Book reviews

DOSIMETRIE ZUR BETATRONTHERAPIE. Von Wolfgang Pohlit. 80 Seiten, 55 Abbildungen, 7 Tabellen. Georg Thieme Verlag, Stuttgart 1965. Preis 25 DM.

This little book deals with the different measurements of the source of radiation and of the electron and photon beams to secure correct treatment dosimetry. These are of great topical interest in modern radiotherapy. Clinical dosimetry, including dose planning, and radiation protection also have their own chapters.

Within the limited space available, a good account is given of the instruments and measuring methods developed over a number of years at the Max-Planck-Institut für Biophysik, Frankfurt am Main. A great number of practical hints on the performance of measurements and various sources of error and their avoidance are given, as well as formulae and numerical data needed for converting the direct instrument readings into absolute dose values in rad. The book will be most useful to hospital physicists working with medical betatrons or other high-energy accelerators but may also be read with advantage by radiotherapists.

Sven Benner

CURRENT TOPICS IN RADIATION RESEARCH. Vol. 2. Edit. by M. Ebert and A. Howard. 398 pages with 118 figures and 7 tables. North-Holland Publishers Company, Amsterdam 1966. Price 45 guilders.

In the first volume of this series the trend was predominantly radiobiologic. In the present volume, some of the chapters are of a nature to demand of the reader some knowledge in physics and chemistry.

The biologic macromolecules are targets of importance in the action of radiation on living matter, and it is of value to find an exposé by HENGLEIN & SCHNABEL on the radiation effects of macromolecules in general. The authors have worked with synthetic polymers, and special attention has been paid to reactions in aqueous solutions rather than in the dry stage. Degradation, cross-linking and gel formation of molecules, as well as the effects of irradiation of varying LET's, are discussed. There seem to be great variations in regard to cross-linking and gel formation between various polymers depending on whether γ-radiation or particle radiation is used. Energy transfer between water and dissolved polymers occur, and free radicals such as OH and H atoms add to the effects.

JUNG & ZIMMER introduce their chapter on 'Some chemical and biological effects of elastic nuclear collisions' with the statement: "It may seem surprising to find a review article written on a topic which does not yet actually exist". This means that up to now no direct evidence of elastic nuclear collisions has been given, but the authors prove their existence and suggest that such reactions give rise to biologic effects. When charged particles of high velocity are used, ionization and excitation predominate and the likelihood that elastic nuclear collisons occur is very small. However, at very low ion velocities more energy is dissipated by elastic collisions than by interaction between incident ions and electrons of the exposed material. Slow particles should therefore be used to prove the effect, which nevertheless meets with diffi-

culties because of their very low penetrative capacity in biologic material. The authors discuss an elegant experimental solution of the problem, by means of protons and thin layers of plastic foils in which the absorption spectra produced the evidence. Work with the enzyme ribonuclease in thin layers also proved that elastic collisions between slow, charged particles and this molecule caused an inactivation that increased linearly with the proton dose.

The chapter by PHILIPS on energy transport in carbohydrate is of biologic significance because of the abundance of such substance in the cells. Already in the metabolic processes energy transfer occurs in steps although not well defined in physical terms. A great number of molecules absorb light, in the range of ultraviolet and visible, and in biochemical processes this is followed by transfer of energy. By the application of ionizing radiation the energy becomes considerably in excess of what can be used in the biologic process. The ionizing radiation action is discussed in detail but cannot be dealt with at length in this review. In particular, two carbohydrates, the d-glucose and cycloamylose complexes are well analysed. A chapter on the effects of ultraviolet light on photoreactivation (by JANE SETLOW) is motivated by the fact that ultraviolet has both lethal and mutagenic actions. The changes caused in nucleic acids in particular are manifold and important. The author discusses chain breaks and depolymerization, cross-linking and partial denaturation. Specific reactions occur in several of the base components of the nucleic acids and DNA may loose its synthetic ability. Ultraviolet lesions can be repaired, as has been shown by many writers. This photoreactivation is in many instances promoted by heat, in which reaction an enzyme seems to take part. The mechanism of ultraviolet-induced mutations appears still not to be completely understood.

