AN ABSTRACT OF THE THESIS OF

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Title A Handbook of Selected Instructional Procedures for Teaching Biology.

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The purpose of the study was to compile a handbook of instructional procedures which could be used to stimulate the interest of the student and to supplement and vary regular classroom work in biology.

Because biology is becoming a required subject in many schools, because the youth studying biology today are less academic in their needs, capacities, and interests, and because little space in textbooks is devoted to the presentation of concrete teaching devices that might interest youth, there is a need for a handbook of interesting teaching procedures. This need has been expressed by educators Harl R. Douglass, Francis D. Curtis, and others; and by the teachers themselves through responses to questionnaires, one nation-wide, one state-wide. The latter was a part of this study.

The procedures presented in this handbook fall into six classes: field trips, games, construction activities, dramatizations, visual aids other than motion pictures, and miscellaneous activities. They were selected from those found in professional magazines, from those found in books, pamphlets, and manuals not easily available to the average teacher, and from those submitted by Oregon teachers, including the writer, as having been successfully used in biology classes.

The selection of procedures was based upon four criteria: (1) Do they challenge the interest of a majority of sophomore boys and girls? (2) Do they provide for educational growth? (3) Are the devices economical? and (4) Are the devices not found in professional manuals or other material readily available to the average teacher?

The handbook includes twenty field trips, twenty-three games, six construction activities, five dramatizations, eleven visual aids, and nine other teaching devices of a miscellaneous nature. Listed in the bibliography are books to which the teacher may go for additional activities.

The appendix contains a list of addresses from which a teacher may obtain some of the material mentioned.

Indices that may be used to find material appropriate for each unit conclude the handbook.
A HANDBOOK OF
SELECTED INSTRUCTIONAL PROCEDURES
FOR TEACHING BIOLOGY
by
E. IRENE HOLLENBECK

A THESIS
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APPROVED:

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The writer wishes to express her sincere appreciation to Dr. Elmo N. Stevenson for his inspiration and guidance throughout the preparation of this handbook and to extend her thanks to all Oregon teachers who returned the questionnaire.
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CHAPTER I

INTRODUCTION

Statement of the Problem

Good teaching employs a wide variety of the avenues of learning. It makes use of many elements of the drama, capitalizes on the peculiar interests of individual pupils, allows many opportunities for expression. Good teachers like to utilize teaching procedures which embody these principles. Many do. Many, however, find themselves handicapped by lack of time to find appropriate aids or are limited in sources of material. To collect a variety of successful teaching devices and assemble them together in a convenient handbook is the purpose of this study.

Need for the Study

Changes in American life have come rapidly. Changes in commerce and industry, in family life and leisure time, in international relations have all brought about a change in the number, capacities, and interests of the young people who enter our secondary schools today. The new pupil is "... more inclined to find fun and humor in all situations, with more compelling desires to be physically
active and to live in the present, usually impatient with books and abstractions, and less likely to favor an intellectual, disciplinary, and decorative education. . ." (16:101)* Such a change in high school population implies a change in methods. According to Douglass (16:76) "... it is a subject worthy of experimentation to determine whether a more informal curriculum and teaching method may be more effective than the highly organized, authoritative system so commonly employed in the schools today". Among the changes he suggests are the following:

Methods should involve more visual and concrete material, especially for those with less ability to deal with abstractions.

.................................

Methods should allow liberally for opportunities to do, as well as to learn -- construction, application, exemplification, illustration, expression of reactions. (16:102)

Curtis, (12) too, mentions the need for "Analyses for the purpose of determining a wide variety of profitable classroom, laboratory, and extra-classroom activities, devices, and practices distinct from teaching methods, with objective determination of the relative values of these."

* The numbers refer to references in the bibliography. A number following a colon indicates the exact page in the reference where the quotation or data may be found.
Because biology is a field rich in material contributing toward an understanding of the principles that underlie good health and intelligent happy living, there is a growing tendency to add it to the list of required subjects in high school. Among the high schools of Oregon already in this category are Salem, Hood River, Grants Pass, Baker, Coquille, Pendleton, and Girls Polytechnic of Portland, according to the findings of a recent questionnaire. Thus biology teachers confronted with large classes of the less academic students find themselves facing new problems: the need to overcome the antagonistic set which accompanies anything required of an individual and the need to adapt teaching procedures to a more heterogeneous group than before. The teachers themselves have expressed this need significantly in the replies to two questionnaires—one sent out by the writer while making this study and one issued by the editor of the American Biology Teacher.

In November of 1943 the editor of the American Biology Teacher invited readers to state their preference in regard to material they would like to have published in the Journal. Out of nearly four hundred replies the subject receiving the greatest number of checks was Teaching Techniques, a preference of one hundred and sixty-two teachers. (4) In the Oregon questionnaire all the teachers
replying expressed a need for such procedures. Space devoted to interesting classroom activities in modern professional textbooks is very limited. But useful, intriguing devices may be found scattered through many periodicals, pamphlets, and high school textbooks. Many biology classes are limited to the use of one textbook. If this book happens to be one which contains few suggested activities, some teachers, especially the beginning teachers, may find it difficult to enrich the biology course with a variety of experiences. The two textbooks adopted for use in the biology classes of Oregon offer the least in the way of suggested activities of all the newer books. It seems, then, that a handbook in which is compiled a variety of interesting teaching procedures should be of value to many.

Procedures Used in This Study

In order to obtain sufficient material from which a selection of devices might be made, the following procedures were used:

1. A survey of professional textbooks dealing with methods of teaching science and biology was made. Only books published since 1920 were used.

2. Recently published high school textbooks, workbooks and laboratory manuals, and teacher's guides were reviewed for teaching aids.
3. Pamphlets and publications of supply houses were checked for suggestions to teachers.

4. Current periodicals were searched for contributions sent in by teachers describing successful teaching procedures.

5. A short questionnaire regarding the use of instructional procedures was sent to biology teachers in Oregon high schools employing twelve or more teachers.

Definition of Terms

In order that there be no misunderstanding regarding the terms used in this study, the following explanations are offered.

Method refers to an established pattern of teaching procedures or the general manner in which a subject is taught.

Teaching procedures include all those activities, devices or techniques, or "tricks of the trade" which may be used for the purpose of stimulating further activity on the part of the student, for developing understandings, or for enriching, introducing, or reviewing a unit.

Visual aid means any picture, model, object, exhibit, or device which provides concrete visual experience to the learner.

Field trip is a teaching procedure which gives the
student a complete sensory experience by studying things in their natural environment.

Recreational techniques include those classroom activities which make use of the spirit of play and the student's urge for expression. These may include games, contests, puzzles, parties, construction activities, listening activities, and dramatization.

Criteria for the Selection of the Devices

The devices selected for use in this study were limited to those which met the following criteria:

1. Do they challenge the interest of a majority of sophomore boys and girls? They should include a wide variety of sensory experiences, provide many opportunities for activity on the part of the student, or possess an element of suspense, exploration, discovery, competition, or wonder. They should be activities which teachers themselves have found highly acceptable to high school students.

2. Do they provide for educational growth? A device may be used for the development of skills; it may provide opportunity for social contacts or the development of civic responsibilities; or it may be employed for the purpose of developing understandings, appreciations, attitudes, or good thinking. Unless the procedure results
in growth of the student, its use cannot be justified.

3. Are the devices economical? They should be economical of the teacher's time and the pupil's time in attaining the goals of education. They should be economical in regard to expenditures and equipment. Since motion picture equipment is still unavailable to many schools today, such visual aids will not be included in this study.

4. Are the devices not found in professional manuals, textbooks, or other material readily available to the average teacher?

Summary of the Chapter

Because biology is becoming a required subject in many schools, because the youth studying biology today are less academic in their needs, capacities, and interests, and because little space in textbooks on method is devoted to the presentation of concrete teaching devices that might interest such youth, there is a need for a handbook of interesting teaching procedures.

The procedures in this handbook were selected from those found in professional magazines, from those found in books not readily available to the average teacher, and from those submitted by Oregon teachers, including the writer, as having been successfully used in biology classes. Selection was based upon the degree to which the device
challenges the interests of sophomore boys and girls, upon its contribution to their educational growth, and upon its adaptability to the average class limited in time, equipment, and space.

Since a variety of procedures is essential for good teaching, the devices in this handbook represent a cross section of those available in field trips, visual aids other than motion pictures, and recreational activities.
CHAPTER II

SOURCES OF DEVICES AND RESULTS OF THE QUESTIONNAIRE

In order to obtain interesting instructional procedures for this study a survey was made of professional books, high school textbooks, workbooks, laboratory manuals, and teachers guides, pamphlets and supply house publications, and current educational periodicals. To ascertain the attitude of Oregon teachers toward the use of various instructional procedures, a questionnaire was sent to biology teachers in the larger schools of Oregon. This chapter includes a discussion of the sources used and a summary of the returns of the questionnaire.

Professional Books

A survey of books on methods of teaching science and biology published since 1920 reveals that, in general, they are limited to a development of philosophy, objectives, and general methods, with little space devoted to concrete suggestions or descriptions of actual devices and procedures that might be useful in attaining the objectives set forth.

Brownell and Wade (6) in *The Teaching of Science and the Science Teacher*, published in 1925, devote Part I to a discussion of the place of laboratory work in teaching
science, textbooks and their purpose, class management, the use of projects, and methods of evaluation; Part II to the preparation and place of a science teacher in the community; and Part III to the specific sciences. Of Part III only sixteen pages are devoted to biology, its place in the curriculum, texts, and a comparison of instructional processes. Other authors follow a somewhat similar organization differing, of course, in the amount of space accorded to various aspects of teaching.

Cole, (10) in The Teaching of Biology, published in 1934, devotes about fifteen pages to methods but gives no practical suggestions.

Methods in Biology by Kinsey, (32) published in 1937, is stimulating and challenging and includes eleven pages of suggestions for field trips, nine pages of suggestions for projects, and eleven pages of general methods.

Miller and Blaydes, (35) in 1938, wrote Methods and Materials for Teaching Biological Sciences, devoting Part I to philosophy, principles, and classroom methods and Part II to the collection and preservation of materials and directions for demonstration experiments. Though this book is invaluable to the biology teacher, it contains only scattered paragraphs which describe actual classroom teaching devices.

Nature Recreation by Vinal, (64) published in 1940,
is a very useful handbook for the teacher who is interested in teaching about living things in their natural environment. Here are over one hundred pages of suggestions for nature experiences in the home, the community, and summer camp. Of these, fifty-five pages contain descriptions of field trips and eighteen pages are devoted to nature games.

Modern Methods and Materials for Teaching Science by Heiss, Hoffman and Obourn, (28) published in 1940, offers a useful list of sources of visual materials in Section III. Here again, however, Section I, or nearly half the book, is on the principles of science teaching, while Section II provides directions for carrying out field trips, making use of the bulletin board, museum materials, designed materials, flat pictures, dramatizations, and projectors.

Another recent addition to the reference library of the high school teacher is the 1941 revised edition of Enriched Teaching of Science in the High School by Woodring, Oakes, and Brown. (67) As a source book it provides hundreds of listings of reference materials, sources of pictures, charts, maps, exhibits, and pamphlets valuable in the presentation of a science course.

Nature Games by Stevenson (54) offers games for use in grade levels from kindergarten through the seventh grade. Teachers may adapt many of these for use at higher
grade levels.

Games and Game Leadership by Smith, (48) presents one chapter on nature games.

