Name: Maurice Broadus James Date of Degree: May 27, 1962

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: A SUPPLEMENTARY STUDY UNIT IN BACTERIOLOGY FOR HIGH SCHOOL BIOLOGY STUDENTS

Pages in Study: 47 Candidate For Degree Master of Science

Major Field of Study: Natural Science

Nature and Scope of Study: This study and report grows out of a conviction that the study of life sciences is being neglected in the present program of high school science curriculum. It presents certain findings in a few typical high schools visited, and pertaining to materials presented in state adopted biology text books for the states of Oklahoma and Texas. Suggestions are presented for a degree of specialization in the study of life sciences in high school. Coverage of the problem is limited to one phase and one field: that of enriching the regular biology course with a unit of bacteriology.

Findings and Conclusions: Average high schools under the present program offer students only one course of life science, which is biology in a general course offered at tenth grade level. Most teachers are willing to specialize, but texts contain very little material usable for special instruction. The author's experience concludes that teaching special units, especially bacteriology, is workable and profitable at tenth grade level.

Use of the Study: A study unit outline is presented that may be used to supplement textual materials in a regular course of general biology at the tenth grade level. A list of useful reference books for the study of bacteriology, its history, progress, and important people, is also presented.

ADVISOR'S APPROVAL James H. Zant

A SUPPLEMENTARY STUDY UNIT IN BACTERIOLOGY FOR HIGH SCHOOL BIOLOGY STUDENTS

By

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Bachelor of Arts

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1949

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1958

Submitted to the faculty of the Graduate School of
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MASTER OF SCIENCE
May, 1962

A SUPPLEMENTARY STUDY UNIT IN BACTERIOLOGY

FOR HIGH SCHOOL BIOLOGY STUDENTS

Report Approved:

Report Adviser

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Grateful and sincere appreciation is hereby expressed for the kind and helpful guidance rendered to the author during the preparation of this report by Dr. James H. Zant, Director of The National Science Foundation, Oklahoma State University, and by Dr. Herbert Bruneau, Associate Professor of Zoology, Oklahoma State University, Stillwater, Oklahoma.

The extraordinary priviledge of being granted this Academic Year of study and research under the program of The National Science Foundation, and of being chosen for participation herein by the selections committee of Oklahoma State University is also deeply appreciated.

M. B. J.

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CHAPTER I

INTRODUCTION

The Problem: It has been found that very few teachers of high school biology in this vicinity give their students more than a bare introduction to bacteria and the important place they play in modern life. It is felt that in view of the importance of bacteriology in college training, in industry, and in every-day life; every high school student should have at least one introductory unit of study in this field. Several high school biology teachers have stated their desire to teach such a unit to their students if they had suitable textual material and/or if they had adequate training. This study is presented in the attempt to help supply some such textual material and instruction that may be used in helping high school teachers to become better acquainted with the teaching of bacteriology in their regular courses, and that may be used as a basis for a study unit in high school bacteriology.

It is proposed that this or some similar unit of study should be made available to high school biology teachers and that such an introductory unit of about six weeks duration be taught to students of high school biology. The content of the unit herein presented shall be limited in scope and content to that of merely an outline unit, such as might be used in teaching a unit of bacteriology. The proceedures and ideas presented may need to be modified and/or added to in order to provide for the needs and desires of particular classes and teachers.

The purpose of this study shall be, therefore, to attempt to justify the need for such a unit of study, and to present in outline form a suggested plan. It will also include a list of source books suitable for reading by high school students and useful in planning the study. Some few items of laboratory equipment, which are needed and which can easily be constructed or acquired by almost any high school teacher and class with very little or no expense, will also be presented.

CHAPTER II

JUSTIFICATION: WHY THE CURRENTLY-USED PLAN FOR HIGH SCHOOL BIOLOGY FAILS TO MEET THE NEED FOR SPECIALIZED TRAINING IN BACTERIOLOGY

Today's high school students are not getting specialized training in the life sciences because no specialized courses are being offered. In the preparation for this study, the author visited and contacted a number of high schools in Texas and Oklahoma. Small high schools offered introductory courses in general science, chemistry, and in biology. This one introductory course in general biology attempts to give the student an acquaintance with both plant and animal life, and is usually offered at the sophomore level. Some larger high schools offer this same course in the eighth grade level of the junior high school, and a slightly more advanced course of the same type to sophomores. The larger high schools offered special courses in chemistry and physics, and several courses of mathematics. Not one high school visited offers any specialized courses in life sciences.

Three reasons are usually given for not offering specialized courses in life sciences. First, the state departments of education do not require it. Second, there are no state-adopted text books available. Third, there is not sufficient time in the real schedule for it. Another reason might be that average high school science teachers are not trained for specialized work. In the schools visited, however, only one individual mentioned this as a problem. As a rule, teachers are willing to branch out into special areas, even if it means additional training for them. Two references were made to the need for additional equipment as a draw-back to specialized training.

When currently adopted text books for the states of Texas and Oklahoma were examined, it was found that the field of bacteriology was almost entirely neglected. Botany and zoology are emphasized throughout most of the texts. All have at least one unit of physiology and health. Safety education and general disease prevention are included in most texts, but only one high school text examined has any type of a unit of study in actual bacteriology. One laboratory work book contains a simple unit of study and experiment in this field. Oddly enough, no school contacted used the workbook, and only one uses the text that goes with it. The findings of this examination of schools and text books are presented at the close of this chapter.

SCHOOL SYSTEMS VISITED

A few schools were picked at random in north central Texas and Oklahoma. It was necessary that this activity be limited, and no cross section analysis was intended. The purpose of this visitation was merely to observe what is being done in a few systems in the field of natural sciences. Two very small schools with fewer than one hundred enrolled in high school were visited, two with three and four hundred, and two larger systems. The small systems were Ninnekah, Oklahoma, and Forestburg, Texas. The medium-sized systems were Decatur and Bridgeport, Texas; and the larger ones were Stillwater, Oklahoma, and Bowie, Texas. A variety of conditions were found, as are presented later in this chapter.

No formal proceedure was used in visiting these schools. A simple informal visit was made with the teacher of life sciences or biology, as the case might be. Listed are the places visited, the names of the teachers of biology, the text book used, and the type of program being presented.

This would be a most interesting study to be pursued farther, perhaps to gather definite information from a large representative number of schools and teachers. It would also be of interest to note where and to what extent biology teachers are educated.

REPORT OF SCHOOLS VISITED

The Stillwater Junior High School, Stillwater, Oklahoma.
Biology teacher: Mr. George Woodruff.

Text: Moon, Modern Biology

Level: Eighth grade, four sections.

Mr. Woodruff is doing an excellent job demonstrating what can be done teaching a course of general biology in junior high school. He is using the same text that is used in many high schools in Texas and Oklahoma for grades ten to twelve. His course of instruction is as advanced as most high school courses in general biology. His students are well-adjusted, interested and ambitious. The quality of work done and the grades received are above average for a general course in biology in high school. The biology laboratory is fairly well-equipped for a general course, and Mr. Woodruff has a number of materials of his own collection that he is using in his teaching. The students are encouraged to specialize and to make special collections of insects, wild flowers, etc. A science fair is planned for the second week in March. A very successful science fair was held last year in this junior high school.

