than the purchase of one new one.

The protozoa should be cultured from the hay infusion for use in later units. Densely populated areas of the infusion can be transferred with a medicine dropper to glasses, fingerbowls, or flasks. A few boiled grains of rice or wheat will supply ample food. The cultures should be kept at about 70° to 80° F.

12 Distribute the pupil self-test.

This test should be as comprehensive in scope as the unit test and should resemble it in form. The self-test must measure all that the teacher's test measures. A scoring key should be made available so each pupil may score his own test. For purposes of motivation the class average, the high score, and the low score should be made available. This enables the individual pupil to pit himself against the class and to rate himself in the class.

Oral presentation of assigned activities.

Each pupil presents orally one or more of the activities assigned from the list at the end of the outline. The number presented by each pupil depends upon the size of the class and the number of activities selected by the teacher to be solved.

The factual material in each presentation is subject to criticism and comment by the remainder of the class. Pupils may make corrections or additions to their solution of these activities as a result of the criticisms.

-
- 13 Continue with the oral presentations and the criticisms.

Supervised study the remainder of the period.

- 14 Summary exercise.

Without books, notes, or other aids the pupil should attempt to represent the relative importance and the interrelationships of the ideas included in the unit just studied. The summary exercise may consist of the pupil's list of the big ideas in statement form, it may be a statement outline of the unit, it may be a topical outline of the unit, or it may be a diagram of the unit. The tendency is for the pupils to include too much factual material.

The summary exercise provides a strong stimulus for thought about the facts and relations of the unit. It is not to be graded and should be regarded by the pupil as a step in the learning process.

Check the laboratory equipment and supplies needed for Unit 2. Secure those that were overlooked in the annual list submitted at the close of school last spring.

Feed the animals in the aquarium and the terrarium.

15 Evaluation of the unit.

Administer some form of test. Numerous suggestions are found in Miller and Blaydes, Hunter, and the Progressive Education Association's, Science in General Education.

Score and discuss the tests.

If the tests are objective they can be scored near the end of the period by having the pupils exchange papers. The answers can be read by the teacher with the pupils checking the wrong answers. A preliminary recording of the scores can be made in pencil at this time with any necessary adjustments coming later.

Make arrangements for guinea pigs to be used in experiment on diet deficient in vitamin C. (See the Plan for Unit 2, 1st and 16th days).

BIOLOGY

Unit 1.

Time: 15 days.

DISTRIBUTION OF ORGANISMS

This unit introduces you to the fascinating study of living forms of which you are the best example from the standpoint of complexity and interest. Here you should find the answers to many of the problems that have confronted you in the past. Each of you could tell us about the many interesting plants and animals that live near your home. Possibly some of you have visited zoos and aquariums or botanical gardens and can recall the variety of interesting forms that you saw there. Suppose that it would be possible to bring together young people from all parts of the world. Wouldn't it be interesting to hear what each of them could relate about the plant and animal life that is common to their home.

In the study of this course you must strive to enlarge your viewpoint. You are seeking facts about plant and animal life in general. To be successful in this undertaking you should examine the life of the whole world. Fortunately the life of this zone is varied enough to present a broad understanding. Now you will proceed to view life with a more critical eye and find what interests and influences are in store for you.

Objectives:

1. To realize that life is diversified.
2. To realize that all forms of life are adapted to the environment in which they live.
3. To increase the vocabulary through the addition of some of the biological terminology.
4. To acquire a general understanding of some of the biological sciences such as: zoology, botany, physiology, taxonomy, hygiene, and ecology.
5. To develop an attitude of inquiry and interest toward the problems arising from this study.

6. To gain practice in the technique involved in the care and use of the laboratory microscope.

7. To realize the diversification found in the racial makeup of human beings.

Outline of the Unit:

I. What Are Some of the Interesting Characters That Have Been Observed of the Different Races of Man?

A. The difficulties encountered in classification.

1. Variation within races.
2. Intermarriage.
3. Absence of a classification scheme that is accepted by everyone.

B. The characteristics that are used in classification.

1. The type of hair: straight, wavy, or kinky.
2. The shape of the head.
 - a. The cephalic index: the width of the head measured above the ears divided by the length of the head. It is always expressed as a decimal fraction and is usually less than 1.00.
 - b. Wide-headed if the index is above .80, medium-headed if the index is between .75 and .80, and narrow-headed if the index is below .75.
3. The color of the skin.
 - a. Due to the presence of a brown pigment (melanin).
 - b. Not a satisfactory basis for comparison as are the more fixed traits.
4. The nasal index, the ratio of width to length of nose.
5. The cubical capacity of the skull.
6. The height.
7. The "sitting height," the length of the upper part of the body.
8. The shape of the lips and the ears.
9. The eye folds.
10. The amount of face and body hair.

C. The races of man.

1. The white race (Caucasian): Nordics, Alpines, Mediterraneans, and Hindus.
2. The Australoid race: Veddoïd (Australoids who live outside of Australia) and the aboriginal Australians.
3. The Negroid race: pygmies, also called Negritos, found in widely separated areas; Bushman (Hottentot); African Negroes, West Coast and Sudanese; and the Oceanic Negroes.
4. The yellow race (Mongolian): Tungusics, eastern Siberian people that were the ancestors of the Manchus and the ancient Huns; the Chinese proper, the most numerous branch of the race; Buryat Mongols, (Genghis Khan was of this race); and the Malays.
5. Secondary races composed of mixed peoples formed by the fusion of two or more of the primary races.

II. What Can We Expect in Regard to the Diversity of Life?

- A. The many different shapes and sizes; the largest and smallest plant and animal.
- B. The estimated number of different plants and animals.

III. What Are the Factors That Combine to Form the Environment of a Plant or an Animal?

- A. The extremes of the temperature.
- B. The amount of moisture.
- C. The amount of light.
 1. Why light is necessary.
 2. Different amounts of light on different parts of the surface of the earth.
- D. The fertility of the soil.
- E. The presence of food.

IV. What Are Some of the Different Conditions to Which Life Has Had to Adapt Itself?

A. Near the poles: Arctic and Antarctic.

B. Jungle: rain, forests, and savannas.

C. High altitudes.

D. Aquatic conditions.

1. Fresh water

a. Environmental factors: temperature, oxygen, sunlight, movement, and impurities.

b. Fresh water plants.

c. Special adaptations found on aquatic plants.

d. Fresh water animals: plankton, invertebrates, and vertebrates.

e. The fresh water aquarium.

2. Brackish water.

3. Marine: pelagic, littoral, deep sea.

a. Plant life.

b. Animal life.

E. Desert.

F. Inside animals.

V. What Technique Must Be Understood Before One Can Successfully Study Biology?

A. History of the development of the microscope.

B. Parts of the laboratory-model compound microscope and their use.

C. How to prepare a slide for study.

D. How to focus the microscope.

E. Things to remember when using the microscope.

Suggested Activities:

Those preceded by an (*) are considered as essential to the development of the unit, those by a (') are considered as near-essential, and those by a (*) as enriching.

- * 1. Take a field trip that will enable you to study at first hand communities of plant and animal life.
- * 2. Orient yourself as to the zone, region, and realm in which you live.
- * 3. What effect does each of the factors that influence the growth of fresh-water organisms have on the organism?
- * 4. With the assistance of the members of your class set up and stock a fresh-water aquarium. If you are favorably located, you might like to make a brackish-water aquarium, too. (Marine aquariums are difficult to maintain without expensive equipment.)
- * 5. Prepare yourself for an oral examination and demonstration on the operation and the parts of the compound microscope. You should be able to demonstrate your ability to use this equipment correctly before expecting to have access to it.
- * 6. Prepare demonstration slides of such common-place objects as hair, fibers, crystals, or parts of insects. As part of your demonstration, locate these objects for your instructor, adjust for best light conditions.
- * 7. Describe your environment.
- ' 8. What are the important life zones found in this state?
- ' 9. With the assistance of the members of your class, construct and stock a terrarium.
- ' 10. Describe the environment, fauna, and flora of each of the following places:
 - a. Bodies of other animals.
 - b. Deserts.
 - c. Fresh water.
 - d. Marine.
 - e. Mountain tops.
 - f. Polar regions.
 - g. Tropical jungles.

- ' 11. On an outline map of North America plot the range of one each of our common plants and animals.
- ' 12. Describe how some plant of this locality is adapted to this environment. Do the same for some animal.
- ' 13. Write an accurate description of the acknowledged largest and smallest plant and animal. Do the same for these extremes within your own experience. (It will be easier if you interpret "largest" as meaning "of greatest length or height.")
- 14. Make a written report on your racial characteristics including hair, color and form, skin color, stature, cephalic index, and eye color. What is your racial stock?
- 15. Construct a rule for measuring the length and width of the head. Fasten a piece of wood at right angles to the end of a meter stick and another similar piece so that it will slide along the stick at right angles with it. Use this device for measuring and determining the cephalic index of the members of the class. Make your readings in millimeters.
- 16. With the members of your class collect pictures of men and paste them on sheets of cardboard according to their race and sub-race.
- 17. With the assistance of the rest of the class make a collection of pictures of the plants and animals found in each of the conditions found in Part IV of the outline.
- 18. Prepare a report on some subject applicable to the material in this unit. The following are offered as suggestions.
 - a. Byrd at the Antarctic.
 - b. Dr. Beebe's descent into the ocean depths.
 - c. The fauna or flora of Oregon.
 - d. The fauna of Australia.
 - e. Make an imaginary trip to some place of your own choice. Describe the environmental conditions and the fauna and flora found there.

- f. The elephant and its home.
- g. Termites.

Reference Books:

The following are numbers of books listed in Bibliography A that will prove to be helpful in the study of this unit:

1, 2, 14, 16, 20, 23, 24, 25, 26, 27, 28, 29, 31, 37, 42, 45, 52, 54, 56, 61, 64, 69, 73, 79, 88, 89, 93, 94, 95, 97, 99, 100, 101, 105, 115, 116, 119, 127, 139, 142, 143, 144, 145, 149, 150, 154, 168, 170, 173, 175, 186, 192, 195, 198, 200, 206, 210, 220, 223, 225, 233, 234, 235, 236, 237, 243, 249, 256, 257, 258, 263, 265, 266, 267, 268, 272, 275, 277, 289, 291.

Visual Aids:

A. Charts

1. Meinhold Zoological Charts.
Crabs, Shrimp, etc.
Octopus, Squid, etc.
Sea Horses, Hydra, etc.
Corals, Sponges.
Starfish, etc.
Jellyfish, Anemone.
2. Matzdorf Biology Charts.
Phosphorescent Sea Animals.
3. Tauber Geographic.
Virgin Forests of Sumatra.
Life in the Antarctic.
North American Pine Forests.
North American Rocky Mountains.
Himalaya Mountains.

4. Lehmann Heredity Charts.
 Races of Europe.
 Races of the World Outside of Europe.
 The Four Principal European Races.
 Distribution of Races in Europe.
 Skulls of European and Asiatic Races.
5. Portraits of Scientists.

B. Films:

1. Oregon State College.

Agricultural Explorations in Ceylon, Sumatra,
 and Java. 16 mm silent.
 Big Game and the National Forests. 16 mm
 silent, 1 reel.
 Trees to Tame the Wind. 16 mm sound, 1 reel.
 Balanced Plenty. 16 mm silent, $\frac{1}{2}$ reel.

2. University of California.

- #22. How Living Things Find a Home on the
 Earth. 16mm. silent, 1 reel, \$1.00.
- #28. Down at Our Pond. 16mm. silent, 1 reel,
 \$1.00.
- #56. People Who Live in the Arctic. 16mm.
 silent, 1 reel, \$1.00.
- #59. People Who Live in The Mountains.
 16mm. silent, 1 reel, \$1.00.
- #114. The Arid Southwest. 16mm. silent,
 1 reel, \$1.00.
- #237. Pygmies of Central Africa. 16mm.
 silent, 1 reel, free to members.
- #252. Mongols of Central Asia. 16mm. silent,
 1 reel, \$1.00.
- #256. Four Seasons. 16mm. silent, 4 reels,
 \$4.00.
- #257. Houses of the Arctic and the Tropics.
 16mm. silent, 2 reels, \$2.00.
- #258. Wanderers of the Arabian Desert.
 16mm. silent, 1 reel, \$1.00.
- #285. Microscopic Animal Life. 16mm. silent,
 1 reel, \$1.00.
- #307. The Jungle Roundup. 16mm. sound, 1
 reel, \$1.00.
- #311. An African Adventure. 16mm. silent,
 1 reel, \$1.00.
- #355. Life in the Sahara. 16mm. silent, 1
 reel, \$1.00.

- #486. Australia's Wild Wonderland. 16mm.
silent, 1 reel, \$1.00.
- #490. Dwellers of the Forest. 16mm. silent,
1 reel, \$1.00.
- #491. Wild Life of the Desert. 16mm. silent,
1 reel, \$1.00.
- #503. Hunters of the White North. 16mm.
silent, 1 reel, \$1.00.
- #2532. Pond Insects. 16mm. sound, 1 reel,
\$5.00.
- #2688. Tragedy of Mt. Everest. 16mm. sound,
1 reel, \$5.00.
- #2739. Sahara. 16mm. sound, 1 reel, \$1.50.
- #2903. Pygmies of Africa. 16mm. sound, 1
reel, \$5.00.
- #2931. T.F.C. Giants of the Jungle. 16mm.
sound, 1 reel, \$1.00.
- #2958. T.F.C. The Sea. 16mm. sound, 1
reel, \$1.00.
- #3010. Mineral Element Deficiencies in Plant
Growth. 16mm. sound, 1 reel, free.

3. Motion Picture Bureau

- #G-753. An Aquarium in a Wine Glass. 16mm.
silent, 1 reel, \$1.00.
- #1828. Top O' the World. 16mm. silent, 1
reel, \$1.00.

4. Bell and Howell Filmosound Library.

- #3408. Under and Over the Moors. 16mm.
sound, 10 min., \$1.50.

C. Lantern Slides

1. Oregon State College.

- #237G. Life Forms in Various Environment.
48 slides.
- #247G. Distribution of Plant Life. 38 slides.
- #283G. Wild Animals. 40 slides, colored.
- #34G. Races of Men. 28 slides.

Free and Inexpensive Reference Material:

A. American Education Press, Inc., 400 South Front St., Columbus, Ohio.

1. Smith, Jeanette, Pets at School, booklet, 24 pp. 11., 15¢.

B. American Museum of Natural History, Columbus Avenue and 77th St., New York City.

1. Guide Leaflet Series:
 - #28. Habitat Groups of North American Birds. 28¢.
 - #74. Outposts of the Sea. 13¢.
 - #72. Miner, R. W., A Drama of the Microscope. 1931. 16 pp. 13¢.
2. Anthony, H. E., The Capture and Preservation of Small Mammals For Study. 1931. 54 pp.
3. Lucas, F. A., The Preparation of Rough Skeletons, 1930. 15 pp.
4. Lutz, F. E., How to Collect and Preserve Insects. 1924. 27 pp.

C. Bausch and Lomb Optical Co., Rochester, New York.

1. Bausch, Edward, Use and Care of the Microscope. 40 pp. Free.

D. Beldt's Aquarium, 2141 Crescent Ave., St. Louis, Mo.

1. Goldfish and Their Care. 24pp. 15¢.

E. Field Museum of Natural History, Roosevelt Road, Chicago, Illinois.

1. Geology Leaflets:
 - #5. Soils.

F. General Biological Supply House, (The), 761-763 East 69th Place, Chicago, Illinois.

1. Turtlox Service Leaflets: (Free).
 - #5. Starting and Maintaining a Balanced Fresh-water Aquarium.

- #6. Growing Fresh-water Algae in the Laboratory.
- #7. Building a Permanent Teaching Demonstration Collection.
- #8. How to Prepare Microscope Slides of Simple Objects.
- #10. The School Terrarium.
- #14. A Selected List of Books for the Biology Library.
- #17. Modeling in the Laboratory.
- #19. Special Projects for Biology Students.
- #20. Notes on Marine Aquaria.
- #22. How to Make Laboratory Drawings.
- #23. Feeding Aquarium and Terrarium Animals.
- #26. Making Biology Charts.
- #36. Care and Use of the Microscope.
- #37. A Miniature Vivarium.
- #45. Lantern Slides Any Teacher Can Make.
- #48. Aquarium Troubles; Their Prevention and Remedies.

2. Turtlox News. (Free).

G. Intourist, Inc., 545 Fifth Avenue, New York City.

- 1. Ascania-Nova, 13 pp., il., free.

H. Leisure League of America, 1309 W. Main St., Richmond, Va.

- 1. Mann, Lucille Quarry, Friendly Animals:
A Book of Unusual Pets. 95 pp. 35¢.

I. Limestone Products, Inc., Dallas, Oregon.

- 1. Make Your Own Soil Tests for Acidity.
16 pp. Free.

J. National Geographic Society, 16th and M. Sts.
N. W., Washington, D. C.

- 1. Miller, Ida. M., Tropical Toy Fishes, March 1931, pp. 288-317, 50¢.
- 2. Back numbers of the National Geographic Magazine at the following rates: specified list (pick your own) 10 for \$1.00. Unspecified list (take what is sent) 10 for 50¢.

K. National Recreation Association, 315 Fourth Avenue, New York City.

1. Price, Betty, Advertising in America; Description of things to do on field trips. 98 pp. 11. 60¢.

L. Nitragin Company, Inc. (The), Milwaukee, Wisconsin,

1. Double Profits From Legumes. 20 pp., free.

M. Oregon State College Experiment Station, Corvallis, Oregon.

1. Extension Circular:

#365. Collecting, Pressing, Drying, and Mounting of Plant Material. 1941. Free.

#367. List of Available Mimeographed Experiment Station Circulars of Information and Extension Circulars. 1941. Free.

2. Station Bulletins:

#365. Composition, Rating, and Conservation of Willamette Valley Soils. 38 pp., free.

N. Rand-McNally & Co., 538 S. Clark St., Chicago, Illinois.

1. Lawson, James L., Wild Animals, 65 pp., 12¢.

O. Scott, Foresman and Company, Chicago, Illinois.

1. Materials For Science. 24 pp. Free.

2. Russell, David W., Suggestions for the Care of Pets in the Classroom. Free.

P. United States Superintendent of Documents, Washington, D. C.

1. Agricultural Circulars:

#378. Practical Laboratory Method of Making Thin Cross Sections of Fibers. 1935. 11 pp., 11., 5¢. (Al.4/2:378).

- #447. Freezing Temperatures of Some Fruits, Vegetables, and Florists' Stock. 1937. 11 pp., 5¢. (A 1.4/2:447).
 - #454. Preparation of Pathological Specimens From Animal Tissues and Their Mounting Under Watch Glasses. 1938. 14 pp., 11., 5¢. (A 1.4/2:454)
2. Agriculture Department, Advance Sheet:
- #6. Atlas of American Agriculture, 1936. 75¢. (A 1.30/a:6).
3. Agriculture Miscellaneous Publications:
- #229. Development and Significance of the Great Soil Groups of the United States. 1936. 40 pp., 11., 10¢. (A 1.38:229).
 - #338. Living and Forest Lands. 1940. 48 pp., 11., 10¢. (A 1.38:338).
4. Agriculture Leaflets:
- #101. Injury To Building by Termites. Rev. 1936. 8 pp. 11. 5¢. (A 1.35:101).
5. Agriculture Yearbook Separates:
- #1633. Nature and Use of Organic Amendments. 1939. 5¢. (A 1.10/a:1633).
 - #1635. Fertilizer Materials. 1939. pp. 487-521. 11. 10¢. (A 1.10/a:1635).
 - #1655. Plants as Soil Indicators. 1939. 10¢. (A 1.10/a:1655).
 - #1657. Physical Nature of Soil. 1939. 10¢. (A 1.10/a:1657).
 - #1659. General Chemistry of the Soil. 1939. 5¢. (A 1.10/a:1659).
 - #1661. Fauna and Flora of the Soil. 1939. 5¢. (A 1.10/a:1661).
6. Bureau of Fisheries Documents:
- #948. Aquatic Plants in Pond Culture. 10¢. (C 6.1:923/app.2).
7. Ethnology Bulletins:
- #119. Anthropological Papers. 1938. 204 pp., 11., 40¢. (S I 2.3:119)

8. Farmers' Bulletins:

- #1047. Dry Farming For Better Wheat Yields. 5¢. (A 1.9:1047).
- #1318. Greenhouse Construction and Heating. Rev. 1937. 38 pp., 1l., 5¢. (A 1.9:1318).
- #1472. Preventing Damage by Termites or White Ants. Rev. 1939. 22 pp., 1l., 5¢. (A 1.9:1472).
- #1545. Dry Farming Methods and Practices in Wheat Growing in Columbia and Snake River Basins. 5¢. (A 1.9:1545).
- #1750. Summer Crops for Green Manure and Soil Improvement. Rev. 1939. 17 pp., 1l., 5¢. (A 1.9:1750).
- #1845. Liming of Soils. 1940. 26 pp., 1l., 5¢. (A 1.9:1845).

9. Public Health Reprints:

- #1281. Physical Measurements of Boys and Girls of Native White Stock, Third Generation Born, in the United States. 10¢. (T 27.6/a:1281).

Q. Ward's Natural Science Establishments, Inc.
Rochester, New York.

- 1. Traver, Jay R., Compendium of Entomological Methods, Part I, Collecting Mayflies. 1940.

CHAPTER III

UNIT 2

FOOD AND ORGANISMS

BIOLOGY

Unit 2.

Time: 35 days.

FOOD AND ORGANISMS

PLAN

DayMethod

1

Pretest for Unit 2.

(See the Plan for Unit 1, pp. 19)

Presentation.

(See the Plan for Unit 1, pp. 19)

Distribute the duplicated copies of the Outline
of the Unit and the Suggested Activities.

Rotate the membership of the standing committees.

Start the experimental and control guinea pigs
on the diets to show the effects of a defi-
ciency of vitamin C (see the 16th day).Feed the animals in the aquarium and the
terrarium.

2

Supervised study.

Examine the Outline of the Unit and use it
as a guide for surveying the data in the
unit.

3 Supervised study.

Continue with the examination of the Outline of the Unit.

Check the data on the subject of the "cell" to be presented at the next meeting of the class.

4 Class discussion.

Purpose: To acquaint the pupils with the appearance, size, shape, structures, and importance of the "cell."

This discussion period may be introduced as a short lecture on the cell by the instructor. Use as much visual and illustrative material as possible to be certain to present a clear picture. Showing one of the several excellent moving pictures can do more to convey the correct impression here than several periods of discussion. Be certain that each pupil receives the correct impression as to the size of cells.

Supervised study the remainder of the period.

Check the cultures of protozoa to see that specimens of amoeba, paramecium, and other forms will be available for the next meeting of the class. You will need an onion, elodea from the aquarium, and prepared slides of cells. A large epithelial cell can be secured by scraping the mucous layers inside the cheek.

Feed the animals in the aquarium and the terrarium.

5 Supervised study.

Examine and sketch the appearance of cells as they appear under the microscope or projected by the micro-projector. Examine amoeba, paramecium, and other protozoa. Mount the thin tissue separating the leaves

of a dry onion. Stain and examine under the microscope.

6 Supervised study.

Work on the Suggested Activities.

Evaluation.

Have a pupil self-test available that will test his understanding of the data relative to the cell.

Check to see that specimens of root forms, stems, and leaves will be available for the next meeting of the class. Most late gardens will have several examples of each form. Go over the available illustrative material.

Feed the animals in the aquarium and the terrarium.

7 Class discussion.

Purpose: To acquaint the pupils with root forms, monocot and dicot stems, the common shapes of leaves, and the anatomy of a typical root and leaf.

Submit specimens of each form for pupil examination. Use illustrative and visual material.

Supervised study for the remainder of the period.

8 Supervised study.

Examine and sketch the root forms and leaf shapes discussed at the previous meeting of the class. Make a cross-section sketch of a dicot and a monocot stem.

9 Supervised study.

Work on the Suggested Activities.

Evaluation.

Have a pupil self-test available that will test his understanding of root forms, stems, and leaves.

Feed the animals in the aquarium and the terrarium.

10 Supervised study

Work on the Suggested Activities.

Plant one dozen sunflower, tomato, or coleus seeds in individual pots for plants to be used in demonstrations of tropistic reaction in plants (see the Plan for Unit 3, 6th day).

11 Supervised study.

Work on the Suggested Activities.

Check the material to be used in the discussion of foods and digestion (12th day). Select the visual aids and illustrative material to be used.

Feed the animals in the aquarium and the terrarium.

12 Class discussion.

Purpose: To acquaint the pupils with the scientific meaning of the term "food" and the process of digestion.

The discussion should establish the fact that foods are chemical compounds and fall into three main groups: proteins, carbo-

hydrates, and fats. Their composition should be illustrated to indicate their similarity and difference. Attention should be called to the "make-up" of our common foods. Photosynthesis should be discussed in relation to its role in food production.

Supervised study the remainder of the period.

13 Supervised study.

Work on the Suggested Activities.

Check the laboratory equipment to see if the necessary supplies are available to test for the presence of proteins, carbohydrates, and fats. Arrange to have samples of common plants used for foods at the next meeting of the class.

14 Class discussion

Purpose: To demonstrate that plants manufacture proteins, carbohydrates, and fats by testing some plant products used as food.

A test for starch. Add a few drops of iodine solution or tincture to the material to be tested. A blue-black color indicates its presence. The iodine solution is made by adding 0.3 g. of iodine (crystals) and 1.5 g. of potassium iodide to 100 cc of grain alcohol (95%). Cornstarch paste, wheat-flour paste, or a freshly sliced potato will produce easily demonstrated results.

A test for sugar. Mix parts A and B of Fehling solution and add to the solution being tested for sugar. Heat. The presence of sugar in the solution is indicated by the formation of a reddish brown (or yellow) precipitate (cuprous oxide). Fehling solution is made as follows: Part A: copper sulfate, 17.3 g. made up to 250 cc with

distilled water. Solution B: sodium potassium tartrate (Rochelle salts), 86.5 g. to 125 cc. distilled water. Benedict's solution is also good for testing for sugar.

A test for protein. Place the food to be tested in a test tube and add 5 cc of nitric acid and a little water. Heat it gradually to boiling. Allow the solution to cool, pour off the liquid, and add 10 cc of ammonium hydroxide to the remainder. A deep orange color indicates the presence of a protein.

A test for fats. Rub the material to be tested on a sheet of glazed paper. Hold the paper over a flame until the area rubbed with the food becomes heated but not scorched, then hold the paper up to the light. If fat is present in large enough quantities the area will be translucent.

Feed the animals in the aquarium and the terrarium.

15 Supervised study.

Work on the Suggested Activities.

Make arrangements to borrow vitamin preparations from a local drug store for a classroom display of popular vitamin preparations.

Contact the manager of a local slaughterhouse concerning the possibility of securing organs of animals for demonstration in the class. Will need several hearts and blood for the demonstration on the 20th day. Examine the possibility of changing these dates to conform with the routine of the slaughterhouse.

Evaluation.

Have a pupil self-test available that will test his knowledge of food.

16 Class discussion.

Purpose: To acquaint the pupils with the relationship of vitamins and a balanced diet to healthful living and to instill a desire to maintain individual health through sensible diet.

The discussion should be directed toward the recognition of certain acceptable facts concerning vitamins and a balanced diet. Most of the questions then can be evaluated in terms of these facts.

The experimental results of feeding vitamin-deficient diets to guinea pigs and rats can be used to illustrate this discussion.

Vitamin C deficiency. Use only half grown guinea pigs (weighing about 300 g.). Have each experimental and control animal marked and kept in a separate pen. Keep the cages clean and supplied with fresh water at all times. Do not allow the animals to be handled at any time during the experiment. Daily records of the feeding and the weights must be kept and plotted on a graph. The following is a diet deficient in vitamin C content: finely ground dried peas, 300 g.; wheat bran, 270 g.; rolled oats, 300 g.; butter, 27 g.; and common salt 3 g. The butter is melted and thoroughly mixed with the dry ingredients. Each pig should be fed about 20 g. of this food mixture daily. The check animals should be fed an additional 20 g. of sprouted peas per day or an equivalent amount of cabbage or tomato or orange juice to supply the vitamin C. As soon as a marked difference appears the experimental pigs should be fed the complete diet and allowed to recover.

Vitamin A deficiency. The following diet fed to the experimental rats should yield results at the end of 5 to 7 weeks: starch, 150 g.; dried beef, 30 g.; wheat, 114 g.; common salt, 3 g.; and slaked lime, 3 g. Add 30 g. of fresh butter for feeding the controls.

Display the exhibit of vitamin preparations.

Feed the animals in the aquarium and the terrarium.

17 Supervised study.

Work on the Suggested Activities.

Check the materials to be used in the discussion and demonstration of circulation in plants and animals.

Evaluation.

Have a pupil self-test available to test his knowledge of vitamins.

18 Supervised study.

Work on the Suggested Activities.

Stand freshly cut stalks of celery and several white carnations in dye solutions in preparation for the demonstration at the next meeting of the class. Use water-soluble dyes.

19 Class discussion.

Purpose: To acquaint the pupils with certain fundamental knowledge concerning circulation in plants and animals.

This discussion period can be effectively motivated by permitting the pupils to observe circulation in living tissue. This

can be seen in the web of a frog's foot, the fins of a fish, the tail of a tadpole, or the tail of the larvae stage of salamanders. The necessary equipment includes a frog board, pins, and piece of cloth about 4" by 12". The frog board is a thin dressed board about 2" by 4" by 1/4" thick. A one-half inch hole is bored near one end. Wet the cloth and wrap the fish or frog in it. Spread the foot or tail fin over the hole in the board and fasten it in place with the pins. If using a frog, the foot can be kept spread and in place by tying thread to the toes and anchoring them in place with pins. Keep the cloth and the web wet at all times. Place the board on the stage of the microscope so that the light will be reflected from the mirror up through the hole in the board and the tissue being examined.

Examine the stalks of celery and the white carnations that were placed in the dye solution. These are fixed by standing freshly cut stems in water soluble dyes.

Demonstrate the beating of the heart in a frog. Anaesthetize or pith a large frog and expose its heart through the ventral wall of its body. Avoid cutting any large blood vessels. The beating of the heart can be prolonged by keeping the tissue bathed with a normal salt solution at room temperature. Several interesting observations can be noted on the rate of the beat as it is affected by changing the temperature of the salt solution.

Summarize the circulatory system in plants and animals.

Feed the animals in the aquarium and the terrarium.

Examine and sketch a heart dissected to show the chambers and the valves. Make sketches

of the cross-section of a vein and an artery.

Hearts can be secured from the local meat market if it is not convenient to contact a slaughterhouse. The best results will be had by explaining ones wants to the manager of a slaughterhouse. The entire heart with attached lengths of the aorta and vena cava can be obtained in this manner. The cross-section sketches of the veins and arteries will likely have to be done from prepared slides.

Exhibit prepared slides of veins, arteries, capillaries, and red and white corpuscles.

Demonstrate how to make a blood smear and allow the members of the class to make their own. Place a droplet of blood upon a slide. Spread it by dragging the edge of a cover glass over the droplet and along the slide. Place the cover glass upon the smear and examine it under the microscope for red corpuscles.

A smear made from the fresh pus of some infected source will reveal white corpuscles.

Plasma and fibrin can be demonstrated by securing about a pint of fresh blood from a slaughterhouse. It must be collected as it emerges from the animal. Nearly fill the container and seal tightly to keep out the air. Pour some of the blood into a bowl and whip with a fork. As a result clotting will take place along with the formation of strings of material. This is the fibrin and enmeshes most of the corpuscles. Allow some of the blood to stand in a beaker for several hours. The clear or straw-colored liquid in the bottom of the beaker is the plasma or serum.

Start germinating the seeds to be used in the demonstrations on the 23rd day. Some must be ready on the 21st day (intervening weekend)

and the balance on the 22nd day. Seeds can be germinated in a warm, dark place between sheets of dampened blotting paper or wrapped in a dampened cloth.

21 Class discussion.

Purpose: To demonstrate the control of bleeding by application of digital pressure.

Demonstrate the pressure points on a "victim" and then have each member of the class locate the point on himself. After all the points have been demonstrated, have the class "count off", form teams of two, and practice on each other. This practice should simulate accident conditions with special emphasis being placed on the position of the victim. Refer to the American Red Cross First Aid Manual.

Set up the experiment on germinating seeds in the presence of potassium pyrogallate for the demonstration on the 23rd day.

Feed the animals in the aquarium and the terrarium.

22 Supervised study.

Work on the Suggested Activities.

Check the equipment to be used in the demonstrations at the next meeting of the class. Put the germinating seeds in the jar and seal. Fix the control jar. Assemble the carbon-dioxide generator and have it generating several hours before the meeting of the class. Make up an ample supply of fresh lime water.

Evaluation.

Have a pupil self-test available to test his knowledge of circulation.

Pot two or three sword ferns and keep in the laboratory for use in Unit 6, 18th day, to show prothallia. Keep in the coolest part of the room in reduced light. Set the pots in saucers or pans of water as an aid to keeping moist. This method generally produces satisfactory results and is suggested in lieu of their culturing on an inverted flower pot or brick in a moist chamber.

