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MANIFESTATION OF CHEMICAL AND BIOLOGICAL MOTION FORMS IN THE EXCEPTIONAL REARRANGEMENT OF MACROMOLECULES

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Introduction

The exploration of structure of the first expressively biological macromolecules: desoxyribonucleic acid, ribonucleic acid, myoglobin, haemoglobin, has opened a new period in the science of biology. The effect of results of the molecular biology is of so wide spectrum that its importance and connections cannot be seen completely, as yet. The results so far may doubtless induce a justified satisfaction giving rise, in the same time, to real doubts, as well. It becomes necessary to generalize the results and to select the research directions that will solve the other essential problems.

As we strive to recognize the cell, we cannot help disassociating the living cell into more and more elementary components, investigating it with isolating methods. In the course of work, getting giddy with some important results, we can be under the impression that the regularities, properties of the elementary particles are summed up simply in the complex systems, i.e., the supra- and macromolecular motion forms can be reduced entirely to the molecular motion forms. The exaggerated enthusiasm and preponderance of those thinking mechanistically is involving the danger of forgetting possibly the truth that "it is proved by any state of substance, from the simplest one till the most complicated state, that the structure is a basic condition of the formation of the whole" (Svidersky, 1963).

In our former monograph (Maróti, 1967) we dealt with specificity of the structure of living beings, with relation of structure and function, the development of its idea. We have emphasized that the structure of living beings is not only the quantity and the simple qualitative relation of their constituents but it is also a definitely directed system of a complex interaction of their elements, being a foundation of their development, their relative stability and qualitative determination. In the introductory part, already, it is to be emphasized that, in contra-

distinction to papers of more authors: Mamzin (1960); Svidersky (1960); Meerson (1964), etc. and in agreement with that of Rózsi Varró (1966), we are endeavouring to disclose the specificity of the structure of living beings.

In our present monograph, we are looking for the connection in the creation of macromolecules that has induced the production of biological motion forms out of the chemical ones. We think to recognize that, in the structures of different levels but connected genetically and being exceptionally rearranged.

I. The structure is an exceptional and necessary rearrangement of the components of living beings

A pioneering work concerning the extensive and comprehensive disclosure of the structure as an internal content of the quality has been performed by Svidersky. First of all the results of organic chemistry, atomic physics and biological sciences have contributed to the constituents of structure being recognized. In the improving analysis of the qualitative determination the works of Holderith-Magyaródi (1963) are eminent, in the field of chemistry those of Erdey-Gúz (1967), and in philosophical connections those of Rózsi Varró (1966).

From the development of motion forms we may draw the conclusion that in the structure of living beings there must be something specific, some law of general validity, separating them from, and simultaneously connecting them to, the inanimate world. We think to recognize this peculiarity in the relation, of a direction exceptionally arranged in time and space, of the constituents forming the structure of living beings.

1. The origin of being exceptionally arranged

It is shown by the dialectics of the parts and the whole that it is characteristic of any states of substance to be arranged. The structure of living beings shows an exceptional arrangement differring from that of the anorganic world but the extraordinary foundation of arrangement is in the inanimate world. The question arises: How is manifested the arrangement in space and what is its cause? Whether the arrangement has quickly originated from the material performing an inferior motion and being generally arranged — or the foundation of the exceptional arrangement can be found already on sub-atomary, atomary and chemical levels, as well.

For a long time it has been a generally known fact that the organizing role of the constituents of structure of the living beings is not corresponding in value. Nevertheless, we have not noticed for long that in the development of the structures of different levels the levels, the new qualities are not originating frontally but owing to primary changes given by the internal feature of a few elements that determine the phenomenon. It is a natural consequence of these considerations that the foundation of a superior arrangement that is characteristic of

the structure of living beings can already be observed on sub-atomary and chemical levels, as well. Thus the interest turns repeatedly and first of all on the carbon atom. Then we have to look for a property of the carbon atom that is common in the course of the arrangements on different levels but it is manifested in different relations in the physical, chemical and biological motion forms.

From the 103 elements recognized so far, carbon is alone able to a replication consisting of more than two identical elements. As we use the notion of replication in a general form, it is desirable to define it exactly.

2. Notion of replication

Replication is a repetition of comparatively homogeneous elements (particles), being energetically interdependent and of nearly identical pattern, in which the first elements of the structure have a directing, determining ability. Replication has two main forms: structural replication — where pattern and copy remain in a strict connection in space — and free replication where the connection between pattern and copy is but temporary.

As a consequence of the replication, from the identical elements there are produced qualitatively new "aggregations" the basic unit of which is two or four. In respect of arrangement, pattern and copy are nearly equivalent but as to the ontology of the phenomenon, the pattern is primary.

In case of structural replication it seems so as if pattern and copy were entirely coincident with each other, i.e., as if the identical elements could form an accidental or discretional aggregation. Actually, in the course of replication the identical elements suppose each other reciprocally, they may be potencially patterns and copies of one another.

As a result of the replication, besides the quantitative conditions, there prevail more and more the complicated and increasing reciprocal effects in the new structures produced, forming the internal content of the new qualities and, at the same time, a foundation of the exceptional arrangement.