Textbooks, Workbooks and Laboratory Manuals, and Teacher's Guides

Teacher's guides are largely answer books for exercises found in the text or in the workbook which usually accompanies each text and have little to offer in the way of suggested teaching procedures. The textbooks themselves provide a wide range of suggestions for student activities, but authors vary to a great extent in the detail in which these are outlined as well as in the number suggested. Some of these suggested activities might be adapted by the teacher for use as instructional devices. Of the more recent biology textbooks the 1943 edition of Baker and Mills (1) offers approximately a page of activity suggestions at the end of each of the twelve units. Most of these are to be carried out independently of the classroom and are not easily adapted for use as a classroom procedure.

Bayles and Burnett (3) offer even less. Each of the thirty-five chapters is followed by a very short section entitled "Projects, Activities, and Investigations" wherein are made three or four suggestions for pupil activity,
usually of the investigation type.

A wider range of experiences is listed by Downing and McAtee, (18) many of them extremely interesting and worthwhile to the student. Each of the fourteen units is followed by four to ten pages which present suggestions for laboratory problems, instructions for the construction of museum models and posters, and directions for field trips.

Another textbook rich in teaching aids, written by Kroeber and Wolff, (33) provides a list of activities for the "junior biologist" at the end of each textbook problem. Though many are designed for out of class use, a number would serve as useful classroom devices.

Many excellent instructional devices are also found in Smith. (50) Each of the thirty-one chapters is followed by one to four pages of well explained activities called "Your biology notebook". Here are found not only laboratory instructions, but directions for field trips, suggestions for games, contests, and projects, directions for the construction of useful equipment for the classroom, and suggestions for interesting related reading.

Ritchie (43) in his massive book of twenty-one units provides a page of suggested activities at the end of each unit. These are, for the most part, of the "study", "learn", "write", type.
Hunter (30) devotes the first ninety-four pages of his social biology to an introduction which includes a fall field trip, a spring field trip, out-of-door activities, home activities, and reading activities. Then each of the short problems, seventy-eight in all, is followed by suggestions for demonstrations, activities, or projects; sometimes all three are included. These include such experiences as "make a collection . . . ", "go on a field trip to . . . ", "visit your . . . ".

Workbooks and laboratory manuals currently used in the schools today give few suggestions for activities. Of those reviewed for this study Curtis (13) offers a field trip to study the struggle for energy and Burnett (7) a field study of soil erosion. Day (14) describes no field trips but suggests some activities which the teacher might modify and use as outdoor study problems if she desires. Downing (17) and Smith (49) make no field trip suggestions.

William's (66) cloth bound laboratory guide is a revision and elaboration of his Systematic Guide to Field Zoology. In it are one or more exercises for each phyla of the plants and animals and a series of field studies ecological in nature. Of the sixty-five exercises, eighteen are field studies.
A Field and Laboratory Manual in Biology by Kinsey (31) lists thirty field trips and five contests among the ninety-three exercises.

Pamphlets and Supply House Publications

The Cornell Rural School Leaflets* offer many excellent teaching aids to the high school science teacher as well as the elementary teacher. The fall issue each year is a teacher's manual outlining useful procedures for the presentation of material in the children's leaflets to follow. A similar publication of equal value is the Science Guide for Elementary Schools* published by the California State Department of Education. Each issue of the science guide develops a subject such as trees, insects, or birds, and provides instructional devices at the end.

Conservation Excursions, (2) a publication of the U.S. Office of Education, is an excellent source book for field trips. The appendix, one third of the book, is in the form of a table listing such information as "Where to go and what to see", "What to do", and "Further Activities".

Adventuring in Nature by Price (38) is packed with suggestions for nature activities, games, field trips, museum workshops, and things to do in general.

* See Appendix B
Another booklet which gives useful directions for specific things to do in nature is *Leader's Nature Guide* by Gaudette. (23) The suggestions are less explicit and are written for a nature counsellor, but a biology classroom teacher could readily adapt them to her own work.

Many suggested teaching aids are found in the publications of the General Biological Supply House which include *Turtox News*, *Turtox Project Leaflets*, and several booklets on the care of organisms in the classroom.* Other house organs offering occasional suggestions to teachers are *Badger Bits*, *Biology Note Book*, *Biology Briefs*, *Ward's Bulletins*, and *Educational Focus.*

Two monographs distributed by the Oregon State Department of Education as part of a series on *Significant Practices in Oregon Schools* provide useful suggestions for biology teachers. These are *A Rural School Museum* by Cason, and *Biology* by Weatheredd.

**Periodicals**

The best source of successful teaching procedures seems to be articles in the periodicals in the field of science education such as *The American Biology Teacher*,

* See Appendix B
School Science and Mathematics, and Science Education. Many good biology teachers have taken the time to contribute written accounts of those classroom procedures which they have found highly successful in practice. Since the average teacher does not have immediate access to all these publications a handbook in which these procedures are compiled should be of value.

Questionnaire Results

A questionnaire was sent to seventy-five teachers of biology in Oregon high schools in order to ascertain their attitude toward the use of instructional procedures. Forty-four questionnaires were returned. All of the teachers replying indicated that they felt there was a need for such procedures. Twenty-seven felt they were extremely valuable. Visual aids were used as teaching devices more often than any other; dramatizations were used by the fewest teachers. Biology teachers of Oregon make moderate to extensive use of aids, more of them using such devices for the development of a lesson than for an introduction or conclusion. Most of them obtain their material from current magazines. Half of the teachers expressed a desire for the completed handbook. A complete tabulation of the results is compiled in the following table.
Table Showing Results of Questionnaire on Instructional Procedures

1. What percent of the students in your high school register for biology?
   - required of all: 6
   - 80-99: 10
   - 70: 10
   - 40: 2
   - 20: 4
   - less than 20: 5
   - no data: 7

2. Do you use interesting instructional procedures?
   - a. extensively: 12
   - b. moderately: 25
   - c. little: 5

3. Check the types you have used.
   - a. field trips: 38
   - b. games: 19
   - c. visual aids other than motion pictures: 41
   - d. construction activities: 30
   - e. dramatizations: 7

4. Where in the lesson plan do you use them?
   - a. introduction: 25
   - b. development: 38
   - c. conclusion: 22

5. Do you feel that such procedures are worthwhile?
   - a. extremely valuable: 27
   - b. limited in value: 4
   - c. moderately valuable: 13
   - d. no value: 0

6. Do you feel there is a need for such procedures?
   - a. no: 0
   - b. yes: 44

7. Do you use any of the following as a source book?
   - a. current magazines: 39
   - b. Cornell Rural School Leaflets: 3
   - c. Nature Recreation, Vinal: 3
   - d. Nature Games, Stevenson: 7
   - e. Science Guide for Elementary Schools: 6
   - f. others: 21
CHAPTER III

FIELD TRIPS

If biology teachers agree with Kinsey (32) and others (46, 52, 60) that one of the most important objectives of biology is to interest the student in the world about him, acquainting him with the plant and animal forms and their behavior, then the most worthwhile and satisfying experience in which teacher and class can engage is the field trip. Field trips enable students to observe and enjoy organisms in their natural surroundings. How much more fun to study living grasshoppers caught in the vacant lot across the street than to dissect preserved ones in the laboratory! Why read about trees and flowers, conservation, or protective adaptations when living examples are but a short distance from the classroom?

In reviewing the findings of thirty writers on the use of the field trip in biology classes Dexter (15) reports that at least half of the students enrolled in biology had had no classwork in the field, that students would have found biology more interesting if outdoor classes had been held, and that modern museums are ahead of schools and colleges in their trend toward directing the attention of visitors toward exhibitions of living materials. In Oregon Stevenson conducted a study of high school
biology field trips through members of classes in the Oregon Colleges of Education. Of the students who had had high school biology about forty percent had been on field trips.

Among the factors which contribute to the inadequate use of the field trip are: (1) large classes, (2) the teacher's lack of experience with field trips, and (3) the feeling on the part of some teachers that successful field trips involve travel with its ensuing problems of transportation, expense, and encroachment upon the time of other classes. Yet, a field trip, to be successful, need not go beyond the school grounds. Large classes may be divided into squads under the leadership of capable students and all members given mimeographed instructions outlining interesting things to do. This chapter includes ideas for only a few field trips; they should suggest many others to the teacher.

Treasure Hunt Trails

The most popular trail of this type is one in which clues are placed at interesting points in the area to be covered. Well written directions give the student an opportunity to apply what he has learned, and the review is fun. For example, in studying flowers, each pair of students is given easy directions for finding a certain
shrub. Pinned to the shrub is a message something like this: "If the flowers on this plant are pistillate flowers, look for the shrubs at the north entrance to the gym; if they are staminate, your next clue is on a branch of the tree at the north entrance to the auditorium". Arriving at the gym entrance they find this clue: "If this plant is the male form of the one you have just seen, go to the yellow blooming shrub across the court; if it is of a different species, go examine the pine tree in the parking lot". At the Scotch Broom is this statement: "If this flower is cross-pollinated, your next clue is in the laurels on the north lawn; if it is self-pollinated, cross the field to the willows by the tennis courts". At the end of the hunt the first to finish bring back a "winner's certificate". When a student makes a wrong decision and arrives at an alternate plant, he finds a note to that effect. It also tells him how to recognize the flower he missed and directs him to start again.

Scavenger Hunt

Another type of hunt is one in which groups of students are given a list of things to find such as: two composite flowers, two trees that bear catkins; three flowers that are cross-pollinated, etc. As such it is used for review. It also makes an interesting teaching
lesson, if, for instance, each member of the class first picks a dandelion, discovers why it is a composite, and is then sent out for two more to be found in that area. When most of the class has returned, they are then instructed regarding imperfect flowers, study some examples, and go out to find a given number. A record is kept of material brought in by each group and the winner determined at the end of the period.

Pictorial Field Trip

Prepare a mimeographed pictorial map of the region to be covered. Sketch interesting items in the margin of the paper and list "things to do" in the center or on the back. After the students have used such a direction sheet, they will enjoy making one of their own. Listed below are the directions which appeared on the back of one such map. The numbers correspond to numbered localities on the map.

1. (open field) Mark off a square yard here. Count all the different plants and animals that you can find. Which plant seems to have crowded out most of the others? Why?

2. (at the tennis court) Find out how these vines that you find here climb.

3. (at mill stream) Look for the "garbage collector's" of the streams. Are they facing up or down stream?
Can you explain why?

4. (oak grove) Open several of the balls on the oak leaves. What do you find inside? Are they all alike?

5. (oak grove) Find three kinds of lichens growing on the branches of the oak trees.

6. (woodpile) Examine the woodpile for cocoons, caterpillars, pill bugs, scorpions, and other animals.

7. (rose bushes near the outdoor fireplace) Find three enemies on the rose bush. Look for the damage each does.

8. (at various places along the route) Collect protective adaptations.

9. (under the ash trees) Gather here to report what you have found.

Map Making Field Trips

To locate unfavorable conditions that will endanger the health of the community students are divided into groups, assigned a block, and told to look for weed patches, open garbage containers, refuse piles, quiet, stagnant water, and outhouses. Upon returning to the classroom they locate unsanitary conditions with signal dots on a map of the community. (1)

A tree map of the community may be made by letting each group of students study the trees in the block.
Having become familiar with the trees on the schoolgrounds, the students should know most of the trees but may take their tree key along for consultation. As a last resort, if the guide fails them, they may sketch the leaf, note leaf arrangement and other characteristics of the tree, and look it up the following day.

The making of a map of a pond or lake calls for a study of ecological conditions and accurate observations. Students like to work in groups, some studying shoreline organisms, others, shallow water plants and animals, and some deep water life. It may be necessary to make several trips to obtain all data on the condition of the water, the temperature of the water in different areas, and the condition of the bottom of the pond, as well as to collect and identify organisms.

