ROYAL SOCIETY

ANNIVERSARY ADDRESS BY SIR ROBERT ROBINSON, F.R.S.

ON behalf of the Fellows of the Royal Society the following telegram was sent on November 16 to His Majesty the King: "Your loyal and dutiful subjects the President, Council and Fellows of the Royal Society of London beg leave to offer our respectful and sincere felicitations on the birth of the Prince".

A message was also sent to Her Royal Highness the Princess Elizabeth, as follows: "The President, Council and Fellows of the Royal Society of London send their respectful and sincere congratulations to Your Royal Highness on the happy event of the birth of the Prince".

We have received gracious acknowledgments in the following terms: "Please convey to the Council and Fellows of the Royal Society the sincere thanks of the Queen and myself for their kind message on the birth of our grandchild.

"GEORGE R."

"We are most grateful for your kind message of congratulations.

"ELIZABETH AND PHILIP"

AWARD OF MEDALS, 1948

Copley Medal

The COPLEY MEDAL is awarded to Prof. Archibald Vivian Hill, for his outstanding contributions to the physiology of muscular processes.

Towards the end of the nineteenth century physiologists discerned a field of investigation in the physical and chemical phenomena involved in the characteristic activity of muscle and nerve; but the questions propounded could receive no satisfactory answers, chiefly owing to the lack of adequate methods. Hill, during the last thirty-five years, has applied profound mathematical skill and a flair for the design and management of delicate instruments to the provision of a sound basis for experimental and theoretical advance. In his hands the thermopile was developed into an instrument of great precision and delicacy, and conditions for its use in relation to the material studied were established so as to provide significant results.

The work on heat production in muscle has led to a picture within a framework which can accommodate many contemporary biochemical studies in a harmonious fashion. Attention has constantly been paid to ensuring the thermodynamic soundness of the systems suggested. Moreover, he was able to exploit some of his findings on isolated muscle in the course of a study of the dynamics of muscular contraction in the living body, including that in the human subject.

A natural extension of Hill's researches has enabled him to contribute notably to our knowledge of the heat-production and excitability of nerve. Previous workers failed to detect any heat-production in nerve tissues, but Hill demonstrated the definite thermal changes that are associated with the passage of impulses. These were found to be so small that no one-way contemporary chemical reaction could account for them. It would be necessary to postulate reversible changes which proceed in both directions. This was a main factor in the elaboration of the modern view that the nerve impulse results in an altered state of polarization of the essential surface membranes. The heat change which occurs after the passage of the impulses was found to be small but definite, and was related to the energy expended in the recovery of the membrane.

Hill has made contributions of great distinction in other fields, and among other topics investigated by him is that of the physical chemistry of the oxy-hæmoglobin equilibrium in the blood.

Hill has been a source of inspiration to many pupils, collaborators and colleagues, and has founded a school of research. His eminent services to physiology have been possible as the result of a happy combination of wide basic knowledge of the physical sciences, unusual skill in the design and execution of experiments, a philosophic outlook, and above all the curiosity and ambition to attack some of the most difficult problems in biophysics and biochemistry.

Rumford Medal

The RUMFORD MEDAL is awarded to Prof. Franz Eugen Simon for his distinguished researches on the properties of matter at low temperatures.

The school of low-temperature physics which Simon has created at Oxford is one of the leading centres of such research in the world and has achieved highly important results in the spheres of both theory and practice.

His great knowledge of thermodynamics was brought into service in the development of extremely simple methods for reaching the temperatures of liquid helium in the laboratory. He realized that at low temperatures adiabatic expansion of helium compressed into a small reservoir would absorb sufficient heat to liquefy the bulk of the gas and to cool the container and specimens under examination to liquid helium temperatures. Thus, provided reasonable supplies of liquid air are available, it becomes possible for any laboratory to carry out investigations at the lowest attainable temperatures with equipment which is inexpensive and simple to operate. Many other contributions to technique in this field have been made by Simon and his co-workers.

With the aid of these new or improved methods many interesting observations, with a bearing on fundamental knowledge, have been made. Outstanding problems in superconductivity, especially the part played by impurities, have been solved and the 'freezing out' of magnetic flux has been explained. The peculiar properties of liquid helium II and the transition to this state have been investigated intensively. The thermodynamics of the approach to absolute zero has been stated very clearly by Simon, and progress has been made in new methods for reaching this temperature. More recently, extended equipment has facilitated the study of the properties of atomic nuclei oriented in magnetic fields.

