

CURRICULUM

QH  
315.5  
A33  
1969  
gr.10-12

CURRGDHT

ALTA  
574  
1969  
Gr10-12

CURR



# **CURRICULUM GUIDE**

**EDUCATION LIBRARY  
CURRICULUM**

## **Senior High School**

### **BIOLOGY 10, 20, 30**



**DEPARTMENT OF EDUCATION  
EDMONTON, ALBERTA  
SEPTEMBER, 1969**

EX LIBRIS  
UNIVERSITATIS  
ALBERTAENSIS



27  
19  
Gr

## Acknowledgement

The Department of Education acknowledges with appreciation the contributions of the following to the preparation of this Senior High School Curriculum Guide for Biology. The Guide has been prepared by the Ad Hoc Committee on Biology. The Committee operated under the guidance of the Senior High School Science Curriculum Committee and the Senior High School Curriculum Board.

### Senior High School Biology Ad Hoc Committee

Dr. C. D. Bird, Department of Biology, University of Calgary, Calgary.

James Grieve, Jasper High School, Jasper.

Dr. C. G. Hampson, Department of Secondary Education, University of Alberta, Edmonton.

Dr. J. S. T. Hrabi, Director of Curriculum, Department of Education, Edmonton.

Mrs. Jean E. McCall, Fort MacLeod High School, Fort Macleod.

W. I. Miller, Stony Plain High School, Stony Plain.

John Pankhurst, McNally Composite High School, Edmonton.

D. N. Youngstrom, Bowness Composite High School, Calgary.

L. R. Tolman, Inspector of High Schools, Red Deer, Chairman.

NOTE: This curriculum guide is a service publication only. The official statement regarding Senior High School Biology is to be found in the Program of Studies. The information in the Guide is prescriptive insofar as the content duplicates that given in the Program of Studies; however, the Curriculum Guide contains, as well as content, methods of developing the concepts, suggestions for the use of teaching aids, and lists of additional reference books.



Digitized by the Internet Archive  
in 2012 with funding from  
University of Alberta Libraries

UNIVERSITY  
OF ALBERTA LIBRARY

<http://archive.org/details/shsbiology10203069albe>

## PHILOSOPHY AND OBJECTIVES IN RELATION TO

### BIOLOGY COURSES

- A. The understanding of biological principles and processes is paramount. While principles cannot be developed in the absence of supporting facts, the memorization of technical detail is unwarranted. But, mastery of a limited number of technical terms is essential for precise communication. Principles become more meaningful when applied to specific problems. The teaching of structure and function should be correlated throughout the course.
- B. The courses are designed to familiarize the student with his immediate biological world. Every student should be given opportunity to participate in field trips, and adequate facilities must be provided for first-hand laboratory study.
- C. In a consideration of evolution, present-day representatives of the biological kingdoms should not be considered as ancestral forms.
- D. The courses should ensure a positive realization of the interdependence of living organisms and the importance of conservation.
- E. Three texts have been recommended for use in Biology 10 and 20. Although a preferred text has been indicated for each course, teachers may use any or all of them to develop the units outlined. For the convenience of teachers, page references have been shown for each text. It is expected, however, that professional judgment will determine how each unit will be developed to meet the needs and interests of the students.

### LABORATORY WORK IN BIOLOGY

Laboratory work is a vital part of the high school biology program. In order that students obtain maximum value from laboratory experiences these should be done concurrently with the text material. It is strongly recommended that living specimens be utilized for laboratory work as the occasion demands. However, it is strongly recommended that (1) no experiment using live animals should be attempted unless the animals have clean, comfortable quarters with adequate food and water, and unless humane procedures are followed at all times and, (2) such an experiment should have as a clearly defined objective the teaching of some biological principle which cannot be taught effectively without animals. Living plants and animals are valuable in creating an appropriate environment for teaching biology.

### RECOMMENDED DISTRIBUTION OF TIME

In Biology 10 and Biology 20 it is suggested that a minimum of 15% of the course time be devoted to each unit.

## GENERAL OBJECTIVES OF HIGH SCHOOL BIOLOGY COURSES

1. To enable the student to familiarize himself with his immediate biological world and to realize the importance of the interdependence of living organisms, and the part man plays in this scheme.
2. To develop the ability of a student to carry out successful independent study and learning.
3. To develop sound procedures for biological field and indoor laboratory study.
4. To develop an understanding of and an appreciation for the methods used by scientists; the means and conditions under which science advances; the role of biologists; the importance of accurate and accessible records, constantly improved instruments, and free communication.

### BIOLOGY 10

#### SPECIFIC OBJECTIVES

1. To explore the current critical biological problems of human overpopulation, resource management, and space biology.
2. To learn the basic principles of the classification of organisms and the application of these principles in the construction of keys.
3. To learn the reasons for and the techniques of collecting and maintaining appropriate biological specimens and to develop an appreciation of the importance of these activities.
4. To develop an understanding of the principles of ecology.
5. To study the principles of cytology and heredity.



RECOMMENDED TEXTS (in order of preference)

1. BSCS Green Version, *High School Biology*, 2nd Edition, W. J. Gage Limited, Scarborough, Ontario, 1968.
2. Otto, J. H. and A. Towle, *Modern Biology*, Holt, Rinehart and Winston, Toronto, 1965.
3. BSCS Yellow Version, *Biological Science An Inquiry into Life*, 2nd Edition, Longmans Canada Limited, Don Mills, Ontario, 1968.

NOTE: Laboratory Manual to accompany (3) above is to be used with both *Modern Biology* and the BSCS Yellow Version. The Laboratory program for the BSCS Green Version is included in the text.

TEACHER AND/OR STUDENT REFERENCES

- Alberta Department of Education, *Renewable Natural Resources in Alberta*, The Department, Edmonton, 1962.
- Alberta Department of Education, *Keys to the Plants and Animals of Alberta*, School Book Branch, Edmonton, 1969.
- Benton and Werner, *Manual of Field Biology and Ecology*, Burgess Publishing Co., Minneapolis, 1965.
- Benton and Werner, *Field Biology and Ecology*, 2nd Edition, McGraw-Hill, Toronto, 1966.
- BSCS Laboratory Blocks (12 Titles). Heath, Boston.
- BSCS *Research Problems in Biology: Investigations for Students*, Series 1-4, Doubleday, Garden City, N. Y.
- BSCS *Teacher's Guide* for Green Version Text, 1968.
- BSCS *Teacher's Guide* for Yellow Version text, 1968.
- Bullough, W. S., *Practical Invertebrate Anatomy*, 2nd Edition, MacMillan, Toronto, 1958.
- Hardy, W. G. (Ed.), *Alberta: A Natural History*, Hurtig, Edmonton, 1967.
- Morholt, E., P. F. Brandwein, and A. Joseph, *A Sourcebook for the Biological Sciences*. Longmans Canada Limited, Don Mills, Ontario, 1958 or 1966.
- Sankey, John, *Guide to Field Biology*, Longmans, London, 1958.
- Savile, D. B. O., *Collection and Care of Botanical Specimens*, Canada Dept, of Agriculture. Publication No. 1113, Ottawa, 1962.

COURSE OUTLINE  
(READ)

Note: Laboratory Investigations

It will be noted in the following laboratory exercises have been suggested. to be basic. Selection from among the teacher and students.

Unit I

Student Biology Project

This project will be guided by the out by the student (or group of students). but should involve laboratory and/or report. It will be started early, will continue until the end of the course.

Unit II

Classification

1. Basis of classification
2. Collecting
3. Preserving specimens
4. How to make and use a key.

BSCS 1968 GREEN

pp. 104-113, pp. 155-157, Labs 1.1\*, 1.3\*, 4.1\*, 4.2\*  
Nil  
Nil  
pp. 782-803, Labs 5.1\*, 5.2\*

Unit III

Ecology

1. Ecosystems and communities
2. Environmental factors
3. Interaction
4. Resource management with emphasis on pollution and conservation
5. Space biology.

pp. 1-101, Labs 1.2\*, 1.4, 1.5\*, 2.1\*, 2.2\*, 2.3\*, 3.1\*, 3.2\*  
pp. 214-338, Labs 7.1\*, 7.2, 7.3\*, 7.4, 8.1\*, 8.2\*, 8.3, 9.1, 9.2\*  
pp. 741-775.

Unit IV

Cell Theory and Genetics

1. Cell theory
2. Mitosis and Meiosis (chemistry not included)
3. Mutation and selection
4. Selective breeding (plant and animal)
5. Human overpopulation

pp. 378, 386, Lab 11.1\*  
pp. 393-397, Lab 11.3\*, pp. 586-591, Lab. 16.2\*  
pp. 624-672, All the labs in Ch. 17 and 18, Labs 17.1\*, 17.2\*, 17.3, 17.4\*, 17.5\*  
Nil  
pp. 748-752

BIOLOGY 10  
ACROSS)

outline that a substantial number of  
Those marked with an asterisk are considered  
others is left to the discretion of the

teacher but will be selected and carried  
The project can be in any area of biology  
field research and the writing of a  
run concurrently with other units and may

OTTO & TOWLE 1965

pp. 199-210, Labs 1.1\*,  
1.2\*

pp. 744-754, Labs 13.1\*,  
17.2\*, 18.1a\*, 19.1\*

BSCS 1968 YELLOW

pp. 348-371, Labs 1.1\*,  
1.2\*,

pp. 762-819, Labs 13.1\*, 17.2\*,  
18.1a\*, 19.1\*

pp. 660-670

pp. 672-698

pp. 699-711, Labs 10.1\*, 11.2\*,  
11.3, 36.1\*, 37.1\*, 37.2\*

pp. 712-741

pp. 1-18

pp. 677-733

Labs 10.1\*, 11.2, 11.3, 36.1\*,  
37.1\*, 37.2\*

pp. 734-738, pp. 743-756  
pp. 668, 692-694

pp. 55-69, Labs 2.1\*, 3.1\*,  
3.2\*, 3.3\*

pp. 103-114, Lab 7.1\*

pp. 116-169, Labs 29.1\*,  
29.2\*, 29.3\*, 29.4

pp. 170-181

pp. 38-53, Labs 2.1\*, 3.1\*,  
3.2\*, 3.3\*

pp. 127-146, Lab 7.1\*

pp. 521-567, Labs 29.1\* 29.2\*,  
29.3\*, 29.4, 30.1, 30.2,

pp. 603-606

pp. 738-743

## BIOLOGY 20

### SPECIFIC OBJECTIVES

1. To investigate further the principles of ecology by carrying out a field or laboratory project.
2. To study the theories of biological evolution.
3. To show the development and relationship of form and function by comparative study of representatives of the biological kingdoms. The study of man is to be included.