3. Characteristics of the exceptional arrangement

After all these we should investigate by what properties the exceptional arrangement in space and time of the different forms of material is shown.

a) A connection of the parts forming the phenomenon in which these parts are capable maximally of preserving and changing their own features.

b) The few elements of the phenomenon that have preserved in an increased degree their homogeneity can change, primarily and directing, as a result of the other elements of the phenomenon.

c) The exceptional arrangement is a manifestation of the general arrangement, a result of the selecting influence of the inorganic world.

d) An aggregation of the configurative energy is a condition of this rare rearrangement.

Ernst, reviewing (1963) the enthropy theorem formulated by Boltzmann-Planck ($S = k \ln W$), is pointing out that the absolute enthropy value consists of the thermic and configurative sums of enthropy: $S=S_k+S_t$.

The mathematical meaning of the law expresses the superiority of the statistical distribution in contradiction to a rare arranged distribution, as well the reciprocal relation of structural arrangement and enthropy. It is obvious, therefore, that from the elements recognized so far, only carbon is able, decisively and determinatively, to accumulate the configurative energy on molecular level (decreasing entropy).

The exceptional arrangement manifests itself in different forms on different levels of development of the organic matter; anyway, every level is conform to the others in being a result of replication and in the reductibility of the potential basis of arrangement to the nuclear structure of the carbon atom.

II. Role of the carbon atom in the development of the exceptional arrangement

We are surrounded everywhere by living beings. Examining our surroundings and ourselves, we may become victims of optical illusions, namely it can seem so as if the biological motion form were a very general one. This is true, however, according to our present knowledge, only on the Earth and on similar planets. Erdey-Grúz (1967) is ascertaining that "the overwhelming majority of the substance of the Universe (in our Galaxy about 97—98 p.c.) don't participate in the chemical motion form". This statement is even more valid to the biological motion forms.

Structure and motion form of substance depend on temperature, pressure, on reciprocal effects of electricity and gravitation:

a) In a temperature of a few hundred thousand C°, under a pressure of some million atmospheres there are neither molecules nor atoms, in the so-called plasma state there are to be found mostly bare nuclei and freely moving electrons between them.

b) In some ten thousand C°, under a pressure of a hundred thousand atmospheres more and more electrons join gradually the nuclei: new quantized qualities, the atoms are produced.

c) In about 12—10 thousand C°, under a pressure of a few ten thousand atmospheres attraction and repulsion between the atoms begin to show themselves. The chemical motion form, however, becomes essential only under 5000 C°.

d) The majority of the organic compounds decompose, are reduced to carbon under 300 C°, and even the comparatively stabler compounds of small molecular weight about 700 C°.

e) In case of living beings, death comes generally at about 50 C° (in case of blue algae of thermal springs, of some bacteria, at 70—75 C°),

and about the freezing-point, the majority of the vital processes cease to be.

Taking all these into consideration, we can ascertain that life is a very rare phenomenon that is a result of the increasing internal and external reciprocal effects of the elements composing the structure (of the increasing sensitivity to heat and pressure). And we again get to the basic point of departure, whether every element (atom, molecule, macromolecule, supramolecule, organellum, etc.) is taking part, as equal, in the increasing mutual effect or only one or a few of them is playing decisive role.

Whether or not the rather vulgar fantastic idea according to which in the colloidal material of some space living beings there is silicon or germanium instead of carbon, and in their energy systems arsenic or sulphur instead of phosphorus, has a real basis?

It follows from the notion of the exceptional arrangement that this real basis is missing. Life could develop only by the primary and directing organization of the carbon atom. If there are living beings on a planet of Universe, the external conditions and their development must be similar to, the internal organization of the living matter must be identical with, those on the Earth.

Before beginning to analyse the development levels of the exceptional arrangement in details, an important question is to be cleared that may have already arisen many times in the reader.

Isn't it a metaphysical speculation, to establish any connection between the organization and function of structure of the living beings and the structure of carbon nucleus and electron shell? In our opinion, it isn't.

If we emphasize only the external interactions (relation to one another and to other molecules) of a given structure (e.g., DNS, ATP, etc.), so we separate its main motion form (function) from its accidental motion forms, from the regularities which are valid in the relation of its constituents, remaining subordinated even in the structure of higher level. So the genetical connection existing in the structures would be neglected, the structures of different levels would be separated mechanically, seeming to be without any correlation what is fully opposite to the evolution of the living world. This is made clear by H e g e l (1957) in connection with the formation of a new thing: "The basis of the origin being gradual is the idea that the thing which is about to come into being is already existing actually sensorially or generally only it isn't perceptible, as yet, owing to its small size; and the situation is the same at a gradual fade-out: the nonentity or something else which will substitute it is already present in the same way, without being anyway perceptible for the time being".

It is similarly a metaphysical way of thinking if in a given structure we are emphasizing only the internal reciprocity of the elements getting, in that way, to the false opinion that the motion form of higher order can be reduced from that of lower order. That is to say, in the structures of different levels there isn't any new quality, they are simply added together mechanically from components (structures) of lower level — what is similarly at variance with experience.

