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Scope of Study: This report has been prepared to give helpful suggestions to biology teachers, administrators, architects, boards of education, and others who share responsibility for planning and developing school facilities for biology instruction. It is difficult to find a complete reference source of constructional information on facilities for biology. The suggestions consist of modern up-to-date advice and essential data on planning, design, location, construction, and equipment for the teaching of biology.

Findings and Conclusions: Adequate, well equipped facilities are essential if an effective program of instruction is to be carried on. Therefore, serious consideration should be given classroom and laboratory facilities, utilities and services, equipment and supplies, facilities for storage and preparation, plans for rooms, and community resources.

It must be realized that the planning of facilities for high school biological science may be altered by the amount of money available, community and student needs, teaching methods, and the philosophy underlying the educational program of the school.

ADVISOR'S APPROVAL J. Wm. H. Lewis

FACILITIES FOR HIGH SCHOOL BIOLOGICAL SCIENCE

By

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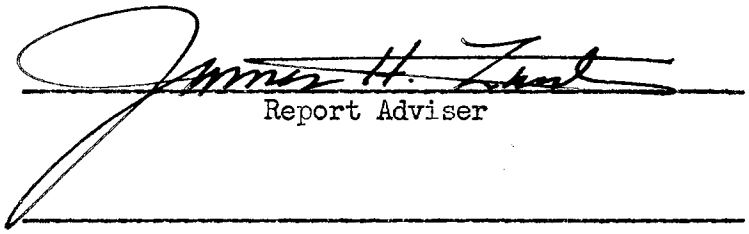

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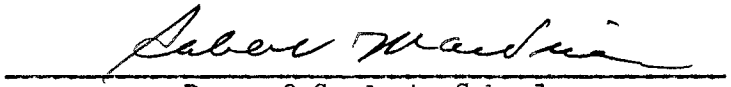

Dean of Graduate School

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PREFACE

This report has been prepared to give help in planning facilities for high school biological science. It is anticipated that the suggestions will be helpful not only to biology teachers and science supervisors, but also to school administrators, architects, boards of education, and school housing specialists, who share responsibility for planning and developing school facilities for biology instruction.

In this scientific age, adequate facilities are second only to abilities. It is very difficult to find a complete reference source of constructional information on facilities for high school biological sciences. It is the aim of this report to fill this gap in the literature by presenting modern up-to-date advice and essential data on the planning, design, location, construction, and equipment for the teaching of biology.

Adequate, well-equipped facilities are essential if an effective program of instruction is to be carried on.

The general public is more aroused than ever before in its demands and expectations of what the school plant should offer by the way of facilities, and as a consequence of this general public concern and interest, modern school plants are becoming more than shells of our educational program.

High school biology can be the life of the student. It is potentially close to his needs and interests; the living, growing world of which he is a part is related to him in ways that he wishes to understand. The mecha-

nism that determines heredity, the production of food by leaves, the digestion of food, the hormones of the ductless glands and their effect upon growth can produce in young people great appreciation of the world in which they live. Such appreciations are worthly because they are the spring board for further exploration of our biological world.

It must born in mind that those who are planning facilities for the teaching of the biological sciences must realize that the plans are determined by the amount of money available, student and community needs, the philosophy underlying the educational program of the school, and the methods of teaching used by teachers in translating this philosophy into practice should be taken into consideration. No matter what type of facilities are being planned, serious consideration should be given classroom and laboratory facilities, utilities and services, equipment and supplies, facilities for storage and preparation, plans for rooms, and community resources.

This report has given maximum consideration to the planning of facilities for high school biological science.

The writer wishes to express his appreciation and gratitude to Dr. James H. Zant, Director of Supplementary Training Program for High School Science and Mathematics Teachers of the National Science Foundation, for his helpful suggestions and counsel in the preparation of this report.

Indebtedness is acknowledged to Mr. H. C. Whitlow, my principal, and the Tulsa Board of Education for allowing me the opportunity to take advantage of this fruitful year of training.

Gratitude is extended to my wife, Loeveta E. Autry, for her inspiration and encouragement throughout the preparation of this paper.

This report is dedicated to my little daughter, Charron Ann Autry, who has just begun facing the problems of an evolving society. May it

make her life more joyous through full relization of the contributions of science to our society.

CHAPTER I

PERSONNEL FOR PLANNING

The planning of biological science facilities should utilize the ideas of many qualified persons. The principal, science teachers, the specialist in the teaching of biology, the consultants on school buildings, and the architects can give valuable information. Here, too, can be explored the ideas of national leaders through articles, pamphlets, and books. Local engineers, technicians, and other professional people as well as grocers, gardeners, and nature lovers have many ideas worth considering. Students in the biological sciences and recent graduates who are mature citizens have many ideas worthy of consideration. No one person should be given the problem of planning the biological science facilities. Many compromises have to be made and many plans changed. According to Phillip G. Johnson, unless the architect and the board of education become sensitized to the ideas of teachers, and other qualified interested persons, many valuable features will be overlooked. Consideration of the ideas of lay citizens promotes support for the school and seeking the ideas of teachers and other local citizens tends to avoid criticisms growing out of compromise which circumstances may require.[1]

The need for many types and many levels of competence is best indi-

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[1]Phillip G. Johnson, School Facilities For Science Instruction (Washington, D. C. 1954), p. 8.

cated when a summary of the activities related to planning is studied. Those responsible for planning should:

1. Evaluate the existing school purposes and programs as those related to science.
2. Recommend changes in the existing purposes and programs so as to meet the current and anticipated needs.
3. Prepare a report of the school facilities for science for which general as well as detailed plans should be made.
4. Assist in the development of all plans and specifications related to the science facilities.
5. Assist in the study and evaluation of plans and specifications as they may be presented for adoption.
6. Assist in the preparation of plans for furnishings, apparatus, equipment, supplies, and other science-related facilities.
7. Assist in the review of the basic plans suggested for adoption.
8. Assist in the evaluation of science facilities during construction and when completed.

The committee or the science teacher has a number of special obligations. These include:

1. A study of the needs of the community that can be met through appropriate facilities.
2. A study of science enrollments over the past years in the biological sciences.
3. A study of plans for shifting enrollment which may be caused by a change in the science program or the presence of suitable facilities.
4. A study of curriculum studies, community surveys and reports of

school building plans.

5. Determination of space requirement for the new facilities.
6. A consolidating and discussion of plans and recommendations going from qualified persons to the planning committee.

