

## CHAPTER 5

### THE CONSTITUENTS

HIERARCHIC ORGANIZATION and dualism have opened the way for a study of the body constituents in an attempt to systematize them and their functioning in accordance with these two concepts. In this research, we considered besides the constituents separated in groups as lipids, proteins, carbohydrates and electrolytes also the elements as a source of interesting information.

With most of the manifestations integrated in dualistic patterns, we planned to test the different constituents by noting their influence on these patterns. It was to be expected that some might have selective activity at certain levels of organization and the manifestations related to these levels. This selectivity did become evident but it also turned out that any agent, in sufficient amount, exerted an effect at any level. The problem was to select the manifestation which would respond most readily to the greatest number of agents. This would make comparisons between agents easier and serve as a practical criterion for the start of classification on this dual basis.

The measurement of the influence exerted by various agents upon the second day wound crust pH (s.d.c. pH) proved to be particularly rewarding and was employed in the first part of the investigation. The s.d.c. pH provided an indication not only of acidifying and alkalizing effects but also comparative values for these effects. Later, the influence exerted upon many other manifestations was studied for corroboration. Details of the s.d.c. pH technique and the results obtained are in Note 1.

In studying the elements, we chose, first, simple combinations in which they appear. Each anion was investigated by studying it as it occurred in the respective acid and in compounds in combinations with different cations; each cation was studied in its combinations with different anions.

In this way, we obtained a series of data which enabled us to pinpoint the influence of each element.

### *The Elements*

Using this method, we could determine that elements such as Li, K, Na, Fe, Ni, Zn, Hg, Bi, B, F, Cl, Br, I—in sufficient amount—produced in the s.d.c. pH an acidifying effect. The opposite effect—alkalization—was seen for Mg, Ca, Sr, Ba, Cu, Pb, S and Se. It must be emphasized that some elements—such as K, Fe, Zn, Hg, Cl in the acidifying group and Ca, Cu, S and Se in the other—produced an intense effect while others had a weak though still clear, action. We must add that Ni and Cr showed a relatively weak acidifying effect. This separation of elements on the basis of acidifying or alkalizing effect agreed with almost all data available about antagonism between elements—for example, the known antagonism between K and Ca, Mg and Cu, and between Mo, Zn and Cu.

As a second step, we related the elements, through their influence upon the s.d.c. pH, to one of the two fundamental offbalances. Those inducing acidification were thus classified as an “inducing offbalance type A,” or “anti offbalance type D” or “anti D,” while those producing alkalization were called “inducing D,” or “anti offbalance type A,” or “anti A.” Going another step, the acidifying elements were considered to have a tendency toward increasing heterotropy; the alkalizing, a tendency toward increasing homotropy. This led us to attribute to the first, the acidifying group, the qualification “hetero” type, and to the second, the “homo” type. We did not give these designations any other meaning than that indicated above, using them for didactic facility.

### *The Series*

After classifying elements into hetero and homo groups, we studied these groupings in terms of the place of the elements in the periodic chart. We could quickly see that when two or more elements are part of the same series, they also belong to the same group. For example, all elements in the I A and the VII A series are A inducing, or “hetero.” The members of the II A and VI A series are D inducing or homo. At this point, we tentatively extended these hetero or homo characters to an entire series after one or more elements in it had been recognized as such. The I A, II B, III A, V A, VII A series and the Fe subseries of VIII were classified as hetero or A inducing, while the II A, I B, VI A series and the Co subseries of VIII were labelled homo or D inducing.

This hetero or homo grouping of the various series permitted us to



make other correlations. We could see that among all the series designated as A in the periodic chart, those numbered oddly are hetero type, while those with even numbers are homo type. Among the B series, the opposite is true; those with odd numbers are homo type, while those with even are hetero type. Extrapolating, we could classify all the series according to this criterion. This view was confirmed by the hetero character seen in Cr and especially Mo, and the homo character for Mn.