1. Specificity of the carbon atom

It is ascertained by Erdey-Grúz (1967) that: "the chemical motion form is connected with the interaction of atoms themselves, its phenomena are the manifestations of internal contrasts showing in the specific (nongravitational) attraction and repulsion".

In the interrelation of carbon atoms an exceptional contrast is showing, as a result of which from the 103 elements only carbon is able to change its properties preserving them, anyway, maximally. What is the cause of that? The replicative structure of carbon atom:

a) Carbon is the first element of the fourth "b" column of Period Two. The mass number of the atom (A) is formed by the amount of even-numbered protons (P) and neutrons (N). The atomic number (Z) and the number of protons is identical $A=P+N=Z+N=6+6$.

b) The origin of carbon nucleus may have been based on the principle of replication. This seems to be verified by the collision of the first element (Berillium) of the second column of Period Two against an α particle:

$$^{9}_{4}\beta e(\alpha, n)\, ^{12}_{9}C$$

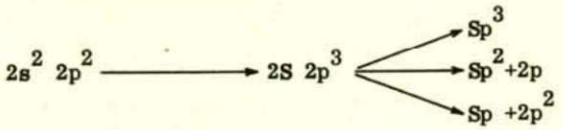
c) The proton-neutron configuration can form a nearly ideal symmetry. In Period Two, the cubical content of grammatom is the smallest, the nucleus having a great influence over the electron shells.

d) According to Bohr-Sommerfeld's theorem, the electron shell of carbon in fundamental position has the most homogeneous structure of replication that is nearly ideally symmetrical. The spherical K and elliptical L main quantum orbits, as well the main, subsidiary, magnetic and spin quantum values are in a relation of progressive replication:

Table 1

Z		K	L		Electron configuration
		1S	2S	2p	
1	H	1			$1S$
2	He	2			$1S^2$
3	Li	2	1		$1S^2\ 2S$
4	Be	2	2		$1S^2\ 2S^2$
5	B	2	2	1	$1S^2\ 2S^2\ 2p$
6	C	2	2	2	$1S^2\ 2S^2\ 2p^2$
7	N	2	2	3	$1S^2\ 2S^2\ 2p^3$
8	O	2	2	4	$1S^2\ 2S^2\ 2p^4$
9	P	2	2	5	$1S^2\ 2S^2\ 2p^5$
10	Ne	2	2	6	$1S^2\ 2S^2\ 2p^6$

e) The nearly ideal symmetry in ground state of the electron cloud of C atom becomes strongly asymmetrical as a result of the polerizing effect of the surrounding atoms; this asymmetry is the basis of a symmetry of higher degree. According to Panling)(1928), in the state of energized electrons of the carbon atom the $2S^2$ electron-pair dissolves: one of the electrons remains on the 2S spheric symmetrical orbit, the other on the 2p orbit takes up a dumbbell symmetrical orbit, forming a right angle to the two electrons there. This carbon atom joins with four, three or two atoms, the orbits of its valence electrons change, by being mixed ,into hybrid orbits oriented tetrahedron-like (Sp^3), plane-trigonally (sp^2) and linearly (sp):



f) The special attraction and repulsion between the carbon atoms change, as a result of the surrounding atoms, dynamically, through relative equilibria. The charge clouds of the hybrid orbits of contrary spinstate and of nearly identical energy level and those of $2p_z$ orbits penetrate into each other in different degrees. As a consequence of that, the value of the bond length characteristic of the molecular orbits of δ and π types is different:

Bond	Bond length A°	Occurrence
C-C	1,36	diacetylene
C-C	1,42	graphite
C-C	1,46	methylacetylene
C-C	1,47	butadiene (1,3)
C-C	1,54	paraffins, diamond
C-C	3,35	graphite
C=C	1,33	aethylene
C=C	1,37	butadiene (1,3)
C≡C	1,19	diacetylene
C≡C	1,20	methylacetylene
C≡C	1,21	acetylene

III. Compounds essential from the point of view of biostructure and function

General characteristics of the organic molecules composing the living beings — besides their properties enumerated above — are: an inclination to a structural heterogeneity, the macromolecules formed by the specification of the atom and elementary units, the structural energy, the increased sensitiveness to heat, the low speed of reaction. The carbon, preserving its homogeneity, is able to get into an electron-bond connection with elements of similar electron shell (H, O, N, S, P)

and, in that way, to change directingly and primarily concerning the whole organic molecules: The extremely various macromolecules, that are often species specific, are built out of a few elementary units, on the principle of replication.

1. Active, elementary organic "molecules"

In the course of the genesis of the natural organic molecules, the carbon atom, owing to its "inclination" to an exceptional arrangement, is capable of changing through minimal alterations-preserving its properties. The minimal alteration is assured by its electron-bond connection with oxygen, the next element of similar electron shell. The electron shell of oxygen is built up, as well, on the principle of replication ($1S^2$ $2S^2$ $2p^4$), it is, however, more mobile and its electron affinity is greater than that of carbon. Taking into consideration the replicative configuration of the electron shell, oxygen has the greatest capability of being polarized.