Just as science teachers have important responsibilities in planning the new facilities so do teachers in other departments of the school. The planning committee should realize that science is one phase of the curriculum and in good schools science is interrelated with other school work. Other committees should be planning for their areas of activities. It is important that such committees work closely with the science committee to give attention to details of planning that are of common concern.

CHAPTER II

PLANNING OVER-ALL FACILITIES

The organization of classes and the kind of activity that students engage in are factors that should influence directly the amount of classroom and laboratory space provided and the kind and amount of equipment to be supplied in a particular school. The variety and number of courses to be offered, the probably enrollment in these courses, and the number of sections of each should be considered when planning facilities for biology. Careful consideration should be given to community aspiration for the educational program, and to the kinds of facilities which would be provided for biology.

While biology is not a required course in all high schools, it is one of the science courses most often found among those studied by high school students. Almost all high schools offer the course. Many schools now offer several other courses in the biological science field.

Enrollments in biology have shown consistent gains during the past twenty years. Thus in planning facilities for the course it is important to consider not only the present needs but to anticipate that enrollment in the biological sciences will increase in direct proportion to the general increase in enrollment in the school. The average size of a biology class is about 30 students with a range of 24 to 40 students.

Some type of laboratory work is usually included as a part of the biological science course. Some schools have set aside double periods for

such activities. The trend today is toward the classroom-laboratory instead of separate classrooms and laboratories.

One type of class organization frequently used in teaching biology is based on the assumption that all students in a class should engage in the same or similar activities at the same time and that adequate space, facilities, and equipment must be provided to accomplish this. This is particular true in teaching of the basic skills. For example, in learning how to use the microscope each student in the class is provided a microscope and other materials at his work station. In this type of learning situation, planning must foresee the maxiumu enrollment in the class, the amount of space for each work station, and the amount of additional space needed for free movement of students to secure and return materials and for supervision and assistance by the instructor.

There is an increasing trend toward the type of class organization in which several different, but related activities are carried on simultaneously. For example, some students would be using the microscope for the examination of samples of water from different sources, another group would be making cultures from the same sources, while a third group would be writing reports on micororganisms.

It can be seen that the first type of class organization requires a more formal and fixed arrangement of facilities, the provision of a maximum of work stations, and a maximum of equipment. The second type of class organization, if used exclusively, requires much less equipment of a given kind, and a much more flexible arrangement of facilities, the provision of a minimum of individual work stations and a more variety of equipment and of work stations for group activities.

Many competent biology teachers favor the first type of class organi-

zation. Many other competent instructors favor the second type of class organization. A third group favors the use of a combination of both types. The extent to which either method is used with any one class depends upon the objectives to be obtained, the fundamental skills and understandings which are to be developed by all the students taking the course, and the various needs and interests of the students involved.

Thus the philosophy of the educational program of a school and the methods of teaching used by teachers to put this philosophy into practice should be taken into consideration in planning facilities for the teaching of the biological sciences.

A factor of primary importance in the planning of new facilities for biology is the location of the room. The trend toward using outdoor facilities as garden plots and school ground should not be overlooked. A desirable location for the biology room would be the first floor near an easily available exit.

The location of the science room in relation to the source of sunlight is of great importance if living plants and animals are to be used a great deal in the course. For balanced-aquaria in schools the best exposure is north, the second best is east. For the raising of snakes and alligators the southern exposure is best. The room should always be equipped with adjustable shades so that direct rays of the sun can be controlled.

The unique needs of biological science teaching should be anticipated in planning such general features as lighting, heating, ventilating, housekeeping, and safety and health.

Much of the work done in the classroom can be done with general lighting. Supplementary lighting from movable desk lamps should be used for observing and dissecting small animals. Supplementary lighting may be

necessary in the reading center, in the conference and repair center. It also may be used for the lighting of display cases and for use above the aquarium for heating and lighting purposes.

Many biological science rooms are dingy and smelly. The odors from plants and animal material which are not fresh as well as from the alcohol and formaldehyde used to preserve specimen make it essential to provide additional ventilation for rooms where such materials are used. The rooms should be vented directly to the outside.

Heating of the classroom-laboratory presents a problem especially if living plants and animals are kept in the room over weekends and during the holidays. Provision must be made for separate and automatic temperature control in order to keep the temperature in the room at a constant temperature even though it is lower in the rest of the building. Heat ducts should not be near stored or preserved specimen. The excessive heat will cause preserving fluids to evaporate and the deterioration of the specimen.

Housekeeping is a continuing problem in biology rooms and very difficult in rooms where living plants and animals are kept. In planning for effective housekeeping in biological science, careful consideration should be given the following provisions:

1. Adequate vents to remove obnoxious odors quickly.
2. An outside exit with a concrete slab for garbage and trash cans.
3. A well equipped utility closet with a deep sink for washing garbage cans and other supplies.
4. Covered earthenware crocks provided at the work stations for plant and animal waste. A large trash can should be provided for trash as paper and leaves.

5. All sinks in the room should be provided with strainers so that organic material can be removed reguarly.
6. A sink with ample supplies of soap and paper towels should be in each workroom for use of students and teacher.
7. Animal cages provided with metal trays to catch all excreta.
8. One sink, preferably in the preparation room, equipped with pegs or racks for drying glassware.
9. All waste receptacle for biology. It should be emptied nightly and sterilized regularly.

For the health and safety of students additional special facilities should be given due consideration. They are as follows:

1. The type of floor covering. The spillage of water and other organic material is common. If this occurs on polished floors, it may cause accidents.
2. Electrical outlets and switches should not be placed near sinks or other places where there is a possibility of water being spilled.
3. The selection of furniture and fixtures. Stools should be constructed to prevent tipping.
4. The provision of first aid cabinets. A plainly marked cabinet should be available in laboratory rooms. A chart of first aid procedures should be attached to the inside of the door.
5. The provision of fire extinguishers. The constant use of bunsen burners and inflamable substances cause fire hazards. Therefore, extinguishers should be placed in the laboratory room and the hall adjoining the laboratory.
6. The provision of a storage cabinet with lock. This is important

because many poisonous chemicals are used in biology. These substances should be stored and locked in the cabinet by the teacher.

The most effective science facilities are those which result from a consideration of many ideas. First and foremost science instruction is a concern of science teachers. Certainly the ideas of the science teacher should be secured.[2]

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[2]Phillip G. Johnson, Ibid.

CHAPTER III

CLASSROOM AND LABORATORY FACILITIES

The choice of furniture and furnishings for biology rooms usually involves many factors, such as the type of work to be carried on in biology, the use of rooms by other classes, the amount of money available for furniture, and the like. Thus the functions to be served should be the basis by which the furniture and furnishings should be selected.