### RECOMMENDED TEXTS (in order of preference)

1. BSCS Yellow Version, *Biological Science An Inquiry Into Life*, Second Edition, Longmans Canada Limited, Don Mills, Ontario, 1968.
2. Otto, J. H. and A. Towle, *Modern Biology*, Holt, Rinehart and Winston, Toronto, 1965.
3. BSCS Green Version, *High School Biology*, Second Edition, W. J. Gage Limited, Scarborough, Ontario, 1968.

NOTE: Laboratory Manual to accompany (1) above, is to be used with both *Modern Biology* and the BSCS Yellow Version. The laboratory program for the BSCS Green Version is included in the text.

### TEACHER AND/OR STUDENT REFERENCES

Alberta Department of Education, *Renewable Natural Resources in Alberta*, The Department, Edmonton, 1962.

Alberta Department of Education, *Keys to the Plants and Animals of Alberta*, School Book Branch, Edmonton, 1969.

1. *Key to Tree-Dwelling Lichens of the Prairies and Parklands of Alberta*
2. *Key to Aquatic Mollusks of the Prairies and Parklands of Alberta*
3. *Key to the Principal Group of Insects Occurring in Alberta*
4. *Key to the Amphibians, Fresh Water Invertebrates and Reptiles of Alberta*
5. *Key to the Families of Alberta Fishes*
6. *Key to the Mammals of Alberta*
7. *Key to the Bryophytes of Alberta*

- BSCS Laboratory Blocks (12 Titles). Heath, Boston.
- BSCS *Research Problems in Biology: Investigations for Students*, Series 1-4, Doubleday, Garden City, N. Y.
- BSCS Teacher's Guide* for Green Version text, 1968.
- BSCS Teacher's Guide* for Yellow Version text, 1968.
- Buchsbaum, R., *Animals Without Backbones*, Penguin, Harmondsworth, England, 1962.
- Budd, A. C. and K. Best, *Wild Plants of the Canadian Prairies*, Queen's Printer, Ottawa.
- Bullough, W. S., *Practical Invertebrate Anatomy*, Second Edition, MacMillan, Toronto, 1958.
- Cronquist, A., *Introductory Botany*, Harper and Row, New York, 1961.
- Hardy, W. G. (Ed.), *Alberta: A Natural History*, Hurtig, Edmonton, 1967.
- Morholt, E., P. F. Grandwein, A. Joseph, *A Sourcebook for the Biological Sciences*, Longmans Canada Limited, Don Mills, Ontario, 1958 or 1966.
- Savile, D. B. O., *Collection and Care of Botanical Specimens*, Canada Department of Agriculture, Publication No. 1113, Ottawa, 1962.
- Storer, T. I. and R. L. Usinger, *General Zoology*, Fourth Edition, McGraw-Hill, Toronto, 1965.

COURSE OUTLINE  
(READ

Note: Laboratory Investigations

It will be noted in the following laboratory exercises have been suggested to be basic. Selection from among the teacher and students.

---

Unit I

Student Ecology Project

This project will be guided by the out by the student (or group of students). but should involve laboratory and/or report. It will be started early, will continue until the end of the course.

---

Unit II

Evolutionary Development

1. Review Unit IV, part 3 of Biology 10
2. The theories of evolution

BSCS 1968 GREEN

pp. 624-672  
pp. 673-713, Labs 18.1,  
18.2, 18.3

---

Unit III

Biological Kingdoms

1. The two, three and four-kingdom systems
2. The relationship of form and function in the study of comparative anatomy, morphology and life cycles of selected representatives of the kingdoms.

pp. 113-213, pp. 591-623

pp. 578-586, Labs 4.3\*, 6.1\*,  
6.2, 6.3\*, 16.1, 16.3\*

outline that a substantial number of  
Those marked with an asterisk are considered  
others is left to the discretion of the

teacher but will be selected and carried  
The project can be in any area of ecology  
field research and the writing of a  
run concurrently with other units and may

OTTO & TOWLE 1965

pp. 116-169  
pp. 182-209, pp. 542-550,  
Labs 32.1, 32.2, 32.3, 32.4

BSCS YELLOW

pp. 521-567  
pp. 568-642, Labs 32.1, 32.2, 32.3,  
32.4

pp. 199-210

pp. 211-540, Labs 9.1,  
10.2\*, 11.1, 12.2\*, 13.2\*,  
14.1\*, 14.2\*, 14.3, 15.2\*,  
15.6\* Labs 16.1\*, 16.2\*,  
17.1\*, 17.3\*, 18.1b\*, 18.2\*,  
18.3, 18.6\*, 19.2\*, 19.3\*,  
19.4\*, 27.1, 27.2\*, 28.1

pp. 177-281, Labs 9.1, 10.2\*, 11.1,  
12.2\*, 13.2\*, 14.1\*, 14.2\*,  
14.3, 15.2\*, 15.6\*  
pp. 296-371  
Labs 16.1\*, 16.2\*, 17.1\*, 17.3\*,  
18.1b\*, 18.2\*, 18.3, 18.6\*, 19.2\*,  
19.3\*, 19.4\*,  
pp. 458-477, Labs 27.1, 27.2\*,  
28.1

## BIOLOGY 30

### SPECIFIC OBJECTIVES

1. To emphasize understanding of biological principles rather than memorization of terms, definitions, diagrams, etc. It is assumed that students will have a background knowledge of structure from studies of Biology 10 and 20.
2. To develop a deeper understanding of life, through a study in depth of such life processes as:
  - (a) ingestion
  - (b) digestion
  - (c) absorption
  - (d) assimilation
  - (e) elimination
  - (f) excretion
  - (g) sensitivity
  - (h) reproduction

### RECOMMENDED TEXTS

1. Brown, *Chemical Background for Biology 30*, School Book Branch.
2. Weisz, *Elements of Biology*, McGraw-Hill, 1963 or 1965 Edition, including *Points of View on the Theory of Evolution*, (supplement).
3. Laboratory Manual: *Laboratory Exercises for Elements of Biology*, McGraw-Hill.

### TEACHER AND/OR STUDENT REFERENCES

- Weisz, *Science of Biology*, McGraw-Hill, 1967 Edition  
This book is an elaboration of *Elements of Biology* and is an essential part of the teacher's reference library.
- Weisz, *Instructor's Manual to Accompany Elements of Biology*, McGraw-Hill. (This one is recommended)



## TIME SCHEDULE

The following time schedule is suggested. It is anticipated that teachers will depart from this schedule as is appropriate to meet the needs and interests of their specific classes.

<u>Unit</u>	<u>Suggested Time</u>
I	5 Weeks
II	13 Weeks
III	9 Weeks
IV	4 Weeks
V	<u>4 Weeks</u>
	35 Weeks

## COURSE OUTLINE

NOTE: Although the former Unit I on "*Chemical Background*" has been eliminated it is expected that necessary chemistry information will be included, where appropriate, in the following units.

### Unit I The Living Organism (3 Weeks)

<u>Topic</u>	<u>Reference</u>	<u>Lab.</u>	<u>Time</u>
1. Protoplasm and Cells	Chapter 6	1,2,3, 4,5,8,9	5 Weeks

### Unit II Metabolism (13 Weeks)

1. Autotrophic Nutrition	Chapter 10	6,7,10, 11,12,13	5 Weeks
2. Heterotrophic Nutrition	Chapter 11	14,15,16	2 Weeks

<u>Topic</u>	<u>Reference</u>	<u>Lab.</u>	<u>Time</u>
3. Gas Exchange	Chapter 12	17	1 Week
4. Cellular Metabolism: Respiration	Chapter 13	18,19,21	3 Weeks
5. Cellular Metabolism: Energy Utilization	Chapter 14	20	2 Weeks

#### Unit III

Self Perpetuation: The Steady State (9 Weeks)

1. The Pattern of Control	Chapter 15		1 Week
2. Cellular Controls	Chapter 16		1 Week
3. The Body Fluids	Chapter 17	22,23,24, 25	5 Weeks
4. Nervous Co-ordination	Chapter 18	26,27,28	2 Weeks

- NOTE:
1. Omit chart p. 323 except as it applies to the Neural receptors.
  2. The diagram on p. 340 is poor. The diagram on p. 341 shows the hair cells incorrectly in contact with the tectorial membrane.