Simon has made significant contributions to the elaboration of devices for the separation of isotopes and to the design of plants in which thermodynamic considerations are of predominating importance.

He has aptly illustrated the thesis that, in the world of modern physics, discovery and the progress of theory follow surely on the introduction of new and powerful tools of research.

Royal Medals

A ROYAL MEDAL is awarded to Prof. Harold Jeffreys for his fundamental investigations in theoretical geomechanics.

Much of Jeffreys' well-known book "The Earth" (1924, 1929) is based on his own work, and this is especially true of the section on near earthquakes. However, the book owes its unique position not only to these original contributions, but also to the skill and insight shown in the building up of a self-consistent picture of the earth from the very diverse and apparently contradictory materials available at the time when it was written. Its great influence has been due to the width of interest and the critical skill as well as to the depth of learning of its author.

During the thirties Jeffreys' main interest was in seismology. In a series of papers he has discussed the available observations in detail and reduced the errors in the seismological time-tables by a factor of 10 or more. This work has had an important effect on our knowledge of the earth's interior and has yielded numerical information of surprising accuracy, and, for example, the radius of the earth's central core is now known with an accuracy of a few kilometres.

Some of his early papers and the book "Scientific Inference" show an interest in the philosophical basis of the scientific method and in the theory of errors. This was intensified by the difficulties he met in adequately treating the seismological travel times, to which orthodox 'least square' methods are inapplicable. The discussion of these observations led to a series of papers on significance tests, and, finally, to a book, "The Theory of Probability", in which he discusses *de novo* the whole problem of the relation between observation and 'physical quantities'. The departures from orthodoxy have not proved universally acceptable, but it is generally agreed that Jeffreys has made an important contribution to a subject on which the last word has not yet been said.

Other topics to which Jeffreys has made material contributions are pure mathematics, the origin of the moon, the constitution of the planets, hydro- and aerodynamics. In particular, he gave the first mathematical discussion of the theory of aerofoils of finite thickness.

Other less relevant examples of the catholic interests of the Plumian professor of astronomy and natural philosophy could be cited. Whether as a specialized applied mathematician or as a teacher and leader of research, the eminent services he has rendered are most widely recognized.

A ROYAL MEDAL is awarded to Prof. James Gray for his distinguished work on the mechanism of posture and locomotion in vertebrate and other animals.

In 1933 Gray, by the use of cinematography, analysed the forces involved in the progression and turning of fish with long and short bodies. The inquiry reached its full development during the last ten years with the extension of these studies to vertebrates generally. In 1936 he discussed the swimming of dolphins; raising the hydrodynamical problem of the type of water flow past an undulating body. Later he analysed the locomotion of Amphibia and of snakes. The results of this part of the work led to a discussion of the mechanics of the tetrapod skeleton which was fundamental and placed an important part of the comparative anatomy of vertebrate animals on a functional basis for the first time. His work shows that the whole body of a tetrapod must be considered as a single functional unit; changes in the tension of one muscle being accompanied by a demonstrable pattern of changes in other muscles. Gray analysed and described the mechanical problems solved by tetrapods standing and moving over ground of varying slope and smoothness; he has also analysed the neuro-muscular phenomena responsible for the evident co-ordination of action. He showed the importance of peripheral reflexes in the initiation and maintenance of swimming movements in fish. This led him to the problem of the origin of locomotory patterns. His experiments on the neuromuscular system of annelids showed the major importance of patterns of peripheral stimuli.

This work, summarized in a Croonian Lecture, was later greatly extended by demonstration of the importance of peripheral reflexes in the locomotor activities of toads. It was found that there was no positive evidence for the existence of central rhythm in these animals, while, on the other hand, the proprioceptive reflexes arising from the muscles provide an adequate basis for locomotor action.

Gray's work is responsible for an important change in the direction of research in the comparative anatomy of vertebrates. Before its appearance, skeletal structure was examined in extraordinary detail and yet little or no attention was paid to musculature and to the relation of structure to the whole system in action. More than any other, Gray has shown that comparative anatomy is certainly not a dead science.

Davy Medal

The DAVY MEDAL is awarded to Prof. Edmund Langley Hirst for his distinguished contributions to the chemistry of carbohydrates.

The first demonstration of the six-membered ring structure of an aldose derivative was offered by Hirst and Purves in their study of methylxyloside, which was published in 1923. Since then, in collaboration with Sir Norman Haworth over a number of years, and independently, Hirst has played a great part in the establishment of fundamentals in the field of carbohydrate structure. His prolific experimentation is characterized by the highest accuracy and has afforded conclusive answers to many questions of importance.