Since demonstrations are of particular importance in biology, a desk for the purpose should be provided. It should be about thirty-six inches high. The acid proof top should be twelve to twenty-four inches square. To increase the utility of the desk, shelves may be built along its sides. The shelves may be used for the storage of small items as dissecting sets, slides, and other small pieces of equipment. Special lighting should be provided for the illumination of the demonstration area. Facilities for the disposal of liquid and solid waste, gas, water, and electricity should be provided. The continous use of the room throughout the day may prevent the taking down of equipment, this may be overcome by using a movable desk equipped with electrical outlets and with an extension cord to be plugged into the regular service outlets.

A wall table approximately thirty-five feet long equipped with eight sinks and service for hot and cold water should be placed along the window side of the room. The table should be provided with storage cabinets beneath.

The two-student and four-student laboratory tables are most commonly used in biology classes today. These tables are usually acid proof.

For most of the activities carried on in the biology class, regular chairs are suitable. If a great deal of work is done with microscopes, these chairs are too low. Adjustable stools would serve this purpose.

Laboratory work usually requires a great deal of moving around by the teacher and students. In planning for the most effective utilization of available space, careful consideration should be given to the placement of furniture, especially of fixed type. This will ensure adequate aisle space in the areas where traffic is heavy.

The biology room should be equipped with a minimum of lineal feet of light yellow or light green chalkboard. A small amount of bulletin board should also be included.

Display cases are very important biological teaching aids. A display case should be built in the corridor adjoining the biology room. The room should include a display case with glass doors and glass shelves. This type of display has proved successful for the showing of mounted specimens, sketches, photographs, and models.

The modern trend of biology teaching is the collection and growing of aquatic plants and animals from the surrounding area. This may be successfully accomplished by the use of a large aquarium. An aquarium of about 30 to 50 gallons would service this purpose. A number of small aquaria with capacities of one to five gallons should be provided for students use in the raising of plants and animals.

Germinating beds are used in some schools. These may be made by the students. For the purpose of observing root growth, the front should be constructed of plate glass. The box should be zinc-lined with a drain in the

center. If possible the tray should be mounted on rubber wheels so that it could be moved to different positions in the room.

The biology room should include furniture for projection. This should consist of a projector stand and a mounted screen. Storage cabinets for the projector and films should not be overlooked. Blackout curtains should be provided for the windows.

Furniture for the reading center should be determined by the use to be made of it and the amount of space available for such purpose. This area should include open shelves for books, magazines, pamphlets, and booklets. If space permits, the reading center may be separated from the rest of the room by book cases.

CHAPTER IV

UTILITIES AND SERVICES

Water has so many uses in the teaching of biology that each room which is planned for biology should be equipped for supplying it in the amount and at the desired temperature.

Cold water should be available in all rooms used for biological activities. In the classroom-laboratory it should be available at the demonstration desk and at each sink. If aquaria and germinating beds are maintained in the room, a faucet threaded for attaching a length of rubbing tubing so that water may be kept flowing through the aquaria.

Hot water with temperature of 120° F. should be provided at each work station. If the sinks are to be used by students, care must be taken to ensure that inadvertent turning on of scalding water does not result in accidents. This may be done by the use of mixing valves.

Sinks and trough for the biology room should be made of acid-resistant materials. Stainless steel, impregnated sandstone, or soapstone will serve this purpose.

Traps and waste lines should be selected with care since many plant and animal wastes are not soluble in water and cannot be flushed out of the sinks. Strainers should be provided for each sink. Traps should be large so that they can be easily cleaned.

Gas as a source of heat is highly recommended for the biology room. Duplex gas outlets should be provided. Cut-off valves should be provided

for each line, and a master cut-off valve for the room. If gas is not available, liquid gas, alcohol burners, and electric hot plates should not be overlooked as a source of heat.

Adequate electric service for present and future needs should be considered during the planning. A 110 Volt A. C. current will be sufficient for carrying out the biological activities. The demonstration desk should include a duplex flush receptacle. Separate curcuits for lighting fixtures, wall plugs, the demonstration desk, for projection, and for the preparation room should provide for 30 amperes. Each work station should have a duplex receptacle.

Electrical devices which are kept in use continously for the operation of ovens, aquatic heaters, and incubators should be equipped with automatic cut-outs so that current will be shut off if the temperature should approach the danger point.

CHAPTER V

EQUIPMENT AND SUPPLIES

One of the most important aspects of planning facilities for biology is the choice of equipment and supplies. Such resources are a major part of the science environment and deserve careful attention.

The source of supplies and equipment for the teaching of biology are determined in part by the needs of the school. As with all areas of science teaching, needs are related to the activities of the students, nature of the school curriculum, and the community.

The immediate environment of the student is one of the most important sources of materials. The purchase of some equipment in most situations is a necessity. Many of the supplies and some equipment for the teaching of biology should come from the surroundings of the students. The student is usually familiar with such supplies. This is an advantage because learning begins with what the student already knows. Another advantage is that local sources provide many biological supplies without cost other than a trip to secure the items. The material may be obtained from ponds, lakes, streams, mountains, fields, and other natural areas.

An accurate and up-to-date inventory should be kept by the biology teacher of all supplies, equipment, and furniture in the biology department. The principal as well as the biology teacher should have copies of the inventory on file. In some school systems a copy is required to be on file in the office of the superintendent. A record should always be kept

of breakages, date and name of new equipment delivered to the department and of supplies loaned to other departments.

A list of commonly needed supplies and equipment for the effective teaching of biology is provided in Appendix II. Sources of equipment and supplies are listed in Appendix III.

CHAPTER VI

FACILITIES FOR STORAGE AND PREPARATION

The space for storage in the classroom is usually provided by separate cabinets, display cases and by drawers which are part of classroom furniture, demonstration desk, and student desks. Supplies which are used frequently for demonstrations should be stored in the drawers of the demonstration desk. Small items should be stored in drawers near the work area.

The stockroom may be used for bulk storage and for supplies not used frequently. Open shelves may be used in the stockroom.

Models should be stored in dust proof cabinets. They should be taken into the classroom as needed.

Microscopes should be stored in dust proof cabinets near the work area.

Insect mounts and herbarium specimens which are susceptible to infestation by insects should be stored in metal-lined cabinets which can be fumigated.

Charts and preserved specimen should be stored on shelves in the storage room where they are easily accessible without disturbing classes while they are in session.

