

**Life Origination Hydrate hypothesis
(LOH-hypothesis):
CH₄-hydrate matrix as a necessary condition for
life origin**

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The Life Origination Hydrate hypothesis (the LOH-hypothesis) is the original one and has no common features with other hypotheses that consider mysterious and stirring origination of this phenomenon.

The LOH-hypothesis has been developed by us for about twelve years. At different steps of its development, it was presented at more than 20 international physical, chemical, thermodynamic, biological, geological, and specialized conferences in the form of invited lectures or oral presentations.

This hypothesis considers the mechanism of life origination, and it can be applied to any celestial body where the appropriate conditions exist.



In our opinion, living matter resulted from thermodynamically conditioned, natural, and inevitable chemical transformations governed by universal physical and chemical laws.

We assume that the same principal physical phenomenon underlies the process of living matter origination and the processes of living matter reproduction in each living organism.

Having this in mind, we developed the Life Origination Hydrate Hypothesis and the Mitosis and Replication Hydrate Hypothesis (MRH-hypothesis), both based on the same principles.

Nature went step by step by its way from minerals to living matter and, at each step, decreased gradually the Gibbs free energy. Just as a result of the directedness of natural phenomena, scientists are principally capable of mental doubling back Nature's route and, thus, of revealing the main milestones in Nature's progression.

Certainly, any naturalist dreams of finding a "hook" in the environment to grasp it and to guess the logics used by Nature in its development. We believe that we found it, and we try to pass back Nature's route, having the thermodynamic laws as a guiding thread.



One of the most principal new ideas of our hypotheses

is the assumption that the life-carriers, i.e., nucleic acids and their constituents, originated within mineral matrixes of a honeycomb structure characterized by the occurrence of intra-structural cavities of different sizes.

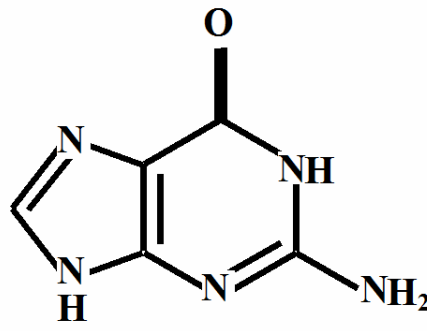
The entire process of synthesizing of the living-matter simplest elements (LMSEs, i.e., N-bases, riboses, nucleosides, and nucleotides), assembling them together in certain sequences with formation of a great number of similar but not identical DNA and RNA molecules, and origination of proto-cells of different simple organisms proceeded in the same localization.

Many of such localizations existed at different points of the underground and underseabed mass, and they produced proto-cells in different time periods, but all they were governed by the same universal natural laws and by the thermodynamic front.

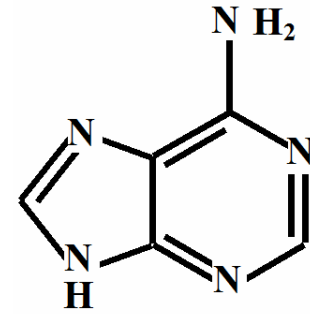
The following peculiar features of the DNA and RNA molecules force us to assert that living matter originated within the methane-hydrate mineral matrix.

(1) In the DNA and RNA compositions, the N-bases (guanine (G), adenine (Ad), uracil (U), cytosine (Cy), and thymine (Th)), riboses, and phosphate groups are located in strictly determined sequences and the N-bases are limited in sizes, in spite of the occurrence in their composition of chemically active groups, which seem to be capable of further chemical transforming.

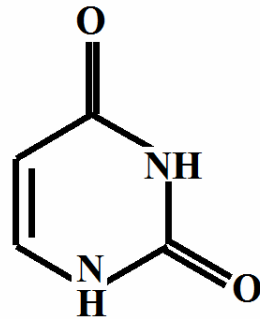
Therefore, such molecules could originate only under very specific conditions.