The Stillwater High School, Stillwater, Oklahoma.

Biology teacher: Mr. Russell Martin

Text: Smith, Exploring Biology.

Level: tenth and eleventh grades, four sections.

Until this year, Mr. Martin has taught a course in general biology, comparable to the one now being taught in the Stillwater Junior High School , described above. This year Mr. Martin is upgrading his course of instruction considerably by teaching units of specialized materials. He plans to include a unit of bacteriology, and some special project students are already doing some experiments with cultures. Mr. Martin's laboratory is well-equipped. He is using a pressure canner for a steam autoclave, and has built an automatic electric incubator in the school shop. His biology students are well-adjusted, interested, and doing much better quality work than the average high school biology student. Mr. Martin is very much in favor of a specialized program of life sciences for high school students.

The Ninnekah High School, Ninnekah, Oklahoma.

Biology teacher: Mr. Bob Vowell

Text: Baker and Mills, New Dynamic Biology

This text book is listed as an adopted text by the state of Texas. It was not listed in the text book list found in the Oklahoma State University Library as adopted by the state of Oklahoma. This is the only school visited where it is being used. It is a good text for general biology, and has some opportunities offered for more specialized study.

Level: tenth and eleventh grades, two sections.

Mr. Vowell is teaching a good course of general biology in this small high school (enrollment 93). He and his students have constructed a greenhouse back of the school building where plants and small animals are grown through the winter. They are attempting to do several small projects of specialized study. They are severely handicapped by inadequate laboratory equipment. Mr. Vowell is highly in favor of teaching general biology in junior high school and specializing in separate fields in high school. He is interested in a unit of bacteriology for high school students. His students seemed well-adjusted and industrious.

The Bowie High School, Bowie, Texas

Biology teacher: Miss Clara Hoeldke

Text: Moon, Modern Biology

Level: tenth and eleventh grades, four sections.

Bowie is a town of about six thousand people and the school system enrolls about twenty-three hundred students each year. The town and school system might be called conservative, and very little modernization of any kind is ever attempted. A few business men have remodeled their store fronts, and many new homes have been built in recent years; but to the present time there has been no organized system of growth and improvement. Home-building has not been zoned, and the entire town is a composite mixture of the new with the old. This is also true of the school. Mr. Darrell Williams is the newly-elected superintendent of schools. He is attempting an improvement program which will include upgrading the music and science instructional programs. He is meeting with much opposition in this effort. The physical equipment of the high school is out of date, inadequate, and in poor condition.

Miss Hoeldke is a teacher of the "old school" conservative pattern. She teaches general biology only, and follows the text book explicitly. Her course consists of a study of textual materials associated with review questions and a series of tests over textual materials. Very little laboratory work is ever attempted, and the students have little opportunity for any kind of specialized work. Miss Hoeldtke expresses no desire for any changes in course materials or patterns of organization.

The Decatur High School, Decatur, Texas

Biology teacher: Mr. ________ Amaya

Text: Moon, Modern Biology

Level: tenth and eleventh grades, four sections.

Decatur is accredited with being quite a conservative county-seat town. Like Bowie, it enjoys very little civic progress. In spite of non-progressive surroundings, the school system is enjoying considerable progress under the capable leadership of Mr. Bill Allen, superintendent. A completely new and modern high school plant has recently been completed and a progressive program is in process.

Mr. Amaya is a native of India and has found adjusting to our society and language somewhat of a problem. He is doing an excellent job of this as well as teaching. His students are always encouraged to branch out into special fields of interest and to pursue special science projects. He is director of the Wise County Youth Fair, Science Division. The Decatur High School science students are one of three or four groups in the county that make the science fair possible. They also have their own local science fair.

Mr. Amaya is very much in favor of upgrading the high school life science program by specialized work projects and units of study. He will probably lead his students in a study of bacteriology this year.

The Forestburg High School, Forestburg, Texas

Biology teacher: Mr. Lee Boyd

Text: Moon, Modern Biology

Level: tenth and eleventh grade students, one section

Forestburg is the oldest town-community in Montague County, Texas. It has been very difficult for the community to keep their high school for several years. They have done so only with great effort and sacrifice under the leadership of Mr. D. E. White, superintendent. The entire school enrollment this year is 130, with 53 in high school. The building is old and poorly equipped for any type of school activity. They have practically no library, and science eqyipment is a bare minimum.

Mr. Boyd is presenting a good course in general biology to a small class of interested students. He encourages individual students to branch out into special projects. His students spend much time studying wild life of the community, and make special collections. Mr. Boyd is in favor of specialized work in high school life sciences. In spite of severe handicaps, he will probably attempt a small unit of bacteria study this year.

The Bridgeport High School, Bridgeport, Texas

Biology teacher: Mr. Eddie Huckabee

Text: Moon, Modern Biology

Level: tenth and eleventh grades, four sections.

Bridgeport is a town of about five thousand people. The school has an enrollment of one thousand, with about three hundred fifty in high school. The town is remarkably progressive, and has completely changed in the past six years. It has a completely new high school plant, modern and fully equipped. Under the capable leadership of Mr. John Edwards, superintendent, the school system enjoys a place of first rank in the community and the county. The entire community is thoroughly sold on the necessity of having a school system of the best quality. The people channel their greatest efforts through their school and their churches. They have built four new churches, numerous new business houses, and three completely new residential sections. Two of the residential sections are zoned with minimum standards comparable to the better sections of many large cities.

The author of this paper was director of the Science Department of Bridgeport High School last year (1960-61) and Mr. Huckabee was a capable assistant. An upgrading program was started that is continueing under the leadership of Mr. Huckabee this year. Excellent courses in both physical and life sciences are taught to the seventh and eighth grades in the junior high school. The Science Department promotes its own annual science fair each year, and maintains a registered Science Club. It takes part in the County Youth Fair at Decatur, Texas, and the Regional Science Fair at Fort Worth. Last year Bridgeport science students brought home every first place award at the County Youth Fair, and placed in the Regional Fair. The local Science Fair lasted a full week and closed with a community program Friday night. Projects were on display by grades from one to twelve. Many of them were in the fields of life science and included such things as drosophila cultures for the study of genetics, plaster casts of life cycles and parts of the bodies of humans and animals, collections of insects, small mammals, wild flowers, etc. Over two thousand guests registered.

A six-weeks unit of bacteriology was taught in January and February. During the spring months of March through May, special emphasis was placed upon the study of local mammals, insects, birds, and wild flowers. Collections were made by individual students, and materials were prepared and preserved for laboratory use.

This school is a good example of what can be done when people desire to have the best, and when a community of parents and students are willing to work toward it.

AN EXAMINATION OF THE STATE ADOPTED TEXT BOOKS FOR HIGH SCHOOL BIOLOGY FOR THE STATES OF OKLAHOMA AND TEXAS

_______, Official List Of All Textbooks For Use In The Public Schools Of Oklahoma. Oklahoma City: State Board Of Education, 1959-1960.

Smith, Ella Thea, Exploring Biology, 5th Edition. Dallas;Harcourt, Brace & Co., 1959.