The preparation room should be included in all building plans. This room provides for the preparation of experiments and demonstrations. This room should consist of work facilities, sink, running water, gas, electricity, work bench and hand tools. At many schools the storage room and preparation room are combined. This room may be used as an office of the tea-

cher.

Wherever science is taught there is a need for storage. Without convenient storage facilities science is likely to become a read-about-talk-about science course which is low in interest and value to students.

CHAPTER VII

PLANS FOR BIOLOGY ROOMS

The general public is more aroused than ever before in the demands and expectations of what the school plant should offer by the way of space facilities, and as a consequence of this general public concern and interest modern school plants are becoming more than shells of our educational programs.

It is obvious that no standardized plans or set of plans for biology rooms would be usable in the great variety of situations which exist in the secondary schools of our country. The plans that are found in Appendix I should be regarded as guides.

There are four types of rooms used for science classes in the secondary schools. These are: separate rooms for class and for laboratory activities; a classroom-laboratory with areas, a front area with seats, a rear area with fixed laboratory desks; a room equipped with one-way facing tables to serve all purposes; and a multi-purpose room for all science activities, with fixed desks around the walls and seats and other movable furniture in the central part of the room.

Many high schools may have the enrollment, the course offering, and the community needs to justify separate rooms for laboratory and for class use. This type of room is appropriate for more specialized work in biology with a minimum of emphasis on formalized laboratory work.

This classroom-laboratory with two areas is desirable for student ex-

perimentation, demonstration, discussion and other types of learning activities needed in the development of a problem. During a single class period students may move readily from short periods of discussion or demonstration to project work of different types, or to individual or group experimentation to answer a question or to clarify a conception or the laboratory work may continue through consecutive periods.

This room plan provides many features essential to good biology teaching. In many medium sized and large schools where homogenous grouping of students for instructional purposes is attempted, and where the course offerings in biology are diversified for the college preparatory, commercial and general curricula, this plan has been used successful. Space for the storage of equipment, for reading center, and for project activity is limited.

The classroom-laboratory with one-way facing desks provides classroom and laboratory space for each student. Rearrangement of the room is impossible because the furniture is fixed to the floor. There is limited space for project work. The modern trend is to exclude this type of room design.

Multi-purpose rooms can be used for a single subject, such as biology, and provide for all the indoor activities of that subject. Many of our small schools have the multi-purpose science rooms.

A room of this type provides for greater flexibility in the use of the facilities, and a greater variety of student activities than rooms of the type previously described. This type of room is good in schools that do not have diversified curricula, and in which no attempt is made at homogenous grouping of students. Today many competent biology teachers believe that there should be enough work space to permit all students to

engage in the same skill developing experiences at one time.

The E. H. Sheldon Equipment Company has modified the multi-purpose science room and calls it the total experience room. The company states that the term total experience laboratory is used to designate facilities for varied activities and varied group size, with emphasis on relationships between special sciences and on relationships to life experience whether for living, for work, or for college preparation.[3]

A multi-purpose room is not necessarily a total experience room because it offers special facilities for several subjects. It must satisfy the above requirements in addition to having a full complement of its special subject facilities as stated by the Sheldon Company.

The biology teacher must do all the planning and paper work that other teachers do. In addition, the science teacher must prepare for experimental demonstrations, keep records of apparatus, supplies, and other materials. The reports of experiments and projects must be examined and retained until they are returned. A desk in the classroom can meet some of the needs, but a place for study and conferences not regularly available to students is necessary.

The science teacher needs to confer with students about project work. Sometimes there must be conferences about conduct. After grades are released many students want to confer about their grades and ways of improving them. Parents sometimes want to talk with the teacher concerning the accomplishment of their son or daughter. A teacher's office occupying a portion of the classroom may be the ideal solution to the conference

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[3]Sheldon Total Experience Science Furniture Catalog, (1957), p. 5.

problem. This combination office and conference room should be separated from the science room by a sound proof clear glass so as to provide a view of classroom activities while in progress.

Rooms for the teaching of biology should be made attractive as well as useful. High polish surfaces should be avoided so as to prevent glare. The use of black top tables should be avoided. The use of lighter colors for walls and furniture will add to the attractiveness of the room. Warm colors as peach, ivory, and buff are suitable for northern exposure, while shades of green are often used for a southern exposure. Many persons like a light yellow color for sunless rooms.

The biology teacher can do much to improve the appearence of rooms through the use of aquaria, terraria, and attractive cages for small animals. Bulletin board displays and posters can include colorful materials that please the eye.

CHAPTER VIII

SCHOOL AND COMMUNITY RESOURCES

Biology is the study of living things. There are many types of facilities which should be provided in the school, on the school grounds, or in the local community for the use of the biology classes.

Some of those usually found in high school buildings are: growing rooms, greenhouses, conservatories, aquaria, and terria.

Many large schools use enclosed areas for flower beds, shrubbery, and fish ponds.

A large number of plants and animals will not flourish in the classroom for a long length of time because of the change in temperature, humidity, and lighting ehich occur over night, weekends, and the summer vacation. This problem may be solved by providing a greenhouse or growing room suitable for plants and animals.

The greenhouse or growing room should be separated from the classroom by doors and windows, although good results can be obtained when growing rooms are not separated from other rooms. The temperature must be lower and the humidity much higher in the greenhouse than in the classroom.

The location of the greenhouse should be on the south side of the building, or on the east side as a second choice. The west side of the building should be avoided and the north side is unsatisfactory.

A separate line directly from the school heating plant to the greenhouse should be provided. This will prevent excessive lowering of heat

during weekends and holidays. Some schools use a separate heating unit.

The school grounds as a biological resource is frequently overlooked. In the plan for landscaping consideration should be given to the development of areas that can be used and maintained by biology classes. Trees should be preserved. Selection and placement of shrubbery should be made so that birds are encouraged to come near the school. Bird houses, baths, and winter feeding stations should be included in the plans.

An increasing number of school systems are buying tracts of forests and farms so that teachers and students can have direct experience with conservation practices and with living things. The school forest and farm can aid the biology teacher to focus attention on local plants and animals and can establish life long interest in many students.

Many school systems today are acquiring sites for the development of school camps. Students can learn a great deal by studying the forms of life found in the vicinity of the camp.

Community resources are excellent for supplementing the biology program. The classes should visit the dairy, water plant, sewage disposal plant, hospitals, greenhouses, and factories where food is processed. Natural resources which should be utilized are: rivers, lakes, ponds, swamp, forests, mountains, desert areas, and fields. A list of these resources should be listed by name, location, when open, and persons to contact for making appointments for visitation.

