lowing the administration of the growth hormone parallels the repair of the adrenals. It is quite probable that the cachectic state and the atrophy of the adrenals are causally interrelated and that it is to the change in the adrenal following administration of the growth hormone that we must refer the remarkable general constitutional restoration. Experiments are now under way to see whether the cachectic symptoms following hypophysectomy can be relieved, although growth is not induced, by injections of adrenal cortical extracts.

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THE TRANSFORMATION OF SERUM ALBUMIN INTO SERUM GLOBULINS[1]

THE antiprothrombin (heparin of Howell) forms with protein complex compounds which show different properties according to the amount of heparin bound to the protein molecule.

The heparin combines with the organic complex of the protein and by means of its affinity for water (lyophil action) increases the solubility of the proteins. The antiprothrombin gives the protein an electronegative charge and moves its isoelectric point towards the acid side.

By adding heparin to pure globulin fraction in salt solution one is able to move the isoelectric point, which for globulins is normally around pH 5.0, towards the acid side; the range depends upon the concentration of the heparin. As is well known, the serum albumin does not flocculate at its isoelectric point. If heparin is added to serum albumin (at pH 5.0), which is freed from globulins by means of dialysis, a flocculation immediately takes place. The degree of flocculation depends only upon the amount of heparin added when excess albumin is present. Albumin-heparin compounds behave as genuine globulins, and we are justified in considering them as identical with the globulins. (Solubility, precipitation by means of weak acids, denaturation, precipitation by means of salts, solubility in heparin (in excess) dialysis, isoelectric point.)

Experiments on quantitative dialysis of whole serum show that the addition of small amounts of heparin results in an increased amount of globulin (determined by weighing).

The antiprothrombin is so far the only substance normally found in the body (the urea does not play any rôle in this connection), having the powerful action described, which is responsible for the formation of the globulins. We found that the amount of globulins present in blood serum is a direct expression of the amount of antiprothrombin. The coagulability of a plasma depends entirely upon the amount of globulins present. By means of the method to isolate the heparin as indicated by Howell, much greater amounts of heparin could be isolated from blood in which the amount of globulin was greater than from any other serums.

From the purified casein (*Hammarsten*) which behaves as a globulin and especially towards heparin, we were able to isolate a heparin-like principle of high activity, if not heparin itself.

Fibrinogen belongs to the globulins. According to the amount of heparin bound to the protein molecule, it is possible to place the various globulins in a certain system. When the various fractions of the serum proteins are precipitated in a buffer system of pH 5.0 as a function of the heparin concentration, the relative charge of heparin on the definite protein fraction may be determined. Heparin acts on the principle of the "unregelmässige Reihe," that is, greater amounts inhibit and smaller promote the flocculation.

The euglobulin goes into solution with a small amount of heparin; the pseudoglobulin needs a larger amount of heparin than the euglobulin for solution. The fibrinogen needs an even greater amount of heparin before it is dissolved. If we consider the serum albumin as heparin free, the other protein fractions of the plasma come as follows: fibrinogen, pseudoglobulin, euglobulin. Our experiments show that the euglobulin fraction is immediately formed when heparin is added to pure serum albumin. We suppose that there exist just as many protein compounds in blood as there are possibilities for heparin-albumin compounds. It is conceivable that the various compounds are dissociated according to the principle of the dissociation of the pluribasic acids. There are just as many dissociation steps as there are possibilities for heparin-albumin compounds, each with its own dissociation constant. This consideration agrees very well with the modern conception (*Sörensen*) which considers the proteins as reversible dissociable systems of components.

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PERIODICAL PROPERTIES OF ATOMIC NUCLEI

ACCORDING to our present knowledge of the structure of atoms, there is no reason to expect *a priori* the existence of a simple relation between the electron coverings of an atom and the internal constitution of the nucleus.

Therefore some experimental facts showing such a relation must be of interest. These facts have a statistical character. It is only possible after the investi-

gation of much experimental material to point out the following regularities.

