

enzyme-substrate complex. To be of real value any comparison of substrates should involve measurement of both the Michaelis constant (K_m) and the reaction velocity, as measures of the two stages.

Examples considered included *ali*-esterases and lipases, cholinesterases, glycosidases, lactonases, peptidases, arginase and fumarase. For the cholinesterases knowledge has accumulated which permits the representation of the catalysis in terms of anionic and esteratic sites on the enzyme surface. The high specificity of glycosidases is well known, and this is paralleled in the recently studied group of lactonases. Proteolytic enzymes may be used, thanks to their high stereospecificity, as tools for the resolution of synthetic amino-acids. Work on the behaviour of synthetic substrates as competitive inhibitors of α -chymotrypsin emphasizes the importance of distinguishing the two stages of enzyme action.

In conclusion, the importance of Ogston's concept (1948) of three-point attachment between enzyme and substrate was emphasized. This idea explains very simply the formation from a symmetrical substrate (CX_2YZ) of an asymmetric product (CXX^1YZ). Ogston has recently discussed this concept further (1958).

Dr. H. Gutfreund (Shinfield) in discussion considered further the specificity of α -chymotrypsin, in the reactions of which three stages can be distinguished ($E + AB \rightleftharpoons E-AB \rightleftharpoons EA + B \rightleftharpoons E + A + B$).

Prof. E. C. Slater (Amsterdam) dealt with oxidation-reduction enzymes. He began by considering dehydrogenases which act on hydroxy acids and more complex systems which can (indirectly) transform one enantiomer into the other (commonly but wrongly called racemases). After a brief discussion of amino-acid oxidases the greater part of the paper was devoted to stereospecificity of hydrogen transfer in the reactions of pyridine nucleotide dehydrogenases. These compounds are dinucleotides, one unit of which is the nicotinamide group which can undergo reversible oxidation and reduction at N and C-4. The elegant work of Vennesland's school in Chicago using substrates and enzymes labelled with deuterium has shown that these dehydrogenases fall into two classes; these are distinguished by the fact that they add hydrogen at C-4 of the diphosphopyridine nucleotide molecule on opposite sides. Other related work dealt with reactions involving cytochrome *c*, flavin and orotic acid.

An important extension of Vennesland's work was the preparation of stereospecifically labelled and

optically active CH_3CHDOH . Alternative mechanisms of action for a typical dehydrogenase have been suggested by Dixon and Webb in their classic textbook on "Enzymes", and by Van Eyk, Kaplan *et al.*

Finally, succinic dehydrogenase, which involves another type of stereospecificity, was introduced.

Dr. H. R. Levy (Chicago) emphasized in discussion that the stereospecificity in the reactions of pyridine nucleotides is another example of the ability of enzymes to distinguish between two identical groups, and gave further examples. Dr. W. Klyne directed attention to the important work of Prelog on microbiological oxidations and reductions of simple decalones and related compounds. The pictorial treatment of these reactions may constitute a valuable extension of Ogston's concept of three-point attachment.

Dr. G. R. Barker (Manchester) dealt with enzymes of nucleotide metabolism. He began by outlining current views on the biosynthesis of D-ribose and 2-deoxy-D-ribose; the important routes leading to ribose involve the 5-phosphates of D-xylulose and D-ribulose. The formation and fission of glycosidic bonds in nucleosides was next considered; these reactions are generally phosphorolyses and not hydrolyses. The stereochemistry of analogous chemical syntheses of nucleosides has been studied with respect to relative configurations at C-1 and C-2, and it is necessary to consider how far the stereospecificity of the enzymic reaction is attributable to the enzyme, and how far it is inherent in the nature of the reaction catalysed. The answer at present is that both factors are involved.

The formation and fission of internucleotide links in polynucleotides were then discussed. Pancreatic ribonuclease degrades ribopolynucleotides via nucleoside 2',3'-(cyclic)-phosphates to 3'-phosphates, and the steric factors involved in this and the reverse reaction were considered. Finally, the polynucleotide phosphorylases were considered; many reactions require a polynucleotide 'primer', the composition of which determines that of the polymer formed; this is a direct demonstration that the primer acts as a template.