23 Class discussion.

Purpose: To assist the pupils to recall that oxygen is necessary for animal life, to demonstrate that oxygen is necessary for plant development, to demonstrate that oxidation results in the formation of new products, and to assist the pupil in his understanding of the mechanics of breathing.

The pupil is likely familiar with the phenomena of burning and rusting. That animals need oxygen will have to be established through the recall of experiences. That some phases of the activities of plants require oxygen can be shown by germinating seeds with and without oxygen.

To germinate seeds with and without oxygen use freshly soaked wheat grains, two large bottles with stoppers, string, two small bags, about 40 cc. of potassium pyrogallate. Make the solution by mixing equal volumes of $6 \frac{2}{3}$ per cent potassium pyrogallate acid solution and a $33 \frac{1}{3}$ per cent potassium hydroxide solution immediately before using. Divide the number of soaked seeds between the two bags, moisten, and suspend from the cork so that they do not touch the liquids. In the first bottle pour 40 cc. of water and stopper. In the second bottle pour 40 cc. of potassium pyrogallate and stopper. This bottle soon becomes oxygen free since this substance has a strong affinity for oxygen. Let set for several days and then examine the seeds.

An experiment that shows that living organisms take oxygen from the atmosphere can be demonstrated by filling a jar about one-third full of germinating corn, bean, or wheat seeds. Close tightly and allow it to stand overnight. At the time of the demonstration, light a long slender stick, remove the stopper and quickly thrust the flaming stick in the jar. The flame should be extinguished, showing the lack of oxygen. Repeat the test with another similar jar that had been sealed at the same time as the one containing the germinating seeds but containing nothing except normal air.

That one of the products of oxidation in plants and animals is carbondioxide can be established by testing the expired gases for carbon dioxide. Have several members of the class blow their breath through soda straws or glass tubes into beakers of lime water. If the lime water becomes milky, carbon dioxide is present.

Lime water is made by placing ordinary slaked lime in water, mixing thoroughly, and allowing it to stand until the excess lime has settled out. Decant the clear liquid and keep it in tightly corked bottles until ready for use. Carbon dioxide unites with this lime water forming a carbonate of lime which is not soluble in water. The carbonate is white in color causing the lime water to become milky.

Carbon dioxide can be generated in the laboratory by setting up a generator which consists of a large wide-mouthed bottle equipped with a two-hole rubber stopper. A piece of glass tubing is inserted in one hole. On the end of this is placed a rubber tube which serves as the discharge outlet to the containers collecting the gas. A thistle tube or long-stemmed funnel is pushed through the other hole far enough that the lower end will be below the water level in the jar. Put about 75 cc. of water in the jar and add a handful of marble chips or

finely broken limestone. Put the stopper with its connections in place. Add hydrochloric, sulfuric, or nitric acid a little at a time through the thistle-tube. Clear the generator by allowing it to run awhile before collecting.

The relation of the ribs and muscles to the chest cavity can be demonstrated by having the class stand and breathe in unison and calling attention to the contour of the chest and its probable volume increase or decrease as a result of inhalation and exhalation. The relation of the diaphragm to the chest capacity and the inflation of the lungs can be illustrated by putting toy rubber balloons on the ends of a Y-tube. This is then pushed up through a one-hole stopper that has been fitted to the top opening of a bell jar. The bottom of the bell jar is covered with rubber mask simulating the diaphragm. A string may be attached to the center of the diaphragm by cementing a rubber band to the outside of the mask with rubber cement.

It is important to distinguish between respiration and photosynthesis.

24

Supervised study.

Work on the Suggested Activities.

Evaluation.

Have a pupil self-test available to test his knowledge concerning respiration.

Ask pupils to bring blankets, robes, or canvas to use while practicing artificial respiration.

Feed the animals in the aquarium and the terrarium.

25 Class discussion.

Purpose: To demonstrate to the pupils the first aid treatment for victims of asphyxiation.

Demonstrate the Schafer Prone Pressure method of administering artificial respiration. If the teacher does not possess an American Red Cross Standard, Advanced, Special, or Instructor's first aid card, he should contact his local or county chapter for some one qualified to demonstrate this technique. Many of the Boy Scout troops, industrial plants, fire departments, and police departments have first aid teams or instructors that would be available.

Divide the class in groups of three and practice. One pupil should be the victim while the other two alternate in administering artificial respiration, changing operators at frequent intervals without losing the rhythm. The turn-over and supplementary treatment should be practiced at the same time.

Each group of three pupils should have two blankets, canvas, or robes. One of these should be used under the victim and one over him. Newspapers spread on the floor will assist in keeping clothes and covers clean.

A demonstration of an inhalator would be very effective at this point. Emphasize that it is an "inhalator" and not a "pulmotor." Contact the nearest fire department as most of them would be happy to send a trained man or crew to demonstrate its use.

26 Supervised study.

Work on the Suggested Activities.

Evaluation.

Have a pupil self-test available to test his knowledge of artificial respiration.

Feed the animals in the aquarium and the terrarium.

27 Supervised study.

Work on the Suggested Activities.

Check over the material to be used in the discussion of excretion.

28 Class discussion.

Purpose: To acquaint the pupils with some of the factual knowledge concerning excretion in plants and animals.

The particular emphasis in this discussion should be placed on the importance of proper habits of excretion to one's general health and social acceptance.

29 Show one of the films listed at the end of this unit.

Evaluation.

Have a pupil self-test available to test his knowledge of excretion and its importance to health.

Supervised study for the remainder of the period.

Feed the animals in the aquarium and the terrarium.

30 Supervised study.

Work on the Suggested Activities.

Contact a first aider to demonstrate bandaging and the first-aid treatment of fractures, strains, and sprains. Arrange for splints and bandages needed. Equipment borrowed from ambulances and fire departments should be picked up just before the meeting of the class and returned immediately afterwards.

31 Class discussion.

Have a first aid instructor or some one proficient in first aid demonstrate bandaging and the first-aid treatment for fractures, strains, and sprains. Contacts can be established through the local or county chapter of the American Red Cross.

A trained first aider is generally superior to a doctor in this work in that he presents the material at the pupil's learning level.

Traction splints should be improvised. However, the full- and half-ring splints should be demonstrated if they can be secured. Highway first aid stations, ambulances, and fire departments generally have some that could be borrowed.

Feed the animals in the aquarium and the terrarium.

32 Distribute the pupil self-test.

(See the Plan for Unit 1, pp. 26)

Oral presentation of assigned activities.

(See the Plan for Unit 1, pp. 26)

33 Continue with the oral presentations and criticisms.

Supervised study for the remainder of the period.

Plant the bean, pea, oat, or sunflower seeds for the demonstration of the response of stems to light (see the Plant for Unit 3, 5th day).

34 Summary exercise.

(See the Plan for Unit 1, pp. 27)

Check the laboratory equipment and supplies needed for Unit 3. Order locally the supplies that were overlooked in the annual list submitted at the end of school last spring.

Feed the animals in the aquarium and the terrarium.

35 Evaluation of the unit.

(See the Plan for Unit 1, pp. 27)

Score and discuss the tests.

BIOLOGY

Unit 2.

Time: 35 days.

FOOD AND ORGANISMS

Objectives:

1. To learn that certain fundamental life processes are common to all organisms.
2. To be able to distinguish between living and non-living material.
3. To acquire a basic understanding of the anatomy and the physiology of the human body.
4. To acquire a brief understanding of comparative anatomy.
5. To develop the proper appreciation of the role of the green plant in all life.
6. To learn about food and its importance to the continuation of life.
7. To destroy certain misconceptions concerning our normal activities that often contribute to poor health.
8. To develop a cause and effect attitude toward the functioning of one's body.
9. To develop an understanding conducive for preserving good health.
10. To acquire the principles of first aid necessary to assist in preventing accidents before the services of a physician can be secured.

Outline of the Unit:

I. Is The Living Organism Comparable to A Machine?

A. Processes involved in a machine.

1. Intake of fuel.
2. Preparation of the fuel for combustion.
3. Burning of the fuel.
4. Expenditure of the produced energy.

B. Processes involved in a living machine.

1. Food getting.
2. Digestion.
3. Circulation.
4. Respiration.
5. Excretion.
6. Motion.
7. Assimilation.
8. Nervous control (Unit 3).
9. Reproduction (Unit 6).

C. Metabolism: the building up and tearing down process that is continuously going on in a living organism.

1. Anabolism.
2. Katabolism.

D. Division of labor.

1. In a machine.
2. In a living organism.

II. What Is The Structural And Functional Unit Of All Living Organisms?

A. The Cell.

1. History of the study of the cell.
 - a. Pioneers with lenses.
 - b. Discoveries with microscopes.
 - c. Early ideas about cells.
 - d. Disproving spontaneous generation.
2. Protoplasm.
 - a. Chemical nature.
 - b. Physical nature.

3. Parts of a cell.
4. Typical plant cell.
 - a. Chlorophyll.
 - b. Chloroplasts.
5. Typical animal cell.

B. Tissue.

1. Function.
2. Examples.

C. Organs.

1. Function.
2. Examples.

III. What Is The Source Of Our Foods?

A. What is meant when we say "food."

1. Carbohydrates.
 - a. Sugars.
 - b. Starches.
2. Fats.
3. Proteins.

B. The role of the green plant in food production.

1. Photosynthesis.
 - a. Manufacturing carbohydrates.
 - (1. The factory.
 - (2. The machine rooms.
 - (3. The energy.
 - (4. The raw materials.
 - (5. The finished product.
 - (6. The waste product.
 - b. Chemistry involved in the production of sugar and starch.
 - c. The role of the green leaves in the production of food.
 - (1. Upper epidermis.
 - (2. Mesophyll.
 - (3. Lower epidermis.
 - (4. Veins.
 - (5. Stomata.
 - (6. Transpiration.

- d. The role of the stem in food manufacturing.
 - (1. Function of the stem.
 - (2. Types of stems.
 - (a. Dicotyledonous.
 - (1) Epidermis.
 - (2) Cortex.
 - (3) Vascular bundles.
 - (a) Phloem.
 - (b) Cambium.
 - (c) Xylem.
 - (b. Monocotyledonous.
 - (1) Epidermis.
 - (2) Inconspicuous cortex.
 - (3) Vascular bundles scattered.
 - (4) No definite central pith.
 - (5) No cambium layer.
- e. The function of the roots in food production.
 - (1. Absorption of raw materials.
 - (a. Root hairs.
 - (b. Osmosis.
 - (2. Storage of food.
 - (3. Classification of roots according to form.
- 2. Production of other foods.
 - a. Fats.
 - b. Proteins.

IV. What Are The Requirements Of Our Bodies?

A. Fuel foods.

- 1. Foods that release energy when oxidized.
- 2. Calorie.
 - a. Bomb Calorimeter.
 - b. Kinds of calories.
- 3. Fuel requirements by people engaged in different activities.
- 4. Factors in food selection.
 - a. The ratio of proteins, carbohydrates, and fats.
 - b. Cost.
 - c. Diet fads.
 - d. Containing sufficient alkaline producing foods.
 - e. Recognition of individual dietary differences.

B. Growth and repair foods.

1. Function.
2. Examples.

C. Water.

D. Oxygen.

E. Vitamins.

1. Hypervitaminosis.
2. Recent development in vitamins.

F. Salts (mineral compounds).

G. Keeping an efficient body with the aid of a correct diet.

V. How Is Food Digested And Absorbed?

A. Digestion in animals.

1. Comparative study.

- a. Amoeba.
- b. Paramecium.
- c. Sponge.
- d. Hydra.
- e. Worms.
- f. Fish.

2. Food digestion in man.

- a. Parts of the digestive tract.
- b. Digestive enzymes.
 - (1. Names.
 - (2. Gland secreted by.
 - (3. Food digesting.
- c. Accessory digestive structures.
- d. Healthful digestive habits.
 - (1. Proper mastication.
 - (2. Atmosphere during meals.
 - (3. Number of meals.
 - (4. Care of the teeth.
 - (5. Temperance.
- e. First aid principles.
 - (1. Poisoning.
 - (2. Appendicitis.
 - (3. Toothache.

- (4. Choking.
- (5. Stomach ache.
- (6. Hernia.

f. Periodic physical examination.

B. Digestion in plants.

C. Absorption of digested food.

- 1. Absorption in the small intestines.
 - a. Villi
 - b. Process of osmosis.
- 2. Absorption in the stomach.
- 3. Absorption of fats.

VI. How Is Digested Food Transported To The Cells?

A. The process called circulation.

- 1. Circulation in plants.
 - a. Vascular bundles.
- 2. Circulation in animals.
 - a. Amoeba.
 - b. Paramecium.
 - c. Sponge.
 - d. Hydra.
 - e. Earthworm.
 - f. Amphibian.
 - g. Fish.
- 3. Types of circulation found in man.
 - a. Pulmonary.
 - b. Systematic.
 - c. Coronary.
- 4. The effect of baths on the functioning of the circulatory system.

B. Special structures used in circulation.

- 1. The heart
 - a. Chambers.
 - b. Valves.
 - c. Functions.
 - d. Periodic examination by competent physician.
- 2. Blood vessels.
 - a. Arteries.
 - (1. Definition.
 - (2. Structure.
 - b. Veins.
 - (1. Definition.
 - (2. Structure.

- c. Capillaries.
 - (1. Definition.
 - (2. Structure.

C. The blood.

- 1. Function.
- 2. Composition.
 - a. Plasma or fluid content.
 - (1. Water.
 - (2. Fuel content.
 - (3. Mineral salts.
 - (4. Fibrinogen.
 - (5. Wastes.
 - (6. Other substances such as hormones.
 - b. Cellular bodies of the blood.
 - (1. Red corpuscles.
 - (a. Shape.
 - (b. Origin.
 - (c. Function.
 - (d. Counting.
 - (2. White.
 - (a. Shape.
 - (b. Origin.
 - (c. Function.
 - (d. Counting.

D. The lymph system.

- 1. Composition of the lymph.
- 2. Important lymph vessels.
- 3. Collecting digested fats.
- 4. Importance of the lymph nodes.
- 5. The lymph as a "medium of exchange" for the cells.

E. First aid principles applicable to the circulatory system.

- 1. Stoppage of bleeding.
 - a. Pressure points.
 - b. Application of digital pressure.
 - c. Tourniquets.
- 2. Treatment for shock.
- 3. Treatment for certain types of unconsciousness.

VII. How Do Plants And Animals Secure The Oxygen

Necessary For The Combustion Of Their Food?

A. Plants.

1. Release oxygen as a by-product of photosynthesis.
2. Use oxygen continuously in the process of respiration.
 - a. Inspiration.
 - b. Expiration.
3. Difference between respiration and photosynthesis.
4. Exchange gases through pores.
 - a. Stomata.
 - b. Lenticels.

B. Respiration in animals.

1. Amoeba.
2. Paramecium.
3. Earth Worm.
4. Starfish.
5. Frog.
6. Fish.
7. Higher animals.

C. How man secures his oxygen.

1. The parts of the respiratory tract.
2. How our breathing apparatus works.
 - a. Diaphragm.
 - b. Intercoastal muscles and ribs.
 - c. Atmospheric pressure.
 - d. Osmosis.
3. Healthful practices in regard to respiration.
 - a. Effect of correct posture.
 - b. Breathing through nose.
 - (1. Adenoids.
 - (2. Other nasal obstructions.
 - c. Correct humidity.
 - d. Proper ventilation.
 - e. Periodic physical examinations.
4. Artificial respiration.
 - a. Causes of stoppage of breathing.
 - b. Methods of securing the victim of such an accident.

- (1. In water.
- (2. Smoke-filled room.
- (3. On electric wire.
- (4. Gas-filled room.
- c. Standard technique.
- d. Supplementary treatment.

VIII. How Are Wastes Removed From The Bodies Of Plants And Animals?

A. Plants.

- 1. Release carbon dioxide.
- 2. Water vapor.

B. Animals.

- 1. Amoeba.
- 2. Paramecium.
- 3. Flat worms.
 - a. Planaria.
 - b. Tapeworm.
- 4. Starfish.
- 5. Earthworm.
- 6. Birds.

C. The excretory system in man.

- 1. Lungs.
- 2. Kidneys.
 - a. Uro-genital system.
 - b. Hygienic practices.
- 3. Large intestine.
 - a. Function.
 - b. Regular elimination is a necessity for an efficient body.
- 4. Skin.
 - a. Structure.
 - b. Functions.
 - (1. Excretory.
 - (2. Thermostatic.
 - (3. Protective.
 - c. Bathing a necessity for efficient functioning of the skin.
 - d. First-aid treatment of wounds and burns.
 - e. The use of cosmetics.
 - f. "Quackery" in skin conditions.
 - g. The value of periodic physical examinations.

IX. How Does The Body Utilize Energy Secured From Food?

A. Muscular system.

1. Muscles differentiated according to structure.
 - a. Smooth.
 - b. Striated.
 - c. Cardiac.
2. Muscles arranged according to use.
 - a. Extensors.
 - b. Flexors.
 - c. Sphincter.
3. Muscles differentiated according to nervous control.
 - a. Voluntary.
 - b. Involuntary.
4. Causes of muscular fatigue.
5. The hygiene of the muscular system.
 - a. Exercise.
 - b. Rest.
 - c. Muscle tone.
 - d. Physical culture.
6. First aid to injuries of muscles.
 - a. Strains.
 - b. Bruises.
 - c. Foreign material imbedded in muscles.

B. Skeletal system.

1. Function of the skeleton.
2. Types of joints.
 - a. Elastic.
 - b. Movable.
 - (1. Hinge.
 - (2. Ball-and-socket.
 - (3. Pivot.
 - (4. Gliding.
3. Divisions of the skeleton.
 - a. Appendicular.
 - b. Axial.
 - (1. Cranium.
 - (2. Spinal column,
 - (3. Thoracic girdle.
 - (4. Pelvic girdle.
4. Structure of a bone.

5. Dietary requirements for healthy bones.
6. First aid treatment for:
 - a. Sprains.
 - b. Dislocations.
 - c. Fractures.
 - (1. Simple.
 - (2. Compound.
 - (3. Green stick.

Suggested Activities:

1. Study and sketch cells as they appear under the microscope. Label as many structures as possible. Observe amoeba, paramecium, other protozoa, onion cells, elodea, any other plant cells available, and prepared slides of cells.
2. Name the important parts of a cell and tell the possible use of each.
3. Consult your instructor and with his advice demonstrate the process of osmosis. Write a short paper explaining this process.
4. Study and sketch the structure of roots, stems, and leaves. Label all parts. On a separate sheet discuss the function of each part.
5. Write a short explanation of the process of photosynthesis.
6. Describe an experiment that will prove that oxygen is produced as a by-product of photosynthesis. Include a sketch of the apparatus.
7. Make a list of methods of testing for the various foods. These methods must be practical for laboratory use. Be prepared to demonstrate them. Ask your teacher about equipment and materials.
8. Make a comparative study of the digestion of food in animals. Record your findings in chart form.
9. Construct a chart listing the vitamins, their use, and their best source.

10. Secure a label from the container of some preparation that is taken mainly for its vitamin content. Write a discussion of this product. Understand all the terms used on the label. Compare the label with the advertising for this product.
11. Investigate and write a paper on the value of local fish in the vitamin processing industry. One member of the class could write to the Bio-chemistry Laboratories, Astoria, Oregon, for information concerning this new industry.
12. Make a list of "food fads" practiced by people of your acquaintance.
13. Select one of the commonly advertised reducing diets. Discuss its merits and its dangers to the health of the person using it.
14. Keep a record of your diet for three days. Examine it from the standpoint of the material studied in this unit. Discuss it as to whether it was correct or deficient.
15. Weigh yourself and consult a height-weight table. If you are overweight, prepare a reducing diet for a three-day period. If you are underweight, prepare a three-day diet that should tend to increase your weight. If you are nearly as you should be, prepare a diet for a like period that should tend to maintain your present weight. These diets should observe all the principles of correct dieting.
16. Discuss the utilization by the body of a glass of milk under such headings as: its composition, structures encountered during its digestion, changes made by the various enzymes, its absorption, and its assimilation.
17. List the names and uses of the permanent teeth.
18. Describe the movement of liquids in plants. Name the structures involved.
19. Make a comparative study of circulation in animals.
20. Discuss the composition of blood. What is the function of each part?

21. After you have examined the laboratory exhibits and demonstrations and any chart or diagram at your disposal, begin with the right auricle, and name the parts of the human circulatory system in the order in which a drop of blood passes through the body.
22. Make a diagrammatic sketch of the heart showing the chambers, valves and point of entry and exit of the important vessels.
23. Be able to demonstrate the pressure points for control of arterial bleeding, the stoppage of bleeding by digital pressure, and the use of the tourniquet.
24. What is the function of the lymphatic system?
25. Record your rate of breathing and pulse before and after exercise. Explain the reason for any change.
26. Explain the operation of the respiratory tract in man.
27. Discuss the importance of proper ventilation.
28. Be able to demonstrate the Schafer Prone Pressure Method of artificial respiration.
29. Divide into groups of three and be able to demonstrate the approved methods of transportation of the injured.
30. Discuss excretion in plants.
31. Describe the process of excretion in man.
32. Discuss the dangers and "quackery" confronting the users of cosmetics and skin preparations.
33. What are the important functions performed by the human skeleton?
34. Name the two chief kinds of muscle and explain the differences between each.
35. Name the types of joints and give an example of each.

Reference Books:

The following are numbers of books listed in the Bibliography A that will prove to be helpful in the study of this unit:

9, 13, 14, 18, 23, 32, 33, 35, 36, 41, 47, 50, 52, 53, 63, 64, 67, 68, 71, 78, 88, 98, 100, 108, 116, 120, 121, 124, 126, 131, 135, 139, 141, 145, 152, 164, 165, 166, 167, 169, 175, 188, 189, 203, 205, 210, 211, 212, 213, 214, 216, 217, 219, 221, 224, 229, 233, 235, 238, 242, 247, 251, 253, 257, 258, 269, 272, 275, 277, 284, 285, 286, 288, 289, 295, 299.

Visual Aids:

A. Charts

1. American Dental Association, Dental Health Charts.
Care of the Teeth.
Normal Healthy Teeth.
2. American Meat Institute.
59 East Van Buren St., Chicago, Illinois.

Meat Buyer's Guide--Pork.
Meat Buyer's Guide--Beef.
3. Bachin Chart.
Vascular System.
4. Fishbein Health and Hygiene Series.
Blood and Circulatory System.
Care of The Ear, Nose, and Throat.
Care of the Teeth.
Cleanliness and Sanitation.
Digestion.
First Aid.
Foods.
Heating, Ventilating, and Respiration.
Lymph and Lymphatics System.
Muscles and Exercise.
Physiological Effects of Alcohol.
Posture.
Safety.
Skeleton.
Social Effects of Alcohol.
Tobacco and Habit Forming Drugs.
Vitamins.
5. General Biology Charts.
Leaves, Roots, Stems.
6. Johnston's Physiology and Hygiene Charts.
Lymphatics and Organs of Digestion.
Showing Effects of Alcohol on the Body.
Showing Effects of Tobacco on the Body.
The Brain, Nervous System and Structure of the Skin.

The Heart, Arterial Blood Vessels, Capillary Blood Vessels, etc.
 The Joints and Ligaments and the Structure of the Ligaments and Cartilage.
 The Muscle System and the Structure of Muscle.
 The Skeleton and Structure of the Bone.
 Veins, Organs of Respiration, Circulatory System.

7. Jurica Biology Charts.
 Animal Cell Types.
 Dicotyledonous Stem.
 Monocotyledonous Stem.
 Root and Plant Functions.
 The Leaf.
8. Longworthy Food Series.
 Series of 15 Charts on Subject of Food and Dietetics.
9. National Live Stock and Meat Board.
 407 South Dearborn Street, Chicago, Illinois

 Food Value Charts. Presenting in Graphic Form the Nutritive Value of Common Foods. 1934, 15 p. Booklet. Free. 8½" x 10" Charts. Food Values: Vitamins, Calories, Protein, Phosphorous, Iron and Copper, and Calcium. Free. 8" x 10½" Series: Identification; Wholesale and Retail Cuts. Free. Veal Chart; Fresh Pork; Lamb Chart.
10. Pfurtscheller Zoology Charts.
 Crayfish.
 Frog.
 Paramecium.
 Perch.
 Starfish.
11. Philips Biology Charts.
 Frog, Vascular System.
 Leaf, Cross Section, Stomata, etc.
12. Smallwood Botanical Charts.
 Leaves, Adjustment to Light.
 Leaves, Kinds.
 Leaves, Special Uses.

Monocots and Dicots.
 Stems, for Display of Leaves.
 Stems, Special Uses.
 Structure and Function of Roots.

13. The Arnold Physiology Charts.
 Circulatory.
 Framework of the Body.
 Muscles.
 Organs of Digestion.
 Skin, Hair, and Excretory Organs.

14. The Winslow Health and Hygiene Charts.
 Circulation.
 Dental Hygiene.
 Digestion.
 Food Values.
 Health and Air.
 Living Substance.
 Secretion and Excretion.
 The Muscular System.
 The Skeletal System.

15. Turtlox Class-Room Charts
 Alimentary Canal.
 Circulation of Blood.
 Corn Stem.
 Dicot Root.
 Dicot Stem Anatomy.
 Excretion of Waste.
 First Layer of Organs of the Human Torso.
 Human Circulatory System.
 Human Heart and Lungs.
 Human Mouth Cavity.
 Human Neck and Pharynx.
 Human Skeleton (CR31) and (CR31.1).
 Human Skin.
 Joints.
 Leaves (CR72.1) and (CR 72.2).
 Monocots and Dicots.
 Monocot Stem Anatomy.
 Muscles.
 Muscles of Human Arm and Hand.
 Muscles of Human Leg and Foot.
 Muscles of Human Trunk.

Privet Leaf.
 Respiration.
 Root Anatomy.
 Second Layer of Organs of the Human Torso.
 The Skeleton.
 Third Layer of Organs of the Human Torso.
 Types of Animal Cells.
 Typical Cells.

16. Turtlox Wall Charts.
 Human Circulatory System.
 Human Head.
 Human Skeleton.
 Human Skin.
 Monocot and Dicot Analysis.

17. U. S. Superintendent of Documents.
 Washington, D. C.
 Childrens Bureau.

- #3 Posture Standards for Boys. 1926. 3 charts. Each 38 x 24 in. 25¢ per set. (L5.14:P84/1-3).
 #4 Health Protection for Every Child. Poster. 1937. 22.5 x 31.5 in. 10¢. (L5.14:H34/4).
 #6 Posture Standards for Girls. 1926. 3 charts. Each 38 x 24 in. 25¢ per set. (L5.14:P84/4-6).
 #7 Good Posture in the Little Child. 1934. Poster. 24 x 35.1 in. 15¢. (L5.14:P84/7).
 #8 Position of Skeleton in Good and Poor Posture. Poster. 1939. 34 x 24 in. 5¢. (L5.14:P84/8).

Health Education.

- #4 Weight-Height-Age Tables for Boys and Girls. (Revised Tables) 1923. 1 page. 111. 5¢. (I16.27:W42/4).

B. Films.

1. Oregon State College.

Food Makes a Difference.
 16mm. silent, 2 reels.

2. University of California.

- #121. Circulation.
16mm. silent, 1 reel, \$1.00.
- #127. Blood, The.
16mm. silent, 1 reel, \$1.00.
- #158. Living Cell, The.
16 mm. silent, 1 reel, \$1.00.
- #159. Breathing.
16mm. silent, 1 reel, \$1.00.
- #160. Circulatory Control.
16mm. sound, 1 reel, \$1.50.
- #203. Body Framework.
16mm. silent, 1 reel, \$1.00.
- #204. Muscles.
16mm. silent, 1 reel, \$1.00.
- #205. Posture.
16mm. silent, 1 reel, \$1.00.
- #206. Skin, The.
16mm. silent, 1 reel, \$1.00.
- #271. Care of the Teeth.
16mm. silent, 1 reel, \$1.00.
- #276. Digestion.
16mm. silent, 1 reel, \$1.00.
- #315. Urinary System.
16mm. silent, 1 reel, \$1.50.
- #316. Respiratory System, The.
16 mm silent, 1 reel, \$1.50.
- #326. Green Plant, The.
16mm. silent, 1 reel, \$1.00.
- #327. Feet, The.
16mm. silent, 1 reel, \$1.00.
- #334. Respiratory and Urinary Systems.
16mm. silent, 1 reel, \$1.50.
- #335. Heart and How It Works.
16mm. silent, 1 reel, \$1.50.
- #336. Blood Vessels and Their Function.
16mm. silent, 1 reel, \$1.00.
- #339. How We Breathe.
16mm. silent, 3/4 reel, \$.75.
- #340. Protoplasm, Beginning of Life.
16mm. silent, 1 reel, \$1.00.
- #869. Protozoa, The.
16mm. silent, 2 reels, \$2.00.
- #883. Pinocytosis--Drinking by Cells.
16mm. silent, 1 reel, \$1.00.
- #2518. Roots of Plants.
16mm. sound, 1 reel, \$1.00.
- #2570. Leaves.
16mm. sound, 1 reel, \$1.50.

- #2588. Mechanics of Breathing.
16mm. sound, 1 reel, \$1.50.
- #2606. Heart and Circulation of The Blood.
16mm. sound, 1 reel, \$1.50.
- #2670. Digestion of Foods.
16mm. sound, 1 reel, \$1.50.
- #2730. Alimentary Tract, The.
16mm. sound, 1 reel, \$1.50.
- #2769. Heart Disease.
16mm. sound, $\frac{1}{2}$ reel, \$1.00.
- #2835. Food and Nutrition.
16mm. sound, 1 reel, \$1.50.
- #2858. Life Saving.
16mm. sound, 2 reels, \$2.00.
- #2867. Men of Medicine.
16mm. sound, 1 reel, (600-ft. size).
\$3.00.
- #2885. Work of the Kidneys.
16mm. sound, 1 reel \$1.50.
- #2890. Control of Body Temperature.
16mm. sound, 1 reel, \$1.50.
- #2926TFC. Fit to Win.
16mm. sound, 1 reel, \$1.00.
- #2962TFC. Sport Stamina.
16mm. sound, 1 reel, \$1.00.

C. Glass Slides.

1. Oregon State College.

- 116G. Health and Common Sense, 36 slides.
- 117G. First Aid, 24 slides.
- 119G. Physiology, 48 slides.
- 253G. Wood Anatomy, 14 slides, colored.
- 274G. Policing The Mouth, 39 slides, colored.
- 275G. A Tale of Soap and Water, 42 slides,
colored.
- U.S.D.A. Food Makes a Difference, 60 slides.

D. Film Slides.

1. Oregon State College.

- 160. Function of Living Things, 29 pictures.
- 162. Bones and Muscles, 18 pictures.
- 163. Blood and Its Circulation, 21 pictures.

- 164. Respiration, Skin, Kidney, 23 pictures.
- 167. Foods and Digestion, 25 pictures.
- 211. Food Makes a Difference, 60 pictures.
- 213. Good Posture for Health and Beauty,
38 pictures.
- 392. Care of the Feet, 53 pictures.
- 393. A Tale of Soap and Water, 49 pictures.
- 394. Policing the Mouth.

E. Models.

- 1. Jewell Models for Biology (come in four series).

Free and Inexpensive Reference Material:

- A. American Dental Association, 212 East Superior Street, Chicago, Illinois.
 - 1. A List of Dental Educational Material. 16 pp. 11. Free.
- B. American Medical Association, 535 N. Dearborn Street, Chicago, Illinois.
 - 1. The Dangers of Carbon Monoxide Poisoning and Measures to Lessen These Dangers. 1930, 17 pp.
- C. American Red Cross, Pacific Area, Civic Auditorium, San Francisco, California.
 - 1. ARC 1026. The Red Cross on the Highways. 1937. Free.
 - 2. ARC 1031. Highway Emergency First Aid Stations. 1939. Free.
 - 3. ARC 1032. First Aid Organization and Courses. 1938. Free.
- D. Cleanliness Institute, 381 Fourth Ave., New York, New York.
 - 1. Hallock, G. T., A Tale of Soap and Water, 1928. 96 pp. Free.
- E. Earl Snell, Sec. of State, Salem, Oregon.
 - 1. Oregon Traffic Accident Facts. An Annual Publication Summarizing Accidents. Free.

- F. Ford Motor Company, Dearborn, Michigan.
 - 1. Ray W. Sherman, "How to Become A Skilled Driver". 63 pp. 1l. Free. (Ford Good Drivers League.)
- G. General Biological Supply House, (The), 761-763 East 69th Place, Chicago, Illinois.
 - 1. Turttox Service Leaflets.
 - #2 Preserving Zoological Specimens.
 - #3 Preserving Botanical Specimens.
 - #4 The Care of Protozoan Cultures in the Laboratory.
 - #21 Preparation, Injection and Care of Embalmed Specimens.
 - #42 Laboratory Dissections.
 - #49 Nutrition Experiments.
 - 2. Turttox News.
- H. Institute of American Meat Packers, 59 East Van Buren St., Chicago, Illinois.
- I. Metropolitan Life Insurance Company, 600 Stockton St., San Francisco, California.