Other important biological resources available in all communities are the local citizens with scientific abilities as engineers, physicians, nurses, technicians, and research personnel. These specialists can make lasting contributions to the education of the youth by talking to them about opportunities in their fields and the qualifications necessary for

pursuing them.

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APPENDIX

This appendix is devoted to four additional types of assistance. The first section is a check list made up of questions which focus attention on factors to be considered in the planning of biological science facilities. The second section consists of ideas of floor plans. The third lists equipment and supplies suggested for biology teachers. The fourth portion gives suggestive sources of equipment and supplies.

APPENDIX I

CHECK LIST OF BIOLOGICAL SCIENCE FACILITIES

1. For what activities in the teaching of biology are provisions made?
2. How many square feet of floor space and how many rooms will be needed for biological science?
3. What type of room arrangement will be most serviceable?
4. What accessory rooms will be needed for biology teaching?
5. What flexibility and what possibility of future conversion are included in the room plan?
6. Is the orientation of the room adequate to the needs of biological science?
7. Do the provisions for room arrangement, decoration, lighting, and care make the room attractive?
8. Are special heating and ventilating requirements provided for?
9. Are the special illumination requirements provided for?
10. Are provisions for good housekeeping adequate?
11. Are the provisions in the biology rooms for safety and good health adequate?
12. Will the various resources of the biology rooms be available for adequate student activity?
13. Is a preparation room or combination of this room with another, provided for use by teachers and students?

14. Can the preparation room or another separate room be used for student project work?
15. Does the furniture selected serve the needs of biology teaching? Is it attractive?
16. Are the provisions for display adequate?
17. Are provisions for storage of biological materials adequate?
18. Are there sufficient provisions for such utilities as water, gas, and electricity? Are the utilities available at appropriate places?
19. Do the list of apparatus and supplies provide adequately for the needs of biology teaching?
20. Is there provision for a classroom library and is there a reading center for student use?
21. Is adequate attention given to the use of out-of-doors in planning for biological science?

(From "School Facilities For Science Instruction" by John S. Richardson, 1954).

APPENDIX II

1. Storage Cases
2. Utility Table
3. Aquaria
4. Germinating Table
5. Soil Bed
6. Instructor's Table
7. Movable Table
8. Storage Cases
9. Utility Tables
10. Blackboard and Screen
11. Storage Cases in Wall
12. Movable Projectile Table
13. Sink

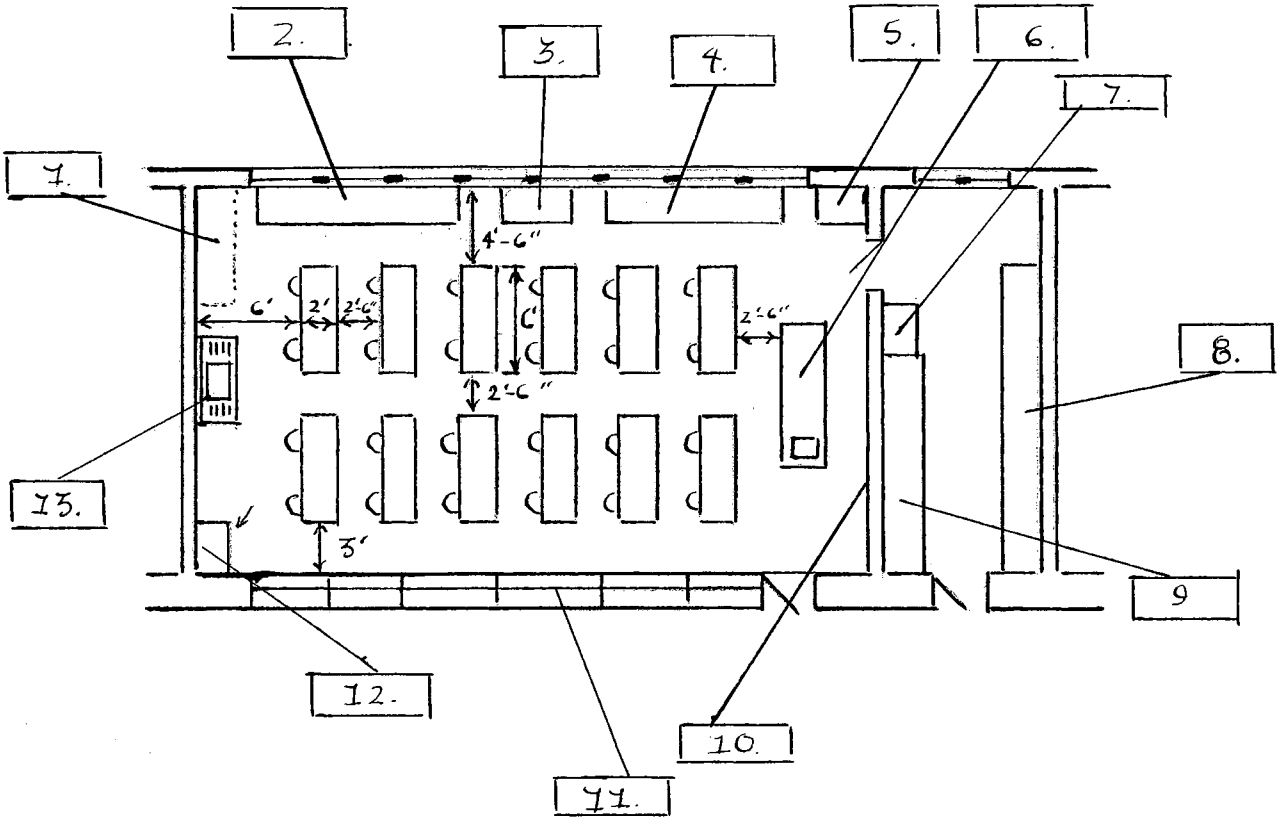

FIG. 1. Floor plan for a biology laboratory (Modified from drawing supplied through the courtesy of Kewaunee Mfg. Co., Adrian, Mich.)

