SOCIETY FOR GENERAL MICROBIOLOGY

THE proceedings of the inaugural meeting of this Society have been reported in *Nature* of March 17, 1945, p. 340, together with a brief summary of the address then given by the Society's first president, Sir Alexander Fleming. It is now possible to add some notes on the contents of the interesting papers read at the inaugural meeting.

In the first place, one point in Sir Alexander Fleming's address not previously mentioned will no doubt interest many research workers. Sir Alexander pointed out that team-work is not always an advantage. If, he said, he had been, in 1928, one of a team studying variation in staphylococci, he would, when a mould contaminated one of his culture plates, have "played for the side" and would have gone with the staphylococci, instead of following up the side track which led, by devious paths, to penicillin. "The lone hand has," he said, "advantages as well as the much-advertised team-work, but each in its own place."

There are many who will agree with this. Team-work can be over-emphasized, and better results, outside the field of 'applied' research at any rate, may come from the looser associations between individuals working in the closely inter-related laboratories of different branches of science in residential universities. These are teams with a difference, and perhaps the difference is often vital to discovery. It could, indeed, be argued that, if we had more residential universities of moderate size, fewer scientific societies would be required and more discovery would result. If teams were needed for organized attacks upon selected problems, these could then be the more easily recruited from groups of men who would work better together because they always had been working together and knew each other's strengths and limitations.

The importance of the constant intercourse of individuals provided by a residential university cannot be over-estimated. It was, in fact, brought out by Dr. Marjory Stephenson in her paper on "Levels of Microbiological Investigation". As knowledge increases, she said, and technique becomes more difficult, interdepartmental collaboration is "strongly indicated". Workers must be refreshed by contacts with work at other levels, and she gave a table illustrating the levels to which she referred. None of these, she insisted, is to be regarded as higher or lower than any of the others. At level *A*, represented by the early Pasteur period from 1858 onwards, and by modern work on marine, river and lake populations, on ruminant digestion and the soil, mixed cultures of organisms growing in natural environments are used. At level *B*, represented by the later Pasteur period from 1876 onwards, pure growing cultures of organisms in laboratory media are used. To this level belong the great triumphs of medical bacteriology, which resulted in the isolation in pure culture and identification of causal agents of infectious diseases, specific fermentation and chemical changes in the soil. Most medical and epidemiological bacteriology is still done at this level and almost every modern discovery must begin here; but this technique cannot reveal the mechanism by which the effects of a given organism revealed by it are brought about. At level *C*, dating from 1919 onwards, the substrate is simplified and a beginning is made with the study of the mechanisms by which an organism in pure culture produces its chemical effects. Non-proliferating cells in pure culture on chemically defined substrates are used This method gave us the early studies on intermediar processes of fermentation, on the use of poisons, inhit itors and fixatives, and also the early studies on oxida tion, reduction, deamination and so on. At level *D* dating from 1930 onwards, pure growing cultures ir highly purified media are used; this level has given us detailed studies of growth requirements, nutritiona needs, chemotherapy and microbiological assay At level *E*, beginning in 1940, cell-free enzymes and co-enzymes in pure substrates are employed. It is a development of level *C*; but the enzymes are separated and it is shown how each produces its effect on its own particular substrate. Greater precision is provided in our knowledge of fermentation processes and correlation with the chemical activity of animal and plant tissues. It is not confined to filterable enzymes. Enzymes can now be extracted from the bacterial cell itself (for example, from *Bact. coli*), and study and work of this latter kind is nowadays gathering momentum and volume.

These levels represent different methods of technical approach. The workers at each level are dependent upon each other, because facts established at levels *A* and *B* provide the starting-point for work at levels *C*, *D* and *E*; and results obtained at levels dealing with enzymes must be referred back to level *B* for epidemiological verification and animal experiment. Incidentally, Dr. Stephenson put in a plea, which many will support, for the abolition of the terms 'fundamental' and 'pure' science.

Mr. F. C. Bawden, discussing plant viruses, reminded the Society that viruses were discovered by the breakdown of bacteriological techniques, namely, by the discovery that an apparently sterile filtrate was infectious. The chief techniques of the bacteriologist are therefore not suited to the study of viruses. The protein chemist provides the most useful new techniques. Several viruses have been obtained from nucleoproteins and some are fundamentally different from organisms; chemically they are less complex and their internal structure is much less regular than that of the simplest known organisms. In their purified state they resemble constituent parts of organisms rather than whole organisms, and we may ultimately have to deal with them as such. They are favourable material for the study of mutations and multiplication, and they are attractive subjects for the protein chemist. Plant viruses provide excellent antigens for serological studies; they readily produce antibodies when they are put into animals. The study of viruses brings together workers in widely separated fields.

Prof. W. B. Brierley used the grey mould, *Botrytis cinerea*, to illustrate his discussion of problems presented by the micro-fungi. The morphology of these organisms is no guide to their physiology, for two individuals may look alike and bear the same name (for example, *B. cinerea*) and yet show very wide difference in behaviour. The unit of behaviour is the experimentalists' strain of the organism. Discussing the value of morphological, cultural and physiological criteria for the delimitation and characterization of species, varieties and strains, and the genetic and taxonomic relationships of these categories in the light of variation in the microfungi, Prof. Brierley concluded that we urgently need genetic and behaviouristic study which aims at systematic grouping on a cultural and behaviouristic basis at the level of the strain.