Health Bulletins For Teachers.

- 1. Cell Architecture. Sept. 1940.
- 2. Controlling the Body's Chemical Activities. Nov. 1940.
- 3. Factors Influencing Arterial Blood Pressure. Feb. 1941.
- 4. Factors of Safety in Body Structure and Function. April. 1941.
- 5. Getting Rid of Waste Products. Nov. 1939.
- 6. Nature and the Physician. May. 1940.
- 7. Out of Old Fields, New Corn. Sept. 1941.
- 8. Regulating Body Temperature. Feb. 1940.
- 9. Sleep. Jan. 1941.
- 10. Telegrams From the Heart. The Electrocardiograph. May. 1939.
- 11. The Chemical Control of Body Functions. March. 1940.
- 12. The Kidneys and Their Work. Dec. 1940.

13. The Manufacture and Safeguarding of Blood. Jan. 1940.
 14. The Tissue Fluids. Oct. 1940.
 15. The Year's Progress in Medical Science and Public Health. June. 1940.
 16. The Year's Progress in Medical Science and Public Health. June. 1940.
- J. National Association of Manufacturers. 14 West 49th St., New York, N. Y.
1. Do Good Working Conditions Pay? 1938. 36 pp. Free.
 2. Industrial Health Advances. 1939. 9 pp. Free.
 3. Who's Too Small For a Health Program? 1939. 9 pp. Free.
- K. National Conservation Bureau, Education Division, 60 John St., New York, N. Y.
1. Getting Results Through Safety Education Series.
- L. National Safety Council, 20 N. Wacker Drive, Chicago, Illinois.
1. Accident Facts. 104 pp. 1l. (Annual Summary on Accidents).
- M. Public Affairs Committee, Inc., 30 Rockefeller Plaza, New York.
1. Rowntree, Jennie I., This Problem of Food. 1939. Pamphlet #33. 10¢.
- N. Signal Press (The), Evanston, Illinois.
1. Parental Alcoholism and the Child. 2 pp. 2¢.
 2. Is Beer Harmless? 2 pp. 2¢.
- O. Taylor Instrument Companies, Rochester, N. Y.
1. Humidity: Its Effect On Our Health and Comfort. 10¢.
- P. U. S. Superintendent of Documents, Washington, D. C.

Write for free price lists of publications
on biological subjects.

- #11 Foods and Cooking.
- #21 Fishes.
- #38. Animal Industries.
- #39 Birds and Wild Animals.
- #41 Insects.
- #43 Forestry.
- #44 Plants.
- #51 Health.
- #71 Children's Bureau.

CHAPTER IV

UNIT 3

BEHAVIOR OF ORGANISMS

BIOLOGY

Unit 3.

Time: 20 days.

BEHAVIOR OF ORGANISMS

PLAN

DayMethod

1 Pretest for Unit 3.

(See the Plan for Unit 1, pp. 19)

Presentation.

(See the Plan for Unit 1, pp. 19)

Distribute the duplicated copies of the Outline of the Unit and Suggested Activities.

Rotate the membership of the standing committees.

Arrange the three potted plants for the demonstration of the response of stems to gravity (see 5th day).

Soak the corn seed to be used the next day.

Feed the animals in the aquarium and the terrarium.

3 Supervised study.

Continue the examination of the Outline of the Unit.

Arrange the two potted plants for the demonstration of the response of stems to light (see the 5th day).

Display charts and models of the eye, ear, brain, and nervous system.

4 Supervised study.

Work on the Suggested Activities.

Check the equipment to be used in the demonstrations on the following day.

Feed the animals in the aquarium and the terrarium.

5 Class discussion.

Purpose: To discuss tropisms in plants and to observe some of the tropistic responses of plants.

Response of stems to gravity. Take three potted plants 6 to 10 inches in height, preferably plants that have but one main stem and no lateral branches. Sunflower, coleus, or tomato are suitable for this. Place one pot on its side so that the stem is horizontal to the pull of gravity. Suspend one upside down so that the stem is pointed toward the gravitational pull. Keep the third plant as a check. Examine the stems at the end of 4 days.

Response of stems to light. Take two potted plants with straight stems. Place one in such a position that it will be strongly lighted from but one side. Keep the second plant where it will receive light equally well from all sides. Com-

pare the two after 2 days. Plant bean, peas, oats, or sunflower seeds in two small containers in moist soil or peat moss. Cut a slit 1 inch by $\frac{1}{4}$ inch in one side of an empty pasteboard box. Invert this over one of the containers. Compare the reaction of these seedlings with those illuminated equally on all sides.

Reaction of roots to gravity. Line a glass funnel with filter paper and fill with peat moss, sand, or sawdust, thoroughly soaking this filler. Place soaked corn grains at 1 inch intervals between the glass and the filter paper. Keep moist and in a warm place. Roots should appear in 3 or 4 days. Note that the primary roots grow in the direction of the pull of gravity. After the roots are about 1 inch long carefully remove half of the germinating grains. With a sharp blade cut off about $\frac{1}{8}$ in. of the root tips of the two or three specimens, leaving the balance of the original half uninjured. Replace uninjured and the cut tips in the funnel so that the primary roots are pointing upward. Keep moist and warm and examine at the end of 3 days. The inverted roots with the tips intact will have curved and turned downward while the cut ones remain upright and uncurved, indicating that the tips (meristematic tissues) are necessary in responding to gravity. Compare with the roots which were not removed from the container.

Have the pupils draw conclusions from their observation of the reaction of the parts of plants to light and gravity. These should be interpreted in terms of positive and negative responses to these stimuli.

Supervised study the remainder of the period.

6 Supervised study.

Work on the Suggested Activities.

Check the equipment to be used in the observation of the response of animals to stimuli at the next meeting of the class.

Examine the root tips of the corn seed used in the demonstration to show the reaction of roots to gravity.

Feed the animals in the aquarium and the terrarium.

7 Class discussion.

Purpose: To observe the reaction of certain animals to stimuli and to interpret these observations in terms of pupil-drawn conclusions of the behavior of these animals.

Many of the experiments of this type can be performed by the individual pupil or can be demonstrated effectively to the class by a group of pupils. For the most part the demonstrations should serve as problems to be solved by the class rather than illustrations of fact already learned. If planning on individual experimentation or pupil-demonstration have an organized procedure to follow. This may be teacher- or pupil-organized and should be placed on the blackboard or duplicated for distribution.

Response of protozoa to light. Fill a pill bottle with protozoa culture, preferably pure culture of paramecium as they can be seen readily with the unaided eye. Cork tightly and place in a horizontal position. Cover one-half of the bottle by placing it in an opaque paper tube large enough so that the bottle can be

inserted and withdrawn without disturbing the distribution of the protozoa. After 30 minutes remove the cover and note the distribution of the organisms.

Response to weak acid. Warm a small piece of paraffin in warm water. Mold a layer of this about 1 1/2 inches long by 1/2 inch wide by 1/8 inch thick on a glass slide. Cut or press out the middle portion of the paraffin so as to form a narrow trough about 1 inch long by 1/4 inch wide. Make a shallow depression in the paraffin layer about 1/8 inch from the end of the trough. Leading from this depression into the end of the trough place a short piece of thread forming a wick. Add a drop of weak hydrochloric acid (about 1 drop of acid to 10 cc. of water) to the depression. Nearly fill the trough with protozoa culture. Observe the reaction of the protozoa when approaching the acid.

Response to electric current. Nearly fill the paraffin trough with protozoa culture. Lay a wire leading from one pole of a dry cell in one end of the trough. Carefully observe their reaction when the wire from the other pole is touched to the other end of the trough. The animals quickly accumulate near the negative pole. If the poles are reversed the response is repeated. If using paramecium, the best results can be seen by using a black background in good light without the microscope.

Many experiments can be worked out using hydra, planaria, earthworms, larvae of insects, and other animals.

Supervised study the remainder of the period.

8 Field trip.

Purpose: To observe the condition of the common plants as to appearance and evidence of growth as compared with the conditions encountered on the last trip and to survey the presence of animal life.

This walk is one of a series to acquaint the pupils with the year-around appearance and condition of plant and animal life in this vicinity. Attention should be called to the presence or absence of typical communities at this season.

Collect the notes made by the pupils on their observations.

9 Supervised study.

Work on the Suggested Activities.

Return the notes on the field trip.

Dissect several animals, such as the earth-worm, crayfish, and frog, to display their nervous systems. These may be preserved in 10 per cent formalin solution (see Suggested Activity No. 8).

Feed the animals in the aquarium and the terrarium.

10 Class discussion.

Purpose: To observe some of the simple reactions of the frog.

Response to contact. Touch the surface of the eye gently with a pencil. Notice the reaction. Repeat this several times for each eye to show that they react independently of each other. Tickle the nostril of the frog with a sharpened

matchstick. Notice that it closes. Repeat and watch the eyes at the same time. The eye on the same side of the head as the stimulated nostril closes. Association between the two reflexes. With a sharp-pointed object scratch the side of the frog. Usually the frog will strike at the stimulated area with its hind foot. This is called the "scratch reflex." Place the thumb on one side of a frog and the forefinger on the other and squeeze repeatedly with a stroking motion. The usual response is a croak at each squeeze.

Response to chemicals. Bring the tip of a match moistened in ammonia slowly toward the frog's eye but do not touch it. Do the same for the nostril. Moisten the match again and touch it to the jaw. This should result in a front leg scratch. Place some ammonia on the frog's back. Wash the frog after each application to remove the ammonia and prevent destruction of the skin.

Response to electric shock. Place the leads from a dry cell about 1/4 inch apart on the side of the frog. This should initiate the scratch reflex.

Prepare a medium-sized frog by decapitating it or pithing the brain and suspend it from a rack by means of a small hook. Apply ammonia to one side of the back and observe the scratch response. Apply it to the abdomen and notice the ability to "locate" the area.

Supervised study the remainder of the period.

Contact a person to discuss mental hygiene and lead the class discussion (see the 15th day).

11 Supervised study.

Check the material to be used in the class discussion of the simple reactions of the human being to stimuli at the next meeting of the class.

Feed the animals in the aquarium and the terrarium.

12 Class discussion.

Purpose: To observe some of the simple reactions of our body to stimuli.

The iris response. Have the class work in pairs. One sits so that he faces a window or source of light while the other observes the pupils of his eyes. Shade one eye with a dark card. Remove the card and observe the shrinking of the pupil. Repeat several times allowing a short interval in each case for adjustment. While one of the pair observes the other's eyes let the subject focus upon an object close at hand and then upon an object far away. The observer will notice a change in size of the pupil.

The inverted image. That an image of an object is really focused upon the retina in an inverted form but that we learn to transpose it mentally and unawares can be demonstrated as follows: make a pinhole in a card or a piece of paper and hold it about 1 inch from the eye, looking through the hole. Close the other eye. With the free hand pass a pinhead between the pinhole and the eye, causing the pinhead to move from below upward. The head will appear to enter the visual field from above.

The knee jerk. Sit in a chair and cross one leg over the other allowing the lower part of the crossed leg to hang limply. Tap the area just below the knee cap with

a mallet, edge of the hand, or a narrow book. The leg straightens without the control of the subject.

Tactile response. Push two sewing needles, one through each side of an ordinary cork at such an angle that their points come together and in such a manner that the distance between the points can be increased by withdrawing the pins. With the points close together explore the forearm. If the pins are close enough together they will give the sensation of a single contact. Separate the points a little at a time until they are just wide enough to give the impression of two points. This represents the distance apart of the separate sense areas of contact. Compare this distance as it is found on the palm of the hand, forehead, and the back of the neck. Do not press hard enough to cause pain as pain and pressure are separate senses.

Temperature response. Check the area of the back of the hand and the forearm to localize areas sensitive to heat and cold. Use steel knitting needles for the exploring. Cool the needles in cracked ice and make a mark every place the sensation of cold is felt. Heat the needles in hot water to localize the warm sensory areas.

Place the finger of one hand in a tumbler of water that feels hot, leaving it there for 1/2 minute. At the same time have a finger of the other hand dipped in a tumbler of cold water, leaving it there for the same length of time. Pour the two tumblers of water together in a third and quickly insert the two fingers. It feels cold to one finger and hot to the other.

Supervised study for the remainder of the period.

13 Supervised study.

Work on the Suggested Activities.

Exhibit any material owned by individual teachers or the school system for measuring intelligence. Use samples of tests not used in the school.

14 Supervised study.

Work on the Suggested Activities.

Feed the animals in the aquarium and the terrarium.

15 Class discussion.

Purpose: To discuss the importance of mental hygiene to the emotional stability of the individual and how to maintain emotional health.

This discussion should consist of a short talk by some outsider followed by a question period. The location of the school will influence the professional types that will be available. Some medical doctors would be willing to discuss this subject. Schools near our state institutions should be able to contact some of their psychiatrists. Members of the local staff that have a major or minor in psychology should be able to present this material in an interesting manner.

Announce the oral presentation for the 17th day. Assign the activities.

16 Supervised study.

Work on the Suggested Activities.

Feed the animals in the aquarium and the terrarium.

- 17 Distribute the pupil self-test.
 (See the Plan for Unit 1, pp. 26)
 Oral presentations of assigned activities
 (See the Plan for Unit 1, pp. 26)
-
- 18 Continue with the oral presentations and
 criticisms.
 Supervised study for the remainder of the
 period.
-
- 19 Summary exercise.
 (See the Plan for Unit 1, pp. 27)
 Check the laboratory equipment and supplies
 needed for Unit 4. Make arrangements to
 secure any that are missing.
 Order properly prepared seeds of albino
 maize (see the Plan for Unit 5, pp. 147
 3rd day).
 Feed the animals in the aquarium and the
 terrarium.
-
- 20 Evaluation of the unit.
 (See the Plan for Unit 1, pp. 27)
 Score and discuss the tests.
-

BIOLOGY

Unit 3.

Time: 20 days.

BEHAVIOR OF ORGANISMS

Objectives:

1. To realize that both plants and animals respond to the stimuli of their environment by behavior which enables them to survive.

2. To learn about the typical responses plants and animals make to the stimuli in their environment.

3. To cultivate an interest in the behavior of organisms and its significance.

4. To realize that it has been the development of increased mental processes that has enabled man to dominate his environment.

5. To develop an understanding and appreciation of mental health.

6. To develop an understanding of dangers to our sensory equipment and how we may prevent its damage.

Outline of the Unit:

I. What Is The Nature of The Responses Made By Plants And Animals To The Factors Of Their Environment?

A. Tropisms. A tropism is a simple turning of a living organism in response to a force, or material outside itself.

1. The response to a stimulus may vary according to intensity.
2. The response to a stimulus need not be a direct positive or negative reaction.
3. Tropisms may change with changes in physiological state.

4. An organism may simultaneously be under the influence of several tropisms.
5. The tropistic response made by an organism must be on the whole favorable to it.

B. Tropisms of plants

1. Phototropisms.
2. Hydrotropism.
3. Geotropism.
4. Thermotropism.
5. Thigmotropism.
6. Chemotropism.

C. Responses made by animals.

1. Behavior not involving intelligence.
 - a. Tropisms.
 - b. Reflex action.
 - c. Instinctive.
 - d. Emotional behavior.
2. Intelligent behavior in animals.
 - a. Memory.
 - b. Reasoning.

II. What Is The Nature Of The Organs And Tissues Involved In The Behavior Of Plants And Animals?

A. Nervous systems in plants and lower animals.

1. Evidence in plants.
2. Coelenterates.
3. Echinoderms.
4. Annelid worms.
5. Mollusks.
6. Arthropods.

B. The nervous system of man.

1. Nervous tissue is made up of irregular-shaped cells called neurons.
 - a. Speculation as to number.
 - b. Parts of a neuron.
 - (1. Cell body.
 - (2. Dendrite.
 - (3. Axon.

- c. Types of neurons.
 - (1. Sensory.
 - (2. Motor.
 - (3. Associative.
- d. Synapse.
- 2. Divisions of the nervous system.
 - a. Cerebrospinal system.
 - (1. Brain.
 - (a. Parts.
 - (b. Size.
 - (c. Function.
 - (2. Spinal cord.
 - (a. Protection.
 - (b. Spinal nerves.
 - (3. Nerves.
 - b. Autonomic system.
 - (1. Ganglia.
 - (2. Plexus.
- 3. Forms of behavior in man.
 - a. Reflexes are simple inherent responses not produced by training.
 - (1. Importance of reflexes.
 - (2. Example of reflex patterns.
 - (3. How a reflex act takes place.
 - b. Instinctive responses.
 - (1. Part played in animal activity.
 - (2. Disagreement among psychologists concerning importance and number.
 - (3. Classification of instincts.
 - (a. Nutritive.
 - (b. Defensive.
 - (c. Reproductive.
 - (d. Social.
 - c. Habits and their formation.
 - (1. Importance.
 - (2. Law of habit formation.
 - (a. Make a strong start.
 - (b. Act on every opportunity.
 - (c. Allow no exceptions until act is learned.
 - (d. Avoid fixed set habits. Keep open-minded and try out new ways of doing things.
 - (3. Conditioning.
 - d. Intelligence.
 - (1. Assisting factors.
 - (a. Health.

- (b. Ambition.
 - (c. Incentives.
 - (2. Measurement.
 - e. Mental disorders.
 - (1. Insanity.
 - (2. Feeble-mindedness.
 - (3. Inhibitions.
 - (4. Neuroses.
 - (5. Psychoses.
 - f. Mental hygiene.
- C. The part played by the hormones in regulating man's body.
 - 1. Hormone.
 - 2. Ductless glands and their secretion (endocrine).
 - a. Thyroid.
 - (1. Hormone.
 - (2. Location.
 - (3. Basal metabolism test.
 - (4. Conditions caused by improper functioning of the gland.
 - b. Adrenal (suprarenal)
 - (1. Hormone.
 - (2. Location.
 - (3. Function.
 - c. Thymus.
 - (1. Location.
 - (2. Association.
 - d. Pituitary.
 - (1. Location.
 - (2. Association.
 - e. Parathyroid.
 - (1. Location.
 - (2. Regulate.
 - f. Pineal gland.
 - (1. Location.
 - (2. Function.
 - 3. Other glands that secrete hormones.
 - a. Pancreas.
 - b. Sex glands.
 - c. Liver.
 - d. Intestines.
 - e. Spleen.

III. What Are The Structures That Enable Man To Contact His Environment?

A. The eye.

1. Parts of the eye and their function.
2. How we see.
3. Care of the eyes.
4. Who should we have examine and prescribe glasses for our eyes?
5. First-aid treatment to injuries to the eyes.

B. The ear.

1. Parts of the ear and their function.
2. How we hear.
3. Care of the ears.

C. The skin as a sense organ.

1. Touch.
2. Pain.
3. Cold.
4. Heat or warmth.

D. Taste buds.

1. Location.
2. Structure of a taste bud.
3. Taste areas on the tongue.
4. Conditions necessary for tasting.

E. Olfactory rods.

1. Location
2. How we smell.

IV. What Are Some Examples Of Social Behavior Demonstrated By Lower Animals?

A. Bees.

1. Castes of bees.
 - a. Queens.
 - b. Drones.
 - c. Workers.
2. Physical adaptations found on bees.

3. The home of the bees.
4. Manufacturing honey.
5. The food of bees.
6. Importance of the bee.
7. Life in the bee colony.

B. Ants.

1. Castes of ants.
 - a. Queens.
 - b. Drones.
 - c. Workers.
2. Homes built by ants.
3. Demonstrations of strength.
4. Life in the ant colony.

C. Birds.

D. Other animals.

Suggested Activities:

1. Prepare a demonstration for the class using commonplace examples that will distinguish between stimulus and response.
2. Set up a demonstration in the classroom that will illustrate one of the tropisms carried on in plants. Select one not already demonstrated so that all the forms will be observed.
3. Discuss any personal observation of animal behavior that illustrates tropisms, reflexes, instincts, memory, and reasoning.
4. If it is possible observe a demonstration bee hive. Discuss the relation of each kind of bee to the normal activity of the colony.
5. With the assistance of your teacher, test the response of some of the protozoa from the laboratory culture to stimuli such as temperature, light, and chemicals. Record your procedure and observation.
6. If possible observe a demonstration ant colony. Describe the social life of an ant.

7. Examine the sensory equipment of the demonstration animals. Describe the structures found on each animal and discuss their use and adaptation.
8. Examine the nervous system of the animal dissected to demonstrate the nervous system. Describe the nervous system of the animal.
9. Examine prepared slides of nerve tissue. Sketch a typical nerve cell.
10. Make a comparative study of the nervous system of animals from the simplest to the vertebrates.
11. Study charts or models of the human eye and ear. Make a sketch of each of these organs. Label.
12. Make a list of the ways in which your nervous system serves you.
13. Discuss the behavior mechanism with which you are equipped when you are born.
14. Discuss the role of habits in your everyday life and behavior and factors in their formation.
15. Make a list of the senses which you possess and the organs that function in each.
16. Examine the charts or models of the human brain. Sketch. Label the parts.
17. Discuss the functions of each of the two great divisions of the human nervous system.
18. Discuss intelligence, its measurement, and the value of treating it objectively in a guidance program.
19. Construct a chart, curve, or graph that illustrates any of the known data concerning intelligence.
20. Discuss mental hygiene and its importance to each of us.

21. Examine the eye charts issued by the State Department of Education. Check the vision of each of your eyes at 20 feet and record your findings.
22. Write a paper entitled, "The Care of The Eyes."
23. With the aid of the Periodical Guide select and brief an article that is applicable to this unit.
24. Prepare an oral report on one of the following subjects:
 - a. First aid treatment of injuries to the eyes.
 - b. The care of the ears.
 - c. Intelligence testing.
 - d. Personal experiences with animals that suggest that they think.
 - e. Diseases affecting vision.
 - f. The difference between an intelligent person and an educated person.
 - g. Studies in genius.
 - h. Forms of hysteria.
 - i. Examples of social behavior in lower animals.
 - j. Psychology.

Reference Books:

The following are numbers of books listed in Bibliography A that will prove to be helpful in the study of this unit:

8, 9, 13, 17, 18, 32, 35, 36, 47, 50, 53, 63, 64, 65, 75, 76, 88, 92, 100, 126, 135, 137, 139, 142, 145, 158, 165, 174, 175, 185, 188, 199, 203, 204, 209, 214, 216, 217, 221, 223, 231, 233, 235, 238, 241, 242, 251, 255, 257, 258, 259, 260, 265, 266, 267, 268, 269, 272, 274, 275, 276, 277, 279, 280, 282, 285, 287, 289, 290, 297.

Visual Aids:

A. Charts

1. Arnold Physiology Charts.
Ear.
Eye.
Nervous System.
2. Fiedler Anatomical Charts.
Ear.
Eye.
Vision.
3. Fishbein Health and Hygiene Series.
Care of the Ear, Nose, and Throat.
Care of the Eyes.
Nervous System.
4. Frohse Anatomical Charts.
The Ear, The Eye.
The Peripheral Nervous System.
The Arteries and Veins.
5. Johnston's Physiology and Hygiene Charts.
Organs of Sense and Voice.
The Brain, Nervous System and Structure of
the Skin.
6. Michel Anatomical Charts.
Circulatory and Nervous Systems.
The Spinal and Peripheral Nervous System.
7. Perrier and Cepede Zoology Charts.
Morphology of the Crayfish.
Nerve Cells and Nerve Fibers.
The Eye and the Retina.
8. Pfurtscheller Zoology Charts.
Clam.
Crayfish.
Frog.
Perch.
Starfish.
9. Turttox Wall Charts for Biology.
Human Eye and Ear.
Human Nervous System.

10. Turtlox Class Room Charts for Biology.
Human Brain.
Human Ear.
Human Head.
Human Spinal Cord.
11. Smalian Histology and Embryology Charts.
Nerve Tissue.
12. Winslow Health and Hygiene Charts.
The Ear.
The Eye.
The Nervous System.

B. Films.

1. Oregon State College.

Realm of the Honeybee, The.
16mm. silent, 4 reels.

2. University of California.

- #82. Man.
16mm. silent, 1 reel, \$1.00.
- #175. Ants, Nature's Craftsmen.
16mm. silent, 1 reel, \$1.00.
- #300. Palace of Honey.
16mm. silent, 1 reel, \$1.00.
- #337. Human Voice, The
16mm. silent, 3/4 reel, \$0.75.
- #866. How We See.
16mm. silent, 1 reel, \$1.00.
- #2604. Nervous System.
16mm. sound, 1 reel, \$1.50.
- #2717. Reactions in Plants and Animals.
16mm. sound, 1 reel, \$1.50.
- #2826. How We Hear.
16mm. sound, 1 reel, \$1.50.
- #2834. Endocrine Glands.
16mm. sound, 1 reel, \$1.50.
- #2920. City of Wax.
16mm. sound, 1 reel, \$1.00.
- #2955. Seeing Eye, The.
16mm. sound, 1 reel, \$1.00.
- #3014. Honey Bee, The.
16mm. sound, 1 reel, \$1.50.

C. Film Slides, Oregon State College.

- #168. Nervous System, Eye, Ear, and Tongue.
19 pictures.
- #239. The Busy Bee, Its Life and Work.
28 pictures.
- #325. How We Hear. 88 pictures.
- #331. How We See. 45 pictures.

D. Models.

- 1. Jewell Models for Biology.

Free and Inexpensive Reference Material:

A. Institution For The Chinese Blind, 156 Fifth Avenue, New York, N. Y.

- 1. Signature of Helen Keller.
- 2. Free information concerning rehabilitation of Chinese blind.

B. General Biological Supply House, (The), 761-763 East 69th Place, Chicago, Illinois.

- 1. Turtlox Service Leaflets: (Free)
 - #35. Studying Ants in Observation Nests.
 - #39. The Fresh-Water Hydras.
 - #42. Laboratory Dissections.
- 2. Turtlox News.

C. Metropolitan Life Insurance Company, 600 Stockton Street, San Francisco, California.

- 1. Health Bulletins For Teachers: (Free)
 - Investigating Sight and Light: Optical Instruments. February, 1939.
 - Special Sensibilities. March, 1941.

D. Oregon State Commission for the Blind, Salem, Oregon.

- 1. Disorders of the Eyes. 1938 by State Board of Social Welfare of Kansas. 16 pp. leaflet. Free.

E. U. S. Superintendent of Documents, Washington,
D. C.

1. Agriculture Bulletin:
#1324. Oviposition Response of Insects.
1925. 18 pp. 5¢. (A1.3:1324).
2. Agriculture Technical Bulletins:
#270. Chematropic Responses of the House
Fly, the Green Bottle Flies, and the
Black Blowfly. 1931. 11 pp. 5¢.
(A 1.36:270).
3. Census Bureau:
Deaf Mutes in the United States, 1920.
1923. 75 pp. 15¢. (C 3.2:34/13).
4. Childrens' Bureau Publications:
#24. Social Study of Mental Defectives in
New Castle Co., Del. 5¢. (L 5.20:24).
5. Education Bulletin:
#18. Adjustment of Behavior Problems of
School Children, Descriptions And Evalua-
tion of Clinical Program in Berkeley,
California, 1932. 78 pp. 10¢.
(I 16.3:932/18).
6. Farmers' Bulletins:
#1198. Swarm Control. 1921. 30 pp. 11.
5¢. (A 1.9:1198).
7. Fisheries Bulletin:
#8. Sensory Stimulation of the Oyster By
Chemicals. 10¢. (C 6.12:37).
8. Labor Standards Bulletin:
#37. Protecting Eyes In Industry. 1940.
18 pp. 5¢. (L 16.3:37).
9. Public Health Bulletin:
#49. Ophthalmia Neonatarium, Analysis of
Laws and Regulations Relating to the
Prevention of Blindness in New Born
Children. 10¢. (T 27:12:49).
#92. Color Blindness, Its Relation to Other
Ocular Conditions and Bearings on
Public Health of Tests For Color
Senses Acuity. 5¢. (T 27.12:92).
#188. Studies in Natural Illumination in
Schoolrooms: 3. Effects of Clouds on
Daylight Illumination And on Daylight
Ratios. 25¢. (T 27.12:188).
10. Public Health Reports:
#146. Supp. Mentally Ill and Mentally Hand-
icapped In Institutions. 1938. 20
pp. 5¢. (T 27.6/2:146).

11. Public Health Reprint:

- #975. Eyesight of School Child as Determined By The Snellen Test. 5¢. (T 27.6/a:975).
- #979. Snellen Test. Variation In Eyesight At Different Ages As Determined By The Snellen Test. 1925. 6 pp. 1l. 5¢. (T 27.6/2:979).
- #983. Endemic Goiter in Colorado. 5¢. (T 27.6/2:983).
- #1031. Strabismus And Defective Color Sense Among School Children, Sex And Age Incidence And Relation To Visual Acuity. 5¢. (T 27.6/a:1031).
- #1081. Goiter. Endemic Goiter and Intelligence (Of School Children). 1926. 16 pp. 1l. 5¢. (T 27.6/a:1081).
- #1108. Endemic Goiter And Physical Development. 1. Cincinnati School Children. 1926. 16 pp. 5¢. (T 27.6/a:1108).
- #1189. Endemic Goiter in Oregon. 1927. 5¢. (T 27.6/a:1189).
- #1265. Nature of Effect of High-Frequency Electric Field Upon Paramecium. 5¢. (T 27.6/a:1265).
- #1235. Special Study of The Vision of School Children. 1929. 36 pp. 1l. 10¢. (T 27.6/a:1235).
- #1364. Mental Disorders and Public Health. 5¢. (T 27.6/a:1364).
- #1373. Hearing of School Children As Measured By The Audiometer And As Related To School Work. 5¢. (T 27.6/a:1373).
- #1455. Jaeger's Test. Measurements For Jaeger's Test Types Used in Near Vision Tests. 1931. 4 pp. 5¢. (T 27.6/a:1455).
- #1940. Lighting For Low Cost Housing. Rev. 1940. 8 pp. 5¢. (FS 2.7/a:1940).
- #2001. Incidence And Future Expectancy of Mental Disease. 1939. 14 pp. 1l. 5¢. (T 27.6/a:2001).
- #2043. Association Between Rheumatic Fever And Exophthalmic Goiter. 1939. 8 pp. 5¢. (T 27.6/a:2034).

12. Standards Circular:
#397. Safety For The Household. 15¢.
(C 13.4:397).
13. Treasury Department:
#940. Protection Against Habit-Forming
Drugs. 1940. 14 pp. 5¢. (T 1.2:
D84/940).
14. Venereal Disease Information Reprint:
#110. Blindness. Cost And Loss From
Syphilitic Blindness in the United
States. 1939. 5 pp. 5¢.
(T 27.26/a:110).

CHAPTER V

UNIT 4

RELATIONSHIP AMONG ORGANISMS

BIOLOGY

Unit 4.

Time: 30 days.

RELATIONSHIP AMONG ORGANISMS

PLAN

DayMethod

1 Pretest for Unit 4.

(See the Plan for Unit 1.)

Presentation.

It is suggested that in this unit the presentation consist of the construction of a microcosm and a discussion of the biological principles involved in the activities of its inhabitants.

A microcosm can be assembled out of existing laboratory equipment by placing one of the fish and some of the aquatic plants from the aquarium in a gallon jug three-fourths full of water. Stopper the jug, invert, and set it in the open end of a battery jar.

Spontaneous comment should be encouraged. Make suggestions to individual pupils concerning experiments that they might like to do in order to check on their contentions. Keep a record of the comment as it will prove valuable in assisting individual pupils. Each pupil should make a prediction as to the probable outcome of the

demonstration, the elapsed time, and the reasons for his contention.

Distribute the duplicated copies of the Outline of the Unit and Suggested Activities.

Supervised study.

Use any remaining time to examine the outline.

Feed the animals in the aquarium and the terrarium.

- 2 Rotate the membership of the standing committees.

Supervised study.

Examine the Outline of the Unit and use it as a guide for surveying the data in this unit.

Assemble the material necessary for soilless gardening demonstrations and controls.

Check on the equipment and the locality for the field trip.

- 3 Field trip.

Purpose:

1. To collect symbiotic, parasitic, and saphrophytic plants common to this locality.
2. To compare the condition of the plants now with their condition as was noted on the previous field trips.
3. To take an animal census.
4. To collect specimens for the aquarium and the terrarium.

Take the class over some route in your locality that will allow them to observe the typical conditions of this season.

Each pupil should take along collecting jars. A written report should be prepared of the trip and turned in immediately on return to the class room.

On returning sort the material and put it in temporary containers.

4 Supervised study.

Continue with the examination of the outline and survey of the data included in the unit.

Check over the materials brought in from the field trip and prepare them for present or future use.

Feed the animals in the aquarium and the terrarium.

5 Class demonstration.

Purpose: To demonstrate the principle that mineral matter is essential for plant development.

