The work of Roughton, Gibson and others on the kinetics of individual constants of the reactions of various ligands with the four hæms of hæmoglobin have presented us with data for the correlation of structure and function. The rapid developments in the crystallographic and chemical elucidation of the structure of hæmoglobin, which were discussed by Dr. M. F. Perutz and his colleagues, together with the work described by Gibson, promise an exciting period of fitting together information obtained from widely different approaches.

The paper by Dr. B. R. Rabin and Dr. A. P. Mathias (University College, London) discussed "The Active Site of Ribonuclease". The complete amino-acid sequence and cross-linking of this enzyme is now established, thanks to the work of Moore, Stein, Anfinsen and their colleagues. As a result of work in several laboratories it has been suggested that histidine has an important role in the catalytic activity of ribonuclease. Rabin, Mathias and their colleagues made a very thorough study of the dependence on *p*H of the velocity and Michaelis constants of the reactions of ribonuclease in a variety of buffer and solvent systems. From these investigations they came to the conclusion that two histidine imidazole groups are involved, one as acid imidazolium ion the other as a base. The two groups reverse their role in the two steps involved in nucleotide hydrolysis. Similar conclusions have also been reached by M. Panar and F. H. Westheimer in a privately circulated description of model building.

Dr. D. E. Koshland (Brookhaven National Laboratory) presented a paper on "Methods for the Study of Active Sites" which was illustrated with examples from work on chymotrypsin and phosphoglucomutase. Dr. Koshland showed that careful quantitative application of the various established methods of chemical modification of histidine and methionine side-chains can give information about the behaviour of enzyme molecules in which only one of several, for example, methionine residues, has been modified. He also described his 'all or none' assay methods, which show, for example, that chymotrypsin with one methionine group oxidized has fractional activity in every molecule and is not a mixture of fully active and inactive molecules. While histidine is essential for the activity of chymotrypsin, methionine modification reduces the activity to about one-third without change in binding, when acetyl-L-tyrosine ethyl ester is used as a substrate.

Dr. B. S. Hartley showed a slide of the sequence of amino-acid residues near the active serine of chymotrypsin and verified the prediction that from the point of view of kinetics methionine must be close to this serine residue. There was some light-hearted discussion between Prof. Neuberger, Dr. Gutfreund, Dr. Hartley and others about the value of kinetic analyses. It was agreed during the symposium that methods involving kinetics had been sensibly used as a powerful analytical tool. Clearly, kinetic analyses of reaction sequences of enzymes form a solid framework into which any proposed mechanism has to fit. The finer resolution of the electronic detail of reaction mechanisms has to be established from the direct observation and identification of transient intermediates by chemical or physical methods.

After the three main papers a round-table discussion of different aspects of sub-unit structure of enzymes was organized. Dr. H. Gutfreund introduced the subject with a statement of the terms of reference. It was proposed that the study of the physico-chemical aspects of dissociation and aggregation of protein molecules will get a new impetus now that protein structures are being solved and biological functional applications of these phenomena are being discovered. Dr. G. A. Gilbert (Birmingham) discussed some new aspects of the energetics of protein aggregation. Dr. J. R. S. Fincham (John Innes Institute) gave an account of sub-unit structure and genetic complementation, with special reference to his work on glutamic dehydrogenase. A discussion followed between Drs. F. H. C. Crick, Fincham and Hartley with questions from the audience. Attempts were made to define the structural conditions which make complementation possible and those which are suitable for experimental investigation. More space and diagrams would be needed to give a fair presentation of this part of the discussion. The time-limit was reached before the possible role of sub-unit dissociation in metabolic control could be discussed. Dr. Gutfreund had stated in his introduction that various physical mechanisms have been described which cause either dissociation into inactive units or in other systems dissociation into active units. More sophisticated mechanisms causing control by dissociation or activation by reduction or oxidation of —S—S-linkages could also be imagined. In connexion with this and the discussion on genetics he also suggested a classification of control phenomena according to the time-scale involved. First, instantaneous control, over milliseconds to seconds, which involves enzyme activation or inhibition and corresponds to the usual term 'primitive control'. Secondly, adaptive control, over minutes to days, which involves *de novo* enzyme synthesis on addition of an inducer or removal of a repressor. Thirdly, evolved control; this is on an evolutionary time-scale and involves the adaptation of tissue to a new and specialized purpose.

H. GUTFREUND

NON-DESTRUCTIVE TESTING IN ELECTRICAL ENGINEERING

TWO groups of tests used industrially constitute 'non-destructive testing'. One group verifies that apparatus in continual use is not deteriorating, and the other is used for initial testing of every article of a batch rather than of samples only. The methods which may be needed range widely and call on experience from many different fields; and it is probably for this reason that organizations exist for bringing together the people interested in these otherwise unrelated topics. The British National Committee for Non-Destructive Testing is a joint body representing physicists and mechanical and electrical engineers. At the request of this Committee, the Institution of Electrical Engineers held, in November, a conference on the applications of non-destructive testing in the electrical industry. Its theme was: "How best may the electrical engineer test the quality and endurance of his materials and structures ?"

