to gardens and laboratories, but included many places of purely historical or literary interest, such as Anne Hathaway's Cottage, Stratford-on-Avon, Kenilworth Castle, and St. Paul's Cathedral. The summer was an interesting one, and one very much worth while from several standpoints, but no experience was quite equal to that of seeing the Statute of Liberty through the mist as we came into New York Harbor.

M. DORISSE HOWE

COMMENTS ON HIGH SCHOOL LABORATORY EXPERIMENTS

THE purpose of this article is to familiarize the biology high school instructors with the organization and preparation of a wide variety of subject material from the standpoint of the teachers—to give them a series of comments that we have made by performing and testing all experiments found in Peabody and Hunt's *Biology and Human Welfare,* the textbook adopted for use in the high schools of Virginia. We hope to lighten their load in teaching and increase the value and effectiveness in their methods of instruction. On the following pages the instructor will find the number of the experiment and the page on which it will be found in the text. Some experiments are omitted because we had no comments to make other than those already given in the text.

Minimum Requirements

A. Time
   1. Three 40-minute recitations
   2. Two 80-minute laboratory periods

B. Experiments
   1. At least 36 Laboratory Experiments

C. Equipment as listed by the Department of Education

Quantity	*Description*	*Estimated Price*
1	Beaker, 150 cc	$ .15
1	Beaker, 250 cc	.17
4	Bottles, wide mouth 4 oz.	.35
1	Lamp, alcohol	.32
1	Pipette, with rubber bulb	.03
1	Test tube support (10 tubes)	.75
1	Test tube brush	.06
1	Tripod magnifier	.75
1	Evaporating dish, 100 mm. diameter	.40
1	Scalpel	.60
1	Forcep	.25
1	Flask, flat bottom 250 cc	.17
1	Clamp, test tube	.15
1	Tripod, iron	.45
2	Cork sheet, 4x2x16-in.	.60
1	Wire gauze	.40
	Total	$ 5.24

ONE SET FOR EACH LABORATORY

Quantity	*Description*	*Price*
1	Trip scale, Harvard	$ 12.00
1 set	Weights, still in block	5.00
2	Battery jars, 6x8-in.	.90
1	Bell jar, 2 qt.	3.25
1 oz.	Cover glass, ¾-in.	1.80
1 doz.	Directing needles	.30
1 doz. pr.	Petri dishes, 100 M. M.	3.60
1 pkg.	Filter papers	.20
2	Funnels, glass, 4-in.	.80
1 lb.	Glass tubing, 3x16x4-in.	.70
12 ft.	Rubber Tubing, 3/16	.96
1	Graduate cylinder, 250 cc	1.10
1	Microscope	65.00
2	Ring Stands	1.80
36	Slides, glass, 1x3-in. med.	.60
36	Test tubes, 6x¾-in.	.90
1	Thermometer 10-100 C.	.90
1 doz.	Water glasses, plain	1.32
1	Lactometer	.65
2	Thistle tubes	.30
6	Student lamp chimneys	1.08
1	Graduated cylinder 100 cc	.70
1	File, rat tail	.10
1	File, triangular	.10
1	Mortar and pestle, 3½-in.	1.30
144	Corks, assorted, 0-11	.60
1 set	Cork borers	.70
1	Trowel	.25
100	Insect pins No. 2	.45
1 sheet	Parchment paper, 17x22-in.	.10
	Total	$107.66

CHEMICALS

(One set for each laboratory)

2 lb.	Paraffin	$ .50
1 lb.	Hydrochloric Acid	.30
2 pts.	Alcohol, Denatured	.70
1 lb.	Ammonium hydrate	.70
½ lb.	Ether	.35
1 lb.	Formalin—40%	.40
½ lb.	Potassium cyanide	.50
10 grms.	Carmine, red	.60

Biology 412, in which these comments were prepared, contained the following students: Lucille Bywaters, Sue Glover, R. A. Haney, L. B. Hedgecock, Hunter Jackson, Beatrice McCraw, Mrs. Christine Rodes, Mary E. Sanford, Hubert Sandy, and Paul M. Shull.

½ lb.—Nitric Acid	.30
1 oz.—Iodine Solution	.15
1 vial—Litmus paper (red)	.10
1 vial—Litmus paper (blue)	.10
½ vial—Manganese dioxide	.10
1 vial—Absorbent cotton	.45
2 vials—Plaster of Paris	.40
½ vial—Cornstarch	.10
1 oz.—Fehling Solution A	.25
1 oz.—Fehling Solution B	.30
Total	$ 6.30
Total equipment (minimum)	$119.20

The equipment may be purchased from the following:

W. M. Welch Scientific Co., Chicago, Ill.
Central Scientific Co., Chicago, Ill.
Standard Scientific Co., New York, N. Y.
Chicago Apparatus Co., Chicago, Ill.
Marine Biological Laboratory, Woods Hole, Mass.
Emer and Amend, New York, N. Y.
Kay-Scheerer Co., New York, N. Y.
New York Biological Supply House, New York, N. Y.

