

been greatly increased, some of the immediate precursors of nucleic acid have been determined, and an upper limit of three seconds established as the time required for protein synthesis, most of the work being carried out with *Escherichia coli* but some with *Torulopsis utilis*. Radioactive tracer studies were carried out with *Hydra littoralis* and carbon-14 glucose. Amino-acid tracers have been followed from a subcutaneous injection through the blood into cellular pools of free amino-acids and into the protein of new-born mice. During the year application of the membrane-filter technique to the problem of nucleic acid synthesis in *E. coli* demonstrated the formation and utilization of metabolic pools of precursors, and indicated the part played by phosphorylated intermediates. A comparatively full account of this work is given in the Departmental report, while that of the Geophysical Laboratory, which had a particularly stimulating and productive year, includes detailed accounts of the work on phase equilibria at high pressure, in which an apparatus has been constructed capable of achieving pressures of 60,000 atmospheres at about 700° C., with which studies have been made of minerals, such as might exist deep in the Earth, of the stability of hydrous iron silicates on primitive magmas, and of the age of rocks and minerals in a co-operative programme with the Department of Terrestrial Magnetism which has shown that concordant ages for potassium-40/argon-40 and rubidium-87/strontium-87 are obtained when measured on ancient minerals. Other work, which has shown that amino-acids such as glycine, sarcosine, alanine and  $\beta$ -alanine can be formed from a variety of primitive atmospheres, work on sulphide systems, which has shown that pyrite ( $\text{FeS}_2$ ) is stable below 815° C. at 5,000 bars, and work on feldspars and feldspathoids, on statistical petrology, and on the routine absolute measurement of beta radioactivity at low level from thick samples, in which a general relation was discovered between the beta-absorption coefficient and the maximum energy of the radioactivity, is also described in detail.

The Department of Plant Biology has obtained evidence suggesting an active participation of carotene in the photochemical action of chloroplasts and, by a simple method developed for recording the absorption spectra of small amounts of pigments in living leaves, an unsuspected intermediate form of chlorophyll was discovered. Further progress was made in the work on the purification and characterization of the protochlorophyll-protein complex from leaves grown in the dark, and it has been found that the frozen and dried, partly purified, proteinaceous particles can transform the protochlorophyll to chlorophyll when illuminated in the dry state just as readily as when dissolved in water. The changes of absorption in *Chlorella* induced by light have been correlated with the ability of this alga to emit light, and three different types of active spectra have been found in studies of the effectiveness of light of different wavelengths in orientating the swimming of dinoflagellates. Data for a description of the behaviour of new types of hybrid grasses are expected to be complete in the next three years, and a comparative study of fifteen apomictic lines derived from a single first-generation hybrid between *Poa ampla* from Kahlotus, Washington, and *P. pratensis* from Athabasca, Canada, indicate that a very wide range of selection is possible among the progeny of a single new, sexually reproducing hybrid. Stable apomictic derivatives from the combination *P. ampla* from the Palouse Prairie

region and *P. arida* from Nebraska have been produced for the first time.

In the Department of Genetics new experimental evidence was obtained that large, functionally intact pieces of viral nucleic acid may pass from parent to offspring phage, while genetic analyses, by the transduction method, of short regions of the chromosome complex of the bacterium *Salmonella typhimurium* have shown that mutations occurring at different sites of a single locus, although they affect one function primarily, may produce mutants differing considerably from one another in various properties. Several different controlling elements in the maize chromosome complement have been identified, and electron micrographs of salivary glands of *Drosophila* and of dividing cells of *Tradescantia* have been interpreted as indicating that the patterns of organization of their chromosomes represent a hierarchy of pairs of helically disposed chromonemata. Studies of the effect of ribonuclease, ethylenediaminetetraacetate and calcium chloride on *Drosophila* and onion roots indicate that any agent which disrupts the normal metabolism of the cell can lead to instability reflected in modification of chromosome form and behaviour. The stage of development of the salivary-gland cell in *Drosophila* at which 'blebbing' of the nuclear membrane into the cytoplasm occurs has been correlated with the assumption of a new function by the cell. A mathematical analysis of the dynamics of bacterial populations was completed.

In the Department of Embryology exploration of the chemodifferentiation of the heart-forming areas of the early chick embryo demonstrated that antimycin A acts as a specific inhibitor of heart formation, while studies on the mechanism of the spacing of blastocysts along the rabbit uterus showed that the spacing was due to the delicate interaction of two mechanisms dependent on progesterone. Studies of the nature of the fluid of the rabbit oviduct were concluded, progress is reported in the analysis of the vascular changes in the menstrual cycle in the rhesus monkey, and further investigations of the vascular patterns of the placenta indicate that maternal blood enters the intervillous space from small blood vessels, the spiral arterioles, under a head of maternal pressure. The first phase of a study of the effects of reserpine on the reproductive cycle of the rhesus monkey was completed.