The primary elementary particles (ions, free radicals, elementary "molecules") that take part in forming the macro- and supramolecules of the structure of living beings are mostly derivatives of carboxylic acid. From the active carbon compounds the derivatives of acetic acid are particularly important. The electron configuration of acetic acid is determined, apart from being polarized inductively, by the configurative interaction of electrons and of the solitary electron-pair.

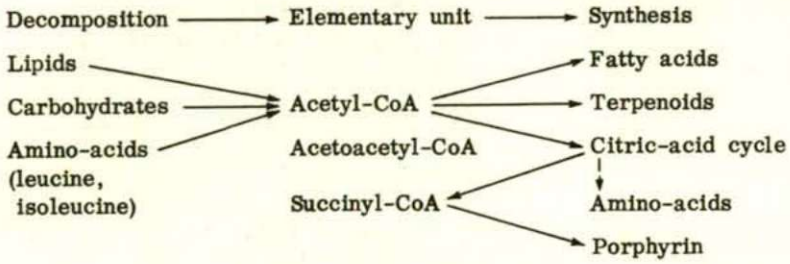
In forming and building the structure, also sulphur that is in a close connection with carbon, has a considerable role. The electron shell of sulphur atom, as well as that of oxygen, are built up in a replicative way ($1S^2$ $2S^2$ $2p^6$ $3S^2$ $3p^4$). Its polerizing and conjugative interaction is, however like that of oxygen.

For demonstrating that in synthesis of the biostructure the exceptional arrangement prevails, it is necessary to reveal the replicative elementary units. Decker and Lynen (1951) have discovered the acetyl-CoA enzyme. They have demonstrated that in the living organism the acetic acid is forming thiol-ester, not in its free shape but the acetyl group with the sulfhydryl group of the coenzyme-A:

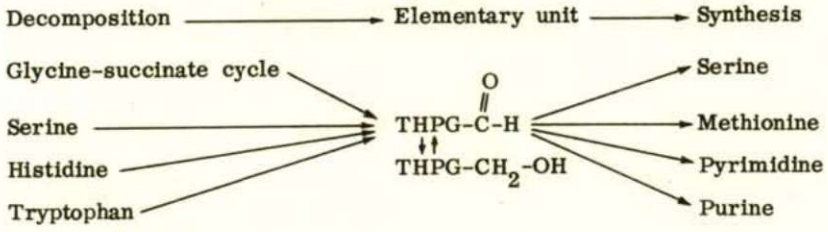
$$CH_3\text{-}\overset{\overset{O}{\|}}{C}\text{-S-CoA.}$$

Since then, it was often demonstrated that the active C_2 compound takes a central place in metabolism.

In the living organism there are a lot of amino-acids and nucleic-acids containing odd numbers (3,5) of carbon atoms. These compounds are mostly formed through a replication of the active C_1 radical (N^5 or N^{10}-formil tetrahydropteroilglutamic acid, THPG) and of the active C_2 or C_4 compounds.



Place of the active C_2 and C_4 compounds in the synthesis of molecules forming the biostructure of cells



Place of the compound C_1 in the cell metabolism

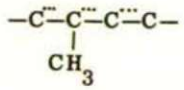
2. Fatty acids

In the formation of the boundary membranes of the cell the lipids have a great importance. Most lipids contain fatty acid in ester-bond. All the fatty acids occurring in the living organisms have even carbon-atomic numbers. In the various organisms there occur mostly fatty acids of 16 and 18 carbon-atomic numbers. The biosynthesis and decomposition of fatty acids are among the most important proofs of the manifestation of the exceptional arrangement. Taking into consideration that the fatty acids are mostly of dimer structure proved by the hydrogen-bond formed between two molecules, so the replicative unit of four carbon-atomic number has a manifold verification.