We could go farther and correlate the above classification, made on the basis of biological properties, with the electronic configurations of the elements. For the members of the A series, those with an odd number of electrons in the valency shell were hetero type, while those with an even number were homo type. Among the B series, this criterion did not hold true. We found, however, that a similar correlation existed if consideration was given not to the valency shell alone but to the sum of the two external shells, the valency and the shell beneath it. This accords with the fact that in the B series elements, the two shells have insufficient electrons to fulfill the quantum numbers. We saw thus that those members of the B series with an odd number for the sum of electrons of the two shells have a homo character, while those with an even number have a hetero. This criterion applies to all members of the B group, including those in the I B and II B series, which have their full quantum quota of electrons in the shell beneath the valency shell. This same criterion was used to classify the three subseries of series VIII shown in the chart. The Fe subseries and Ni subseries were considered hetero type, the Co homo type. This antagonism was seen to be in accord with experimental findings.

These considerations also permitted us to classify the members of the Lanthanium and Actinium Series. Characteristically, all show nonfulfillment of three of their electron shells—the valency and the two shells beneath. We established for these elements a separate series designation, C. Using the sum of the electrons of the three shells, we separated the elements of the C series into hetero and homo categories. Here, the criterion was the opposite of that used for the B series. The members with odd numbers of electrons were considered hetero, those with even numbers homo.

We will discuss later the biological significance of this separation of elements into A, B and C series with their respective one, two and three unfulfilled shells. For the moment, we will only remark that if we consider an even number of electrons as corresponding to a kind of partial fulfillment of quantum forces, especially as compared to an odd number, such partial fulfillment is seen, among all the A series, in those with even num-



bers (II, IV, VI); among all the B series, in those with odd numbers (I B, III B, V B, VII B); and, among the C series, in those with alternate numbers which can be considered to correspond to even numbers. All these series—with partial fulfillment for the sum of their shells—have a D inducing or anti A, character, and thus a homotropic tendency.

### *Periods*

Coming back to the influence exerted by the elements on test manifestations, we found that elements of the same series show some similar properties when acting at a certain level of organization, but some differences appear when they are acting at different levels. Some of these differences are important. Magnesium, calcium and strontium act similarly on the s.d.c. pH, and against convulsions as well. However, magnesium has been found to induce somnolence or even deep sleep in test animals, while calcium immediately wakes them from magnesium-induced somnolence. This type of antagonistic action among members of the same series sometimes appears especially pronounced between two consecutive members in the series—for example, between sodium and potassium, magnesium and calcium, oxygen and sulfur, and sulfur and selenium.

Study of this “antagonism” has permitted us to recognize a specific characteristic. When two elements of the same series act upon the same entity, one may substitute for the other. Sodium may replace potassium in cells. Magnesium and calcium, oxygen and sulfur, and sulfur and selenium can replace each other in this kind of reciprocal activity. There is no truly antagonistic action between them. This explains the fact that two elements of the same series, if in sufficient amount can have similar activity at a given level—that of the tissular, for instance, where the changes of the s.d.c. pH take place.

Further analysis of the activity of members of the same series has revealed another important characteristic which has permitted further classification. Differences in activity of members of the same series could be related to the organizational compartments involved. This became clear when activity of members of the I A series was analyzed according to whether these elements form constituents of the metazoic, nuclear or subcellular compartments. Sodium is the predominant cation of the metazoic compartment, which consists of the interstitial fluids, lymph and blood. Potassium is the principal cation of the cellular compartment. Ammonium, which corresponds in most of its properties to rubidium, represents the cation at the nuclear level. It could be seen that the development of hier-



archic organization has involved elements with progressively smaller atomic weights.

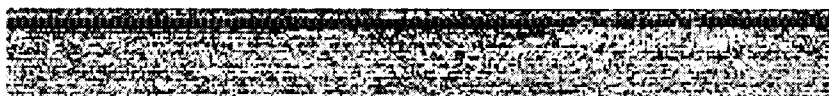
Study of constituents in compartments and in the environment has further permitted us—as seen above—to correlate the metazoic compartment with the sea, the cellular compartment with the crust of the earth, and the nuclear and subnuclear compartments with the formations in which their constituents were found in the vicinity of volcanoes.

