

reflexions on the profile hundreds of miles long, so that, apart from the fact that several independent results were obtained, Pratt's value must be accepted rather than the much deeper American figure.

A short refraction line at the South Ice station, 300 miles inland from the main Shackleton base, showed that the velocity in the 80-90 metre thick surface layer varied from 0.5 to 3.96 km./sec., in agreement with observations in other parts of the world. An interesting point emerged from the refraction results. The line ran over undulating snow, but there was no sign on the record of the surface variations in height. It must be assumed, therefore, that the troughs of the undulations consist of lower-velocity material than do the humps. Some shots fired on the ice-shelf yielded reflexions from the sea bed, but not from the bottom of the ice. This is a familiar experience with Antarctica geophysicists, but Pratt has pointed out that a unique solution of ice thickness can be obtained from the travel time of waves reflected from the sea-bed.

Dr. Lister's simple method of following the accumulation of snow by laying down strings at fortnightly intervals and afterwards checking their profile by digging was supplemented by counting the years indicated in the stratification caused by seasonal changes in climate. Pits and drilled cores at South Ice enabled Lister to look back to the year 1895, and across the continent twenty bore-holes reached back twenty years and sixty more were deep enough to include the deposition of the past five years. Along the central portion of the traverse followed by the Trans-Antarctic Expedition the deposition-rate was found to be fairly constant at 8-9 cm. water equivalent a year. This is rather higher than the 6 cm. found by the American observers at their South Pole Base, but may be accounted for by the fact that much of the expedition's route followed a trough in the surface topo-

graphy. The accumulation increases to about 25 cm. water equivalent at the edges of Antarctica, and Lister calculates a deposition-rate of 13.1 gm./cm.²/year as an average over the whole continent. The wastage is assessed at 10.1 gm./cm.²/year mainly made up of 5.0 melting, 4.0 icebergs, 1.0 evaporation and 0.1 deflation. It appears then, from the present-day observations, that there is a net gain of ice, a result (ignoring any time-lag) opposite to that indicated by the negative gravity anomaly. During the discussion it became apparent that the figures for melting and for loss by breaking off of ice-floes might be changed in the light of other observations, but in any event the present material balance was one that applied to decades rather than to the thousands of years (at least) during which changes in the ice-cap, sufficient to account for the gravity results, would be expected to take place.

Some of Lister's observations made it clear that precipitation favoured hollows rather than the crests of undulations, and that there was a migration of the crests with time. Nye raised the question of whether the presence of the undulations might affect the travel of the whole sheet, because their presence implies a big change of slope over a distance larger than the thickness of the sheet. There was clearly a mechanism here which could give local fluctuations of velocity and hence it would be very difficult to make sense of any isolated measurements of ice-sheet velocity. It is possible that the movement of the crests is only apparent, and is caused by the erosion of hard wind-blown snow at the crests of the undulations, with a simultaneous build-up of a new crest above the snow-filled troughs. Whether they are caused by aerodynamic or by hydrodynamic means, the undulations and sastrugi deserve further attention, and the results that have been collected recently should call forth a new advance on the theoretical side.

T. F. GASKELL

THE NATIONAL SCIENCE FOUNDATION

REPORT FOR 1957-58

MORE than half the eighth annual report of the National Science Foundation for the year ended June 30, 1958*, is occupied by appendixes listing the membership and staff of the Board, its committees and advisory panels, grants for basic research, fellowship awards, publications of the Foundation and others resulting from research grants and fellowships. The latter now runs to some 1,315 items, compared with 850 in 1956-57, and is arranged according to the several divisions of the Foundation. Fellowship awards during the year totalled 1,527, amounting to about 5.6 million dollars in value. Of these, 408 were in the biological sciences, 314 in physics and astronomy, 306 in chemistry, 206 in mathematical sciences, and 193 in engineering. Of the total, 1,084 were predoctoral, 227 postdoctoral and 216 in the science faculty programme for improving the quality of science teaching. Grants for research amounted to more than 19 million dollars, and of these 1,120 grants, 605, totalling 8,881,130 dollars, were in biological and medical sciences; 466 grants, totalling 9,507,825 dollars, in mathematical,

physical and engineering sciences; and 49 grants, totalling 725,950 dollars, in social science. During the year, 190 scientists received grants, totalling 113,220 dollars, in support of travel to international scientific meetings, and the Foundation sponsored and provided partial support for thirty-four scientific conferences and symposia.