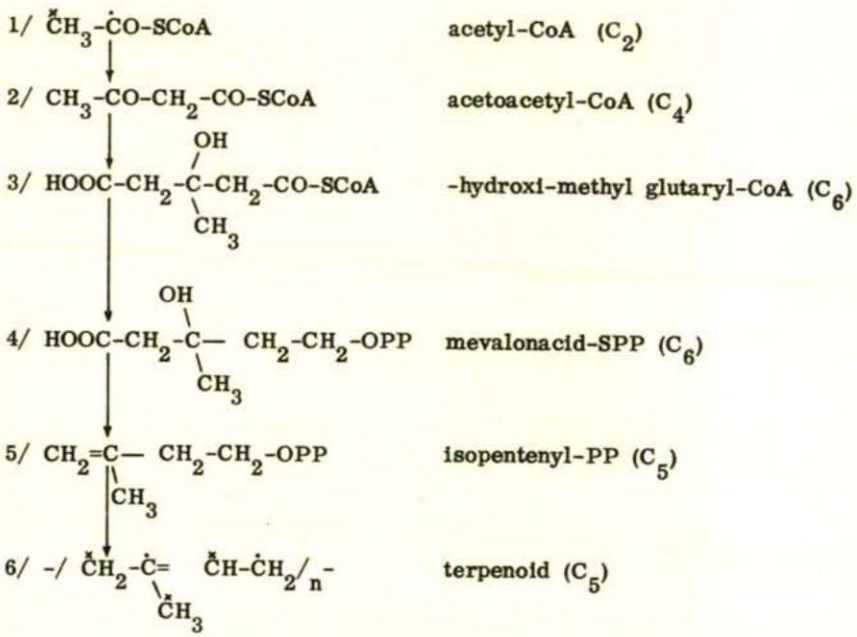
3. Compounds of isoprene skeleton

The terpenes (ether oils, phytol, K and A vitamins, carotinoids, steroids, caoutchouc, etc.) are compounds rather general in the flora and fauna. The terpenes are characterized by being constructed of the isoprene structural unit. A property of the isoprene skeleton is that the body of an "elementary molecule" is formed by four carbon atoms in an sp^2 plane-trigonal hybrid state that are connected with π delocalized conjunctive mutual effects induced by δ-bond and p-electron orbits

orientated at right angles to it. The reflection symmetry of the four carbon atoms is decomposed by the electron-repulsive methyl group connected with δ-bond to the double carbon atom.



The unit containing five carbon atoms seems to be in contradiction to the principle of replication, i.e., the C-atomic numbers 1, 2, 4, 6 are to be expected as a structural unit. In the course of studying the production of terpenes, however, it was ascertained by Grob (1951), Decker and Lynen (1960) that the active C_2 compound, acetyl-CoA, is one of the precursors of isoprene, as well. The major parts of the bi-synthesis of terpenoids are summed up, on the basis of the works of Lynen (1959), Tada (1961), Sandermann (1962), as follows:



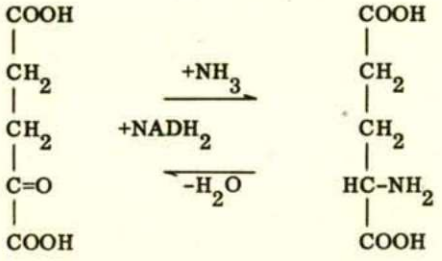
4. Amino-acids

In the genesis of macro-molecules, besides the relation of carbon with oxygen also its connection with nitrogen, the other element of a similar electron shell, is of decisive importance. Oxygen is the activating, motile "relation", nitrogen is the most consistent with carbon, the organizing, directing element. Besides the great importance of nitrogen, Doby's (1941, 1959) opinion is one-sided saying that N is the "vital

element" of cells, so-called governing element. Carbon, getting into an electron-bond connection with nitrogen, preservs and partly disintegrates its hegemony and is, therefore, able to direct syntheses in which the elementary particles change preserving, anyway, their own properties in an increased degree.

In forming the macro-molecules, the decisive process in the first degree is the synthesis of amino-acids. To take nitrogen into an organic compound can be connected with the inductive polarizing ability of oxygen. A decisive evidence for the amino-acids being synthetized by replication would be if we could establish which was the very first elementary compound, amino-acid, possibly amino-acids that the other amino-acids can be derived of. The great lot of experimental data collected in the latter decades don't give any satisfying reply to this question. This can partly be explained also by the fact that the bulk of experiments took place with heterotrophic organisms, first of all with animal objects.

It is a general opinion that in the synthesis of amino-acids glutamic acids play the primary role. This opinion is supported by the primary appearance of α-keto-glutamic acid in Szentgyörgyi-Krebs's cycle and by the reversible transformation of NAD with co-enzyme into glutamic acid.



The central significance of glutamic acid is still more emphasized by Cohen's and Cammarata's (1950) remarkable results according to which they could transaminate the synthesis of 20 sorts of amino-acids with α-keto-glutamic acid. In spite of several convincing results, in our opinion the primary amino-acid is not the glutamic acid but aspartic acid:

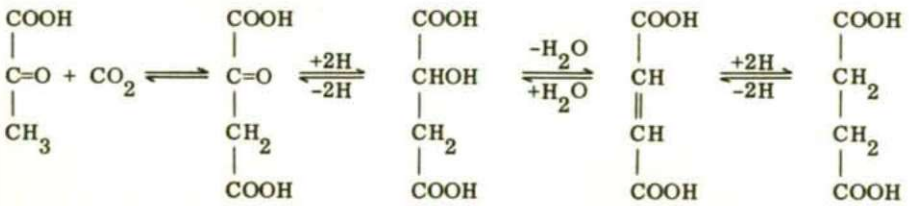
a) Glutamic-acid is of 5 carbon-atomic number, therefore, it cannot be an elementary unit of replication.

b) In the course of photo- and kemo-synthesis, it appears later than aspartic-acid.

c) Glutamic-acid is produced first of all during dissimilation.

In the course of kemo- and photo-synthesis, the dicarboxylic acids that contain four carbon atoms can appear primarily, too, thus they take a central place in the synthetizing and decomposing processes, among others, in the primary formation of aspartic acid. C_4 acids are produced even at the assimilation of CO_2 in darkness. These acids were earlier considered to be productions of a decomposition. On the other hand,

Werkman and Wood (1936) supposed in case of bacteria producing propionic acid, and Krampitz and Werkman (1951) verified about them, that the enzymes of the citrate cycle synthetize succinic acid, functioning in a reversible way.



pyroracemic acid | oxalacetic acid | hydroxysuccinic acid | fumarolic acid | succinic acid

This process has a great importance for the primary formation of the active C_4, succinyl-CoA and aspartic acid. In genesis of the amino-acids, the primary appearance of aspartic acid has been established during the investigation of photosynthesis, as well.