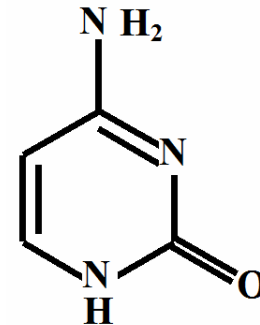
Guanine (C₅H₅N₅O)



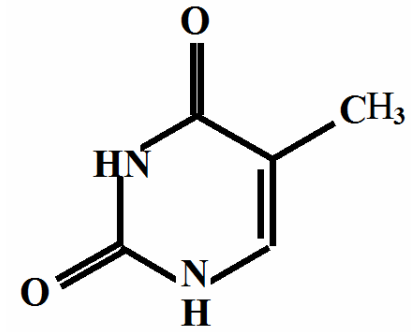
Adenine (C₅H₅N₅)



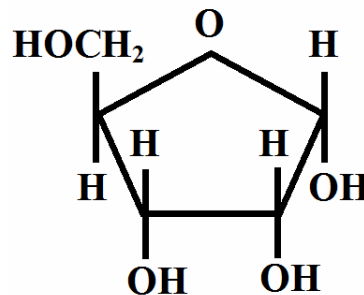
Uracil (C₄H₄N₂O₄)



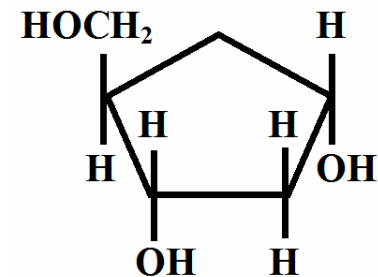
Cytosine (C₄H₅N₃O)



Thymine (C₅H₆N₂O₂)



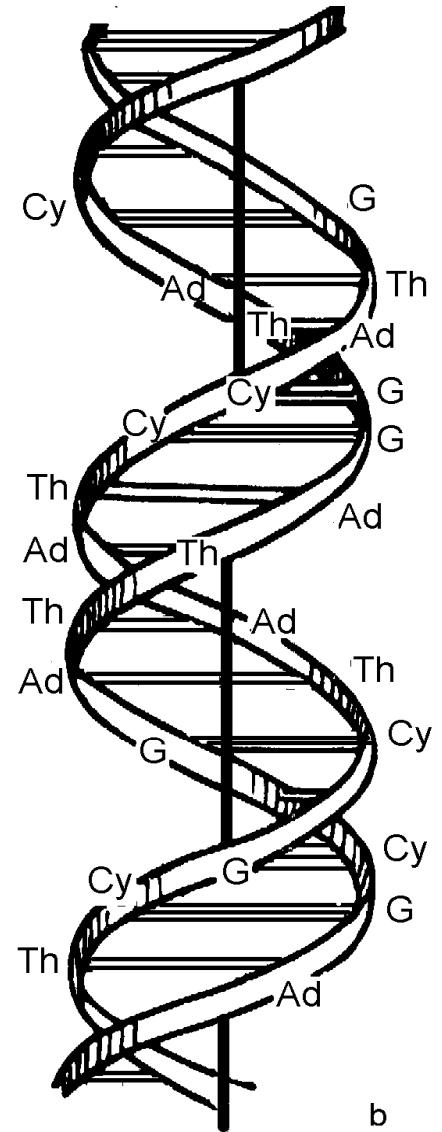
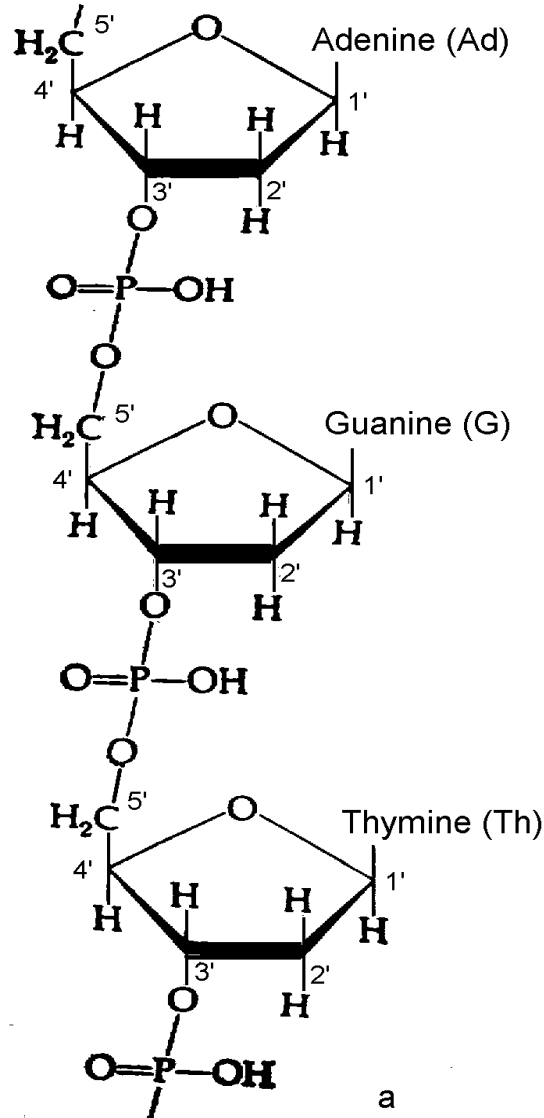
D-ribose (C₅H₁₀O₅)