Discuss the requirements of plants in the process of photosynthesis (Unit 2). Demonstrate the establishment of a soilless garden. This can be done by filling a container to a depth of 3 or 4 inches with inert material such as quartz sand or screened cinders that have been thoroughly leached, if the cinders come from coal other than our Western type. Cinders from Western coal has been found to contain materials harmful to plant growth. A suitable container can be provided by drilling a hole in the bottom of a metal pan, preferably one approximately 6 x 10 by at least 4 inches deep. Solder a short tube over the hole. Excessive wash through the outlet can be prevented by covering the bottom of the container with several layers of burlap. Fit a piece of rubber tubing over

the outlet and close with a pinchcock. Support the tank on two wooden blocks. In it plant seeds, cuttings, slips, and transplantings.

To feed, water twice a week, or oftener if necessary with a chemical solution made by adding one teaspoon of the commercially prepared soilless-garden chemicals to one gallon of water. Several hours after applying the solution, draw off the excess through the outlet.

Light and temperature requirements are the same as for regular soil gardening.

Checks should be established for comparative purposes. For example, make similar plantings in soil and feed with the same nutrients, in soil and feed with distilled water, and in sand or cinders and water with distilled water.

Supervised study.

Work on the activities the balance of the period.

Check on the equipment necessary to construct an incubator.

6 Construct an improvised incubator.

Select a tight wooden box, preferably one about 12 x 12 x 20 inches, and insulate by lining it with corrugated paper, secured from the dismantling of several cartons, or with regular insulating board. Install a wall receptacle on one end of the box in such a position that an electric light globe can be suspended over a shallow pan full of water. This is to serve as the heating unit. A wooden top should be made and in it bore a hole large enough to take a one-hole rubber stopper. Fit a laboratory thermometer in the stopper and extend the thermometer so that when the stopper is

placed in the hole, the mercury bulb will be suspended directly over the materials to be incubated.

Place the incubator in a place where the temperature will vary the least. Turn on the light and after several hours check the temperature. This can be regulated by increasing or decreasing the size of the lamp and by adjusting the size of an opening formed at the top of the box by not fitting the cover on tightly. Do not place anything in the incubator until it has been regulated to maintain the desired temperature constantly.

A lattice shelf should be fitted across a part of the box near the bottom. This will allow the air to surround the articles to be incubated.

A more satisfactory incubator can be constructed by regulating the heat from the electric light with a thermostat.

Supervised study.

Work on the activities the balance of the period.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

7. Supervised study.

Work on the activities.

Check the temperature of the incubator.

8. Supervised study.

Work on the activities.

Check the temperature of the incubator.

9 Supervised study.

Work on the activities.

Check the temperature of the incubator.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

10 Supervised study.

Work on the activities.

Check the temperature of the incubator.

Check the equipment and supplies to be used to demonstrate the culture of yeast and molds.

11 Class demonstration.

Purpose: To prepare cultures of yeast and molds for future examination by members of the class.

Yeast are found in great quantities in the scum from sauerkraut juice and open-crock preserved dill pickles. Yeast may be cultured by adding a part of a commercial yeast cake to a 5 per cent sugar solution and placed in a warm place. It should be ready for examination at the next meeting of the class.

One of the commonest molds is the bread mold (*Rizopus*). This form can be cultured by rubbing a slice of bread across a table top or some exposed surface. The bread should be slightly moistened and placed in a closed container. Place this in the

incubator or in a warm, dark place. When a white cottony growth bearing scattered black dots appears, examine under the microscope using 20 to 50 per cent alcohol as the mounting medium for the best results.

Supervised study.

Work on the activities.

Check the temperature of the incubator.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

12 Supervised study.

Examine the yeast culture. Yeast should be examined under the high power (4 mm.) with reduced light.

Work on the activities while not examining the yeast.

13 Supervised study.

Work on the activities.

Check the temperature of the incubator.

Examine the bread for evidence of bread mold.

14 Supervised study.

Work on the activities.

Check the equipment and supplies necessary for culturing bacteria using the sterile potato method.

Check the temperature of the incubator.

Examine the bread for evidence of bread mold.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

15 Class demonstration.

Purpose:

1. To demonstrate some of the more common techniques used in the study of bacteria.
2. To secure bacteria for pupil examination.

Make a mixed culture by placing a handful of decaying grass or weeds or dead, dried honey bees or flies in a container with water in the incubator or in a dark place at about 70° F. or higher for 7 to 10 days. Bees may be obtained from an apiary by gathering the dead ones from the front of the hives. They may be dried and kept indefinitely.

To grow a pure culture it is necessary to have a sterile medium on which to grow the desired form, a transfer needle, test tubes or Petri dishes, and a pressure cooker or double boiler.

Sometimes reasonable success can be obtained by using sterilized slices of Irish potatoes as a medium. The Petri dishes should be thoroughly scrubbed with soap and water. To each is added a slice of potato and some water to prevent drying. Cover the dish and sterilize in the pressure cooker for 30 minutes at 15 pounds pressure. If the double boiler is used, keep it at the boiling point for an hour or longer. Remove the sterilizer from the source of heat and allow to remain until

the next meeting of the class without removing the cover.

The Home Economics Departments of most schools will have a pressure cooker. Possibly the mother of one of the pupils would have one that could be borrowed.

(If the nutrient agar medium is preferred to the sterile potato method).

Arrange to have $3/4$ lb. of ground round steak at the next meeting of the class.

Supervised study.

Work on the activities.

If you do not have a microscope equipped with an oil-emersion lens, arrange for the use of one.

16 Class demonstration.

Remove the dishes from the sterilizer being careful that none are uncovered. Uncover one of them and examine a bit of the potato under the microscope for the presence of organisms. Replace the cover after 5 or 10 minutes and keep at room temperature in the incubator. Inoculate the balance of the plates by having students cough or sneeze in one; draw their fingers over one; expose one each in the hallway, lunch room, and class room; or coax a fly to walk over one. This can be done the easiest by clipping the wings from the fly.

(If using the nutrient agar medium)
Class demonstration.

Nutrient agar medium gives the best results. It can be purchased from most of the laboratory supply houses or made in the laboratory. Steps in the making of the nutrient agar medium are as follows:

1. Add 710 cc. of water to $\frac{3}{4}$ lb. of ground round steak and let stand in a cool place overnight.

Supervised study.

Work on the activities the balance of the period.

Check the temperature of the incubator.

Examine the bread for evidence of bread mold.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

17

Supervised study.

Work on the activities.

Examine the sterile potato medium for evidence of bacterial development (24 hours).

Check the temperature of the incubator.

Examine the bread for evidence of bread mold.

(If using the nutrient agar medium).
Class demonstration.

Continue with the making of the nutrient agar medium:

2. Strain off the juice, remove all possible by squeezing through a cloth sack.
3. Bring the total volume up to 750 cc. by adding water.
4. Boil for 15 minutes to coagulate the albumin, then filter through a layer of absorbent cotton in a funnel.
5. Add 7.5 g. of peptone and 3.7 g. of common table salt (sodium chloride).

Stir until these are dissolved.
This may be used as a liquid medium for growing bacteria. Put the liquid medium for growing bacteria in test tubes or flasks, plug with cotton, and put in the sterilizer for one hour.

18 Supervised study.

Work on the activities.

Examine the sterile potato medium for evidence of bacterial development (48 hours).

Check the temperature of the incubator.

Examine the bread for evidence of bread mold.

(If using the nutrient agar medium)
Class demonstration.

Continue with the making of the nutrient agar medium.

6. Heat 300 cc. of the beef broth to the boiling point, then add 4.5 g. of agar-agar.
 7. Boil until the agar is dissolved. Filter through absorbent cotton. Wet the cotton with boiling water before pouring the agar.
 8. Make up the volume of 300 with water. At this point professional bacteriologists usually adjust the pH. Not necessary for work of this nature.
 9. If attempting to make some pure cultures, pour some of the agar in two or three test tubes, filling them about 1/4 full. Pour the balance in the smaller half of Petri dishes.
 10. Plug the tubes with cotton and cover the Petri dishes. Sterilize for one hour.
 11. Take the tubes from the sterilizer and place them in a sloping position to cool. Leave the Petri dishes until ready for use.
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19 Supervised study.

Work on the activities.

Examine the bread for evidence of bread mold.

Check the temperature of the incubator.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

20 Supervised study.

Work on the activities.

Examine for evidence of bread mold.

Check the temperature of the incubator.

21 Supervised study.

Work on the activities.

Examine the sterile potato medium for evidence of bacterial development (72 hours). Should colonies be present, transfer a small part of one to a slide and examine it with the oil emersion lens.

Examine the bread for evidence of bread mold.

Examine the mixed culture for evidence of bacteria.

Check the temperature of the incubator.

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

(If using the nutrient agar medium)
Class demonstration.

The medium should now be ready for inoculation. If making a pure culture by transferring bacteria to a sterile tube, use a transfer needle. These can be made by taking a 3-inch piece of nichrome wire (#24) and inserting it into the end of a glass rod. One end of the rod is heated until it is soft, the wire inserted into it about 1/4 inch and cooled. Another may be made by splitting one end of a 1/8 inch x 5 inch aluminum rod. Insert one end of the nichrome wire in the slit and hammering the halves of the rod tightly around the wire.

Nichrome wire may be secured by dismantling an old heating unit or electric iron unit. These units may be purchased new at the five- and ten-cent stores.

Always heat the transfer needle to a red heat in a flame to sterilize it before and after each transfer. Allow the needle to cool before touching it to the culture. Steps in making the transfer:

1. Remove cotton plug from the culture tube of flask, holding it between the third and fourth fingers of the left hand. Be certain that it does not touch anything.
2. Hold the tube in a slanting position between the thumb and first finger of the left hand.
3. Heat the mouth of the tube in a flame for a few seconds.
4. Flame the needle and allow to cool in the neck of the culture tube. When cool, dip the sterile tip in the culture to be transferred.
5. Insert the needle into the sterile tube, touching the agar slope near the bottom and draw it lightly to the top of the agar.
6. Flame the needle before putting it down.
7. Flame the mouth of both tubes.

8. Flame the plugs and insert them in their respective tubes.
9. Place the inoculated tubes in the incubator and keep at 98° F.

Take the Petri dishes from the sterilizer, being careful not to lift the lids. They are now ready to inoculate.

1. Expose one for two minutes in the hallway while classes are changing.
2. Expose one in the same hallway for two minutes about 30 minutes after the classes have changed.
3. Expose one in each dressing room in the gymnasium.
4. Pour a small amount of tap water on the medium. The water can be spread evenly by holding the dish in the hand and giving it several horizontal revolutions.
5. Do the same for distilled water or water that has been recently boiled.
6. Allow a fly to walk across the medium of one of the dishes.
7. Allow one of the students to draw his fingers across the medium in one of the dishes.
8. Number, label, and place the dishes in the incubator for 48 hours at a temperature of about 98° F.

22 Supervised study.

Work on the activities.

Examine the mixed culture for evidence of bacteria.

Examine the inoculated tubes and Petri dishes for evidences of bacteria (24 hours).

Make arrangements for field trip to a dairy, a milk producing plant, or a hospital.

23 Supervised study.

Work on the activities.

Examine the inoculated tubes and Petri dishes for evidence of bacteria (48 hours).

24 Supervised study.

Work on the activities.

Examine the inoculated tubes and Petri dishes for evidence of bacteria (72 hours).

Feed the animals in the aquarium and the terrarium.

Feed the plants in the soilless garden demonstration.

25 Field trip.

Purpose: To observe the practices used by various commercial enterprises to safeguard the public welfare.

Visit a dairy, a milk producing plant, or a hospital.

A written report should be prepared of the trip and turned in immediately on return to the class room.

26 Show one of the films listed at the end of this unit.

Supervised study.

Work on the activities.

27 Distribute the pupil self-tests.

(See the Plan for Unit 1).

Oral presentation of the assigned activities.

(See the Plan for Unit 1)

- 28 Continue with the oral presentations and criticisms.

Supervised study the remainder of the period.

- 29 Summary exercise.

(See the Plan for Unit 1.)

Check the laboratory equipment and supplies necessary for Unit 5.

- 30 Evaluation of the unit.

Score and discuss the tests.

(See the Plan for Unit 1.)

BIOLOGY

Unit 4.

Time: 30 days.

RELATIONSHIPS AMONG ORGANISMS

Objectives:

1. To understand some of the relationships that exist among organisms.
2. To learn some of the relationships that exist between organisms and their environment.
3. To understand the relationship of certain organisms to the welfare of man.
4. To appreciate the regulating and balancing power exercised by nature in the prevention of an overabundance of certain forms and the use and restoration for future use of certain elements in the food cycles of plants and animals.
5. To appreciate the dangers that are associated with man's activities that destroy nature's balance.
6. To learn the specific controls that man has learned to use to check the attacks of his enemies.

Outline of the Unit:.

- I. What Are Some of the Relationships Among Organisms?
 - A. Some interdependencies between the plant and animal kingdom.
 1. Carbon cycle.
 - a. Animals need oxygen for respiration and give off carbon dioxide.
 - b. Plants use carbon dioxide for photosynthesis and give off oxygen.
 - c. The balanced aquarium or microcosm.

2. Nitrogen cycle.
3. Other cycles.
4. Soilless gardening (hydroponics).

B. Symbiosis--the living together of different organisms.

1. Commensalism--symbionts living together without one feeding on the other.
 - a. Ivy and the tree in which it climbs.
 - b. Little crabs (*Pinnixa littoralis*) that live in the mantle cavity of the empire clam (*Schizothaerus nuttallii*).
2. Mutualism--symbionts benefit each other.
 - a. Plant and animal cells in green hydra.
 - b. Algae growing in a specie of paramecium.
 - c. Protozoans that live in the intestines of termites.
 - d. The sea anemone and the hermit crab.
 - e. Nitrogen bacteria and the leguminous plants.
 - f. The ants and the aphids.
 - g. Lichens, fungi and algae.

C. Parasitism. A parasite is a living organism that exists at the expense of another living organism known as its host. (A saprophyte is an organism that lives on dead rather than living organic matter.)

1. Parasitic plants.
 - a. Spermatophytes.
 - b. Fungi.
 - (1. Molds destructive to plant life.
 - (2. Molds damaging to animal life.
 - (3. Rusts.
 - (a. Examples.
 - (b. Life history.
 - (4. Smuts.
 - (a. Examples.
 - (b. Life history.
 - (5. Bacteria (pathogenic).
2. Parasitic animals.
 - a. Internal parasites.
 - (1. Plasmodium malariae.
 - (2. Tapeworm.

- (3. Roundworms.
- (4. Liver flukes.
- (5. Trichina worm.
- b. External parasites.
 - (1. Fleas.
 - (2. Bedbugs.
 - (3. Ticks.
 - (4. Chiggers.

D. Saprophyte. An organism that lives on dead rather than living organic matter. Saprozoon is an animal that lives on dead organic matter.

- 1. Sour milk.
- 2. Ripened cheese.
- 3. Fermentation.
- 4. Decomposition.

E. Predaceous organisms.

- 1. Plants.
 - a. Pitcher plants.
 - b. Sundew.
- 2. Animals.
 - a. Protozoan.
 - (1. Noctilucas.
 - b. Coelenterates.
 - (1. Hydra.
 - (2. Anemone.
 - c. Echinoderms.
 - (1. Starfish.
 - (2. Sea urchin.
 - d. Arthropods.
 - (1. Dragon fly.
 - (2. Praying mantis.
 - (3. Black widow spider.
 - (4. Cockroaches.
 - e. Mollusks.
 - (1. Octopus.
 - (2. Squid.
 - f. Vertebrates.
 - (1. Fish.
 - (2. Reptiles.
 - (3. Carnivorous mammals.

II. What Are Some of the Relationships Between Organisms and Their Environment?

A. Protective mimicry.

1. Color protection.
 - a. China pheasant hen.
 - b. Grouse.
 - c. Deer.
 - d. Animals that can change their color to fit their surroundings.
 - (1. Chameleon.
 - (2. Nassau grouper.
2. Imitation of form.
 - a. Viceroy imitates monarch butterfly.
 - b. Insects that resemble twigs, leaves, mosses, or flowers.

B. Defense found in organisms.

1. Plants.
 - a. Defense against grazing animals.
 - (1. Mechanical weapons.
 - (2. Chemical weapons.
 - b. Other defenses.
2. Animals.

C. The balance of nature.

1. Interdependencies noted by Darwin.
2. Examples where man has unwittingly interfered with nature's balance.
 - a. German carp.
 - b. Striped bass.
 - c. San Jose scale.
 - d. Codling moth.
 - e. Cotton boll weevil.
 - f. Irish gorse.
3. Action that man has been forced to take.
 - a. Plant inspection stations on state borders for purpose of plant quarantine. (California-Oregon).
 - b. Government programs for extinction and control of undesirable organisms.
 - (1. Mosquito control.
 - (2. Extinctions of undesirable species by offering bounties and employing government hunters.

- (3. Eradication of white pine blister rust.
- (4. Establishment of experiment stations to do research and supply information concerning control of agriculture pests.
- (5. World-wide search for insect pest's natural enemies.
- (6. Programs for control of Mormon cricket.
- c. Establishment of conservation programs.
 - (1. Game and food fish.
 - (2. Migratory water-fowl.
 - (3. Upland game birds.
 - (4. Game and fur-bearing animals.
 - (5. Plummage birds.
 - (6. Wild flowers and shrubs.
 - (7. Forest conservation.
 - (8. Erosion control.
- d. Laws concerning pollution of waters and streams.

III. What Is the Relationship Between Man and Pathogenic Organisms?

A. Characteristics of pathogenic organisms.

- 1. Protozoa.
- 2. Bacteria.
 - a. Shapes of bacteria.
 - b. Food supply and nutrition.
 - c. Reproduction.
 - (1. Method.
 - (2. Rate.
- 3. Filterable viruses.

B. General information about certain diseases caused by pathogenic organisms.

- 1. How bacteria cause diseases.
- 2. Methods of spreading diseases.
 - a. Nasal or oral discharges.
 - b. Intestinal discharges.
 - c. Insect bites.
 - d. Contact.

C. Examining some of the most common diseases.

1. Common cold.
2. Tuberculosis.
 - a. Tuberculin skin test.
3. Typhoid fever.
4. Malaria.
 - a. Life cycle of the malaria parasite.
 - b. Life cycle of the mosquito.
5. Syphilis.

D. How our body resists diseases.

1. Body protectors.
 - a. Outer body protectors.
 - b. Inner body protectors.
 - (1. Phagocytes.
 - (2. Antibodies and their function.
2. Immunity.
 - a. Natural immunity.
 - b. Acquired immunity.
 - (1. Active.
 - (2. Passive.
3. Tests for diseases.
 - a. Schick.
 - b. Dick.
 - c. Widal.
 - d. Tuberculin.
 - e. Wasserman.
 - f. Direct examination.
4. Recent development in resisting diseases.
 - a. Bacteriophage of d'Herelle.
 - b. Sulfanilimide and its derivatives.

E. Disease prevention.

1. Quarantine laws.
2. Use of fumigants.
3. Disinfection.
 - a. Types of disinfectants.
 - b. Terms associated with disinfectants.
4. Sanitation.
 - a. Personal.
 - b. Community.
 - (1. Sewage disposal.
 - (2. Safeguarding water and food supply.

F. Laboratory technique for bacteriology.

1. Equipment.
2. Isolation.
3. Means of identification.

G. Important figures in the war against disease.

1. Louis Pasteur
2. Robert Koch.
3. Sir Joseph Lister.
4. Edward Jenner.

Suggested Activities:

1. Re-examine the balanced aquarium in the laboratory. Make a list of all the ways in which one form of life in the aquarium is dependent upon some other form.
2. As your part of a class project, contribute specimens of plants and animals that would be classed as parasites, saprophytes, partnerships, and predators.
3. Take a field trip to some locality near the school. Pay particular attention to any example of parasitic or saprophytic plants, partnership relations among organisms, and protective mimicry. Take notes on what you observe and turn in your report at the end of the trip.
4. When possible visit a zoo, botanical garden, natural history museum, or taxidermist shop and observe the adaptations that animals have developed for existence in their environment.
5. Discuss some of the sanitation laws in force in this state that have a direct relationship to our individual health.
6. Make a table listing all of the plant and animal adaptations you have seen. List the adaptations in plants under such headings as: roots, stems, and leaves. The animal adaptations may be listed under such headings as: feet, tails, mouthparts, integument, and appendages.

7. Make a table showing the food cycles of green plants.
8. Prepare cultures of yeast and molds. When they have developed sufficiently examine them under the microscope and make habit sketches. Consult your teacher concerning equipment and technique.
9. If laboratory conditions are satisfactory, prepare a culture of bacteria. When sufficient development has taken place examine and sketch the colonies. If your class has access to a microscope equipped with an oil-emersion lens, examine members of the colonies. Sketch. Examine prepared slides of bacteria. Consult your teacher concerning equipment and technique.
10. Observe the feet and wings of a house fly, using the low-power objective of the microscope. Sketch any adaptations that are present that enable the fly to take an active part in spreading diseases.
11. Make a study of the pupil absenteeism in this school due to illness. Associate it with such factors as seasons, atmospheric conditions, and days of the week.
12. Be prepared to demonstrate the American Red Cross First Aid Treatment for wounds to the class.
13. Compile a list of diseases for which immunity has been developed. Describe the immunization process for each.
14. Make a list of disinfectants, fumigants, and antiseptics available for use with a statement of their properties and value.
15. Write a short biography of one of the men that have made important contributions to the fields of science discussed in this unit.
16. Construct a large display chart illustrating some topic of this unit. You may use photo-

graphs, pictures clipped from magazines, or colored sketches. The following list is submitted for suggestions:

- a. Sketch of a water purification system.
 - b. Sketch of a sewage disposal plant.
 - c. Diagram of the life cycle of any disease organism that has an alternate host, such as those responsible for trichina, tape-worm, typhus, malaria, and bubonic plague.
 - d. Graphs or curves emphasizing important facts about diseases.
17. Assist the members of your class in exposing culture media in different parts of the building, such as the halls, lunch room, dressing rooms, lavatories, and classrooms. Your teacher will supply the equipment and supervise the technique.
 18. Observe the microcosm and its contents. Keep a day-by-day record of the activities associated with it. On the first day of your observation, predict the outcome of the demonstration, the elapsed time, and the reasons for your opinion.
 19. Collect as many different fungi as you can find among those growing in your locality. Learn the names of the more common ones.
 20. Examine as many different parasitic organisms as it is possible to bring to the classroom. Discuss the economic value of each form examined.
 21. Formulate a practical conservation program adapted to local conditions and needs for one of the sections found under Outline of the Unit, II, C, 3, c.
 22. Grow some plants in the laboratory by one of the recommended soilless gardening methods. Be certain and set up a control demonstration. Consult your teacher for advice concerning the technique.
 23. With the aid of the Readers Guide to Periodical Literature select and brief a current article applicable to this unit.

24. Prepare an oral report on some topic associated with this unit. The following are offered as suggestions:

- a. The construction and care of a balanced aquarium.
- b. The value of crop rotation.
- c. Strange partnership relations found in the animal kingdom.
- d. Pathogenic yeasts and molds.
- e. The production of vaccines, serums, or antitoxins.
- f. The narcotic traffic.
- g. Program for eradication of the white pine blister rust.
- h. Oregon State College Experiment Station.
- i. Destructive plants and animals that have been transplanted in this area.

Reference Books:

The following are numbers of books listed in Bibliography A that will prove to be helpful in the study of this unit.

8, 16, 18, 19, 34, 38, 40, 41, 50, 51, 53, 56, 59, 60, 64, 67, 68, 71, 72, 73, 88, 92, 94, 99, 100, 108, 109, 110, 113, 124, 126, 128, 135, 139, 142, 143, 145, 148, 150, 153, 158, 160, 161, 162, 164, 168, 169, 175, 178, 180, 181, 186, 188, 189, 191, 193, 195, 198, 200, 201, 204, 206, 207, 216, 219, 221, 223, 228, 233, 235, 247, 251, 257, 258, 259, 264, 272, 274, 276, 277, 280, 289, 298, 299.

Visual Aids:

A. Charts

1. Dressel Charts on Diseases of Plants.
 - DA1. Diseases of Cereals.
 - DA2. Diseases of Potatoes.
 - DA3. Diseases of Vegetables.
 - DA4. Diseases of Miscellaneous Plants.
2. Fiedler Anatomical Charts
 - FA13. Tubercular Lung
Tubercular Bacilli
3. Fishbein Health and Hygiene Series.
 - #15. Causes of Disease.
 - #16. Insects Injurious to Health.
 - #17. Prevention of Disease.
4. General Biology Series.
 - GB3. Flatworms and Roundworms.
 - GB15. Wheat Rust.
5. Johnston's Physiology and Hygiene.
 - JPl1. Showing Cause of Typhoid Fever.
 - JPl2. Showing Cause of Malaria or Ague.
6. Jung, Koch and Quentell Series.
 - QB40. Yeast.
 - QB28. Striated Wall Lichen.
 - QZ27. Tapeworm.
 - QZ32. Trichina.
7. Jurica Biology.
 - JBS3. Bacteria, Molds, and Parasites.
 - JBS4. Yeast, Cup Fungus, Mildew and Lichen.
 - JBS5. Fungi.
 - JZS4. Tapeworm and Hookworm.
8. Matzdorf Biology Charts.
 - MZ1. Mimicry.
 - MZ2. Mimicry.
 - MZ4. Symbiosis.
9. Pfurtscheller Zoology Charts.
 - PZ9. Human Tapeworm.
 - PZ38. Ascaris lumbricoides.

10. Smallwood Botanical Charts.
 2. Fucus-Bacteria, Yeast, Lichens, Bread Mold.
 3. Mushrooms-Bracket Fungus, Wheat Rust, Puff Balls.
11. Smallwood Zoological Charts.
 5. Flatworms and round worms.
 9. Arthropoda.
12. Sussmann Chart of Bacteria.
13. Turttox Class Room Charts.
 - CR3.7. Parasitic Protozoa.
 - CR3.9. Malaria.
 - CR8.3. Liver Fluke.
 - CR8.4. Tapeworm Anatomy and Life History.
 - CR8.5. Tapeworm.
 - CR8.6. Ascaris.
 - CR8.61. Trichina.
 - CR8.7. Hookworm.
 - CR14.2. Beneficial Insects.
 - CR14.3. Harmful Insects.
 - CR14.4. European Corn Borer.
 - CR20.8. Mosquito Life Cycle.
 - CR50.0. Bacteria.
 - CR50.01. Bacteria, Free-living.
 - CR50.02. Bacteria, Photogenic.
 - CR58. Rhizopus (Bread Mold) Life History.
 - CR58.01. Slime Molds.
 - CR58.1. Saprolegnic.
 - CR58.2. Lichens.
 - CR58.3. Peziza.
 - CR58.4. Powdery Mildews.
 - CR58.5. Penicillium and Aspergillus.
 - CR59. Puccinia (Wheat Rust).
 - CR77. Insectivorous Plants.
 - CR79. Parasitic Plants.
 - CR85. Poisonous Plants.
14. Turttox Wall Charts.
 - WC62. Molds.
 - WC63. Wheat Rust.
15. Winslow Health and Hygiene, The
 - WL3. Germs and Germ Diseases.
 - WL4. Municipal Sanitation.
 - WL5. Insect Enemies.
 - WL6. The Health Department.

B. Films

1. Oregon State College

Screw Worms

16mm. sound, 2 reels.

Fungi Snare and Destroy Nematodes

16mm. sound, $\frac{1}{2}$ reel.

Black That Termite

16mm. sound, 2 reels.

Trout Stream Improvement

16mm. sound, 1 reel.

Vanishing Herds

16mm. sound, 2 reels.

White Fringed Beetle,

16mm. sound, 2 reels.

Forests and Health, The

16mm. sound, 1 reel.

Forest and Wealth, The

16mm. sound, 1 reel.

Forest Fires or Game

16mm. sound, 1 reel.

Forest Serves Man

16mm. sound, 1 reel.

For Health and Happiness

16mm. sound

Do Unto Animals

16mm. sound, 2 reels.

Livestock and Mankind

16mm. sound, 1 reel.

Three Counties Against Syphilis

16mm. sound, 2 reels.

Morman Cricket, The

16mm. sound, 2 reels.

Mosquito-Public Enemy, The

16mm. sound, 2 reels.

Choose To Live

16mm. sound, 2 reels.

Suppressing Hoof and Mouth Disease

16mm. sound, 1 reel.

Tree of Life, The

16mm. sound, 2 reels.

Grasshoppers

16mm. sound, 1 reel.

Mosquitoes

16mm. silent, 3 reels.

2. University of California

- #278. Bacteria.
16mm. silent, 1 reel, \$1.00.
- #357. Tuberculosis and How It May Be Avoided.
16mm. silent, 1 reel, \$1.00.
- #2605. Body Defenses Against Disease.
16mm. sound, 1 reel, \$1.50.
- #2526. How Nature Protects Animals.
16mm. sound, 1 reel, \$1.50.
- #2523. Plant Traps.
16mm. sound, 1 reel, \$1.50.
- #2522. Dodder, The.
16mm. sound, 1 reel, \$1.50.
- #243. Animal Camouflage.
16mm. silent, 1 reel, \$1.00.
- #83. Armies of Health and Disease.
16mm. silent, 1 reel, \$1.00.
- #2601. Behind the Shadows.
16mm. sound, 1 reel, \$1.00.
- #84. Disease Carriers.
16mm. silent, 1 reel, \$1.00.
- #258. Drinking Health.
16mm. silent, 2 reels, \$1.00.
- #2536. House Fly.
16mm. sound, 1 reel, \$1.50.
- #180. How to Get Rid of Rats.
16mm. silent, 1 reel, \$0.30.
- #122. Life History of the Mosquito.
16mm. silent, 1 reel, \$1.00.
- #358. Sewage Disposal.
16mm. silent, 1 reel, \$1.00.
- #2521. Fungus Plants.
16mm. sound, 1 reel, \$1.50.
- #873. Nitrogen Cycle.
16mm. silent, 1 reel, \$1.00.
- #303. Traps For Insects.
16mm. silent, 1 reel, \$1.00.
- #2607. Animals in Modern Life.
16mm. sound, 1 reel, \$1.50.
- #33. Friends to Man (Ruminants).
16mm. silent, 1 reel, \$1.00.
- #448. Furred and Feathered Hunters.
16mm. silent, 1 reel, \$1.00.
- #308. Killing the Killer.
16mm. silent, 1 reel, \$1.00.

- #458. Our Wild Life Resources.
16mm. silent, 2 reels, \$.50.
- #2708. Birds of Prey.
16mm. sound, 1 reel, \$1.50.
- #2768. Cancer, Its Cure and Prevention.
16mm. sound, $\frac{1}{2}$ reel, \$1.00.
- #30. Pirates of the Sky.
16mm. silent, 1 reel, \$1.00.
- #296. Countless Enemies.
16mm. silent, 1 reel, \$1.00.
- #473. Trout for Tomorrow.
16mm. silent, 1 reel, \$1.00
- #2973TFC. Beneath Our Feet
16mm. sound, 1 reel, \$1.00.
- #269. Termites.
16mm. silent, 1 reel, \$1.00.
- #301. Partnerships Under the Sea.
16mm. silent, 1 reel, \$1.00.
- #2920. City of Wax.
16mm. sound, 1 reel, \$1.00.
- #2533. Aphids.
16mm. sound, 1 reel, \$1.50.
- #2527. Beach and Sea Animals.
16mm. sound, 1 reel, \$1.50.
- #2531. Beetles.
16mm. sound, 1 reel, \$1.50.
- #2935TFC. Great Heart.
16mm. sound, 1 reel, \$1.00.
- #2865. Milk and Health.
16mm. sound, 1 reel, \$.50.
- #2742. Milk Parade.
16mm. sound, 1 reel, \$.50.
- #2749. Miracle of the Meadows.
16mm. sound, 1 reel (800-ft. size)
\$3.00.
- #2690. Mouse Control in Orchards.
16mm. sound, 1 reel, \$.50.
- #2532. Pond Insects.
16mm. sound, 1 reel, \$1.50.
- #2961TFC. Story of Dr. Jenner, The
16mm sound, 1 reel, \$1.00.
- #2968TFC. Trading the Sleeping Death.
16mm. sound, 1 reel, \$1.00.
- #2858. War on Insects.
16mm. sound, $1\frac{1}{3}$ reel, \$.50.
- #862. Horses and Bots.
16mm. silent, 2 reels, \$.50.
- #297. Insect Farmers and Laborers.
16mm. silent, 1 reel, \$1.00.

3. Motion Picture Bureau.

- SS-900. Science and Modern Medicine.
16mm. sound, 3 reels, \$6.00.
- SS-901. With These Weapons.
16mm. sound, 1 reel, \$5.00.

C. Glass Slides, Oregon State College.

- 114G. Swat the Fly. 26 slides.
- 115G. Sanitation and the Housefly. 58 slides.
- I.H.C. Fight the Fly. 60 slides.