Tree Trail

To help the students become familiar with the trees on the school grounds prepare a mimeographed direction sheet for a trip around the schoolgrounds. Give the students the correct location of each tree, call their attention to specific observations to make, and, if space permits, tell them something interesting about the tree. Following are some of the directions for a trip that was taken in the fall.
1. Leave the building by the stairway nearest the classroom. The tree just outside the entrance is a mountain ash. Examine the fruit, the leaves, and the trunk, and write here two ways you may recognize the tree in other places on the grounds.

2. Go out the walk toward the shop. The tree on the south side of the walk is a sugar maple. Does it bear fruit? What is the tree on the north of the walk? Find out why all maples are called Acer when you go back to the classroom.

3. As you walk south along the drive the trees on your left are Lombardy Poplars. What is their characteristic branch arrangement? Find two other places on the grounds where poplar trees are growing.

4. There are two kinds of birch trees growing in the south court. Which one is the cut-leaf birch? Describe interesting features of the bark of birch trees. (64)

Tree Detectives

To gain practice in using a key, review leaf forms, and become familiar with the trees on the school grounds the class is divided into squads of three or four each. The leader of each squad is given a card describing the location of a tree on the school grounds. The students then use a previously prepared key to trees and follow up
each "clue". When the identity of the tree is discovered the name is written on the card and returned to headquarters where another detective job is assigned. The squad identifying the most trees within the class period is the winner.

This game is more fun when played outside but can be adapted for use inside. Twigs or flowers may be substituted for trees.

Conversation About Conservation

For a field trip to encourage an appreciation of the problems of conservation prepare a mimeographed direction sheet. The following introduction was used for a trip of this type.

"You are about to go on a self-guided expedition. It will be 'double exploration', in that you will search your minds and the fields at the same time. Today we hear a great deal of 'idle chatter' about conservation. Some people believe it means sitting in an auditorium, listening to a lecture, saying 'ain't it awful', and then going back to the same routine the next morning. Other people think that it is time we did something about it . . . .

This modern expedition will start from the Pine Tree Camp 'Wonder House'. You will stroll less than a mile, and yet you will see worldwide examples of conserva-
tion needs. You will go in small groups. Take your walking leisurely. If possible, be energetic in your thinking. Each stop represents a new experience. Through discussion, come to a conclusion and then proceed according to directions to the next station." (64:160)

This was followed with directions for finding and thinking about a number of conservation problems found in the area -- a weed patch, insect damage, evidence of a forest fire, a tumor on a tree, and others.

Exploring the School Grounds

A good field trip for the first week of school is one in which the class becomes an "exploring party". The "exploring party" is divided into groups and each group is given the equipment necessary for collecting representative specimens of a specific habitat: the stream, the woods, or the open field. Those organisms which cannot be collected are noted in a record book. The groups return to the laboratory in time to place their living catch in a suitable habitat. The party having the largest number of organisms is considered the most "expert". The following day the chairman of each group makes a report using the organisms as illustrative material. Mention is usually made in each report of the difficulty in catching or finding animal life and
a discussion of adaptations of organisms follows;

A Fall Field Trip

The following games may be used to introduce a unit on taxonomy:

1. **Head the line.** The students are arranged in single or double file. The leader halts frequently and asks the person in front to identify the object pointed out, which may be near or far. If this person fails, he goes to the end of the line and the second person has a turn. If this person fails, he or she goes to the end and so on down until the answer is given. The one who remains at the front longest wins. Instruction is best given at the halts and is usually called for by the questions of the players. Correct answers may be drawn from the student by skillful questioning. Interesting instructional material for this trip may be obtained from Vernon Quinn's book "Shrubs in the Garden and Their Legends".

2. **Legs and Whiskers.** This is a game to play while on a long hike enroute to the place of interest. Students vie with each other for the greatest total number of legs observed.

3. **Roadside Cribbage.** Small groups work out a list of six to eight objects to be looked for enroute and attach
to each a rating as: each bird's nest -- two points, each wild animal track -- two points, etc. Only the person who first observes the object first can score for his side. Sometimes one point is given to observer and another to the namer. Instructor is umpire.

4. I Saw is a good game for summarizing and reviewing the objects seen on the trip. The players are seated in a circle. The one who is to start the game is determined by lot. The starter names an object which he observed and describes it briefly. The second player mentions that object and adds one observed by him with a brief description. Succeeding players mention these in order adding a new one each time.

5. Prove it is a variation of "I Saw" in which the players merely name the object describing it only when challenged by a player to prove it. If he cannot, he pays a forfeit; if he can, the challenger pays a forfeit. (53)

Winter and Life

To find out how and where organisms survive the winter students work in teams and investigate the following habitats.

1. Inside rotting logs.
2. Under shaggy bark of trees.
3. Inside galls on various kinds of plants.
4. Among decaying leaves on the ground.
5. In the top layer of soil.
6. In soil more than a foot down.
7. On water plants in a pond.
8. In the mud at the bottom of a pond or stream.
9. Walls of a cellar or cave.
10. In garages, barns, unheated buildings.

Compare the temperature of the various habitats, in the air, in the snow, in the soil, at various levels of pond water, on north and south sides of trees, and on north and south slopes. Compare readings for cold and warm days. Students will discover why earthworms migrate downwards, why surface insects seek refuge in soil, and why more organisms are found in some locations than in others. (62)

Other suggestions for winter field trips include the examination of a pail of frozen earth. Put this in warm water in the laboratory and watch for insects rising to the surface. (45)

**Biology of the Stream**

Trips to collect organisms may be used for an introduction to a study of adaptations or habitats.

In quiet pools or backwaters look for algae, water
cress, duckweed, Euglena, protozoa, hydra, rotifers, and water fleas. In a moderate current will be found planaria, hairworms, annelids, and crayfish. Spiders will be found on shore near the water's edge. Many stages of the life cycles of insects are present in the mud or shallow waters of quiet streams. Minnows, suckers and sunfish are often seen in the stream while frogs, turtles, and snakes are found on the shore. Look for birds that build nests near streams and for such mammals as the muskrat and beaver.

Such physical factors of temperature, hardness, turbidity, concentration of minerals, oxygen content, acidity or alkalinity, depth, velocity, type of bottom, type of shore, and presence of obstructions in the stream should be measured and the effects noted in terms of their effects on plant and animal life.

Change in population should be noted during flood, drouth, and winter. Observations regarding adaptations to aquatic conditions should be made.

In small streams an ecological succession may be started by constructing a small dam or submerging a log. (5)

An Activity When Leaves Come Out

To observe the response of plants in springtime and to stimulate further observation of twig and leaf develop-
A spring field trip is worthwhile.

A walk around the school grounds will disclose on some of the bushes buds that are larger than on others, the opposite and alternate mode of growth of buds, the old leaves protecting the new, thorns, fur, gum, and other means of protecting the buds, the color of young twigs, and the catkins blooming on some of the trees. The following exhibits may be arranged as a result of the trip: (1) where buds grow, (2) how buds are protected, (3) what buds make such structures as blossoms, leaves, and stem, and (4) the color of young twigs. Ensuing activities might include a diary of the growth and development of twigs kept indoors compared with those outdoors, an exhibit of twig and leaf growth, and an exhibit of catkins. (29)

A somewhat different activity was suggested and carried out by a class at the end of a unit on behavior. The leaders posted the blue print of the school grounds, told each student to select a tree and observe its response to the spring conditions of light, warmth, and soil conditions. If possible the students were to compare trees growing on the sunny side with those growing on the shady side of the building. Upon returning some students expressed dissatisfaction with the chosen tree because the buds were still dormant. It was decided that five trees should be observed the following week, and to continue this activity
each week, keeping a diary of each tree.

Field Study in Ecological Successions

To determine what plants year after year invade, gain supremacy, or fail, in a given area select a plot of ground in a place which is apt to be untouched for a number of years. Mark it off and remove the top soil for a depth of one foot. This should be done in the spring for a fall study. Keep a geographical description of the area, observe the total species growing there, the total number of all species and record accurately. Tabulate results carefully and predict what is likely to happen in the way of succession or failure. (68)

Bird Study Out of Doors

The classroom study of birds should be supplemented by some outdoor activities which help the student to build up an acquaintance with the resident and migratory birds of that area.

Besides being able to answer the question, "What bird is that?" the attention of students should be directed toward the following observations: What food is available for the birds? What evidence can you find that birds are controlling insects? Which birds are found in the open woods? How are different birds adapted for their
mode of feeding or flight?

In collecting bird nests in the fall it is well to select one of each type for exhibit, compare the nesting in one area with another, and compare the nests as to type of trees used and the height of the nest above the ground.

A survey of the food and shelter plants for birds about the school may be made.

Weekly observations by class or by individuals during the migratory period make interesting data. (65)

A Zoo Trip

A field trip to a zoo may be made educational as well as amusing by giving each student a direction sheet. One such direction sheet entitled "How is your Eyesight?" contained fifty questions requiring close observations of nine animals at the zoo. It began with the following introduction: "You are about to go on a voyage of discovery! You will visit several continents in a short walk. After entering the main door, turn to the right and observe each animal according to the suggestions. The numbers on the right indicate the score if you observe correctly."

(64:232)

Stump Scouting

Stumps provide interesting material for an appreciation
of the past history of trees. A questionnaire was given several groups of students. Each group was given an opportunity to observe the stump and make out its own report. The questions called for keen observation and interpretation of the data. Evidences and conclusions were discussed by the entire group later. (64:242)

A Museum Trip

A trip to a museum was used to study the many adaptations of birds. Each member of the party was asked to look for the most interesting bird, for interesting adaptations of birds, and to count the number of species in the collection. When this was finished the group discussed each student's nomination for the "most interesting bird". (51)

Community Health Survey

An interest in community health problems may be aroused by making a study of the ways a community protects the health of its residents.

Each class committee chooses one of the following places to visit: dairy, creamery, meat market, grocery, restaurant, bakery, slaughter house or meat packing company, beauty shop, the city health department, the Pure Food and Drug laboratory, or some other place which performs
a service to the public. The day before the trip the committees meet to formulate questions for the interview and to make an appointment with the manager of the place to be visited. The students will want to find out something about the city, state, and federal laws regarding sanitation and the handling of food and how these laws are enforced, how instruments are sterilized, what diseases might be transmitted if people are careless, and whether or not employees have to have a health examination.

The day following the trip the chairman of each committee acts as a member of a panel which discusses the city water supply, food supply, sewage and garbage disposal, and facilities for caring for the sick. The class then decides what improvements might be made and what part each student as a citizen can play in bringing about the desired improvements.

Field Trip Suggestions by Kinsey

Kinsey, (31) in his Field and Laboratory Manual in Biology gives adequate directions for carrying out the following trips:

1. Introduction: one field period to discover and observe some interesting plants and animals.

2. Plant groups: a contest to identify groups of plants.
3. Genera: a field trip to gain a better understanding of genera by arranging leaves according to characteristics.

4. Animal groups: to discover and recognize groups.

5. Insect-collecting trip: to learn how to make an insect collection.

6. Woody plant organs: to observe how the organs of plants function under normal conditions.

7. Some physiologic processes: to observe conditions that concern photosynthesis, nitrogen fixation, destructive metabolism, release of energy, and secretions.

8. Market foods: to observe the number, quantity, and methods of handling foods in our markets.

9. Commercial sources of foods: to observe ways in which food is prepared, preserved, or distributed. Profitable trips may be made to creamery, cannery, chicken farm and others.

10. Good breeds and bad breeds: to observe the extent to which the principles of heredity are applied on our farms.

11. New breeds: a visit to a greenhouse, farm, or fair to observe the recently introduced breeds of domesticated plants and animals.