#### Unit IV

Self Perpetuation: Reproduction (4 Weeks)

1. The Pattern of Reproduction (Mitosis and meiosis are to be taught essentially as a review of Biology 20)	Chapter 19	29	1 Week
2. Reproduction: Monera Protista, Metaphyta	Chapter 20		1 Week
3. Reproduction: Metazoa	Chapter 21		2 Weeks

<u>Topic</u>	<u>Reference</u>	<u>Lab.</u>	<u>Time</u>
Unit V			
Self Perpetuation:	Adaptation (4 Weeks)		
1. Heredity	Chapter 22	30,31,32	2 Weeks
2. The Mechanism of Evolution	Chapter 23		1 Week
3. The Course of Evolution	Chapter 24 and <i>Points of View</i> Supplement		1 Week
			<hr/> 35 Weeks

## APPENDIX A

### SUGGESTIONS REGARDING FIELD TRIPS

It is desirable that every student in every class go on at least one field trip. Numerous difficulties may make this impractical for every school. Each teacher must determine his own limitations because of number of students, transportation problems, timetable and period length as well as the interests of the class and the available regions for a visit. Permission must always be obtained from appropriate authorities--usually the principal. Liability in event of accidents must be clearly understood.

#### Preparation

- Teacher must cover the route to check details for pre-briefing of the class.
- Arrangements with other personnel to assist must be confirmed to avoid confusion.
- Class should be given an outline of plans in a pre-briefing session.
- Items of special interest and problems to watch should be listed.
- Designation of responsibilities for each group should be made here.
- Arrangements for transportation, time of departure and return, and equipment needed should be clearly outlined.

#### Follow-Up

- Collected items should be sorted and labelled for future reference.
- Information gathered should be summarized and distributed.
- Specimens collected should become the basis for laboratory work:
  - living specimens kept in an aquarium or terrarium,
  - others may be preserved or mounted.
- Identification of organisms using a simple key is desirable.
- Labelling and mounting for a simple museum will be useful in future years to enlarge the school classes' outlook.

### Assessment

Each participant should appraise their trip as a personal help.

Teacher should check usefulness to the course and the school and student.

Problems in management need immediate listing for revising future planning of a similar trip.

### Applied Biology Field Trip Suggestions

1. Experimental Farms
2. District Agriculturist and Local Fairs
3. Water Purification Plants and Sewage Disposal Plants
4. Vocational Businesses e.g., Seed Plant

### Information Field Trip Suggestions

1. Hospital and Clinic
2. Food Processing Plants
3. Greenhouse or other special production
4. University or Museum

### Collecting Field Trip Suggestions

1. A Pond Life Study
2. A Woodland Habitat
3. A Creek or River Habitat
4. Rock Types and Samples
5. Ecology--in any area

## APPENDIX B

### SUGGESTED OUTLINE FOR A POND COMMUNITY STUDY

#### Preparation

- Divide the class or group into teams--about four.
- Outline the duties of each team and suggest equipment needed.
- List equipment to be used:
  - Glass marking pencils
  - Jars--screw top and wide mouth  
gallon or larger, 2  
quart, 6  
pint, 12
  - Insect net
  - Plankton net--with metal loop and collecting bottle
  - Can #3 with ends cut and a #8 mesh soldered on
  - Forceps, 2
  - Plastic bags--assorted, 4
  - Rubber bands
  - String--strong
  - Preservative solution
  - Insect killing jar

#### Field Work

- Each group collects different materials, e.g., plankton, sediments, water plants, water animals, etc.
- Samples collected with ample water in jars and labelled.
- Plant specimens should be whole if possible.
- Only one or two of each animal type is needed.
- Large jars of water, plants, sediment, etc., should be preserved for maintenance in the laboratory and later study.

#### Follow-Up Work

- Each group reports on its collection to the class.
- Identification, labelling and study of the organisms by each group. Phylum level may be sufficient--more detail can follow if interest is good.
- Description of whole community to show relationships, nutrition groups etc.
- Use of reference books to arouse interest and complete study for interested students.

## APPENDIX C

### ECOLOGICAL STUDY OF TWO HABITATS\*

#### Purpose

To compare the physical and biological characteristics of two habitats and to observe the factors that enable organisms to live there.

#### Theory

The term habitat implies a particular kind of environment in which an organism may be found. Such physical characteristics as types of soil, temperature, light conditions, air currents, and available water would limit the organisms that could tolerate a particular environment. Other living things present in the environment of the organism are considered the biological characteristics.

#### Method

Select two areas of different topographical nature in which to do the study. For example, a heavily wooded area could be compared with an open field. Or north and south-facing slopes could be studied. Procedures that may be followed in doing such studies are outlined in the Green Version text pp. 76-82, and pp. 98-99. At the conclusion of gathering the data cite evidence that physical factors influence the type of organisms that occupy a habitat. Consider, also the ecological relationship between the biological factors found in the study.

#### References

BSCS Green Version, *High School Biology*, Second Edition, Rand McNally and Company, Chicago, 1968.

Dowdeswell, W. H., *Animal Ecology*, Harper and Brothers, New York, 1952.

Otto, Towle, and Crider, *Biology Investigations*, Holt, Rinehart and Winston, 1969.

\*Prepared by Mr. D. N. Youngstrom, Bowness Composite High School, Calgary.

## BARK LICHEN FLORA AND AIR POLLUTION\*

### Purpose

To discover if urban and industrial air pollution exists in a particular town or city by comparing and contrasting the bark lichen flora of a selected region within the community with that of a similar region from an area thought to be free of pollution.

### Theory

Lichens differ from other chlorophyll-bearing land plants in lacking a cuticle layer and thus, when they are wet, they are able to absorb material directly into their bodies. They are particularly sensitive to the pollutants present in gases issuing from settled and industrial areas, e.g., hydrocarbons in exhaust fumes, and are killed or damaged when the concentration of these pollutants is too high. Sulfur, in a variety of forms, is the most harmful airborne pollutant. As one approaches a city there is a gradual restriction of lichens to tree bases, parks and around bodies of water. Fruticose species disappear first, followed by foliose and finally by crustose species. The prevailing wind direction determines the axis and position of the affected area.

### Method

Select a grove of trees in each of two areas: (1) an area which is thought to have air pollution; and (2) an area where there is thought to be no or relatively little air pollution. In each case the trees should be of the same species, close to the same age, of approximately the same density, and occupy similar habitats.

Within each grove, at least 10 mature trees should be selected for study. On each tree two areas should be marked off. (1) a band 30 cm. wide at the base of the tree; and (2) a band 40 cm. wide centered at 1.3 m. from the ground level. Within these two areas all lichens should

\*Prepared by C. D. Bird, Department of Biology, University of Calgary, Calgary.



be located and named, or at least classified as fruticose, foliose, crustose, and squamulose. All doubtful plants should be collected and taken back to the school for identification. The approximate bark area occupied by each species should be recorded by means of the following scale: 1 - up to 5%, 2 = 25%; 3 = 25-50%; 4 = 50-75%; and 5 = 75-100%. The data from each of the 10 or more trees of each grove should then be put in tabular form and averages should be computed. The final step is to compare the two sets of data to see if the two areas have different species, compositions and coverages and, if so, the magnitude of the pollution effect.

### References

- Bird, C. D., *Key to Common Tree-dwelling Lichens of the Prairies and Parklands of Alberta*, School Book Branch, Edmonton, 1969.
- Brodo, I. M., "Lichen Growth and Cities; A Study on Long Island, New York." *The Bryologist* 69: 427-449, 1960.
- Hale, M. E., Jr., *Lichen Handbook*, Smithsonian Institution, Washington, 1961.
- Ing, B., "Studies on Bark Epiflora." *School Science Review* 49, (167): 44-55, 1966.
- Rao, D. N. and F. LeBlanc, S. C., "Effects of Sulfur Dioxide on the Lichen Algae, with Special Reference to Chlorophyll." *The Bryologist* 69: 69-75, 1966.

## THE ECOLOGY OF FRESH WATER ALGAE\*

### Purpose

To study types of algae in Alberta ponds, sloughs and streams, and to note adaptations and interrelationships with other life forms.

NOTE: To adapt this project for winter, one needs merely to break ice and proceed with study.  
See also General Objectives No 1, 2, 3, 4; Specific Objectives for Biology 10: No. 2, 3, 4; Specific Objectives for Biology 20: No. 1.

### Materials Needed

Several jars with tight-fitting lids  
Plankton or diatom net (see Sankey, p. 63)  
Numerous plastic vials with snap-on lids  
4% formaldehyde solution  
Forceps  
Thermometer  
Notebook for recording data  
Labels or tags

### Theory

Different types of algae vary greatly in their tolerance of certain environmental influences such as pressure of current, temperature of water, gases dissolved in water, acidity or alkalinity of water, presence of other organisms, amount of light, and periods of fluctuating water supply.

### Suggested Procedure

Students individually or in teams might investigate streams, ponds and sloughs in their vicinity for unicellular algae, filamentous and sheet colonies of algae--noting variations in numbers and types in varied habitats, collecting and preserving for study and identification samples of each type. Collected algae samples in water would be taken in vials, speed of water movement noted, as well as temperature of water, anchorage

\*Prepared by Mrs. J. McCall, MacLeod Jr.-Sr. High School, MacLeod.

if any, relative amount of shade or sunlight, signs of fluctuating water level. Sample jars to be filled to capacity with water from each habitat should be capped tightly to be checked later in lab for presence of O<sub>2</sub> and for pH value.

Life forms associated with the algae (insect larvae, fish, hydra, etc.) should be noted, and collected if desired.

If specimens are taken from tree trunks or damp roofs of buildings, care should be taken that they are not allowed to dry beyond the degree of humidity of their natural habitat. Careful notes of all sources should be kept.

Probably, from each sampling, it would be wise to preserve half of the material as soon as possible, retaining the remainder fresh for study under classroom conditions. (4% formaldehyde would be a suitable preservative.)

Materials should be sorted and identified as soon as possible after collecting.

Comparisons of results from various collection sources should be made, to find out what adaptations led to the success or failure of certain algal types in varied habitats.