The importance of the general theme discussed by

Prof. Brierley is underlined by the trend of discovery in more than one field of biological research. In helminthology, for example, the existence of what are called 'physiological strains' of certain species of helminths which are morphologically indistinguishable has long been known. Epidemiologically these strains are often very important. Thus it is not possible to distinguish structurally *Ascaris lumbricoides* of the pig from *A. lumbricoides* of man; yet, when Koino infected himself with *A. lumbricoides* of the pig, he suffered only respiratory symptoms due to the migration of the larvæ to his lungs, and the strain was unable to develop to the adult stage in his intestine. It has been claimed, conversely, that the human strain of *A. lumbricoides* will not develop to the adult stage in the pig, although it may do so provided that the experimental pig's resistance is lowered by a diet deficient in vitamin A. Similar physiological strains of the sheep stomach worm, *Hæmonchus contortus*, and the gapeworm *Syngamus trachea* of poultry have also been recognized.

This subject was further discussed in the paper given to the Microbiological Society by Dr. Cecil A. Hoare, who described the morphologically identical but biologically different strains of certain Protozoa. Because many of these strains exist among the blood-inhabiting Protozoa, their host-relationships are important from several points of view. Some strains differ from each other in their host specificity; others cause different diseases in the same host; others vary in their degree of virulence to the host. These biological groups include both races which are stable and hereditarily fixed and strains which are environmentally induced and unstable, the latter being comparable to the so-called 'enduring modifications' or *Dauermodifikationen*. Biological races of Protozoa are equivalent to the 'types' recognized among the bacteria. The available data indicate that in both instances the differences between the groups in question are determined by the same factors, namely, by variation in antigenic composition. In both Protozoa and Bacteria, therefore, the distinction between biological races resolves itself into differences in the chemical constitution of their antigens. Dr. Hoare directed attention to the unsatisfactory nature of the nomenclature used for biological groups in general, and suggested that biological races should be assigned to an independent systematic position, representing a taxonomic unit subordinate in rank to species or subspecies. With this most parasitologists, at any rate, will agree. Some such measure is indeed being forced upon them by the epidemiological and other consequences of modern work on the host-parasite relationships of many kinds of parasites. No doubt the necessity for it will be even clearer and the scientific basis for it will be provided when improvements in the technique of the cultivation of metazoan parasites makes possible work at the levels *D* and *E* indicated by Dr. Stephenson.

Prof. R. H. Hopkins, discussing yeasts, pointed out that the chemist's conception of yeasts as unicellular budding organisms which produce alcoholic fermentation of certain sugars does not coincide with either the 'true yeasts' or the 'yeast-like fungi' of the mycologist. Earlier classifications of the yeasts are likely to be replaced by a classification based upon genetic work. The introduction of a synthetic medium will at least remove discrepancies due to the variable composition of media upon which yeasts are grown. Discussing recent genetic work, Prof. Hopkins suggested that from it we may expect not only a new and sound system of classification, but also perhaps improved yeasts, for industrial purposes, produced by planned breeding. While the breeding of hybrids is confined to spore-forming yeasts, new yeast types may result from mutations induced by irradiation, toxic chemical agents, such as lithium chloride, cyanides and camphor, and other means, and these methods should be applicable to non-sporing yeasts also. Among examples of this kind of work given by Prof. Hopkins was Thaysen's production of *Torulopsis utilis* var. *major* by the use of camphor (*Nature*, **152**, 526; 1943).

Dr. A. T. R. Mattick discussed some basic problems of dairy bacteriology. One of these is the resistance of bacteria to heat, which is intimately connected with the sterilization of milk equipment and with pasteurization. Cheese-making provides the problem of the lactic streptococci which are normally added to milk to produce the lactic acid necessary for the optimum coagulation due to rennet; but these streptococci produce, if they are heated above the normal cultivation temperature of 22° C., large quantities of acetic acid; and at lower temperatures other products appear. The practical importance of bacteriophage in cheese-making is considerable, for bacteriophage freely attacks the lactic streptococci used, and strains of streptococci insusceptible to local bacteriophages are needed. Dr. Mattick also described the steps by which he and Mr. A. Hirsch (see also *Nature*, **154**, 551; 1944) developed the work of Whitehead in New Zealand on the substance or substances recoverable from milk which inhibit the growth of streptococci used to start the production of acid. Mattick and Hirsch found that this inhibitory substance inhibits also, both *in vitro* and *in vivo*, the growth of some streptococci which are pathogenic to man and also that of certain acid-fast bacteria, including *Mycobacterium tuberculosis*. It is possible that this substance may be useful for the control of bovine mastitis. The work being done at the London School of Tropical Medicine upon what is apparently the same substance has already been noted in *Nature* (**155**, 584; 1945). In cheese-making, said Dr. Mattick, the moulds are also important, for they are used to ripen some of our choicest cheeses. Thus *Penicillium roquefortii* ripens Stilton cheese, but the strain used makes "a world of difference to the flavour".

Dr. G. H. Wooldridge, discussing the relationship of veterinary science and microbiology, said that veterinary science has gained much from the work of microbiology and has also contributed its share to our knowledge of microbiology. He gave many examples of outstanding work by veterinarians. To them we owe much of our knowledge of anthrax, tuberculosis, glanders, rabies, foot and mouth disease, braxy, rinderpest, the diseases of sheep caused by anærobic bacteria and other diseases which may profoundly affect human civilization. The discovery made by Griffith Evans in 1850 that surra is due to a trypanosome was the forerunner of the work of Bruce, a medical man, on nagana, a disease of horses due to a trypanosome; and Bruce applied that work to the study of human trypanosomiasis. Co-operation between the medical man Theobald-Smith and the veterinarian Kilburn in the United States discovered that red water fever in cattle is due to a piroplasm transmitted by a tick. Veterinary workers should study more intensively the host-parasite relationship and the control of the spread of disease.