"Unit 6: The Fight For Health
Chapter 16: Diseases And Their Causes, p.428
Chapter 17: Improved Control Over Diseases, p.448

The physiology of these chapters is good. On page 430 is a simple experiment entitled, "Examining Living Bacteria." It includes growing some living colonies, but has no mention of anything to do with them except to "Look at them." On page 446 are listed some simple experiments in which agar plates are exposed to hands, washed and unwashed, to see if colonies will grow. Specimens from toothbrushes are to be examined under the microscope to see if bacteria can be seen. Nothing is mentioned about what kind of microscope, staining techniques, etc. These are very poor sixth-grade-level experiments.

Morholt, Evelyn, Experiences In Biology. Dallas; Harcourt, Brace and Co., 1960.

This is a laboratory manual written to accompany the text cited above. On pages 167-172 is one fairly good high school experiment entitled, "Diseases, Their Causes and Methods of Control."

Vance, B. B., and Miller, D. F. Biology For You. Chicago: J. B. Lippincott Co., 1954.

"Unit 10: How To Protect Our Bodies From Disease." This unit mentions "germs" one time as causing disease. The book gives nothing about bacteriology at all.

______. Biology In Daily Life. Dallas: Ginn and Co., 1953.

This book is listed on the adopted book list, but could not be found in the Oklahoma State University Library, nor in any of the schools visited.

Lauby, C. J., and Silvan, J. C. Biology. Dallas: The American Book Company, 1958.

This book contains nothing whatever about bacteria or bacteriology.

Moon, Truman J., et al., Modern Biology. New York: Henry Holt and Co., 1960.

This is a revision of the old book, Modern Biology, by Moon, used in so many schools of Oklahoma and Texas. It is quite an improvement over the old edition. Only one school visited is using this edition.

Chapter 45, pp.558-570: "Microbes, Mighty Mites Of Infection." This is general teaching with no bacteriology introduced and no culturing suggested.

This new revised edition is taught in the eighth grade, Stillwater Junior High School.

______, State Education Agency, State Adopted Text Books. Austin, Texas: Texas State Board Of Education, 1960.

Vance, B. B., and Miller, D. F. Biology For You. Chicago: J. B. Lippencott Co., 1954.

This text is considered above in the Oklahoma list.

Dodge, Ruth A. Elements Of Biology. Dallas: Allyn and Bacon, Inc., 1955.

Part Four, Unit VIII, Chapters 31-32, pp. 438-461 contains a few simple experiments to introduce the nature and effects of bacteria. These propose to show the effects of moisture, heat, and cold, on the growth of bacteria. It also contains an observation experiment of the appearance of yeast, bread mold, and a mushroom.

Smith, Ella Thea. Exploring Biology, 5th Edition. Dallas: Harcourt, Brace and Co., 1959.

This book is described in the listing for Oklahoma.

Baker, Arthur O., and Mills, Lewis H. New Dynamic Biology. Rand, McNally and Co., 1956.

This book is used in the Ninnekah, Oklahoma, high school, although not listed in the Oklahoma listing. It is a good general biology text, with no bacteriology.

Moon, Truman J., et al. Modern Biology. New York: Henry Holt and Co., is described in the listings for Oklahoma.

CHAPTER III

WHAT CAN BE DONE TO FACILITATE SPECIALIZED TRAINING IN LIFE SCIENCES IN HIGH SCHOOL?

Our present world of rapidly changing rates of scientific developments demands thorough preparation for any field of endeavor. In most fields, this preparation is best begun early in life. The formable period of high school education has long been recognized as an ideal time for groundwork in those materials and pursuits that will be useful in higher education and in later life. Students who postpone all technical training until college often find it very difficult to acquire an adequate background before being forced to enter advanced and sometimes difficult courses. In most such courses, this background training is essential for best results. In the preparation for music and other arts, this necessity has long been recognized, and students preparing for careers in them usually begin serious study and preparation early in life. More recently we have become aware that this is also important in business, chemistry, and physics. With the life sciences, however, we have been content with giving high school students a mere introduction to general biology. Such non-specific training might be satisfactory for students who would never be associated with life sciences in college or in later life. Such disassociation with life sciences in the world of today is practically impossible. One who has no thoughts of a vocation other than a good housewife is faced with the need of some knowledge of the nature and workings of bacteria every day. To the farmer, this knowledge is very valuable.

We have recognized this need for special training in other fields. We do not simply give students an introductory in mathematics in high school. The same is true of the physical sciences. After the student has had introductory work in general science and general mathematics in junior high school, he is offered courses in algebra, geometry, trigonometry, and sometimes calculus; and in geography, chemistry, and physics. It is just as important that biology be offered in general in junior high school, and that high school students be presented with separate courses of physiology, botany, bacteriology, and other related special fields.

The nature and scope of this work limits the consideration of this question to only one phase of the problem. Only the proposed thesis can be considered herein; that a unit of bacteriology be taught along with other materials in the presently scheduled general biology courses.

CHAPTER IV

HOW CAN A UNIT OF BACTERIOLOGY BE HELPFUL TO HIGH SCHOOL BIOLOGY STUDENTS?

The increasing importance of bacteriology in industry in the past ten years indicates that it will be in much more demand in the near future. Medical sciences demand more and more technicians specifically trained in bacteriology. This training is often rigorous and demands several years of thorough preparation. It is equally as important that future bacteriological technicians start their specific training in high school as it is for mathematicians and musicians to do so.

As stated in the purpose of this study, an attempt will be made to present suggestive material that may be useful as an outline for a special unit of study in bacteriology at the high school level. Such a unit was taught to the sophomore students of Bridgeport High School, Bridgeport, Texas, where the author was director of the high school science department, in the school year of 1960-1961. It was taught to four classes of general biology at the tenth grade level. The results were most gratifying. A greater interest was shown in this unit of study than in any other phase of the course. Almost invariably, more students took active part, did more out-of-class work, projected a more cooperative and enjoyable attitude in class, and made better grades, for this unit of study than for any other part of the course. It is believed that this was not due to any superiority of the material or of the teaching process; but was the natural result of student interest in specialized training at the high school level, and may be experienced with any group in almost any such field of study.

CHAPTER V

OUTLINE OF A STUDY UNIT OF BACTERIOLOGY FOR HIGH SCHOOL STUDENTS

The first concern will be laboratory materials and equipment, in almost any school system. For the past three years, such magazines as The Science Teacher, published by the National Science Teachers' Association; The Biology Teacher, by the Association of American Biology Teachers, and others, have carried articles giving instructions for constructing laboratory equipment and using materials readily available around the average school and home. This information is quite helpful to smaller schools whose budget will not permit the purchase of equipment for special experiments. They are also useful to any school as training projects for gifted young people. On the following pages are listed several items necessary for the study of bacteriology. Some of these were suggested in various articles, but for the most part, our young people had ideas and developed them on their own inituitive. Each experience brings new and better ideas about both equipment and technique. Other examples can be found in The American Biology Teacher, Vol. 22, June, 1960.

1. A good microscope is almost a necessity for any biology laboratory. If funds are short and only one piece of good equipment can be bought, make that piece a microscope. Contrary to popular opinion, however, much instruction in bacteriology is possible without ever seeing bacteria under

a microscope. In fact, unless a very good one is available, they will not be seen individually anyway, and an attempt to do so is a waste of time.