Table 2. Percentage and temporal appearance of $^{14}CO_2$ in primary compounds produced during photosynthesis

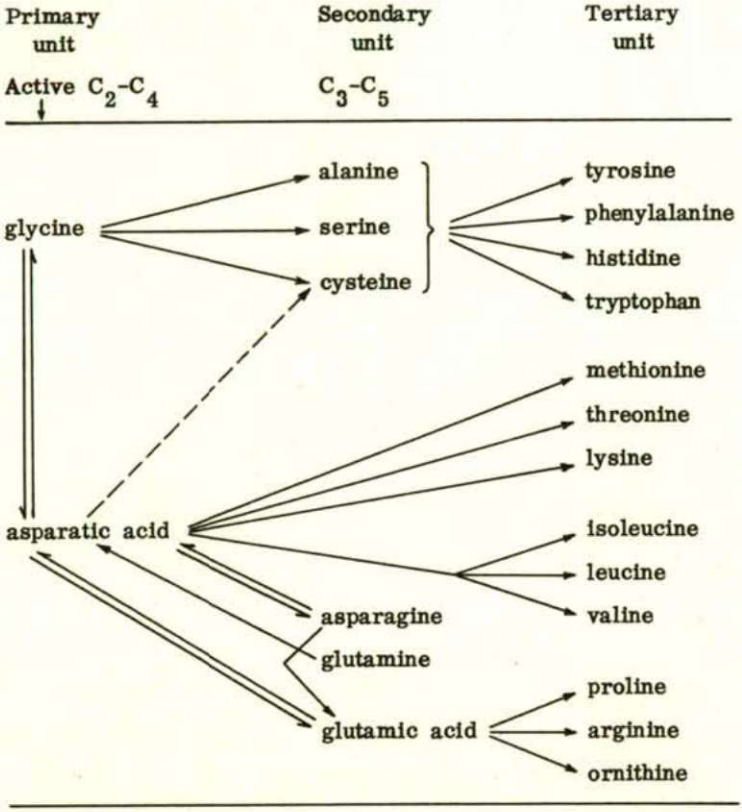
Investigated plant	Scenedesmus[1]				Chloroplast[2] + cell sap	
Duration of photosynthesis	5 sec.	30 sec.	90 sec.	5 min.	1 min.	30 min.
glycol acid	-	++	+++	+++	-	-
phosphoglycerate	+++++	+++++	+++++	+++++	61	78
hydroxysuccinic acid	+	++++	+++++	+++++	4,2	4,0
fumarolic acid	-	-	+	+	-	-
succinic acid	-	-	+	-	-	-
glycine	-	+	+	+	-	7,8
alanine	-	+	++	+	-	1,8
aspartic acid	+	+	++++	++	7,9	4,5
glutamic acid	-	-	-	+	-	-

[1] Signs according to Calvin and Benson (1948): - none, + hardly observable, ++ very weak, +++ weak, ++++ strong, +++++ very strong

[2] Results of Holm-Hausen et al. (1959) obtained from chloroplast suspension isolated of spinach leaves.

Aspartic acid is an active compound, turning fast into other amino-acids. Rautanen (1948) fed pease with aspartic acid and it became manifest that aspartic acid did not accumulate even in that case in a larger amount but it was changed into glutamic acid, glutamine and alanine. If this proved true generally in case of several plants, it would considerably support the theory of the genesis of amino-acids by repli-

cation. The origin of amino-acids is not known in several respects. Nonetheless, it is certainly not a rash conclusion if we think on the basis of literary data that the primary role in the origin of the amino-acids is played by the molecules C_2 and C_4:



The supposed replication relations of the amino-acids.

5. Biosynthesis of heme, chlorophyl and cyanocobalamine

The natural synthesis of the porphyrine skeleton of tetrapyrolic structure is a remarkable proof of the organic molecules of every living being originating in their main features in a unitary way. This applies particularly to the formation of the primary and secondary elementary "molecules". In genesis of the organic molecules, levels, points of jonction can be distinguished. The appearance of life is proved by complicated structures continuously and broken from the atomary level. However complicated these molecules are, anyway, numerically they are very limited as compared to all those molecules that could be produc-

ed with another rearrangement of the same atoms. The discrete parts (molecules) that don't prove the exceptional arrangement being continuous, are selected out, their importance in the formation of structure is but of minor value. On the basis of the investigations of Shemin (1962), Granick (1967) and others we know that both in case of plants and in that of animals, the porphyrine skeleton may be reduced to the replication synthesis of succinyl-CoA and glycine (active C_2 and C_4). The amphoteric porphyrine-ring is built up by 20 carbon atoms and 4 nitrogen atoms, forming a heterocyclic, conjunct aromatic system. The continuous conjunction extends over 16 carbon atoms and two nitrogen atoms. The specifity that is characteristic of the single molecules and taxons is assured by the change of a few elements, radicals, connected with the macrocycles.