1. Student Tables
2. Storage
3. Reading Desk
4. Books
5. Desk
6. Plants
7. Sink
8. Preparation Room
9. Dark Room
10. Storage
11. Utility Table

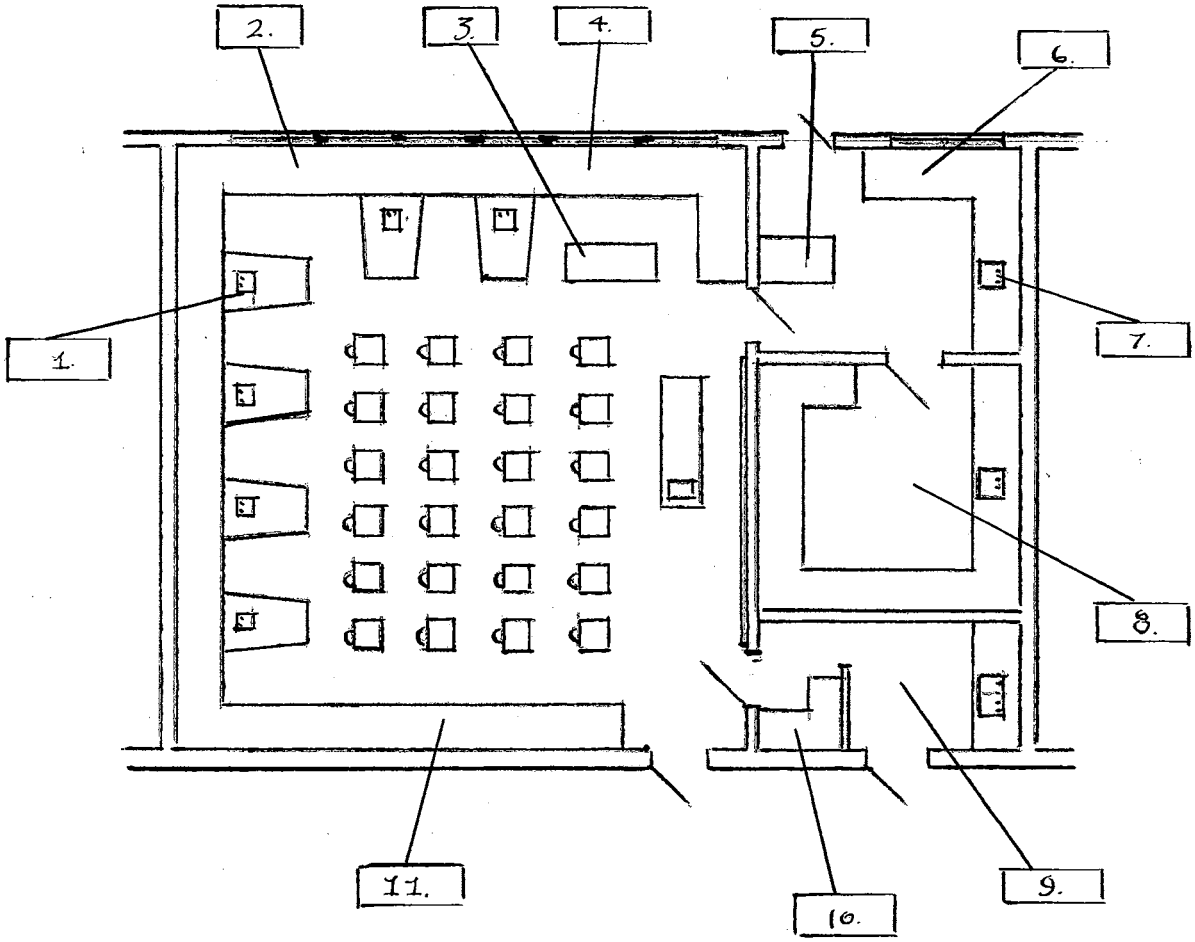

FIG. 2. A multipurpose science room of the square type with movable student desks and fixed laboratory tables. Modified from "Science Facilities for Secondary Schools," Office of Education Bulletin Misc. No. 17.)

1. Storage and Display
2. Sliding Chalk Boards
3. Demonstration Desk
4. Storage and Preparation
5. Sinks
6. Wall table and Storage

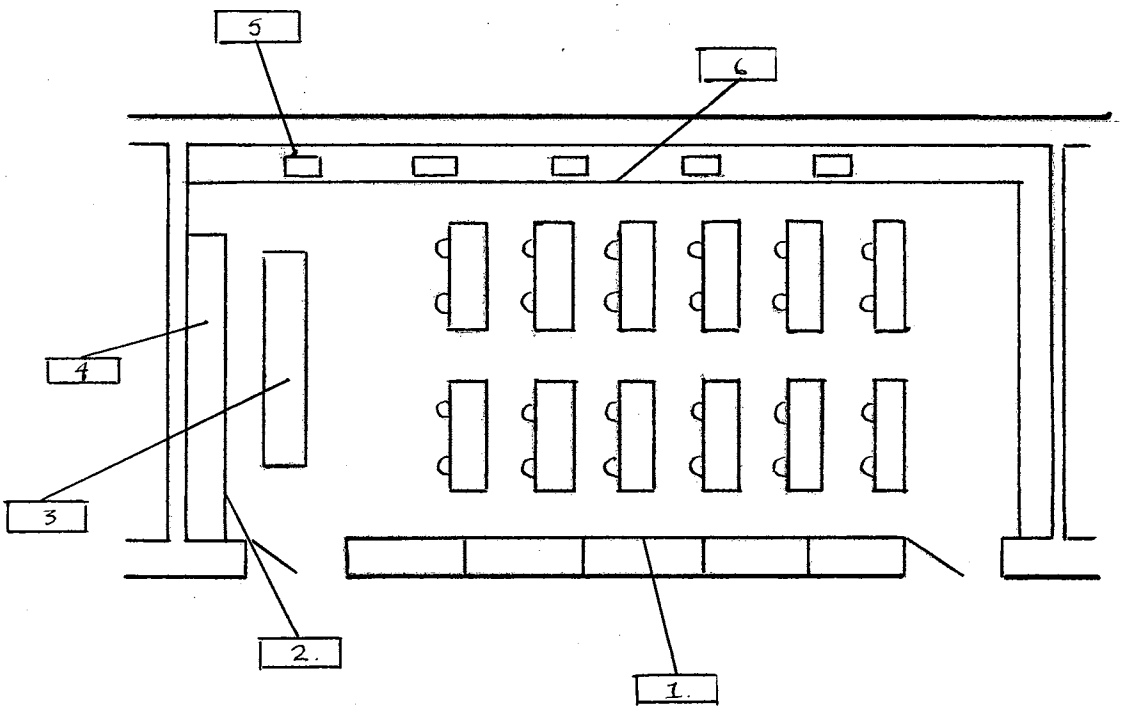

FIG. 3. Floor plan for classroom laboratory This is the floor-plan of Biological facilities at the Booker T. Washington High School, Tulsa Oklahoma. Utilities are available only on wall tables and demonstration desk.

