Physiology. — "*On Polonium Radiation and Recovery of Function.*" By Prof. H. ZWAARDEMAKER.

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Several organs discontinue their functions, when we remove from their environment the potassium-ions, which are always present in the circulating fluids. These functions are restored directly when potassium is replaced by other radio-active atoms in the circulating fluids to a quantity aequi-radioactive to the removed potassium [1]).

It does not matter whether the substitute is an α-rayer or a β-rayer, provided its amount be such that the total radio-activity of the new constituent is about equal to that of the original one. No organ serves our purpose in this experimentation better than the heart of a cold-blooded animal, namely of the frog, because the blood flows on all sides round its cells, which are separated from it only by an endothelium.

There is a rather large number of elements that can replace potassium. Besides rubidium, which was known as such to S. RINGER, my co-workers and I found uranium, thorium, radium, ionium, emanation and actinium (as an admixture to lanthanium and cerium) to be fit substitutes, while of non-radioactive elements only caesium proved serviceable.

However, it is not only the addition of radio-active elements along the blood that can restore the lost function; this can also be effected by radiation from the outside [2]). We succeeded in obtaining this result with mesothorium contained in glass, with radium screened by mica, and unscreened polonium (galvanoplastic on copper). The quantity is of equal order with that which inhibits from the same distance the cultures of bacteria in their growth. 1½ mgr.-hour served for radiation that restored the function; 12 mgr.-hour for excitation of sterility of bacteria.

The recovery of function is, therefore, brought about by radio-activity, anyhow it is in the case of free radiations.

[1]) Verslag Vol. 25, p. 517 and p. 1096, p. 1282. Vol. 26, p. 555 and p. 776. Proceedings Vol. 19, p. 633 and p. 1043, p. 1161. Vol. 20, p. 768 and p. 773.

[2]) H. ZWAARDEMAKER, C. E. BENJAMINS and T. P. FEENSTRA, Radiumbestraling en hartswerking. Ned. Tijdschr. v. Geneesk. 1916 II, p. 1923 (10 Nov. 1916).

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It is a moot point as yet whether this action of radiation is direct or indirect.

It may be, namely, that the radiations first liberate the potassium from the potassium-dépôts [1]), which are present in the cardiac muscle and that only then this liberated potassium, diffusing to the circulating fluid, causes the function to revive.

This possibility could not be ignored a priori, it being a fact that during the radiation rather considerable quanta of potassium may quit the blood-cells and perhaps the heart-cells [2]).

One of these days I was in a position to carry out an experimentum crucis.

There is namely antagonism between α- and β-rayers. When applied coincidently with the same activity, they counter-balance each other's action completely.

This antagonism also obtains with external polonium-radiation (α-rayer) and internal appliance of potassium (β-rayers). This became evident when a frog's heart, which had been brought to a standstill by removing the potassium from the circulating fluid, and had recovered its beats again through polonium, ceased beating again after being given a physiological dosis of potassium, whereas it resumed its pulsations both by removal of polonium and by that of potassium.

When the polonium was removed, the potassium gradually regained its influence; when the potassium was removed, only the after-effect of the α-radiation remained.

From the existence of the antagonism polonium-potassium we must conclude that in this case there is a direct action of radiation.

For, if the liberation of potassium-atoms (supposing it to occur)

[1]) In the cells of the cardiac muscle there is a rich store of potassium. It is strange that this permanent substance is of itself not competent to keep up the function. This inactivity cannot be due to incapacity of the radiation of the potassium dépôt to reach as far as the seat of automaticity. To W. E. RINGER and to myself the radiation seemed to be too penetrating for it. Nothing less than a tissue sheet of 1 m.m. thickness is capable of lessening by half the high penetrating power of potassium. I have therefore been obliged to relinquish my original hypothesis. I am now inclined to look for the explanation in the coincident presence of iron. The cells of the cardiac muscle contain iron atoms where also the potassium-atoms are located. Consequently the miniature magnetic fields surrounding the iron atoms, will dislodge the β-particles of the potassium. It may, therefore, be considered whether perhaps this circumstance constitutes an obstacle for outward radiation.

Biologically, various explanations are given, starting from the inactivity of continuous causes and the stimulation of temporary ones.

[2]) Researches not published yet. They will be recorded elsewhere.

should have had to serve as an intermediary, it would be impossible to conceive that the addition of a small quantity of potassium, entirely within physiological limits, should have doomed the polonium-heart to a standstill. On the other hand, if the supposition had come true, the liberated and the newly added potassium-atoms would have aided each other and would have maintained the function, instead of disturbing it as was the case now in consequence of the joint action of polonium-radiation and the internal circulating potassium.