Of his joint work in the Birmingham School the following must be cited: the recognition of pyranose and furanose forms of the simple sugars, the isolation of a crystalline furanoside for the first time, and the determination of the constitution of sucrose and other disaccharides.

His independent work on optical rotatory dispersion in the carbohydrate derivatives introduced new methods of attack on constitutional problems, which were of immense service in his later work on the constitution of vitamin C. In that investigation of outstanding merit he determined the structure of ascorbic acid and studied a large number of related products. In 1933 he shared in the synthesis of ascorbic acid and in the study of the physiological activity of the synthetic vitamin.

His researches on the polysaccharides have been conspicuously successful over a wide field, and largely

because of his development of new methods of end-group assay in the determination of structure. He has applied these methods successfully to starch, glycogen, and other polysaccharides, and to him we owe many advances in our knowledge of the nature of alginic acid, the plant gums and pectic substances.

The regularities and irregularities that have been disclosed have been of equal interest and unexpectedness.

Hirst has been a pioneer in unravelling the complexities of carbohydrate architecture, and to him must be attributed much of our present knowledge of this group of such great biological significance.

Darwin Medal

The DARWIN MEDAL is awarded to Prof. Ronald Aylmer Fisher for his distinguished contributions to the study of biological evolution.

A general principle that is consistently developed in Prof. Fisher's writings is that the course of evolution is not controlled by mutation but by selection operating upon the heritable variability which Mendelian recombination supplies.

In 1928 he was the first to suggest that dominance is the product of selection operating in the gene-complex of the organism. This theory he tested and confirmed experimentally with domestic poultry and later with mice.

The implications of his concept extend beyond the dominance phenomena, and underlie the whole theory of the modification of gsnic effects through selection acting on the gene-complex. This enables a character, even when under unifactorial control, to be adjusted to the needs of the organism. To Darwin, selection was a mechanism for rejecting the bad and conserving the good ; it is largely to Fisher that we owe the view that it may mitigate the bad and enhance the good effects of the hereditary units.

The studies of Fisher on abundance and variability, the first of them undertaken in collaboration, have provided means for proving in general terms the proposition, implicit in the modern concept of evolution, that genes having minute favourable effects are in process of being spread through populations and are bringing about evolutionary change at the present time.

Fisher's methods of population analysis, developed from 1930 onwards, have made it possible to study the numerical aspect of animal communities with an exactitude previously unattainable.

The special opportunities for evolutionary study presented by polymorphism have always attracted Fisher, and he has repeatedly analysed the balance of selective agencies which may be involved. This point of view is apparent in his extensive work on human serology. He has also studied a polymorphism which had especially interested Darwin, that of the heterostyled plants, and he has extended the subject to elaborate the general theory of crossing-over in polyploids—a pioneer work of wide application.

Fisher's great contributions to statistics and to experimental design have provided tools now deemed essential to the quantitative biologist. But they are fundamental also to the experimental studies of evolution which have become so important a feature of modern biological research.

Hughes Medal

The HUGHES MEDAL is awarded to Sir Robert Watson-Watt for his pioneer researches in radio-telegraphy.

Watson-Watt has been a leader in the field of radio research since the early nineteen twenties. He began to work on the subject of atmospherics in 1915, paying attention at first to the subject of the direction of arrival. He published the first English studies on this subject, establishing the 'cum-solar' swing of the place of origin throughout the day. He developed the cathode-ray direction-finder as a means for finding the direction of arrival of individual atmospherics. This has proved of immense value in the location of thunderstorms during the War. With a number of collaborators he later studied the wave-form of atmospherics.

He has been the leading exponent of the use of the cathode-ray oscillograph for a great variety of purposes in physical research.

Watson-Watt was the leader of the earliest British work on radar, or radiolocation, as it was then called. Although the basic principles were known, enormous technical difficulties had to be overcome before radar could be developed in the form of an operational instrument. That these difficulties were, in fact, overcome was due, in Great Britain, more to Sir Robert Watson-Watt than to any other man. He is now turning with equal insistence to the peace-time applications of radar, especially in the service of civil aviation.

New Officers

Sir Alfred Egerton now lays down his office as Physical Secretary of the Society. During the past ten years he has shown a deep concern for the Society's welfare, and the utmost willingness to undertake onerous duties.