12. Some plant adaptations: to observe adaptations by means of which the plant is protected, its growth fur-
thereed, and its seeds distributed.

13. Ecological relations: a visit to a park or weed patch to discover as many types of parasitic, symbiotic, social, economic, and scavenger relationships as possible.

14. Forest products: a trip to an industrial establishment that depends upon forest products for its raw materials.

15. Fly breeding places: to discover the possible breeding places of house flies in a given area.

16. Plant galls: a trip to the fields and scrub growth to observe the way in which normal plant tissues are modified by gall fungi and gall insects.

17. Mid-winter plants and animals: a hike taken after a light snowfall to observe evidences of animal activities.

18. Mosquito breeding places: to make a survey of a small area for stray tin cans, buckets, mud puddles, or other possible breeding places.

19. Habitats: to observe some of the habitats of local plants and animals, and to note some of the ecologic conditions of each habitat.

20. Plant sleep movements: a special trip to observe the positions of leaves at night.

21. Leaf mosaics: a study of the plants in the school yard to observe the positions of leaves and note the cause
of leaf mosaics.

22. Instincts of domesticated animals: a trip to a farm to observe and analyze some instinctive behaviors of domestic animals.

23. Ant nests: to observe some of the instinctive behavior of ants in their nest-building, care of the young, slave-making, etc.

24. Experiments with ants: to observe the behavior of ants under difficulties and their behavior toward stranger ants.

25. Bird behavior: to observe some bird habitats and feeding, fight, song, and other behaviors.

26. Bird nests: a trip to the open country or to a city park to observe the number of birds that nest in a limited area.

27. Observation race: a trip to a familiar path or street to observe as many different kinds of plants and animals as possible.

28. A field survey contest: to determine the number of species in a limited area, and to test the student's ability to make observations.

29. A discovery game: to test the student's knowledge of, and ability to observe some one kind of plant.

30. Spring flowers: to observe the beauty and interesting biology of spring flowers.
Conservation Excursions

The booklet Conservation Excursions by Bathurst (2) devotes thirty-six pages to a table of field trips. The seventy-five excursions are distributed among the following fields:

- soil: 8
- water: 8
- flowers: 7
- trees: 14
- birds: 10
- fish: 2
- minerals: 7
- history: 19

The table gives good directions for each trip telling where to go and what to see, what to do, and follow-up activities.
CHAPTER IV

GAMES

Learning proceeds more rapidly and easily in an atmosphere of informality and relaxation. Among the many ways of attaining this condition games rank high with some teachers, are little used by others. Games provide an opportunity for fun and laughter and a happier student-teacher relationship. One teacher found that with laughter as an activating force material was learned thirty to forty percent faster, retained better, and emotional blocking to learning was eliminated. (36)

Games provide an element of sport and competition so much enjoyed by boys and girls that drill ceases to be dull. Games mean active participation, require quick thinking, develop good sportsmanship, and contribute greatly toward the socialization of the students.

In urging teachers to use a variety of methods not only to keep the class interested but to keep the teacher alive and interesting Kinsey (32:17) suggests the use of games as one of the activities and adds "It is well to acquire a repertory of competitive games for laboratory and field use". A few games which might serve as a nucleus for such a repertory are presented in this chapter. A resourceful teacher will be able to adapt them to many
situations and to develop others of a like nature.

What Am I?

This game is an extremely popular one with the students. It may be used to review the characteristics of some of the organisms studied or it may be used to introduce a unit on animals or plants.

The teacher tells the class that she is going out of the room for a few minutes and while she is gone the class is to give her the name of some animal and review as many characteristics of the animal as possible. She may suggest some of the questions she will ask when she returns. The students call her when ready.

Upon returning to the classroom the teacher attempts to find out what she has been named by asking questions which can be answered by only "yes", or "no". If it takes her more than fifteen questions to ascertain her identity the class wins; if less than fifteen questions, the teacher wins. If the student must answer "I don't know" the question does not count. In some cases the teacher may again leave the room while the students look up the right answer.
Guess My Name

As a play-way method of lecturing this game is a good introduction to a unit on the classification of animals or plants.

Ask each pupil to number from eight to one in column form on a sheet of paper. The teacher then reads eight statements about an animal. As she reads the first statement the student writes opposite the number eight the name of the animal to which he thinks the statement refers. He does the same for each of the following statements. Each student receives a score equal to the sum of the numbers opposite which the correct answer has been written. Should he be fortunate enough to answer correctly the first time and each succeeding time his score would be thirty-six.

Eight items which may be used about the skunk follow.

8. I am an important fur-bearing animal.

7. I am distinguished by the disproportionately large size of the posterior half of my body and by my long bushy tail.

6. I am most commonly found in areas of mixed woodland and fields and generally live in holes in the ground.

5. I am omnivorous, but live mainly upon insects or rodents.

4. I walk upon the soles of my feet instead of my
3. I am gentle, readily domesticated, and become a delightful pet.

2. My color is black, striped with white, and I sometimes weigh ten pounds.

1. In spite of all the above, I am probably the most unpopular of all animals because of my method of defense. (48:331)

Lingo

This game is a vocabulary drill that helps the student realize that a memorized definition of a word is not the equivalent of an adequate understanding of a term.

The day before the game is to be played for the first time give the students the following directions. (A little mystery about the whole procedure adds to the fun.)

1. Fold a piece of notebook paper lengthwise.
2. Now fold again in thirds; unfold.
3. Fold the paper crosswise, fold again in thirds; unfold.
4. Copy the thirty-six words from the board in the marked off spaces. Copy them in any order.
5. Be sure you understand the meaning of each term tomorrow if you want to win this game.
The following day distribute colored squares of paper, or counters, to the students who have arranged their chairs in a circle. One student starts the game by giving a "clue" or explanation of one of the words and covering it up on his paper. All students who think they know the word he has in mind cover it up on their paper. Continue around the circle each student giving a clue to a new word until one member has a complete row covered and calls "Lingo". Before the student is the acknowledged winner all terms must be explained, subject to challenge by other class members. If all are acceptable, the game begins again. In succeeding games all clues to previously used words must be different. For variation the teacher gives all the clues or a good student may volunteer to do so.

Of What Are You Thinking?

Review of a subject or a unit is always looked forward to if it takes the form of a game. For this game the teacher chooses the name of a subject studied during the unit. In studying health it might be the name of a health hero, a method of preventing disease, or some other phase of the work. When she announces she is ready the pupils try to determine the subject by asking direct questions which she can answer by yes or no. After the teacher has answered about twenty of these questions the game really
begins. The first member of each team writes at the top of a sheet of paper the subject he thinks the teacher has in mind. He folds it down and passes it on to the next. In this manner the writing, folding and passing continues until all have had a chance. When the last member of the class has finished writing the teacher announces her subject. The team that finishes first receives one point. Each correct answer counts one point. The team having the highest number of points wins. (48:326)

Vocabulary League

It is sometimes desirable to have a weekly vocabulary review. To maintain interest let the class become a vocabulary league of five teams and once each week hold a vocabulary match. The leader of each team "pitches" words in turn to the members of the team "at bat" against his group.

To advance the standing of his team during the week the student may bring in any book or magazine with a list of the "contest words" and slips marking pages where these words occurred or he may bring in newspaper clippings with these words underlined. Each word reported on scores one point. Each poster with a drawing or cut-out picture accompanied by an appropriate legend containing one of the words counts five points.
At the close of the contest a party is held in class for the winning team. (63)

Who? Me?

To review the life functions and characteristics of animals divide the class into two sections or teams. Pass out two identical sets of animal names, one to each team. Each team member draws one. The teacher then gives a series of characteristics of an animal and when a student recognizes them as a characteristic of the name he drew he stands and calls, "Who, Me?" The student scores one point for his side when he properly identifies himself.

"Bees"

The following types of programs were worked out by students for the final week of review.

1. Question bees. The class is divided into two teams and eliminations take place until a winner remains.

2. Professor Quiz. The professor (a student) prepares a number of questions on individual sheets of paper and puts them in a box or hat. He calls for volunteers and each contestant selects a question which he hands to the professor to read aloud. Each answer is rated and the ratings tabulated on the blackboard. After a
definite number of rounds the winner is selected.

3. Baseball bees. Questions made up on separate sheets of paper are awarded a base value of first, second, or third base, and home run on the basis of difficulty. This base value appears on each slip of paper above the question. Two teams of nine each are chosen by captains, a diamond marked off on the blackboard, and a scorekeeper appointed. Each team has a chance to strike out three times before the side is retired. A strike occurs when a person fails to answer a question correctly.

4. Football bees. Similar to baseball bees but football teams, football field, and football values are used.

5. Spelling bees. These bees are confined entirely to the spelling of biological terms. (22)

Puzzles

The following types of review were originated by students in a New York City high school for their final week of work.

1. The student chairman calls up the students during the period and instructs them to assume certain poses or positions or to perform various actions. The rest of the class attempts to guess the biological process or structure shown.
2. Simple sketches are outlined rapidly on the board and the class attempts to arrive at the correct name or term represented in each sketch.

3. Students brought into class elaborate drawings on large sheets of paper and held these up to the view of the class.

4. Crossword puzzles were used in the following ways: A stencil of the puzzle was cut and mimeographed and individual sheets distributed to the members of the class. The first one to hand in a correct solution wins. The class is then shown the correct answers and the various terms reviewed. At other times the puzzle was ruled on the blackboard or drawn on a large sheet of cardboard which was held up for the class to view. When the definition was read off the first student to guess the correct word was awarded a certain number of points. The student who had the greatest number of points at the end of the game won. (22)

Spotting

To introduce a study of environmental relationships place objects representative of a particular habitat on a table. Students are given a few minutes to observe them and then write down all that can be recalled. In another column the characteristic of adaptation for that habitat
may be recorded. (8)

Find the Spot

To review the study of adaptations of organisms to their environment place a large outline map of the region on the bulletin board. Pictures of animals or plants being studied are drawn from a pile on the desk by students who pin them to appropriate places on the bulletin board. (8)

I Am

A card game makes an unusual and interesting review. This one may be used to review the characteristics of organisms or to review interesting facts concerning scientists.

Construct playing cards by mounting pictures of scientists or organisms or whatever is being studied on small pieces of cardboard. To play the game from four to six students sit at a table and place the shuffled cards in the center. A student draws a card, gives three distinguishing characteristics of the subject found on the card, and may then keep the card. He continues until he fails to give three characteristics. The student with the most number of cards at the end of the game wins. (8)
Twig Game

To learn to identify types of leaves divide the group into sides. One side might be called opposites, the other alternates. Each member of the alternates is given a card with the name of a tree having leaves arranged in an alternate manner. Each player on the opposites side receives a card bearing the name of a tree having opposite leaves. Ten minutes are allowed in which to find the trees and pin the cards on them. The side which finishes first with the most correctly named wins. Each side may collect the tags of the other team as a check. Variations include leaf venation, simple and compound leaves, or annuals and perennials. (150)

Characteristics, A Card Game

Though this game, which parallels rather closely the old game of "Authors", was prepared to teach the characteristics of gilled mushrooms, it may be adapted to teaching the characteristics of other organisms.

The name of each of forty-nine selected genera of gilled mushrooms is written separately on a card with three to six descriptive characteristics, enough to distinguish the genus, listed beneath the genus name.

A second set of cards, each one the size of ordinary
playing cards was prepared, and on each of the smaller card one descriptive characteristic of a mushroom genus was printed.