D. Film Slides, Oregon State College.

- #467. The Horsefly and Its Control. 35 pictures.
- #43. Barberry Eradication. 73 pictures.
- #54. Cabbage Diseases. 41 pictures.
- #55. Cattle Grubs or Heel Flies. 24 pictures.
- #56. Codling Moth or "Apple Worm, The." 26 pictures.
- #57. Control of the European Corn Borer. 32 pictures.
- #58. Control of Stinking Smut or "Bunt" of Wheat. 39 pictures.
- #60. The Eradication of Tuberculosis from Livestock and Poultry. 59 pictures.
- #62. How Insects Attack Garden Vegetables and Methods of Control. 56 pictures.
- #63. Japanese Beetle. 37 pictures.
- #64. Nature of Plant Diseases, The. 44 pictures.
- #474. Subterranean Termites and Their Control. 48 pictures.
- #141. The Ancient Enemy (Tuberculosis and How to Avoid It) 55 pictures.
- #142. Tuberculosis is Curable. 65 pictures.
- #154. No More Diptheria. 38 pictures.
- #155. One Scar or Many. 60 pictures.
- #161. Micro-organisms and Disease. 19 pictures.
- #166. Relation of Insects to Disease. 19 pictures.

Free and Inexpensive Reference Material:

- A. Abbott Laboratories. North Chicago, Illinois.
 - 1. The Treatment of Syphilis. 61 pp.
- B. American Society For the Control of Cancer (The). 350 Madison Avenue, New York, N. Y.
 - 1. Answers to the Public Questions on Cancer. 11 pp. pamphlet. Free.
 - 2. Cancer Facts For Men. 4 pp. pamphlet. Free.
 - 3. Cancer Facts For Women. 4 pp. pamphlet. Free.
- C. Boy Scouts of America. 2 Park Avenue, New York, N. Y.
 - 1. Conservation Pamphlet, 49 pp. 11. 20¢.
- D. California Agricultural Extension Service. University of California. Berkeley, California.
 - 1. Circular:
 - #97. Weed Control. 1936. 87 pp. 11.
- E. Doernbecker Children's Hospital. Portland, Oregon.
 - 1. Free data concerning the work of this institution.
- F. Forest Service, Portland, Oregon.
 - 1. Key for the Identification of the Common Coniferous Forest Trees of Oregon. 1937. 5 pp. Free.
 - 2. Key to the Identification of the Common Broadleaf Forest Trees of Oregon. 1937. 3 pp. Free.
- G. Foundation for Narcotic Research and Information. 150 Fifth Avenue, New York, N. Y.
 - 1. Narcotics and Youth Today. 1934. 10¢.
- H. General Biological Supply House (The). 761-763 East 69th Place, Chicago, Illinois.
 - 1. Turtox Service Leaflets:
 - #32. Culturing the Common Molds.
 - #34. Insect Metamorphosis.
 - 2. Turtox News.

- I. Metropolitan Life Insurance Company, 600 Stockton Street, San Francisco, California.
 - 1. Health Bulletins for Teachers:
 - a. Poleomyelitis. October 1937.
 - b. Sanitation of the Environment. October 1941.
 - c. The Body's Natural Defenses. April 1940.
- J. Keep Oregon Green Association. 712 Porter Building, Portland, Oregon.
 - 1. Free material for a state-wide forest fire prevention program.
- K. Northwest Regional Council. 606 Bedell Building, Portland, Oregon.
 - 1. Forest Depletion in Outline. 25¢.
- L. Office of the Surgeon General. United States Army, Washington, D. C.
 - 1. Prevention of Typhoid Fever and Smallpox by Vaccination. 6 pp. folder. Free.
- M. Oregon Milk Control Board. Terminal Sales Building, Portland, Oregon.
 - 1. Report of the Oregon Milk Control Board. 1940. 54 pp. Free.
- N. Oregon State Board of Health, 816 Oregon Building, Portland, Oregon.
 - 1. Weekly Bulletin. 2 p. weekly sheet on current health problems. Write for copies.
- O. Oregon State College, Corvallis, Oregon.
 - 1. Extension bulletins:
 - #412. The Most Important Noxious Weeds of Oregon. 1929. 56 pp. il. Free.
 - #544. Common Dandelion. October 1940.
 - #545. Death Weed. October 1940.
 - #546. Sheep Sorrel and Dock. October 1940.
 - #547. Johisson Grass. October 1940.
 - #548. Poison Oak. October 1940.
 - #553. Controlling Rodents and Other Small Animal Pests in Oregon. 1941, 22 pp. il.
 - 2. Station Bulletin:
 - #388. The Portland Metropolitan Milk Market. 1931. 36 pp.
 - #389. Pea Aphid Control in Oregon. 1941, 23 pp. il.

- #393. Sprays, Their Preparation and Use. 1941. 34 pp.
3. Station circulars:
- #45. Insect Pests and Diseases of Bramble Fruits. 1923. 14 pp. il.
- #49. Mosaic and Other Systemic Diseases of Brambles in Oregon. 1923. 15 pp. il.
- #53. Brown-rot and Related Diseases of Stone Fruits in Oregon. 1923. 18 pp. il.
- #112. The Black Widow Spider. 1935. 9 pp. il.
4. Station circular of information:
- #71. Yellow Rust of Red Raspberry. 1932.
- #237. The Red Hop Spider and Dusting Equipment for its Control. 1941.
- #242. A Progress Report of Investigations Concerning the Symphyliid and Its Control. 1941.
- #243. Strawberry Root-weevil Control in Oregon. 1941.
- #244. Bean and Pea Weevils. 1941.
- #245. House Ants. 1941.
- P. Oregon State Teacher's Association, The. 602 Studio Building, Portland, Oregon.
1. The Education of Handicapped Children. 1936. Mimeographed Committee Report.
- Q. Oregon Tuberculosis Association, 605 Woodlark Building, Portland, Oregon.
1. Facts About Tuberculosis. 8 p. folder. Free.
2. Growing Healthfully, A Teaching Unit. 12 pp. pamphlet. Free.
3. Tuberculosis from 5 to 20. 6 pp. il. Free.
4. The Tuberculin Test. 4 pp. il. Folder. Free.
5. Let Us Look At Facts. 12 pp. Free. Contains a good bibliography.
- R. Public Affairs Committee, Inc., 30 Rockefeller Plaza, New York.
1. Stewart, Maxwell S., America's Children, 1940. Pamphlet #47.
2. De Kruif, Paul, Toward A Healthy America. 1939. Pamphlet #31.

3. Little, Clarence C., The Fight on Cancer. 1939. Pamphlet #38. 10¢.
 4. Broughton, Philip S., Behind the Syphilis Campaign. Pamphlet #24, 1938. 10¢.
- S. Shriners' Hospital. Portland, Oregon.
1. Real Houses of Magic. 32 p. 1l. pamphlet showing corrective work being done by these hospitals. Free.
- T. State Board of Forestry. Salem, Oregon.
1. Cronemiller, Lynn F., The Planting and Care of Trees on Oregon Farms. 1938. 31 pp. 1l. Free.
 2. Peavy, George B., Oregon's Commercial Forests, 1929. Bulletin #2. Free.
- U. State Planning Board. Spaulding Building, Portland, Oregon.
1. Oregon's Forest Problem. 1936. Free.
 2. Oregon's Wild Life Resources. 1936. Free.
- V. United States Forest Service, Department of Agriculture, Washington, D. C.
1. Guthrie, John D., Great Forest Fires of America. Pamphlet, 10 p. 1l. Free.
- W. U. S. Superintendent of Documents, Washington, D. C.
Write for free price lists of publications on biological subjects.
- X. (W.P.A.) Oregon Writers' Project, 409 Elks Building, Portland, Oregon.
Oregon Oddities: Vanishing Wildlife, Part I, Sept., 16, 1940 and Part II, Oct. 1, 1940.
Mimeographed, 5 pp.

CHAPTER VI

UNIT 5

CHANGE AND ORGANISMS

BIOLOGY

Unit 5.

Time: 25 days.

CHANGE AND ORGANISMS

PLAN

DayMethod

1 Pretest for Unit 5.

(See the Plan for Unit 1, pp. 19)

Presentation.

(See the Plan for Unit 1, pp. 19)

Rotate the membership of the standing committees.

Distribute the duplicated copies of the Outline of the Unit and Suggested Activities.

Feed the animals in the aquarium and the terrarium.

Water the plants in the soilless gardening demonstration if it is being maintained.

2 Supervised study.

Examine the Outline of the Unit and use it as a guide for surveying the data included in this unit.

Prepare several sets of boxes for Suggested Activity #18 by placing 50 white and 50 colored beans in an empty chalk box.

Prepare several sets of coins for Suggested Activity #13. Put two pennies in an envelope for each of these sets.

3 Supervised study.

Continue with the examination of the outline.

Call attention to Suggested Activity #10 and airmail the request for the forms.

Plant 100 grains of maize carrying the factor for albinism in two shallow wooden boxes filled with sandy loam. These are to be examined on the 12th day for the 3:1 ratio of dominant and recessive characters. These seeds must be properly prepared and can be obtained from Meyers Hybrid Seed Company, Hillsboro, Ohio, or Dr. George S. Carter, Genetics Laboratory Supplies, Clinton, Connecticut. This demonstration may be prepared by a group of pupils or by single individuals. The greater the number of seedlings the more close the approach to the 3:1 ratio. Allow the pupils to examine the seeds to establish the fact that there is no apparent difference in any of them.

4 Supervised study.

Work on the Suggested Activities.

Select a suitable place, such as a cliff or road cut for a field trip to examine the underlying strata. Consult a geological survey map of the area for location of fossiliferous formations. Valuable information can be secured from a geologist that is acquainted with the area. Possibly some amateur geologist could be secured to accompany the class on the trip.

5 Field trip

Purpose: To secure some understanding of the nature of the formations underlying this area and to search for fossils.

If someone that understands the geology of this region can be secured for this trip, the value to the pupils will have been greatly increased. Fossils are generally found imbedded in hard formations. A tool known as a "geologist's pick" is adapted for

removing them. They should be cleaned of excessive rock in the laboratory where the choice of tools is greater and where more time can be spent on this tedious task.

Collect the notes of the pupil's observations on the field trip.

- 6 Return the notes on the field trip.

Supervised study.

Work on the Suggested Activities.

Display dioramas that have been made by the pupils of other classes. Discuss the necessary equipment with the pupils that are interested in making them (see pp. 208-210 of #10, Bibliography B).

Feed the animals in the aquarium and the terrarium.

- 7 Supervised study.

Work on the Suggested Activities.

- 8 Supervised study.

Work on the Suggested Activities.

- 9 Supervised study.

Work on the Suggested Activities.

Feed the animals in the aquarium and the terrarium.

- 10 Supervised study.

Work on the Suggested Activities.

11 Supervised study.

Work on the Suggested Activities.

Check the discussion material for the next meeting of the class.

Collect the equipment necessary for the supervised study period on the 13th day.

Feed the animals in the aquarium and the terrarium.

12 Class discussion.

Purpose: To discuss Mendel's contribution to the study of genetics, to observe the results of a demonstration of the ratio of dominants over recessive, and to assist the pupil in concluding that the mathematical ratio is a genetic principle.

Have the pupils count the maize seedlings that show indications of albinism. Determine the ratio. Point out that an exact 75:25 (3:1) ratio is seldom obtained with such a small number of cases. Dispel any idea that the results might have been effected by environmental factors by pointing out that all the seedlings developed under the same environmental conditions.

Discuss the preparation of the seed for this demonstration.

Supervised study for the remainder of the period.

13 Supervised study.

Have each pupil gain practice in problem solving by making charts of theoretical crosses substituting seed types, sketches, or pictures clipped from magazines instead of using the conventional symbols.

Human problems such as feeble-mindedness, color blindness, and baldness can be worked out in chart form using pictures clipped from magazines.

Colored matches can be used as an aid in visualizing problems relative to chromosomes. These can be glued into circles representing cells of the body or the gametes during crossing and segregation.

Toy animals cast in plaster or metal, cardboard cut-outs, or clay models tend to make the application of the principles more realistic and simplified.

14 Supervised study.

Continue with the chart making.

Feed the animals in the aquarium and the terrarium.

15 Supervised study.

Work on the Suggested Activities.

Make the arrangements to secure the plants, vegetables, and fruits to serve as examples for the discussion at the next meeting of the class.

Make the announcement concerning the socialized recitation for the 20th day. Appoint the necessary committees.

16 Class discussion.

Purpose: To discuss variation in plants and animals and to differentiate between those that are hereditary and those that are noninherited.

Discuss and call attention to examples of mutations, hybrids, hybrid segregates, and

fluctuations. Displays are profitable with this discussion.

Any trip to the ocean can be profitable spent in collecting a large number of adults of a single specie of any of the common marine snails. These can be cleaned and arranged as an interesting display of variation within a specie. They should be boiled and then have as much of the bodies removed as is possible with a hooked wire. Much of the offensive odor can be eliminated by long exposure to the weather or by soaking in 10 per cent formalin and then drying. Limpets will also show variation and present less of a cleaning problem.

A trip to a vegetable market, a feed store, and a commercial nursery will yield a large number of plants that will serve as examples of some form of variation. Discuss the history of the examples.

Feed the animals in the aquarium and the terrarium.

17 Supervised study.

Work on the Suggested Activities.

18 Supervised study.

Work on the Suggested Activities.

19 Supervised study.

Work on the Suggested Activities. Be prepared to take part in the discussion of the next day.

Announce the oral reports for the 21st day.

Feed the animals in the aquarium and the terrarium.

20 Class discussion.

Purpose: To discuss the social steps that would tend to eliminate the occurrence of socially and biologically inferior individuals in our society.

It is suggested that this material be discussed as a forum, a panel discussion, or a debate. The complete organization should be turned over to the pupils.

21 Oral reports.

Allow each pupil to present an oral report on some subject applicable to the subject matter in this unit.

Feed the animals in the aquarium and the terrarium.

22 Distribute the pupil self-test.

(See the Plan for Unit 1, p. 26.)

Oral Presentation of assigned activities.

(See the Plan for Unit 1, p. 27.)

23 Continue with the oral presentations and criticisms.

Supervised study for the remainder of the period.

24 Summary exercise.

(See the Plan for Unit 1, p. 27.)

Check to see about the laboratory equipment and supplies needed for Unit 6. Secure those that are needed.

Feed the animals in the aquarium and the terrarium.

25 Evaluation of the unit.

(See the Plan for Unit 1, p. 27.)

Score and discuss the tests.

BIOLOGY

Unit 5.

Time: 25 days.

CHANGE AND ORGANISMS

Objectives:

1. To understand the significance of the fossil remains that have been unearthed.
2. To learn that like tends to beget like in all life.
3. To appreciate the fact that organisms are not permanently fixed but are constantly undergoing slight change.
4. To consider some of the theories that seek to explain the methods of change.
5. To become acquainted with the Mendelian and other laws of heredity.
6. To become acquainted with some of the practical applications of the science of genetics to the improvement of plants and animals.
7. To learn how an application of the laws of heredity would tend to eliminate some of man's social problems.

Outline of the Unit:

- I. What Evidence Do We Have That Plants And Animals Have Not Always Been As They Are Now?
 - A. The evidence from preserved specimens.
 1. Ancient animals found in "cold storage."
 2. Plants and animals preserved in oil and amber.
 3. Petrified plants and animals.
 4. Evidence submitted by molds, yeasts, footprints and trails.

B. Other sources of evidence of change.

1. "Series of fossils."
 - a. Trilobites.
 - b. The story of the horse.
 - c. The elephant.
 - d. The camel.
2. Changes indicated by mammal embryos.
 - a. Recapitulation.
 - b. Appearance of gill openings in the embryos.
 - c. Development of the embryonic heart.
3. The evidence suggested by vestigial structures.
 - a. Splints in the leg of the horse.
 - b. Pelvic bones in whale and porpoise.

C. Evidence concerning changes in man.

1. A story of human development.
 - a. How modern scientists piece together the story.
 - b. Man's development traced by his tools.
2. Species and genera of men.
 - a. The earliest species of men.
 - b. Distribution of early human species.
3. The biological basis of human progress.
 - a. How man differs from other social animals.
 - b. How discoveries have led to human progress.

II. What Explanations Have Been Offered Concerning These Apparent Changes?

A. The necessity of some of these changes.

1. Necessity to adjust to changed geographical conditions.
2. Necessity for changed mode of living.
 - a. Development of wings by the birds.
 - b. Development of good legs on mammals.
 - c. Marine mammals.

B. Explanations that have attempted to explain the apparent change.

1. Definition of a theory.
2. The explanation of special creation.
3. Lamarck's theory of the inheritance of acquired characters.
4. Darwin's theory of natural selection.
5. Hugo de Vries mutation theory.
6. Recent research on the effect of newly isolated vitamins.

C. The time element involved in these apparent changes.

1. Variations brought about by Burbank.
2. The Geological Time Scale.
 - a. Azeoic (period without life).
 - b. Archeozoic.
 - c. Proterozoic.
 - d. Paleozoic.
 - e. Mesozoic.
 - f. Cenozoic.
3. Methods used to determine geologic time.

III. What Evidence Would Lead One To Believe That There Are Certain Laws Of Heredity In Operation?

A. Resemblances and differences in parent and offspring.

1. Each organism produces its own kind.
2. Presence of variations.
 - a. Some caused by environment.
 - b. Most are caused by the operation of inheritance factors.

B. Some of the laws of inheritance.

1. What is a "law"?
2. Sexual reproduction provides for the transmission of hereditary character.
 - a. Germ cells.
 - b. Maturation of the germ cells.
 - c. Chromosomes.
 - (1. Number in various organisms.
 - (2. Genes.
 - (3. Unit character.
3. Mendelian heredity.
 - a. Life of Gregor Mendel.
 - b. Mendel's famous experiments.
 - c. Mendel's Law of Heredity.

- (1. Law of independent unit characters.
- (2. Law of dominance (not always accepted today).
 - (a. Hybrids.
 - (b. Dihybrids.
- (3. Law of Segregation.
4. Important developments in the field of heredity since Mendel.
 - a. Incomplete dominance (also known as blended inheritance and imperfect dominance).
 - (1. Four-o'clock.
 - (2. Andalusian fowl.
 - b. Cumulative genes (multiple factors).
 - c. Sex inheritance.
 - d. Sex-linked inheritance.
 - (1. In man.
 - (a. Haemophilia.
 - (b. Color blindness.
 - (2. Other examples.
 - e. Lethal factors.
 - f. Linkage.
 - g. Crossing over.

IV. What Has Been Suggested As Explanations For The Appearance Of Variation Among Plants And Animals?

A. Fluctuations.

B. Mutations.

1. Hugo De Vries.
2. Examples.
 - a. Hornless cattle.
 - b. Short-legged sheep.
3. Suggested causes of mutation.
 - a. Genes may interchange positions.
 - b. The chromosomes may become changed in number.
 - c. Chromosomes may become changed in character.
4. Known causes of mutations.
 - a. Gene mutations sometimes occurred in the fruit fly (*Drosophila*) when the germ cells were exposed to X-rays.

- b. Exposing the flies and eggs to sudden and great changes of temperature increased the variation.
- c. Chemical colchicine.

V. What Biological Principles Have Been Applied In The Improvement Of Plants and Animals?

A. Methods that are practiced.

- 1. Selection and isolation.
 - a. De Vries' Elementary species.
 - b. U.S.D.A. Bureau of Plant Introduction.
 - c. Hydroponics.
 - d. New plant vitamins.
- 2. Pure breeding.
 - a. Pedigrees.
 - b. Grading.
- 3. Inbreeding.
 - a. Line breeding.
 - b. Thoroughbred.
 - c. Outcross.
- 4. Hybridization.
 - a. Hybridization and selection.
 - b. Hybridization and inbreeding.
 - c. Double-cross for hybridizing corn.
- 5. Recognizing mutants.

B. Plants and animals that have been improved.

- 1. Plants.
 - a. The creations of Luther Burbank.
 - b. Others.
- 2. Animals.
 - a. Difficulties encountered in animal breeding.
 - b. Horses.
 - (1. Race.
 - (2. Draft.
 - c. Chickens.
 - (1. Hybrid breeds.
 - (2. Hanson breeds.
 - d. Cattle.
 - e. Dogs.

VI. How May Mankind Be Improved Through Application Of These Principles?

- A. Is there a need for improvement?

1. Feeble-mindedness.
 - a. In U. S. A.
 - b. State of Oregon. Oregon Fairview Home had a "daily average population for year 1940 of 1029.6; cost of maintenance and operation for year 1940 was \$208,314.84; capital investment as of July 1, 1940, \$1,016,586.00."
 - c. Cost.
 - d. Contributes to other social delinquencies.
 2. Crime.
 - a. Confined in institutions in U. S. A.
 - b. Confined in institutions in Oregon.
 - (1. Oregon State Penitentiary. "Present June 30, 1949, 1,032; maintenance for the biennium (Jan. 1939 to June 30, 1940) \$679,989.50."
 - c. Estimated cost to U. S. A.
 3. Physical degeneracy.
 4. Insanity.
- B. Evidence that would indicate that Mendel's laws operate in man.
1. Studies showing the transmission of social characters or traits.
 - a. The Jukes family.
 - b. The Kallikaks family.
 - c. The Edwards family.
 - d. The Darwins.
 - e. The Bach's of Germany.
 - f. The Hereshoff family.
 2. Evidence that physical weakness and defects may be transmitted.
- C. Movements designed for improvement.
1. The science of Eugenics.
 2. The science of Euthenics.
 3. Agencies working for the betterment of mankind.
- D. Projects actually underway.
1. Legislative action.
 - a. Better marriage laws.
 - b. Sterilization laws.
 - c. Immigration regulations.

2. Government agencies assisting.
 - a. Slum clearance.
 - b. Improvement of diet of individuals.
 - c. Improvement of health of individuals.
 - d. Settlement houses.
 - e. Elimination of causes of crime.
3. Movements in Europe.
 - a. Germany.
 - b. Russia.
 - d. Italy.

Suggested Activities:

1. Collect as many fossils as you can and arrange on a display table in the classroom. With the assistance of the available reference material try to identify your specimens. Label all of them with what you "think" they are.
2. Examine a rock collection or specimens from some of the various rock strata in your neighborhood. Familiarize yourself with the general appearance of the more common forms.
3. Take a field trip to some nearby cliff or road cut. Diagram the layer composition of the formation. Search for fossil remains.
4. Compare the internal structure of the wings of a bird, the flippers of a seal or whale, and the arms of man.
5. Compare the skeletons of fish, amphibians, reptiles, birds, and mammals. Note the similarity of form despite their different mode of living and general appearance.
6. Prepare a chart that will show the fossil pedigree of the horse, the elephant, or camel.
7. Collect pictures of prehistoric animals. Arrange them according to their geological periods and mount on a large cardboard.
8. Collect pictures of prehistoric plants.
9. Prepare a chart to show the geological history of fossil men. Use the following headings:

name of prehistoric man, place found, geological age, nature of the fossil, and the reconstructed appearance of the man.

10. Make a chart of your family pedigree. Include on it some physical character such as color of hair, color of eyes, or outstanding hand or ear shape. Send to the Eugenics Record Office, at Cold Spring Harbor, New York, for a chart on which to record your results.
11. Make a list of the well known plants and animals that have been developed and improved by the application of the laws of heredity.
12. Make a study of the Jukes, Kallikak and Edward's families and the cost of human deficiency to the taxpayers of this state and the United States. What suggestions would you offer that in your estimation would have a tendency to eliminate the undesirable members of our society and would promote the development of a better human race?
13. Toss two coins in the air for at least one hundred times. Tabulate the number of heads and heads (HH), heads and tails (HT), and tails (TT). How does your result correspond with the ratio of Mendel's law of segregation, (1-2-1) ratio?
14. Outline the technique one should use to cross-pollinate a plant artificially. Demonstrate to the class.
15. Make as complete a list as you can of dominant and recessive unit characteristics.
16. Make a list of plant and animal mutants.
17. Show by diagram how color blindness or hemophilia is inherited.
18. Show the relation of chance to Mendel's law of segregation by taking beans from a box. Put 50 white beans and 50 colored beans in a box. Draw two out at a time and tabulate your results-- (WW), (WB), and (BB). Note the ratio or their various associations.

19. Prepare a diagram of two unit characters showing the results for three generations of cross-breeding. Be original in your choice of characters.
20. Devise a scheme or diagram to show the correct relations of the following: chromosome, individual, gene, nucleus, cell, species.
21. Set up an experiment with the fruit fly (*Drosophila*), which will prove or disprove some question of inheritance.
22. Read as much as you can about the work of the following men and tell what each man contributed to the science of heredity: Darwin, Davenport, De Vries, Galton, Lamarck, Mendel, and Weismann.
23. With the aid of the Readers' Guide to Periodical Literature, select and brief a current article applicable to this unit.
24. Prepare an oral report on some topic associated with this unit. The following are offered as suggestions:
 - a. Oregon coal.
 - b. Geological history of Oregon.
 - c. Fossils remains from the Los Angeles tar pits.
 - d. Fossil contributions from the state of Oregon.
 - e. Local fossil beds.
 - f. Recent paleontological findings.
 - g. Fruits and vegetables our great grandparents did not have.
 - h. Luther Burbank.
 - i. Gregor Mendel.
 - j. A study of the pedigrees of some royal family.
 - k. The armored fishes.
 - l. The dinosaurs.

Reference Books:

The following are numbers of books listed in Bibliography A that will prove to be helpful in the study of this unit:

7, 11, 15, 18, 20, 31, 39, 48, 49, 50, 55, 57, 64, 67, 69, 71, 80, 85, 87, 99, 100, 102, 103, 104, 106, 107, 122, 135, 140, 147, 157, 172, 175, 176, 195, 197, 208, 215, 218, 221, 222, 231, 233, 235, 240, 244, 254, 257, 258, 262, 272, 273, 277, 281, 283, 289, 292, 293, 297.

Visual Aids:

A. Charts.

1. Jurica Biology Charts.
Mendel's Laws of Inheritance.
2. Lehmann Heredity Charts.
LC104. Inheritance of Hair Form in Man.
LC105. Inheritance of Eye Color in Man.
LC106. Inheritance of Hair Form and Eye Color in Man.
LC202. Incomplete Dominance in the Four-O'-Clock.
LC203. Complete Dominance in the Snail.
LC204. Independent Assortment of Genes in Guinea Pig, Snail, and Corn.
LC205. Variation of External Characteristics.
LC206. Stability of Hereditary Traits.
LC207. Human Inheritance--The Family Zero.
3. Philips Biology Charts.
P201. Incomplete Dominance of Color in the Four-O'-Clock.
P202. Incomplete Dominance of Plumage Color in Andalusian Fowls.

- P203. Complete Dominance of Shell Color
and Pattern in the Wood Snail.
P204. Inheritance of Comb Characters in
Fowls.

4. Smallwood Botanical Charts.
#30. Inheritance--Mendel's Law.
5. Smallwood Zoological Charts.
#30. Diagrams to Illustrate Mendel's Law.
6. Turtox Class-Room Charts.
The Six Monohybrid Matings.
Di-Hybrid Mating.
Independent Inheritance.
Di-Hybrid Crossing.
Inheritance of Tallness and Dwarfness.

B. Films.

1. Oregon State College.

- Testing Seeds in Soil.
16mm. silent, 1 reel.
When the Cows Come Home.
16mm. silent, 1 reel.
Naturalized Plant Immigrants.
16mm. silent, 3 reels.
Poultry, National Improvement Plan.
16mm. sound, 3 reels.
Breeding for More and Bigger Eggs.
16mm. silent.

2. University of California.

- #48. How to Grow Hogs.
16mm. silent, 2 reels, \$.50.
#77. Earth, The.
16mm. silent, 1 reel, \$1.00.
#212. Luther Burbank.
16mm. silent, 1 reel, \$1.00.
#235. Cycle of Erosion.
16mm. silent, 1 reel, \$1.00.
#381. Dairy Cattle.
16mm. silent, 1 reel, \$1.00.
#870. Lost World, A.
16mm. silent, 1 reel, \$1.00.

#2721. Earth's Rocky Crust.
16mm. sound, 1 reel, \$1.50.

#2727. Heredity.
16mm. sound, 1 reel, \$1.50.

3. Motion Picture Bureau.

#GS-139. Evolution.
16mm. sound, 3 reels, \$4.50.

#S-218. Thoroughbred.
16mm. sound, 2 reels, Free.

#E-923. Social Science.
16mm. silent, 1 reel, \$1.00.

#1618. Story of the Pedigreed Silver Foxes.
16mm. silent, 2 reels, Free.

#1836. Digging Up the Past.
16mm. silent, 1 reel, Free.

C. Glass Slides From Oregon State College.

#224-G. Earth's Former Inhabitants. 38 slides.

#227-G. Geology. 38 slides.

#256-G. Oregon Geology. 17 slides.

D. Film Slides From Oregon State College.

#1. Breeds of Sheep. 35 pictures.

#2. Breeds of Swine. 32 pictures.

#16. Standard Breeds of Poultry. 47 pictures.

#18. Types and Breeds of Beef and Dual Purpose Cattle. 33 pictures.

#261. The Cooperative Bull Association. 36 pictures.

#365. Breeds of Dairy Cattle. 47 pictures.

#366. Some Principles of Breeding Demonstrated With the Herediscope. 40 pictures.

#455. Better Sires--Better Stock. 49 pictures.

#477. Facts About Jerseys and the Jersey Breed Improvement Program. 43 pictures.

Free and Inexpensive Reference Material:

A. American Museum of Natural History. Columbus Avenue, St. Louis, Missouri.

1. Guide Leaflet Series:

#70. The Hall of Dinosaurs. 13¢.

#75. How Old Is the Earth? 23¢.

2. Handbook Series:

#4. Animals of the Past. 85¢.

B. Field Museum of Natural History. Roosevelt Road, Chicago, Illinois.

1. Botany Leaflet:

#5. A Fossil Flower. 10¢.

2. Geology Leaflets:

#9. How Old Are Fossils? 15¢.

#13. The Geological History and Evolution of the Horse. 40¢.

#14. A Forest of the Coal Age. 25¢.

3. Geological Series:

#5. Vol. IV. Contributions to Paleontology. 50¢.

#9. Vol. I. The Dinosaur Beds of the Grand River Valley of Colorado. 50¢.

C. General Biological Supply House (The). 761-763 East 69th Place, Chicago, Illinois.

1. Turttox Service Leaflets: Free.

#15. The Culture of Drosophila Flies and Their Use in Demonstrating Mendel's Law of Heredity.

#46. The Study of Fossil Plants.

#47. The Study of Fossil Animals.

2. Turttox News: Free.

D. Metropolitan Life Insurance Company. 600 Stockton Street, San Francisco, California.

Health Bulletins For Teachers:

The Physical Basis for Heredity. May, 1941.

E. Oregon Social Hygiene Society, The. 376 Pittock Building, Portland, Oregon.

This organization distributes material on the subject of eugenics. Write for list.

F. Oregon State College Experiment Station,
Corvallis, Oregon.

1. Station Bulletins:

#395. Reproductive Performance in Dairy Cattle. 1941. 27 pp.

2. Station Circular of Information:

#41. Official Testing of Dairy Cattle in Oregon. 1923. 38 pp.

#241. Progress Report--Corn Breeding Project, Yield Trials With Hybrid Field Corn. 1940. 1941.

G. Percheron Horse Association of America. Union Stock Yards, Chicago, Illinois.

How To Select Percherons. 1936. 47 pp. 1l. Free.

H. U. S. Superintendent of Documents, Washington, D. C.

1. Agriculture Bulletins:

#754. Inheritance of Waxy Endosperm in Maize. 1919. 99 pp. 15¢. (Al.3:754).

#1090. Effects of Inbreeding and Crossbreeding on Guinea Pigs: 1. Decline in Vigor; 2. Differentiation Among Inbred Families. 1922, 63pp. 1l. 15¢. (Al.3:1090).

#1354. Productiveness of Successive Generations of Self-Fertilized Lines of Corn and of Crosses Between Them. 1925. 19 pp. 1l. 10¢. (Al.3:1354).

#1396. Comparison of Maize Breeding Methods. 1926. 22 pp. 1l. 5¢. (Al.3:1396).

2. Agriculture Circulars:

#268. Golden Cross Bantam Sweet Corn. 1933. 12 pp. 1l. 5¢. (Al.4/2:268).

#366. Safflower, Possible New Oil-Seed Crop for the Northern Great Plains and the

- Far Western States. 1935. 11. 5¢.
(Al.4/2:366).
- #391. New Sugar-Beet Varieties for the Curly-
Top Area. 1936. 5pp. 11. 5¢.
(Al.4/2:391).
- #420. Houma Potato, A New Variety. 1936.
4 pp. 11. 5¢. (Al.4/2:420)
- #424. Distribution of the Varieties and Clas-
ses of Wheat in the United States in
1934, 1937. 68 pp. 11. 10¢.
(Al.4/2:424).
- #461. Two New Varieties of Sugar Cane for
Sirup Production. 1937. 4 pp. 5¢.
(Al.4/2:461).
- #493. Earlane Potato, A New Early Variety.
1938. 6 pp. 11. 5¢. (Al.4/2:493).
- #501. Reaction of Wheat, Barley, and Rye
Varieties to Stripe Rust in Pacific
Northwest. 1938. 15 pp. 5¢.
(Al.4/2:501).
- #503. Sebago Potato, A New Variety Resistant
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provement. 20 pp. 6 il. Not in 1941
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4. Agriculture Miscellaneous Publications:
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American Varieties of Tomatoes. 1933.
23 pp. 31 plates. 50¢. (Al.38:160).
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American Varieties of Cabbages. 1934.
24 pp. 11. 50¢. (Al.38:169).
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1934. 39 pp. 11. \$1.00. (Al.38:170).
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60 pp. 11. 25¢. (Al.38:316).