I would like to remind you of some of his many activities. In the early days of 1939 he was chiefly instrumental in the creation of a Central Register of Scientists. The significance of this action by the Society was by no means exhausted by the end of hostilities. Almost in the first month of the War he took a leading part in persuading the War Cabinet to set up a Scientific Advisory Committee. These efforts, after initial setbacks, succeeded in October 1940, and the Committee functioned usefully during the war period and was the forerunner of the present Advisory Committee on Scientific Policy. I cannot deal at length with his services in a more personal capacity, for example, to the Ministry of Fuel and Power, but we recall with gratitude his interest in the re-organisation of the Gassiot Committee and in the survey, which the Society conducted, of the needs of fundamental science after the War. He has been an ever-welcome guest overseas, and has a distinguished record as an ambassador of science. His great services to the Empire Scientific Conference of 1946 and its offspring, the Scientific Information Conference of the present year, are fresh in our memory. He worked zealously, carefully and effectively—an unusual and difficult combination—and the results will benefit every part of the Commonwealth in which scientific activity exists.

Sir Alfred will continue to act as virtual representative of the Society in several important capacities ; if I may mention just one as an example, it may be as a member of the Scientific Advisory Council for the Festival of Britain, 1951.

We shall not be able to take so much advantage of his habitual generosity as in the past, but, in case of need, we shall certainly seek his help and advice.

Prof. David Brunt has been elected as the Physical Secretary of the Society. To him we offer the most

cordial welcome and good wishes, coupled with thanks for his willingness to assume the duties and responsibilities of the office.

One of the most valuable of the traditions of the Society is our claim to exercise initiative when the circumstances suggest a new departure. So far as I am aware it has not previously been thought desirable to designate any person as honorary librarian to the Society; but the Council felt that the present chairman of the Library Committee had given services which were probably without precedent. Prof. E. N. da C. Andrade's knowledge of the older scientific literature is unrivalled, and has been freely available to the great advantage of the Society.

The retirement of Mr. H. W. Robinson as librarian occurred at the end of March of this year. He joined the staff in 1902 and assisted the chief clerk and the librarian; in 1910 he became library assistant and in 1930 assistant librarian. He has been librarian since 1935. His work for the Society and its Library has been invaluable, and we may recall with special gratitude the care he showed in the safe bestowal of our treasures in the time of danger. An earnest student of the history of science, he has paid special attention to the study of Robert Hooke, on whose life and work he is a recognized authority. In expressing our gratitude for his devoted labours, we note with pleasure that Mr. Robinson will continue to assist Prof. Turnbull in editing the Newton letters.

Scientific Information

The outstanding event of the past year in connexion with the Society has been the Scientific Information Conference. We welcomed delegates from the countries of the Commonwealth and also from the National Academy of Sciences of the United States, and from Unesco. It can thus be claimed that the whole of the English-speaking scientific world was well represented. More than half of all scientific literature is written in English, and in making such a comprehensive review of scientific information services, I think the Society may be judged to have taken a timely initiative. We were gratified by the interest shown by Fellows and the time and energy so freely given by them to ensure the success of the Conference.

The Council of the Royal Society received from the Conference many recommendations dealing with the publication of papers reporting original work, abstracting services, reviews and annual reports, library services, classification and indexing, and other relevant matters. It has been decided to implement these, so far as proves possible, with the aid of a Treasury grant, and for this purpose the Council has set up an Information Services Committee, which has just held its first meeting. I believe that an energetic follow-up of the recommendations will result in real progress. The value of the Conference itself, irrespective of these recommendations, should not be under-estimated. Divergent points of view were advocated, and many of the difficulties besetting the free and rapid communication of new knowledge were at least recognized as the result of discussion and, in many cases, were removed. The problem is a complex one, and its solution demands both due regard for traditional methods and an acute appreciation of novel techniques.

Having given this lead, the Society will now be expected to play an increasingly important part, nationally and internationally, in improving scientific information services.

