

A METHOD OF TEACHING BACTERIOLOGY IN A BIOLOGY COURSE.

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Teachers who take up the work of general science or civic biology for the first time soon find themselves fairly aghast at the number and variety of "ologies" and otherwise with which they must needs have more than a bowing acquaintance, and to such as are out of reach of libraries which can furnish helpful reference work, or have not some friend at hand well-versed in the particular strange "ology" to be presented, a slight record of what was recently done by a band of explorers at the University of Oregon High School may be of interest.

Bacteriology was the unexplored country, and the teacher thought as she looked across the holiday vacation into its mysterious reaches, that, though there might not be giants in that land, there were problems for her equally fearsome.

The class was large, over thirty pupils, one hundred per cent alive, and having a wide range of preparation as well as of ability, so that no uniform assignment could be given, neither was actual laboratory work possible for all, and, as I have intimated, the teacher herself had no training in the subject.

Discipline was difficult in such a group, as was also the problem of keeping everyone working at full efficiency, but it was decided to capitalize these problems. For the half dozen most advanced pupils, who were in second year high school, she arranged special assignments, the work on which would occupy much of the month to be devoted to this particular phase of biology.

During the holiday vacation the reference works on this subject to be found in the University library were examined, and some few found which could be used by this group of "specials." Abbott, "Principles of Bacteriology," and Frost, "Laboratory Bacteriology," were found especially helpful for reference, while for her own use, Moore, "Laboratory Directions for Beginners in Bacteriology," was most illuminating and convenient as well.

At the first meeting of the class after vacation the special assignments were given out in the form of problems, and the pupils told that upon the work of this assignment would depend their grade for the month.

Each problem was in writing and was made sufficiently explicit, and the directions for procedure sufficiently definite so that

there was little or no need for further explanation. The group was dismissed at once to go to the University library, situated within the block, for work on the initial stages of their problems.

This left a more homogeneous group to deal with in class, and automatically solved much of the problem of discipline for the time. The remainder of the period was given over to a discussion of the general characteristics of bacteria and of their economic importance.

The specials reported at the *end* of each class period unless otherwise directed, in order that they might not abuse their liberty and fail to report promptly for the class following biology.

All were required to prepare an outline in writing showing in detail:

- (a) Method of preparing beef bouillon and nutrient agar-agar for the culture of bacteria
- (o) Sterilization of glassware
- (c) Tubing of media
- (d) Sterilization of media in tubes
- (e) Methods of obtaining and cultivating bacterial colonies
- (f) Of innoculating tubes of nutrient agar
- (g) Of pouring agar plates

The individual problems were such as deal with everyday circumstances in the lives of the pupils. One culture was made by moistening the hand, scraping it with a sterilized scalpel, then inoculating a tube of bouillon with this, and from the culture developing in it, growing colonies in a petri dish.

Another was from an old coin, another from scraping about the base of the teeth with a flamed scalpel *before* brushing the teeth, and still another was made by placing a hair from a pupil's head *before shampoo* in a tube of bouillon.

Quite the most conspicuous bacterial colonies came from the dirt from the pupil's hand. They spread rapidly in a silvery, lichen-like growth, and excited much interest in all the members of the class.

Special reports upon the preparation of media were presented to the class on Wednesday and Thursday. All were required to take note of these, the important features were discussed, and points not clearly understood were explained. On Friday morning three of the specials demonstrated the preparation of beef bouillon at the laboratory table before the class. The laboratory is equipped with gas for experiments requiring heat, with running water both hot and cold, with balances, and with a fair supply of glassware, but has no special equipment for bacteriology, so certain necessary pieces of apparatus were evolved from materials at hand.

An old rice-cooker, having an inner compartment of aluminum and still in good condition was brought by the teacher for use in preparing the media, and two Bunsen burners under it furnished sufficient heat to bring the water in it quickly to a boil.

As the preparation of extract from fresh beef involves more time than the class could well afford, Liebig's beef extract was used instead. The extract, peptone and salt required were each carefully weighed and then dissolved in a beaker in a part of the five hundred cc. of water which had been measured into the cooking utensil: all was brought to a boil and the boiling continued in a covered dish for about twenty minutes, when the preparation was ready to be tubed.

Since there was not time in that period for further work the bouillon was poured into a sterilized fruit jar and sealed for use on the following Monday, when it was reheated and poured into test tubes. These tubes had been well cleansed first with soap powder, hot water, and a brush, then boiled for several minutes in clear water to make sure that they were surgically clean.

About ten cc. of bouillon was poured into each tube, the tubes carefully stoppered with cotton batting, placed in a wire test tube basket, and sterilized. Through the kindness of the Bacteriology Department of the University this sterilization was done in their laboratory autoclave, but the same results may be obtained by using an ordinary kettle and colander or perforated pan which fits closely into the kettle top and will hold the test tubes or other material to be sterilized.