Desoxy-D-ribose (C₅H₁₀O₄)

These peculiarities of nucleic acids led us to the idea that they originated inside such mineral honeycomb three-dimensional solid matrixes which selectively absorbed source substances of definite compositions and whose cavities had sizes that limited the chemical accretion of each individual LMSE but did not hamper polycondensation of LMSEs .

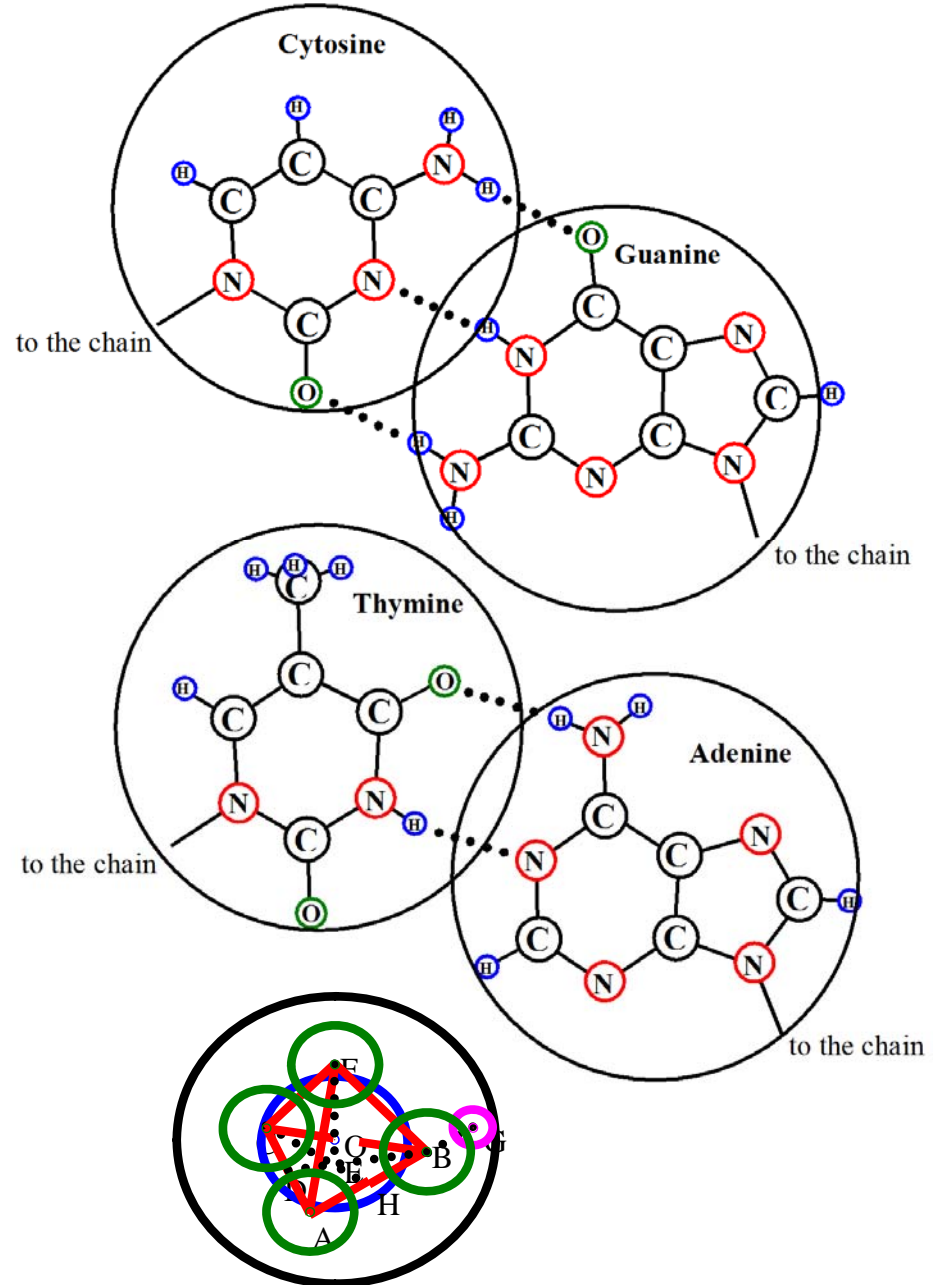
Fragments of DNA and DNA double helix



It should be expected that such matrixes are not constructed from cavities of one size but include the cavities of different geometric forms, because the sizes of N-bases, riboses, and phosphate groups are different.

The structural cavities of the underground methane-hydrate solid mineral are as if moulds for the N-bases, riboses, and phosphate groups.

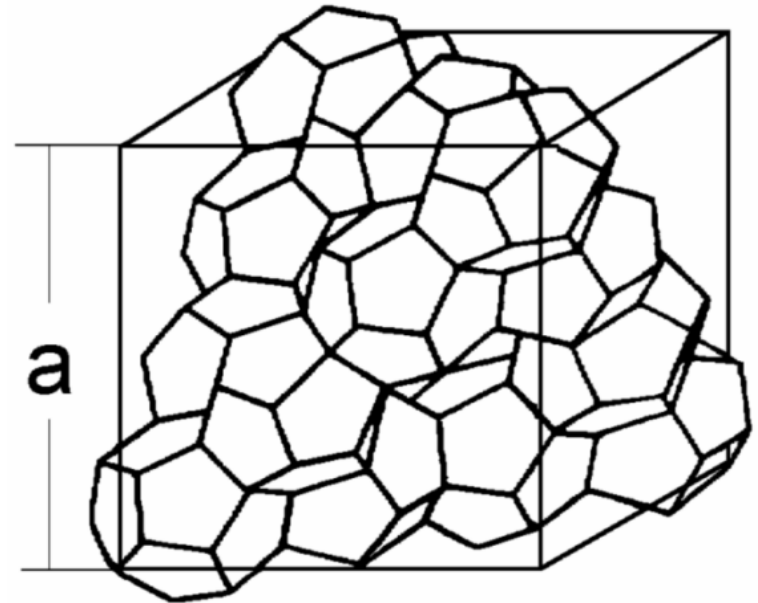
Filled methane-hydrate cavities at scales



(2) DNA and RNA molecules and living matter as such generally consist of only five chemical elements: **H, C, N, O,** and **P**. This fact means that the set of the source substances that produced DNA and RNA molecules within the **“parent” matrix** had to include a key component capable of selective reacting with the other components of this set and with no other chemical substance that occurred in the environment.

Source substances

- (1) Methane (**C, H**)
- (2) Niter (**NO₃⁻ ions**) (**N, O**)
- (3) Phosphate (**PO₄³⁻**) (**P, O**)
- (4) **Parent CH₄-hydrate matrix**



(3) In the DNA compositions and in the RNA compositions, all riboses are similar in their chemical nature and the diversities of N-bases are rather restricted. These features give us grounds to think that the LMSEs originated as a result of the strict directedness (i.e., of the thermodynamic front) of the chemical reactions inside a mineral matrix and that the thermodynamic front was caused by a low temperature level and, as the consequence, by slowness of the reactions that proceeded one by one in the direction of decreasing in the free energy of the system until the structural cavities are completely filled; after the free volume in the cavities of any one size became too small for ubiquitous formation of the same additional atomic group, the final filling of the cavities was regulated in a special manner.

**Kononov's
reactions (1888)**
proceed slowly
between **NO₃** and
CH₄ at about 273 K
with formation of
different organic
substances.