It is doubtful whether the general progress of science has ever been more impressive than at the present time, and this fact emphasizes the importance of adequate outlets for the publication of the great volume of original work that is being poured out. Formidable archives are undoubtedly accumulating. To meet the demand many new journals have been founded, and here is a short list of them. *Agricultural Chemicals*, Baltimore, 1946; *British Journal of Pharmacology and Chemotherapy*, U.K., 1946; *Hungarica Acta Chimica*, Budapest, 1946; *Journal of Colloid Science*, N.Y., 1946; *Journal of Polymer Science*, N.Y., started publishing 1946; *Zeitschrift für Naturforschung*, Wiesbaden, 1946; *Acta Chemica Scandinavica*, 1947, Chemical Societies of Denmark, Finland, Norway and Sweden; *Analytica Chemica Acta*, N.Y., 1947; *Biochemica et Biophysica Acta*, N.Y.; *Die Makromolekulare Chemie*, Basle, 1947; *Food Technology*, N.Y., 1947; *Heredity*, London, 1947; *Journal of Glaciology*, U.K., 1947; *Nucleonics*, N.Y., 1947; *Acta Crystallographica*, U.K., 1948; *Acta Physica Austriaca*, Vienna, 1948; *Annali di Geofisica*, Rome, 1948; *Australian Journal of Scientific Research*, Australia, 1948; *Deutsche Hydrographische Zeitschrift*, Hamburg, 1948. Furthermore, the scientific reviews are constantly being extended in scope; one can even be thankful that they show a tendency to overlap. *Nature*, playing a more important part than ever before, is now supplemented by *Research*, while *Endeavour*, *Science Progress* and *Discovery* worthily maintain our reputation in the field of popular exposition. The Press is far better informed on scientific affairs than was the case a few years ago, and we can anticipate useful autocatalysis in the reaction between public appreciation and public information.

A Science Centre

A year ago I mentioned the formation of a committee to study the means whereby adequate accommodation for the scientific societies may be made available, and tactful reference to its activities will be found in the Report of Council. Without being too indiscreet, it is possible to provide some further information on a subject of great interest to the Fellows of the Society. In the first place, the Scientific Accommodation Committee has so far considered only the long-term problem, and it is matter for congratulation that representatives of so many interested parties reached full agreement on this aspect. It was unanimously agreed that the institution of a science centre would provide the best solution. Naturally, everybody would like to know where that will be and exactly what the proposal involves. In regard to the first point, a specific suggestion is being explored, and we hope that it will soon be possible to announce a definite outcome, such that a suitable site will be allocated for the eventual creation of a worthy science centre. It is unlikely that this site will please everybody; but we have reason to believe that a large majority will welcome it in view of the many advantages secured. In any event, we have the assurance that favourable consideration will be given by Ministers to transference to a better site, should such be found.

The course of the discussion showed that the co-operation of several scientific societies depended on that of the Royal Society, and your representatives

accepted the flattering implications, though not without some hesitation. To speak directly, that means willingness, if necessary in the general interest, to leave Burlington House and to function as the heart of the science centre located elsewhere.

The elaboration of so far-reaching a scheme is not at all a simple matter, and involves polypartite negotiations and agreements. The Fellows of the Society will be directly consulted on the major issue just so soon as it can be put to them in a precise form.

One possibly related matter may be adumbrated at this early stage, so that we may think about it.

The Report of Council mentions the reconstitution of a 'Rutherford Memorial Committee', which has various schemes under consideration. At the last meeting of this Committee I ventured to suggest that, as one aspect of the memorial, a 'Rutherford Hall' of noble design should form a part of the science centre, and this was given general approval by the Committee and later by Council.

Freedom of Science

Unfortunately, I must now turn from these roseate dreams of future glory to an incident of the present which has rudely disturbed our peace of mind. It is possible that our information is incomplete, or even inaccurate; but it is probable that we have ascertained the more important facts of the case.

I refer to the report that eminent Russian biologists have been constrained to subscribe to interpretations of the data in the field of genetics which they had previously rejected, or perhaps had thought unworthy of serious consideration. According to *Pravda*, "The Academy of Sciences forgot that the most important Principle in Science is the Party Principle". That is a forthright declaration which leaves little scope for ambiguity. The incident is evidently of political, rather than of scientific, importance, and the Royal Society is not concerned with politics.

We regret that the Academy of Sciences of Moscow has broken off its long correspondence with us. We trust that the new conditions will not seriously impede the advance of biological science, for which such qualifications as 'Western' are as irrelevant as they would be for a multiplication table. We impute no blame and express no opinion as a body, but that does not mean that we must take no cognizance of the occurrence, which may have some lessons for us, at least by way of analogy. For example, we may observe that governments are not infallible, yet must be obeyed. This reflexion should make us more than ever alert to preserve intact the prized freedom of science in our own domain. Actually no direct attack is likely here, and should the unexpected happen it will certainly not be along the lines of compelling us to espouse some particular scientific theory or doctrine. Conceivably it could take the more subtle form of control of the character and direction of our scientific work. There is immediate danger in the current deprecation of fundamental research, not of course absolutely, but relatively, in comparison with technological applications. I hope it will be the opinion of all Fellows that the Royal Society should take a leading part in upholding our ideals and in clarifying ideas on these topics, and particularly in insisting on the vital role which the highest kind of disinterested investigation must take in the life of the community. It is certainly not sufficiently realized that the body scientific can only flourish when all its organs are in a healthy condition. As in a biological equilibrium, there is a natural interdependence between pure and applied research. Pure science is fertilized by the advance of technology and *vice versa*. It would be quite consistent, though lamentable, to take up the position that we will have no more research at all, and devote our energies to the exploitation of present knowledge. But it is impossible to dissect the elements of real progress. If we isolate one of the limbs of the organism it will not grow, and will soon die.