2. A steam sterilizer, or autoclave, is essential. All materials used must be sterilized, and this will require an autoclave. For the average high school, a steam pressure canner, or even a pressure saucepan, makes a very good autoclave. Many people have pressure cookers they never use. Someone may be glad to donate one to the laboratory, or at least will lend it to be used.

3. Sometimes dry oven heat is needed. If a kitchen range in the Home Economics Department cannot be used, a small sheet-iron oven may be purchased or made, and used over a gas or electric hotplate.

4. Another essential is a constant-temperature incubator. Some young people and their teacher at Stillwater High School constructed a very attractive and efficient incubator of plywood in the school shop. Two boys and the teacher at Bridgeport High School made a very efficient one from an apple crate, cardboard, and other odds and ends. A description of this model is shown at the close of this chapter.

5. Refrigeration may be desirable. Again, it is very convenient to be able to use equipment from the Home Economics Department. This can be done with order and sanitation, and with no danger of infection or contamination of food stuffs, if proper care is exercised.

6. Culture dishes will be needed. It is nice for each class to have glass or plastic petri dishes for all students, but this is not always practical. Glass bottles, flat on one side, with plastic caps, can be obtained from any drug store for about three cents each. These will serve remarkably well, and will take up much less space.

7. Test tubes are a necessity. Special test tubes are not necessary, and those ordinarily found in the science laboratory will serve well, except for fermentation tubes. It will be necessary to obtain fermentation tubes, or some very small vials may be used inside ordinary test tubes.

8. Flasks for water blanks can easily be large medicine bottles. Six ounce size bottles are excellent.

9. Transfer needles are made from nichrome wire such as that used in electric heating coils. This can be bought from most hardware or electric shops. Small wooden dowel stock makes good handles for these. They are also illustrated at the end of this chapter.

10. Nutrient broth can be made by straining broth from cooked vegetables and/or bouillon cubes. Bean and carrot broth make excellent nutrient for general purposes.

11. Other materials needed are as follows:

One pound of sterile cotton

One pound of powdered Agar Agar

1/4 pound of Lactose U.S.P. (from a drug store)

One pound Brilliant Green Bile, 2%

Sufficient paper towels, detergents, etc., to keep glassware, tables, and students clean.

Please note that absolute cleanliness is always a "must" when working with bacteria. While it is not very likely, and certainly not desirable, that high school students work with infectious or dangerous materials; unsanitary habits almost always result in failures of experiments and wasted materials and time. It is always wise, too, to teach young people from the start to properly respect and handle anything connected with a scientific experiment.

A number of different experiments can be carried out that will be of great interest and instructional value to high school students. A good beginner's bacteriology laboratory manual almost always contains experiments that are good for high school level. Mr. Kay Hutchinson Martin, 1957 National Science Foundation Academic Year Institute student at Oklahoma State University, compiled a number of such experiments in his report, Bacteriology Experiments Designed For Use In A Course Of High School Biology. His report is on file in the National Science Foundation office at O S U. A few similar experiments, together with an outline for a unit of study, are included in this report.

The best source discovered by the author is *High School Biology: A Laboratory Block On Microbes: Their Growth, Nutrition, And Interaction,* published by the Biological Sciences Curriculum Study Committee on Innovation in Laboratory Instruction; developed by Dr. Alfred S. Sussman, Department of Botany, University of Michigan; and distributed by the University of Colorado, Boulder, Colorado, 1960. This manual offers all the average high school instructor will ever want in special instruction in bacteriology. Parts are highly suitable for enrichment of a regular course in biology, for enrichment material for advanced student work, or the whole as a separate advanced specialized course. Contents cover the following:

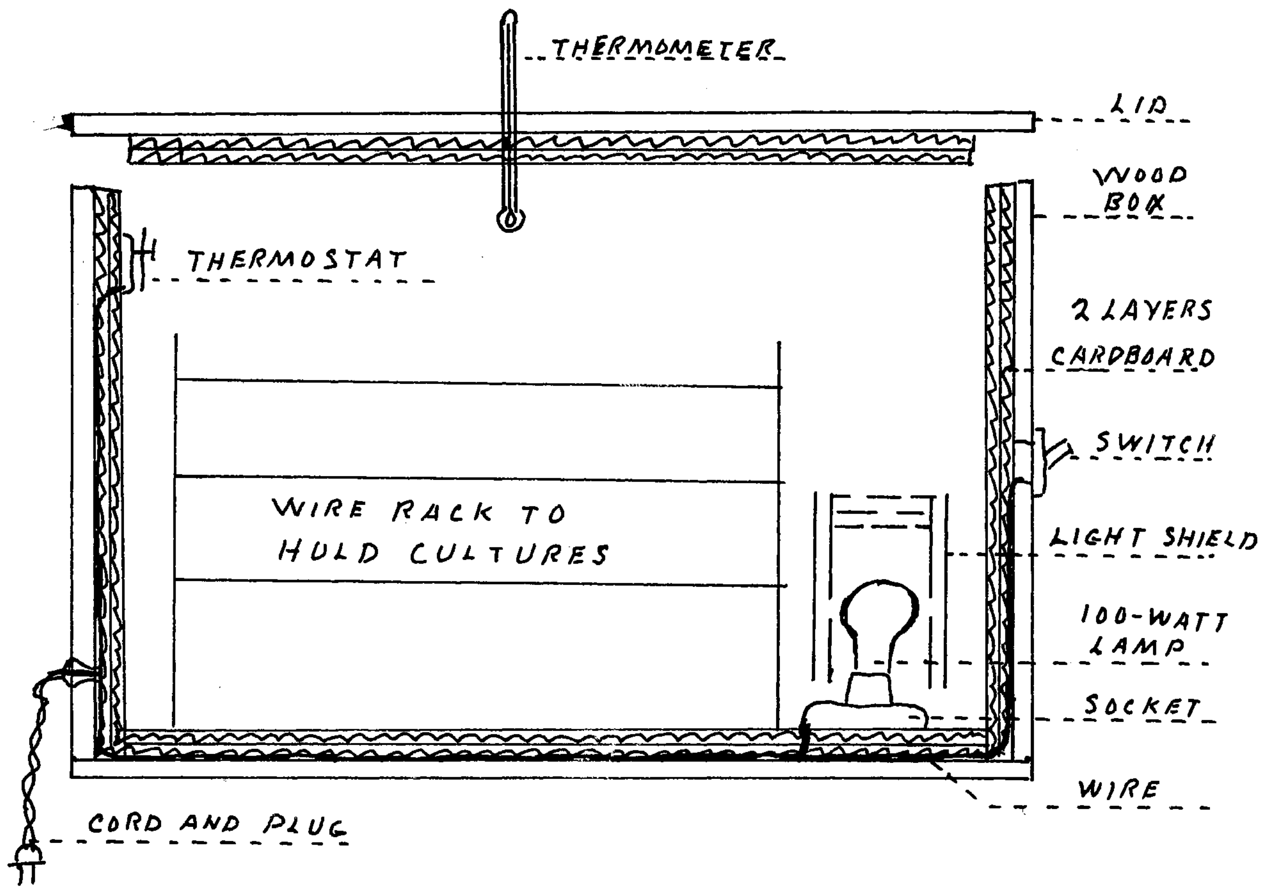
1. Glossary of terms
2. Experiments in culturing
3. Recognition and isolation of strains
4. Tests for water, milk, soil, etc.