Dr. R. W. Sillars, in an introductory lecture, stated emphatically that there was no well-defined group of physical principles underlying non-destructive testing,

which looked wherever it could for appropriate properties for test. Mere non-destructiveness is not enough; the test must be correlated with a property required in actual service, and to establish these correlations it is essential that the physical phenomena should be well understood. It is not surprising that the electrical engineer looks chiefly to electrical properties—insulation resistance, capacitance, power factor, and the like—for his indications. The list extends, however, to the use of X-rays and nuclear radiation; to the observation, by one means or another, of electrical discharges and ionization; and to the measurement of magnetic properties. Dr. Sillars ended with a challenge to find yet more properties which could be used similarly.

Forty-five papers were presented, grouped mainly according to the material or apparatus tested. Thus, there were sessions on insulating materials; on the insulation of assembled apparatus (mainly high-voltage); on cables (again mainly high-voltage); on the detection of concealed internal features; on electrical contacts; and on the measurement of mechanical vibration.

A good example of the papers was that by Dr. J. B. P. Williamson on the significance of the measurements made in the non-destructive testing of electrical joints. The joints in question are the bolted-up ones in overhead high-tension lines. True electrical contact in such a joint occurs only in small isolated regions, and the function of clamping devices is to increase the area of contact by deforming the surfaces where they do not fit. Local heating at points of contact may be intense enough to relax the stress and thereby reduce the effect of clamping. Oxidation of the heated metal then leads to failure of the joint. At first sight the problem does not lend itself to theoretical treatment, but the situation is entirely calculable if heat transfer and electrical transfer occur along the same paths—which is approximately the case.

Dr. A. Nemet and his colleagues described a combination of X-rays and xerography in which a xerographic plate is substituted for a fluoroscopic one. It is sensitive more to the gradient of intensity of radiation than to the intensity itself, so that contours and discontinuities are revealed even where the general absorption of X-rays differs in various parts of the object being examined. The pictures shown, however, appeared grainy in comparison with some excellent examples made by ordinary methods, and shown by other authors. Preference for one method or the other would depend on the type of object being examined.

Electrical discharges claimed much attention. They are not necessarily harmful, and if an apparatus is said to be free from discharges at its working voltage it may mean only that the available instruments are not sensitive enough to detect them. Discharges of as little as 2 pC. (pico-Coulombs) may be detectable, but some speakers were willing to tolerate discharges of up to 100 pC.

Four hundred people attended the conference: these included visitors from five countries overseas. They comprised physicists and both power and light-current engineers. The contact between the various groups was stimulating, and future conferences on similar lines would probably be useful.

A. C. LYNCH

THE NATIONAL RESEARCH DEVELOPMENT CORPORATION

THE annual report and statement of accounts of the National Research Development Corporation for the year ended June 30, 1961*, surveying the twelfth year of the Corporation's activities, returns to the routine pattern, but the appendix in which the position is reviewed of each of the 37 development projects being sponsored by the Corporation at the end of the year is of special interest, in view of the attention which, in the past year, has been focused on development contracts. The hovercraft project is making encouraging progress and five different vehicles embodying this principle will be undergoing trials during the next four months. The interest of the services in the *Dracone* project for flexible containers has been firmly established, and attention is directed to the Corporation's concern with the possibilities of electronic computers in the calculations entailed in basic ship design, as well as for the control of production in shipyards and to the interest found in the shipbuilding industry in such possibilities.

The Corporation's activities in the development of drugs are also extending, and, besides the arrangements made for assisting the development of cephalosporin *C*, the Corporation's experience has been invoked by the Medical Research Council and industry for setting up arrangements for technical collaboration and commercial exploitation of the anti-viral substance interferon and the common cold vaccine. Besides those already mentioned the report lists the following major revenue-earning inventions: alignment of light projectors; anemometers; anti-cancer compounds; anti-thyroid compounds; Bailey bridge; cathode-ray polarograph; collet chocks; electrically conductive films; exploders for firing charges electrically; fire and heat detectors; gyroscopic apparatus; hecogenin; Hutchinson-Scarrott pulse height analyser; ignition systems; ionization gas detector; insecticide fumer; manufacture of cheese; microdensitometer; National Institute of Agricultural Engineering potato harvester; photosensitive cells; preparation of hydrazine; Prof. R. L. Wain's selective weed killers; resonant electronic circuits; triiodothyronine; and universal joints.

The income from royalties, options and the like was £232,000 compared with £259,000 in 1959–60, which included some exceptional option payments, but recurring royalty payments increased by £10,000 to £188,000 although nearly two-thirds of this was derived from a relatively small number of inventions. The development aspect of the Corporation's work is, however, regarded as of greater importance to the nation and a severe test of the Corporation's capacity to discharge its functions. At the end of the year the Corporation was providing financial and other assistance for 37 projects, and expenditure on development was £812,000 compared with £422,000 in the previous year. Forward commitments amounted to £1,155,000 and recoveries of development expenditure to £47,000. Seven of the projects were newly under-

* National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1960, to 30th June, 1961. Pp. ii+32. (London: H.M.S.O., 1961.) 2*s*. 3*d*. net.