It is well known that the number of nuclear electrons is not a simple function of the atomic weight. There are many isotopes of different elements having the same atomic weight, but different numbers of nuclear electrons.

The number of isotopes having the same atomic weight, N, can be regarded as a function of this atomic weight. Curve 1 in Fig. 1 represents such a function.

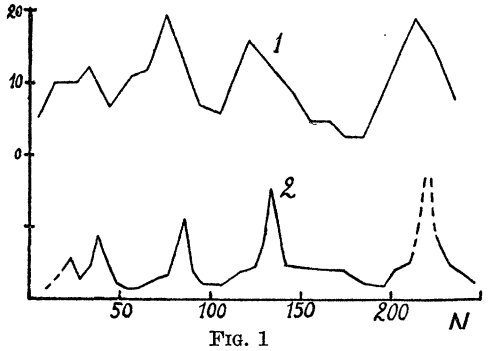

FIG. 1

Each point represents a mean value for an interval of ten atomic weights. It is easy to recognize the periodical character of this curve. It may also be pointed out that the periods correspond to those of the periodical system of the elements. This can be seen comparing curve 1 with curve 2 in Fig. 1. Curve 2 shows also the atomic volume as a function of the atomic weight.

The number of isotopes having the same atomic weight is determined by the properties of the nuclei. On the other hand the atomic volume is determined by the properties of electron coverings of the atom. If we have in both cases the same periodicity we must have also a connection between the outer electrons and the protons and electrons in the nucleus.

There is also another fact showing the same relation. It is known that generally elements having even atomic numbers exist in larger quantities than elements with odd numbers (Harkins' law). This fact can be explained by the greater stability of nuclei with even atomic numbers. Let n_1 be the relative quantity of a given element with an odd number and n_2 the quantity of the next one with an even number. The value

$$E = \lg h_1 - \lg h_2 = \lg \frac{n_1}{n_2}$$

can be regarded as a function of the atomic number 7. Taking experimental material from a work of I and W. Noddak[1] it is possible to receive a curve illustrating this function and shown in Fig. 2 (curve 1). This curve can be compared also with the curve of atomic volumes. (Fig. 2, curve 2).

[1] *Naturwissenschaften*, 18, 757, 1930.

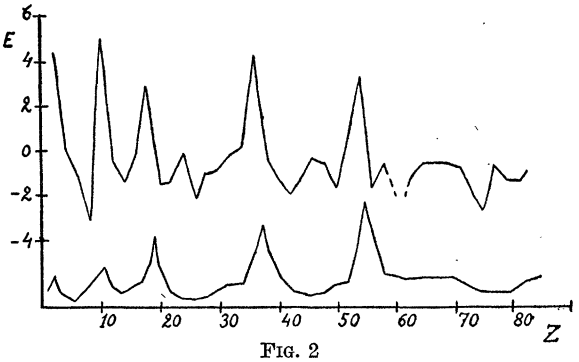

FIG. 2

All the described facts show the existence of some connection between the nucleus and its electron covering. It seems to be probable that quantum laws can be applied not only to the electron covering but also to the nucelus of the atom.

Assuming, (1) that atomic nuclei having the same geometrical structure must have also the same physical properties, (2) that the volumes of nuclei are proportional to the numbers of protons and (3) the protons can not be deformed in the nucleus, it is easy to show that only such nuclei can have the same form as a proton, which have the following atomic weights:

$$N_1 = 1 = 1^3$$
$$N_2 = 8 = 2^3$$
$$N_3 = 27 = 3^3$$
$$N_4 = 64 = 4^3$$
$$N_5 = 125 = 5^3$$
$$N_6 = 216 = 6^3$$

Therefore the atomic nuclei with given values of N must have analogical physical properties. We obtain therefore a periodical system of nuclei, each period limited by N_1, N_2, etc. This is in good agreement with the experimental facts shown in Fig. 1 and Fig. 2.

It is possible also to receive an analogical result from the standpoint of wave mechanics. A more detailed discussion of this possibility will be given in another place.

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