This work would also make an excellent short course of study to help any high school biology teacher.

The following pages contain a study done at Bridgeport High School, Bridgeport, Texas, 1960-1961, and a few other simple experiments such as may be carried out in any beginning course of bacteriology.

A BACTERIOLOGICAL INCUBATOR

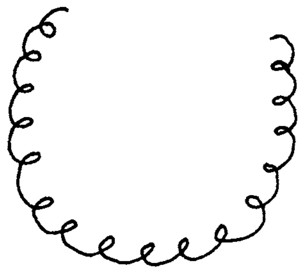
AS BUILT BY HIGH SCHOOL STUDENTS OF BRIDGEPORT, TEXAS



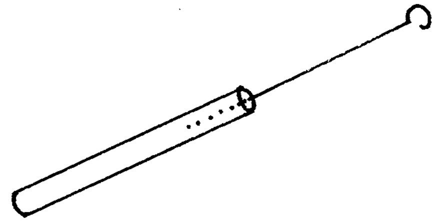
EXPLANATION

This bacteriological incubator was built from a wooden box insulated with corregated box cardboard, heated with an electric bulb, and controlled by a thermostat taken from an old heating pad. The light shield was made from tin cans cut so as to allow circulation but to break up the light beams. A heating element flat on the bottom would serve better. An upright model with hinged lid on the side might be better suited to some purposes than this chest type.

TRANSFER NEEDLES MADE FROM NICHROME WIRE

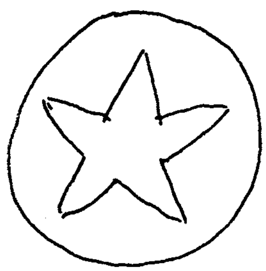


Nichrome Heating Coil (toaster coil) may be purchased from almost any electric store.

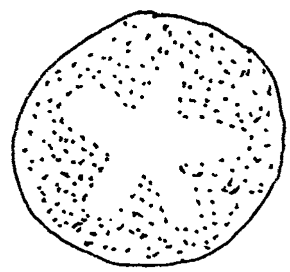


Wire straightened and mounted in wooden dowel handle

EFFECT OF SUNLIGHT OR ULTRA-VIOLET LIGHT ON BACTERIA



White Cardboard Mask



Culture Dish Demonstrating Effect of Light On Bacteria

The white cardboard mask (may be cut to any simple pattern) is placed over a petri dish culture and exposed to sunlight or ultra-violet light for three minutes. Observe that where the radiation reached the culture, bacteria colonies did not grow; while the area that did not receive radiation grew well. This demonstrates that warmth favored growth, but direct radiation of the light source did not.

GENERAL OUTLINE OF A STUDY UNIT AS
TAUGHT IN BRIDGEPORT HIGH SCHOOL,
BRIDGEPORT, TEXAS, 1960-1961

THE STUDY OF BACTERIA

I. Morphology

1. Tiny, colörless, one-celled organisms

2. Cell wall, cell structure, and ability to synthesize foods classify them as plants.

3. Size range from 15 to 30 microns

4. Shape

   A. Rod-shaped, single or in chains

   B. Round; single, in chains, in colonies

   C. Curved or spiral

   D. With or without cilia

5. Reproduction: fission, or produce spores

6. Where found: everywhere; from ocean bottom to 12 miles above the earth

7. Affect on other organisms

   A. Beneficial: some necessary to life of higher plants and animals

      a. nitrogen-fixing in soil

      b. vitamin-forming in digestive system of animals and man

      c. chemical decomposition everywhere: break down organic substances into usable food materials: convert inorganic materials into food materials

   B. May be harmful to higher plants and animals

      a. toxins produced cause disease

b. break down living cells by chemical decomposition

c. simply parasitic: consume food of host

II. Growth requirements

1. Temperature: average 37° C. or $98-100^{\circ}$ F.

2. Moisture: dry conditions unfavorable

3. Darkness: sunlight, ultraviolet light destructive

4. Food media

A. Inorganic substance which can be converted to usable food substance

B. Waste products of plants and animals

C. Food materials of host

D. Body cells of host

E. Laboratory culture media

5. Respiration

A. Aerobic: requiring oxygen

B. Anaerobic: cannot live in free oxygen

6. Stages of growth of a culture

A. Lag period: increase very slowly

B. Log period: increase very rapidly

C. Death period: decrease because of unfavorable conditions caused by excess crowding

7. Stages of growth of individual bacterium

A. In favorable conditions, reproduce every 20 minutes: <u>E Coli</u> kept in log stage 24 hours produce mass size of earth

B. Slow development or dormancy when conditions unfavorable

C. Some form spores in very unfavorable conditions and live that way for years

III. Studying bacteria

1. Indirect method: the experience and observation of others: research, oral reports, and/or themes from source and reference materials

2. Direct laboratory study

   A. By effects produced on other organisms and materials

      a. decomposition of food substances: observation of "rotting" action

      b. synthesis of food: tested chemically

      c. fermenting: forming acids, etc.

   B. By study of growth habits and characteristics

   C. By observation of culture incubated and/or refrigerated in laboratory

   D. By direct observation with microscope

IV. Important rules for laboratory work with bacteria

1. Aseptic conditions: keeping things clean and sterile

   A. Laboratory tables clean and free of materials not being used

   B. Hands washed with soap before and after each laboratory period

   C. Hands and all materials kept away from face or any skin break or wound

   D. Cultures never taken from laboratory

   E. Transfer needles heat-sterilized before and after usage

   F. All cultures destroyed and disposed of after usage, unless kept for future experiment

   G. Form used considered non-pathogenic to man, but all should be respected and treated as though deadly

V. Instruction for working with bacteria cultures

1. Preparation of media

A. Broth culture

a. 1/2 cup of beans cooked in 1 liter water strain, sterilize, store for future use

b. four cubes meat extract or bouillon dissolved in 1 liter water, sterilize and store

c. leach one cup soil in 1 liter water,strain sterilize, store

d. boil 1 medium potato and 2 carrots in 1 liter water, strain, sterilize, store

e. to show fermentation, use milk with small amount of litmus

B. For gel culture dishes, dissolve 20 grams Agar Agar in small amount water, add to any broth desired, sterilize and leave in desired position until set

2. Growing cultures

A. Expose culture dishes to desired bacteria source, incubate until colonies form

B. Culture pure strains by selecting colony and streaking: repeat if necessary

3. Testing antiseptics for toxic action to bacteria

A. Using aseptic conditions, transfer small amount of colony to culture bottle, wash with 10 cc antiseptic chosen, using aseptic conditions, incubate and observe