Since the heating in the autoclave is under fifteen pounds of steam pressure, sterilization is completed in much less time than can be done otherwise, but by steaming for an hour in an improvised sterilizer such as the one suggested, all bacteria will be destroyed. To make sure of the destruction of spores which may be present it is well to repeat the steaming operation on two or three successive days, making sure that the water in the bottom compartment is actually boiling for fully twenty minutes each time, and that the steamer part is closely covered.

Empty glassware, such as petri dishes, flasks, etc., may be sterilized by heating in an ordinary range oven at 170 degrees C. for one hour, allowing the oven to cool down to a point where there will be no danger of breakage of the glass from drafts of cold air before opening the oven.

At the class period following the sterilization of the bouillon

tubes each of the specials took two test tubes and inoculated them: some with *before* and *after* tests, as for example, before brushing the teeth, and after brushing with a dentifrice. The tubes were set aside in the laboratory locker for a few days of incubation, but as the weather chanced to be quite cold they did not show activity during that week, so were taken home by the teacher and kept in a living room where the temperature was kept nearly equal both night and day. By the sixth day following inoculation there was noticeable cloudiness in the culture from an old coin, so two agar tubes were inoculated with this and agar plates poured.

As evidence of bacterial action became pronounced in other tubes agar plates were made from those cultures, but on account of lack of heat the latter ones did not become well developed in the time allotted to this study.

It seems to the writer that an incubator might be improvised somewhat on the order of a homemade fireless cooker, by padding the inside of a box well with some substance of low conductivity, and using a heated soapstone to supply the heat necessary for rapid incubation.

The nutrient agar was prepared by those of the specials who had not taken part in preparing the boullion, its preparation being demonstrated before the class, explained by the teacher, and reason for the use of the different ingredients, as well as for the successive steps in its preparation discussed and explained.

Each member of the class was required to write out this problem, methods and materials, observations, and conclusion, and was held responsible for knowing just how to do the work. This, of course, does not take the place of actually doing the work one's self, but where individual laboratory work is out of the question it serves as a helpful substitute.

Directions for the preparation of both beef boullion and nutrient agar may be found in laboratory manuals or texts on bacteriology, but the straining of agar through filter paper as recommended by them is such a long and tedious process that workers in this field will be glad to know of a process recommended by Prof. A. R. Sweetser, head of the Bacteriology work in the University of Oregon.

A handful of excelsior is placed in the funnel to be used. Over this is spread a layer of cotton batting to extend out onto the sides of the funnel. The straining apparatus is placed in the steam bath, the boiling agar poured upon the cotton, and—

Presto! The thing is done! Only those who have used filter paper and an improvised steam bath can fully appreciate the difference.

The agar is tubed while hot, sterilized, and part of the tubes laid in a slanting position to cool for the preparation of slant agar, while other tubes are left upright for "stick" or "stab" cultures.

One phase of work taken up while studying bacteria was life sketches of men who have contributed largely to building up the science of biology. The pioneer work of Jenner in vaccination for smallpox; the importance of Liebig's work in Organic Chemistry as bearing upon experimental bacteriology; the contributions of Koch; and the revolutionary effect of Darwin's discoveries and the theories which grew naturally from them. All these as well as several others which were taken up, proved intensely interesting, but for real, thrilling romance, Pasteur was easily in the lead.

Most of the materials for these life sketches were taken from "Biology and Its Makers," W. H. Locy, although some excellent ones came from other sources, and one or two from "Science" or "The Science Monthly," which can scarcely be called milk for babes, but such was the interest and enthusiasm aroused in this study that it was with real regret that the pupils left it before more fully covering the ground.

For the study of Pasteur's life, "Pasteur, The History of a Mind," Duclaux, and "Life of Pasteur," Vallery Radot, are highly recommended for the teacher's reading, but are somewhat beyond the grasp of most high school pupils.

Looking back over the month's work, there are mistakes to be noted, omissions of important points that might have been covered, and some work not completed because we did not know in time to profit by the knowledge of how to overcome certain difficulties. Viewed as a whole it stands out as a month of enthusiastic endeavor, of real progress, and of inspiration for further work in the same field.

ENORMOUS RESERVES OF LIGNITE IN ALASKA.

The reserves of lignite in the Nenana region, Alaska, are estimated by the United States Geological Survey to be nearly 10,000,000,000 tons, which exceeds by nearly 3,000,000,000 tons the estimate made a few years ago, on the information then available, of the total quantity of lignitic coal in the territory. The new estimates, which are very moderate, indicate that the quantity of coal available in the Nenana coal field is greater than that in all the other surveyed fields of the territory.