Progress of Science

I do not propose to add more than brief comment on new scientific discovery. It will be conceded that the great privilege of addressing the Fellows of the Royal Society is not without its own peculiar embarrassments. For example, I have recently delivered two lectures summarizing results of many years in my own field of work. If I venture on other ground I shall be speaking as an amateur to some of the leading specialists in the world.

Without attempting any kind of assessment of values, or any completeness of survey, I will mention a few things that have been brought to my notice in recent months, often as the result of casual conversation.

Two years ago I referred to the very great value of spectroscopic methods for the study of complex molecules of organic compounds. Since that time there have been striking applications of both ultra-violet and infra-red absorption measurements which have solved some otherwise intractable problems. But one difficulty that threatened to impede progress was the management of minute quantities of material, especially in the solid state.

Dr. C. R. Burch, Warren Research Fellow, has built a reflecting microscope which is perfectly achromatic, and this has now been harnessed to an ultra-violet spectrometer by Barer, Holiday and Jope, and to an infra-red spectrometer by Thompson, Barer and Cole. In the latter case the spectral range 1–14 μ can be covered, and the results are identical with those obtained with larger specimens in more usual apparatus.

The spectra of single biological cells or single crystals weighing less than 10^{-7} gm. have been measured. Polarized infra-red radiation has also been used, and this promises to open up a new method for study of biological specimens, such as muscle fibre, in which orientation exists, as well as new possibilities for crystal analysis. This arises from the relations existing between absorption and orientation of the vibrating groups, whence the angle between certain characteristic bonds and the crystal axis can be determined. Measurements have already been made with minute quantities of new antibiotics and similar substances in connexion with their identification, or the diagnosis of their molecular groups.

The importance of this advance for organic chemists and biochemists cannot be exaggerated. It will surely lead to the routine study of the infra-red absorption of many new compounds, and the relation between the spectra and constitution will therefore become still better known. As the method thus increases in power the demand for its help must also become more insistent.

I am most grateful to Dr. H. W. Thompson for advance news of this remarkable development in

technique, details of which will be published in a short time. Soon we shall all be repeating the wistful inquiry that ends Barrie's play: "How much do they cost—those machines ?"

I cannot pretend to be competent to discuss applied mathematics, astronomy, or physics; but it is obvious even to the uninitiated that great advances are being made in our knowledge of the mesons and of nuclear fission.

Sir George Thomson, in his Bakerian Lecture, gave a fascinating account of the evidence provided by study of the effects of cosmic rays on atoms, while Prof. E. O. Lawrence, with the aid of his new synchrocyclotron, has been able to produce mesons in the laboratory for the first time.

Prof. E. A. Milne's forthcoming new book will evoke lively discussion, for he tells me that acceptance of his theoretical system involves the assumption that Planck's constant h varies secularly with the time.

On the technical side we hear from America of a new type of valve, a crystal of germanium, which can be made to function as an amplifier.

Coming nearer to my personal interests, the chemists and biologists of Parke, Davis and Co. are to be warmly congratulated on their discovery and investigation of chloromycetin, a new antibiotic which has proved to be highly effective against scrub-typhus and certain analogous infections. The constitution of chloromycetin has not yet been disclosed; but it is said to be known, and apparently the substance has been synthesized. It makes possible the first satisfactory chemotherapy of a disease caused by a Rickettsia, and opens up the possibility of the control of virus diseases more generally.

Another discovery of vast medical, agricultural and biochemical interest arises from the isolation of the intrinsic anti-pernicious anæmia factor from liver. This brilliant consummation, a further triumph of modern chromatography, has been reached by A. Lester-Smith and his colleagues in the Glaxo Laboratories and by a team of chemists of Merck and Co. (New Jersey), led by K. Folkers. The red crystalline substance contains cobalt in a co-ordination complex which has a molecular weight of about 1,600 and probably includes three atoms of phosphorus. It is proposed to call the factor vitamin B_{12} and it is one of the most physiologically active of known substances, a dose of one microgram daily being fully effective therapeutically.