B. Prepare control bottle innoculated but not treated; incubate and observe

C. Prepare control bottle not innoculated, but treated; incubate and observe

4. Effect of temperature on bacteria

   A. Innoculate culture bottle, boil 10 minutes in water bath, incubate and observe

   B. Innoculate culture bottle, freeze in refrigerature 24 hours, incubate and observe

   C. Innoculate culture bottle, let stand (sealed) in room 24 hours, incubate and observe

   D. Innoculate coltrol bottle, incubate and observe

5. Effects of light on bacteria

   A. Innoculate culture bottle, let stand in bright sunlight 2 minutes, incubate, observe

   B. Innoculate culture bottle, let stand under incandescent light bulb 2 minutes, incubate and observe

   C. Innoculate culture bottle, let stand under ultraviolet light 2 minutes, incubate and observe

   D. Innoculate culture bottle, keep in dark place 2 minutes, incubate and observe

   E. Make smear innoculation on agar blank in petri dish, place white cardboard cut-out mask over dish, let stand under ultraviolet light 2 minutes, incubate and observe

6. Effects of moisture on bacteria

   A. Innoculate a dry piece of bread (sterile), incubate and observe (keep dry)

   B. Innoculate a moist piece of bread (sterile), incubate and observe

   C. Other food substances may be used as desired

OBSERVING BACTERIA WITH THE MICROSCOPE

MATERIALS AND APARATUS: Compound microscope with oil immersion lens, bunsen burner

Gram staining solutions, transfer needles, slides, sterile water

Pure strain bacteria culture

Using aseptic methods, smear a small amount of bacteria on slide in a drop of water.

Allow to dry, fix by passing slide through flame of bunsen burner.

Stain with gentian violet. Allow stain to set 15 seconds, wash gently with water. Apply Gram's iodine and allow to set 10 to 15 seconds. Again wash gently with water. Flood slide with decolorizing solution for about 20 seconds, and again wash. Counterstain with safranin solution for 30 seconds, again wash, allow to air dry.

Locate the bacteria under low power. (A colored smear will appear) Place a drop of immersion oil on object, lower lens into oil, and focus upward. (Oil immersion lens is marked with a dark band around objective.)

This proceedure can be repeated for each type of bacteria colony available. Find as many shapes of bacteria as possible. Try to identify the strains from their shapes and the manner of staining. (Refer to a good bacteriology text, such as A Textbook Of Bacteriology And Its Applications, by Curtis M. Hilliard, (Ginn & Co, Dallas, 1936) for classification.) (This is an old text, but it is a good one for this purpose.)

TESTING WATER SOURCES FOR BACTERIA

MATERIALS: Nutrient ágar dishes, sterile water blanks (9 ml.) sterile medicine droppers, empty sterile bottles, 1 fermentation tube of lactose broth, one of 2% brilliant green bile for each water sample tested.

PROCEEDURE: Collect water samples in sterile bottles from sources such as streams, wells, school fountain, etc

Place 20 drops of a sample in one of the 9 ml. sterile water blanks. Shake to mix. Place 20 drops (1 ml.) of this solution in another water blank. This makes a solution of 1/100. Place 20 drops (1 ml.) of this 1/100 solution in sterile petri dish, melt ágar in water bath at 50° C., pour into dish and mix carefully with circular motion.

Do this with each water sample taken. Incubate the culture dishes 48 hours and observe. Use one uninnoculated dish for control.

Place 20 drops (1 ml.) of each sample in a tube (10 ml.) of lactose broth and one of brilliant green bile. (Be sure to label each tube: what it is, and where the water came from.)

Incubate 24 hours and observe, If inner tube of lactose broth fermentation tube shows gas collected, water is contaminated. If fermentation has occured in bile tubes, it is fairly certain that bacteria are _E coli_, or colon bacteria, or _A aerogenes_, a soil bacteria. Most likely if fermentation takes place in green bile, it is _E coli_ , and water is unfit for human usage.

(This, and many other similar tests, can be found in almost any bacteriology laboratory manual or text book. Many of them are easily adapted to high school usage.)

TESTING MILK FOR BACTERIA COUNT

MATERIALS: Empty sterile bottles, sterile water blanks (9 ml.) nutrient agar dishes, medicine droppers.

PROCEEDURE: Obtain various milk samples. Get one bottle of fresh milk, allow to sit sealed at room temperature for 2 hrs. Allow another to sit uncovered at room temperature for 2 hrs. Seal and refrigerate a third. Number 4 should be placed in a boiling water bath for 30 minutes. Number 5 should be boiled gently for ten minutes.
(Note: "fresh" milk means taken directly from the cow: not commercially bottled milk.)
Number 6 can be raw or pasturized milk taken from commercial family supply. (Do not allow brand names to be known. High school experiments may not be accurate enough to form concrete opinions about actual counts.)
Sample number 7 can be milk that has set in an open bottle in the family refrigerator, and number 8 from a bottle setting open on kitchen table.

Dilute by placing 20 drops (1 ml.) in a 9 ml. sterile water blank and thoroughly mixing. Of this solution, place 20 drops in another blank and mix. Of this, place 20 drops in a third blank and mix. This gives a solution of 1/1000. Place 20 drops of this 1/1000 solution in a nutrient agar dish and gently melt in water bath of 50° C. Mix thoroughly by rotary motion and incubate for 36 to 48 hours. Observe, count colonies in each dish, and record data.

(Be sure to label each dish with the source of the milk and the conditions under which it was kept.)

This, and other such experiments are of little value unless they are accompanied with suitable recording of data and conclusions drawn in a scientific way. In the hands of a capable teacher, they can impart valuable scientific lessons, as well as useful information about food handling.

FOLLOW-UP STUDY FOR WATER AND MILK TESTING

SUGGESTIONS FOR FOLLOW-UP STUDY:

I. Have the student make an oral report on E coli bacteria.

1. What is the usual source of these bacteria?
2. What are the possible effects they may produce in human beings?
3. What are the possibilities of other more harmful bacteria coming from the same source?

II. Have oral reports or papers written concerning public sanitation methods used to insure safe drinking water for our cities and public schools.

III. Make a field trip to a city water plant and find out what methods are used to test the water supply, and what is done to insure its safety. Make a blackboard sketch of the water supply source, noting the possible sources of contamination.

IV. Visit several rural homes and observe four or five different sources of water supply. Report on the possibility of their safety or contamination, and suggest what could be done to insure their purity.

V. Visit a local dairy farm and observe measures used to insure the purity of the milk supply.

VI. Visit or talk to a representative from a local milk distributing company and observe measures taken to insure the purity of the milk supply.

VII. Make a study and oral reports on measures to be resorted to in case of community flood, atomic attack, or other natural disaster, in order to insure safe supplies of drinking water and milk.

VIII. Find out and report on state legislation or local ordinances governing the water and milk supplies of our towns and cities.

IX. Find out and report on assistance offered to rural families by county agents, state and federal control agencies, and other agencies, to aid in insuring safe drinking water and milk supplies.

X. Find out and report on health conditions, etc., of farm animals that might affect the milk supply for the family or customers.

FOLLOW-UP STUDIES FOR HOME AND PERSONAL SANITATION

I. After becoming acquainted with bacteria culturing and testing suggested in the previous experiments, make personal bacteria cultures and counts from the following:

1. From the air in classrooms, in halls between classes, in the caferteria, and outside fresh air.

2. From hands left unwashed several hours, from hands freshly washed with soap and water, from hands rinsed with water and no soap, etc.