The genus cards are distributed equally among the players which may number from two to ten. The "characteristic" cards are then shuffled and five are distributed to each player. The remaining "characteristic" cards are placed in a pile in the center of the table to be drawn from later.

The player looks at his genus cards and notes the number and kind of "characteristic" that he needs. Each player in turn may demand a characteristic card from any other player and if his request cannot be honored the player draws a card from the top of the deck in the center of the table. A player may continue to call for the "characteristic" cards as long as he is lucky to obtain the card he wants by calling or drawing. When a player has all of the characteristics that are needed to identify a genus he has a "book". The value of any book depends upon the number of characteristics listed on the genus card. (A three-term book counts three points.) At the conclusion of the game the player with the most points wins the game. (37)
What Is It?

Place a different organism upon each desk. Students move from seat to seat at the signal from the teacher and each tries to identify the leaf before him. He writes the name opposite the corresponding number on his paper. At the end of a given time the teacher reads a key list. The student having the largest number correct wins. Drawings, flowers, fungi, bird pictures, and leaves may be used. This game provides drill in the recognition of common organisms or objects.

Curio Collector

When it is necessary to take a long hike on a field trip play a game like the following.

Divide the group into four units. While traveling along the trail the leader names a curio and the players scatter to find it. The one who finds it first shouts; the others gather about and the discoverer scores for the group. The game continues with a new curio being named. Some curios that might be sought are: a conifer that sheds its needles, a broad-leafed tree that has woody cones, a twig that grew a foot last year, a tree with lichens on the south side, a woodpeckers nest, the nest of tent caterpillars. (54:167)
Blind Feeling

To introduce or review a lesson in natural objects ask the students to place their hands behind their backs. Put a natural object in the hands of each one. Students may have thirty seconds to feel it. The name is then given. Some objects suited for this game are: various seeds, leaves, fruits, evergreens, flowers, bark of trees, feathers, shells, or soils.

Variations of this type of game are Blind Tasting, and Blind Smelling. Material useful for the sense of smell includes mint, balsam, skunk cabbage, onion, tomato, rose, cedar, apple, mold, and cucumber. For the sense of taste use rhubarb, sorrel, sugar, salt, peach, radish, cabbage, licorice, orange, and cucumber. (54:102)

Reaction Time

To introduce a discussion of neurons students and teacher join hands in a circle. The teacher starts a message around the circle by pressing the hand of the student on her right, at the same time starting the stop watch held in his left hand. As each student feels the pressure he passes it on to the student on his right. When the message arrives at the teacher he stops the watch and checks the number of seconds it took the message to
complete the circuit. Try it several times to the right, then to the left. Try it using foot pressure instead of hand pressure and compare the time. It may also be varied by having circles of boys and girls competing against each other.

The ensuing discussion or study of pathways to, across and from the brain, appearance, size, and growth of neurons, speed and method of travel of messages, habit formation, attention, etc., will have the student's undivided attention.

Pilot Tests

To develop a better understanding of the sense of balance try some of the following tests:

1. Blindfold a student, spin him around three times, and ask him to walk the chalk line drawn down the center of the room. Boys may compete against girls to see which can walk the farthest without straying off.

2. Have a student hold a cane in his right hand with the tip on the floor in front of him. Ask him to bend over, lay his forehead on his hand, and sidestep around the cane three times with his eyes closed. He should observe that his dizziness is quite different from that which results after whirling. (18:429)

3. Ask all members of the class to stand, close their
eyes, and see if they can stand with one foot off the floor for fifteen seconds.

Spoon Tunes

These devices help the student develop a better understanding of the sense of sound.

1. Ask each student to do the following: Tie a piece of string around a spoon so that the spoon is near the middle of the string. Wrap the free ends of the string around a finger of each hand. Swing the spoon until it hits a chair or the end of a table, and listen for a slight ringing sound. Then, while the spoon is still ringing, put the fingers around which the string is wrapped in your ears. Note the rich sound. (44:53)

2. Play part of a record and then remove the needle. Next have a student hold a common toothpick between his teeth and using it as a needle touch it lightly to the turning record. Report on how clearly the sound is heard. (44:53)

Peg It

To demonstrate an advantage of binocular vision arrange two pegs on a table about a yard apart and mark the midpoint of an imaginary line between them. Draw a second line at right angles to the first and place a third
peg on it. Let the students work in pairs. One sits with his eyes at the level of the table and asks the second to move the third peg backward or forward in the direction shown below until he thinks it is just on the line between A and B. Measure the mistake each time. Try it using only one eye. (44:124)

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A * - - - - - - - - * B

* C

Student

Tree Tag
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For a game to help the students become acquainted with the trees in a given area divide the class into two teams. Give each team twenty tags with the names of twenty trees common to that area. Let them have twenty
minutes to pin the tags five feet from the ground on the south side of the tree named. No tree is to have more than one tag on it. All trees correctly named count one point. As a check each team collects the tags posted by the opposite side.

One Hundred Dollars

To review a unit get the individual attention of each pupil by giving each of them ten squares of paper, each representing ten dollars. Thus each pupil would have one hundred dollars.

Ten sentences about whatever you happen to be studying are written on the board by an equal number of pupils. As the board material is discussed one unit at a time the students are required to agree or disagree with the statement on the board. If the sentence is correct those who disagree give up ten dollars; if incorrect all who agree give up ten dollars. (27)

Electrical Chart

The uses to which an electric chart can be put are unlimited. It may be used by individuals to learn the names of flowers, birds, trees, or mammals, or to review the names of scientists, biological principles, or organs
and their functions. It may be used as a contest device with one team pointing out the questions, the other finding the answers. It is often used as a project by individual students who make and replace sets of pictures and answers weekly. With the subject always changing it never ceases to be an interest center in the room.

The materials needed for a chart are: one piece of wall board three by four feet, one pound of copper wire, two contact points for each picture on the chart, (one inch paper fasteners or brass headed tacks may be used for this), two pointers similar to blackboard pointers, a flashlight, and a set of pictures and answers.

Space the contact points far enough apart so that a picture may be tacked above each point on one side of the board, an answer tacked above each point on the other side of the board. The flashlight should be between the two sides and near the top of the board. A picture contact must be connected with a name contact by a piece of bell wire on the back of the board. Electrical connections are made with the flashlight in such a way that when one pointer is put on a picture contact and the other placed on the correct name contact the lamp lights.

Complete directions for making this chart will be found in Science Guide for Elementary Schools. (47)
CHAPTER V

DRAMATIZATIONS

Among the recreational techniques that might be used to greater advantage are dramatizations. The elements of the drama -- suspense, conflict, action, and dialog are interest-holding. Plays are an excellent device for giving a measure of reality to other times, persons, or places. In biology the lives of scientists and scientific discoveries lend themselves well to drama, impersonations, or dialog. Plays are also a means of organizing material. Ideally they are written as well as produced by the students. If properties and costumes are kept at a minimum, the new understandings and appreciations gained by the students warrant the time spent on the production. This chapter contains some available drama material which may be adapted to high school biology classes.

Plays

Most of the following plays have been written and produced by students as a result of some interest or need. They provide good suggestions for other classes wanting to do the same, or ready-made plays for those who haven't the time to write their own.

1. A Scientific Tableau. A play concerning the
Herschell family, the Curies, and the Wright Brothers. (26)

2. Convincing Harold. A play written about the sewage disposal problems of Detroit. This is an interesting example of the way oral reports may be worked into a play. (9)

3. The Advancement of Medical Science through the Ages. This production consists of four parts, each a separate tableau or play. (28:222)

4. A Lesson in Forest Conservation. A puppet play having four scenes, and requiring four puppets. (28:223)

5. Food for Thought. A one-act play about how plants get their food and what it means to us.

The following plays are reprints that may be obtained from School Science and Mathematics.*

1. The King of Plants. 25¢
2. Youth Looks at Cancer. 25¢
3. An English Christmas Tree -- A Conservation play. 25¢

* See Appendix B
Of the Pupil, By the Pupil, For the Pupil

The following original plays were presented during review week by a New York high school class.

1. The Digestive System Goes on a Strike. A sketch which portrays the dream of a little boy who has gone to sleep with a bad stomach-ache. In his dream he sees and hears the various organs of his digestive system arguing among themselves. They are discussing the advisability of calling a strike against their employer. The organs cite their grievances such as irregular hours, mushy sweets, and the lack of good substantial nutrients they need. The boy awakens just as they are about to call the strike.

2. March of Science. This may be given as a radio broadcast by having each student read his part of the script showing developments in biological science. If given as a play a comparison of the crude surgery of the past with the modern methods of today is effective. Blood-letting in the barber shop may be contrasted with our modern use of instruments and anesthesia.

3. Jury Trial: The State versus Dr. Jones. Dr. Jones is a prominent physician who tries out a new serum on a dying patient. The patient dies and the wife sues. Attorney for the defense cited many instances where-in
great scientific discoveries had been made possible through experimentation on lower animals and subsequent application to human beings. (22)

Dramatic Biology During Review

The following dramatizations were devised by students for a review.

1. The Reincarnation of Aristotle. The members of the class were changed into ancient Greeks and had the honor of listening to the new theory proposed by an esteemed contemporary, Aristotle. A volunteer gave a forceful proof of spontaneous generation.

2. The Trial of Insects. The classroom was the courtroom, the class the jury, and the teacher was the judge. The jury was told that the entire insect world was to be brought up on charges and that the decision would be "Guilty" with a verdict for all insects, or, "Acquittal", in which case all would go free. An Attorney for the Defense and a Prosecuting Attorney were chosen and witnesses were called to the stand -- Farmer Brown, a grasshopper, a clothes moth, and others. Attorneys, of course, attempted to confuse the witnesses in the approved manner. The case was summed up and the jury was asked to retire to consider its verdict. (39)
Halloween Party

The ghosts of famous biologists meet for a banquet. Each student impersonates a famous scientist and must be prepared to relate some interesting anecdote regarding his life or discoveries. Each guest at the banquet is responsible for introducing the scientist on his right. Students bring cookies and punch or some other refreshment to eat while enjoying the recollections of other scientists.

Radio Scripts

The following radio scripts suitable for use in biology classes may be borrowed from the Educational Radio Script and Transcription Exchange.*

802 Medicine Under the Nazi Regime (30 min, 7m, 3f) An intensely dramatic presentation of facts concerning the degeneration of German medical science.

851 Trees (15 min. Narr., 2m, 1 boy, 1 girl) Stresses the importance of conservation.

852 Apples in the Orchard (15 min. Narr., 8m, 1f, 4 children) A charming script of the legend of Johnny Appleseed.

* See Appendix B
Contributions in Science (Ann., 2 Narr., Reader, 26m, 5f) a thirty minute program which is a panorama of American achievements in agriculture, medicine, exploration, and physics.

Women in Medicine (30 min., Ann., 3 Narr., 11m, 16f, 1 boy)

Women in Nursing (30 min., Ann., 3 Narr., 8m, 11f, 5 girls, 2 boys, voices)

Women in Science (30 min., Ann., 3 Narr., 11m, 3f, 1 girl, 1 boy, voices)

George Washington, the Farmer (15 min., Ann., 10m, 5f) George Washington discusses with his neighbors such problems as soil erosion, rotation of crops, soil fertility, and disinfection of seeds.

The Conquest of Fate (30 min., Narr., 3m, 3f) This script portrays the absorbing story of the personal and family life of Edward Livingston Trudeau so inextricably involved with tuberculosis.

Food for Victory (15 min., Ann., Narr., 10m, 7f, 1 child) Here is a record of the part which food is playing as a weapon of war.