All three papers emphasized in different ways the essentially complementary nature of enzyme and substrate and the two (or more) stage character of the enzyme-substrate reaction.

A. NEUBERGER
W. KLYNE

OIL IN NAVIGABLE WATERS

IT is now seven years since a group of representatives of the interests in Great Britain which are most affected by oil pollution formed themselves into the Co-ordinating Advisory Committee on Oil Pollution of the Sea, under the chairmanship of Mr. James Callaghan, M.P. In 1953 this Committee organized an international conference in London which called for a meeting of governments of all maritime countries to take action to prevent the growing pollution of the oceans of the world. This request met with considerable success, for an inter-governmental conference was held in 1954, at which an international convention was drawn up. This Convention came into force in July 1958, and has been ratified by the

United Kingdom, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, the Irish Republic, Mexico, the Netherlands, Norway and Sweden.

The Convention does not prohibit the discharge of waste oil entirely, but merely within certain zones, and the countries which observe the Convention represent only about one-half of the world's tanker shipping, notable omissions being the United States, U.S.S.R., Poland, Italy, Panama and Liberia. The Co-ordinating Advisory Committee on Oil Pollution of the Sea therefore decided to organize an international conference to discuss, among other aspects, how far the 1954 Convention had been effective in

diminishing the contamination of coasts and beaches, and the destruction of bird life. This Conference was held in Copenhagen during July 3-4. It was presided over by Mr. James Callaghan, M.P., with Dr. Bøje Benzon (chairman, Danish National Section, International Council for Bird Preservation) and Hr. Ekspeditionssekretær Sven Lunddahl (Secretary, Danish Council for the Prevention of Oil Pollution of the Sea) as vice-chairmen.

The meeting was very well attended, and included a wide range of interests, for among those present were representatives of government departments of transport and commerce, ship owners, port authorities, ship repairers, seamen's unions, sea-fisheries associations, local authorities, pleasure resorts, tourist organizations, hotel and restaurant associations, and conservation, ornithological, and humanitarian organizations, of many countries, together with the diplomatic representatives of nineteen nations. In addition, seven international bodies, the Inter-governmental Maritime Consultative Organization, the Food and Agriculture Organization, the Council of Europe, the International Union of Biological Sciences, the International Council for Bird Preservation, the International Union for the Conservation of Nature and Natural Resources and the World Federation for the Protection of Animals were represented.

The Conference was opened by Mr. Helge Juul, deputizing for the Danish Minister of Commerce, and the first section of the proceedings was devoted to a review of the situation arising from the 1954 intergovernmental Conference. In a paper on the working of the Oil in Navigable Waters Act, 1955, Mr. D. C. Haselgrove, under-secretary, U.K. Ministry of Transport and Civil Aviation, pointed out that the provisions of this act go beyond the basic requirements of the 1954 Convention, and quoted as an example that the sea zones in which British ships registered in the United Kingdom must not discharge oil extend beyond the zones laid down in the Convention. He paid a warm tribute to the ready co-operation of British ship owners, dock and harbour authorities, and the oil industry. Capt. K. C. Angus, Marine Regulations Branch, Department of Transport, Canada, in a report on the preventive measures taken by the Canadian Government, stated that the coasts of Newfoundland suffered most from oil pollution, and after them the eastern maritime provinces and the St. Lawrence river, but the whole Atlantic coast was subject to heavy and habitual contamination. He stressed the value of weight of public opinion, and directed attention to the fact that in many countries only a very small percentage of the population was aware of the existence of oil pollution and its serious consequences. Mr. Lester A. Giles, jun., American Humane Education Society, in association with Mr. John W. Mann, State Department, Washington, D.C., announced that an inter-departmental Committee had unanimously adopted a draft report for submission to the Secretary of State, recommending that the United States accept the 1954 Convention with reservations of a technical nature, a statement that was received with acclamation.