IV. The increasing arrangement in space and time is a condition of the exceptional rearrangement of the elementary molecules

In our first monograph we have emphasized that the exceptional arrangement is multilevelled and that these levels are connected with one another. Erdey-Grúz (1967) establishes in connection with the rearrangement of matter that the three-degree classification of the rearrangement of matter (atom, molecule, macrobody) is already antiquated. The chemical substance is arranged in more degrees, through new material qualities. The formation and development of the living substance, as well, are realized through main stages and smaller points of junction.

The primary and secondary elementary units of organic compounds (free radicals, elementary molecules) originate spontaneously in the inanimate nature. The atomic groups produced in that way get into connection with one another, the direction of their reactions is reciprocal, in compliance with the laws of concentration and mass effect, pointing to a statistical equilibrium, while their entropy is growing. The parts, and only those ones that have preserved in an increased degree their exceptional arrangement in the course of their reactions, can temporarily get into a progressive dynamic equilibrium by using external energy through more points of junction, i.e., their structural arrangement is growing, their entropy decreasing. After having reached certain degree, however, they are no more capable of any further spontaneous arrangement and decomposed get into a static equilibrium. The elementary particles of carbon, oxygen, nitrogen content that in the structural heterogeneity have preserved their homogeneity in a higher degree get, primarily too, more frequently into a temporary dynamic equilibrium, increasing in that way their own directing, arranging, catalysing "inclination".

As a result of the increasing arrangement in space and time, there are produced units of primary, secondary, tertiary and n-th order in different amounts. The molecular number of the primary units is much higher than e.g. that of the units of the fourth order.

Each of the molecules comes, because of its internal structure, into conflict with the surroundings created by itself and by other molecules. The struggle of contrary tendencies is resulting in a peculiar distribution of molecules in space and time. The identical molecules accumulate more and more in space, getting localized. The temporary accumulation and absence of these elementary units induce an increasing rhythm.

The exceptional arrangement predominates over the particular relation of the elements, besides the characteristic quantitative changes. Without discussing any further interrelations of these elements, their determined symmetrical (right and left) and temporary connections, we only call the attention to the peculiarity of the quantitative connections.

On the different evolutionary levels of the exceptional arrangement. the elementary particles often form double and fourfold, rarely sixfold, fivefold and threefold elementary aggregations. Pressed for space, we are giving here only a few examples of the double and fourfold units:

1. General properties of the organic compounds playing an outstanding role in the structure of living organisms are the replication of the atomic and elementary atomic groups and a structural heterogeneity. The units of replication containing double and fourfold carbon atoms are the following:

a) In the cocoanut oil the percentage of fatty acids of different carbon-atomic numbers is: C_8=9 p.c.; C_{10}=8 p.c.; C_{12}=52 p.c.; C_{14}=19 p.c.; C_{16}=10 p.c.; C_{18}=12 p.c.

b) The "body" of the isoprene skeleton is formed by four carbon atoms. Phytol and vitamin A are consisting of 20, carotenoids of 40 carbon atoms.

c) In the ring of ribose, desoxyribose, xylose, arabinose, furanose, four carbon atoms form a unitary electron shell structure.

d) The dicarboxylic acid of four carbon atoms and the succinyl-CoA have a central role in forming the cell structure.

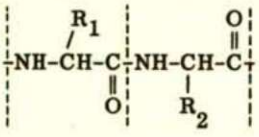
e) In the production of the amino acids, glycine and aspartic acid have supposedly a primary importance.

f) The porphyrine skeleton consists of quadruple units.

g) In the ring of cytosine, uracil and timine pyrimidine four canbon atoms, two nitrogen atoms form a conjunction unit.

h) The value of the 9.N-glycoside bondlength of adenosine and guanosine is supposedly smaller than 1,47 A°, thus the 1'-carbon atom of ribose β-configuration can belong, as to the electron distribution, to the furanose as well to the imidazole ring.

i) In the ridge of the polypeptide chain



units are repeated.

2. A general propriety of the macro- and supramolecular systems is the occurence of stereo-heterogeneity and the molecular replication.

The increasing of space-specificity is made possible by the formation of the primary filamentary, helical structures. The secondary and tertiary conformations are verified by the hydrophobic mutual effects, hydrogen-bonds, disulphide-bridges. During the molecule-replication or autocatalysis, pattern and copy are separated from each other. The first revolution of „independence" is a consequence of structural replication and of the increased arrangement in time. On this level, as well, the nx4 complexes are frequent:

a) DNS and RNS are formed by four bases;
b) Proteins are formed by 20 kinds of amino-acids;
c) Haemoglobin consists of four sub-units. The structure of the quadruple one is formed by two α- and two β-polypeptid chains;
d) The nucleic acid of the bacteriophage marked as Φx174 is covered with 12 protein molecules. On the nucleic acid of the poliomyelitis virus (pathogene of infantile paralysis) 60, on that of the Bushy stunt virus 120 protein molecules take place;
e) The pyruvate dehydrogenase multienzyme-complex is formed by 16 molecules decarboxylase, 64 molecules lipoic acid transacetylase and 8 molecules flavoprotein;
f) The cilium of the bacterium *Salmonella* is built up of four elementary filaments;
g) On the external side of the thylacoid membrane of chloroplast the multi-enzyme complexes take place in groups of 4 (quantasoma) or in those of 8, 12 and 16.