NOTE: Some students might wish to branch out from this project to experiments with maintenance of the collected materials under lab conditions.

### References

Palmer, C. M., *Algae in Water Supplies*, U. S. Dept. of Health and Welfare, Public Health Service Publication No. 657, Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C., 1959.

Prescott, G. W., *How to Know the Freshwater Algae*, W. C. Brown Co., 135 S. Locust St., Dubuque, Iowa, 52003, 1964.

Sankey, J., *A Guide to Field Biology*, Longmans, London.

## THE SURVIVAL OF SMALL MAMMALS UNDER THE SNOW\*

### Purposes

To discover the nature of temperature conditions at various levels above and beneath the snow, particularly during days when the air temperatures are quite low.

### Theory

Small mammals tend to have high surface to volume ratios, i.e., for their size, they have a large surface area exposed to the environment. In addition, they are not large enough to either grow a heavy coat of fur or carry it around with them during their normal activities. For these reasons, small mammals are faced with the problem of rapid loss of body heat during cold weather, and might well freeze to death unless they can find some means of slowing down the rate of heat lost to their surroundings. Naturally, this rate of heat loss rises sharply as the difference between their normal body temperature and that of their immediate environment becomes greater.

### Method

The following investigations should be carried out during very cold days when the snow cover is prominent. It is understood that average or mean temperatures are seldom destructive of animal populations; it is the extremes that are critical.

Take the temperature reading in the air, six feet above the snow. Then take the temperature at the surface of the snow and at four-inch intervals as the thermometer is lowered into the snow. Record the reading at the base of the snow and then beneath the loose litter covering the ground. A needle bar or sharp crowbar may be used to probe to greater depths until the students have secured readings below the frost-line.

Graph the results, obtaining a temperature gradient. This will clarify the conditions under which small mammals live at the surface of the ground beneath the snow, as well as the conditions under which others hibernate at greater depths. The investigation should be repeated several times on different occasions, noting the effects of variations in air temperature and snow cover.

An extension of this investigation might be undertaken in which the readings are secured over and under the snow on the surface of a body of water such as a pond, stream or lake. Here, readings should be taken at ice level, the surface of the water and the bottom of the pond. This should give some appreciation of the temperatures of the environment in which freshwater invertebrates survive.

\*Prepared by Dr. C. G. Hampson, Faculty of Education, University of Alberta, Edmonton.

## References

(The Survival of Small Mammals Under the Snow)

Formozov, A. N., *Snow Cover as an Integral Factor of the Environment*, Boreal Institute, U. of A., Edmonton, 1946.

Pruitt, W. O., *Biological Papers of U. of Alaska*, 1960.

## SURVEY OF BEAVER POPULATION\*

### Purposes

- (a) To do field research to determine if beaver exist in a locality.
- (b) If they do exist in the area, to determine the location of dams, lodges, feeding areas and type of food used.
- (c) To determine the number of beaver in the locality and if possible some of their habits.

### Theory

Beaver control water flow by building dams. Eventually ponds fill with silt and become areas of land suitable for plant growth. The beaver fills an important niche in the web of life.

### Method

Travel through the selected area and note, by actual observation, the location and number of beaver. Take special note of the size and length of the dams, position of the dam and location of the lodge. Look for "skid-ways" beaver use in hauling branches to the water. What type of vegetation is used? Are any of the lodges abandoned? If so, what appears to be the reason for this? If a large-scale map of the locality is available indicate on it the exact location of dams and lodges. If no map is available then draw one. Prepare a written record of your observations. You may support your writing with photographs. If you are able to determine periods of activity of beaver, methods of protection or any other data about these animals, include it in the record.

\*Prepared by Mr. J. D. Grieve, Jasper Jr., Sr. High School, Jasper

APPENDIX D

SUGGESTED LIBRARY REFERENCE BOOKS

- Abercrombie, M., *A Dictionary of Biology*, Penguin, Harmondsworth, England, 1962.
- Adler, I., *How Life Began*, Signet Key Book, Ks369, New American Library, New York, 1959.
- Adshead, P. C. et al., *On the Hydras of Alberta and the Northwest Territories*, National Museum Canada, Bull. 199, Queen's Printer, Ottawa, 1963.
- Alexander, R. D., *Singing Insects. Four Cases in the Study of Animal Species*, Rand McNally, Chicago, 1967.
- Alexopoulos, C. J. and H. C. Bold, *Algae and Fungi*, Macmillan, Toronto, 1967.
- Allee, W. C. et al., *Principles of Animal Ecology*, Saunders, Philadelphia, 1959.
- Allen, A. A., *The Book of Bird Life*, 2nd Edition, Van Nostrand, Toronto, 1961.
- American Institute of Biological Sciences, BSCS Pamphlets 1-23, *Biological Sciences Curriculum Study*, Prentice-Hall, 1962-1965.
- Anderson, R. M., *Catalogue of Canadian Recent Mammals*, National Museum Canada, Bull. 102, Queen's Printer, Ottawa, 1946.
- \_\_\_\_\_, *Methods of Collecting and Preserving Vertebrate Animals*, 3rd Edition, National Museum Canada, Queen's Printer, Ottawa, 1960.
- Ardrey, R., *Territorial Imperative*, Dell, New York, 1968.
- \_\_\_\_\_, *African Genesis*, Dell, New York, 1967.
- Asimov, I., *The Genetic Code*, Signet Science Library, T3224, New American Library, New York, 1962.
- \_\_\_\_\_, *The Bloodstream: River of Life*, Collier-Macmillan, Toronto, 1962.
- \_\_\_\_\_, *The World of Carbon*, Collier-Macmillan, Toronto, 1962.
- \_\_\_\_\_, *The World of Nitrogen*, Collier-Macmillan, Toronto, 1962.

- Austin, O. L., *Song Birds of the World*, Golden Press, New York, 1967.
- Ball, G. E., *Tips on Making an Insect Collection*, Dept. Entomology, University of Alberta, Edmonton, 1959.
- Bates, M., *The Forest and the Sea*, Vintage Books, Random, New York, 1966.
- \_\_\_\_\_, *Man in Nature*, 2nd Edition, Prentice-Hall, Toronto, 1964.
- Beaumont, W., *Experiments and Observations on the Gastric Juice and the Physiology of Digestion*, Dover, New York, 1963.
- Beaver, W. C. and G. B. Noland, *General Biology: The Science of Biology*, Mosby, Saint Louis, 1966.
- Beebe, W., *Pheasants: Lives and Homes*, (2 vol.) Dover, New York, 1927.
- \_\_\_\_\_, *Edge of the Jungle*, Duell, Sloan and Pearce, New York, 1951.
- \_\_\_\_\_, *The Bird. Its Form and Function*, Dover, New York, 1965.
- Beidelman, R. G., *Dynamic Equilibrium, Patterns of Life Series*, Rand McNally, Chicago, 1966.
- Beirne, B. P., *Preparing and Preserving Insects*, Queen's Printer, Ottawa, 1955.
- Bell, P. and C. Woodcock, *The Diversity of Green Plants*, Arnold, London, 1968.
- Bent, A. C., *Life Histories of North American Birds*, (20 vols.), Dover, New York.
- Benton, A. H. and W. E. Werner, *Manual of Field Biology and Ecology*, Burgess, Minneapolis, 1965.
- Bernard, C., *An Introduction to the Study of Experimental Medicine*, Dover, New York, 1957.
- Berrill, N. J., *Journey into Wonder: Voyages of Exploration and Discovery*, Collier-Macmillan, Toronto, 1962.
- \_\_\_\_\_, *Biology in Action*, Dodd, Mead, Toronto, 1966.
- Birby, C., *Simple Experiments in Biology*, Heinemann, London, 1956.
- Bird, R. D., *Ecology of the Aspen Parkland of Western Canada in Relation to Land Use*, Queen's Printer, Ottawa, 1961.
- Bold, H. C., *The Plant Kingdom. Foundations of Modern Biology Series*, Prentice-Hall Toronto, 1964.

- Bonner, D. M., *Heredity, Foundations of Modern Biology*, Prentice-Hall, Toronto, 1961.
- Bonner, J. T., *Cells and Societies*, Oxford, Toronto, 1955.
- \_\_\_\_\_, *Morphogenesis: An Essay on Development*, Antheneum, New York, 1963.
- Booth, E. S., *How To Know the Mammals*, Brown, Dubuque, Iowa, 1961.
- Botany, Dept. of; University of Alberta, *Collecting and Identifying Plants*, University of Alberta, Dept. of Extension, Edmonton.
- Brandwein, P. F. et al., *Life: Its Forms and Changes*, Harcourt, Brace and World, New York, 1968.
- Bristow, W. S., *The World of Spiders*, Collins, New York, 1958.
- BSCS, *Biological Science: Molecules to Man*, (Blue Version), Houghton Mifflin, Boston, 1968.
- \_\_\_\_\_, *Laboratory Blocks for Biology*, (A series of booklets, with accompanying Teachers Supplements, dealing with laboratory study of particular areas of biology.) Heath, Boston.
- Buchbaum, R., *Animals Without Backbones*, (2 vols.), Penguin, Harmondsworth, England, 1962.
- Budd, A. C. and K. Best, *Wild Plants of the Canadian Prairies*, Queen's Printer, Ottawa.
- Buffaloe, N. D., *Animal and Plant Diversity. Foundations of Biology Program, Part 1*, Prentice-Hall, Toronto, 1968.
- Buffaloe, N. D. and J. B. Throneberry, *Principles of Biology*, Prentice-Hall, Toronto, 1967.
- Burnett, A. L. and T. Eisner, *Animal Adaptation. Modern Biology Series*, Holt, Rinehart and Winston, Toronto, 1964.
- Burr, M., *The Insect Legion*, Nisbet, London, 1954.
- Burt, W. H. and R. P. Grossenheider, *A Field Guide to Mammals*, Houghton Mifflin, Boston, Massachusetts, 1964.
- Butler, C. G., *The World of the Honey Bee*, Oxford, Toronto, 1954.
- Cairns, J., Jr., *Population Dynamics, Patterns of Life Series*, Rand McNally, Chicago, 1966.
- Canada Dept. of Agriculture, *Diseases of Field Crops in the Prairie Provinces*, Canada Dept. Agriculture, Publ. 1008, Queen's Printer, Ottawa, 1957.