These supplies may be secured through the Virginia School Supply Co., Richmond, Va.

Laboratory furniture may be secured from the following:

Kewannee Manufacturing Co., Kewannee, Mich. Branch office, Richmond, Va.
Leonard Peterson Co., Chicago, Ill.
E. H. Sheldon Co., Muskegon, Mich.
Urese Laboratory Furniture Co., Manitouse, Wis.

NOTE.—Furniture manufactured by the State Penitentiary similar in design and quality may be obtained much cheaper from the Superintendent of the Industrial Department, State Penitentiary, Richmond, Va.

Criticism of Experiments in Peabody and Hunt

EXERCISE I, P. 12

Care should be taken to have the top of the glass put in parrellel with the water; otherwise, if the glass is put in sideways, bubbles of air will escape from the glass, and will be replaced by the water. If the water is over three inches deep, the glass will tumble over. The small amount of water in the glass is due to the compression of the air when the glass is pressed hard against the bottom.

EXERCISE 2, P. 12

By experimentation it was found that it makes no difference whether the glass is full of water or not, but the paper should be pressed down with the palm of the hand before inverting to keep the paper from falling off.

An extra experiment can be used here on "How to made a barometer and read air pressure." The directions can be found in a General Science or Physics text.

EXERCISES 3, P. 13

Although limewater gives the best results, due to the white precipate it forms with carbon dioxide, other bases such as lye may be substituted. The lye may be obtained from soaking wood ashes.

The part of the experiment that proves nitrogen is present in the air is poor. This part only proves that there is an inert gas present.

You will not be able to get the exact proportion of oxygen in the air, as the candle cannot possibly use up all the oxygen before it is extinguished by the carbon dioxide gas.

EXERCISE 4, P. 17

An automobile pump may be substituted for the bicycle pump. You may not get results you expect in five minutes, because of the small per cent (.04%) of carbon dioxide present in a ventilated room.

Parallel with this, the children should now exhale the air from their own lungs through the limewater. From this experiment, they can immediately see the results of a larger amount of carbon dioxide on limewater.

EXERCISE 9, P. 39

Sometimes in making the starch test on a number of substances, you may get a positive test when you shouldn't. Free-running salt gives the characteristic test for starch, which is due to the cornstarch that is added to absorb the moisture.

When applying the iodine test, if you cannot see the desired color results, it is advised that you use the microscope. In the apple, for instance, the blue starch grains are visible under the microscope within the larger plant cells.

EXERCISE 10, P. 39

The reducing sugar test should not be tried on ordinary cane sugar, unless the cane sugar has been changed to a reducing sugar by addition of an acid.

Old Fehling's solution should be tested by boiling. If it retains its transparent blue color, it is ready to use; otherwise a fresh supply should be made.

It has been found that the Fehling's tablets are very convenient. They may be obtained from any chemical supply house or from many drug stores.

EXERCISE 11, P. 40

Heavy brown paper reveals the presence of fat in food materials more satisfactorily than white paper.

Chloroform, benzine, ether, carbona, or any solvent of fat may be used, but caution should be given about the use of inflammable substances. The last solvent mentioned does not afford this danger if bottle is kept corked.

EXERCISE 13, P. 42

The tumbler must be cold, or else the moisture from the foods will not condense and the wrong conclusions may be drawn.

EXERCISE 15, P. 44

In the preparation of hydrogen dilute acid must be used, but it must not be over 50% water.

The connections may be made airtight by using the wax from a burning candle.

Be sure you have pure hydrogen not mixed with air before applying a lighted match. The text gives the test in that hydrogen mixed with air give an explosion. Pure hydrogen burns quietly. The testing is done in a test tube of collected gas, and not at the apparatus in which hydrogen is prepared.

EXERCISE 16, P. 45

Unless the substances are thoroughly dried and tested with a cold tumbler as to dryness, the wrong conclusions may be drawn as to the presence of hydrogen, since burning hydrogen forms moisture.

EXERCISE 18, P. 51

Carbon paper may be substituted by tin foil. Whatever substance is used, care must be taken to see that no sunlight reaches the leaf.

The covered and uncovered leaves must be left on the plant several hours in the sunshine before testing, or else you might get the same results with the covered as with the uncovered leaves.

A caution might be given here as to the boiling of alcohol over a direct flame. A water bath is much safer.

