Meetings

Applied Microbiology in Developing Countries

The application of microbiology to developing nations was the subject of a symposium held in Washington, D.C., on 5 May 1964 during the annual meetings of the American Society for Microbiology. The symposium was organized in response to the interest and concern expressed by microbiologists and related specialists with regard to the standards of education, competence, and research in many of the developing countries and with particular reference to the adequacy of the U.S. training programs for students from abroad.

In his introductory remarks, M. Alexander (Cornell University) considered the various needs for the further training of applied microbiologists in the developing areas. It was pointed out that, in view of the availability of competent specialists acquainted with the general and specific problems of research and instruction in many regions of the world, small study groups of specialists should be sent to selected countries where they could formulate the major needs and establish a series of priorities in training and research.

A comprehensive summary of the potential for increasing food production through microbiology was given by R. C. Dawson (Food and Agriculture Organization, United Nations). Particular emphasis was placed upon the direct contribution that microbiologists could make to the world's food supply without generating new programs that would make further demands on the diminishing supply of arable land. Inoculation of legumes with the root-nodule bacteria is a prime example of such a contribution. Because of the widespread requirement for large amounts of supplemental nitrogen for crop production, the relatively high cost of many fertilizers in developing regions, and the fact that simple skills can be applied to cultivating the bacteria required for the conversion of molecular nitrogen into plant-available forms, harnessing the root-nodule microorganisms for the benefit of agriculture overseas appears to be a microbiological measure that would assuredly provide major economic returns.

Dawson described the use of yeasts and algae for human and animal consumption, the control of insect pests by pathogenic microorganisms, and means for the regulation of certain of the harmful activities of various microorganisms in agriculture. Surprisingly little attention has been given to effective and practical means for the exploitation of microorganisms important to the food supply of regions where shortage of agricultural land and lack of technology are often limiting factors to economic development. The following microbiological approaches to increasing the food supply were considered in some detail: the control of plant and animal disease, the application of measures of microbiological pest control, practical utilization of the nitrogen-fixing species, the conversion of cheap agricultural wastes to food and feed supplements, and the preservation of food commodities from spoilage.

E. L. Gaden, Jr. (Columbia University), presented a highly original examination of the application of microbiology to industrial technology in the developing nations. Useful materials produced by microbiological systems on a large scale were grouped into four major categories: (i) industrial chemicals; (ii) therapeutic agents including antibiotics, vaccines, and pharmaceutical enzymes; (iii) nutritional supplements such as vitamins and amino acids; and (iv) complete food components. Industrial chemicals were not considered attractive prospects for manufacture inasmuch as adequate markets often do not exist for the fermentation products. Competition from petrochemical sources in many of these countries may potentially be quite great. Moreover, it was suggested that therapeutic products are probably best obtained by inviting foreign manufacturers to establish local or regional packaging plants and, later, primary production facilities.

Foods and food supplements are, in Gaden's view, the microbiological process areas of choice. This has been highlighted by recent successes in the conversion of hydrocarbon raw materials to high-quality dietary proteins. If these products are to be truly valuable, however, new approaches must be followed in the design of processes and plants. It is not sufficient to simply transplant the microbiological technology of the United States and Europe to the less developed areas. A variety of specific examples of capital and operating cost reductions through imaginative design were cited. The speaker emphasized the importance of sound economic judgment in deciding what is important biotechnologically in developing countries and the necessity for differentiating between industrial processes which are technically attractive and those which are economically feasible.

In a highly controversial but well-documented and carefully considered review, C. Lamanna (U.S. Army Research Office) weighed the public health microbiological needs in underdeveloped nations. In his first remarks, Lamanna seriously questioned the relevance and the limits of application of professional and technical experiences in this country to specific needs abroad. Following this initial challenge, he pointed to the current decrease in relative emphasis placed upon microbiology in public health practice with the concomitant increase in technological sophistication, a trend coinciding with the broadening horizons and ambitions of the microbiologist. In the light of the slow spread of technology in the developing nations, it becomes increasingly important for the public health specialist in the advanced countries to carefully assess the actual requirements abroad in order to avoid abortive attempts to graft one type of microbiological experience onto an incompatible economic environment.

Attention was also focussed upon the economic implications of public health microbiology. Unfortunately, microbiologists or health workers are not commonly called in as a part of economic evaluations of underdevel-

oped areas; conversely, microbiologists often fail to seek advice on the economic consequences of their actions in the medical disciplines. A number of relevant examples and cases were cited. Moreover, often the skilled professional is not needed at all, and either paramedical personnel or sanitarians could as effectively and far more cheaply perform essentially the same functions. Thus, instruction in site selection for privies and in the construction of safe water supplies may be far more important than having a microbiologist routinely estimate coliform bacteria.