3. The basis of the exceptional arrangement of the living beings is the process-heterogeneity and the cellreplication. The structural organization gets a definite direction: it progresses from a relative homogeneity towards a heterogeneity, then it jumps to a homogeneity of higher degree. Owing to the characteristic "own space" and "own time" symmetry, rhythm, process of the cells, they get free gradually and more and more from the immediate influence of the inorganic world. The numerical observation of the cell division at the multicellular beings is difficult to follow after the fourth rhythm. The cell replication can be observed well in cell families living in loose colonies.

a) At some kindes of bacteria, e.g., in *Thiosarcina* and *Sarcina* colonies the nx4 location of cells can be seen well;
b) In the cell families of blue algae surrounded by mucilage-covers the change of cell numbers can be followed, as well: e.g., *Chroococcus turgidus* forms loose colonies consisting of 4 cells, *Merismopedia glauca* those of 32 cells, *M. punctata* those of 64 cells;
c) From the green algae, the species of the orders *Volvocales* and *Chlorococcales* afford the most beautiful and various examples of the colonies of cell-number 4;
d) Apart from enumerating still several examples, finally we mention that all the micro- and macrospores, as well ova and spermia, are generally formed in fours, rarely in nx4s.

In our monograph we have wanted to emphasize only a few aspects of the states of the exceptional rearrangement. With that, we should

like to emphasize. For being able to understand the idea of life and the laws of living matter, we ought to look in the inanimate and living world not only for differences but also for similarities.

The exceptional rearrangement manifested in the motion form of the supra- and macro-molecules is produced first of all by the free replication. The main role is played in the free replications by the van-der-Waals forces, in the structural replication by the chemical bonds. The free replication can be reduced genetically from the structural replication.

References

Calvin, M. and Benson, A. A. (1950): 7. Expt. Bot. *1*, 63—75.

Cohen, P. P. and Cammarata, P. S. (1950): The Enzymes. — Acad. Press. New York.

Decker, K. and Lynen, F. (1960): Handbuch der Pflanzenphysik XII/1. 5+7—619.

Doby, G. (1941): Nitrogen is the vital element. — Term. tud. Közl. *5*.

Erdey-Grúz, T. (1967): About the chemical motion form. — Magyar Tudomány *2*, 71—81.

Erdey-Grúz, T. (1967): About the degrees of rearrangement of the chemical matter. — Magyar Tudomány *12*, 769—776.

Ernst, J. (1963): Molecular biology and the thermodynamical bases. — MTA Biol. Oszt. Közl. *6*, 75—80.

Granick, S. (1967): The Heme and Chlorophyll Biosynthetic Chain. Biochemistry of Chloroplast. — Acad. Press. London and New York.

Grob, E. C. and Poretti, G. C. (1951): Experimentia 7, 218—231.

Hársné, Varró, R. (1966): Structure and function as essential elements of being qualitatively determined in the living world. — M. M. Tájékoztató *2*, 5—16.

Hegel (1957): The art of logic. I. — Akad. Kiadó, Budapest.

Holderith, H. — Magyaródi, S. (1963): The problem of organic molecules being qualitatively determined. — Magyar Fil. Szemle *1*, 51—65.

Holm-Hansen, O., Pon, N. G. and Calvin, M. (1959): Physiol. Plantarum *12*, 475—492.

Krampitz, L. O. and Werkman, C. H. (1951): Enzymol. *12*, 42—151.

Lynen, F. and Henning, V. (1959): Angew. Chem. Internat. Edit. Sample Issue.

Mamzin, A. S. (1960): Kategorii "soderzhanie" i "forma" v biologii. — Voprosy Filosofii 7, 70—77.

Maróti, I. (1967): Structure — as a relation of exceptionally rearranged direction of the components of living beings. M. M. Tájékoztató *5*, 52—63.

Meerson, F. Z. (1964): Dialektitcheskoe edinstvo funktsii i struktury. — Voprosy Fil. *11*, 65—72.

Rautanen, N. (1948): Ann. Acad. Sci. Fen. *2*, 33—48.

Sandermann, W. (1962): Holzforschung *16*, 65—82.

Shemin, D. (1962): Methods in Enzymology. — Acad. Press. New York and London *5*, 883—896.

Tada, M. and Lynen, F. (1961): J. Biochem, *49*, 758—772.

Svidersky, V. J. (1960): Ob otrazhenii materialistitcheskoy dialektikay soot-nosheniya elementov i strukturi v yavlenivakh. — Filosofskie nauki. *2*, 79—87.

Svidersky, V. J. (1963): Programme of SKP and some characteristics of the development in the obejctive world. Hungarian transl. — Magyar Fil. Szemle *1*, 15—25.

Werkman, C. H. and Wood, H. C. (1942): Adv. Enzymol. *2*, 135—182.

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