Reviewing the support given to basic research in the sciences, in the Division of Biological and Medical Sciences, the report stresses the clue to the control of tuberculosis provided by the study of the honey guide, a wax-eating bird found primarily in Africa, from the intestinal tract of which a wax-splitting bacterium was isolated that contains a protein which inhibits the growth of the tubercle bacillus in tissue cultures. Doubts have been thrown on the basic genetic axiom regarding the individuality of genes by the discovery that the gene in corn which produces colour in the kernel can be permanently modified by bringing it into combination with a particular partner gene. Results have been obtained suggesting that some plants may operate as a well-knit group or unit having a common physiology, and it has also been found that nerve growth factors similar to the tumour factors are present in the

* National Science Foundation. Eighth Annual Report for the Fiscal Year ended June 30, 1958. Pp. xv+246 (8 plates). (Washington, D.C.: Government Printing Office, 1959.) 1 dollar.

salivary glands of the mouse and rat, in snake venoms and in the venom of the Gila monster. Sex hormones have been found to control growth in the more primitive plants such as water moulds and ferns, and protein-like material has been produced by application of heat (170° C.) to mixtures of amino-acids. The discovery of a method for introducing sulphhydryl and disulphide groups into proteins and protein-like molecules has permitted the physical, chemical and physiological characteristics of proteins to be altered at will. Deoxyribonucleic acid has been synthesized by adding an enzyme obtained from bacteria to a previously prepared mixture of nucleic acids, and in studies of the growth of *Brucella abortus* and *Diplococcus pneumoniae* addition of a mixture of bacterial deoxyribonucleic acid and deoxyribonuclease to growing cultures of these organisms had striking effects upon the selective establishment of virulent cells in an initially non-virulent population.

In the Division of Mathematical, Physical and Engineering Sciences, the report directs attention to the cloud-seeding experiments near Tucson, Arizona, where radar observations indicated that precipitation from larger seeded clouds was greater than from similar unseeded ones; to the development of a neurological instrument which enables ultrasonic waves to be used to cut out tiny regions of the inner brain without disturbing the inner structure; to a laboratory model of a stream which, used in conjunction with a high-speed motion-picture camera, has clarified the motion of individual sand grains in a flowing stream; to the laboratory confirmation of the hypothesis that pegmatites are relatively dry melts (magmas) and are closed physico-chemical systems, and that the giant crystals are formed during a 'second boiling'; to the development of

techniques whereby free radicals are formed and immediately trapped on cold surfaces (-424° F.): to the measurement of variations in the pull of gravity in Utah and Eastern Nevada which have permitted charting the major contours of the buried bedrock and given important clues to the configuration of the fault blocks and other structural patterns; and to the total stereospecific synthesis of several antibiotics and the production of a substance identical with natural rubber in physical characteristics by careful control of the spatial relations of the groups in the molecule.

In the Social Science Research Programme, electronic computers have been used to determine more quickly and sensitively the stages of the business cycle and to separate significant trends from temporary irregularities.

Besides the surveys made by the Foundation of the research and development effort of the United States and a brief report on the Conference on Research and Development and its Impact on the Economy called by the Foundation for May 20, 1958, the report summarizes the Foundation's activities in the International Geophysical Year. Apart from the fellowship programme already noted, the report deals at some length with the work which the Foundation is doing to improve science education. For this purpose the Foundation received a supplemental appropriation of 9 million dollars, which was used for the award of additional fellowships and to assist the attendance of more high-school science teachers at the summer institutes, of which 126 were held in 1958 in forty-seven States and three Territories. For 1959 the appropriation for the Foundation's educational programmes was increased to about 60 million dollars, but the educational implications of the report are discussed separately.

ENERGETIC COUPLING IN THE RESPIRATORY CHAIN

By DR. POUL E. GLAHN and DR. SIGURD O. NIELSEN

Carlsberg Laboratory, Copenhagen

THE important part played by the energetic coupling between substrate oxidation and adenosine triphosphate (ATP) synthesis (oxidative phosphorylation) in the energy economy of animal cells is well known¹. The demonstration, *in vitro*, of energetic coupling between oxidation and reduction of carriers in the respiratory chain and adenosine triphosphate synthesis at present requires particulate preparations containing either mitochondria or multifunctional mitochondrial fragments. Experiments with such preparations indicate that the oxidation of reduced diphosphopyridine nucleotide (DPNH) by ferri-cytochrome *c* is coupled to the synthesis from adenosine diphosphate and free orthophosphate (P_i) of two moles of adenosine triphosphate per mole of reduced diphosphopyridine nucleotide oxidized^{2,3} and that the oxidation of ferri-cytochrome *c* by molecular oxygen is coupled to the synthesis of at least one mole of adenosine triphosphate (two moles being energetically possible) per two electrons transferred^{3,4,14}. The detailed mechanism of this energetic coupling in the respiratory chain is essentially unknown in contrast to the coupling at substrate level⁵ and its elucidation constitutes a major problem of contemporary bio-

chemistry. In view of this fact and the great difficulty of experimental work with multifunctional, highly organized, and relatively ill-defined particles, it is amazing that no more speculation has appeared in the literature concerning the chemical nature of the coupling reactions, in particular the primary ones involving oxidation-reduction of respiratory carriers. It would appear that 'educated guesses' at the possible organic chemistry of these primary coupling reactions involving known or hypothetical respiratory carriers might be useful in the planning of new experimental approaches. The present article presents some ideas on the primary coupling reactions at all three phosphorylating sites between oxygen and reduced diphosphopyridine nucleotide. We feel less hesitant about publishing these views, which may eventually turn out to be wrong, because it has been possible to consider the primary coupling reactions at all four phosphorylating sites, including those at the cytochrome a_3 - and substrate-levels, from a unified point of view.

The total number and location of carriers in the respiratory chain are still unknown, although it is generally agreed that diphosphopyridine nucleotide