This correlation of the metazoic compartment to the environment of the sea became especially interesting when we could recognize in its constituents not only sodium, but, curiously enough, the other members forming the same period in the periodic chart. Chlorine, magnesium and sulfur, predominant in the sea and also found in the metazoic compartment, are in the same period in the chart as sodium.

We have thus tried to extend the concept of a correlation between the periods of the chart and the different compartments of hierarchic organization. Tentatively we correlated the second period of the chart to the total organism as an entity. Oxygen, carbon and nitrogen—principal elements in air—enter into direct contact with the organism as such. The third period contains sodium, magnesium, sulfur and chlorine, which are found in the sea and can be correlated with the metazoic compartment. The fourth period contains potassium, calcium, iron, nickel, copper, selenium and bromine—all common to the earth's crust—and, according to our tentative systematization, correlated with the cellular compartment. Following the same plan, we could relate the fifth period—containing rubidium, molybdenum, silver, tellurium and iodine—to the nuclear compartment.

As a possible basis for a working hypothesis, we could consider the sixth period—with cesium, barium, gold, mercury, lead, bismuth—and the lanthanum series to belong to a subnuclear or, rather, submorphologic compartment. The seventh period includes the radium and actinium series, characterized by radioactivity. This period could be related to the lowest level of the biological organization, the primary one, probably even the submolecular level. This would relate the intervention of radioactivity—from cosmic rays and especially from the earth's radioactive elements—to the beginning of the biological realm. Such radioactive intervention could have brought together C and N to form N-C-N-C, which we considered in our hypothesis to be the first entity in the biological realm. This view represents, at least, a new basis for an interesting working hypothesis.

Thus we have the concept of hierarchic compartments related to changing environments. We also can correlate, further, the environments to the



periods in the periodic chart to which their principal constituents belong. It is difficult to accept as purely accidental the correlation of the changes in environments with the progressive displacement of their constituents toward periods in the chart with members each time having lower atomic weights. It is in this progression that we can see homotropy developing toward its maximum, complete value. This view, which will be discussed in more detail later, again relates evolution of the biological realm to progress of homotropy, with the environment representing the concrete realization of homotropic evolution.

The entire chart can be considered in terms of hetero and homo series and of periods that correspond to hierarchic compartments, as shown in TABLE V.

For the moment, the possibility of relating an element, through its membership in a series, to the hetero or homotropic trend and, through its place in a period, to an organizational hierarchic compartment, helps to explain many of the peculiarities seen in the biological distribution of the elements and especially in the role played by them at the "proper" levels to which they belong.

As a general rule, the presence of an element at the level to which it belongs is directly correlated to quantitative optimum values corresponding to the constants of the level and to the qualitative role which it performs. Its presence at levels other than its own must be interpreted in connection with its activity at its own proper level. Increase or decrease in the amount of an element has a different meaning according to the level at which the variation occurs. If it occurs at the specific proper level to which the element belongs, it would indicate a direct quantitative or qualitative change in the activity of the element. At other levels, this is not true. If the activity of an element is qualitatively impaired at its own level, the amount of the element at the immediate superior level will increase. The increase at the superior level can be interpreted as taking place in order to keep at the disposal of the impaired level a sufficient amount of the element for possible later use. On the other hand, an abnormally intensive activity of an element at its own level will reduce the amount of it present at the level immediately superior. The decrease at the upper level can be interpreted as a defensive attempt to reduce the abnormal activity by limiting the supply.

The general rule, which appears to govern the variations in distribution of an element within the organism, makes it important to know the proper level of an element. Some examples will illustrate what we mean. An increase of copper is seen in the blood serum of cancer patients, although



PERIODIC CHART OF THE ELEMENTS

	IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII	IB	II B	IIIA	IVA	VA	VIA	VIIA	Inert gases											
	Ht	Hm	Hm	Ht	Hm	Ht	Hm	Ht	Hm	Ht	Ht	Hm	Ht	Hm	Ht	Ht											
	H	Be	Sc	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	B	C	N	O	He											
ORG.	Li	Mg	Ca	Sr	Rb	Cs	Ba	La	Y	Zr	Nb	Mo	Tc	Re	Os	Pt	Au	Hg	Tl	Pb	Sn	Sb	Te	Po	At	Xe	Rn
MET.	K	Na	Sc	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	B	C	N	O	He											
CELL.	Rb	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	B	C	N	O	He										
NUCL.	Rb	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	B	C	N	O	He										
SUB. NUCL.	Cs	Na	Ca	Sc	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	B	C	N	O	He										
PRIM.	Fr	Ra	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu											
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No												