APPENDIX III

SUGGESTED EQUIPMENT AND SUPPLIES FOR HIGH SCHOOL BIOLOGY COURSE

This listing of equipment and supplies is an approximation. No listing can be complete, particular in view of the desirable use of materials and apparatus obtained from local sources. The selection and compiling of apparatus is in itself an educational experience.

The needs of the learning situation determine the kinds and amount of supplies and equipment to be provided.

Many items listed will not be needed except for special project work. Quantities are difficult to estimate, even assuming a basic class size of thirty pupils.

Those articles listed below marked with an asterisk (*) represent materials which will fulfill the minimum needs of the high school biology department operating on a limited budget. It is assumed that supplies as toy balloons, fuses, sand, salt, etc. are secured locally. The list is suggestive for a class of twenty-four students.

Quantity	Material	Quantity	Material
	Microscope Slides		
1	* Type bacteria	1	* Spirillum volutans
1	Typhoid flagella stain	1	* Bacillus subtilis spore stain

Quantity	Material	Quantity	Material
1	* Volvox	1	Desmids
1	* Distoms	1	* Penicillium
1	Sponge, commercial, skeleton	1	Spongilla, gemmules
1	* Hydra	1	Asterias
1	* Planaria	1	Earthworm
1	Housefly, proboscis	1	Housefly, cornea
1	* Insect tracheal system		
	Museum Preparations		
1	* Harmful weeds, herbarium sheets (set of 10)	1	Insectivorous plant ser (set of 4)
1	* Systematic demosection collection, animal	1	Grantia Bio-gram
		1	Gonionemus Bio-gram
1	Pleurobrachia Bio-gram	1	Liver fluke Biogram
1	Tapeworm (Taenia) Bio-gram	1	* Earthworm Bio-gram
1	* Crayfish Bio-gram	1	Lubber grasshopper Bio-gram
1	Insect wing types Bio-gram	1	Slime molds Biogram
1	* Rhizopus, nigricans, zygospores	1	Yeast budding
		1 set	Wheat rust (3 slides)
1	* Aspergillus	1	Fern prothallium
1	* Lichen	1	* Male pine cone with pollen
1	* Fern sporangia		

Quantity	Material	Quantity	Material
1	* Stems, monocot and dicot	1	* Leaves, monocot and dicot
1	Tilia stem	1	Corn stem
1	* Roots, monocot dicot	1	Root hairs
		1	Pollen tubes
1	* Asterias embry-ology, all stages	1	Rat testis
1	* Whitefish mitosis	1	Cat ovary
1	* Human bone	1	Frog tadpole, serial
1	* Muscle, human, striated and smooth	1	* Human blood smear
1	Ear internal (Organ of Corti)	1	* Frog blood smear
1	Necator americanus (male and female)	1	* Taenia, pisiformis, tapeworm
1	* Euglena	1	Stigmata (spiracles) of house fly larvae
1	Paramecium		
		1	Puccinia (wheat rust) Bio-gram
1	Grantia		
1	Lichen Bio-gram	1	Marchantia Bio-gram
1	Mushroom Bio-gram		
		1	Seed germination Bio-gram
1	Polytrichum moss Bio-gram		
		1	Honey bee life history (Riker mount)
1	Fern Bio-gram		
1	* What is a Fossil (complete teaching unit)		

Skeletons

1	Human skeleton and steel cabinet	1	Grass frog

Quantity	Material	Quantity	Material
1	Chicken	1	Turtle
1	Perch	1	Cat
	Models		
1	* Model of typical cell	1 set	Ten models of mitosis
1	* Model of paramecium	1	* Model of amoeba
1	* Model of hydra	1 set	Models of frog embryology
1	Anatomical model of human eye	1	Anatomical model of human ear
1	Anatomical model of human trunk with head		
	Apparatus		
2	* Insect nets, nylon	1	Water dip nets, nylon
200	* Water faucet plankton gatherer	24	* Carbon tetrachloride insect killing jars
1800	Cyanide lepidoptera jars	24	* Insect pins (200 ea. size)
250	* Spreading boards	6	Vasculums
24	* Spreading pins	2	*Plant mounting sheets
6	* Insect boxes	1	* Dip tube
6	* Plant presses	1	* Aquarium net
1	Gitsknives	1	Hydroponics outfit
1	* Aquarium, 6 gallon	4	Entomological breeding chambers
1	* Footed terrarium		
1	Dietetic scale		

Quantity	Material	Quantity	Material
2	Rat cage assemblies for nutritional experiments	1	* Seed germinating boxes
		24	* Dissecting sets
1	Fern spore germinating outfit	1 lb.	* Dissecting pins
2	* Sharpening stones	4	Large forceps
1	Bone shears	1	Bone saw
1	Autopsy knife	1	Instructor's dissecting set
1	Steel cabinet for small instruments	1	Eder-Lite lamp for cavity explorations
24	* Dissecting pans, waxed	1	Dissecting pan, large
24	* Aluminum dissecting and utility pans	1 gal.	Formalin Fumelock
		4 oz.	* Deodorant
4 oz.	Plastic specimen bags	100	Waterproof tags
		24	* Kerodex Barrier Cream (K71 for formalin)
1	Utility cart		
1	* Hand microtome	1	* Section razor
1	Interval timer	1	Slide making kit
24	* Tripod magnifiers	4	Wide-field tube microscope
4	* Microscopes with case	4	* Turtox Scope-aid
12	* Universal Clamp-on Lamps	1	Tri-Simplex Micro-Projector
1	Projector for 2 x 2 slides, with case	1	Metal tripod screen, glass bead surface
1	Double boiler	1	Inoculating loops
1	* Steam pressure sterilizer	1	Vertical autoclave

Quantity	Material	Quantity	Material
3	Culture tube baskets	12	Test tube racks, wood
2	Haemoglobin scales	24	Inoculating loops
1	* Frog holder (for circulation demonstrations)	1	Blood typing kit (80 tests)
1	* Harvard trip balance	24	* Measuring slides
12	Test tube brushes	1	Respiration apparatus
20 ft.	* Rubber tubing, $\frac{1}{4}$"	12	* Photosynthesis light screens
100	Corks, assorted	1	* Tripod support
1	Aspirator	20 ft.	* Rubber tubing, 3/16"
24	Drawing paper pads (20 sheets each)	2 lb.	* Rubber stoppers assorted
1 pkg.	* Filter paper, 25cm.	1	* Ring stand
24	Drawing pencils, 2H	2	Beaker tongs
		24	Drawing pencils, 4H
	Glassware		
12	* Pyrex beakers, 250 cc.	1	* Osmosis apparatus
4	Graduates, assorted 10 cc., 50 cc., 250 cc., and 10000 cc.	2	Desiccators
1	Busen's funnel	2	Pyrex Erlenmeyer flasks, 250 cc., and 1000 cc.
12	Culture bowls, (fingerbowls)	24	* Petri dishes
1	* Storage jar, 3 gal.	24	Stacking watch glasses
1 gr.	* Test tubes, 6 x 5/8"	1	* Storage pail, Polyethylene

