istry of ptomaine and toxin formation, of pigment formation, of enzyme production, may be worked out in this way. The chemist laughs at our present methods of testing the production of gas, the reduction of nitrates, the production of indol, the fixation of nitrogen. And yet when these processes are tested in synthetic media how simple are the chemical tests involved and how accurate may be the results!

Slowly and laboriously the physiological chemist is now trying to work out the chemistry of protoplasm, of the proteins, such as the albumens, the peptones and proteoses. His principal line of attack is by a study of their decomposition products. The brilliant work of Fischer opened up an entirely new field of research when he undertook the study of the synthetic production of the polypeptides from amino acids by an amide link. Still more light might be thrown upon this important problem by the study of the growth of bacteria in simple chemical solutions. For in the synthetic culture medium we would be able to study step by step the synthesis of protein under conditions accurately controlled and completely known. For when bacteria are growing on simple chemical media and are building up untold millions of bacterial bodies from the simple salts present, we can almost see protoplasm in the making.

And finally, aside from the important chemical information which may in this way be obtained, I believe that some most interesting biological information lies along this path. Who would dare to deny that some day it might be possible by some such method as this to discover the secret of the very origin of life itself!

These then are some of the lines of work which appear to me to mark progress in the science of pure bacteriology. Brilliant as may be the results of the study of the applications of bacteriology, fully as interesting, and hardly less important, will be the results that come from the application of exact chemical methods to our at present inexact and rather uncertain bacteriological procedures.

F. P. Gorham

Brown University

THE TEACHING OF MICROBIOLOGY IN COLLEGES OF UNITED STATES AND CANADA[1]

In his admirable presidential address delivered before the Society of American Bacteriologists at the Ithaca meeting in December, 1910,[2] Professor V. A. Moore made a strong argument for bacteriology as a science for general culture as well as for professional value, and a vigorous appeal for better teaching and more carefully developed courses. As a result of this exposition of the subject a committee of this society was appointed to make a systematic inquiry into the teaching of microbiology, including bacteriology, protozoology and the study of the lower fungi, in the educational institutions of the United States and Canada.

The purpose of the inquiry is primarily to learn to what extent bacteriological instruction is given in these institutions, and secondarily to note the character of the teaching in these subjects and the scope of the work. It is possible that as a result of these data submitted the committee may be able to formulate a generally broad and satisfactory plan of instruction in this subject, although this is not the immediate purpose of the committee and it is possible that an attempt to do so would react harmfully in certain instances.

While it is hoped the inquiry will eventually embrace institutions of all ranks, the first report of progress presented at the Washington meeting dealt only with the colleges and

[1] An abstract from the first report of progress by the Committee on Education of the Society of American Bacteriologists.

[2] Science, N. S., Vol. XXXIII., No. 843.

technical schools. These may be classed as follows: (1) The colleges of arts and sciences leading in general to the A.B. or S.B degree; (2) the colleges of agriculture; (3) the colleges of medicine; (4) the technical schools or schools of applied science.

At the outset it should be said that the report on the teaching in these institutions is far from complete, that many schools have not supplied information, and that the following statements form merely the beginning of what, it is hoped, will be a comprehensive and useful study.

The chairman of the committee early in the year prepared a set of questions which were submitted to the other members of the committee for suggestions and desirable changes. These were incorporated in the final list. These questions have been submitted to about 550 institutions of the rank as stated above in the United States and Canada. The collegiate institutions of Canada were not found in any list of the colleges available, but a list was obtained by direct application to the Canadian commissioner of education, to whom cordial thanks are extended. The questions were as follows:

1. What courses in bacteriology, if any, are given in your institution?
2. How many hours of lecture, recitation and laboratory work are devoted to each?
   Lecture
   Recitation
   Laboratory
3. Is the subject a required one, or elective?
4. At what year in the college course is it given?
5. To what group (department) or groups of students is it given?
6. What preliminary training in biological sciences is required?
7. What preliminary training in physics, chemistry, mathematics and languages is required?
8. Is the subject presented as
   (*a*) Part of a course in general biology or botany?
   (*b*) As a general science course for its educational value?
   (*c*) As a special or professional course in applied science?
   (*d*) As a part of any other course? If so, what course and how extensively?
9. If more than one course is given, will you state the scope and character of each, and the approximate number of students in each?
10. If the courses are given from the applied science standpoint, are they given in their relation to
    (*a*) Medicine?
    (*b*) Public health?
    (*c*) Dairying?
    (*d*) Soil and agriculture?
    (*e*) Industrial processes?
11. What is the character of the laboratory work actually performed by the students, *i. e.*, how elaborate experimentation do they actually do?
12. Are the students directed in what might be called research work in bacteriology, *i. e.*, advanced work and investigation, aside from ordinary routine class work?
13. What books do you use as text-books for the course?
    As collateral reading?
14. What courses in protozoology are given?
15. What text and reference books used?
16. What courses devoted to other branches?

