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3343

The Action of X-Rays on the Organism.

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X-rays can produce cancer as well as destroy it. The action of X-rays, therefore, will be understood only when we have first understood the mechanism of growth in tissue cells. One of us had shown[1] that the protoplasm is a colloidal fluid substance which reacts differently according to its immediate state of aggregation. The state of its aggregation is regulated by a substance or substances which is formed by the cells. This substance or substances has been called the archusia (S). In low concentrations (S^1) the archusia has no effect. In medium concentration (S^2) it causes the cells to migrate, to coagulate extracellular proteins, engorge themselves with proteins and fat particles, or to function. In high concentrations (S^3) the cell digests these proteins and fats, absorbs water, grows and divides by mitoses. In all higher concentrations (S^4) it causes the cells to disintegrate or suffer self-digestion.

In the growth of the cell protein synthesis is not the only essential reaction, but the cell must also acquire or form a lipoid substance, the ergusia. This substance is essential for maintaining the structure of protoplasm. It is an active coagulant of protein. It is liberated by the cells in an (S^2) concentration of the archusia. It is the active agent in the specific absorption of water and other substances necessary for growth, and the surface tension lowering substance necessary for the migration of the cells. The ergusia in excess in the tissue inhibits growth, as any substance, formed in any incomplete reaction, inhibits the reaction. It is also liberated by cells when they disintegrate as the result of a high concentration (S^4) of the archusia.[2]

The cells do not form the ergusia in excess. It exists in excess in the normal organism. The excess is supplied in the form of vitamin A.[3] The cells also do not form and retain ample archusia for growth, except when they are crowded, as in cancer. The archusia in the normal organism is also supplied in part from without as vitamin B.[4]

Having ascertained these facts, it became of interest to study the effect of X-rays on animals fed on normal diets, diets deficient in either vitamins A or B, and diets balanced in these vitamins, but deficient in other vitamins necessary for a normal existence.

Carefully graded doses of X-rays (Ernst's method)[5] were used in treating these animals. The results of these experiments have shown that the life of rats, fed on a diet deficient in vitamin B, is increased by giving 10 milliampere minutes (13 "e" units) of X-rays twice a week. This dose has no effect on rats fed on a diet deficient in vitamin A.[6] Twenty-five and 50 milliampere minutes (34 "e" units and 68 "e" units respectively) increase not only the length of life, but also the growth of rats fed on both a minus A and a minus B diet,[7] while larger doses, 75 and 100 milliampere minutes (102 "e" and 136 "e" units respectively) cause rapid deterioration and death of these animals.[8]

It has been known for a very long time that many toxic substances show evidence of stimulation in small doses. X-rays evidently belong in this class. Their action as noted from these observations, is one of molecular disintegration. In small doses X-rays stimulate in regular sequences those molecular disintegrations which are the source of the normal energy for life. In larger doses they cause the disintegration of the more important molecular constituents of the cell. It is also interesting to note that moderate doses of X-rays act very much the same as ultraviolet light, in that they liberate vitamin A from tissues absorbing it so that this vitamin can be used by other tissues in the organism.[6]

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[1] Burrows, M. T., *Am. J. Anat.*, 1926, xxxvi, 289.

[2] Burrows, M. T., and Jorstad, L. H., *Am. J. Physiol.*, 1926, lxxvii, 38.

[3] Burrows, M. T., and Jorstad, L. H., *Am. J. Physiol.*, 1926, lxxvii, 24.

[4] Ernst, E. C., *Radiology*, 1925, v, 468.

[5] Burrows, M. T., Jorstad, L. H., and Ernst, E. C., *Radiology*, 1926, vii, 279.

[6] Burrows, M. T., Jorstad, L. H., and Ernst, E. C., *J. Am. Med. Assn.*, 1926, lxxxvii, 86.

[7] Burrows, M. T., Jorstad, L. H., and Ernst, E. C., to appear in *Radiology*.