In a paper dealing with the working of the Convention from the point of view of British tanker and oil companies, it was recalled that since the Second World War the use of oil, and consequently the number of tankers, had increased enormously, and that ownership was now spread over a great variety of flags, some quite new to shipping, and it was urged

that universal ratification be strenuously pursued. In the discussion regarding methods of cleaning cargo tanks which followed, Mr. A. Logan (Shell Tankers, Ltd.) uttered a word of warning regarding the indiscriminate use of chemicals, and pointed out that the use of large amounts of detergent might lead to a situation even more destructive and less manageable than that arising from the original oil-sludge.

Disposal of oil waste and facilities in ports were dealt with by speakers from Denmark, the Netherlands and the United Kingdom. Mr. S. Glazenburg (Netherlands) forecast that the consumption of 134 million tons of oil by European countries in 1957 would rise to a consumption of 190 million tons in 1963 and 340 million tons in 1975, with a corresponding expected rise in refinery capacity, particularly in Western Europe. Comparatively more oil products would be exported from Western Europe, and in proportion to this increase in oil movements the problem of the disposal of oil residues would become more acute.

Speaking for 43 coastal municipalities in the Netherlands the Burgomaster of Bergen described the system of weekly reports on the condition of the beaches in Holland, which are summarized annually in order to give a general survey of the amount of oil pollution during the year. He urged that municipalities in other countries should organize similar surveys and that the information should be co-ordinated on an international scale. From the point of view of tourism it was pointed out by Mr. Eric D. Croft, director-secretary of the British Hotels and Restaurants' Association, that dollar earnings from tourism exceed the total value of exports of cars and Scotch whisky together from the United Kingdom to the United States, and he stressed the serious loss to the tourist trade presented by pollution of beaches.

Reports, on the destruction of birds by waste oil, received from Canada, the German Federal Republic, the Netherlands, Newfoundland, Poland and the United Kingdom, showed that in the Netherlands it was estimated that a minimum of 20,000 and a maximum of perhaps 50,000 birds are destroyed annually, and that 50 different species have been affected; in Newfoundland all species of sea-birds around the coasts are victims, further evidencing the great toll of sea birds which has been continuing for more than forty years.

Major Bertil Funck (Sweden) directed attention to the recurring pollution of the Baltic, especially east and south-east of the island of Gotland. Under the Convention there is an area in the Baltic, south-east of Gotland, 50 nautical miles from the island and the mainland, where discharge of oil is permitted. He emphasized that the Baltic is too small in area for oil discharge, and proposed that a resolution be passed seeking to obtain the inclusion of the Baltic as a prohibited zone for oil discharge. He also recommended that the whole North Sea should similarly be declared a prohibited zone.

The representative of the secretary-general of the Inter-governmental Maritime Consultative Organization, Kommerseraadet G.M.E. Böös, stated that the bureau functions for the International Convention for the Prevention of Pollution of the Sea by Oil had been discharged by the United Kingdom up to June 15, 1959, when the Organization took over the duties and obligations conferred upon it under the terms of the Convention. Among other responsibilities the Organization would have the duty of convening a further conference to review both the

working of the Convention, and the possibility of bringing about complete cessation of discharge of persistent oils into the sea. In resolving to take over its functions, however, the Organization pointed out to the governments concerned that, owing to other urgent tasks, it would not be possible to convene a further conference before 1961. Mr. Böös ended on a personal note, stating that though the convening of a further conference on oil pollution was not an obligation made under the Convention, he would characterize it as a moral undertaking inspired by the first resolution of the 1954 Conference. The aim of that resolution was certainly the same as the object of the present conference, namely, the complete avoidance of discharge of persistent oils into the sea, which, so far as was known, was the only entirely effective method of preventing oil pollution.

Two resolutions were adopted by the conference. The first urged that the governments of countries which had not yet ratified the Convention of 1954 should do so; that further efforts should be made to

impress upon governments and upon ship owners and ship's officers and crews the serious consequences arising from the discharge of oily wastes into the sea; that all necessary facilities be provided for the disposal of oily wastes in main ports and harbours; that technical research into means of avoiding discharges of oily wastes into the sea be intensified, and the results made widely known through the Inter-governmental Maritime Consultative Organization; that with a view to achieving the aim of total avoidance of the discharge of persistent oils into the sea, the governments and the Organization should make preparations for holding a further inter-governmental conference as soon as possible.