Replies have been received from 121 of these and it is on the basis of the replies received up to the present time that the following tabulations and statements are made. A second list of questions has been submitted to those institutions of the original list and supplementary institutions not on the original list from which no replies had been received up to December 21. The failure to reply undoubtedly means in certain instances that no courses are given or that there is no professor dealing with the subject in hand, and consequently letters have failed to be properly received, or there may have been oversights on the part of the professor in charge. Because of the possibility of the second alternative it has seemed desirable to send out the second set of questions.

The replies which have already been received in response to the circular have been of much interest, and careful study may be grouped into a number of tolerably definite classes. In general the replies indicate fairly clearly the scope of microbiological instruction, and in several instances there have been

submitted course schemes showing the exact range of subject matter presented.

On the basis of the study of these replies the chairman has grouped the institutions into several classes which I have characterized as follows:

Group I.—Those institutions in which some phase of the subject of bacteriology is presented very briefly, and in general avowedly from the standpoint of general education, or in connection with courses in general biology, botany or hygiene given from the culture rather than the professional standpoint. Some actual laboratory work is done, however.

In addition there is sometimes an intention to introduce the student to some phase of applied bacteriology in a very brief way. These brief courses vary much in character and extent, and this group is, therefore, the most difficult to classify. A few have made pretentious claims which obviously can not be lived up to in the courses given.

In many of these courses the plan of attack seems to be well thought out, and the relations of lecture and laboratory work is well calculated to give the student a fair general introduction to the whole subject. However, it is only an introduction, and the student product can not be regarded as a trained bacteriologist. On the other hand, some of the courses seem to be badly balanced, to give an undue weight to lectures and too little to laboratory work, and to emphasize some particular and rather narrow phase of the subject.

The institutions which I have included in this group are 39 in number and include for the most part the smaller colleges, or those having no highly specialized courses in applied sciences leading to a professional degree. These courses are apparently sometimes taught by instructors who have had no special or thorough training in bacteriological methods, but who have gained some knowledge of the bacteria, and who have introduced the work in the curriculum because of their personal interest in the subject or their ability to adopt such knowledge to supplement courses already given. In none of these institutions is there any attempt to carry on worthy investigations or research, although in a few of the replies it has been stated that "investigations" are conducted. Examination of the type of research, however, shows it to be trivial and to consist generally in the microscopical examination or plating out of bacteria from a water supply, milk supply or some such simple source. The consideration of this group of institutions can not fail to impress the members of the society with some of the statements made by the president in his address last year, in which he put in a forceful plea for more scientific methods in teaching and more training on the part of those giving instruction in this important subject in many institutions.

Group II.—This group includes institutions having in general but one course or at most two separate courses, but in which work is conducted on broader lines, with more abundant laboratory work and generally in which the teacher is himself a trained worker in some field of bacteriological study and in close sympathy with the subject.

The courses here grouped may in some instances be described as presented primarily for the educational value of the subject as seen in a broad way, and are given from the standpoint of general culture and in the same spirit as that exhibited in the teaching of courses of general chemistry, general botany or general zoology.

Frequently after a fairly broad and comprehensive introduction the work is later restricted to some special phase of bacteriology, as soil, dairy, or sanitary work, so that the subject is actually given with the applied science end in view.

In this group there are undoubtedly some courses which are poor in the sense that they fail to give to the student a broad knowledge of the fundamental principles underlying bacterial behavior and activity. In other words, the biology of the bacteria as a group of living things is frequently subordinated to the examination of water for colon bacilli or the microscopical study of a few restricted types, such as the more common of the pathogens. On the other hand, many of the replies from

institutions which should be placed in this group indicate that bacteriological instruction is on a good foundation, and may be built up with comparative ease when opportunity offers.

In these institutions investigation work of a legitimate character is frequently conducted, and the best of the institutions of this class are contributing valuable work to the sum total of our bacteriological knowledge year by year, through their researches.

I have grouped 22 institutions in this class, in half of which, probably, work of high character is being carried out, while in the others the results do not appear to be so satisfactory.

Group III.—In Group III. I have brought together 28 institutions. In 25 of these, as appears from the catalogues or from subject matter presented in the reports, there is what may be called a well-rounded department of bacteriology or microbiology, with a central fundamental course in general bacteriology. Following this and dependent upon it may be found well organized courses in several of the applied branches, such as soil bacteriology, dairy bacteriology, sanitary bacteriology, fermentation work and medical or public health work. Twenty-five of the twenty-eight institutions here grouped present the breadth of work which I have just described. In three of them the work is organized with a somewhat less broad scope, but it appears to be evident that the work in these institutions is excellent as far as it goes.

