man—can afford to waste thousands of ill-adapted individuals for the sake of a single better adapted one. It is probable that in the course of evolution every species establishes a balance between the frequency with which its genes mutate and the amount of natural selection to which it is exposed. It is also probable that for mankind this balance has already been upset through the relaxation of natural selection, and that the frequency of even natural mutation may be rather higher than is desirable. Any additional mutations will shift the balance even further in the direction of genetical deterioration.

Manufacture of Nuclear Devices by Private Firms

I should like to make one final point. Prior to the discussion of radioactivity in the House of Commons on April 28, the Prime Minister was asked a question regarding safety measures in private firms which produce nuclear devices. The Prime Minister answered that the Atomic Energy Authority exercized the same sort of control and supervision in these firms as in its own establishments doing similar work. No doubt this is true; but there is a different angle to this question. The industrially permissible dose has been lowered repeatedly, and at present is only 1/14 of what it was in 1934. Yet it is still fairly high, and, if received in full by many employees for many years, would be a cause for concern, especially to geneticists. It is, however, asserted that very few workers in Government plants receive anything like this dose. In 1957, Prof. H. J. Muller, the leading expert on the genetical effects of radiation, pointed out that in private firms "the pressure of costs will tend to prevent the observance of more rigorous standards than those officially recognized, and there is therefore a danger of considerable radiation being received from the so-called peaceful atom, unless we further lower the ceiling". It would seem that in the United Kingdom we are reaching the stage where such a lowering of the officially permissible dose for employees in nuclear establishments should be taken into serious consideration.

C. Auerbach

[1] Medical Research Council. The Hazards to Man of Nuclear and Allied Radiations. (Cmnd. 9780.) Pp. vii+128. (London: H.M. Stationery Office, 1956.) 5*s*. 6*d*. net. See *Nature*, **178**, 453 (1956).

[2] National Academy of Sciences–National Research Council. The Biological Effects of Atomic Radiation: a Report to the Public from a Study by the National Academy of Sciences. Pp. ii+40. The Biological Effects of Radiation: Summary Reports from a Study by the National Academy of Sciences. Pp. xiv+108. (Washington, D.C.: National Academy of Sciences–National Research Council, 1956.)

[3] Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. (General Assembly—Official Records: Thirteenth Session, Supplement No. 17 (A/3838).) Pp. iii+228. (New York: United Nations; London: H.M. Stationery Office, 1958.) 2.50 dollars; 18*s*.; 10.50 Swiss francs. See *Nature*, **182**, 1543 (1958).

[4] Medical Research Council. Statement on the Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. Pp. 15. (Cmnd. 508.) (London: H.M. Stationery Office, 1958.) 1*s*. net. See *Nature*, **182**, 1543 (1958).

OBITUARIES

Dr. Jesse P. Greenstein

Biochemistry and cancer research lost one of its leading figures with the sudden death on February 12 of Jesse Phillip Greenstein. He had been chief of the Laboratory of Biochemistry at the National Cancer Institute, Bethesda, Maryland, since 1946 and held this position at his death.

Born in New York in 1902, he graduated first from the Polytechnic Institute of Brooklyn in 1926 and then took an M.S. and finally Ph.D. in biochemistry at Brown University. In the next two years he held fellowships at Harvard (Prof. E. J. Cohn) and at the Kaiser-Wilhelm Institute, Dresden (Prof. M. Bergmann). This one year spent with Bergmann in Germany confirmed Greenstein's interest in amino-acids and settled much of the pattern of his future researches. Two valued reference books he always kept to hand on his desk were the collected works of Emil Fischer and of Max Bergmann. He returned to Harvard and during 1933–39 was instructor in biochemistry at Harvard College, and a research associate of Harvard Medical School. His research interests in this period were concerned with peptide synthesis, the physico-chemical characteristics of peptides in solution and the role of sulphydryl groups in protein structure and denaturation. Much of this work was of a new and fundamental nature and has retained a permanent place in the literature.

Leaving this special field of research, Greenstein entered the second and major phase of his career when in 1939 he moved to join the staff at the National Cancer Institute. He extended his earlier interests to include nucleoproteins and nucleic acids, and then with a team of workers devoted his energies to a survey of the enzyme spectra of living cells, normal and neoplastic. Greenstein's activities in this field undoubtedly stimulated the post-war surge of research into the chemistry of growth. With his colleagues he published more than a hundred papers in the period 1940–47 dealing with this problem. Much of this work was incorporated in his first book published in 1947, "Biochemistry of Cancer". This book has remained the most important and most quoted survey of experimental cancer research. It was revised and of necessity greatly extended in its second edition in 1954 and is unlikely to decrease in value for many years to come.

While retaining an interest in enzymology, Greenstein turned his interest back to amino-acid chemistry. Papers published over the period 1948–58 describe the use of enzymatic methods for the resolution of amino-acids. Making use particularly of a kidney enzyme, designated 'acylase', Greenstein and his colleagues showed that by asymmetric hydrolysis of acyl-DL-amino acids both the pure L- and D-forms could be obtained in good yield and of high optical purity. During the past three years the application of these pure isomers in nutritional and metabolic experiments was being studied.

The volume of published work conveys some idea of Greenstein's immense energy. The carpeted office approached through a protective screen of secretaries was not for him. Instead, there was an open door and a pair of hands ready, indeed anxious, to help with practical work and a fund of advice and experience. He was always anxious to help along the younger workers of his group and would always give them full credit for any achievements. He also afforded a very generous welcome to workers from many countries, and the hospitality of his family, as well as of the laboratories, must have left them with a very happy impression of American life.