The second resolution, though reiterating the only effective solution of the problem, proposed in the meantime an extension of the prohibited zones for oil discharges in such areas as the Gulf of St. Lawrence, the Grand Banks of Newfoundland, and the eastern seaboard of North America, and also in the Baltic and North Seas. P. BARCLAY-SMITH

RADIOACTIVATION ANALYSIS

NEW methods of chemical analysis using techniques derived from nuclear physics were discussed at a Symposium on Radioactivation Analysis held in Vienna during June 1-3. Sponsored by the International Atomic Energy Agency and the International Council of Scientific Unions, the meeting brought together research workers from twenty-one countries for the first international conference on a subject of rapidly growing importance in many branches of science, medicine and industry.

An introductory survey by G. B. Cook (Atomic Energy Research Establishment, Harwell) was followed by reviews of the uses of activation analysis in geochemistry (W. Herr, Max-Planck Institute of Chemistry, Mainz), biochemistry and medicine (J. M. A. Lenihan, Western Regional Hospital Board, Glasgow) and metallurgy (J. Hoste, University of Ghent). P. Leveque (Centre d'Études Nucléaires, Saclay) spoke of applications in industry and G. W. Leddicotte (Oak Ridge National Laboratory) described recent developments in the United States. Several shorter contributions were also given.

Most analytical methods depend on the behaviour of electrons. Activation analysis depends on the properties of the nucleus, in particular the radioactivity induced by bombardment with neutrons or other particles. Many elements have isotopes which decay slowly enough for the assay to be done a day or two after irradiation, but work on short-lived activities can only be done close to a neutron source. A reactor is the instrument of choice for activation analysis, but more modest facilities are often serviceable. Discharge tubes using the deuterium-tritium reaction give neutron fluxes as high as 10^9 $n/cm.^2/sec.$ at moderate cost. Useful work has been done with the lower fluxes provided by radium-beryllium or antimony-beryllium sources; a recent innovation is the americium-beryllium source, which has the merit of freedom from residual γ -ray emission.

Since nearly seventy elements become appreciably radioactive after a few hours exposure inside a nuclear reactor of moderate thermal neutron flux (10^{12} $n/cm.^2/sec.$), the irradiated sample generally contains

several different activities. Fortunately many of the common matrix elements (aluminium, silicon, iron, carbon, nitrogen, oxygen) have relatively small cross-sections for thermal neutron capture. Differences in half-life and decay energy between trace element and matrix or between different trace elements in the sample are also advantageous.

The isolation of individual activities for radioactive assay may often be achieved by γ -ray spectroscopy, but a preliminary chemical separation is generally advisable, even when dealing with short-lived nuclides. When once the experimental material has been irradiated, along with a known amount of the element under investigation (to serve as a standard), the isolation may be simplified by the addition of stable carrier in any desired amount. Another useful advantage of the activation method is that contamination of reagents, often a source of trouble in the micro-determination of trace elements, need not be considered at all.

The sensitivity of thermal neutron activation analysis for trace estimation is remarkable. Many elements can be estimated at levels of 10^{-8} to 10^{-11} gm. using a neutron flux of 10^{12} $n/cm.^2/sec.$ acting on a 1-gm. sample. The detection of trace elements by this method has been useful in several industrial problems, notably the measurement of deliberate or fortuitous contamination in semi-conductor materials. Applications in the oil industry are so numerous (and so important financially) that many companies have acquired neutron sources of their own. A typical problem, in which conventional methods of analysis are not sufficiently sensitive, is the control of vanadium, which acts as a catalyst poison in cracking operations and as a corrosive agent in fuel oils.

The same element is important in a different connexion as a constituent of high-alloy steels. Here the activation method of analysis is valuable for its speed and accuracy. A 10-second irradiation, at a flux of 10^{10} $n/cm.^2/sec.$, is sufficient for analytical determinations using the isotope vanadium-52 (half-life 3.8 minutes). In prospecting for vanadium, a useful technique is to lower into a borehole a neutron