## CHEMICAL RESEARCH LABORATORY REPORT FOR 1956

THE wide variety of research now in hand at the Chemical Research Laboratory is described in a report\* entitled "Chemistry Research 1956", published by H.M. Stationery Office for the Department of Scientific and Industrial Research. The investigation of corrosion problems has been continued. It includes research into the possibility of improving the efficiency of corrosion inhibitors for use in anti-freeze mixtures for engine-cooling systems, the study of the rapid pitting of boiler tubes in marine boilers, which it was found could be prevented by the addition

\* Chemistry Research 1956: The Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory. Pp. vi+86. (London: H.M. Stationery Office, 1957.) 4s. net.

of small amounts of copper to the steel used in the manufacture of the tubes, the discovery that the corrosion of buried pipes and underground fittings was due to the bacterial reduction to sulphide of large amounts of sulphates in the soil, and the corrosion of fuel pumps in aircraft by sulphur compounds, produced by bacterial reduction of sulphates in water, finding their way into petroleum above the water storage tanks. There were also purely scientific investigations of corrosion.

Work on the separation of a number of rare earth metals by the use of columns of ion-exchange resins yielded important results improving the understanding of the process and in particular the control of the various factors involved in a separation. Improved techniques have made possible better separations of light-earth fractions than have previously been achieved. A large-scale apparatus capable of handling kilogram quantities of rare earths is now being used for this work. A simple but very effective method for the purification of mercury is described; investigations of the purification of elements of interest as semiconductors are in progress, and reliable methods of measuring very small amounts of impurities in such materials are under investigation.

Work on the extraction of uranium and thorium from minerals and ores is being done on behalf of the

United Kingdom Atomic Energy Authority, and new recovery methods are being studied. A great increase in the use of radioactive tracer techniques has taken place during the year.

Much valuable work has been done on the properties of pure organic compounds and the mechanism of organic reactions. Determinations of heats of combustion are being carried out in collaboration with the National Physical Laboratory. Two principal lines of investigation into high polymers are the study of the structure and permeability of polymer films, and work on the fractionation of polymers and the determination of their molecular weights. Basic research into the ion-exchange and allied properties of cross-linked polymers is being continued. The preparation of ion-selective polymer films is of particular industrial importance in the treatment of brackish water and also of effluents.

It will be seen that the Chemical Laboratory is actively engaged on a large number of researches of both purely scientific and industrial interest. The report is by no means a bare summary of this work but is an interesting and useful source of much information which research workers will be pleased to have in such a compact form. The cover of the book shows a portion of the periodic table, and, of the atomic weights in it, fifteen differ from the values in the 1955 international table.

## AUTONOMOUS ACTION OF LETHAL MUTATIONS INDUCED IN THE GERM CELLS OF *DROSOPHILA MELANOGASTER* BY 2-CHLOROETHYL METHANESULPHONATE

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**I**N young *Drosophila* males the sperm to be utilized for successive broods of offspring comes from successively earlier stages of spermatogenesis in the testis, from mature sperm to early spermatogonia. Following treatment with a mutagen, the pattern of effect measured in successive broods will be a reflexion of the sensitivity of the various germ cell stages to the action of the mutagen.

The mutagenic properties of 2-chloroethyl methanesulphonate (*C.B.* 1506) have been studied by Fahmy and Fahmy<sup>1</sup>, who found that the ratio of sex-linked recessive visibles to lethals rises in the later broods, from 0.35 in broods utilizing sperm from post-meiotic cells to 0.6–1.0 in broods utilizing sperm from pre-meiotic cells at the time of treatment. Three possible explanations of the phenomenon may be listed.

(1) The mutagen may have some specific action on the visible loci concerned. This presupposes some common chemical properties of the visible loci as a whole as compared to the lethals as a whole and also leaves unexplained the difference between pre- and post-meiotic cells.

(2) The mutagen may induce more 'point mutations' in the pre-meiotic cells. This would produce

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an increase in the visible to lethal ratio, since in larger areas of chromosomal damage, the locus with the earliest action<sup>2</sup> would be the definitive one, masking the presence of others, in this case, visibles.

(3) Essentially the same proportions of the different mutations may be produced in all cells; but some of the lethals induced in the pre-meiotic cells may act autonomously, killing the cell before it produces sperm, thereby increasing the observed proportion of visibles.

This present investigation was undertaken to examine the last possibility, that the increase in the ratio of visibles to lethals was produced by adverse selection in the germ line against lethals functioning autonomously.

Approximately 0.2  $\mu$ l. of a 0.2 per cent solution of *C.B.* 1506 in 0.4 per cent saline was injected into the abdomens of *Drosophila* males (Oregon-*K* stock), 48  $\pm$  4 hr. after emergence. The treated males were tested by the *Cy/L* technique<sup>3</sup> for the detection of autosomal (2nd chromosome) and sex-linked mutations. Lethals were scored as cultures containing no non-Muller-5 males at all in the  $F_2$  and confirmatory  $F_3$  for the sex-linked data, and no  $Cy^+/L^+$  flies in the  $F_3$  and  $F_4$  for the 2nd chromosome data. Visible