In the series here presented, we were greatly impressed with the rapidity in which improvement was found. The cases were given the best hygienic supervision and the food was modified in quantity as well as in quality and cod liver oil concentrate was added as the vitamine and reconstructive factor. Progress was always noted, but it was slow progress.

Our observations were confined to two classes of cases. In the first series we depended on food, fresh air and cod liver oil, and in the second series, food, fresh air and sunshine. The influence of the sunshine was notable not only on the weight, sleep, metabolism and on the blood cells, but it also showed a marked healing tendency and influence on the calcium deposit in the bones. The influence of sunshine was apparent in every case. We have an excellent roof garden on which continuous sunshine is found.

The x-ray reports showed considerable difference in the healing process and the calcium deposit. Improvement was usual after two weeks of steady treatment and healed rickets was reported in most cases after one month's continuous treatment.

In the series of clinical observations here reported, we employed a cod liver oil concentrate similar to that used by Dr. Dubin in his studies on experimental rickets. His results are reported elsewhere in this issue.

The cod liver oil concentrate, as first employed by me, was mixed with syrup. Subsequently, it was found more convenient to give a 1 grain tablet in which the cod liver oil concentrate is mixed with sugar, each tablet being equivalent to a half teaspoon of fresh cod liver oil.

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The biological action of the beta rays of radium.

By ISAAC LEVIN.

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Methods of radium therapy commonly employed consist in the application of the radium over the surface of the area to be treated or in the insertion into the tissue to be influenced of

metal needles containing radium. In both instances the radium rays are filtered in such a manner that only the gamma rays penetrate into the tissues and act as a therapeutic agent.

More recently a method of radium therapy has been developed by the aid of which not only the gamma but also the beta rays of radium are employed in therapy. This method consists in the following:

Radium emanation—an elementary body in the state of a heavy gas—is the first active product of decomposition of radium. It is collected by means of appropriate apparatus in capillary glass tubes from 1 to 5 mm. long and 0.25 mm. in diameter. These tubes may be made to contain anywhere between 0.1 to several millicuries of radium emanation. They are inserted into the tissue to be influenced by the aid of a trocar. The thin glass wall of the capillaries filters off only the alpha rays and allows the free passage of both the beta and gamma rays.

It is difficult to separate the beta rays from the gamma rays and study the biological action of the former, though R. Abbe made recently an attempt in the direction. However, the biological and therapeutic results obtained by the action of gamma rays alone and by the combined action of beta and gamma rays differ to such an extent that certain conclusions as to the action of the beta rays can be drawn.

In coöperation with Michael Levine, the writer employed this method experimentally on normal and neoplastic tissues of animals and plants. The capillary glass tubes were inserted into normal liver, spleen and bone marrow of rabbits, into muscles and testicles of rats and mice, into sarcoma of rats, carcinoma of mice, into normal young plant tissue, into crown galls of geranium and into club roots of cabbage.

A gross and microscopical analysis of the irradiated tissues was made. The zone of tissue immediately surrounding the glass capillary was in a state of complete necrosis. The second zone showed characteristic gamma ray irradiation changes in the protoplasm and nuclei of the cells. This latter zone was more extensive in tumor than in normal tissues.

Alongside of the experimental investigations the writer subjected to microscopical study tissues obtained on clinical material at various intervals after the insertion of the glass capillaries. In general the clinical results are very significant. Pathological

conditions, which do not yield to large quantities of filtered rays, respond readily to the beta ray action.

Microscopically human tissues examined one to two weeks after the insertion of the capillaries show the same condition as in animal and plant tissues, *i. e.,* a narrow zone of necrotic tissue and a second larger zone which shows the effect of gamma radiation. In material studied six to eight weeks after the insertion of the capillaries the necrotic tissue is found mostly to be absorbed and the second zone of tissue is replaced by connective tissue.

A superficial analysis of the results obtained may produce the impression that the beta ray which acts on the first zone of tissue is a simple caustic agent. A closer study of the phenomena involved, however, shows that the mechanism of the action of beta rays differs widely from the caustic effects of heat or chemical agents and is qualitatively analogous to the action of the gamma rays.

The biological action of the gamma rays of radium and of the analogous x-rays must depend in the ultimate analysis of the intraatomic action of these rays on the atoms of the elements. This action in accordance with the present day conception of physics is as follows:

Gamma rays and x-rays are rays of light of very small wave lengths. When they enter an atom of matter they disturb the electronic equilibrium and free a certain number of electrons of the influence of the positive nucleus of the atom. These free electrons travel in a certain direction with a given velocity and as a result produce within the ether secondary scattered or characteristic x-rays. The results will be the same whether the original agents were the gamma rays or the x-rays.

A biological effect of the rays on tissues means a change in the structure of the tissues and must be a result of changes in the atoms of the tissues. A gamma ray entering the tissues sets into motion a number of electrons. The latter produce secondary x-rays which influence the other component parts of the tissue. Beta rays are themselves electrons in motion and when they enter the tissue they must produce analogous secondary x-rays because beta rays of radium are products of the gamma rays of radium and must have a velocity similar to the velocity of the electrons produced in the tissue by the gamma rays of radium. Conse-

quently the biological action of the gamma and beta rays must be analogous. The difference is quantitative and is due to the fact that the ratio of beta and gamma rays in a unit of radium is about 100 to 1. Five millicuries of radium emanation distributed in 10 capillaries will destroy 10 cubic millimeters of carcinoma. To produce the same effect by surface application the gamma rays of 500 millicuries would have to be employed. The statement made by physicists that the biological effect of one millicurie of radium emanation buried in the tissues equals 132 millicurie hours of surface application of filtered radium must be corrected since it does not take into account the action of the beta rays and their secondary x-rays.

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A crystalline substance from the parathyroid glands that influences the calcium content of the blood.

By LOUIS BERMAN.*

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Parathyroid glands from oxen were extracted with acidified alcohol. Lipins and proteins were removed from the extract. Crystalline material was obtained by concentration which increases definitely the calcium content of the blood when dissolved in Ringer solution and injected into the circulation. Its effects upon the calcium content of the blood have been compared with those of adrenalin, pituitrin and insulin. Whether this crystalline material is the active calcium-mobilizing substance in the gland or merely a carrier of it in the preparation, remains to be determined. Its separation is additional evidence in favor of the view that the parathyroid glands secrete a hormone that influences the calcium content of the blood.

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* Introduced by William J. Gies.