\* Lanthanum Series  
 \*\* Actinium Series  
 Ht = Heterotropic  
 Hm = Homotropic

a manifest reduction in catalase as well as in copper content is seen in the tumor cells themselves and in the liver cells. According to the view presented above, these findings can be interpreted to reflect a primary insufficiency of copper at its specific level, that of the cell. Copper is quantitatively deficient at the level of the cell not because of its low availability, but because it cannot be utilized well enough qualitatively to form catalase. The qualitative impairment in copper's use at its proper level would lead to an increased amount of copper in the immediately superior compartment, that of the blood serum.

The knowledge that copper belongs to the cellular level, because of the period to which it belongs, could explain this peculiarity. The organism does not have *too much* copper although the amount of it in the blood is increased. Neither does it have too little copper at the proper level. The abnormality resides in a qualitatively impaired capacity of abnormal cells to utilize copper. In tentative therapeutic application, we have to try neither to increase nor decrease the amount of copper but to obtain its proper utilization by the abnormal cells.

This view applies also to potassium. An increase of potassium in blood serum is seen in subjects with type D offbalance. With potassium belonging to the cellular level, the primary abnormality has to be sought at this level. In fact such a primary anomaly of potassium metabolism is seen in the cells for, in offbalance D, the cells are poor in potassium, possibly because the cation moves out of the cells as the result of being displaced by sodium. The increase in the amount of potassium found in the circulating blood thus can be interpreted as secondary, designed to offer the cells a sufficient amount of potassium to be utilized in attempts to overcome this offbalance. On the other hand, in abnormal offbalance A, when quantities of potassium are found present in proliferating cells, an abnormally low amount of potassium is found in blood (as low as 3.0 m Eq or less). As potassium is still excreted through the kidney, this low blood potassium is not to be interpreted as a quantitative deficiency but rather as a teleological response to the abnormally high utilization at the cellular level.

A study of potassium, presented under this aspect, is the subject of Note 2.

The relationship between elements, periods and levels of the organization explains a curious distribution of elements as seen in the following experiment. 1/10 molar solutions with pH, of dibasic phosphates of lithium, sodium, potassium, ammonium and rubidium were prepared. Each solution was injected intravenously into mice, 1/4 cc. per minute, until the animal died. The organs, and especially the brains, were immediately





fixed in Bouin solution and studied histologically. For ammonium and rubidium, vacuoles were seen present in cells and especially in nuclei; for potassium, the vacuoles were present in the cytoplasm, while for sodium, only a pericellular edema was noted. No such changes were observed for lithium. Considering the dimension of the atoms, an opposite occurrence would have been expected with lithium penetrating most into the cells and rubidium the least. The fact that the heavier elements correspond to the lower levels of the organization, according to the concept presented above, explains the occurrence.

This could also be seen for the distribution of selenium and tellurium. We could show that while selenium accumulates in the cytoplasm, tellurium—which is the next heavier element of the VI series—is fixed preferentially in the nuclei.

It must be recognized that many problems result from exaggerated or reduced amounts of elements at compartments where they do not belong as characteristic constituents. The therapeutic effort, until now, has been to try to eliminate an excess or make up for a deficiency at any level. According to the view presented above, the main effort should be to try to correct the anomaly in the metabolism of the element at its proper level for this will lead to correction at other levels. We will consider, later, some examples of such effort.

The concept of dualism and of the place of elements in hierarchic organization has opened a new way to study the influence exerted by these elements in abnormal conditions as will be presented below.

The same type of analysis used for elements can be applied to the other body constituents. We will start with those which we believe to be the most important for the problem of the offbalances, the lipids.