3. From lips, hair, fingernails, and other parts of the body.

4. From personal articles such as pencils, combs, toothbrushes, books, etc.

II. Decide and make reports on the value of various antiseptics.

III. Take samples and cultures from teeth washed with plain water, with various dentifrices, and with baking soda, and unwashed.

IV. Make reports on various methods of house cleaning, rugs, bathroom fixtures, kitchen utensils, garbage disposal, etc

V. Decide about the advisibility of trying to be "germ-free", and some helpful bacteria that are needed.

VI. Arrange for a visit from the laboratory technician of a local hospital and find out:

1. What training is necessary for his work?

2. Some of the ways in which he is called upon to apply that training in his work.

3. Some of the methods used by hospitals to control bacteria.

4. What types of treatment are necessary in handling patients with contageous or uncertain diseases.

VII. Arrange for a visit from the county health officer and find out about the range of his duties.

NATURAL CONTROLS OF BACTERIA

1. Make a report on "checks and balances in nature."

2. Find out how fast bacteria multiply. What would happen if all the bacteria "born" lived and produced other bacteria? Why does this not take place?

3. Make a report on some of the natural enemies of bacteria.

4. Develop the thought, "Bacteria have to struggle for food, the same as other living creatures."

5. What types of barriers does the human body offer to bacteria? What are some other control methods found in our bodies?

6. What control mechanisms are found in certain natural food substances, such as fruits?

7. How many examples can you find of compatable existance of bacteria and other forms of life? (Conditions in which bacteria and some other form of life live together and help each other.)

8. Are bacteria ever "cannibilistic" toward each other? What evidence do we find of one type of micro-organism being hostile to another type? How have we learned to take advantage of this for our own protection?

IMPORTANT MICRO-ORGANISMS OTHER THAN BACTERIA

AN EXPERIMENT WITH YEAST

MATERIALS: Test tubes, 15% sugar solution, lime water, yeast, laboratory tubing and aparatus.

PROCEEDURE: Half fill two test tubes, "A" and "B" with sugar solution. Fill two other tubes 3/4 full of lime water. Stopper tubes "A" and "B" with one-hole rubber stoppers, other two tubes with two-hole stoppers. Run glass tubing from top of tubes with sugar solution to the bottom of tubes of lime water. Provide vent for tubes with lime water, not for tubes with sugar.

Place a small piece of yeast in tube "A". Incubate entire arrangement 24 to 48 hours.

OBSERVATIONS: Why has the lime water in one tube turned cloudy?

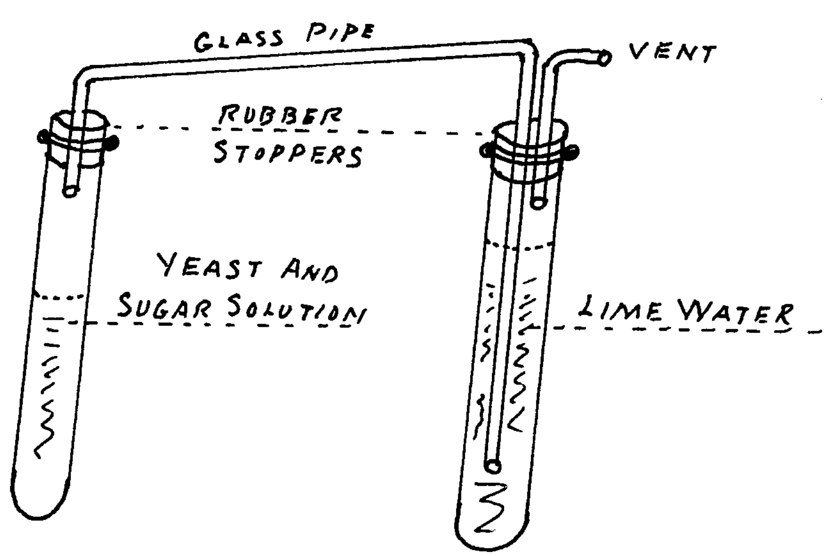
What has happened to the sugar solution?

What narcotic poison has been formed by the action of the yeast?

Observe yeast cells under the microscope. How do they differ from bacterial cells?

How do yeast cells reproduce?

What would you say is the most important useage of yeast for human beings?



MICRO-ORGANISMS FOUND IN HAY INFUSION

Micro-organisms of various kinds are widely distributed in natural environments. This can be demonstrated by microscopic examination of hay infusion.

PREPARATION: Acquire about a gallon of pond or stream water. Place a tuft of hay in the water and allow to soak several days in a warm place.

MATERIALS: Hay infusion as prepared above, slides and cover slips, microscope, dropper.

PROCEEDURE:

1. Carefully obtain liquid in dropper from surface of hay infusion.
2. Place a small drop of infusion liquid on slide and cover with cover slip.
3. Examine under low and high power magnification. Pay attention to size, shapes, and movement of organisms.
4. Repeat, using a drop of liquid obtained from the bottom of the hay infusion.
5. Make drawings of a typical microscope field as observed with water from surface and bottom of infusion; low and high power.

Some organisms may be found in spore-form on the hay. Pond or stream water also contains organisms. Nutrients that leach out of the hay support growth of some of the microbes. It is possible to observe bacteria, yeasts, molds, protozoa, and algae in such experiments. When the students have studied and identified such organisms from other experiments, this exercise is useful for recognition purposes.

THE GROWTH AND CULTURE OF MOLDS

Molds are tiny plants called fungi. There are many kinds of fungi; in fact as many kinds as there are materials upon which they grow.

Make a report on molds and their importance to man.

AN EXPERIMENT TO SHOW GROWTH AND STRUCTURE OF MOLDS

MATERIALS: "Moldy" bread. (Moisten a piece of bread, expose it to the air an hour, incubate it for 48 hours. It should contain plenty of mold or fungi.)

Stale bread, (not moldy) fresh bread, sterile jars with lids. (5 jars and lids)

PROCEEDURE: 1. Moisten a piece of bread, place a small amount of fungus on it, place it in sterile jar and seal.

2. Moisten a piece of bread, do not innoculate, place immediately in sterile jar and seal.

3. Innoculate a piece of bread without moisture, place in sterile jar and seal. (Be sure to label all jars.)

4. Moisten and innoculate another piece of bread the same as No. 1, place in jar and seal.

5. Innoculate a piece of dry bread, same as No. 3, place in jar and seal.

6. Place the slice of fresh bread somewhere in the laboratory.

7. Incubate the jars 1, 2, and 3. Place jars 4 and 5 in refrigerator. In about 48 hours, examine and compare results.

OBSERVATIONS: Where did the fungus come from?

What does this experiment show to be necessary to promote the growth of fungus?

Study these different fungi under the microscope. Identify them from a text book. Make drawings and label the parts, fruiting bodies, etc.

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Corrington, Julian D., _Working With The Microscope_. New York: Whittlesey House, 1941.

Doughtery, Joseph M., _Textbook Of Bacteriology_. St. Louis: The C. V. Mosby Co., 1954.

Hilliard, Curtis M., _A Textbook Of Bacteriology And Its Applications_. Dallas: Gin and Co., 1936.