EXERCISE 20, P. 55

The experiment is often a failure because enough of the growing water plant is not used. Elodea is very satisfactory.

The note at the bottom of p. 56 on why this experiment fails should be read with care.

An extra experiment, "A Balanced Aquarium," will work splendidly here. Two biology manuals that contain this experiment are Meier's *The Study of Living Things,* p. 27 (Ginn and Co.), and Bailey and Green's *Biology Manual,* p. 64, (Allyn and Bacon.)

EXERCISE 22, P. 63

If no Dewar flasks nor thermos bottles are available, improvised ones may be made by using sawdust as a non-conductor of heat. This is placed in a fruit jar, and a smaller jar containing the sprouting seed is placed down in the sawdust. An opening should be left just large enough for the thermometer. Cotton may be used for plugging as a cork would exclude oxygen.

EXERCISE 23, P. 67

Poor results might be obtained if enough sponge material is not put in the bottom of the jar to hold moisture in a wide-mouthed jar over night.

EXERCISE 24, P. 68

This experiment fits in so well with the

unit of work, "The Air as a Part of Our Environment," that the suggestion might be given here to recall the results obtained when carbon dioxide passes through lime-water as found in Ex. 4.

EXERCISE 25, P. 69

Clear filtered lime water should be used, so that you may readily observe the change that takes place in a short time.

Special attention should be given to the fact that respiration, which is the taking in of oxygen, and giving off of carbon dioxide, is taking place night and day. Photosynthesis, which means putting together by light, occurs only in sunlight. At this time carbon dioxide is taken up and used by the plant in the manufacture of sugar, and the oxygen is set free from the carbon dioxide, the plant using only the carbon for photosynthesis.

EXERCISE 26, P. 77

The iris plant gives equally as good results as onion bulbs when studied under the microscope as to plant cell structure. For this purpose the epidermis is stripped off with a knife.

At this point a suggestion may prove helpful about reproducing slides or drawings of cells, cell-division, etc., on oilcloth or the blackboard at a nominal cost.

Focus the lantern slide you wish to reproduce on the back or rough side of the oilcloth. Make it any size you desire, preferably large enough to be seen by pupils from any part of the room. Now trace with pencil or crayon the outline. Different colored crayons or ink may be used to make your chart clear and helpful. You will find this is a cheap way for obtaining permanent charts, as the oilcloth can be rolled up, and kept in a minimum amount of space.

EXERCISE 27, P. 78

Although this experiment calls for the study of human cells, this is a splendid opportunity for the pupils to see the likenesses of cells of the human body, one-celled animals, bacteria, etc.

The same reference that was used in Ex. 20 may prove helpful "Study of Living Things," p. 25.

EXERCISE 29, P. 131

A membrane which might be substituted (the intestines of calf called for in the experiment might not be procurable) is the skin or covering of sausage.

Parchment paper may be used.

Another way than suggested by the text that proves water will pass through a membrane is the egg experiment. The large end of the egg is shelled, so that the membrane is exposed. Through the small end of the egg a hole is bored and a tube is placed substantially in the egg yolk. Sealing wax will help to seal the tube to the edges of the bored hole, and help hold the tube upright. The egg is now placed in a glass filled with enough water to cover the membrane exposed. The tube may be several feet long, and if this experiment be left for several days a greater part of the tube will be filled with egg yolk.

A root plant, such as a carrot, may be placed in a jar of water. Through the top a glass tube is placed through a bored cork in upright position. A hole is made in the top of the carrot with a large cork borer to receive the cork.

EXERCISE 32, P. 137

The germination of grain requires air, moisture, and heat. Do not cover the grain with water and expect good results.

The "Rag Doll" method may be used, in which grain is spread out on a towel, the edges folded over so that the spread-out grain can be rolled up and tied. One end of the doll can be placed in a jar with enough water to allow the towel to become saturated, and some extra for evaporation. In twenty-four hours the grain will show sprouts.

EXERCISE 33, P. 138

Diastase contains the enzyme needed to digest or change starch into sugar. Other enzymes, such as pancreatin, may be used with similar properties. Allow time for the enzyme to act.

EXERCISE 34, P. 138

Allow time for action of saliva before testing for reducing sugars.

EXERCISE 35, P. 144

Any red solution will show up in the plant, but blue substances can not be seen so well.

If the plant is left too long before being examined the colored solution will diffuse to the phloem and you will not be able to distinguish the path the soil water takes to the leaf from the path it takes from the leaf.

EXERCISE 40, P. 155

The wax from a burning candle or melted paraffin will seal any place that moisture might escape from the container if top and sides are coated with it.

If a bell jar is not available, a half-gallon fruit jar or large candy jar may be inverted over the potted plant.