JOSET, MOUSTACCHI & MARCOVICH report on determinations of the initial sites of radiation effect on microorganisms, essentially *Escherichia coli* and yeast cells. Roentgen rays as well as ultraviolet rays are considered. The problem is that it usually takes several generations to detect a lethal mutation. Experiments were carried out by irradiating *E. coli* K12 Hfr male cells (Hfr for high frequency of recombination) and mating them with non-irradiated F^- recipient ones. During conjugation between a Hfr donor and a F^- recipient, the genetic determinants of the donor are transferred to the zygote sequentially and in an order that is constant for a given Hfr strain. The frequency of transfer of a marker decreases as a function of its distance from the point of the chromosome first transferred: the origin O. One can thus define a gradient of transfer of the male characters, and a degree of linkage between them, expressed as their probability of being simultaneously transmitted to the recombinants. The study of the variation of these two factors as a result of the irradiation of the male or of the female has been used as a tool to analyse the radio-induced lethal damage. Any dominant lethal lesion induced on the male chromosome should have a lethal effect on the zygote.

BRINKMAN & LAMBERTS report on several experiments of interest in radiation therapy. The first example is on water filtration through the subepidermal layers of membranes. The permeability is greatly increased by irradiation with such small doses as 1 to 2 R and the application of moderate water pressure. This effect is counteracted by radiation-protective compounds like SH-groups and serotonin. The experiments have some bearing upon the penetration of activity, should the situation be such that heavy fall-out occurs. Further, enzymes may be rapidly released, e.g. from erythrocytes, by comparatively low doses. It is reported that ozone in low concentration has radiation-sensitizing effects as demonstrated by irradiation of mice given O_3 inhalations of about 1 part per million. This treatment, which has no deleterious effect as such, increased the death rate considerably after a nearly lethal dose. The authors suggest that it may be worthwhile to follow up the ozone effect more in detail.

The last chapter by FOWLER on 'Radiation biology as applied to radiotherapy' constitutes a discussion of great interest both to radiation biologists and therapists. The experimental

material on survival curves of cells or cell populations has increased considerably in the last decades, as has information on the biochemical and other factors that settle the issue of the irradiation. The author discusses cellular theories of radiosensitivity and variations due to factors such as in vivo or in vitro exposure, stage of mitotic cycle, and degree of differentiation. It is not easy to recommend definite clinical procedures. He believes that the most important aspects to deal with are the anoxic cells in tumours and to find rational ways of fractionation. It is generally known that radiation sensitivity increases when cells and tissues are well oxygenated, and that in anoxia 2 to 3 times higher doses are needed for an equivalent damage. The author also points to the fact that living tumour cells are situated around capillaries, whereas tissue at some distance may be necrotic. Tumour cells at the edge of necrotic regions may survive for some time, however, and because of the anoxic state also survive irradiation and eventually regrow. One of the main problems in radiotherapy are these anoxic and consequently resistant cells.

FOWLER considers some of the possibilities in dealing with the problems. The first of these is the application of high pressure oxygen during irradiation, as practised by Churchill-Davidson and his team, although many radiotherapists seem to be sceptical about this form of therapy. However, six centres in the UK, at least two in USA, and two in Australia, are by now engaged in such treatment. The second is the breathing of 95 % O_2 plus 5 % CO_2 at normal pressure, to afford hyperventilation and capillary dilatation, and the third is local infusion of H_2O_2, which should be followed by the reaction $2H_2O + O_2$. Lastly, radiation at high ionizing density, because it kills even anoxic cells almost as well as normal cells, is mentioned.

The last section is on dose fractionation, in which the methods are discussed. It seems impossible to generalize or even to give preference to a particular schedule of fractionation at the present time. The author states: "There is no a priori reason why any number of fractions might be better than any other, from 2 to 200 fractions or even continuous irradiation". This drastic statement can be rephrased to mean that each therapy problem must be approached in an individual way.

Arne Forssberg

BIOPHYSIKALISCHE PROBLEME DER STRAHLENWIRKUNG. Jahrestagung der Deutschen Gesellschaft für Biophysik am 23./24. April 1965 in Homburg/Saar. Herausgegeben von H. Muth. 191 Seiten mit 114 Abbildungen und 10 Tabellen. Georg Thieme Verlag, Stuttgart 1966. Preis: 29.70 DM.

This book of twenty-six congress papers is introduced with a review of biophysics by B. Rajewsky. Some of the papers consider radiation dose calculations and the biologic actions of Thorotrast, ^{226}Ra and ^{224}Ra and their disintegration products, while others deal with radiobiologic and radiochemical questions, the reactions of free radicals and their detection by electron-spin resonance, radioprotective and mutagenic agents, and the metabolism of ^{137}Cs. The use of analogue computers in medical and biologic research is discussed in one paper. In another paper it is pointed out that unwarranted conclusions regarding underlying mechanisms are often drawn from the shape of dose-survival curves. Finally, the new biophysical institute at Homburg/Saar is described.

The book should be of great interest to all active in radiation biophysics, as it gives a good, though necessarily somewhat disjointed, account of the present state of the science as well as of work going on in West Germany. The selection of the topics was of course determined by the contributors.

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