Sarles, William Bowen, et al, _Microbiology, General And Applied_. New York: Harper and Brothers, 1951.

_____. _Difco Manual Of Dehydrated Culture Media And Reagenta_. Detroit: Difco Laboratories, Inc., 1953.

(various) . "Bacteriology In Introductory Biology". _The American Biology Teacher, Special Issue_. Danville, Ill.: National Association Of Biology Teachers; Interstate Press, (June, 1960) 22:6

Sussman, Alfred S., compiler. _High School Biology, A Laboratory Block On Microbes; Their Growth, Nutrition, And Reaction_. Boulder, Col.: American Institute of Biological Sciences, Biological Sciences Curriculum Study: Johnson Publishing Co., 1960.

APPENDIX

SOME SUGGESTED REFERENCE BOOKS FOR A STUDY OF BACTERIOLOGY IN HIGH SCHOOL

(This list is arranged by books in groups according to subject matter groups and importance of study.)

BIOGRAPHICAL:

Doctors Of The World, Murray Morgan. New York: The Viking Press, 1958.

Women Doctors Of The World, Esther Pohl Lovejoy. New York: The Mac Millian Co., 1957.

The Doctors Mayo, Helen Clapesattle. Minneapolis: University of Minnesota Press, 1941.

Men With Golden Hands, E. H. G. Lutz. New York: Appleton-Century-Crofts Inc., 1956.

Men Against Death, Paul DeKrief. New York: Harcourt Brace and Co., 1932.

Nobel Prize Winners In Medicine And Physiology, Lloyd G. Stevenson. New York: Henry Schuman, 1953.

Men Of Medicine, Katherine B. Shippen. New York: The Viking Press, 1957.

HISTORICAL:

Great Adventures In Medicine, Samuel Rapport and Helen Wright, editors. New York: The Dial Press, 1956.

Microbiology And Human Progress, Madeline Parker Grant. New York: Rinehart and Co., 1957.

A Short History Of Medicine, Edwin H. Ackernecht. New York: The Ronalds Press Co., 1955.

Natural History Of Infectious Disease, Sir Mcfarlane Burnet. Cambridge University Press, 1959.

The Story Of Microbes, Albert Schatz and Sarah R. Reedman. New York: Harper and Brothers, 1952.

Milestones Of Medicine, Ruth Fox. New York: Ransom House, 1950.

Miracle Drugs And The New Age Of Medicine, Fred Reinfeld. London: The Sterling Publishing Co., Inc., 1959.

Devils, Drugs, And Doctors, Howard W. Haggard. New York: Harper and Brothers, 1929.

Wonders Of Modern Medicine, Steven W. Spencer. New York: McGraw-Hill Book Co., 1953.

The Hospital In Contemporary Life, Nathaniel W. Faron. Cambridge: The Harvard University Press, 1949.

Eleven Blue Men And Other Naratives Of Medical Detection, Berton Roueche. Boston: Little, Brown and Co., 1953.

Microbe Hunters, Paul DeKrief. New York: Harcourt, Brace and Co., 1926.

The White Plague, Tuberculosis, Man And Society, Rene and Jean Dubos. Boston: Little, Brown and Co., 1952.

Harvard Case Histories In Experimental Science, James Bryant Conant, editor. Cambridge: Harvord University Press, 1957.

INSTRUCTIONAL AND EXPERIMENTAL:

The Microscope And How To Use It, George Stehli. New York: Sterling Publishing Co., Inc., 1960.

Microbes And You, Stanley F. Wedberg. New York: The Macmillan Company, 1954.

The World Of The Microscope, L. J. Ludoviei. New York: C. P. Pulman's Sons, 1959.

Wonder Book Of Microbes, Madeline P. Grant. New York: Whittesey House, McGraw-Hill Book Co., 1956.

The Science Book Of Wonder Drugs, Donald G. Cooley. New York: Franklin Watts, Inc., 1954.

Experiments With A Microscope, Nelson F. Beeler and Franklin M. Branley. New York: Thomas Y. Crowele Co., 1957.

Fun With Your Microscope, Raymond F. Yates. New York: D. Appleton-Century Co., 1943.

Microbes At Work, Millecent E. Selsam. New York: William Morrow and Co., 1953.

Magic In A Bottle, Milton Silverman. New York: The Macmillan Co., 1953.

ENCYCLOPEDIAS:

Late editions of most good encyclopedias have fair articles on bacteriology. The 1960 edition of _Encyclopedia Britannica_ has the best article of any examined. _Comptons Pictured Encyclopedia_ rated second, and _Colliers Encyclopedia_ was third.

Please Note:

The books included in this list are all suitable for high school usage. They will be good additions to the high school library, whether or not a unit of bacteriology is taught in the school.

VITA

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Master of Science

Thesis: A SUPPLEMENTARY STUDY UNIT IN BACTERIOLOGY FOR HIGH SCHOOL BIOLOGY STUDENTS

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Educational: Attended grade school at Midway, near Cleburne, Texas; Fort Smith, Arkansas; Greenbriar, near Alvarado, Texas; Thompson, near Venus, Texas. Graduated from Venus, Texas, High School May, 1930. Received the Bachelor of Arts Degree from Howard Payne College, Brownwood, Texas, with a major in Bible and minor in Education May, 1949; received the Master of Education Degree with major in Secondary Education from North Texas State University, Denton, Texas, August, 1958; completed requirements for the Master of Science Degree with major in Natural Science at Oklahoma State University May, 1962.

Professional Experience: Worked as radio technician and rural electrician 1932-1939. Was pastor of Baptist churches at Joy and Belcherville, Texas 1939-1941; the First Baptist Church, Lewisville, Texas, 1941-1943; the First Baptist Church, Granbury, Texas, 1943-1945; the First Baptist Church, Alvord, Texas, 1945-1947; the Harmony Baptist Church, Eastland, Texas, 1947-1949; The First Baptist Church, Goodlett, Texas, 1949-1954; The First Baptist Church, Ninnekah, Oklahoma, 1954-1955; the Forestburg Baptist Church, Forestburg, Texas, 1955-1958. Taught High School English at Forestburg High School, Forestburg, Texas, 1955-1958. Served as television technician in Forestburg, Texas, 1955-1958. Was high school Principal and taught high school sciences at Midway High School, Henrietta, Texas, 1959-1960; and was director of science department and taught high school sciences at the Bridgeport High School, Bridgeport, Texas, 1960-1961. Was Music Director of the First Baptist Church 1959, and director of Junior Choirs, First Baptist Church, Bowie, Texas, 1959-1961.

Was affiliated with local, county, state and national organizations of The Southern Baptist Convention while pastor of Baptist churches; was Associational Moderator and member of District Board two years, and Associational Clerk six years. Was affiliated with local, county and state organizations of Texas State Teachers Association five years; local and county committee chairman two years. Am member of National Science Teachers Association, and American Association of Biology Teachers. Have been member of Alphi Chi National Honor Society since 1949, and won Lena Vincent Scholarship Award at Howard Payne College. Have been awarded two National Science Foundation Summer Institutes, at Howard Payne College and Texas Christian University; one Inservice Institute at North Texas State University, and one Academic Year Institute at Oklahoma State University.