- Carl, G. C., *The Amphibians of British Columbia*, British Columbia Provincial Museum, Victoria, 1959.
- \_\_\_\_\_, *The Reptiles of British Columbia*, 3rd Edition, British Columbia Provincial Museum, Victoria, 1960.
- Carl, G. C., W. A. Clemens and C. C. Lindsey, *The Freshwater Fishes of British Columbia*, 3rd Edition, British Columbia Provincial Museum, Victoria, 1959.
- Carson, Rachel, *The Edge of the Sea*, New American Library, Houghton Mifflin, New York, 1955.
- \_\_\_\_\_, *Silent Spring*, Houghton Mifflin, Boston, 1962.
- \_\_\_\_\_, *Under the Sea Wind*, New American Library, New York, 1964.
- Carthy, J. D., *The Study of Behaviour. Studies in Biology, No. 3*, St. Martin, New York, 1966.
- Cheesman, E., *Insects: Their Secret World*, Peter Smith, Magnolia, Mass., 1963.
- Christensen, C. M., *Common Fleshy Fungi*, 2nd Edition, Burgess, Minneapolis, 1965.
- \_\_\_\_\_, *The Molds and Man: An Introduction to the Fungi*, McGraw-Hill, Toronto, 1965.
- Clark, W. E. Legros, *History of the Primates*, British Museum (Natural History), London, 1960.
- Clark, S. E., J. A. Campbell and J. B. Campbell, *An Ecological and Grazing Capacity Study of the Native Grass Pastures in Southern Alberta, Saskatchewan and Manitoba*, Canada Dept. Agriculture, Publ. 738, Queen's Printer, Ottawa, 1942.
- Clausen, L., *Insect Fact and Folklore*, Collier-Macmillan, Toronto, 1962.
- Clay, T. and M. Rothschild, *Fleas, Flukes and Cuckoos*, Collins New Naturalist, Toronto.
- Coker, R. E., *Streams, Lakes, Ponds*, Univ. North Carolina Press, Chapel Hill, 1954.
- Collis, J. S., *The Triumph of the Tree*, Cape, London, 1950.
- Conard, H. S., *How to Know the Mosses and Liverworts*, Brown, Dubuque, Iowa, 1956.
- Cook, S. A., *Reproduction, Heredity, and Sexuality. Fundamentals of Botany Series*, Wadsworth, Belmont, California, 1964.

- Cormack, R. H. G., *Wild Flowers of Alberta*, Queen's Printer, Edmonton, 1967.
- Corner, G. W., *The Hormones in Human Reproduction*, Antheneum, New York, 1963.
- Cowan, I. McT. and C. J. Guiguet, *The Mammals of British Columbia*, British Columbia Provincial Museum, Victoria, 1960.
- Craighead, J. J. et al., *A Field Guide to Rocky Mountain Wildflowers*, Houghton Mifflin, Boston, 1963.
- Crisler, L., *Arctic Wild*, Harper and Row, New York, 1958.
- Croal, A. G., A. H. Louden and L. A. Smith, *General Biology*, 2nd Edition, Copp Clark, Toronto, 1955.
- Cronquist, A., *Introductory Botany*, Harper and Row, New York, 1961.
- Cunningham, G. C., *Forest Flora of Canada*, Queen's Printer, Ottawa, 1958.
- Darwin, C., *Autobiography and Selected Letters*, Dover, New York, 1963.
- \_\_\_\_\_, *Origin of Species*, Collier-Macmillan, Toronto, 1962.
- Davies, J. L., *Seeds of Life*, Signet Key, New American Library, New York.
- Dawson, E. Y., *Marine Botany: An Introduction*, Holt, Rinehart and Winston, 1966.
- Deason, H. J. and R. W. Lynn, *An Inexpensive Science Library*, 5th Edition, American Association Advancement Science; Washington, D. C., 1961.
- DeLeweyas, T., *Plant Diversification: Modern Biology Series*, Holt, Rinehart and Winston, Toronto, 1966.
- Dept. of Forestry, *Native Trees of Canada*, Bull. 61, 6th Edition, Queen's Printer, Ottawa, 1962.
- Dice, L. R., *Natural Communities*, Univ. Michigan Press, Ann Arbor, 1952.
- Ditmars, R. L., *Snakes of the World*, MacMillan, New York, 1962.
- Dobzhansky, T., *The Biological Basis of Human Freedom*, Copp Clark, Toronto, 1960.
- Dorst, J., *The Migration of Birds*, Houghton Mifflin, Boston, 1963.
- Doyle, W. T., *Nonvascular Plants: Form and Function. Fundamentals of Botany Series*, Wadsworth, Belmont, California, 1964.

- Durrell, G., *The Bafut Beagles*, Penguin, Harmondsworth, England.
- \_\_\_\_\_, *A Zoo in My Luggage*, Penguin, Harmondsworth, England.
- \_\_\_\_\_, *The Overloaded Ark*, Penguin, Harmondsworth, England.
- \_\_\_\_\_, *Three Singles to Adventure*, Penguin, Harmondsworth, England.
- \_\_\_\_\_, *The Whispering Land*, Penguin, Harmondsworth, England.
- \_\_\_\_\_, *The Drunken Forest*, Penguin, Harmondsworth, England.
- \_\_\_\_\_, *My Family and Other Animals*, Penguin, Harmondsworth, England.
- Ebert, J. D., *Interacting Systems of Development. Modern Biology Series*, Holt, Rinehart and Winston, Toronto, 1965.
- Eddy, S., *How to Know the Freshwater Fishes*, Brown, Dubuque, Iowa, 1957.
- Edlin, H. L., *Trees, Woods, and Man*, New Naturalist, Collins, Toronto, 1956.
- Ehrensvard, G., *Life, Origin and Development*, Univ. Chicago Press, Chicago, 1963.
- Ehrlich, P. R. and A. H. Ehrlich, *How to Know the Butterflies*, Brown, Dubuque, Iowa, 1961.
- Emerton, J. H., *The Common Spiders of the United States*, Dover, New York, 1961.
- Erickson Jones, J. R., *Fish and River Pollution*, Butterworth, London, 1964.
- Etkin, W., *Social Behavior From Fish to Man*, Univ. Chicago Press, Chicago, 1967.
- Facilities and Equipment for Science and Mathematics*, U. S. Government Printing Office, Washington 25, D. C., 1960.
- Farb, P., *Ecology*, *Life Nature Library*, Time-Life, New York, 1963.  
Others in series: *The Earth, The Sea, The Forest, The Desert, The Mountains, The Universe, The Poles, Evolution, The Insects, The Fishes, The Reptiles, The Birds, The Mammals, The Plants.*
- Farley, F. L., *Birds of the Battle River Region of Central Alberta*, Institute of Applied Art, Edmonton, 1932.
- Fink, B., *The Lichen Flora of the United States*, Univ. Michigan Press, Ann Arbor, 1960.
- Fisher, J., *The Fulmar*, Collins, Toronto, 1952.
- Frankton, C., *Weeds of Canada*, Queen's Printer, Ottawa, 1955.

- Free, J. B. and C. G. Buter, *Bumblebees*, New Naturalist, Collins, Toronto, 1959.
- Freuchen. P., *I Sailed with Rasmussen*, Macmillan. Toronto, 1958.
- \_\_\_\_\_, *Book of the Eskimos*, Fawcett World Library, New York, 1965.
- Frost, S. W., *Insect Life and Insect Natural History*, Dover, New York, 1963.
- Gabriel, M. L. and S. Fogel, (Eds.), *Great Experiments in Biology*, Prentice-Hall, Toronto, 1955.
- Galston, A. W., *The Life of the Green Plant*, Prentice-Hall, Toronto, 1964.
- \_\_\_\_\_, *The Green Plant*, Foundations of Biology Program, Part 3, Prentice-Hall, Toronto, 1968.
- Galbraith, D. I. and D. G. Wilson, *Biological Science: Principles and Patterns of Life*, Holt, Rinehart and Winston, Toronto, 1966.
- Gertsch, W. J., *American Spiders*, Van Nostrand, Toronto, 1949.
- Gilliard, E. T., *Living Birds of the World*, Doubleday, New York, 1958.
- Godfrey, W. E., *Birds of the Cypress Hills and Flotten Lake Regions, Saskatchewan*, National Museum Canada, Bull. 120, Queen's Printers, Ottawa, 1950.
- \_\_\_\_\_, *The Birds of Canada*, National Museum Canada, Bull. 203, Queen's Printer, Ottawa, 1966.
- Goetsch, W., *The Ants*, Univ. Michigan Press, Ann Arbor, 1957.
- Goldstein, P., *Genetics is Easy*, 2nd Edition, Viking Press, New York, 1961.
- Goodwin, D., *Instructions to Young Ornithologists, No. 2 Bird Behavior*, Burns and MacEachern, Don Mills, Ontario, 1961.
- Griffin, D. R., *Animal Structure and Function*, Holt, Rinehart, and Winston, Toronto, 1962.
- Grzimek, B. and M. Grzimek, *Serengeti Shall Not Die*, Hamish Hamilton, Dutton, New York, 1961.
- Groves, J. W., *Edible and Poisonous Mushrooms of Canada*, Canada Dept. Agriculture, Publ. 1112, Queen's Printer, Ottawa, 1962.
- Hale, M. E., Jr., *Lichen Handbook*, Smithsonian Institution, Washington, 1961.
- \_\_\_\_\_, *The Biology of Lichens*, Arnold, London, 1967.