EXERCISE 41, P. 169
EXERCISE 42, P. 170

The two experiments listed under "Digestion in the Human Body" deal only with teeth as related to digestion.

Since a laboratory for high school biology is not equipped to carry out experiments dealing with the different steps in digestion, a suggestion might be made that this phase of work be taught by means of charts. These charts, illustrating the mechanical and chemical processes involved, can be prepared by the pupils as described in Exercise 26.

The average pupil can understand the digestion processes much better if each class of food is carried through separately.

A very good experiment on digestion is given in Bailey and Green's *Biology Manual* (Allyn and Bacon), pp. 130-132, which includes (1) mouth digestion (2) stomach digestion (3) intestinal digestion (4) action of bile.

EXERCISE 43, P. 194

The part of the experiment 63 that deals with the circulatory system of the frog may be used in connection with the unit of work in "How Circulation is Carried On."

There is a note at bottom of p. 493 describing how the movement of the corpuscles in a tadpole's tail can be observed under the microscope. This is an excellent demonstration of the blood current. The same thing can be shown by using the web of the foot of a live frog.

EXERCISE 44, P. 212

Again the part of experiment 63 p. 484 on the breathing organs, etc., of a frog may be used in connection with the unit of work, "How Living Organisms Breathe."

EXERCISE 50, P. 256

If possible, have the pupils bring an isolated stalk of corn, and after examining the ear of corn explain why the ears are not well developed.

In working out the experiments on plants and plant reproductions, let the pupil plant his seed, watch it change its form, bring in photosynthesis in the growing plant, and finally reproduction.

This exercise and also No. 48 would be helpful in the unit, "How Living Things Reproduce."

EXERCISE 53, P. 281

The teacher must be certain that the hay infusion contains no one-celled animals or plants that the pupils might mistake for bacteria. The one-celled animals are often very numerous in infusion, and this must be explained so that the wrong idea of bacteria may not be gotten.

EXERCISE 54, P. 283

It may be necessary to have high school

pupils know something about culture media for bacteria such as agar mixture, but since the topic of the experiment is "Where are bacteria found?" they should look for the more common sources of natural bacteria culture, such as milk, cooked food, soil water, roots of leguminous plants, hay infusion, and teeth scrapings.

Again a reference that might prove helpful in this topic is Meier's *The Study of Living Things,* p. 59 (Ginn and Co.).

EXERCISE 55, P. 284.

Other disinfectants may be tried besides iodine, such as bichloride of mercury, potassium permanganate, carbolic acid, lysol, salicylic acid, chlorine, hydrogen peroxide, alcohol, formaldehyde, and mercurichrome, as well as various combinations of table salt or sugar.

EXERCISE 56, P. 347

Fish, such as sun perch, can be kept in an aquarium for study while the unit is being studied. A large aquarium of very few fish are necessary. Water plants are desirable.

They can be used later for the experiments that call for dissection.

EXERCISE 61, P. 472

The common mistake made by some authors is that hay infusion gives paramecium. This may happen if pond water or other such sources of water be put over the chopped hay, but if chlorinated tap water or distilled water is used the single-celled animals will not be paramecia. They may be exytricha colpodium and others that have ability to become cysts in the dry hay, but since paramecium does not encyst, it is a fallacy to leave the directions as they are given. In preparing pure paramecium culture boil hay infusion to kill all other animals and cool. Innoculate with a small number of paramecia.

EXERCISE 63

Part of this experiment could be used in connection with the unit, "How Circulation is Carried On." Another part could be used in connection with the unit, "How Living Organisms Breathe." Otherwise the exercise is too long to obtain understanding.

GEORGE W. CHAPPELEAR AND OTHERS

SOME PROBLEMS OF BIOLOGY

THE term biology most frequently calls to the lay mind visions of bugs and worms and all manner of crawly things. Those of us whose life work it is either to teach the subject to others, or to further extend the boundaries of biological knowledge by painstaking investigations, may in the very intensity of our work be as prone to miss some of the "bigger and better" bearings of biology on human life, and the enrichment of the human mind and spirit which come from the great truths of biology itself and those which become evident when we survey the borderland between biology and other branches of natural science, as our less well informed brother to whom the thought of our subject is uninteresting if not actually repulsive. It is the purpose of this brief article to note some of the major problems of this science and point out their application to human beings that we may better understand one another and the better appreciate some forms of human need.

Biology, embracing as it does all scientific knowledge concerning matter in the living state, has for purposes of convenience been grouped into a number of subsidiary sciences, most of which may be considered from either the botanical or the zoölogical point of view according to individual interest. Closely related to animal physiology are the sciences of psychology and sociology. The investigation of the behavior of animals as individuals and in groups brings us to the realization that their various reactions differ from our own more in degree