Story of Vitamins (30 min., Ann., 29m) A dramatization about the men who discovered and developed the great medical weapon, vitamins. The use of vitamins in combatting the four diseases - scurvy, beri-beri, pelagra, and rickets is discussed.

Mary Meets the Vitamins (15 min., 1f, 7 boys, 1 girl) A radio script dramatizing the role of vitamins in promoting vigorous health and growth; suitable for young audiences.

Moth Control in Wartime (15 min., 7m, 4f) The secrets of the deadly mischief performed by moths on woolens, furs and feathers are revealed in a dramatization between two moths. This script is "dated" in such a way as to make it unsuitable for broadcasting but furnishes excellent script material for adaptation.
Forests and the War (30 min., Ann., 1 lm, 2 voices) This program develops in dramatic form the premise that "to be without wood in time of war is almost as bad as being without bread".

Epoch Discoveries of the Past. A volume of six scripts for radio plays of a scientific nature.

1. The Scientist Spallanzani
2. Eli Whitney and the Cotton Gin
3. Boots, Boots, Boots!
4. The Romance of Radium
5. The Glass Heart
6. The Magic Hormone

Each year the National Tuberculosis Association sends out short radio plays which are used for publicity during National Tuberculosis Week. These may be obtained from the local health office.
CHAPTER VI

VISUAL AIDS

Probably the oldest of all supplementary devices and the most widely used today are the visual aids. Next to the actual specimen itself they are the most effective. Most teachers recognize the fact that one picture is worth pages of print, and that the opportunity to see and handle an object gives reality to words. The term visual aid is comprehensive. It often includes pictures, objects, specimens, models, graphs, charts, the blackboard, the bulletin board, field trips, motion pictures, slides, and strip films. In this study field trips have been considered in a separate chapter because they are so extremely important in biology. Motion pictures have not been included in this study because many high schools are not equipped to show them. This chapter contains a few of the ways in which teachers have made use of visual aids such as the blackboard, the bulletin board, and exhibits.

What's Wrong with This Picture?

To introduce a study of habitats draw on the blackboard a nature relationship scene such as a typical marsh, field, or forest in which there are a number of errors in relationships. Students are divided into groups and all
are given one minute to observe the scene. At the end of the time each group lists the errors. The group detecting the most number of errors wins. (54:186)

The "Do you Know" Quiz Book

This is an excellent way to arouse curiosity about nature subjects. A book made of two pieces of wood hinged together and captioned "Do you Know" is hung in a conspicuous place. On the front is a place to insert the question card between two strips of wood; inside is a place for the answer card. Use interesting questions such as "Do you know what insects buries the dead, covering the dead body with dirt and using it as a storehouse for future meals?" Change the question daily or let students contribute questions and answers. A more complete description of this device will be found in a leaflet obtained from the National Recreation Association.*

What is it? Shelf

Set aside a shelf labeled "What is it?" On it place unidentified finds until someone discovers their names. Here, too, put objects which you wish to call to the attention of the class. Give credit for proper identifi-

* See Appendix B
Root Hairs Via the Test Tube

To provide root hairs that can be studied without being destroyed by air currents grow seeds in test tubes. Corn kernels may be soaked and placed on watersoaked paper towels for germinating. Place them in a large flower pot saucer and invert a second saucer over it to prevent moisture from escaping. Test tubes are prepared by cutting strips of cardboard so that they will easily slide into the test tubes. Provide for one-eighth inch on either side for expansion when the strip becomes saturated. The strip should be one inch shorter than the test tube to provide room for a cotton plug. As soon as the process of germination has started pin the kernels singly to the strips by placing the pin to the side of the embryo. Slide the strip into the test tube. Pour about one inch column of water into the tube. Cotton plugs may be used if root hairs do not develop satisfactorily. Observe the daily rate of seedling growth, root hair development, location of root hairs, appearance of different sections of root, and the areas of lateral root origin. (42)

Pollen Tube Growth

In order to illustrate pollen tube growth and the
chemotropic movements of pollen tubes to the students use a number of pollen grains from an available plant. Place a drop of specially prepared solution on a glass slide. This solution is made up of one gram of gelatine, four to five grams of cane sugar and fifty cubic centimeters of distilled water warmed until the solution is homogenous. Add pollen to the drop of the solution. Cover with a cover glass. Keep it in a moist chamber at about eighteen degrees Centigrade and examine eight or ten hours later. The pollen tubes will point towards the center of the preparation or away from contact with the air. Make a second preparation and treat as above, but seal the edges of the cover glass with vaseline to make it air tight. The germinating pollen tubes will grow in all directions.

Soil Conservation

To guide the student toward a better understanding of the problems of conservations arrange the following exhibit.

Provide seven funnels equal in size. Put a different type of soil in each one: leaf mold, subsoil, rich top soil, barren top soil, dry leaves, sand, gravel. Be sure the soil is dry. Arrange a glass below each funnel. Pour equal quantities of water into each funnel and after a given time measure the amount of water that has run
Invertebrate Animals

As a follow-up study of invertebrate classification scatter about forty or fifty specimens about on the laboratory tables. Number them but cover all labels. Give the students a laboratory sheet giving the invertebrate phyla, a few of the most important classes, and the characteristics of all the phyla and classes. Provide a space for recording the number, the common name, and the most important characteristics of each specimen. This procedure "results in a scene of scholastic activity that is pleasant to behold". (21)

Science on Display

Arrange interesting displays at regular intervals on bulletin board, shelves, tables, cabinets, or in regular glass display cases. Some displays which might be used are:

1. Believe It or Not.
2. Biology's Tool -- for exploring into the world of things too small to see -- the microscope. Display all types of microscopes, what may be seen, pictures of the first scientists to use them.
3. Bugs and How to Kill 'Em. Large colored pictures
of insect pests obtained from advertisements of a spray company are mounted on cardboard. Samples of stomach poisons and contact poisons are shown along with pictures or exhibits of methods of applying them. A toy airplane, a spray gun, or a bellows are among those which might be shown.

4. Seasonal exhibits. The Easter lily, facts about the lily, its growth habits, propagation, and its close relatives may be displayed. At Christmas time a showing of "Native Shrubs for Christmas Cheer" is effective. When the state flower is in bloom it may be used for an educational display.

5. Series of exhibits on some one subject. A series on "Health", "How to Make", or "The Parade of the Animal Kingdom" provides effective teaching material.


Calendars

Many interesting kinds of calendars may be posted throughout the year.

1. Clock calendar. Construct a poster resembling the face of a clock with months instead of hours. Place pictures of birds seen during the month in the proper
2. Migration of birds calendar. Keep a daily watch of migratory birds in order to get the peak of migration. Record the number of birds seen on each date, what they were eating. (56)

3. Wild Flowers. Make a chart showing the date, common name of the flower, flower family, habitat, and name of finder. Whenever a student brings in the first wild flower of a certain kind it is his privilege to record it on the calendar. A contest between classes is an added stimulus. The calendar may also be compared with that of previous years.

4. Spring buds. There is such a variation in the time the leaves come out that some students are interested in keeping a calendar of tree buds recording the date when the first green shows.

A Calendar of the Birthdays of Scientists

To commemorate the birthdays of scientists the bulletin board may be used in the following ways.

1. An attractive reproduction of the calendar or a part of the calendar may be placed in the center of the bulletin board and ribbons run from the names of the men studied in a particular unit to pictures depicting some events associated with the scientists.
2. "Ask Me Another" is a calendar surrounded with cards bearing questions related to the key scientists of the unit.

3. The calendar may be used to assist the teacher in the selection of men whose work is to be emphasized in a particular display. The teacher of biology may wish to show something of the history of the microscope during October and could select the name of Anthony von Leeuwenhoek around which to enter the bulletin board display during the week of October twenty-fourth.

4. Surround the calendar with pictures of the scientists whose work will be discussed during the month.

Following is a list of birthdays of scientists that are of interest to biology students. Many other birthdays of scientists are listed by Teller (59, 60) in a series of articles in School Science and Mathematics.

<table>
<thead>
<tr>
<th>Month</th>
<th>Day</th>
<th>Year</th>
<th>Name</th>
<th>Birthplace</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>13</td>
<td>1851</td>
<td>Walter Reed</td>
<td>Glouster Co. Virginia</td>
</tr>
<tr>
<td>September</td>
<td>14</td>
<td>1849</td>
<td>Ivan Pavlov</td>
<td>Ryazan, Russia</td>
</tr>
<tr>
<td>October</td>
<td>24</td>
<td>1833</td>
<td>Alfred Nobel</td>
<td>Stockholm, Sweden</td>
</tr>
<tr>
<td>October</td>
<td>24</td>
<td>1632</td>
<td>Anthony van Leeuwenhoek</td>
<td>Delf, Holland</td>
</tr>
<tr>
<td>November</td>
<td>7</td>
<td>1867</td>
<td>Marie Curie</td>
<td>Warsaw, Poland</td>
</tr>
<tr>
<td>November</td>
<td>14</td>
<td>1891</td>
<td>Frederick Banting Alliston</td>
<td>Ontario</td>
</tr>
<tr>
<td>Month</td>
<td>Day</td>
<td>Year</td>
<td>Name</td>
<td>Birthplace</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>------</td>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>December</td>
<td>11</td>
<td>1843</td>
<td>Robert Koch</td>
<td>Klausthal, Germany</td>
</tr>
<tr>
<td>December</td>
<td>21</td>
<td>1823</td>
<td>Jean Henri Fabre</td>
<td>Aveyron, France</td>
</tr>
<tr>
<td>December</td>
<td>25</td>
<td>1642</td>
<td>Sir Isaac Newton</td>
<td>Woolsthorpe, England</td>
</tr>
<tr>
<td>January</td>
<td>10</td>
<td>1729</td>
<td>Lazaro Spallanzani</td>
<td>Scandiano, Modena, Italy</td>
</tr>
<tr>
<td>January</td>
<td>17</td>
<td>1706</td>
<td>Benjamin Franklin</td>
<td>Boston, Mass.</td>
</tr>
<tr>
<td>February</td>
<td>11</td>
<td>1847</td>
<td>Thomas A. Edison</td>
<td>Milan, Ohio</td>
</tr>
<tr>
<td>February</td>
<td>15</td>
<td>1564</td>
<td>Galileo Galilei</td>
<td>Pisa, Italy</td>
</tr>
<tr>
<td>February</td>
<td>16</td>
<td>1848</td>
<td>Hugo de Vries</td>
<td>Haarlem, Holland</td>
</tr>
<tr>
<td>March</td>
<td>7</td>
<td>1849</td>
<td>Luther Burbank</td>
<td>Lancaster, Mass.</td>
</tr>
<tr>
<td>March</td>
<td>10</td>
<td>1628</td>
<td>Marcello Malpighi</td>
<td>Crevalcuore, Italy</td>
</tr>
<tr>
<td>March</td>
<td>14</td>
<td>1854</td>
<td>Paul Ehrlich</td>
<td>Strehlen, Silesia</td>
</tr>
<tr>
<td>April</td>
<td>5</td>
<td>1827</td>
<td>Joseph Lister</td>
<td>Upton Essex, England</td>
</tr>
<tr>
<td>April</td>
<td>26</td>
<td>1780</td>
<td>John Hames Audubon</td>
<td>Santo Domingo</td>
</tr>
<tr>
<td>May</td>
<td>4</td>
<td>1825</td>
<td>Thomas Henry Huxley</td>
<td>Ealing, England</td>
</tr>
<tr>
<td>May</td>
<td>20</td>
<td>1807</td>
<td>Jean Louis Agassiz</td>
<td>Lake Morat, Switzerland</td>
</tr>
</tbody>
</table>
Interesting picture shows may be presented by using a baloptican or a slide projector.