The role of microbiology in communicable disease control was assessed by M. M. Brooke (Communicable Disease Center, Atlanta). Brooke placed particular stress upon the availability of microbiological competence in the developing nations and the limited facilities or resources for the training of the required specialists or technicians. Without minimizing the value of the instruction received in the United States, there can be little doubt that these domestic programs alone probably never will be adequate to meet the extent of the problem. Frequently, as speakers at the symposium reiterated, U.S. educators present to overseas trainees concepts and facts that the teachers are interested in rather than those essential to the student upon his return home. It is only human for the trainees to lean toward sophisticated subjects and direct their attention to complicated equipment, particularly if obscurity tends to be associated abroad with status. Too often the drive for education and microbiological training is not directed to the requirements of the economy, and too commonly, it was pointed out, educational experiences formulated for Americans or individuals from advanced nations have no relevance in the economic and social contexts of the student's homeland. Each of the speakers emphasized the necessity for modifications in study programs in order to fit the educational levels and the medical, agricultural, and industrial requirements of the developing nations.

It was generally agreed by the participants in the symposium and aptly stated by Lamanna that after feeding upon a diet rich in manometers, microbial genetics, molecular biology, and, as a frosting upon the cake terminating the rich repast, a measure of intellectual snobbery—a snobbery often associated with an intolerance of the efforts of those not engaged in the newest research areas—the potential microbiologist will commonly not be in a position to assess the requirements or handle the issues facing his profession in a resource-limited, economically underdeveloped area. To cope with the problems of education, research, and the development of priorities, microbiologists themselves should take the initiative in suggesting means by which microbiological efforts can contribute to international assistance.

M. ALEXANDER
Cornell University, Ithaca, New York

Heterogeneity of Antibodies

Heterogeneity of antibodies was the topic of the 3rd annual midwinter conference of immunologists held in Pasadena, California, 26–28 January 1964.

During the first session, on theoretical considerations, Talmage discussed the question of how many different gamma globulins exist. Using as an analogy the combination of the relatively few letters of the English alphabet to form several hundred thousand words, he suggested that a relatively small number of different globulins, of the order of a thousand, present a few at a time in various combinations, might be sufficient to explain the known specificity properties of immunologic reactions. The number of possible combinations (which he called families) was calculated by means of the binomial coefficient $\binom{N}{F}$, N different globulins taken F at the time. He suggested that F might be determined from experimental observations and that the order of magnitude of other parameters might then be estimated. He also discussed certain consequences of this hypothesis concerning antibody synthesis and specificity.

A theory of electrophoretic transport of interacting systems was reported by Cann. He considered reactions of the type $A + nN \rightleftharpoons B$, where A represents a protein molecule in solution and B is its complex formed by binding of n moles of an electrically neutral constituent N of the supporting medium. The assumptions underlying this treatment were that the complex migrates with electrophoretic mobility different from that of the uncomplexed macromolecular ion, and that equilibrium between A, N, and B is established instantaneously. The conservation equations were solved numerically on a digital computer for the case where N is undissociated acetic acid. The theoretical electrophoretic patterns were shown to account for the essential features of the observed electrophoretic behavior of a number of proteins in media containing varying concentration of acetate buffer at *p*H 5.7 and 4.0.

Aladjem presented a new quantitative theory of the precipitin reaction. The theory describes the interactions between multivalent antigen and bivalent antibody; antibody is considered to be heterogeneous with respect to equilibrium constants. Heterogeneity is described in terms of a multivariate probability density function ($2f$ variate, where 2 is the valence of antibody and f the valence of antigen). He presented a method for finding this function from experimental measurements of the amount of antigen-antibody precipitate and the amount of soluble complexes. Briefly, the method consists of (i) making an initial estimate of the function and computing by means of the theory of distribution of complexes; (ii) comparing the computed distribution of complexes with the experimental data; and (iii) using the criterion of least squares and iterative procedures for consecutively better approximations, finding that distribution of complexes and hence that probability density function which best fits the experimental data. The theory suggests experiments and a new method of interpretation of the result.

Other sessions were devoted to chemical investigations of heterogeneity. Singer reviewed recent data relevant to the heterogeneity of antihapten antibodies. Hapten-protein conjugates, which are usually used as immunizing antigens, are very likely heterogeneous with respect to haptenic determinants; there may be many causes for structural heterogeneity of haptenic determinants. Singer emphasized the variations in the local environment on the protein surface and suggested that the points of covalent attachment of the haptenic groups on a given protein may be different. He concluded that the observed heterogeneity of combining sites of antihapten antibodies may therefore be due to antigenic heterogeneity and that heterogeneity of antibody-combining sites against a single determinant has not yet been demonstrated. Singer also reported some observations of Eisen. To minimize haptenic determinant heterogeneity, Eisen used as immunizing an-