5. Agriculture Technical Bulletin:

- #136. Breeding Hard Red Winter Wheats for Winter Hardiness and High Yield. 1929. 28 pp. 5¢. (Al.36:136).
- #143. Field Studies on Rust Resistance of Oat Varieties. 1930. 36 pp. 10¢. (Al.36:143).
- #145. Life History and Habits of Grasshopper Mice, Genus Onychomys. 1929. 20 pp. 1l. 10¢. (Al.36:145).
- #222. Genetic Growth Differentiation in Guinea Pigs. 1931. 36 pp. 10¢. (Al.36:222).
- #279. Correlation of Hereditary and Other Factors Affecting Growth in Guinea Pigs. 1939. 36 pp. 10¢. (Al.36:279).
- #292. Inheritance of Colored Scutellums in Maize. 1932. 44 pp. 1l. 10¢. (Al.36:292).
- #329. Experiments in Wheat Production on Dry Lands of Oregon, Washington and Utah. 1932, 68 pp. 1l. 10¢. (Al.36:329).
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- #422. Field Studies on Resistance of Hybrid Selections Oats to Covered and Loose Smuts. 1934. 10 pp. 5¢. (Al.36:422).
- #459. Classification of Wheat Varieties Grown in the United States. 1935. 164 pp. 1l. 25¢. (Al.36:459).
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6. Agriculture Yearbook Separates:

- #985. Bulls Bred Pure Replace Scrubs in More Counties. 1927. 5¢. (Al.10/a-985).
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- #1601. Heredity in Dogs. 1937. p. 1314-49. 11. 10¢. (A 1.10/a:1601).
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#576. Breeds of Sheep For Farm. Rev. 1937. 14 pp. 11. 5¢. (A 1.9:576).
#619. Breeds of Draft Horses. Rev. 1936. 17 pp. 11. 5¢. (A 1.9:619).
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- #1437. Swine Production. Rev. 1937. 31 pp. 1l. 5¢. (A 1.9:1437).
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 - #12. Introduction of Japanese Oysters Into The United States. 1932. 16 pp. 1l. 5¢. (C 6:13:12).
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 - Study of Some Unproductive Sports of the Montmorency Cherry. 1935. 22 pp. 1l. 5¢. (A 1.23/a:C424/4).
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- Correlated Inheritance in Oats of Reaction to Smuts, Groven Rust, Stem, Rust, and Other Characters. 1940. 1l. 5¢.
(A 1.23/a:Oa8/30).
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Inheritance of Eggshell Thickness in White
Leghorn Pullets. 1939. p. 383-396.
5¢. (A 1.23/a:Eg39/26).

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of Feathering in the Growing Chick.
1938. p. 679-706. 1l. 5¢.
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and Dairy Breeds. 1937. p. 239-287.
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(A 1.23/a:W56/141).

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(A 1.23/a:so32/35).

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Comb Rhode Island Red Fowl. 1934.
14 pp. 1l. 5¢. (A 1.23/a:R346/3).

12. National Museum Bulletins:

#53. Catalogue of Type and Figured Specimens
of Fossils, Minerals, Rocks, and Ores
in Department of Geology, National
Museum: Pt. 1, Fossil Invertebrates.
1905. 704 pp. 40¢. (SI3.3:53).

#64. Critical Summary of Troost's Unpublished
Manuscript on Crinoids of Tennessee.
1909. 150 pp. 1l. 25¢. (SI3.3:64).

13. Public Health Report:

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tion in United States, Comparative
Summary of Statutes and Review of
Court Decisions. 1940. 45 pp. 10¢.
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I. University Apparatus Company, Berkeley, Cali-
fornia Hydropanics, Pamphlet, 4 pp. Free.

J. (W.P.A.) Oregon Writers' Project. 409 Elks
Building. Portland, Oregon.

Oregon Oddities: Prehistoric Lands in Oregon.
Sept. 1, 1940. 13 pp. mimeographed. Free.

CHAPTER VII

UNIT 6

PERPETUATING ORGANISMS

BIOLOGY

Unit 6.

Time: 25 days.

PERPETUATING ORGANISMS

PLAN

DayMethod

1

Pretest for Unit 6.

(See the Plan for Unit 1, p. 19)

Presentation.

(See the Plan for Unit 1, p. 19)

Distribute the duplicated copies of the Outline of the Unit and the Suggested Activities.

Rotate the membership of the standing committees.

Set up the improvised incubator used in Unit 4. Turn on the light and start regulating the temperature to 103 degrees F. Fill the water pan. The constant temperature will be easier to maintain if the incubator is placed in a closet. Check for any fire hazard!

Make the necessary arrangements to have about three dozen eggs available for the third day. Be certain that these are fertile!

Feed the animals in the aquarium and the terrarium.

2 Supervised study.

Examine the Outline of the Unit and use it as a guide for surveying the data in the unit.

Check the temperature of the incubator.

3 Supervised study.

Continue with the examination of the Outline of the Unit.

Check the temperature of the incubator and if it has been regulated so that it is maintaining a constant temperature of about 103 degrees F. put the eggs in. Mark each egg so as to be able to determine if it has been turned and put it in a pan or wire basket, raised slightly from the floor of the incubator. The eggs must be rotated 180 degrees each day (preferably twice a day). Arrangements will have to be made to have someone do this and check on the temperature on Saturdays and Sundays. It is better to have a small light globe that maintains the correct temperature with a minimum of crack in the lid than to have a larger bulb and a larger heat-escape crack. Some of the pupils will enjoy labelling the eggs before they are placed in the incubator.

Check the route for the field trip for the next meeting of the class.

4 Field trip.

Purpose: To survey the plant and animal conditions for this time of the year and to collect materials that should be helpful in the study of reproduction.

Examine a pond, the edge of a stream, or the shallow water near the shore of a lake for frog, toad, and salamander eggs. These animals lay their eggs early, varying with the season and the location. Freshly laid eggs can be "brought along" to fit the work in this unit by keeping them in an open container in a refrigerator. The development is rapid at a higher temperature. Preserve a series of stages in vials of formalin or alcohol.

Amphibia eggs should be collected with a minimum of handling and brought to the laboratory in water from the place of collection. Allow them to remain in the water in which they were collected in until it has reached the room temperature. If slowly running water can be provided the chances for success are greater.

Bring in some dead grass or hay to use in the preparation of new protozoa cultures.

Collect the notes on the field trip.

Check the temperature of the incubator and turn the eggs.

Feed the animals in the aquarium and the terrarium.

5 Return the notes on the field trip.

Supervised study.

Work on the Suggested Activities.

Prepare to rear several insects in the laboratory that will illustrate complete life cycles. The fruit fly, blow fly, house fly, wax moth, meal worm beetle, and the cheese skipper are well suited for this. All of them have a complete metamorphosis and a life cycle that is within the limits of this unit. They can be reared in insect

cages or in 1- and 2-quart jars with cheesecloth covering the open ends. Place the food in the container with the insects, cover the opening, and await the developments.

Boil the grass or hay brought in from the field trip for 20 or 30 minutes. Divide the boiled material and its liquor into four or five test tubes or tumblers and expose for bacterial contamination (see 13th day).

Check the temperature of the incubator and turn the eggs.

6 Class discussion.

Purpose: To demonstrate the method used to examine the development of the chick embryos.

Remove an egg from the incubator and place it upon a warm cloth pad or one made by folding several kleenex tissues. Puncture the shell at a point toward the large end with a pair of sharp-pointed scissors and remove a section of the shell about the size of a one-cent piece. Attempt to locate the position of the embryo by looking through this opening and gently rotating the yolk. When the location is determined enlarge the opening in the shell to it. A finger bowl or a beaker filled with crumpled sheets of kleenex makes an excellent receptacle for the opened egg. The best results are obtained by allowing the embryo to remain in the shell and examining it with a hand lens under a strong light. If it is desirable to examine it under the microscope, empty the contents into a shallow dish and then lift the embryo upon a glass slide or in a petri dish. The pupils should keep notes and make sketches of their observations of the progress of the development.

Check the temperature of the incubator and turn the remaining eggs.

Feed the animals in the aquarium and the terrarium.

7 Supervised study.

Work on the Suggested Activities.

Have planaria or earthworms available for the next meeting of the class.

Have a pupil open one of the eggs from the incubator (6th day of the development).

Inquire among the members of the class (outside of class) about the possibility of securing a pregnant female pet mouse, rat, guinea pig, or rabbit. Secure one that will be available on the 20th day. If the inquiry fails to secure results, explain the needs to the manager of a slaughterhouse. He will probably be able to supply pig embryos with the membranes unbroken. Adjust the date for the discussion to coincide with the availability of the material.

Check the temperature of the incubator and turn the remaining eggs.

8 Supervised study.

Work on Suggested Activity #7. Have planaria or earth worms available for the use of the pupils. They may work in fairly large groups on this exercise.

If using planaria, put the worm on a sheet of wet paper by means of wide-mouthed pipette. Use a razor blade to cut the worm in two parts, making the cut midway between the anterior and the posterior ends. Transfer each of these parts to a single dish of water, label, and attend to them daily to see that they do not dry.

Watch the progress of the worms. Cut additional ones using the same technique but varying the position of the bisection.

Cut three or four earthworms in two parts, varying the position of the bisection for each worm. Examine the cut ends for constriction bands. Put all the anterior ends in one container or soil and all the posterior ends in another. Label each container. The better results should be expected from the anterior ends.

Have a pupil open one of the eggs from the incubator (7th day of the development).

Check the temperature of the incubator and turn the remaining eggs.

9 Supervised study.

Work on the Suggested Activities.

Have a supply of complete flowers for pupil-examination at the next meeting of the class. There should be one specimen of the same flower for each member of the class. Hand or dissecting lens and razor blades will be necessary. Also have a variety of flowers that illustrate some of the different incomplete and irregular conditions that are encountered in inflorescence types.

Have a pupil open one of the eggs from the incubator (8th day of the development).

Check the temperature of the incubator and turn the remaining eggs.

Feed the animals in the aquarium and the terrarium.

10 Supervised study.

Examine a flower, dissect, and identify each part. Know the function of the parts

in their role of reproduction. Make a diagrammatic sketch of a complete flower. Have a selection on display that will illustrate the different conditions that are encountered in flowers (see Suggested Activity #14).

Have a pupil open one of the eggs from the incubator (9th day of the development).

Check the temperature of the incubator and turn the remaining eggs.

Feed the animals in the aquarium and the terrarium.

11 Supervised study.

Examine prepared slides of conjugation of paramecium, sexual reproduction in vaucheria, and mitosis. Make sketches of these. Whenever possible use fresh material, supplementing it with the prepared slides.

Put some bean and corn seeds to soak (see the 15th day).

Have a pupil open one of the eggs from the incubator (12th day of development). Select this one by candling the eggs with a strong light. Go over the remainder of the eggs, candling them, and throwing away those that are not developing.

Feed the animals in the aquarium and the terrarium.

12 Supervised study.

Continue with the examination of the slides.

Check the equipment to be used in making the micropipettes and the new protozoa cultures at the next meeting of the class.

Start germinating the soaked bean and corn seeds by placing them in a damp cloth or between sheets of moistened blotting paper and keeping them in a warm place. Put more to soak (see the 15th day).

13. Supervised study.

Examine the protozoa culture for evidence of simple division.

Occasionally some of the protozoa can be observed in the process of division. Indirect evidence can be furnished by watching the daily increase in the population of new cultures. These can be established by isolating droplets of culture spread on a slide that contain but a single individual. Pick this droplet up with a micropipette, examine under the microscope to check on the presence of a single individual, and then blow it into a culture tube. These culture tubes are made by boiling hay or dead grass in water for 20 to 30 minutes. Divide this material and its liquor into four or five test tubes or tumblers and allow it to stand until it is contaminated with bacteria (appearance of a scum). A micropipette can be made by drawing out a glass tube over a wing-top burner until it is of a very fine bore (about 1 mm. in diameter). Allow to cool and then break off near the shoulder.

The procedure described above establishes pure cultures.

Start the freshly soaked bean and corn seeds to germinating. Put more to soak (see the 15th day).

Have a pupil open one of the eggs from the incubator (14th day of the development).

Check the temperature of the incubator and turn the remaining eggs.

14 Supervised study.

Work on the Suggested Activities.

Start the freshly soaked bean and corn seeds to germinating. Put some more to soak for use at the next meeting of the class (see the 15th day).

Check the temperature of the incubator and turn remaining eggs.

Feed the animals in the aquarium and the terrarium.

15 Supervised study.

Work on the Suggested Activity #5. Sketch the embryonic development of a typical monocot and dicot seed. Use the corn and bean seeds that have been germinated in a series designed to show the development of the embryo.

Have moss plants available for next meeting of the class. Examine for evidence of reproductive bodies.

Have a pupil open one of the eggs from the incubator (16th day of the development).

Check the temperature of the incubator and turn the remaining eggs.

16 Supervised study.

Examine local mosses. Work out the life cycle of a typical moss plant (see Suggested Activity #12).

Have a pupil open one of the eggs from the incubator (19th day of the development).

Check the temperature of the incubator and turn the remaining eggs.

Feed the animals in the aquarium and the terrarium.

17 Supervised study.

Work on the Suggested Activities.

Check the temperature of the incubator and turn the remaining eggs. Examine for "pip" marks (20th day of the development).

18 Supervised study.

Examine the laboratory ferns for evidence of reproductive structures. Work out the life cycle for the ferns (see Suggested Activity #13). An examination of the soil of the potted ferns likely will reveal the growth of numerous prothallia (gametophytes). These should be examined for the presence of reproductive structures (antheridia and archegonia). To secure sperms allow some of the prothallia to wilt for 20 to 30 minutes. Place this on a slide with a drop of water. If the antheridia are developed, sperms may be seen swimming about after 2 or 3 minutes. Archegonia are found on the underneath side of the prothallium just below the notch.

Check the temperature of the incubator. Examine for "pip" marks. If any are present, crack the shell and release the chick. It is highly unlikely that the development will proceed to completion in equipment of this nature. It does work nicely in the earlier stages which are the most important for this work.

19 Supervised study.

Work on the Suggested Activities.

Announce the oral reports for the 21st day.

Check the material for the discussion period the following day. Select a boy or boys to kill the animal by anesthetizing it before class.

Examine the remaining eggs in the incubator. Perform post mortems on those failing to complete the development. Dismantle and store the equipment.

Feed the animals in the aquarium and the terrarium.

20 Class discussion.

Purpose: To demonstrate the development of a mammal embryo and the female organs of reproduction.

Open the pregnant female ventrally to expose the uterus. Point out the uterus and its blood vessels to the class. Make an incision in it and expose one of the embryos. Be careful not to rupture the membranes. Remove and expose one of them. Point out the umbilical cord and its connections, an ovary, and oviduct.

If the time is sufficient and material permits, a male animal may be dissected to expose a testis, its connections with the urethra and smears of living sperms can be prepared. These are made by smearing some of the contents of the connecting tube thinly on a warm slide. Examine under the high power of the microscope.

Discussions on reproduction require very careful planning.

21 Oral reports.

Have each pupil make an oral report on some subject that is applicable to this unit (see Suggested Activity #22).

- 22 Distribute the pupil self-test.

(See the Plan for Unit 1, pp. 26).

Oral presentation of assigned activities.

(See the Plan for Unit 1, pp. 26).

- 23 Continue with the oral presentations and criticisms.

Supervised study for the remainder of the period.

- 24 Summary exercise.

(See the Plan for Unit 1, pp. 27).

Check the laboratory equipment and supplies needed for Unit 7. Secure those that are needed.

Feed the animals in the aquarium and the terrarium.

- 25 Evaluation of the unit.

(See the Plan for Unit 1, pp. 27).

Score and discuss the tests.

BIOLOGY

Unit 6.

Time: 25 days.

PERPETUATING ORGANISMS

Objectives:

1. To develop a better understanding of the beginning of life.
2. To observe that all forms of life are equipped to reproduce their own kind.
3. To study the elementary embryology of a few common plants and animals.
4. To understand the sexual and asexual methods of reproduction.
5. To understand the meaning and intelligent use of the scientific vocabulary involved.
6. To develop a scientific respect for reproduction and its associated problems and a consequent wholesome attitude for it.

Outline of the Unit:

- I. Why Is Reproduction Necessary?
 - A. Race preservation.
 - B. The life span of plants and animals.
 1. Short-lived organisms.
 2. Long-lived organisms.
- II. What Are the Common Methods of Reproduction?
 - A. Asexual--a part of the body of an organism is dissociated from the parent body and becomes a new organism.
 1. Cell division (fission).
 - a. Amitosis.

- b. Mitosis.
 - (1. Stages in plant cells.
 - (2. Stages in animal cells.
 - 2. Formation of spores.
 - 3. Vegetative processes.
 - a. Budding.
 - b. Extending runners.
 - c. Growing from underground stems.
 - d. Grafting.
 - e. Regeneration.
 - B. Sexual--two different kinds of sex cells are united.
 - 1. Conjugation.
 - 2. Fertilization.
 - C. Parthenogenesis.
- III. What Are the Common Methods of Reproduction Utilized by Plants?
- A. Simple forms of plants.
 - 1. Algae.
 - 2. Fungi.
 - B. Mosses.
 - 1. Differentiated structures for reproduction.
 - 2. Alternation of generation.
 - C. Ferns.
 - D. Flowering plants.
 - 1. Flower parts and their function.
 - 2. Pollen formation.
 - 3. Pollination.
 - a. Definition.
 - b. Methods.
 - 4. Pollen grain germination.
 - 5. Fertilization.
 - 6. Seed formation.
 - a. Types of containers.
 - b. Methods of seed dispersal.

IV. What Are the Common Methods of Reproduction Utilized by Animals?

A. Alternation of generations.

B. Asexual methods.

C. Sexual methods.

1. Conjugation.
2. Fertilization.
3. Comparative study of methods and organs of lower animals.
 - a. Flatworms.
 - b. Roundworms.
 - c. Starfish.
 - d. Earthworm.
 - e. Crabs or crayfish.
 - f. Insects.
4. Comparative study of methods and organs in vertebrates.
 - a. Amphibian.
 - b. Reptiles.
 - c. Birds.
 - d. Fish.
5. Mammalian reproduction.
 - a. Organs.
 - b. Method.
 - c. Fecundity.
 - d. Gestation periods.

V. What Is the Development of the Organism From the Time of Fertilization to Independent Organism?

A. Embryonic development of typical plants.

1. Bean.
2. Corn.

B. Embryonic development of typical animals.

1. Frog.
2. Chick.
3. Mammal.
 - a. Fraternal twins.
 - b. Identical twins.

C. Parental care.

Suggested Activities:

1. Observe the development of the frogs in the laboratory. Continue with the developmental record started at the time the eggs were gathered. Supplement your record with a series of sketches that show the different stages of development.
2. Examine prepared slides that show mitosis. Sketch the appearance of cells in the typical stages of development, or better yet prepare your own slides to show mitosis. Examine and sketch any phase of the process that you observe.
3. Sketch the various steps in the conjugation of paramecium. You may use prepared slides or, preferably, live paramecium taken from the culture.
4. If possible incubate some chicken eggs and open one each day to note the successive stages of development. Make a series of sketches based on your observation that will illustrate the complete development.
5. Dissect germinated corn and bean seeds that have been prepared in a sequence that will illustrate successive stages of development. Sketch the embryonic development.
6. If available, examine prepared microscopic slides of developing embryos.
7. Attempt some regeneration experiments on planaria. Write it up in the form of a laboratory experiment and illustrate with sketches.
8. Collect and mount pictures of animals showing parents and offspring.
9. Culture bread mold to show spores. Examine under the microscope. Sketch their appearance.
10. Examine slides or laboratory specimens of Spirogyra to show conjugation. Sketch typical examples.

11. Examine slides or laboratory specimens of *Vaucheria* to show sexual reproduction among the algae. Make sketches illustrating the process.
12. Examine moss plants. Make a chart that will illustrate its life cycle.
13. Examine a fern. Make a chart that will illustrate its life cycle.
14. Examine a flowering plant. Dissect and sketch each part. Know the function of each part of the flowering plant in the role of reproduction. Make a chart that will illustrate the reproduction of seed plants.
15. Examine an obelia. Sketch the alternation of generations found in its life cycle.
16. Examine the demonstration animal dissected by the instructor. Sketch the reproductive system.
17. Demonstrate to the class how you would make a bud or graft.
18. Examine pollen grains under the high-power lens of the microscope. Pollen grains may be grown in a three per cent sugar solution. Sketch.
19. Construct a table in which you have as headings all the ways in which plants are propagated. Under each heading list all the examples with which you are familiar.
20. Construct a table in which you have as headings all the ways in which animals reproduce. Under each heading list all the examples with which you are familiar.
21. With the aid of the Readers' Guide to Periodical Literature, select and brief a current article applicable to this unit.
22. Prepare an oral report on some topic associated with this unit. The following are offered as suggestions:

- a. Gland grafting in human beings.
- b. Interesting methods of seed dispersal.
- c. Interesting animals that care for their young.
- d. Commercial hatchery methods.
- e. How certain plants are pollinated by the horticulturists.

Reference Books:

The following are numbers of books listed in Bibliography A that will prove helpful in the study of this unit:

18, 23, 32, 38, 43, 47, 50, 52, 53, 56, 62, 67, 70, 74, 76, 77, 90, 100, 111, 116, 120, 122, 126, 135, 169, 171, 175, 183, 185, 202, 204, 213, 214, 216, 221, 233, 235, 242, 244, 257, 258, 269, 272, 277, 285, 289, 299.

Visual Aids:

A. Charts.

1. Elfving-Arvonen Structural Botany Charts.
Mitosis and Cell Division.
2. General Biology Charts.
Cell Division.
Fern.
Flowers.
Frog Development.
Germination of Seeds.
Liverwort.
Moss.
Pine.
Stems.
3. Jurica Biology Charts.
Flowers--Apple Blossom and Lily.
Frog--Reproduction.

- Life History of Fern.
 - Life History of Liverwort.
 - Life History of True Moss.
 - Meiosis and Mitosis.
 - Seeds and Germination.
4. Lehmann Heredity Charts.
Reproduction in Plants and Animals.
 5. Philips Biology Charts.
Algae, Spirogyra, etc.
Earthworm, Reproductive.
System and Cross Section.
 6. Smallwood Botanical Charts.
Buds--Kinds and Uses.
Ferns--Life History--Anatomy.
Flowers--Parts, Kinds, etc.
Marchantia--Mosses.
Pines--Life History--Anatomy.
Pollination--By Insects, etc.
Pollination--By Wind.
Seed Dispersal.
Seeds and Seedlings.
Stems--In Reproduction.
 7. Turttox Class Room Charts.
Animal Mitosis.
Beetle.
Blastulae.
Chick Development.
Cleavage.
Complete Metamorphosis in Insects.
Ectocarpus.
Equisetum. Life History.
Fern. Life History.
Floral Development.
Flower.
Flower Types.
Frog.
Frog Embryo.
Fucus.
Gametes.
Gastrulae.
Germination.
Hookworm.
Honeybee Anatomy and Life Cycle.
Incomplete Metamorphosis in Insects.

- Lichens.
 - Lily. Life History.
 - Liver Fluke.
 - Liver Fluke (Fasciola).
 - Marchantia.
 - Metridium Anatomy and Life History.
 - Mosquito Life Cycle.
 - Moss. Life History.
 - Mushroom.
 - Oedogonium.
 - Pine. Life History.
 - Plant Mitosis.
 - Pollination.
 - Rhizopus (Bread Mold) Life History.
 - Saprolegnia.
 - Seeds and Fruits.
 - Seed Plant.
 - Seed and Seed Dispersal.
 - Spermatogenesis and Oögenesis.
 - Spirogyra.
 - Sphagnum.
 - Tapeworm Anatomy and Life History.
 - Termite Life Cycle.
 - The Reproductive System.
 - Trichina.
 - Ulothrix.
 - Vaucheria.
 - Volvox.
8. Turtlox Wall Charts.
- Animal Mitosis.
 - Fern.
 - Fucus.
 - Lily.
 - Marchantia.
 - Molds.
 - Moss.
 - Spirogyra.
 - Volvox.
 - Wheat Rust.
9. U. S. Superintendent of Documents. Extension Service:
- Educational Charts on Corn. Group 10, Rev. 1940. 15¢, per set of 7 charts. (A43.22:10.1 to 10.7).

B. Films.

1. Oregon State College.

- ABC of Forestry, The.
16mm. sound, 1 reel.
- Cicada, The.
16mm. sound, 1 reel.
- In The Beginning.
16mm. sound, 2 reels.
- Life of Plants, The.
16mm. sound, 1 reel.
- Operation of a Forest Nursery.
16mm. sound, 1 reel. \$.50.
- Ovulation, Fertilization, and Early Development of Mammalian Egg.
16mm. sound, 2 reels.
- White Fringed Beetle.
16mm. sound, 2 reels.

2. University of California.

- #26. Seaside Friends and Their Cousins.
16mm. silent, 1 reel. \$1.00.
- #27. Day at the River, A.
16mm. silent, 1 reel. \$1.00.
- #28. Down at our Pond.
16mm. silent, 1 reel. \$1.00.
- #36. Growing Things.
16mm. silent, 1 reel. \$1.00.
- #43. Chick Embryo--Rat Fibroblasts.
16mm. silent, 1 reel, \$1.00.
- #81. Life.
16mm. silent, 1 reel. \$1.00.
- #88. Butterflies and Moths.
16mm. silent, 1 reel. \$1.00.
- #89. Evolution of a Butterfly, The.
16mm. silent, 1/2 reel. \$.75.
- #122. Life History of the Mosquito.
(Aedes Aegypti).
16mm. silent, 1 reel, \$1.00.
- #171. Seeds and Seed Dispersal.
16mm. silent, 1 reel. \$1.00.
- #277. Development of a Bird Embryo.
16mm. silent, 1 reel. \$1.00.
- #279. Frogs, Toads, and Salamanders.
16mm. silent, 1 reel. \$1.00.

#284.	Wild Flowers.	
	16mm. silent, 1 reel.	\$1.00.
#299.	Nesting Habits.	
	16mm. silent, 1 reel.	\$1.00.
#300.	Palace of Honey.	
	16mm. silent, 1 reel.	\$1.00.
#304.	Underwater Households.	
	16mm. silent, 1 reel.	\$1.00.
#313.	Castles of Paper.	
	16mm. silent, 1 reel,	\$1.00.
#332.	Reproduction in Lower Forms of Life.	
	16mm. silent, 1 reel.	\$1.50.
#333.	Reproduction in Higher Forms of Life.	
	16mm. silent. 1 reel.	\$1.50.
#384.	Early Development of Rabbit Egg--	
	Cleavage in Monkey Egg.	
	16mm. silent, 1 reel.	\$1.00.
#2517.	Plant Growth.	
	16mm. sound, 1 reel.	\$1.50.
#2519.	Flowers at Work.	
	16mm. sound, 1 reel.	\$1.50.
#2520.	Seed Dispersal.	
	16mm. sound, 1 reel.	\$1.50.
#2524.	Frog, The.	
	16mm. sound, 1 reel.	\$1.50.
#2528.	Tiny Water Animals.	
	16mm. sound, 1 reel.	\$1.50.
#2529.	Butterflies.	
	16mm. sound. 1 reel.	\$1.50.
#2530.	Moths.	
	16mm. sound, 1 reel.	\$1.50.
#2531.	Beetles.	
	16mm. sound, 1 reel.	\$1.50.
#2532.	Pond Insects.	
	16mm. sound, 1 reel.	\$1.50.
#2533.	Aphids.	
	16mm. sound. 1 reel.	\$1.50.
#2536.	House Fly,	
	16mm. sound, 1 reel.	\$1.50.
#2650.	Reproduction Among Mammals.	
	16mm. sound, 1 reel.	\$1.50.
#2887.	Sea-Urchin, The.	
	16mm. sound, 1 reel.	\$1.50.
#2915.	Born to Die.	
	16mm. sound, 1 reel.	\$1.00.
#2920.	City of Wax.	
	16mm. sound, 1 reel.	\$1.00.

Free and Inexpensive Reference Material:

- A. American Education Press Inc., 400 South Front Street, Columbus, Ohio.

Withrow, Vest. The Story of Seeds. Booklet.
36 pp. il. 15¢.

- B. American Genetic Association. 306 Victor Building, Washington, D. C.

A One-Celled Cow. 8 p. 10¢.

- C. General Biological Supply House, (The). 761-763 East 69th Place, Chicago, Illinois.

1. Turttox Service Leaflets:

- #13. Rearing the Silk Worm Moth.
- #16. The Culture of Planaria and Its Use in Regeneration Experiments.
- #32. Culturing the Common Molds.
- #34. Insect Metamorphosis.
- #43. Embryology in the High School Biology Course.
- #44. Growing Fern Prothallia in the Laboratory.

2. Turttox News. Free.

- D. U. S. Superintendent of Documents, Washington, D. C.

1. Agriculture Bulletins:

- #1508. Sterility of Oats. 1922. 8 p. il. 5¢. (A 1.3:1058).
- #1195. Sterilities of Wild and Cultivated Potatoes With Reference to Breeding From Seed. 1924. 32 pp. il. 10¢. (A 1.3:1195).

2. Agriculture Circulars:

- #79. Application of Statistical Methods to Seed Testing. 1929, 18 pp. 5¢. (A 1.4/2:79).
- #480. Rules and Recommendations for Testing Seeds. 5¢. 1929. 18 pp. il. (A 1.4/2:480).

- #502. Sweet Potato Propagation and Trans-planting Stories. 1938. 16 pp. 5¢. (A 1.4/2:502).
- #525. Artificial Insemination of Chickens and Turkeys. 1939. 13 pp. 1l. 5¢. (A 1.4/2:525).
- 3. Agriculture Leaflets:
 - #1. Ways to Save Young Livestock. 4 pp. 4 il. 1936. not in 1941 price lists.
 - #19. Improving Dairy Herds. 1928. 4 pp. 5 il. not in 1941 price lists.
 - #51. Improving Cattle in Areas Freed of Ticks. 8 pp. 1l. 5¢. (Not listed in 1940 catalog).
 - #93. Red Clover Seed Production in the Inter-Mountain States. 1932. 8 pp. 1l. 5¢. Not listed in 1940 catalog.
 - #172. Why Fruit Trees Fail to Bear. 1939. 5 pp. 5¢. (A 1.35:172).
- 4. Agriculture Technical Bulletins:
 - #100. Respiration of Sorghum Grains. 1928. 16 pp. 1l. 5¢. (A 1.36:100).
 - #616. Reproductive Cycle of the Coyote. 1938. 12 pp. 1l. 10¢. (A 1.36:616).
 - #655. Dormancy in Lettuce Seed and Some Factors Influencing Its Termination. 1938. 20 pp. 5¢. (A 1.36:655).
- 5. Agriculture Yearbook Separates:
 - #1084. Seed Samples of Introduced Plants Make Big Collection. 5¢. (A 1.10/a:1084).
- 6. Bureau of Fisheries Documents:
 - #974. Growth and Degree of Maturity of Chinook Salmon in the Ocean. 35¢. (C 6.3/a:Sa35/17).
 - #1103. Annual Growth of Fresh-Water Mussels. 15¢. (C 6.3/a:M975/12).
 - #1056. Propagation of Pond Fishes. 5¢. (C 6.1:929/app.2).
- 7. Farmers' Bulletins:
 - #849. Capons and Caponizing. Rev. 1932. 12 pp. 1l. 5¢. (A 1.9:849).
 - #948. Rag-Doll Seed Tester, Its Use in Determining What Ears of Corn Are Fit For Seed. 5¢. (A 1.9:948).
 - #1134. Castrating and Docking Lambs. Rev. 1935. 12 pp. 1l. 5¢. (A 1.9:1134).