1. The Life and Love of Imogene Anopheles. In the Nature Magazine for May, 1944, is a picture story of the malarial carrying mosquito. Obtain two copies, cut and paste the pictures in order on a roll of paper and pull through the opaque projector a picture at a time. Similar stories may be drawn and presented by students.

2. Murder Mystery. On etched glass make a sketch of animal tracks in the snow showing signs of a struggle and bloodshed. Print "Whodunit" at the top of a second slide and under it print the following questions: Who was the villain? Who was the victim? Who were the witnesses? Draw as many slides as needed of the feet and mouth parts of animals that might have been present at the time of the crime. Show these pictures in the order given above and let the students try to unravel the mystery.

Bulletin Board Cut Outs

To vary the use of the bulletin board try some of the following ways:

1. Cut pieces of flower parts out of colored paper,
arrange and fasten to the bulletin board to represent a generalized flower. These may later be rearranged by students to represent imperfect flowers, incomplete flowers, adaptations for pollination, or other phases of the study.

2. Cut out strips of colored paper to represent chromosomes. Pin these to a poster upon which a large cell has been drawn. Demonstrate reduction division by rearranging the chromosomes.

3. To demonstrate mitosis the paper chromosomes may be replaced by two-strand yarn which may then be split to represent the splitting of the chromosomes.

Preview of Biology

To provide the student with an interesting and active introduction to biology while the teacher is occupied with the registration of her class on the first day of school arrange the room like a "Science Fair". Invite the students to explore the biology room, to examine carefully anything of interest to them and to be ready to report to the class the next day on interesting discoveries.

On the tables and bulletin boards about the room arrange some of the following exhibits. These will vary with the location of the school, the equipment available, and the time of year.
Do You Agree?

On this table display believe-it-or-nots such as the following:

<table>
<thead>
<tr>
<th>Display</th>
<th>Accompanying Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Tomato on a plate</td>
<td>a. The tomato is a fruit</td>
</tr>
<tr>
<td>b. Banana</td>
<td>b. The banana is a berry</td>
</tr>
<tr>
<td>c. Two similar bowls of flowers; aspirin</td>
<td>c. Aspirin helps make flowers stay fresh</td>
</tr>
<tr>
<td>d. Eggs (insect, chicken, others available)</td>
<td>d. Eggs breathe. (Can you prove it?)</td>
</tr>
<tr>
<td>e. Various kinds of seedy fruits; an appendix</td>
<td>e. Appendicitis is often caused by seeds lodging in the appendix</td>
</tr>
<tr>
<td>f. Horned toad</td>
<td>f. The horned toad is not a toad</td>
</tr>
<tr>
<td>g. Corn worm</td>
<td>g. This is a young moth</td>
</tr>
</tbody>
</table>

Biology and Your Future

On a bulletin board post large pictures of people in various occupations. Connect these by means of colored ribbon to materials associated with that occupation which are on display on a table below. It is also helpful to place near each exhibit cards bearing stimulating questions or suggesting things to do or observe in connection with the display.
1. Artist. Display commercial art work making use of biological designs (greeting cards, wall paper, Disney insignia for the air corps); photographs handcolored; decorative textiles having biological designs.

2. Aviator. Display the book *Biology of Flight* and any of the manuals regarding fauna and flora of various regions in which pilots might be forced down.


4. Doctor. Set up a microscope with some easily observed specimens. Have a former student on hand to answer questions or assist in its use. *Doctors at Work* and *Miracles of Military Medicine* are two of many good books which may be displayed.

5. Entomologist. Exhibit insect cases with instructions to the students to count the number of flies in the mount, find the fly that mimics a bee, find the tachina fly which was imported to kill the earwigs, etc.

6. Farmer. Exhibit local products of inferior and superior quality with the accompanying question: What knowledge of biology helps the farmer produce the superior quality?

7. Forest Ranger. Seedling trees, tree posters, and the books *Green Kingdom* and *Forest Trees of the Pacific Slope* attract the boys interested in forestry.
8. Housewife. Display government charts on nutrition, exhibits of mold, damage done by clothes moths, or other household pests.

9. Gardener or florist. Display seeds, cuttings, and bulbs of interesting plants with an invitation to start the schoolroom garden. Girls are also attracted by unique flower arrangements.

Biology and You

1. Your Health. Post student-made colored posters dealing with health on the bulletin board. Exhibit a map showing a student-made sanitary survey of the community health problems.

2. Your Leisure Time. Display campcraft equipment (a tin can stove, for example); projects made by previous classes (collections, models, maps, posters); empty aquaria, terraria, ant nests, animal cages and a few of the materials and animals that belong in them with suggestions as to how and what to collect to complete them.

3. Reading. Arrange a table display of interesting travel and science books and magazines opened to dramatic stories or pictures. Book reports of former students who have recommended the books for a permanent reading list may be displayed also.
Things to Do

1. Run the projector. In one corner of the room set up a projector and a selection of student-made slides which tell a story.

2. Play a Game. Locate a game device such as an electric chart in an uncrowded corner of the room so that a number of students may assemble around it.

3. Look through the Microscope. Set up a microscope showing some of the larger animals to be found in pond water. If possible have a former student present to assist.

4. What Is It? Arrange a number of interesting specimens such as cocoons, a water tiger, a shark's egg, and a skull on a shelf or table and direct the students to answers posted elsewhere.

5. What's Wrong With This Picture? Draw on the blackboard or post on a bulletin board several pictures such as a hawk with the wrong kind of toes, a group of polar bears against a dark background, or a Darwinian insect with the head of a bee on a butterfly. Have slips of paper handy so that the students may write their answers out and place in a ballot box below the pictures.

6. What Can You Make? Provide modeling clay, etched glass slides, and colored pencils for those who would like to try out this activity.
7. Can You Figure This Out? Place an interesting model out where students can examine it. Questions concerning the model may be written on one side of a card and the answers may be written on the back.
CHAPTER VII

CONSTRUCTION ACTIVITIES

Rare is the individual who does not feel the urge to make something when materials for its construction are suggestively within reach. Rare, too, is the teacher who makes use of this type of procedure to its fullest extent. Yet, more and more emphasis is being placed on the importance of the construction activities in the learning process for "... understandings are best developed when pupils have the opportunities to engage in a variety of experiences which may include much manipulation and construction." (69:84) Such teaching means cooperative planning and unlimited and stimulating suggestions from an enthusiastic teacher.

The majority of construction activities are projects. A project is a large unit of work or undertaking of a lifelike nature planned and carried to completion by the students. Some problem, usually the doing or making of something, is attacked as a whole. The construction activities presented in this chapter, however, are of a different nature since they are devices used by a teacher to stimulate interest in the introduction, development, or conclusion of a unit.
Matchbox Mitosis

To help the students develop an understanding of mitosis provide a matchbox, scissors, cellophane, and a sheet of blank paper for each two students. Have the students cut eight strips of paper to represent chromosomes, roll them loosely in a ball, and wrap cellophane around them. Let this ball represent the nucleus at rest. Place it in the center of the inner part of the match box, which represents a cell with the top cell wall removed.

Now let the students do the following:

1. Remove the cellophane, unroll the eight strips of paper, cut each strip in half lengthwise, and place half of each strip in one pile and the other half in another pile.

2. Wrap in cellophane the eight halves of paper strips from one pile. Do the same for the other pile.

3. Place the two balls in opposite ends of the box and insert a piece of cardboard to represent the new cell wall. (49:255)

The Diorama as a Teaching Aid

The construction of a diorama is a useful device for reviewing or organizing material presented in a unit. Miniature dioramas may be made of the life cycles of
plants and animals, habitat relationships, or typical events in the lives of great scientists. After a scene has been decided upon a box is made to house the completed picture. The background is painted on a curved cardboard. Items such as actual specimens, drawings, paintings, or cutouts may be used in the foreground. (11)

Diorama cases are about one foot square and eight inches wide and may be constructed from ordinary wooden boxes. Figures are modeled about a wire frame or armature. Plastic clay figures are posed on the wire nails to prevent them from falling forward. Trees are made from small twigs which are forced on to small wire nails for support. Leaves may be made from artificial flowers. Rock formations may be imitated by smearing screen wire with plastic clay. The screen can be bent in any shape and tacked into place on small blocks of wood. The entire study should be protected by glass in front of the diorama case. (24)

Model Making for Biology

Though the making of models takes several periods of class time it is an excellent means of review. Complete directions for making four types of models -- plastocene, bas-relief models, plaster cast plaques, and three-dimensional latex models -- are given in an article in the December, 1943, issue of School Science and Mathe-
matics. Suggestions for subjects, materials to be used, and procedures to be employed are included in the directions. (25)

Soap Modeling

Use a soft soap, "orange-wood" sticks, and a sharp knife. A drawing of an appropriate size is made on paper and transferred by means of carbon paper to the soap. Use the orange stick to remove the area between the parts to be shown in relief. The regions may be colored with water color. Shellac will prevent the cake from warping later. (55)

Bird Eggs

These may be made from plaster of paris. A mold can be made by placing a rounded end of stick into soft clay. Plaster of paris is then poured and when hard the egg is shaped with a knife and the rough spots sandpapered. Color the models to duplicate real eggs. (56)

Human Manikin

The Turtox human manikin obtained from the General Biological Supply House is one-seventh natural size when completed. It consists of a cover showing the muscles and a page each of the skeleton, circulatory system,
organs of the digestive and respiratory systems, and the nervous system. In coloring, cutting out, arranging, and making a key to the organs the student gains a good understanding of the important systems of his body. Each separate page may be used as an introduction to a new system.

Map Making

1. Ecology. The conservation stamps obtained from the National Wild Life Association may be placed in the proper place on a map of the United States.

2. Conservation. The location of state fish hatcheries and state parks can be shown on a map of Oregon by using colored signal dots. Bird sanctuaries, game refuges, and National Forests may be colored in.

3. Sanitation Survey. An interesting map of the community may be made. Show the location of the water supply, sewage disposal plant, garbage dump, incinerator, unsightly places, insect breeding places, or other areas which concern public health.

4. Tree maps. Make maps showing the location of trees on the school grounds, in a park, or in the area adjacent to the school.

5. Ecology. Make a map of the area covered in a field trip to study the relation of organisms to their environment.
Lantern Slides

Etched glass slides provide an interesting and worthwhile activity for students. Each student is provided with a slide upon which he sketches something the class is studying at the time (adaptations, cells, organs). Colored pencils are used to bring out certain parts. When the slides are complete one student operates the projector and each student gives a short talk about his slide when it is shown. After the "show" the slides may be washed and made ready for the next unit.
CHAPTER VIII

OTHER TEACHING AIDS

The greater the variety of learning aids used, the greater the interest and attention of the class will be and the more complete and permanent the learning. In this chapter are supplementary aids that make use of the sense of taste and smell, listening aids, and aids that appeal to a student's urge for expression.

Cheese Day

In order to study bacteria and molds in relation to the flavoring of cheese committees of students were organized to plan the work. Some brought in cheese of various types, others crackers, and still others looked up articles on the subject of cheese and volunteered to make oral reports to the class. The cheeses were labeled and placed on the demonstration desk. After each different type was reported on the students lined up and sampled the cheese. The reports included the historical background of the cheese, the process of manufacture and how the sample was flavored. (4)

Apple Day

One biology class celebrated apple week by arranging a program and apple exhibits. A committee planned the
program which consisted of reports on apple pests, apple relatives, grafting, cultivation, apple storage and marketing, nutritive value of apples, apples in legend and history, apples in song and verse, apples around the world, the development of apples from flower to fruit, and the economic value of apples in our county, state, and nation.