Changes in the enthalpy, entropy, and Gibbs free energy for formation of N-bases and D-ribose from hydrocarbons and KNO_3

Reaction	$\Delta_i(\Delta_f H_j^0)$ kJ/mol	$\Delta_i S_j^0$ J/mol K	$\Delta_i G^0$ kJ/mol
$38 \text{ CH}_4(\text{g}) + 28.2 \text{ KNO}_3(\text{cr}) = \text{C}_4\text{H}_4\text{N}_2\text{O}_2(\text{cr}) +$ uracil $+ \text{C}_4\text{H}_5\text{N}_3\text{O}(\text{cr}) + \text{C}_5\text{H}_5\text{N}_5\text{O}(\text{cr}) + \text{C}_5\text{H}_5\text{N}_5(\text{cr}) +$ cytosine guanine adenine $+ 4\text{C}_5\text{H}_{10}\text{O}_5(\text{cr}) + 28.2 \text{ KOH}(\text{cr}) + 32.4\text{H}_2\text{O}(\text{lq}) +$ ribose $+ 6.6 \text{ N}_2(\text{g})$	-9410	-3787	-8281

It is seen that the full set of the necessary N-bases and riboses can be produced from CH_4 and KNO_3 with no external energy; moreover, the summed reaction goes with a great decrease in the Gibbs free energy.

This reaction enriches the atmosphere with N_2 .



Changes in the enthalpy $\Delta_i(\Delta_f H_j^0)$, entropy $\Delta_i S_j^0$, and Gibbs free energy $\Delta_i G^0$ for Cy, G, Ad, or U formation from methane and KNO_3

Reaction	$\Delta_i(\Delta_f H_j^0)$ kJ/mol	$\Delta_i S_j^0$ J/mol K	$\Delta_i G^0$ kJ/mol
$2 KNO_3(cr) + 5 CH_4(g) + 2 O_2(g) = C_5N_2O_2H_6(cr) + 6 H_2O(lq) + 2 KOH(cr)$	-1666	-869.6	-1407
$3 KNO_3(cr) + 4 CH_4(g) = C_4N_3OH_5(cr) + 4 H_2O(lq) + 3 KOH(cr) + 0.5 O_2(g)$	-858.0	-384.0	-743.5
$5 KNO_3(cr) + 5 CH_4(g) = C_5N_5OH_5(cr) + 5 H_2O(lq) + 5 KOH(cr) + 2 O_2(g)$	-893.0	-281.4	-809.0
$5 KNO_3(cr) + 5 CH_4(g) = C_5N_5H_5(cr) + 5 H_2O(lq) + 5 KOH(cr) + 2.5 O_2(g)$	-613.1	-187.1	-557.3
$2 KNO_3(cr) + 4 CH_4(g) + 1.5 O_2(g) = C_4N_2O_2H_4(cr) + 5 H_2O(lq) + 2 KOH(cr)$	-1421	-682.9	-1218

Each of N-bases could be produced inside hydrate structure.

Niter and methane can also react with formation of N-bases and O_2 with a great decrease in the Gibbs free energy..

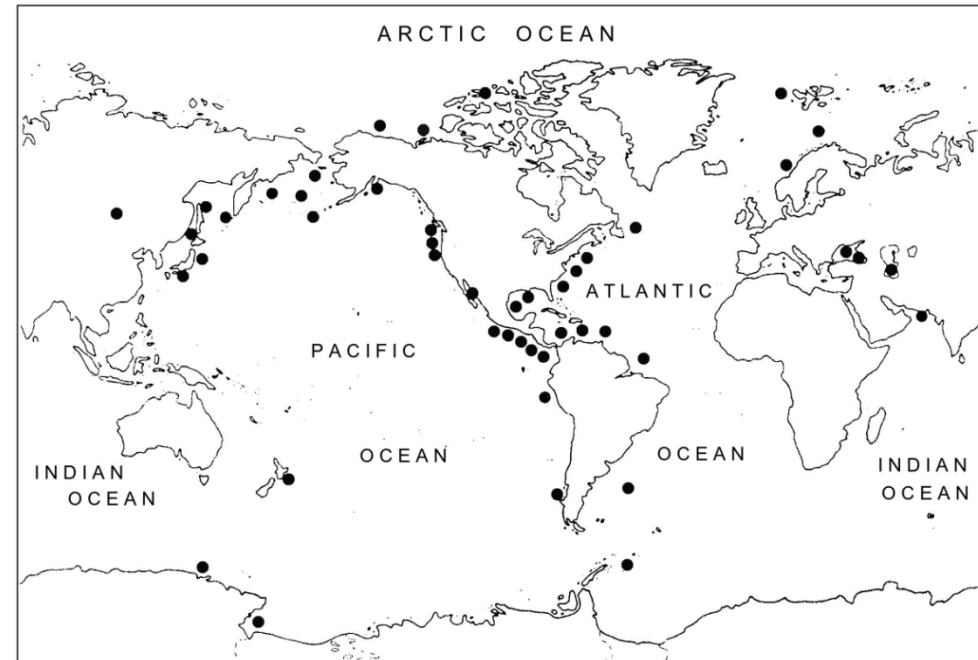
These reactions enrich the atmosphere with oxygen.