- Hanson, E. D., *Animal Diversity*, Foundations of Modern Biology, Prentice-Hall, Toronto, 1964.
- Hardin, G., *Biology: Its Principles and Implications*, Freeman, San Francisco, 1966.
- Hardy, A. C., *The Open Sea*, Collins, Toronto, 1958.
- Hardy, G. A. and W. V. Hardy, *Wild Flowers in the Rockies*, Larson, Saskatoon, 1949.
- Hardy, W. G. (Ed.), *Alberta: A Natural History*, Hurtig, Edmonton, 1967.
- Harris, J. R., *An Angler's Entomology*, New Naturalist, Collins, Toronto, 1952.
- Harrison, J. M., *Bird Taxidermy*, Percival Marshall, London, 1964.
- Hegner, R. and K. Stiles, *College Zoology*, 7th Edition, Collier-Macmillan, Toronto, 1959.
- Helfer, J. R., *How to Know the Grasshoppers, Cockroaches and Their Allies*, Brown, Dubuque, Iowa, 1963.
- Hellmuth, F. J., *A Wolf in the Family*, New American Library, New York, 1965.
- Hickey, J. J., *A Guide to Bird Watching*, Doubleday, Garden City, New York, 1963.
- Hill, B. J., et al., *Botany*, 4th Edition, McGraw-Hill, Toronto, 1967.
- Hockbaum, H. A., *Travels and Traditions of Waterfowl*, Branford, Newton Center, Mass., 1955.
- Hocking, B., *Insects and How to Collect Them*, Dept. Entomology, Univ. Alberta, Edmonton, 1960.
- \_\_\_\_\_, *The Ultimate Science*, Canadian Broadcasting Corporation, Ottawa, 1963.
- Hooke, R., *Micrographia of Minute Bodies*, Peter Smith, Magnolia, Mass., 1963.
- Hubbs, C. (Ed.), *Zoogeography*, American Association Advancement Science, Washington, D. C., 1958.
- Hynes, H. B. N., *The Biology of Polluted Waters*, Liverpool Univ. Press, Liverpool, 1960.
- Imms, A. D., *A General Textbook of Entomology*, 9th Edition, Ryerson, Toronto, 1964.

- Jackson, D. F. (Ed.), *Algae, Man and Environment*, Syracuse Univ. Press, N. Y., 1968.
- Jackson, R. M. and F. Raw, *Life in the Soil*, St. Martin's Press, New York, 1966.
- Jacques, H. E., *How to Know the Insects*, Brown, Dubuque, Iowa, 1947.
- \_\_\_\_\_, *How to Know the Beetles*, Brown, Dubuque, Iowa, 1951.
- Jahn, T. L., *How to Know the Protozoa*, Brown, Dubuque, Iowa, 1949.
- Jensen, W. A., *The Plant Cell, Fundamentals of Botany Series*, Wadsworth, Belmont, California, 1964.
- Jepson, G. L., G. G. Simpson, and E. Mayr, *Genetics, Palaeontology, and Evolution*, Atheneum New York, 1963.
- Johnson, W. H. et al., *Biology*, Holt, Rinehart, and Winston, Toronto, 1966.
- Kalmus, H., *Genetics*, Anchor, Doubleday, N. Y., 1964.
- \_\_\_\_\_, *One Hundred One Simple Experiments with Insects*, Doubleday, N. Y., 1953.
- \_\_\_\_\_, *Variation and Heredity*, Humanities Press, New York, 1957.
- Kaston, B. J., *How to Know the Spiders*, Brown, Dubuque, Iowa, 1953.
- Keith, L. B., *Wildlife's Ten-Year Cycle*, Univ. Wisconsin Press, Madison, 1963.
- Keen, F. P., *Insect Enemies of Western Forests*, U. S. Dept. Agriculture, Misc. Publ. 273, U. S. Government Printing Office, Washington, 25, D. C., 1952.
- Keeton, W. T., *Biological Sciences*, Norton, New York, 1967.
- Kelsall, J. P., *The Migratory Barren-ground Caribou of Canada*, Canadian Wildlife Service Monograph 3. Queen's Printer, Ottawa, 1968.
- Kimball, J. W., *Biology*, Addison-Wesley, Reading, Massachusetts, 1968.
- Klots, A. B., *A Field Guide to Butterflies*, Thomas Allen, Toronto, 1951.
- Kormondy, E. J. (Ed.), *Reading in Ecology*, Prentice-Hall, Toronto, 1965.
- Kortright, F. H., *The Ducks, Geese and Swans of North America*, Stackpole, Harrisburg, Pennsylvania, 1953.
- \_\_\_\_\_, *Ducks, Geese and Swans of North America*, Wildlife Management Inst., Washington, D. C., 1953.

- Kranzer, C., *American Biology Teacher*, Pennsylvania State Univ., University Park, Pennsylvania.
- Kroeber, E. et al., *Adventures with Animals and Plants*, Copp Clark, Toronto, 1966.
- Krutch, J. W., *The World of Animals*, Simon and Schuster, New York, 1961.
- Lack, D., *Evolutionary Theory and Christian Belief. The Unresolved Conflict*, Methuen, London, 1957.
- Lange, M. and F. B. Hora, *Collins Guide to Mushrooms and Toadstools*, Collins, Toronto, 1965.
- Large, E. C., *The Advance of the Fungi*, Dover, New York, 1940.
- Lawson, C. et al., *Laboratory Studies in Biology*, Holt, Rinehart and Winston, Toronto.
- Leopold, A. C., *Plant Growth and Development*, McGraw-Hill, Toronto, 1964.
- Levine, R. P., *Genetics*, Holt, Rinehart and Winston, Toronto, 1968.
- Loewy, A. G. and P. Siekevitz, *Cell Structure and Function, Modern Biology Series*, Holt, Rinehart and Winston; Toronto, 1963.
- Logier, E. B. S. and G. C. Toner, Check list of the Amphibians and Reptiles of Canada and Alaska, Royal Ontario Museum, *Zoology and Palentology No. 41*, Toronto, 1955.
- Lorenz, K., *King Solomon's Ring*, Apollo, New York, 1957.
- \_\_\_\_\_, *On Aggression*, Bantam Books, Toronto, 1967.
- Lutz, F. E., *Field Book of Insects*, 3rd Edition, Putnam's, New York, 1948.
- Maeterlinck M., *The Life of the Bee*, Dodd, Mead, New York, 1912.
- Macan, T. T., *A Guide to Freshwater Invertebrate Animals*, Longmans, London, 1960.
- \_\_\_\_\_, *Freshwater Ecology*, Wiley, New York, 1963.
- Macan, T. T. and E. B. Worthington, *Life in Lakes and Rivers*, Collins, Toronto, 1951.
- Macey, R. I., *Human Physiology. Foundations of Biology Program, Part 4*, Prentice-Hall, Toronto, 1968.
- Mackean, D. G., *Arco Book of Biology*, Arco, New York, 1966.
- Marsland, D., *Principles of Modern Biology*, Holt, Rinehart and Winston; Toronto, 1964.
- Mason, A. S., *Health and Hormones*, Pelican, London, 1960.

- Maxwell, G., *Ring of Bright Water*, Dutton, New York, 1963.
- McClane, A. J. (Ed.), *McClane's Standard Fishing Encyclopedia and International Angling Guide*, Holt, Rinehart and Winston, Toronto, 1965.
- McElroy, W. D. and C. P. Swanson, *Modern Cell Biology, Foundations of Biology Program, Part 2*, Prentice-Hall, Toronto, 1968.
- McMullen, R. D., *The Insect Collector's Guide*, Entomological Society of Alberta, Dept, Entomology, Univ. Alberta, Edmonton, 1955.
- Mech, L. D., *The Wolves of Isle Royale*, Fauna Series No. 7, U. S. Government Printing Office, Washington, D. C. 1966.
- Medawar, P. B., *The Future of Man*, The Reith Lectures, Methuen, London, 1960.
- Metcalf, C. L., W. R. Flint, and R. L. Metcalf, *Destructive and Useful Insects*, McGraw-Hill, Toronto, 1962.
- Miller, D. F. and G. W. Flaydes, *Methods and Materials for Teaching Biological Sciences*, 2nd Edition, McGraw-Hill, Toronto, 1962.
- Miller, R. B., *A Cool Curving World*, Longmans, Toronto, 1962.
- Milne, L. J. and M. Milne, *The Biotic World and Man*, 2nd Edition, Prentice-Hall, 1958.
- Moment, G. et al., *Frontiers of Modern Biology*, Thomas Allen, Toronto, 1962.
- Moore, J. E., *Notes on the Leeches (Hirudinea) of Alberta*, National Museum Canada, Natural History Paper 27, Queen's Printer, Ottawa, 1964.
- Morgan, A. H., *Field Book of Ponds and Streams*, 8th Printing, Putnam's, New York, 1930.
- Morholt, E. et al., *A Sourcebook of the Biological Sciences*, Harcourt, Brace and World, New York, 1966.
- Moss, E. H., *Flora of Alberta*, Toronto Press, Toronto, 1960.
- Mowat, F., *Canada North*, McColland and Stewart, Toronto, 1968.
- Muenschler, W. C., *Keys to Woody Plants*, 6th Edition, Cornell Univ. Press, Ithaca, New York, 1950.
- Muller, W. H., *Botany: A Functional Approach*, Macmillan, Toronto, 1963.