Greenstein himself went outside the United States on two occasions only—to a conference at the Papal Academy in Vatican City in 1949, and to Japan in 1956. He did, however, take a very prominent part in American scientific affairs. He was, for example, a past chairman of the Division of Biological Chemistry of the American Chemical Society and a member of the National Research Council's Committee on Biochemistry. He was on the editorial boards of *Cancer Research* and *Archives of Biochemistry and Biophysics*, while in recent years he was joint-editor with Prof. A. Haddow of "Advances in Cancer Research". At the time of his death he was just completing a major treatise on amino-acid chemistry. Among many formal acknowledgments of his work were included a Distinguished Service Award from the U.S. Government (1954) and the Hillebrand Prize of the American Chemical Society (1957).

Though modest about his own contribution, he was visibly proud of the work of his section, of his country and above all of his family. He will be greatly missed and all will sympathize with those near to him at their loss.

DOUGLAS HAMER

DR. GREENSTEIN'S contributions extended widely in the fields of amino-acid, peptide and protein chemistry, and of nutrition. In the past few years he had devoted much effort to the elaboration of a completely soluble diet composed of chemically defined constituents; and at the time of his death he was engaged (with M. Winitz), in the final stages of a major work on the chemistry of the amino-acids, which is to appear in three volumes, of which the first is now in the press. But apart from these, his contributions to cancer research alone would have more than sufficed to establish him among the leading biochemists of his time. He was an accomplished writer, and his "Biochemistry of Cancer" had, and has, immense influence, and proved a very significant stimulus to the subject as a whole.

Of his own work, two aspects were of particular importance; first, his studies of the mechanism of production—and the significance—of the dramatic decline in liver catalase activity which is observed in tumour-bearing animals; and secondly, his analysis and comparison of the distribution and activity of a host of enzyme systems in normal and cancer cells. In spite of the extreme difficulty and complexity of these problems, there gradually emerged a real and satisfying conclusion, namely, that although tumours mostly possess the same enzymes as do normal tissues, qualitatively, none the less they tend, enzymatically, to converge to a common type, and hence show more resemblance to one another biochemically than to the normal tissues from which they arose.

All these, and many other contributions, embodied in upwards of 250 papers, brought him international acclaim. But we shall also remember him for his human qualities, and his combination of serious devotion with much courage and humour. Certainly I have good cause to be grateful for many years of happy association with him; and Bethesda without him can never be quite the same. All who admired him will be glad to know that there has now been established, in his remembrance, a Jesse P. Greenstein Memorial Foundation, to be administered by a small committee of his colleagues, and which will, in cases where it is necessary or helpful, provide tuition and support during the years of undergraduate study in the arts or sciences, "to the son or daughter of a scientist who has made notable contributions to the medical, physical or biological sciences, and who is deceased".

ALEX. HADDOW

Dr. Arthur Walton

DR. ARTHUR WALTON, who died suddenly in Cambridge on April 6, was best known for his pioneering research in the field of sperm physiology and artificial insemination of farm animals. He was born in London, on March 16, 1897, of Scottish parents, and educated in Edinburgh, first at Daniel Stewart's College and later at the University, where he obtained in 1923 the degree of bachelor of science (agriculture). It was also in Edinburgh, at the Animal Breeding Research Department, where he received his early training in research methods and published, in 1924, his first paper, on "The Flocculation of Sperm Suspensions in Relation to Surface Charge". Keen interest in sperm physiology prompted Walton to move to Cambridge and take up research on animal reproduction. In 1926 appeared his first communication in *Nature*, on "Preservation of Mammalian Spermatozoa", a subject which he expanded in the following year in his Ph.D. dissertation, and to which he devoted his special attention throughout his scientific life.

Among Walton's most outstanding contributions to the subject of sperm physiology was the first demonstration that ram semen, properly collected and stored, can be sent on long journeys to distant countries, to be used there for successful insemination of ewes; next, there were the experiments which proved that 'cold shock' can destroy the fertilizing ability of bull and ram spermatozoa. Of great scientific significance was his observation that the metabolic activity of ram and bull spermatozoa, particularly their respiration, is directly correlated with motility; and the discovery that respiring spermatozoa produce under certain conditions hydrogen peroxide which, in turn, is responsible for a gradually developing inhibitory effect on respiration and a decline in sperm motility. During his more recent investigations, Walton developed a novel and ingenious method of maintaining sperm alive for long periods, in a perfusion apparatus where nutrient substrates are fed continuously to a sample of semen and the toxic metabolites removed at the same time.

In addition to the work on spermatozoa, Walton has been keenly interested in various other aspects of reproductive physiology, including mating behaviour in animals and female fertility. He was the first to make detailed observations on ovulation in the rabbit, and to study the effect of maternal influences on the size of offspring in reciprocal crosses between large and small breeds of horses.

As a member of the University School of Agriculture and the scientific staff of the Agricultural Research Council, Walton spent nearly thirty years of his life in Cambridge, much of it in his laboratory at the Animal Research Station, in close association with many young research workers, always ready to help, to guide, and to advise. Although primarily concerned with physiological problems, Walton had also a profound knowledge in the field of general biology and agriculture. His contributions to agriculture, especially those which led to the establishment of the practice of artificial insemination in farm animals, were recognized in 1957, by the award of