Actually, the reactions of this and previous tables went simultaneously.

(4) Our mechanism could be realized only under the condition of the absence of heat flows, electrical discharges, and weather perturbations, which are capable of destroying any order rather than of creating and maintaining it.

The best conditions for the thermostat used by Nature for DNA origination could be provided in the Earth's crust under ground or under seabed.

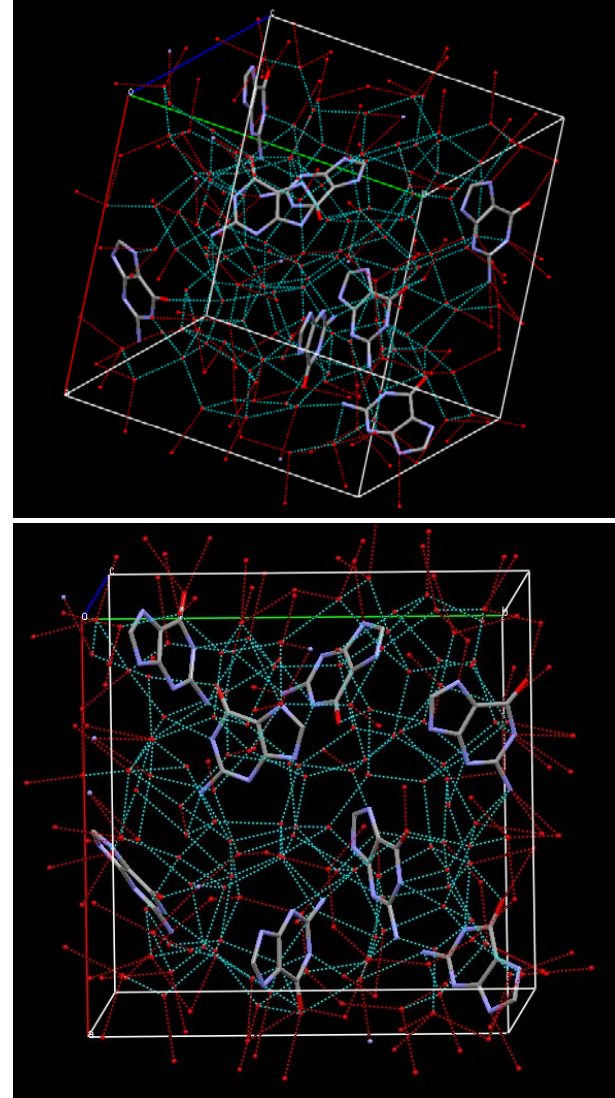
Issue (4) counts in favor of production of the LMSEs within the underground mineral matrix structure.



Points are CH₄-hydrate deposits (submarine). Mineralized H₂O carries NO₃⁻ and PO₄³⁻ ions into the hydrate structure.

(5) In DNA double helixes, purines are bound with pyrimidines, but purines are never bound with purines and pyrimidines are never bound with pyrimidines; moreover, Cy is never bound with Ad and Th is never bound with G.

These features were discovered in the 1950s and are not explained up to now. It is unlikely that this collection of events is explainable by any cause of non-geometric nature, and, apparently, this cause is hidden in a specific matrix character of the media of DNA origination and reproduction.



Purines cannot be located in close proximity to each other within the CH_4 -hydrate lattice large cavities: such an arrangement leads to 5% distortion of the lattice.