- Murie, A., *The Wolves of Mount McKinley*, Fauna Series No. 5, U. S. Government Printing Office, Washington, D. C., 1944.
- Murie, O. J., *A Field Guide to Animal Tracks*, Thomas Allen, Toronto, 1954.
- Murphy, R. C., and D. Amadon, *Land Birds of America*, McGraw-Hill, Toronto, 1953.
- Nason, A., *Textbook of Modern Biology*, Wiley, New York, 1965.
- \_\_\_\_\_, *Essentials of Modern Biology*, Wiley, New York, 1968.
- Nason, A. and P. Goldstein, *Biology: Introduction to Life*, Addison-Wesley, Don Mills, Ontario, 1969.
- National Science Teachers Association, *Biological Science Teaching Tips from TST: A Compilation of Articles From Seven Years of the Science Teacher*, National Education Association, Washington, D. C., 1967.
- Natural History*, Incorporating Nature Magazine. The Journal of American Museum of Natural History, New York.
- Needham, J. G., *Culture Methods for Invertebrate Animals*, Dover, New York, 1937.
- Needham, J. G. and P. R. Needham, *A Guide to the Study of Freshwater Biology*, Holden Day, San Francisco, Calif., 1962.
- Nelson, G. E. et al., *Fundamental Concepts of Biology*, Wiley, New York, 1967.
- Novakowski, N. S., *Whooping Crane Population Dynamics on the Nesting Grounds, Wood Buffalo National Park, Northwest Territories, Canada*, Canadian Wildlife Service Report, Series 1, Queen's Printer, Ottawa, 1966.
- Nuffield Foundation, *Nuffield Biology*, Texts for years 1-5, Longmans-Penguin, London, 1966-1967.
- Oakley, K. P. and H. M. Muir-Wood, *The Succession of Life Through Geological Time*, British Museum (Natural History), London, 1959.
- Oldroyd, H., *Insects and Their World*, British Museum (Natural History), Univ. Chicago Press, 1960.
- Oparin, A. I., *Origin of Life*, Dover, New York, 1953.
- Organization for Economic Cooperation and Development*, New Thinking in 'School Biology, The Directorate of Scientific Affairs, Belgium, Queen's Printer, Ottawa, 1963.'

- Palmer, C. M., *Algae in Water Supplies*, An illustrated manual on the identification, significance and control of algae in water supplies. U. S. Government Printing Office; Washington 25, D. C., 1959.
- Palmer, R. S., *The Mammal Guide*, Doubleday, Garden City, New York, 1954.
- Pennak, R. W., *Fresh-water Invertebrates of the United States*, Ronald, New York, 1953.
- Pesson, P., *The World of Insects*, Harrap, London, 1959.
- Peterson, R. T., *A Field Guide to Birds*, 2nd Edition, Thomas Allen, Toronto, 1947.
- \_\_\_\_\_, (Ed.), *The Bird Watchers' Anthology*, Harcourt, Brace, New York, 1957.
- \_\_\_\_\_, *A Field Guide to Western Birds*, Thomas Allen, Toronto, 1961.
- Peterson, R. T. and J. Fisher, *Wild America*, Thomas Allen, Toronto, 1955.
- Pettingill, O. S., *A Laboratory and Field Manual of Ornithology*, Burgess, Minneapolis, Minnesota, 1961.
- Phillipson, J., *Ecological Energetics. Studies in Biology, No. 1*, St. Martin, New York, 1966.
- Pledge, H. T., *Science Since 1500*, Her Majesty's Stationery Office, London, 1939.
- Pohl, R. W., *How to Know the Grasses*, Brown, Dubuque, Iowa, 1968.
- Pond, G. G., *Science Materials: Preparation and Exhibition for the Classroom*, Brown, Dubuque, Iowa.
- Ponting, H. G., *The Great White South*, Evans, London, 1950.
- Pope, C. H., *Snakes Alive*, Viking, New York, 1937.
- Portmann, A., *Animal Camouflage*, Univ. Michigan Press, Ann Arbor, 1959.
- Pough, R. H., *Audubon Western Bird Guide*, Doubleday, Garden City, New York, 1957.
- Prescott, G. W., *How to Know the Freshwater Algae*, Brown, Dubuque, Iowa, 1964.
- Putnam, H. L., *Isotopes*, Penguin, Harmondsworth, England, 1960.

- Rand, A. L., *Mammals of the Eastern Rockies and Western Plains of Canada*, National Museum Canada, Bull. 108, Queen's Printer, Ottawa, 1948.
- Ray, P. M., *The Living Plant*, Holt, Rinehart and Winston, Toronto, 1963.
- Readers Digest, *Marvels and Mysteries of Our Animal World*, Readers Digest, New York, 1964.
- Reid, G. K., *Ecology of Intertidal Zones*, Patterns of Life Series, Rand McNally, Chicago, 1967.
- Reid, L., *The Sociology of Nature*, Penguin, Harmondsworth, England.
- Richards, O. W., *The Social Insects*, Peter Smith, Magnolia, Mass., 1953.
- Richards, P., *Mosses*, King Penguin, Harmondsworth, England, 1950.
- Robbins, W. W. et al., *Botany: An Introduction to Plant Science*, Wiley, New York, 1965.
- Roe, F. G., *The North American Buffalo: A Critical Study of the Species in Its Wild State*, Univ. Toronto Press, Toronto, 1951.
- Romer, A. S., *Man and the Vertebrates*, Penguin, Harmondsworth, England, 1954.
- Round, F. E., *The Biology of the Algae*, Arnold, London, 1965.
- Rowe, J. S., *Forest Regions of Canada*, Canada Dept. Northern Affairs and Natural Resources, Bull. 123, Queen's Printer, Ottawa, 1959.
- Rowett, H. Q., *Basic Anatomy and Physiology*, Transatlantic Arts, Levittown, N. Y., 1966.
- Rudd, R. L., *Pesticides and the Living Landscape*, Univ. Wisconsin Press, Madison, 1964.
- Salisbury, F. B. and R. V. Parke, *Vascular Plants: Form and Function. Fundamentals of Botany Series*, Wadsworth, Belmont, Calif., 1964.
- Salt, W. R. and A. L. Wilk, *The Birds of Alberta*, School Book Branch, Edmonton, 1958.
- Sankey, J., *A Guide to Field Biology*, Longmans, London, 1960.
- Savage, J. M., *Evolution. Modern Biology Series*, Holt, Rinehart and Winston, Toronto, 1963.

- Savile, D. B. O., *Collection and Care of Botanical Specimens*, Queen's Printer, Ottawa, 1962.
- Savory, T. H., *Spiders, Men and Scorpions*, Univ. London Press, London, 1961.
- Scagel, R. F. et al., *An Evolutionary Survey of the Plant Kingdom*, Wadsworth, Belmont, California, 1965.
- Schaller, G., *The Year of the Gorilla*, Univ. Chicago Press, Chicago, 1964.
- School Facilities for Science Instruction*, National Science Teachers Association, Washington, D. C., 1954.
- The Science Teacher*, 1201 Sixteenth Street N. W., Washington 6, D. C.
- Science World*, 33 West 42 Street, New York 36, N. Y.
- Scientific American, *The Living Cell*, Freeman, San Francisco, 1965.
- \_\_\_\_\_, *From Cell to Organism*, Freeman, San Francisco, 1967.
- \_\_\_\_\_, The Scientific American Inc., 515 Madison Avenue, New York, 17, N. Y.
- Scientific American Offprints*, Readings in the Life Sciences, Freeman, San Francisco, California.
- Scott, P., *Wild Geese and Eskimos*, Country Life, London, 1951.
- Selkurt, E. E., *Physiology*, Little, Brown, Boston, 1962.
- Simpson, G. G., C. S. Pittendrigh and L. H. Tiffany, *Life, and Introduction to Biology*, Harcourt, Brace, Toronto, 1957.
- Singer, C., *History of Biology*, Abelard Schuman, Toronto, 1959.
- \_\_\_\_\_, *A Short History of Anatomy and Physiology*, Dover, New York, 1959.
- Sinnott, E. W., and Katherine Wilson, *Botany: Principles and Problems*, McGraw-Hill, Toronto, 1963.
- Sistrom, W. R., *Microbial Life*, Holt, Rinehart and Winston, Toronto.
- Smallwood, W. L. and E. R. Green, *Biology*, Silver Burdett, Morristown, New Hersey, 1968.
- Smith, A. H., *The Mushroom Hunter's Field Guide*, Univ. Michigan Press, Ann Arbor, 1963.