Group IV.—In ten institutions, which are almost without exception medical departments or pre-medical courses, the work in bacteriology is arranged with one point in view, namely, to introduce to the student the more common of those types of microorganisms which are the causes of disease. It seems to me that the chief criticism to be made of these courses is that the student loses sight entirely of the important general relations of the bacteria to human welfare and is likely to regard the group simply from the standpoint of disease-production and never from the standpoint of industrial or economic value, or from the standpoint of general culture. In all the institutions of this class, the work is carried out in the graduate department or in the school not connected with the university, and in the former case no serious attempt is made to interest undergraduate men in the subject at all.

Group V.—I have made a separate group for those institutions, schools of engineering, in which a smattering of bacteriology is given to civil or sanitary engineers, in order that they may more properly appreciate sanitary problems. This group is very small, replies having been received from but few institutions. In these the narrowest kind of instruction is given, and the matter is presented in such a way as to leave the impression with the student that deciding upon the sanitary condition of the water supply is a perfectly simple matter requiring no special training. For example, one of the institutions which reports having a class in water bacteriology, states that the number of lectures given in the subject is but four, the laboratory work of the three brief periods and consisting in the examination of but one sample of water and one sample of sewage for the total count and presumptive test for colon bacilli. In the opinion of the writer such courses do positive harm, because they give to the student a false sense of knowledge and ability to decide problems which may be of the utmost importance for the welfare of thousands of people.

The remaining replies may be all grouped in a class together. This includes eighteen institutions. In seventeen of these no real courses in bacteriology are given, although the informants have stated that brief consideration of the subject is taken up in connection with botany, physiology or hygiene. No laboratory work is done, however, and it is evident that these institutions do not require any special consideration. In one of the institutions here grouped, a brief course is given in the examination of bacteria, yeasts and molds, from the standpoint of household economics. The work, however, is very elementary in character.

While it is somewhat disappointing to receive replies from less than one fourth of the

institutions to which the sets of questions were sent, this possibly represents a fairly high proportion of institutions in which instruction in this subject is given. While I am certain that well-defined bacteriological courses are presented in several institutions from which no replies have been received, a survey of the institutions with which I am familiar would lead me to believe that the replies had come probably from a majority of the schools giving bacteriological instruction. From the standpoint of geographical distribution, it seems to be evident that the middle west has done more in the promotion of microbiological education by the installation of courses than has the east or the south. Practically all the central and western state universities and agricultural colleges seem to have well-defined courses, and since these schools occupy very prominent positions in the field of education in the west, it appears to be evident that the student of the central and western part of the country has a greater opportunity to take work in this subject than has the eastern student, who is more likely to attend the privately endowed institutions. New England, with approximately thirty-five colleges and technical schools has, outside of the purely agricultural colleges, but five institutions in which comprehensive bacteriological instruction is given to the candidates for the Bachelor's degree in arts or science. No definite courses are offered in the collegiate department at Harvard, Yale, Dartmouth, Williams, Amherst, Bowdoin, Columbia, Princeton, Pennsylvania or Colgate, and this list could, with a little consideration, be very greatly extended.

It does not seem to the writer that this is the time to suggest methods of instruction, or the exact ground which should be covered in microbiological subjects. It is, however, worth emphasizing that the proper interpretation of bacteriological problems can not be had until the instruction in bacteriology is placed upon a very broad biological and physiological basis, and until there are correlated with such courses training in physics, chemistry and mathematics. These correlated subjects should be of sufficiently advanced character that the student may consider the organisms in their physical, chemical and biometric relations, for it must be admitted that modern bacteriology includes far more than the microscopical examination and cultivation of a few pathogenic types.

Samuel C. Prescott

A Botanical-Zoological Laboratory in Porto Rico

The University of Porto Rico announces that it plans to offer to students facilities for research in botany and zoology in the American tropics.

Special space will be set aside in the agricultural building now in process of erection and the well-equipped physical, chemical, botanical, zoological, bacteriological and plant pathology laboratories may be drawn upon for supplies and apparatus. The research laboratories will be equipped only with the usual essentials, but endeavor will be made to meet special needs, in the way of equipment, which the problems of each student demand.

It is probable that a seaside laboratory, within a few yards of the ocean, will also be provided with needed equipment, including a motor launch for marine collecting, and that a third laboratory will be located on some suitable elevated region. These facilities will be extended to all who are competent to use them and are properly accredited by reputable institutions.

Free tables will be provided for a limited number of advanced students under conditions which will be explained upon communication with the director.

Students who desire to use the laboratories are requested to communicate, as early as possible, to the director, their needs and dates at which accommodation is desired, since there is often delay in procuring supplies.

For the information of prospective students, the following data are given:

Porto Rico lies between 17° 54′ and 18° 30′ north latitude. Geologically it is of much interest, though but little studied as yet. It is extremely rugged and picturesque with its