- #1332. Seed Potatoes and How to Produce Them. Rev. 1936. 14 pp. 1l. 5¢. (A 1.9:1332).
- #1339. Red Clover Culture, With Notes on Insect Enemies of Red Clover. 5¢. (A 1.9:1339).
- #1357. Castration of Hogs. Rev. 1930. 6 pp. 1l. 5¢. (A 1.9:1357).
- #1369. Bridge Grafting. 5¢. (A 1.9:1369).
- #1412. Care and Management of Dairy Bulls. Rev. 1938. 27 pp. 1l. 5¢. (A 1.9:1412).
- #1436. Why Potatoes Run Out. Rev. 1927. 21 pp. 1l. 5¢. (A 1.9:1436).
- #1538. Incubation and Brooding of Chickens. 1928. 28 pp. 1l. 5¢. (A 1.9:1538).
- #1567. Propagation of Trees and Shrubs. Rev. 1932. 52 pp. 1l. 5¢. (A 1.9:1567).
- 8. Journal of Agricultural Research:
 - Length of Dormant Period in Cereal Seeds. 1936. 26 pp. (A 1.23/a:C334/10).
 - Effect of Failure of Pollination on Composition of Corn Plants. 1934. 9 pp. 5¢. (A 1.23/a:C814/71).
 - Macrosperogenesis and Embryo-Sac Development in *Euchlaena Mexicana* and *Zea Mays*. 1938. 5¢. (A 1.23/a:T265/3).
 - Seed Germination in *Lobelia* With Special Reference to the Influence of Light in *Lobelia Inflata*. 1936. 5¢. (A 1.23/a:T551/29).
 - Composition of the Various Parts of the Oat Plant at Successive Stages of Growth, etc. 1939. 1l. 5¢. (A 1.23/a:Oa8/29).
 - Development of the Oat Panicle. 1937. 1l. 5¢. (A 1.23/a:Oa8/25).
 - Chemical Elimination of Saprophytes During Laboratory Germination of Seed Peas. 1939. 5¢. (A 1.23/a:P32/24).
 - Methods of Controlling Pollination in Pecans. 1933. 10 pp. 1l. 5¢. (A 1.23/a:P331/13).
 - Germination of Seed of Farm Crops in Colorado After Storage for Various Periods of Years. 1933. 8 pp. 5¢. (A 1.23/a:-Se32/16).

- Germination Studies on Aged and Injured Seeds. 1936. 14 pp. 1l. 5¢.
(A 1.23/a:Se32/18).
- Anthesis, Pollination, and Fertilization in Sorghum. 1934. 14 pp. 1l. 5¢.
(A 1.23/a:So68/17).
- Reproductive Efficiency of the Albino Rat Under Different Breeding Conditions. 1940. p. 847-854. 5¢.
(A 1.23/a:R186/4).
- Growth of the Hen's Ovum. 1939. p. 875-894. 5¢. (A 1.23/a:H36/6).
- Unfruitfulness in the Tomato Caused by Mole Sterility. 1939. p. 621-630. 1l. 5¢.
(A 1.23/a:T591/26).
- Classification of Chick-Embryo Positions at Different Ages and Malposition as a Cause of Mortality. 1935. 9 pp. 1l. 5¢. (A 1.23/a:C432/28).
- Time Factor in Fertilization and Embryo Development in Sugar Beet. 1934. 21 pp. 1l. 5¢. (A 1.23/a:So32/34).
9. Public Health Reprints:
#1495. The Relation Between Cell Growth and Division in Amoeba Proteus.
(T27.6/a:1495).
10. Public Health Service, Educational Publication:
#7. High Schools and Sex Education. 1939. 110 pp. 20¢. (FS 2.20:7).
11. Venereal Disease Pamphlets:
#7. Problem of Sex Education in Schools. 1934. 16 pp. 1l. 5 ¢. (T 27.20:7).
#59. Wonderful Story of Life, A Parent's Talks With Children Regarding Life and Its Reproduction. 1937. 19 pp. 10¢. (T 27.20:59/2).
#83. You and Your Boy. 5¢. (T 27.20:83).
12. Wildlife Circular:
#4. Pseudopregnancy in Domestic Rabbits. 1940. 13 pp. 1l. 5¢. (I 49.16:4).
- E. Wild Flower Preservation Society, Inc. (The).
3740 Oliver Street, Washington, D. C.
- Price list of aids. Free.
Sample packets of literature of Wild Flower Study, Cultivating, and Conservation. 10¢ each. 3 for 25¢.

CHAPTER VIII

UNIT 7

GROUPING OF ORGANISMS

BIOLOGY

Unit 7.

Time: 25 days.

GROUPING OF ORGANISMS

PLAN

DayMethod

1 Pretest for Unit 7.

 (See Plan for Unit 1.)

Presentation.

 The presentation in this unit could well consist of a short nature walk.

Distribute the duplicated copies of the Outline of the Unit and Suggested Activities.

Supervised study for the remainder of the period.

Feed the animals in the aquarium and the terrarium.

2 Supervised study.

 Examine the Outline of the Unit as a guide for surveying the data included in this unit.

 Have a diversified collection of plants and animals present in the laboratory. The regular classroom aquaria and terraria

can be supplemented with forms kept in suitable cages. Many of the spring flowers can be potted for this purpose.

3 Supervised study.

Continue with the examination of the Outline of the Unit.

Secure a live fish 8 or 10 inches in length for Suggested Activity #11. It can be kept in an improvised container should there be no aquarium tank available. A constant supply of fresh water will be necessary to keep it alive. This can be supplied by keeping the container in a sink or over a drain near a faucet. Fresh water can be brought to the tank through a hose. A constant water level can be maintained by adjustment of the faucet and through the use of a siphon. (See Miller and Blaydes for the construction of an automatic siphon).

4 Supervised study.

Continue with the examination of the Outline of the Unit.

Check to see that the keys, plants, and animals necessary for the next day's discussion are available.

Feed the animals in the aquarium and the terrarium.

5 Class discussion.

Purpose: To acquaint the pupils with binomial nomenclature.

Discuss the elementary phases of the subject. Follow some common plant and animal through its various divisions. Discuss the keys

that are available for accurately identifying some specimens. Identify some common plant or animal by means of one of the keys.

Supervised study for the remainder of the period.

Check the route for the field trip for the next day.

6 Field trip.

Purpose: To observe the habits and to learn to identify as many as possible of the trees common to this area.

Proceed to examine and identify as many as possible of the trees encountered on the walk.

Each pupil should keep accurate field notes and turn them in at the end of the trip. These are to be examined and returned at the next meeting of the class.

Collect field notes.

Feed the animals in the aquarium and the terrarium.

7 Return the field notes to the pupils.

Supervised study. Work on the Suggested Activities.

Review field notes on trees common to this area.

8 Supervised study.

Work on the Suggested Activities.

Evaluation.

Have available a pupil self-test on the identification of the trees common to this area that were identified on the last field trip.

Arrange to have at least one specimen of a common flower and enough of two additional flowers for each member of the class for the demonstration on plant identification at the next meeting of the class.

9 Class demonstration.

Purpose: To discuss some of the keys used to identify plants and to demonstrate their use on a common plant.

Demonstrate the use of the key by identifying some common plant. Distribute a second plant. Identify this together. Distribute a third plant. This one should be attempted by the individual pupils.

Post a list of the pupils in the order of their responsibility for the class project in Suggested Activity #3.

Check a route to collect spring flowers. Permission should be obtained from the property owners. Remember that it is a violation of the law to pick or remove plants from areas adjacent to certain highways.

Supervised study for the remainder of the period.

Feed the animals in the aquarium and the terrarium.

10 Field Trip.

Purpose: To observe the habits of spring flowers and to collect those common to this area.

Collect specimens of the flowers found on the walk. A trowel is useful in digging up the roots of the plants. Whenever it is practical the whole plant should be brought in. Emphasize conservation by picking or digging up only the minimum needs of the class. One specimen of each flower will be sufficient for 6 or 8 pupils. Once a plant has been identified, emphasis should be placed on studying it in its habitat without removing it. A vasculum can be improvised from any container that is easily carried. Specimens will be in better condition and more easily recognized if they are wrapped in sheets of newspaper. Each should be given some identifying mark and recorded in the field notes with the data concerning its habitat.

Arrange the specimens to preserve their naturalness for the next day's examination. This can be done by placing them in water in suitable containers. Plants that were brought in with their roots intact should be dampened or immersed without removing the protective newspaper.

Collect the field notes.

-
- 11 Return the field notes to the pupils.

Ask each pupil to bring to class a small wide-mouthed jar equipped with a tight-fitting lid. The small mayonnaise jars make satisfactory killing bottles.

Check supplies and equipment necessary for making the killing bottles, carbon tetrachloride, cotton, blotting paper, and scissors.

Supervised study.

Examine and identify as many as possible of the spring flowers collected on the field trip.

Feed the animals in the aquarium and the terrarium.

12 Class demonstration.

Purpose: To demonstrate the preparation and use of an insect killing bottle and equipment used in insect collecting.

Prepare killing bottles for members of the class that brought their bottles. The safest and easiest type to make is that using carbon tetrachloride. The bottom of the bottle should be covered to a depth of one-half to three-quarters of an inch with cotton. On top of this put several layers of heavy blotting paper cut to fit the inside shape of the bottle. The cotton should be thoroughly soaked with the liquid. The cap should be kept tightly closed.

Supervised study.

Work the remainder of the period on the Suggested Activities.

13 Evaluation.

Have available a pupil self-test on identification of the spring flowers identified on the last field trip.

Supervised study.

Work on the Suggested Activities.

Check the equipment for the discussion on herbariums for the next meeting of the class.

Ask pupils to inquire about securing binoculars and field glasses to use on the bird walk (16th day).

14 Class demonstration.

Purpose: To discuss and demonstrate methods and equipment used in the herbarium and to stimulate an interest in a classroom herbarium.

Demonstrate presses, absorbent materials, pressed specimens, labeling, attaching to paper, preserving, and displaying. Arrange and place some flowers in the press.

The department that does not own its own press can often borrow one from the library. Suitable presses can be made in the Industrial Arts department of the school. Books or other heavy objects may be stacked on top of the materials being pressed. Regular blotters are superior to any improvised materials. Acceptable results can be obtained by placing the plant to be pressed on a firm surface covered by several thicknesses of newspaper spread on a sheet of cardboard carton. The plant is covered with a thickness of newspaper and then carton, newspapers, plant, newspapers, carton, and so on until a practical height has been reached. This can be compressed in a press or by means of weights. The material being pressed should be suspended over a stove, a radiator, or a hot air vent as heat is necessary to prevent fermentation and discoloration of the plants. Data concerning the identity of the plant should be placed with the plant in the press.

A permanent label should be attached to the herbarium sheet. This is generally placed in the lower right-hand corner. It should contain the scientific name of the plant, common names, notes concerning the habitat, date collected, and collector's name.

The shattering of the leaves from the stems of plants such as spruce, hemlock, and fir can be prevented by first preserving the specimens in the following solution until

the leaves return to their normal color: glycerin 100 cc., grain alcohol (50 per cent) 100 cc., formalin 5 cc., glacial acetic acid 5 cc., and one lump of copper sulfate about the size of one's fingertip. After a week or 10 days, or when the leaves return to a more or less normal green color, the specimens should be carefully rinsed and then may be dried in the usual way.

Dried specimens should be poisoned before attaching to the herbarium sheets. This may be done by painting them with a solution of 70 per cent grain alcohol or ordinary rubbing alcohol saturated with mercuric chloride. The solution should be painted on the specimen with a paint brush to avoid any danger to the user.

Specimens may be attached to the herbarium sheet by glue or transparent mending tape.

Supervised study for the remainder of the period.

Feed the animals in the aquarium and the terrarium.

15 Supervised study.

Work on the Suggested Activities.

Check site for observation of bird life for next meeting of the class.

Arrange to have a bird in the classroom for the next week or 10 days. Generally a canary can be brought from home by one of the pupils. Pigeons are easily obtained and will get along nicely in a pen.

16 Field trip. Purpose: To observe the bird-life of this area.

Select some locality and observe the bird-life that frequents it. In most cases it is better for the novice to observe the birds that come to a particular area rather than to attempt to cover a large territory. Binoculars or field glasses assist in making the identification more positive.

Established feeding stations serve as excellent places for this type of work.

Field notes should be kept for each bird that is observed. These should include the name of the bird, data concerning its behavior, and characteristic appearance.

Collect the field notes at the end of the trip.

Feed the animals in the aquarium and the terrarium.

-
- 17 Return the field notes to the pupils.

Supervised study.

Work on the Suggested Activities.

- 18 Evaluation.

Have available a pupil self-test that will test his ability to identify the birds observed on the bird walk.

Supervised study.

Work the remainder of the period on the Suggested Activities.

- 19 Make assignment of the Suggested Activities for the oral presentation (21st day).

Supervised study.

Work on the Suggested Activity assigned for the oral presentation.

Feed the animals in the aquarium and the terrarium.

20 Visual aids.

Show one of the moving pictures from the list at the end of the unit.

Supervised study.

Work the remainder of the period on the Suggested Activities.

21 Distribute the pupil self-test.

(See the Plan for Unit 1).

Oral presentation of assigned activities.

Each pupil presents orally one or more of the activities assigned from the list of Suggested Activities. The number assigned to each pupil should be such that all those attempted by the class will be covered in the discussion. (See Plan for Unit 1).

Feed the animals in the aquarium and the terrarium.

22 Continue with the oral presentation and criticisms.

Supervised study for the remainder of the period.

23 Summary exercise.

Without books, notes, or other aids the pupil should attempt to represent the relative importance and the interrelationships of the ideas included in this unit. (See Plan for Unit 1).

24 Evaluation of the Unit.

(See the Plan for Unit 1)

Score and discuss the tests.

25 Clean up, check in, and store equipment for the next school year. Inventory equipment and supplies.

Dispose of the laboratory plants and animals. Dismantle the terrarium and the aquarium. Many of the plants and animals can be left with the pupils through the summer vacation. The common forms should be liberated.

Return all library and reference books as well as any other equipment belonging to other departments.

See that lists of supplies and equipment needed for the next school year are in the hands of the proper official.

Crate all damaged equipment that is to be sent to the supply house for repair.

BIOLOGY

Unit 7.

Time: 25 days.

GROUPING OF ORGANISMS

Objectives:

1. To develop an understanding of the fact that all known living organisms have been classified.
2. To develop an appreciation for the necessity of some scheme of classification.
3. To understand the system of "binomial nomenclature" and its terminology.
4. To learn to identify some of the more common plants and animals.
5. To become acquainted with the more important plant and animal groups by studying such details as economic importance, things of interest concerning them, and avocational possibilities.

Outline of the Unit:

- I. Why Is It Necessary to Have a System of Classification?
 - A. The great number of known species of organisms.
 1. 250,000 plants.
 2. 1,250,000 animals.
 - B. The problem of new species.
 - C. Common names are inaccurate and confusing.
 1. Coos Bay Myrtle trees (*Umbellularia californica*) which is a laurel tree and not a myrtle.
 2. Empire clams (*Schizothaerus nuttallii*) which has as many common names and "stories" about its "plantings" as there are bays between Alaska and South America.

3. "Ground hog" may apply to different animals in different areas.
4. According to one authority the common foxglove (*Digitalis purpurea*) is known by seventy-one common names.

II. What Has Been Accomplished in Creating an Orderly System for Classification of Organisms?

A. Early history of taxonomy.

1. Aristotle (384-322 B.C.) received specimens from the conquests of Alexander the Great. Identified about 500 plants and a like number of animals.
2. Pliny (23-79) was able to identify many more species.
3. Linnaeus (1707-1777), a Swedish scientist, organized system of classification of plants and animals which in its general plan is in use today.

B. Structure is used as the basis for classification.

1. Group organisms according to their natural relationship.
 - a. Bacteria and other small forms are often judged by ability to cause certain chemical change or disease.
 - b. Large organisms are classified by the structures that are found in them. It is the belief that the same structures show relationship.
 - c. Recently scientists have resorted to chemical tests to determine relationship.
2. All animals with backbones are called vertebrates.
3. All animals with feathers are called birds.
4. All animals with a body covering of hair and having glands that secrete milk are called mammals.

C. The classification system.

1. The first division of all living things is into the plant and animal kingdoms.

2. Each kingdom is divided into groups called phyla.
3. The phyla are divided into smaller groups known as classes.
4. Each class is further divided into orders.
5. The orders into families.
6. The families into genera.
7. Each genera is divided into species.
8. The complete scheme looks like this:

Kingdom.
 Phyla.
 Class.
 Order.
 Family.
 Genera.
 Species.

D. Difficulties encountered in classification.

1. Absence of sharp lines of demarcation between groups.
2. Great variation found in external structures within a specie.

E. The naming system.

1. Each plant or animal specie is given a scientific name.
 - a. Composed of the names of the genus and the specie of which it is a member.
 - b. Names are always in Latin because it is a universal language understood by the scientists all over the world.
 - c. The specific name (name of the specie) is generally descriptive of the organism. It may sometimes name the discoverer or some other person to which the classifier wishes to pay homage.
2. This method is known as "Binomial Nomenclature."
3. The scientist who names the species also writes a description of the distinguishing characters of that particular organism.
4. Confusion that arises in writing generic names.
 - a. When the generic name is also used as the common name; i.e., Rhododendron, Azalea, Hydrangea, Magnolia; when using such terms in a strictly scien-

tific manner, capitalize and italicize.

- b. When using a generic name repeatedly to identify an organism or group, capitalize and drop the italics.
 - c. Where generic names are used as familiar common names with no attempt to be scientific drop both the capital and the italics.
5. The variations and discrepancies found in taxonomic works are often confusing.
- a. The lack of a "type specimen."
 - b. The recognized differences in the ability of people to describe the same object.
 - c. Slowness of progress in this type of work.

F. Practical uses of taxonomy.

- 1. Vocational.
 - a. The basis of systematic biology.
 - b. Authorities on identification are in demand at zoos, museums, botanical gardens, and aquariums.
 - c. Government positions are open for plant and animal authorities.
- 2. Avocational.
 - a. "Every person needs a hobby."
 - b. Healthful recreation because it gets its "fans" out with nature.
 - c. Benefits derived from belonging to taxonomic organizations such as the American Fern Society.

III. What Is There of Interest in the Plant Kingdom?

- A. Thallophytes, the simplest forms of plant life. Have a body known as a thallus; no stems or leaves with the thallus varying from one to many cells.
 - 1. Algae, water-loving plants that contain chlorophyll and are able to make their own food.
 - a. Classes of algae.
 - (1. Blue-green algae (Cyanophyceae) found in fresh water, brackish

- water, marine, and in moist climates on damp objects such as rocks and trees. Simplest of the algae:
- (a. Gloeocapsa, colony of one-celled plants.
 - (b. Nostoc, filamentous, necklace-like chain.
 - (c. Oscillatoria, filamentous, filaments oscillate.
- (2. The green algae (Chlorophyceae) called "green algae" because of their characteristic grass-green color. They assume a wide range of forms, structures and life histories.
- (a. Protococcus, colonial, composed of spherical cells. Forms the green sheen that appears on the north sides of moist objects such as trees, fence posts, and banks.
 - (b. Spirogyra, a green algae that grows only in fresh water. It is one of the free floating plants commonly known as "pond scum." It may be distinguished from most other filamentous greens by its slippery feeling, due to a gelatinous outer layer of the cell wall.
 - (c. Cladophora, a green algae that occurs both in fresh water and marine. Characterized by each cell having many nuclei. Has branched filaments that display apical growth.
- (3. The brown algae (Phaeophyceae) with few exceptions are marine. They include the large kelps which are observed bobbing up and down in the ocean and are often washed on shore. They grow best in cold water. They are anchored by hold-fasts and have bladders on the free end enabling them to float.
- (a. Postelsia, a common brown algae that is observed when one goes

to the seashore. It grows on the rocks and has been descriptively named, "the palm tree of the sea."

- (b. *Fucus*, common brown algae growing on the rocks farther up the shore. It has two finger-like branches. During reproductive seasons these branches are covered with dark-colored bumps.
 - (c. *Macrocystis*, reportedly the largest of plants. It has been reported to have "reached a length of 200 meters."
 - (d. *Nerocystis* has been known to grow to a length of 120 feet. This plant with the *Macrocystis* form the extensive kelp beds off this coast.
- (4. The red algae. (*Rhodophyceae*). Mostly marine forms that are noted for their graceful forms and beautiful colors. These algae reach their greatest development in the warmer waters of the ocean.
- (a. *Ptilota*, a very fine brown algae with feathery tips.
 - (b. *Corallina*, of two general forms, those that have calcareous blades and those that form encrustations on the rocks. This algae is the one that transforms the tide-pools into the beautiful pink color effects that are beyond the powers of description.
- (5. The diatoms. (*Bacillariaceae*). These are one-celled algae which, by means of a gelatinous substance, are frequently held together in bands or masses. The membrane is made up of silica which makes it rigid and hard and bears minute definite markings. It is always composed of two parts of valves, which may be separated from each other.

- (a. Naviculae, a boat-shaped diatom, free swimming.
- b. Importance of algae.
 - (1. Food for fish and other organisms.
 - (2. Used as food by the people of some countries.
 - (3. Preparation of agar used in culture media.
 - (4. Gathered and spread on the land to add fertility.
 - (5. Diatoms produce "infusorial earths" used as polishing powders and as filters.
 - (6. Extracts supposedly useful in correcting iodine deficiencies.
- 2. Fungi, a large and varied group that are conspicuous by the absence of chlorophyll. The body of a fungous plant is composed of threadlike filaments called hyphae. A mass of hyphae is called a mycelium.
 - a. Classes of fungi.
 - (1. Bacteria. (Schizomycetes). Strictly unicellular organisms without definite nuclei. Multiplications are entirely by fission.
 - (a. Bacteria are found everywhere from high altitudes to a depth of six feet or more in the soil.
 - (b. Their size is measured in terms of a micron (Mu) or 1/25,000 of an inch. They vary from 1/5 to 1/2 Mu to 4 or 5 x 50 or 60 Mu.
 - (c. Bacteria multiply very rapidly, some as often as every 20 minutes. If one of these would maintain its maximum rate for 24 hours one bacterium would produce 16 followed by 14 zeros. This is equal to 25,000 times the number of seconds since the birth of Christ.
 - (d. Form types of bacteria.
 - (1) Cocci or Spherical.
 - (2) Bacilli or rod-shaped.
 - (3) Spirilla or spirals.

- (2. Slime fungi. (Myxomycetes).
Plants that during the vegetative part of their existence resemble the simplest of animals. Their delicate structure and brilliant coloring make many of them remarkably beautiful.
- (3. The algal fungi. (Phycomycetes).
The distinguishing characters of this fungi are: the hyphae are lacking in crosswalls, non-sexual spores are found in the sporangia, and zygospores are formed by conjugation.
 - (a. "Saprolegnia is a water mold that appears as white coating of radiating lines about the bodies of dead or living insects and fish." This mold may be easily secured for study by placing dead flies in stagnant water.
 - (b. Rhizopus. (Bread mold). May appear on bread, potatoes, pears, and apples as a thick patch of hyphae studded with dotlike fruiting bodies. It gives off a musty odor. Grows best in a warm moist, dark place.
- (4. The sac fungi. (Ascomycetes).
These fungi are characterized by septate hyphae and by fruiting body either closed or open that bears sexual spores in sac-like cases called asci.
 - (a. Yeasts are most readily obtained from commercial yeast cake. They secrete enzymes that attack sugar in solution, changing it to alcohol and carbon dioxide.
 - (b. Peziza is a common cup-shaped fungus which grows as a parasite on decaying vegetable matter. The cups may be red, white, yellow or pink.

- (c. Sclerotinia resembles *Peziza* but is of great economic importance.
 - (d. Powdery mildews attack higher plants.
 - (e. Blue-green mold is a saprophyte as well as a parasite. Food rotting molds.
 - (1) *Penicillium*.
 - (2) *Aspergillus*.
 - (f. Lichens are composed of algae enclosed in a mass of fungus hyphae.
 - (1) Crustose or crust-like forms.
 - (2) Fruticose or erect or pendant and branching forms.
 - (3) Foliose or flat forms.
- (5. The club fungi. (*Basidiomycetes*) are characterized by septate hyphae and reproductive spores borne in groups of four.
- (a. Smut is a destructive parasite of cereals especially wheat and corn.
 - (b. Rusts are destructive parasite plants that attack a range of other plants. They have a complicated life cycle demanding two hosts and five stages of development.
 - (c. Fleshy fungi such as mushrooms, bracket fungi, tooth fungi (coral fungi), puff balls, and birds' nest fungi.
- b. Importance of fungi.
- (1. Bacteria.
 - (a. Pathogenic--discussed in Unit 4.
 - (b. Non-pathogenic.
 - (2. A slime fungi (*Plasmodiophora brassicae*) causes Club Root of cabbage.
 - (3. Alga fungi.
 - (a. *Saprolegnia* (water mold) causes great damage to the fish in fish hatcheries.
 - (b. White rust of mustard (*Albugo Candida*).

- (c. Rhizopus destroy foodstuff.
- (4. The sac fungi.
 - (a. Yeasts.
 - (b. Sclerotinia causes brown rot of stone fruits, lettuce drop, and stem rot of clover.
 - (c. The powdery mildews.
 - (d. The blue-green molds.
 - (1) Penicillium.
 - (a) Penicillium Roqueforti.
 - (b) Penicillium Camembertii.
 - (2) Aspergillus.
 - (e. Lichens.
 - (1) The reindeer moss serves as food for the reindeer in the far north.
 - (2) Litmus and other pigments are produced from lichens.
 - (3) Some are used for food by man and domesticated animals.
- (5. The club fungi.
 - (a. Smuts do untold damage to cereals.
 - (b. Rusts damage a wide range of plants.
 - (c. Fleshy fungi produce edible forms as well as Amanita, the well-known genus of the deadly poisonous mushrooms.

B. Bryophytes. This division of plants is in many respects more complicated in structure than the Thallophytes. It includes two groups, the liverworts (hepaticas) and the mosses (musci). It has a distinct alternation of generation and the conspicuous form of the plant is the gametophyte or sexual plant upon which the sporophyte or asexual plant is dependent.

- 1. Classes of bryophytes.
 - a. Liverworts.
 - (1. Lunularia, a dichotomously-branched thallus form.
 - (2. Marchantia is characterized by leaves with midribs.

- (3. *Pellia* looks much like *marchantia*.
- (4. *Porella* is an example of a leafy liverwort.
- (5. *Anthoceros* is an example of a horny liverwort.
- (6. *Scapania*, another leafy liverwort.

b. Mosses.

- (1. *Minium* is recognized by the large roundish, tongue-shaped green leaves.
- (2. *Polytrichum* is also known as the hair-cap or pigeon-wheat moss. It is distinguished by the long, dark green, needle-like leaves that are sheathed at their bases.
- (3. *Hypnum*s are slender, prostrate or creeping mosses with irregular heads. These are the most common mosses.
- (4. *Sphagnum* mosses are characterized by their pale gray-green color, and by the arrangement of its branches which either grow straight out from the stems or are pendant. It grows in bogs, swamps, and extremely wet soil.

2. Compared with the thallophytes the bryophytes have very little importance.

- a. *Sphagnum* (*Sphagnum* moss) is found in Coos Bay.

C. Pteridophytes. This division comprises the most highly developed flowerless plants. Its members differ from the bryophytes in that they have a large, conspicuous sporophyte consisting of a stem, roots, and leaves.

1. Classes of pteridophytes.

- a. Ferns (*Filicineae*). Ferns have a distinct alternation of generations.

- (1. The Licorice Fern (*Polypodium occidentale*s). also (*Polypodium vulgare*).
- (2. The Leather Leaf Fern (*Polypodium scolieri*).
- (3. The Sword Fern (*Polystichum munitum*) our common fern that grows in shady woodlands. It is gathered

and used for decorations. It is sometimes called the "Christmas Fern."

- (4. The Shield Fern includes several common species.
 - (a. Male fern (*Dryopteris filix-mas*).
 - (b. Wood fern (*Dryopteris spiculosa*).
 - (c. Coastal wood fern (*Dryopteris arguta*).
 - (d. The oak fern (*Dryopteris linnaeana*).
- (5. The Deer Fern (*Etrutheopteria spicant*).
- (6. The Maiden Hair Fern (*Adiantum pedatum*).
- (7. The Bracken Fern (*Pteridium aquilinum* var. *pubescens*). Sometimes called (*Pteris*). This is our common hillside fern.

b. Horsetails (*Equisetineae*). This class is represented by but a single genus (*Equisetum*) of which there are about thirty species. A South American horsetail (*Equisetum giganteum*) may grow to a height of thirty feet.

- (1. *Equisetum arvense* is the common specie found growing along the banks of streams and ditches. The leaves are without chlorophyll so all food making is carried on in the stems.

c. Club Mosses (*Lycopodineae*). The remaining species of this class represent the most ancient Pteridophytes. Fossil remains show that during the coal-forming period they were the largest plants. Today their growth is restricted to the northern woods and the tropics. Some of the more delicate members of this group are grown in greenhouses for decorative purposes.

- (1. *Lycopodium*.
- (2. *Selaginella*.

2. Importance of the Pteridophytes.

- a. Some ferns and club mosses are valuable for decorative purposes.

- b. Horsetails, commonly known as scouring rushes, have been used by people to scour their utensils. They were especially good for this purpose because there is a large amount of silica imbedded in their outer epidermis. Of recent years they have been employed by geologists as "indicators" of the presence of certain metals in the soil.

D. Spermatophytes. These plants are distinguished from all other plants by the fact that they bear seeds and by the complexity of the practically independent sporophyte.

1. Subphyla of the spermatophytes.

- a. Gymnosperms or conifers are trees with needle-like leaves.

- (1. Pines (*Pinus*) are all evergreen trees and, with one exception, bear their leaves in bundles of two to five.
- (2. *Pseudotsuga*. These are not true firs. The leaves are distinctly spirally arranged and are not borne on woody projections.
 - (a. Douglas fir (*Pseudotsuga taxifolia*).
- (3. Spruce (*Picea*).
- (4. Hemlock (*Tsuga*).
- (5. Firs (*Abies*).
- (6. Cedars.
 - (a. Western Red Cedar (*Thuja plicata*).
 - (b. Port Orford Cedar (*Chamaecyparis lawsoniana*).

- b. Angiosperms.

- (1. Monocotyledons, plants with one seed leaf comprising about forty-five families.
 - (a. Grass family.
 - (b. Lily family.
 - (c. Palm family.
 - (d. Orchid family.
- (2. Dicotyledons, plants with two seed leaves.

- (a. Deciduous trees.
 - (1) Oregon Ash (*Fraxinus* *aregana*).
 - (2) Maples (*Acer*).
 - (3) Dogwood (*Cornus*).
 - (4) Oaks (*Quercus*).
 - (5) Madrona (*Arbutus*).
 - (6) Cottonwood (*Populares*).
 - (7) Alders (*Alnus*).
 - (b. Mustard family.
 - (c. Legume family.
 - (d. Rose family.
 - (1) Berry-type fruits.
 - (2) Stone fruits.
 - (3) Pome or core fruits.
 - (e. Composites.
 - (f. Mint family.
 - (g. Nightshade family.
 - (h. Heath family.
2. Value of spermatophytes.
- a. As food for man and other animals.
 - b. Industrial plants.
 - (1. Produce fibers.
 - (2. Wood.
 - (3. Rubber.
 - (4. Plants that produce oil.
 - c. Other uses of plants.
 - (1. Condiments and seasonings.
 - (2. Stimulants.
 - (3. Medicinal uses of plants.
 - (4. A great many plants contain substances called alkaloids, many of which are powerful poisons.
 - (5. Plants prevent erosion.
 - (6. Protection and cover for wild life.
 - (7. Some plants are injurious to man.
 - (a. Poison oak (*Rhus diversiloba*).
 - (1) Recognition.
 - (2) Treatment.
 - (b. Nettles (*Urtica Lyalli*).

IV. What Is There of Interest in the Animal Kingdom?

A. Protozoa. Microscopic one-celled animals.

- 1. Common examples that will appear in a protozoa aquarium.

2. Importance of protozoa.
 - a. Diseases of man produced by protozoa.
 - b. Diseases of animals produced by protozoa.
 - c. Foraminifera.
 - d. Chalk.
 - e. Feed on bacteria.
 - f. Their main importance is that they serve as food for larger organisms.
- B. Porifera. (sponges) Most porifera are marine but a few live in fresh water. They are usually attached and stationary in the adult stage.
1. Classes of sponges.
 - a. Calcarea, with spicules of carbonate of lime.
 - b. Hexactinellida, with triaxon spicules of silicon.
 - c. Demospongia, usually with spongin, or with both spicules and spongin.
 2. Structure of a typical sponge.
 3. Importance of sponges.
- C. Coelenterates. All of these animals have a body wall consisting of two layers of cells between which is a non-cellular substance, the mesoglea. They are radially symmetrical animals with single body cavities. All have tenacles and stinging cells.
1. Classes of Coelenterates.
 - a. Hydrozoa. This class includes the freshwater polyps such as the hydra, the small jellyfish, and the obelia, which is strictly a marine animal.
 - b. Scyphozoa. Most of the large jellyfishes are placed in this class.
 - c. Anthozoa. Includes the sea anemones and most of the stony corals.
 2. The hydra, a fresh-water gydrozoan.
 - a. Appearance.
 - b. Protective devices.
 - c. Food-getting habits.
 3. Importance of Coelenterates.

D. Worms. The worm belongs to four distinct phyla. It has a slender, elongated body which is bilaterally symmetrical. This means every worm has an anterior or head end, a posterior or tail end; a dorsal or top surface, and a ventral or bottom surface.