- Smith, G. M., *The Fresh-water Algae of the United States*, McGraw-Hill, Toronto, 1950.
- Smith, J. M., *The Theory of Evolution*, Penguin Books, Baltimore, Md., 1958.
- Smith, K. M., *Beyond the Microscope*, Penguin, Harmondsworth, England.
- Smithsonian Institution, *A Field Collector's Manual in Natural History*, Publication 3766, The Smithsonian Institution, Washington, D. C., 1944.
- Soper, J. D., *The Mammals of Alberta*, School Book Branch, Edmonton, 1964.
- Stebbins, R. L., *Amphibians and Reptiles of Western North America*, McGraw-Hill, Toronto, 1954.
- \_\_\_\_\_, *A Field Guide to Western Reptiles and Amphibians*, Thomas Allen, Toronto, 1966.
- Stegner, R. W., *Plant Pigments with Laboratory Activities*, Rand McNally, Chicago, 1967.
- Stephenson, E. M. and C. Stewart, *Animal Camouflage*, Verry Lawrence, Mystic, Conn., 1955.
- Steward, F. C., *Plants at Work*, Principles of Biology Series, Addison-Wesley, Reading, Massachusetts, 1964.
- Storer, J. H., *The Web of Life*, Signet Key, New American Library, New York.
- Storer, T. I. and R. L. Usinger, *General Zoology*, 3rd Edition, McGraw-Hill, Toronto, 1957.
- Strickland, E. H. and B. Hocking, *Insects of the Alberta Farmstead*, Faculty Agriculture, Univ. Alberta, Edmonton, 1950.
- Sutton-Vane, S., *The Story of Eyes*, Viking Press, New York, 1962.
- Swanson, C. P., *Cell*, Prentice-Hall, Toronto, 1964.
- Symington, F., *Tuktu*, Queen's Printer, Ottawa, 1965.
- Taber, W. A. and R. A. Taber, *The Impact of Fungi on Man*, Patterns of Life Series, Rand McNally, Chicago, 1967.
- Taylor, A. E., *Aristotle*, Dover, New York, 1963.
- Taylor, G. R., *The Science of Life*, McGraw-Hill, Toronto, 1963.

- Teale, E. W., *Autumn Across America*, Dodd Mead, New York, 1956.
- Teilhard de Chardin, P., *The Phenomenon of Man*, Reader's Union, Harper-Row, 1961.
- Thomas, W. L., Jr. (Ed.), *Man's Role in Changing the Face of the Earth*, Univ. Chicago Press, Chicago, 1956.
- Tiffany, L. H., *Algae, The Grass of Many Waters*, Thomas, Springfield, Illinois, 1968.
- Trump, R. F. and D. L. Fagle, *Design for Life*, Holt, Rinehart and Winston, Toronto, 1963.
- Tuck, L. M., *The Murrees*, Queen's Printer, Ottawa, 1960.
- Turtax Service Leaflets*, General Biological Supply House, 8200 South Hoyne Avenue, Chicago 20.
- Unquhart, F. A., *Introducing the Insect*, Wayne, New York, 1949.
- Vallery-Radot, R., *The Life of Pasteur*, Dover, New York, 1963.
- Van Leeuwenhoek, L., *Antony Van Leeuwenhoek and His Little Animals*, Dover, New York, 1963.
- Von Buddenbrock, W., *The Senses*, Univ. Michigan Press, Ann Arbor, 1953.
- Von Frisch, K., *The Dancing Bees*, Harcourt, Brace and World, 1965.
- \_\_\_\_\_, *About Biology*, Oliver and Boyd, Edinburgh, 1962.
- Voss, B. E. and S. B. Brown, *Biology as Inquiry: A Book of Teaching Methods*, Mosby, Toronto, 1968.
- Walker, K. M., *Human Physiology*, Penguin, Harmondsworth, England, 1962.
- Wallace, B., and A. M. Srb, *Adaptation*, Prentice-Hall, Toronto, 1964.
- Wallis, J. B., *The Cicindelidae of Canada*, Univ. Toronto Press, Toronto, 1961.
- Ward's Culture Leaflets*, Ward's Natural Science Establishment, Rockester, N.Y.
- Weinberg, S. L., *Biology: An Inquiry into the Nature of Life*, Allyn and Bacon, Boston, 1966.
- Weisz, P. B., *The Science of Biology*, 2nd Edition, McGraw-Hill, Toronto, 1963.
- Weisz, P. B. and M. S. Fuller, *The Science of Botany*, McGraw-Hill, Toronto, 1962.

- Wetly, J. C., *The Life of Birds*, Saunders, Philadelphia, 1962.
- Wetmore, A. (Ed.), *Water, Prey and Game Birds*, National Geographic Society, Washington, D. C., 1965.
- Whaley, W. G. et al., *Principles of Biology*, Harper and Row, New York, 1964.
- Whitcomb, J. C. and H. M. Morris, *Genesis Flood*, Presbyterian and Reformed, Philadelphia, 1960.
- Wilkinson, D., *Land of the Long Day*, Clark, Irwin, Toronto, 1966.
- Williams, C. B., *Insect Migration*, New Naturalist, Collins, 1958.
- Winchester, A. M., *Heredity and Your Life*, Dover, New York, 1960.
- Wing, L. W., *Natural History of Birds. A Guide to Ornithology*, Ronald, New York, 1956.
- Yapp, W. B., *Introduction to Animal Physiology*, 2nd Edition, Oxford, Toronto, 1960.
- Young, J. Z., *The Life of Vertebrates*, 2nd Edition, Oxford, Toronto, 1962.
- Young, S. P. and E. A. Goldman, *The Wolves of North America*, Dover, New York, 1964.
- \_\_\_\_\_, *The Puma*, Dover, New York, 1964.
- Zim, H. S. and H. H. Shoemaker, *Fishes. A Golden Nature Guide*, Musson, Toronto, 1956.
- Zim, H. S., and H. M. Smith, *Reptiles and Amphibians. A Golden Nature Guide*, Musson, Toronto, 1956.

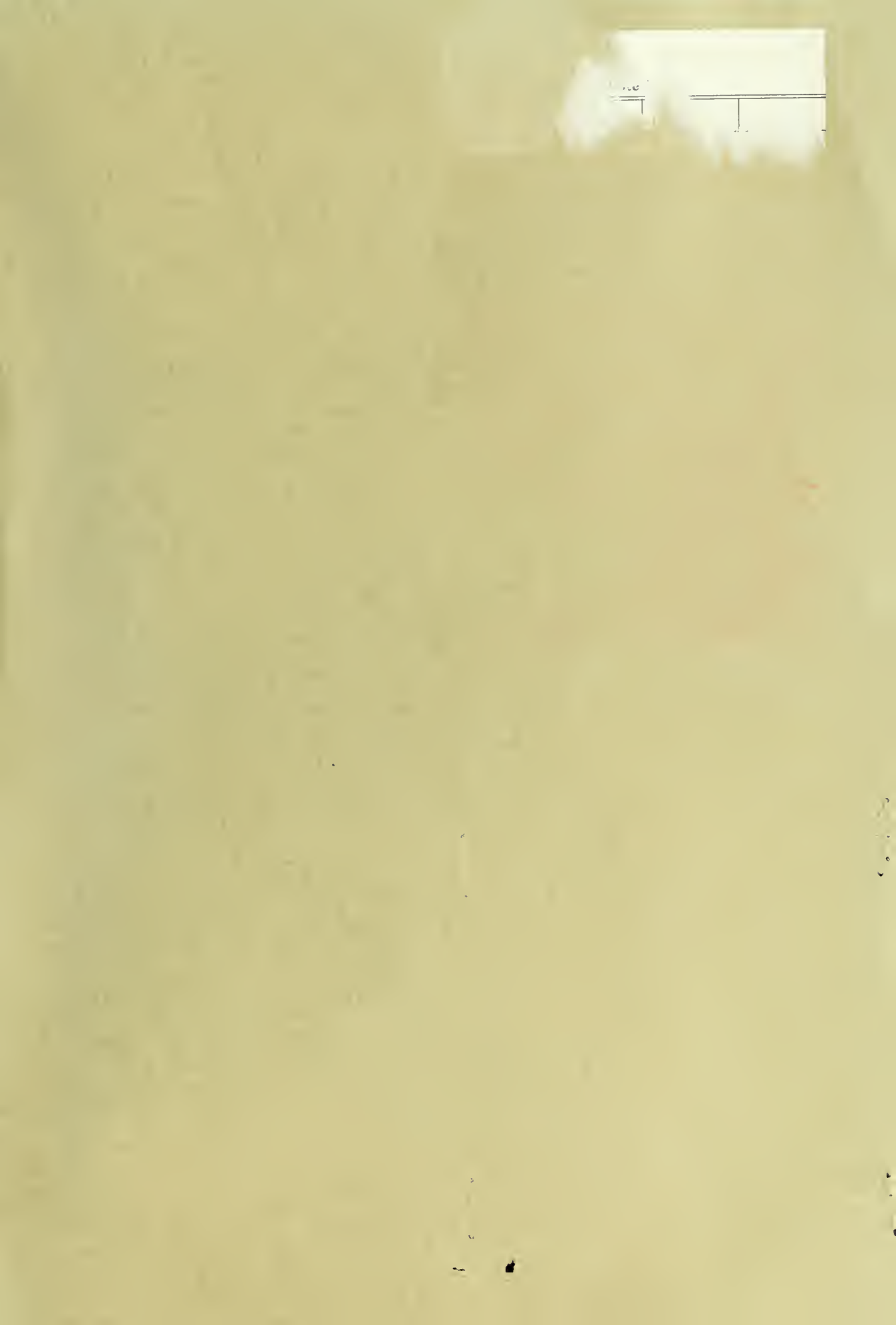
## APPENDIX E

### EQUIPMENT LISTS

The Teacher's Guides for the BSCS Green and Yellow versions contain lists of all equipment and materials necessary to carry out the laboratory work required. Similarly, all equipment and materials required for Biology 30 are listed in the index of the laboratory manual.

Teachers should note that some of the supplies can be purchased locally as required. In some systems, it may be necessary to make arrangements with the proper authorities to ensure that funds will be available for such purchases.







QH 315-5 A33 1969 GR-10-12  
SENIOR HIGH SCHOOL BIOLOGY  
10 20 30 --

39841051 CURR HIST



\*000020735502\*

QH 315.5 A33 1969 gr. 10-12  
Senior high school biology 10,  
20,30. -

39841051 CURR HIST

CURRICULUM GUIDE

**For Reference**

NOT TO BE TAKEN FROM THIS ROOM  
EXCEPT WITH LIBRARIAN'S PERMISSION