The picture is very quickly being filled in; we heard from Dr. Marston quite recently of his outstanding researches on the cobalt requirements of sheep. A defect of cobalt in the soil leads to sickness and stunted growth with anæmia. Other recent and related work by Drs. Tosic and Mitchell at Aberdeen concerns the assimilation of cobalt by micro-organisms. We may be sure that knowledge of the constitution of B_{12} will suggest other correlations, perhaps with nucleotides, perhaps with folic acid, which will be of vast significance. The molecule is not especially complex by modern standards and its structure can be determined, provided sufficient effort is made. If I am reminded that we are unable to synthesize penicillin, the reply would be that the problems are not comparable. Analysis of substances of this degree of complexity must nowadays always succeed, whereas synthesis may present a difficulty of a different order altogether. The trouble will be to get enough of the factor for investigation by ordinary methods, and this is a good illustration of the value of micro-physical devices. I am told that the infra-red absorption spectrum, determined by the new technique previously mentioned, has already given valuable information, confirming the presence of PO, NH and OH groups, and indicating absence of aliphatic CH, but probable presence of aromatic CH as in benzene or purines.

We seem to be on the verge of great discoveries in another field perhaps not entirely unconnected with the last-mentioned, namely, the problems connected with the effects of chemical substances on cell growth, including malignancy. There cannot be said to be any satisfactory treatment of cancer by chemical means, though various agents exert a beneficial effect in special cases. Such are stilbœstrol, testosterone and the so-called nitrogen mustards. Of these, stilbœstrol has the best claim to be regarded as a curative agent in a proportion of cases, and the halo-alkylamines ameliorate the condition of the patient. In the United States, Dr. Rhoads and his colleagues have paid much attention to antagonists of folic acid. These are synthetic compounds the molecules of which are planned to resemble those of folic acid. Several of them have been found to exert an inhibitory effect on the bone marrow, producing anæmia, which can be reversed by folic acid. Similar antagonism is observed with bacteria, and furthermore Hertz has reported that certain of these substances inhibit the action of stilbœstrol on the oviduct of the chick.

One of the most promising of the substances is called A-methopterin. This is folic acid with an amino-group replacing hydroxyl and a methyl group replacing hydrogen, quite a close analogue. The substance is anti-folic, anti-œstrogenic, and it has a definite inhibitory effect on the growth of tumours in laboratory animals, as well as of malignant cells in tissue culture. Folic acid is regarded as necessary for the growth of all cells, and the hope is to find a substance of low toxicity which will antagonize this factor to the level necessary to immobilize the more sensitive malignant growth without serious detriment to normal cells. It is known that laboratory work has encouraged clinical trials, but the results have not yet been disclosed.

Dr. T. B. Heaton and my wife have published a preliminary account of work which finds its origin in observations made many years ago on a growth-inhibiting constituent of yeast (Heaton, 1926). This was a differential growth-inhibitor affecting the connective tissue cells but not the epithelia of cultures *in vitro*.

They have now prepared carbohydrate material from wheat middlings which is either itself active, or more probably contains an active principle. This produces retrogression of the implanted Walker carcinoma in rats.

It is decidedly interesting to find such a substance in a foodstuff; it may even be a vitamin. Since in some of the earlier experiments the material had been held at a low *p*H, the formation of hydroxymethyl-furfuraldehyde was a possibility, and it was known that many aldehydes possessed growth-inhibitory properties. It was found that hydroxymethylfurfuraldehyde, or better its polymeride, also caused the retrogression of the tumours. The connexion, if any, between these findings is not yet clear.

At the Chester Beatty Research Institute, Dr. A. Haddow and his colleagues have tested the effects on normal growth of a number of pyrimidine derivatives. The developments have sprung from experi-

ments designed for other purposes—and the sequence is of more than passing interest. It started with the yellow enzyme and a series of experiments designed to test the effect on growth of a series of synthetic analogues of the flavins.

Administration of 9-phenyl-5 : 6-benzo-*iso*-alloxazine to albino rats was accidentally, and most unexpectedly, found to produce an orange-yellow pigmentation of the hair (Haddow, Elson, Roe, Rudall and Timmis, 1945). Pursuing this curious observation, other coloured substances of a similar type were tested, and among them xanthopterin, the butterfly wing pigment, first isolated by Wieland and Schöpf in 1925. This did not colour the coat but produced a significant enlargement in the size of the rat kidney. It was an actual growth of the organ due to a great outburst of cell division in the kidney tubules.