1. Representatives of phyla comprising the worm group.

- a. The rotifers (wheel worms) (wheel animalcules). Microscopic worms that gain name from their appearance under the microscope. Their ciliated head beats in a synchronized manner, creating the illusion that two wheels are rotating on the animal. They are of no importance except as food for larger organisms.
- b. The flatworms are unsegmented and have bilateral symmetry. They have three layers of cells (triploblastic). Food is taken in and waste is excreted through the mouth.
 - (1. Planaria.
 - (2. Tapeworm.
 - (3. The rubber worm (Carinella rubra), the long red worm that is often found in the tide pools at the seashore.
- c. The roundworms. These worms have a digestive tube with both a mouth and an anus. Their bodies contain a blood-like body fluid that is not confined to blood vessels.
 - (1. The hookworm. These are carried by the blood stream to the lungs where they do considerable damage. When mature they crawl into the windpipe and then into the throat. They are then swallowed and carried to the intestines where they make themselves fast and begin feeding on the blood of their host through the wound at the point of attachment.
 - (2. Gapeworm produces a disease called gapes in chickens.
 - (3. Trichina.

d. The segmented worms. These worms belong to the phyla Annelida and are characterized by having their bodies composed of segments. They display bilateral symmetry and dorsal-ventral as well as anterior-posterior differentiation.

- (1. The (Lumbricus terrestris) is our common worm and is characterized by a body composed of segments each of which, except the first and the last, bears four pair of appendages called setae.
- (2. The tubifex (Tubifex tubifex) is a reddish worm about one-half inch long that lives in a tube of its own manufacture on the muddy bottom of fresh or brackish water streams and ponds. Normally, its head is buried in the tube and the posterior end of its body protrudes and is kept waving constantly back and forth.
- (3. The pile worm, clam worm, (Nereis vexillosa) is the marine relative of the earthworm.

2. Importance of the worm group.

- a. Food for other animals.
- b. Flatworms parasitic in man and animals.
- c. Nematodes (roundworm) living on the soil and on the roots of plants.
- d. Nematodes parasitic in certain insect pests.
- e. Roundworms living as parasites in man and animals.
- f. Earthworm's value as a soil improver.
- g. Medicinal leeches.

E. Echinoderms. The members of this phylum are marine. They are sluggish bottom dwellers that are covered with a "spiny-skinned" epidermis.

1. Representative members of this phyla that one is apt to see on visits to the sea coast are:

- a. The starfish.
 - (1. The common starfish (Pisaster ochraceus) is found clinging to

the rocks and piles and in the tide pools. It appears in a variety of colors.

- (2. The red starfish (*Henricia leviuscula*), a small, reddish specie characterized by five, narrow, smooth rays.
 - (3. The twenty-rayed sunflower-starfish (*Pycnopodia helianthoides*).
 - b. Sea urchins, sea eggs, or sea porcupines, the animals inhabiting the tide pools commonly called "pin cushions."
 - (1. The common Pacific form along the Oregon coast is the purple urchin (*Strongylcentrotus purpurata*).
 - (2. The big red urchin (*Strongylcentrotus franciscanus*) is occasionally found along this course.
 - c. Sand dollars, sea biscuits (*Dendraster excentricus*) is a much flattened echinoderm. There is but one specie found on this coast.
 2. Importance of the echinoderms.
 - a. Scavengers of the ocean.
 - b. As food for man.
 - c. The starfish and the oyster growers.
 - d. The twenty-rayed starfish and the crab-fishermen.
- F. Mollusks. This phylum is very large and widely distributed and comprises the group of unsegmented animals in which the body is enclosed in a calcareous shell and has a muscular foot and mantle.
1. Representative animals comprising this phyla.
 - a. Clams and mussels.
 - b. Snails, fresh water, marine, and land; slugs.
 - c. Octopus, cuttle fish, and squid.
 2. Importance of mollusks.
 - a. Food for man.
 - b. Mother of pearl.
 - c. Pearls.
 - d. Scavengers.

G. Arthropods. This phylum contains a greater number of species than all the other phyla combined. They are characterized by being bilaterally symmetrical animals with segmented bodies, bearing paired and jointed appendages, and an exoskeleton of chitin.

1. Classes of arthropods.

a. Crustacea.

(1. Examples of crustaceans.

(a. Terrestrial.

(b. Aquatic.

(2. Examination of the crayfish.

(a. Food habits.

(b. Exoskeleton.

(c. Appendages.

(d. Eyes.

(e. Internal structures.

b. Arachnids.

c. Insects.

(1. Characteristics of an insect.

(2. Body parts of an insect.

(3. Respiration.

(4. Sense organs.

(5. Metamorphosis.

(6. Insect collections.

(7. Important orders of insects.

(8. First aid treatment of insect bites.

2. Importance of arthropods.

a. Food.

b. Scavengers.

c. Parasites on man and animals.

d. Poisonous to man and animals.

e. Insects of value to man.

f. Insects destructive to man's interests.

H. Chordates. Bilaterally symmetrical animals with an endoskeleton, a notochord, gill slits which connect the pharynx with the exterior, and a nervous system which is dorsal to the notochord.

1. Subphyla of the chordata.

a. Body soft and worm-like.

b. Body sac-shaped.

c. Body lance-shaped, firm and muscular.

d. Backboned animals (Vertebrata).

2. Characteristics of a vertebrate.
3. Classes of vertebrates.
 - a. Fishes (Pisces).
 - (1. Orders of fish.
 - (2. Fish common to this locality.
 - (3. Sense organs.
 - (4. External parts of a fish.
 - (5. Food getting.
 - (6. How a fish breathes.
 - (7. Famous game fish.
 - (8. Importance of fish.
 - b. Amphibians.
 - (1. Characteristics.
 - (2. Orders.
 - (3. Examples.
 - (4. Importance.
 - c. Reptiles.
 - (1. Characteristics.
 - (2. Orders.
 - (3. Examples.
 - (4. Poisonous reptiles of the United States.
 - (5. First-aid treatment for snake bites.
 - d. Birds (Aves).
 - (1. Characteristics.
 - (2. Orders.
 - (3. Adaptations to environment.
 - (a. Feathers.
 - (b. Feet.
 - (c. Bills.
 - (4. Courtship and mating.
 - (5. Incubation period.
 - (6. Migration.
 - (7. Interesting birds.
 - (8. Importance of birds to man.
 - (9. Destructiveness of birds.
 - e. Mammals.
 - (1. Characteristics.
 - (2. Orders.
 - (a. Egg laying mammals.
 - (b. Toothless.
 - (c. Pouched.
 - (d. Fish-like.
 - (e. Insect eating.
 - (f. Winged.
 - (g. Hoofed.
 - (h. Flesh-eating.
 - (i. Erect.

- (3. Interesting mammals.
- (4. Importance of other mammals to man.

V. What Has Nature to Offer in the Way of Interesting Avocations?

A. Photographing plants and animals in their natural habitat.

- 1. Telescopic lens.
- 2. Feeding stations.
- 3. Blinds.
- 4. Flash light and shutter tripping arrangements for night pictures.

B. Preparing wild plant calendars.

- 1. Place of observation.
- 2. Nature of habitat.
- 3. Date observed.
- 4. Additional remarks.

C. Cultivating wild flower gardens and ferneries.

D. Preparing collections.

- 1. Collecting technique.
- 2. Preservation.
- 3. Identification.
 - a. Terminology.
 - b. Use of keys.
 - c. Labels.
- 4. Suggested subjects.
 - a. Wild flowers.
 - b. Leaves.
 - c. Seeds.
 - d. Birds' nests.
 - e. Birds' eggs.
 - f. Marine algae.
 - g. Sea shells.
 - h. Fossils.

E. Taxidermy.

F. Microscopic hobbies.

- 1. Making permanent slides of interesting subjects.

2. Making diatom pictures.
3. Foraminifera displays.

G. Keeping an aquarium, herbarium, terrarium, or microcosm.

Suggested Activities:

1. Construct a chart using the following as column headings: plant and animal phyla, characteristics of each phylum, the more important classes comprising each phylum, and a list of the most common species composing each class.
2. Examine all of the demonstration animals and plants in the classroom. Place each in its correct phylum.
3. With the assistance of your instructor undertake a class project of identifying one new wild flower each day. Each member of the class should take his turn at bringing in a flower and being responsible for its identification.
4. Prepare a herbarium using the common spring flowers of your locality. Press, identify, and label each of your specimens.
5. Prepare a collection of leaves or wood specimens of the common trees of your locality.
6. If you are located within a reasonable distance from the coast, take a field trip to the beach. Consult a tide table and select a day and time that would allow you several hours of collecting and observation while the tide is at its lowest.
7. If you would enjoy doing so, make natural color paintings or crayons of some of the wild flowers common to this area.
8. Learn the scientific names for as many of the animals of your acquaintance as you can. A notebook record will be of material assistance.
9. Take a field trip over some route typical of the area. Observe the birds, collect wild

flowers, collect and note the habitat of insects, and compare the general condition of the plant life with its condition as noted on the previous trip. Turn in your notes at the end of the trip.

10. Examine the external parts of a typical insect. Sketch. Label such parts as legs, wings, eyes, feet, divisions of body, respiratory parts, and mouth parts.
11. Examine a fish. Sketch and label all the external structures. Describe in detail the function of each structure and how a fish is adapted to a life in water.
12. Examine a live bird, stuffed bird, bird skin, or bird chart. On an outline sketch block in all the areas that are useful in the identification of birds. Label these areas as well as all the external structures.
13. Discuss in detail how birds are adapted to flying. List wing, feet, bill, and leg adaptations, observed on local birds.
14. Start a project that will familiarize you with your local birds. It is recommended that you undertake to become familiar with at least a bird each day. Keep a list in your notebook of the birds you know along with notes on their identifying characteristics.
15. Make a study of the feeding habits of some local bird.
16. Construct and distribute for actual use: bird baths, bird houses and feeding stations. Be certain that they are protected from the cats. More enjoyment will be derived from this project if you place them where you can watch the activities of the birds.
17. With the aid of the Readers' Guide to Periodical Literature, select and brief a current article applicable to this unit.

18. Prepare a report on some topic associated with this unit. The following are offered as suggestions:
- a. The fishing industry in the Pacific Northwest.
 - b. Interesting methods of fish cookery.
 - c. Interesting facts about monkeys, baboons and apes.
 - d. Shell collecting on our Pacific beaches.
 - e. Carnivorous plants.
 - f. The Sequoias.
 - g. Interesting facts about the striped bass.
 - h. Some of the common marine algae.
 - i. Trees of Oregon.
 - j. Oyster culturing on the Pacific Coast.
 - k. Local birds of prey.
 - l. The life of James Audubon.
 - m. Audubon Society.
 - n. English sparrows in this country.
 - o. The life of Carolus Linnaeus.

Reference Books:

The following are numbers of books listed in Bibliography A that will prove to be helpful in the study of this unit:

1, 2, 3, 4, 5, 6, 10, 12, 15, 16, 21, 22, 24, 25, 26, 27, 28, 29, 30, 40, 42, 43, 44, 45, 46, 51, 52, 54, 58, 60, 61, 66, 67, 75, 79, 81, 82, 83, 84, 88, 90, 91, 95, 96, 99, 100, 102, 105, 111, 112, 113, 114, 115, 117, 118, 119, 122, 125, 126, 127, 132, 133, 134, 135, 144, 146, 149, 150, 151, 153, 154, 155, 156, 158, 159, 162, 168, 174, 177, 180, 181, 182, 184, 187, 190, 191, 192, 194, 200, 201, 208, 209, 223, 225, 226, 227, 228, 230, 232, 236, 237, 239, 243, 245, 246, 248, 250, 252, 254, 256, 264, 265, 266, 267, 268, 270, 271, 272, 274, 278, 289, 297, 299.

Visual Aids:

A. Charts.

1. Andersen-Balslev Insect Charts.
Beetles (#1. eleven figures).
Beetles (#7. eight figures).
Beetles (#8. ten figures).
Butterflies and Moths.
Fly and Mosquito.
Grasshoppers and Dragon Fly.
Honeybee and Ant.
Wasps and Bumblebees.
True Bugs.
2. Audubon Bird Charts.
Twenty-six Common Birds Including Bluebird,
Bobolink.
Twenty-six Common Birds Including Cardinal,
Cowbird.
Twenty-three Migrants.
Twenty Winter Birds.
3. Church and Dwight Co., Inc., 10 Cedar Street,
New York, N. Y.

Useful Birds of America. Fifteen 2" x 3"
pictures in natural color. Free.
4. General Biology Charts.
Algae.
Bird Studies.
Clam.
Crayfish.
Earthworm.
Fern.
Flatworms and Roundworms.
Frog Anatomy.
Honeybee.
Hydra and Jellyfish.
Insect Structures.
Liverwort.
Moss.
One-celled Animals.
Perch.
Pine.
5. Jung-Koch-Quentell Botany Charts.
Corn.
Field Buttercup.

Garden Pea.
 Hair Cap Moss.
 Headed Mold.
 Liverwort.
 Mushroom.
 Spirogyra.
 Yeast.

6. Jung-Koch-Quentell Zoology Charts.
 Amoeba Diffflugia, Gregarina Trichinella.
 Cabbage Butterfly.
 Clam.
 Coral.
 Crayfish.
 Earthworm.
 Frog.
 Honeybee.
 Housefly.
 Hydra.
 Jellyfish.
 Perch.
 Starfish.
 Tapeworm.
 Vorticella, Paramecium, Euglena.

7. Jurica Biology Charts.
 Amoeba and Euglena.
 Birds and Their Tools.
 Brown Algae.
 Clam and Starfish.
 Earthworm.
 Grasshopper.
 Green Algae.
 Housefly and Honeybee.
 Hydra and Obelia.
 Paramecium.

8. Oregon State Board of Health, 816 Oregon Building, Portland, Oregon.

Important Information Concerning the Prevention
 and Control of Communicable Diseases. 9" x
 12" chart.

9. Philips Biology Charts.
 Algae, Spirogyra, etc.
 Earthworm.
 Protozoa, Amoeba, Paramecium, Vorticella, etc.

10. Schmidt Fresh Water Algae Charts.
Chlorophyceae (#4).
Chlorophyceae (#5).
Conjugate.
Cyanophyceae.
Diatomaceae.
Rhodophyceae and Phaeophyceae.
11. Singer Sewing Machine Co., Inc., Singer
Building, New York, New York.

American Songbirds. 16 - 4 $\frac{1}{2}$ " x 6" pictures
in natural color. Free.
12. Smallwood Botanical Charts.
Composite Family.
Ferns.
Grass Family.
Lily Family.
Monocots and Dicots.
Mustard Family.
Parsley Family.
Pine Family.
Rose Family.
Typical Cells.
13. Smallwood Zoological Charts.
Annelida.
Coelinterata.
Echinodermata.
Flatworms and Roundworms.
Porifera.
Protozoa.
14. Sussman Chart of Bacteria.
15. Turttox Classroom Charts.
Amoeba.
Animal Kingdom Phylogenetic Tree.
Ascaris.
Bacteria.
Bacteria, Free Living.
Bacteria, Pathogenic.
Beneficial Insects.
Bird Adaptations of Bills and Feet.
Blue Green Algae.
Clam.
Crayfish (CRL3).
Diatoms.
Earthworms.

- Fern.
 - Free Living Protozoa.
 - Frog (CR23) Dissection.
 - Grantia.
 - Harmful Insects.
 - Hookworm.
 - Hydra.
 - Lichen.
 - Marchantia.
 - Moss.
 - Obelia.
 - Orders of Insects.
 - Paramecium.
 - Parasitic Protozoa.
 - Penicillium, and Aspergillus.
 - Pidgeon.
 - Planaria.
 - Plant Kingdom Phylogenetic Tree.
 - Powdery Mildews.
 - Puccinia (Wheat Rust).
 - Slime Molds.
 - Snail Anatomy.
 - Spider Anatomy and Development.
 - Spirogyra.
 - Squid.
 - Starfish.
 - Tapeworm, Anatomy and Life History.
 - Trichina.
 - Types of Insect Legs.
 - Types of Insect Mouth Parts.
16. Turtlox Wall Charts.
- Amoeba.
 - Clam.
 - Crayfish.
 - Earthworm.
 - Fern.
 - Fucus.
 - Grantia.
 - Grasshopper.
 - Hydra.
 - Lily.
 - Marchantia.
 - Molds.
 - Moss.
 - Spirogyra.
 - Starfish.
 - Volvox.

17. U. S. Superintendent of Documents, Washington,
D. C.

Extension Service:

Educational Charts on Corn, Group 10,
Rev. 1940. 15¢ per set of seven charts
(A 43.22:10.1 to 10.7).

B. Films.

1. Oregon State College.

Big Game and the National Forests.

16mm. silent, 1 reel.

Cow Business, The.

16mm. silent, 2 reels.

Duck Farming.

16mm. silent, 1 reel.

Forest and Health, The

16mm. sound, 1 reel.

Game Management.

16mm. silent, 2 reels.

How Forests Serve.

16mm. silent, 1 reel.

Pineways to Profit.

16mm. sound, 2 reels.

Poultry--A Billion Dollar Industry.

16mm. sound, 1 reel, (1200-ft. size).

Recreation.

16mm. sound, 3 reels.

River. 16mm. sound, 1 reel (1200-ft. size).

Stop Forest Fires.

16mm. sound, 2 reels, \$1.00.

Sugar Cane.

16mm. sound, 2 reels, \$1.00.

2. University of California.

#26. Seaside Friends and Their Cousins.

16mm. silent, 1 reel, \$1.00.

#29. In Birdland.

16mm. silent, 1 reel, \$1.00.

#30. Pirates of the Sky.

16mm. silent, 1 reel, \$1.00.

#31. Our Pets.

16mm. silent, 1 reel, \$1.00.

#32. Furry Creatures (Rodents).

16mm. silent, $\frac{1}{2}$ reel, \$.75.

- #57. Work Dogs of The North.
16mm. silent, 1 reel, \$1.00.
- #66. Life History of the Pear.
16mm. silent, $\frac{1}{2}$ reel, \$.75.
- #88. Butterflies and Moths.
16mm. silent, 1 reel, \$1.00.
- #137. Conquest of the Forest.
16mm. silent, 1 reel, \$1.00.
- #154. Cotton--From Seed to Cloth.
16mm. silent, 2 reels, \$1.00.
- #158. Living Cells.
16mm. silent, 1 reel, \$1.00.
- #169. Br'er Rabbit and His Pals.
16mm. silent, 1 reel, \$1.00.
- #193. Lumbering in the Pacific Northwest.
16mm. silent, 1 reel, \$1.00.
- #194. Meat Packing.
16mm. silent, 1 reel, \$1.00.
- #200. Pacific Coast Salmon.
16mm. silent, 1 reel, \$1.00.
- #208. Bird Homes.
16mm. silent, 1 reel, \$1.00.
- #209. Game Birds.
16mm. silent, 1 reel, \$1.00.
- #210. Birds of the Sea Coast.
16mm. silent, 1 reel, \$1.00.
- #211. Wading Birds.
16mm. silent, 1 reel, \$1.00.
- #213. Some Water Insects.
16mm. silent, 1 reel, \$1.00.
- #214. Rocky Mountain Mammals.
16mm. silent, 1 reel, \$1.00.
- #215. Some Larger Mammals.
16mm. silent, 1 reel, \$1.00.
- #234. Baby Songbirds at Mealtime.
16mm. silent, 1 reel, \$1.00.
- #236. Crayfish; Stickleback.
16mm. silent, 1 reel, \$1.00.
- #254. Great Arctic Seal Hunt.
16mm. silent, 1 reel, \$1.00.
- #274. Reptiles. 16mm. silent,
1 reel, \$1.00.
- #275. Spiders.
16mm. silent, 1 reel, \$1.00.
- #279. Frogs, Toads, and Salamanders.
16mm. silent, 1 reel, \$1.00.
- #285. Microscopic Animal Life.
16mm. silent, 1 reel, \$1.00.

- #298. Study of Coelenterata.
16mm. silent, 1 reel, \$1.00.
- #302. Silver Swimmer.
16mm. silent, 1 reel, \$1.00.
- #307. Jungle Round-up, The.
16mm. silent, 1 reel, \$1.00.
- #312. Game Bird Farming.
16mm. silent, 1 reel, 30¢.
- #343. Rabbit Farming.
16mm. silent, 2 reels, 50¢.
- #390. Why Save the Elk.
16mm. silent, 1 reel, 30¢.
- #397. Trapping Tuna.
16mm. silent, 1 reel, 50¢.
- #422. Sponges.
16mm. silent, 1 reel, 50¢.
- #439. Romance of Silk.
16mm. silent, 1 reel, 50¢.
- #443. Upland Game Birds.
16mm. silent, 1 reel, \$1.00.
- #444. Striped Bass Fishing.
16mm. silent, 1 reel, \$1.00.
- #445. Western Birds at Home.
16mm. silent, 1 reel, \$1.00.
- #446. Wealth of the Sea, The.
16mm. silent, 1 reel, \$1.00.
- #447. New Game Birds For Western Fields.
16mm. silent, 1 reel, \$1.00.
- #449. Fishing in the Surf and Sea.
16mm. silent, 1 reel, \$1.00.
- #458. Our Wild Life Resources.
16mm. silent, 2 reels, 50¢.
- #461. Porcupine Control in Western States.
16mm. silent, 2 reels, 50¢.
- #467. Flax to Linen.
16mm. silent, 1 reel, \$1.00.
- #471. Feathered Beach Combers.
16mm. silent, 1 reel, \$1.00.
- #490. Dwellers of the Forest.
16mm. silent, 1 reel, \$1.00.
- #493. Western Waterfowl.
16mm. silent, 1 reel, \$1.00.
- #494. Duck and Goose Shooting.
16mm. silent, 1 reel, \$1.00.
- #495. Winter Visitors.
16mm. silent, 1 reel, \$1.00.
- #498. Hummingbird Home Life.
16mm. silent, $\frac{1}{2}$ reel, 50¢.

- #501. Beavers at Home.
16mm. silent, 1 reel, \$1.00.
- #503. Hunters of the White North.
16mm. silent, 1 reel, \$1.00.
- #504. Horse and Man, The.
16mm. silent, 1 reel, 30¢.
- #515. Regulated Deer Hunting.
16mm. silent, 2 reels, 50¢.
- #811. Rubber.
16mm. silent, 1 reel, \$1.00.
- #869. Protozoa, The.
16mm. silent, 2 reels, 50¢.
- #2525. Animals of the Zoo.
16mm. sound, 1 reel, \$1.50.
- #2527. Beach and Sea Animals.
16mm. sound, 1 reel, \$1.50.
- #2528. Tiny Water Animals.
16mm. sound, 1 reel, \$1.50.
- #2532. Pond Insects.
16mm. sound, 1 reel, \$1.50.
- #2534. Spiders.
16mm. sound, 1 reel, \$1.50.
- #2568. Game Bird Farming.
16mm. sound, 1 reel, \$.50.
- #2584. California Giants.
16mm. sound, 1 reel (1600 ft.)
\$5.00.
- #2600. Regulated Deer Hunting.
16mm. sound, 2 reels, \$1.00.
- #2693. Thrushes and Relatives.
16mm. sound, 1 reel, \$1.50.
- #2694. Shell Fishing.
16mm. sound, 1 reel, \$1.50.
- #2695. Gray Squirrel.
16mm. sound, 1 reel, \$1.50.
- #2708. Birds of Prey.
16mm. sound, 1 reel, \$1.50.
- #2718. Animal Life.
16mm. sound, 1 reel, \$1.50.
- #2724. Robin Redbreast.
16mm. sound, 1 reel, \$1.50.
- #2828. Science and Agriculture.
16mm. sound, 1 reel, \$1.50.
- #2846. Big Fish.
16mm. sound, 1 reel, \$1.50.
- #2860. Amoeba, The.
16mm. sound, 1 reel, \$1.50.
- #2861. Hydra, The.
16mm. sound, 2 reels, \$3.00.

- #2888. Annelid Worms.
16mm. sound, 1 reel, \$1.50.
- #2904. Truck Farmer, The.
16mm. sound, 1 reel, \$1.50.
- #2905. Fishing in the Fiords.
16mm. sound, 1 reel, \$1.50.
- #2931. T.F.C. Giants of the Jungle.
16mm. sound, 1 reel, \$1.00.
- #2958. T.F.C. Sea, The.
16mm. sound, 1 reel, \$1.00.
- #2974. Elephants.
16mm. sound, 1 reel, \$1.50.
- #2984. Yes, Bananas.
16mm. sound, 1 reel, \$.50.
- #2964. T.F.C. Story of Dr. Carver.
16mm. sound, 1 reel, \$1.00.
- #2994. Snapping Turtle.
16mm. sound, 1 reel, \$1.50.
- #3006. Horned Owl, The.
16mm. sound, 1 reel, \$1.50.

Free and Inexpensive Reference Material:

- A. American Petroleum Industries Committee, 616 S. Michigan Avenue, Chicago, Illinois.

Corn Alcohol. 6 p. folder.

- B. Field Museum of Natural History, Roosevelt Road, Chicago, Illinois.

1. Botany Leaflets:

- #3. Wheat. 10¢.
- #4. Cacao. 10¢.
- #7. Spring Wild Flowers. 25¢.
- #8. Spring and Early Summer Wild Flowers. 25¢.
- #9. Summer Wild Flowers. 25¢.
- #10. Autumn Flowers and Fruits. 25¢.
- #11. Common Trees. 25¢.
- #12. Poison Ivy. 25¢.

2. Zoology Leaflets:

- #1. The White-Tailed Deer. 10¢.
- #3. The American Alligator. 10¢.
- #4. The Periodical Cicada. 10¢.
- #6. The Wild Turkey. 10¢.

C. General Biological Supply House, The. 761-763
East 69th Place, Chicago, Illinois.

1. Turtox Service Leaflets: (Free)
 - #1. How to Make an Insect Collection.
 - #24. Preparing and Caring for a Herbarium Collection.
2. Turtox News. (Free)

D. Gilkey, Helen M., Associate Professor of Botany,
Oregon State College, Corvallis, Oregon.

Wild Plants Eaten as Greens. 2 pp. mimeographed,
il. free.

E. Howes Bird Attractors, 77 Rachelle Ave., Stam-
ford, Connecticut.

How to Attract Wild Birds. Looseleaf, cumula-
tive catalog and treatises on all branches of
bird study, il., 50¢.

F. Kalamazoo Public Schools, Kalamazoo, Michigan.

Whitney, Arnold L., Key for Trees. 10¢.

G. Mrs. Martha E. Mulkey, Coos Co. School Supt.,
Coquille, Oregon.

Lans Leneve--Wild Ducks of Southwestern Oregon.
4 pp. mimeographed, free.

Olive Barber--Birds of Coos County. 1938, 8 pp.
mimeographed.

H. National Audubon Society. Audubon House, 1006
Fifth Avenue, New York, N. Y.

Audubon Society membership:

Mrs. Christine N. Morgan (Oregon Representative)
1504 N. E. 11th Avenue, Portland, Oregon.

I. Nefco, New England Fish Co., Spokane Street
Terminal, Seattle, Washington.

From Sea to Shelf. 1936, 61 pp. pamphlet, il.,
free.

J. Oregon State College Experiment Station, Cor-
vallis, Oregon.

1. Experiment Station Bulletin:
 - #359. Agriculture Research Serves to Relieve the Tax Burden. 1938, 132 pp. il.
 - #375. Some Economic Implications of Milk Control in Oregon. 1940, 19 pp.
 - #379. Preparation of Starter for Cheese, Buttermilk, Butter. 1940, 24 pp. il.
 - #383. Sampling-Preserving-Testing Milk. 1940, 44 pp. il.
2. Extension Bulletins:
 - #525. The Farm Vegetable Garden. 1939, 8 pp.
3. Extension Circulars:
 - #361. Spinach Growing and Preparation for Market. Jan. 1941.
 - #366. Freezing Fruits, Vegetables, and Meats. 1941.

K. Richfield Oil Company.

Wild Flowers of the Pacific Northwest. Natural color photography. 16pp. il. free.

L. Swift and Company, Chicago, Illinois.

1. Agricultural Research Bulletin:
Monthly bulletin of subject of meat production. Free.
2. The Meat Packing Industry in America. 1937. 105 pp. il. booklet, free.

M. United States Forest Service, Portland, Oregon.

Jewett, S. G., Check List of 50 Common Birds in Washington and Oregon, 1935, free.

N. U. S. Superintendent of Documents, Washington, D. C.

Write for free price lists of publications on biological subjects.

O. (W.P.A.) Oregon Writers' Project, 409 Elks Building, Portland, Oregon.

Oregon Oddities:

Horticulture, Part I, April 15, 1941; Part II, May 1, 1941. Free.

Oregon Wild Flowers. Part I, Feb. 15, 1941; Part II, March 1, 1941. Mimeographed, each 4 pp. Free.

Snakes in Oregon. April 15, 1940. Free.

P. Whitman Publishing Co., Racine, Wisconsin.

Trazzini, William David, Bugs of America.
93 pp. 1l. 20¢.

Q. Wild Flower Preservation Society, Inc., (The),
3740 Oliver Street, Washington, D. C.

Price list of aids. Free.
Sample packets of literature on Wild Flower
Study, Cultivating and Conservation. 10¢
each, or the 3 for 25¢.

R. Works Progress Administration, Bedell Building,
Portland, Oregon.

Flax in Oregon. 1939. Free.

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2. Akeley, Carl E., In Brightest Africa. New York: Doubleday, Doran & Co., Inc., 1923.
3. Akeley, Delia J., Jungle Portraits. New York: Robert McBride & Co., 1933.
4. Akeley, Mary Lee, Carl Akeley's Africa. New York: Dodd Mead & Co., 1929.
5. Allen, A. A., Illustrated Key to Bird's Nests. Ithaca: Slingerland-Comstock, 1927. 28 pp.
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7. Altenburg, Edgar, How We Inherit. New York: Henry Holt & Co., Inc., 1928.
8. Alverdes, Frederick, Social Life in the Animal World. New York: Harcourt, Brace & Co., 1927. 205 pp.
9. Andress, J., A. K. Aldinger, and I. H. Goldberger, Health Essentials. Boston: Ginn & Co., 1928.
10. Andrews, Roy Chapman, Whale Hunting With Gun and Camera. New York: Appleton-Century Co., 1916. 333 pp.
11. _____, On The Trail of Ancient Man. Garden City: Garden City Publishing Co., Inc. 1926. 375 pp.
12. Anthony, H. E., Field Book of North American Mammals. New York: G. P. Putnam's Sons, 1928. 626 pp.
13. Arey, Leslie Brainerd, Developmental Anatomy. Philadelphia: W. B. Saunders Co., 1930.
14. Baer, Marion E., The Wonders of Water. New York: Farran and Rhinehart. 1938. 122 pp.
15. Bailey, L. H., Manual of Cultivated Plants. New York: The Macmillan Co.

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18. Barrows, William Morton, Science of Animal Life. Yonkers-on-Hudson: World Book Co., 1927.
19. Bayne-Jones, S., Man and Microbes. Baltimore: The Williams & Wilkins Co.
20. Bean, Robert Bennett, The Races of Man. New York: The University Society Inc., 1935.
21. Beard, Dan., The American Boy's Book of Bugs, Butterflies, and Beetles. Philadelphia: J. B. Lippincott Co., 1932. 365 pp.
22. Beaty, John, Trees. New York: M. A. Donohoe Co., 1938. 916 pp.
23. Beavis, Gerald, The Book of the Microscope. Philadelphia: J. B. Lippincott Co., 1931.
24. Beebe, William, Beneath Tropic Seas. New York: G. P. Putnam's Sons, 1928. 234 pp.
25. ———, Exploring With Beebe. New York: G. P. Putnam's Sons. 1932.
26. ———, Galapagos, World's End. New York: G. P. Putnam's Sons, 1932.
27. ———, Half Mile Down. New York: Harcourt, Brace & Co., 1939.
28. ———, Jungle Days. New York: G. P. Putnam's Sons, 1925. 201 pp.
29. ———, Nonsuch: Land of Water. New York: Harcourt, Brace & Co., Inc., 1939.
30. ———, Zaca Adventures. New York: Harcourt, Brace & Co., 1938.
31. Benedict, Ruth, Race: Science and Politics. New York: Modern Age Books, 1940. 274 pp.

32. Best, C. H., and N. B. Taylor, Living Body. New York: Henry Holt & Co.
33. Bilik, S. E., The New Trainers Bible. New York: The Atsco Press, 1934. 224 pp.
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35. Bogen, Emil, and L. W. S. Hisey, What About Alcohol. Scientific Education Press, 1934.
36. Bogert, L. J., and M. Porter, Dietetics Simplified. New York: The Macmillan Co., 1937.
37. Boulenger, E. G., The Aquarium Book. New York: D. Appleton-Century Co., 1934. 208 pp.
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39. Branson, E. B., and W. A. Tarr, Introduction to Geology. New York: McGraw-Hill Book Co., 1935.
40. Brinser, Ayers and Ward Shepard, Our Use of the Land. New York: Harper Bros., 1939. 303 pp.
41. Broadhurst, Jean, Home and Community Hygiene. Philadelphia: J. B. Lippincott Co., 1929.
42. Brown, R. N. Rodnose, The Polar Regions. London: Methuen & Co., 1927.
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