Quantity	Material	Quantity	Material
4 lb.	* Glass tubing, 7-8 mm. O. D.	4 lb.	* Glass tubing, 10-12 mm. O. D.
1 gr.	Culturing jars, 1 gal.	24	* Plugging cotton, bacteriological
1	Bell jar	6	* Microscope slides
24 oz.	Hanging drop slides	2 oz.	* Dripping pipettes
1	Filtering flask with side tube, 250 cc.	4 dz.	* Coverglasses, 22 mm. sq. No. 2
48	* Specimen jars, 3/4 oz.	1	Clinical thermoneter
48	* Specimen jars, 8 oz.	4	* Laboratory thermometers
24	* Specimen jars, 3-1/8 oz.	48	* Specimen jars, 16 oz.
24	* Display jars, 8 oz.	24	* Display jars, 16 oz.
24	* Clear shell vials with polethylene stoppers	24	* Display jars, 30 oz.
		12	Glass marking pencils, red

Chemicals

1 lb.	Acetic acid, glacial C. P.	1 lb.	Acid carbolic U.S.P., cryst.
1 lb.	Acid Hydrochloric, C. P.	1 gal.	* Alcohol iso-Propyl, anhydrous
1 lb.	Calcium carbonate, U. S. P.	1 lb.	Ether, U. S. P.
1 lb.	* Formaldehyde, 40%	1 lb.	* Glycerine, U. S. P.
4 oz.	Iodine, U. S. P. cryst.	4 oz.	Potassium iodide, U. S. P., cryst.
1 pint	Xylol, pure	4 oz.	Benedict's solution qualitative

Quantity	Material	Quantity	Material
1 lb.	Bouin's Fluid	4 oz.	Wright's blood stain
4 oz.	Eosin solution, aqueous 1%	2 lb.	Paraffin 53 M.P.
4 oz.	* Methyl cellulose (to reduce movement of protozoa), 10% strength	5 lb.	* Paradichlorobenzene
		23 gr.	* Bacto Nutrient Agar (B1) to make 1000 cc.
2 vi.	* Litmus paper, red	2 vi.	* Litmus paper, blue
2 vi.	* Litmus paper, neutral	25	P. T. C. Taste-test leaflets
1 vi.	* Potassium iodide, starch paper	1 qt.	Table-top dressing, glossy black
1	Turtox Plastic Embedding kit[4]		

[4]Turtox Service Leaflet No. 59, Basic Laboratory Equipment For High School Biology, (1957).

APPENDIX IV

SOURCES OF EQUIPMENT AND SUPPLIES

The biology teacher finds that some of his equipment and supplies may be purchased locally. This leads to closer relations between school and community and often results in economical purchases. Local sources vary from one community to another.

The list which follows is suggestive for equipment and supplies not found locally.

American Museum of Natural History, 77th and Central Park West, New York, New York. Latern slides, photographs, and pamphlets.

Bausch and Lomb Optical Company, Rochester, New York. Microscopes, microtomes, and other optical equipment.

Biological Supply Company, 1176 Mount Hope Avenue, Rochester, New York. Preserved biological materials and general biological supplies.

California Botanical Material Company, 787 Melville Avenue, Palo Alto California. Microscope slides and preserved botanical materials. Many Pacific Coast species available.

Camboso Scientific Company, 370 Anthwerp Street, Boston, Massachusetts. Biological materials, collecting supplies, etc.

Carolina Biological Supply Company, Elon College, North Carolina. Living and preserved biological materials.

Central Scientific Company, 1700 Park Blvd., Chicago, Illinois. Laboratory apparatus.

Chicago Apparatus Company, 1735 North Ashland Avenue, Chicago, Illinois. Biological materials, mivroscope slides, general laboratory apparatus and reagents.

Denoyer-Geppert Company, 5235 Revensword Avenue, Chicago, Illinois. Preserved biological supplies, microscope slides, charts, models,

and general laboratory equipment.

Eastern Kodak Company, Rochester, New York. Projection apparatus, cameras, motion pictures, chemicals, etc.

Fisher Scientific Company, 709-719 Forbes Street, Pittsburg, Pennsylvania. Laboratory apparatus.

General Biological Supply House, 8200 South Hoyne Avenue, Chicago, Illinois. Living and preserved biological materials, microscope slides, and general laboratory apparatus.

Hazer, J. M., Alburg, Vermont. Living frogs.

Kewaunee Manufacturing Company, Kewaunee, Wisconsin. Laboratory furniture.

Marine Biological Laboratories, Supply Depot, Woods Hole, Massachusetts. Living and preserved biological materials. Many marine apecies available.

New York Scientific Supply Company, 111-113 East 22nd Street, New York, New York. Preserved species and slides.

Oregon Biological Supply Company, 1806 S. E. Holgate Blvd., Portland, Oregon. Biological materials.

Spencer Lens Company, Buffalo, New York. Microscopes and other optical equipment, microtomes, etc.

Southern Biological Supply Company, 517 Dacatur Street, New Orleans, Louisiana. Living and preserved biological materials, microscope slides, etc.

South-Western Biological Supply Company, 415 Tyler Avenue, Dallas Texas. Living and preserved materials, microscope slides, etc.

U. S. Department of Agriculture, Washington, D.C., Division of motion pictures. Supplies motion picture films.

Triarch Botanical Products, Ripon, Wisconsin. Living and preserved botanical materials, microscope slides, etc.

Victor Animatograph Company, Davenport, Iowa. Projection apparatus.

Ward's Natural Science Establishment, Inc., 302 Goodman Street, Rochester, New York. Preserved biological materials, microscope slides, skeltons, insect collections, fossils, etc.

W. M. Welch Manufacturing Company, 1516 Orleans Street, Chicago, Illinois. Preserved biological materials, microscope slides, and general laboratory equipment.

Zeiss. Carl Zeiss, Inc., 458 Fifth Avenue, New York, New York.
Microscopes and other optical equipment.

VITA

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Candidate for the Degree of

Master of Science

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