Refreshments planned by another committee were served whenever the program called for it. They consisted of apple sauce, apple jelly on saltines, cider, applesauce cake, tiny apple pies with cheese. (19)

Christmas Suggestions

In order to integrate biology with other school subjects a program of topics relating both to biology and Christmas was planned for the day before the Christmas vacation. A student chairman introduced the speakers who reported on the following topics: mistletoe, origin of the Christmas tree, fruits for Christmas, decorative plants, nuts, topics related to animals such as the Geese in Lithuania, Reindeer, or Turkeys, Christmas poems, paper, yule log, candles, relation of yeast and bacteria to Christmas, frankincense, Myrrh, and Santa Claus. (20)

Recordings

The records listed below may be obtained from New
Tools for Learning.* Those listed "for loan" are sent free of transportation charges.

R26 This Land We Defend (series) Each recording 15 minutes playing time; 16" at 33 1/3 r.p.m. For loan. Ten dramatizations dealing with different phases of the great battle to stop soil erosion.

R27 Help Yourself to Health (series) Each recording 15 minutes playing time; 16" at 33 1/3 r.p.m. For loan. Six dramatizations prepared and produced by the U.S. Public Health Service and U.S. Office of Education presenting vital and authentic information on venereal diseases, tuberculosis, pneumonia, cancer, and heart disease.

R28 Health for America (series) Each recording 15 minutes playing time; 16" at 33 1/3 r.p.m. For loan. Eight dramatizations produced by the U.S. Public Health Service on the necessity for proper medical and dental care.

R45a Science as a Career (Adventures in Research series) 15 minutes playing time; 16" at 33 1/3 r.p.m. For loan. Two recordings featuring Dr. Phillips Thomas outlining the various abilities, personality traits, and skills which the scientist must have and pointing out that the post-war world will vastly increase the opportunity which science offers as a career.

R41 Walter Reed (Calvalcade of America series) 25 minutes playing time; 16" at 33 1/3 r.p.m. Sale price $3.50; 12" at 78 r.p.m. Sale price $4.50. A dramatization featuring the American soldier-physician and his efforts to discover, clarify, and to take steps to eradicate the disease called "Yellow-Jack".

R42 The Mystery of the Spotted Death (Calvalcade of America series) 25 minutes playing time; 16" at 33 1/3 r.p.m. Sale price $3.50; 12" at 78 r.p.m. Sale price $4.50. A dramatization depicting the people living in the mountain

* See Appendix B
valleys of America's west visited by a dreadful plague.

R43 Red Death (Calvalcade of America series) 25 minutes playing time. 16" at 33 1/3 r.p.m. Sale price $3.50. 12" at 78 r.p.m. Sale price $4.50. A dramatization of Dr. Goldberger's investigation of pellagra.

Records of American Song Birds

The following records of American Bird Songs may be obtained from Nature Storehouse.* Single records are $1.25 postpaid; the six records in an attractive album cost $6.00 postpaid. The bird songs were recorded by the Albert R. Brand Bird Song Foundation, Laboratory of Ornithology, Cornell University. They are the product of many months of travel and many hours of patient prowling in the birds' natural haunts by a group of Cornell ornithologists using the finest of modern equipment for photographing and transcribing delicate sounds.

1. Birds of the Northwoods
2. Birds of Northern Gardens and Shade Trees
3. Birds of Southern Woods and Gardens
4. Birds of the Fields and Prairies
5. North American Game Birds
6. Birds of Western North America

Other records of bird songs are:

Victor Records: 17735, 55049, 25765
Columbia Records: A-2860, A-3118, 3832
Luther Burbank Recordings

Gardening the Luther Burbank Way. Seven 16" records, each containing two fifteen minute programs at 33 1/3 r.p.m. are available from Educational Radio Script and Transcription Exchange.*

Science Questions

Science questions or quizzes may be used in a number of ways to stimulate the interest of students. They may be placed on the electric game chart, on a game wheel, or in the "Do You Know" quiz book. They may be used as a radio quiz program or as questions for a contest. Below are some of the quizzes which students have thoroughly enjoyed.

Who's Who in the Animal Kingdom

1. What great animal gives birth to its young during the long twilight sleep of hibernation? (polar bear)

2. What is the only bird that can fly straight up, down, sideways, and backward? (hummingbird)

3. What is the largest creature this earth or its waters have ever known? (blue whale)

4. What creature has the curious habit of swallow-
ing some hard, indigestible substance such as a stone, or
a tree-knot before it hibernates? (alligator, crocodile)

5. What wild animal is the hardest to trap? (wolf)

6. What bird is always in continuous flight while
away from the nest? (chimney swift)

7. What animal made many of the trails over the
hills and plains of North America -- routes so perfect
from an engineering standpoint that many of our highways
and railways have been built upon them? (bison)

8. What wild animal refuses to eat food that he does
not carefully wash? (raccoon)

9. What animal thumps on the ground with its feet
to communicate with its fellows? (rabbit)

10. What bird will plunge at full speed into a snow-
bank in order to escape the rigors of a winter's night?
(grouse)

11. What three natural enemies in nature will some-
times be found together in the same burrow underground?
(owl, prairie dog, and the rattlesnake)

Animal Families

Name the male of the species

1. cow
2. hen
3. goose
4. doe
5. sow
6. duck

bull
rooster
gander
buck
bear
drake
Name the female of the species:

7. tiger  tigress
8. ram  ewe
9. stallion  mare
10. fox  vixen

Name the young:

11. bear  cub
12. sheep  lamb
13. duck  duckling
14. frog  tadpole
15. swan  cygnet
16. chicken  chick
17. hen  pullet
18. horse  colt, foal
19. mare  filly
20. deer  fawn
21. elephant  calf
22. cat  kitten
23. goose  gosling
24. bull  bullock
25. cow  heifer

Name the shelter we build for them:

26. for dogs  a kennel
27. for pigeons  a coop
28. for pigs  a pen
29. for fish  an aquarium
30. for cows  a shed
31. for doves  a cote
32. for rabbits  a hutch

What do we call their natural homes:

33. of birds  nests
34. of lions  den
35. of beavers  lodge
36. of rabbits  burrow
37. of eagles  aerie

What do we call groups of animals:

38. of sheep  flock
39. of cattle  herd
40. of lions  pride
41. of wolves  pack
42. of snipe  wisp
43. of fish  school
44. of quail  covey
45. of geese  flock
46. of bears  sloth
47. of bees  swarm

Animal Sounds

Name the sounds they make:

1. lions  roar
2. pigs  squeal
3. sheep  bleat
4. cows  moo, low
5. ducks  quack
6. wolves  howl
7. crows  caw
8. snakes  hiss
9. donkeys  bray
10. geese  gabble, cackle
11. wild geese  honk
12. hens  cackle
13. cocks  crow
14. frogs  croak
15. doves  coo
16. elephants  trumpet
17. owls  hoot, screech

Three other quizzes popular with the students are:

1. Natural History Quiz by Roy Chapman Andrewes available in the June 21, 1941, issue of Liberty.

2. Science or Superstition in the April, 1939, copy of Reader's Digest.

3. Nature-Fact or Nature-Fiction by Alan Devoe in Reader's Digest, April, 1943.
Science Newspaper

To review science progress made in recent months each student in class was appointed science editor of his own newspaper. He planned the make-up, placement of stories, headlines, cartoons, and all other details of his own paper. All available sources of current science news were used for reference. The activity lasted several days giving the students a chance to exercise originality in cartoons, headlines, etc. The best paper was posted.

Biology Diaries

To give the student training in making observations they were given mimeographed sheets of directions for keeping biology diaries. This sheet stressed accuracy, the making of personal observations, and giving credit to those who helped. It also contained suggestions as to what to write about:

1. Examples of biological principles such as the balance of nature, protective adaptations, and energy cycle.
2. Effect of weather and change of season on living things.
3. Identification of living things.
4. How plants and animals carry out the life functions.
5. Scientific discoveries.
6. Examples of good or bad scientific attitudes, or poor attitudes. (61)

Recording Nature Specimens Brought to the Classroom

One good way to encourage students to bring in nature specimens is to have a system whereby proper credit may be given to such individuals. Cards with the pupil's name on the top are filed alphabetically according to sections and held together by a rubber band. These are kept in the teacher's desk. Whenever a pupil brings in something, identifies it, and arranges it for display he records his work on the card. Students may also record laboratory material, pictures, and clippings brought in, as well as outside reading. At the end of the grading period the teacher may go through the cards and give the student credit for all contributions he has made. (41)

Panel Discussions

A procedure which varies classroom activities and fosters sustained group attention is the panel discussion. It is an excellent way to present subject matter in an organized but informal manner. A good panel consists of about seven intelligent students who like to search out information and have a feeling of personal responsibility. In preparation for the discussion they read all the material on the subject, take notes, and jot down questions that
In presenting the discussion all members are seated at a table and remain seated while talking. It is the duty of the chairman to introduce the members of the panel, state the topic for discussion, and tell the audience that they may take part. It is also his duty to see that each member of the panel has an opportunity to speak, to check long speeches, and to summarize the discussion. Any member of the panel makes a remark which serves to start the discussion. Other members talk or ask questions in any order; there should be no long speeches. The teacher is in the audience as a source of reference. (57)
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APPENDIX A

QUESTIONNAIRE ON INSTRUCTIONAL PROCEDURES
Dear Fellow Teacher:

As a part of my work toward a master's degree at Oregon State College I am preparing a handbook of interesting instructional procedures for teaching secondary school biology. It will be greatly appreciated if you will take a few minutes to check your reactions to the questions below.

1. What per cent of the students in your high school register for biology before graduation? _____%

2. Do you use interesting instructional procedures--activities, devices, or techniques which may be used for the purpose of stimulating further activity on the part of the student, developing attitudes and understandings, or for introducing, enriching, or reviewing a unit?
   a____ extensively   b____ moderately   c____ little

3. Check the types that you have used:
   a____ field trips   d____ construction activities
   b____ games   e____ dramatizations
   c____ visual aids other than motion pictures

4. Where in the lesson plan do you use them?
   a____ introduction   b____ development   c____ conclusion

5. Do you feel that such procedures are worthwhile?
   a____ extremely valuable   c____ moderately valuable
   b____ limited in value   d____ no value

6. Do you feel there is a need for such procedures?
   a____ no   b____ yes

7. Do you use any of the following as a source book for instructional procedures?
   a____ current literature
   b____ Cornell Rural School Leaflets
   c____ Nature Recreation, Vinal, McGraw-Hill
   d____ Nature Games, Stevenson, Greenberg
   e____ Science Guide for Elementary Schools, California State Department of Education
   f____ others:

8. If you have some interesting instructional procedures not found in current literature or professional books that would be of value to this thesis and to others teaching biology, please outline them on the back of this sheet. Full recognition of the source will be indicated. It is hoped that the completed handbook will be made available to all those who might be interested in receiving it. If you are interested in receiving a copy of the handbook at the cost of mimeographing, please give your name and address.
APPENDIX B

SOURCE ADDRESSES
APPENDIX B

SOURCE ADDRESSES

American Biology Teacher, Lancaster, Pa. Annual membership, including subscription, $1.50.


National Recreation Association, 315 Fourth Avenue, New York, 10, New York.

Nature Storehouse, 1820 Bushness Avenue, South Pasadena, California.


Pictorial Statistics, 142 Lexington Avenue, New York, New York.

School Science and Mathematics, 450 Ahnaip Street, Menasha, Wisconsin. Subscription $2.50 a year.

Science Education, 374 Broadway, Albany, New York. Subscription $2.50 a year.


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