In the course of still another research, that on the carcinogenicity of many styrylpyrimidines (Haddow and Kon), it was found that two substances of this group closely allied to xanthopterin in structure had the same effect in increasing the growth of the kidney. This cannot be mere coincidence and proves that the effect is a primary one of xanthopterin and the related pyrimidines on the cell. The phenomenon has been observed in the rat, mouse, *Peromyscus*, the rabbit, hamster and guinea pig.

Now xanthopterin is of natural occurrence in the kidney and it is possible that it is present as a growth regulator. Its structural relationship with folic acid will not be overlooked. Haddow and his associates feel that it is at least as important to study the means by which normal growth is so delicately adjusted as to inquire directly why the malignant cell is unregulated.

There are further experimental foundations for these ideas which lead Haddow and his collaborators to surmise that the co-ordinated growth of the normal tissues may depend upon the supply of essential substances from an external source and that, contrariwise, malignant cells may have acquired the power to synthesize these essential substances, or their equivalents, themselves. Such suggestions are fully consonant with all that we know of the subject as a whole and give a new prospect for the chemistry of growth and differentiation.

I am much obliged to Dr. Haddow for kindly acquainting me with results and ideas which are not yet published in full and for permission to mention them to-day.

I would not like to leave this subject without an incidental reference to Berenblum's significant discovery of sensitization of tissues to the action of carcinogenic agents. The constituents of croton oil, for example, directly or indirectly, prepare the ground for a carcinogenic hydrocarbon in a remarkable manner. The underlying biochemical processes may be hard to bring to light; but the effort to do so would doubtless be repaid with interest.

As a drama like that of the pyrimidine group unfolds we can look back on the steps of the pioneers and be thankful that they selected the paths which led into such rich territory. But it often appeared to contemporaries that they were wandering into a barren wilderness. Whatever makes Hopkins think that there can be any possible interest in the pigments of butterflies? Why does Windaus waste his time and talent on that impossible substance cholesterol? I have heard those actual questions asked in past years and would invite consideration of the answers that can be given to them now.

Another thought arising from recent progress is that the world of biochemistry, though of vast extent and interest, is finite, and we are beginning to sense the existence of its boundaries. We seem to encounter the same thing more often than might be expected; coincidences are indeed of frequent occurrence.

An example has already been mentioned and another is the recent discovery that the photodynamic colouring matter of St. John's wort, hypericin (Brockmann *et al.*, 1939, 1942; Pace and McKinney, 1941; Dhéré, 1939, 1943) is closely allied to a pigment of the Aphididæ, erythroaphin, studied by A. R. Todd and his collaborators at Cambridge (1948). Further, these substances are related to a mould pigment, oxypenicilliopsin, isolated by Oxford and Raistrick (1940). The pigments are *bis*-anthracene derivatives of some kind and it is surprising to find these little investigated and highly characteristic substances so widely distributed in Nature.

A notable coincidence in my own field of work arose very recently from a theory of Woodward regarding the course of the synthesis of strychnine in the plant. He advanced what seemed at first the fantastic idea that a benzene nucleus, originally that of dihydroxyphenylalanine (or tyrosine), suffers fission so as to give two oxidized chains which enter into further transformations.

Transferring this mechanism piecemeal into an entirely different group of alkaloids, it was found to predict that constitution of emetine which can now be experimentally demonstrated to be correct. I am glad of this opportunity to say that I was unaware until quite recently of parallel, independent work by Dr. H. T. Openshaw on the constitution of emetine. This was submitted for publication some months ago and includes the establishment of one detail of the structure not fully proved by the work of Späth, of Pailer and of Karrer. A few months ago no connexion whatever could be discerned between strychnine and emetine, they seemed poles apart. Now at one stroke they are connected by recognition of a common and remarkable type of biogenesis.

A PROPOSED INSTITUTE OF BIOLOGY

By Dr. J. F. DANIELLI

INSTITUTES or analogous foundations have rendered great services to physicists, medical men, engineers, chemists, anthropologists and many other professional groups. No such foundation exists to serve the needs of biologists. Recently the Biological Council, consisting of representatives of nineteen different biological societies, was asked by a number of these societies to examine the possibility of forming an Institute of Biology. In a preliminary investigation the views of a number of representative biologists were obtained, and information was also available from the Institute of Biology recently established in the United States under the auspices of the National Research Council.

There are two aspects of an Institute which are of general interest: on one hand there is the daily life