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WHAT IS LIFE ? LIFE AS A BIOINFORMATION SYSTEM

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The aim of the present work is to apply the Shannon-Weaver (1949) theory of the information to the relation between the number of the nitrogen bases and the number of amino acids present in each one of the coacervates of the prebiotic soup (Oparin, 1938).

In agreement with the information theory, the identification of a particular amino acid among m different amino acids will require a quantity of information equal to $I_m = \log_2 m$, whereas the quantity of information supplied by a nitrogen base in a system of n bases will be given by $I_n = \log_2 n$.

The proposed model is based on the following postulates:

- i) The relation number of nitrogen bases/number of amino acids contained in each coacervate, will depend on which area of the soup are isolated such molecules by membrane formation.
- ii) Not all nitrogen bases take part in the identification of an amino acid. However, from the total of these bases depend the total of amino acids among which one is going to be identified.
- iii) The number of amino acids takes a maximum value when $I_n = I_m$ or $\sum I_n = I_m$, whereas this does not take place it will be fulfilled that $I_n > I_m$.
- iv) We do not consider the repetition of bases of the same nature, for example AA, BBB, AAB, etc. Nevertheless, we permit the formation of groups of nitrogen bases (two bases codon, three bases codon, etc) of different nature, for example AB, ABC, etc. This will allow a greater simplicity of the model.

A system of these characteristics will be a BIOINFORMATION SYSTEM, in which the relation number of nitrogen bases/number of amino acids can be expressed as $()^k - ()$.

In the parenthesis of the left the nitrogen bases, which participate in the identification of amino acids, are written, being k the total number of bases and it is omitted when $k=1$. In the parenthesis of the right we place the number of amino acids among which one of them is going to be identified, and whose number depends on the total number of bases of the system. As an example, a present-day organism will have the following expression:

$$(ABC)^4 - (abc..20)$$

Since from the number of the nitrogen bases present is going to depend the number of amino acids able to support the system in agreement with the theory of the information, in the proposed model we have analysed the bioinformation systems constituted by 1, 2, 3 or 4 nitrogen bases. Once analyzed, these have been classified into three groups according to the loss of information which takes place when a base or group of them

identifies an amino acid. These groups are:

GROUP A) There is not loss of information. They are the following cases: $(A) \rightarrow (a)$, $(A)^2 \rightarrow (ab)$, $(AB)^2 \rightarrow (abcd)$, $(A)^3 \rightarrow (abc)$, $(AB)^3 \rightarrow (abc..9)$.

GROUP B) There is a loss of information amounting to 50%. The general expression is $(AB)^k \rightarrow (k)$. They are the following cases: $(AB)^2 \rightarrow (ab)$, $(AB)^3 \rightarrow (abc)$, $(AB)^4 \rightarrow (abcd)$.

GROUP C) There is a loss of information amounting to 100%. The general expression is $(A..Z)^k \rightarrow (a)$. They are the following cases: $(AB)^2 \rightarrow (a)$, $(A)^2 \rightarrow (a)$, $(A)^3 \rightarrow (a)$, $(AB)^3 \rightarrow (a)$, $(ABC)^3 \rightarrow (a)$.

Finally, all these situations have been graphically represented as shown in Fig.- 1.

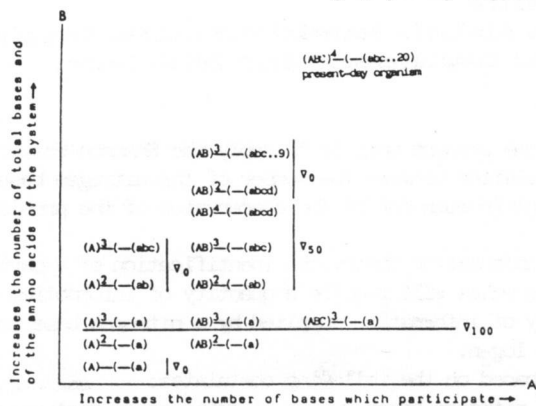


Fig.-1. Graphical representation of the bioinformation systems according to the number of bases which participate (A) and to the number of the amino acids of the system (B). ∇ = loss of information.

We have reached to the following conclusions:

- 1) The evolution of the primitive bioinformation systems to the present-day system took place within the limits of redundancy between 0% and 50%.
- 2) These coacervates could be originated one from the other, or to proceed from the anterior one. This last case has its experimental support in the work by Hsu, Brooke, and Fox (1971) about microspheres communication.
- 3) In horizontal sense (Fig.-1) a coacervate proceeds from the anterior by increasing the number of bases which participate in the identification of a amino acid.
- 4) In vertical sense (Fig.-1) a coacervate proceeds from the anterior when increasing both the number of the total bases and of amino acids of the system.

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