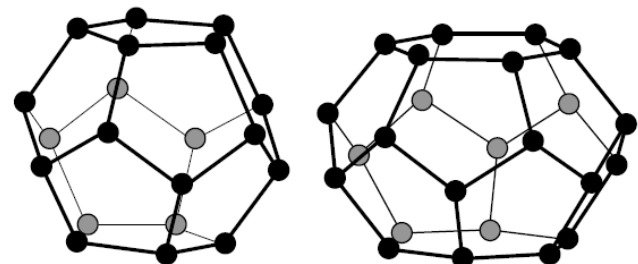
(6) How can the DNA chirality be explained; i.e., why did Nature used only desoxy-D-ribose in DNAs, and how did it manage to do this?

This riddle has the sole realistic explanation. Namely, DNAs originated within a matrix of a honeycomb structure with such geometry that only D-ribose could join together the N-bases with PO_4^{3-} groups. The consumption of D-ribose led to a shift of the equilibrium and formation of new D-ribose.

Thus, we come again to the concept of a mineral matrix.

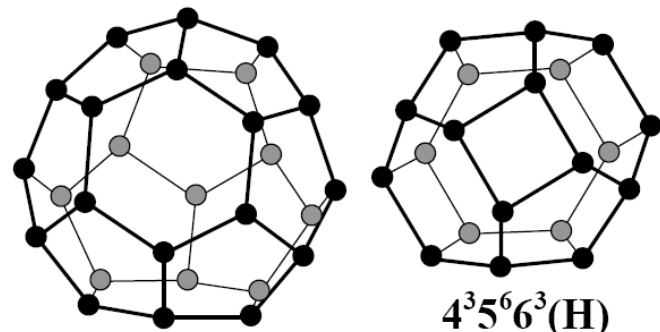
We believe that solution of the monochirality problem should be easy, because, according to Newton's "Principles": "Nature is simple and does not luxuriate in excesses".

Hydrate-structure cavities
 Points are O-atoms of H_2O
 Edges are the sums of the O-H and O...H bonds



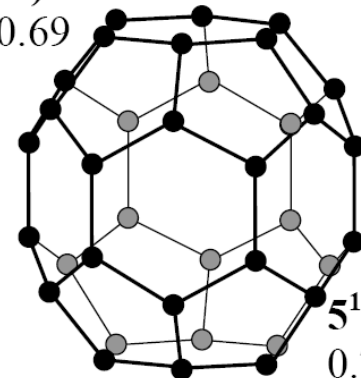
$5^{12}(\text{I,II,H})$
 0.36–0.48

$5^{12}6^2(\text{I})$
 0.36–0.54



$5^{12}6^4(\text{II})$
 0.56–0.69

$4^3 5^6 6^3(\text{H})$
 0.36 nm

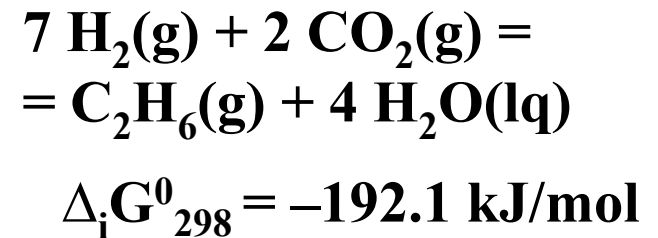
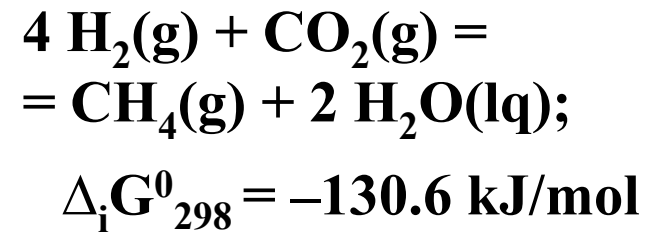


$5^{12}6^8(\text{H})$
 0.70–0.86

(7) Oparin's opinion on the necessity of external energy for synthesizing biologically active substances from minerals is disproved unambiguously. At present, there is no doubt that no external energy is required for formation of LMSEs, DNAs, RNAs, cells, and multi-cellular organisms from minerals.

Nature had to provide removal of the energy that evolved as a result of these natural syntheses. However, no problems arose in the course of living-matter origination within CH₄-hydrate mineral matrixes, because the syntheses proceeded under low temperatures and went very slowly.

Interplanetary projects showed that different CH₄ hydrocarbons are widely distributed over the Solar System. Apparently, they are produced as follows:



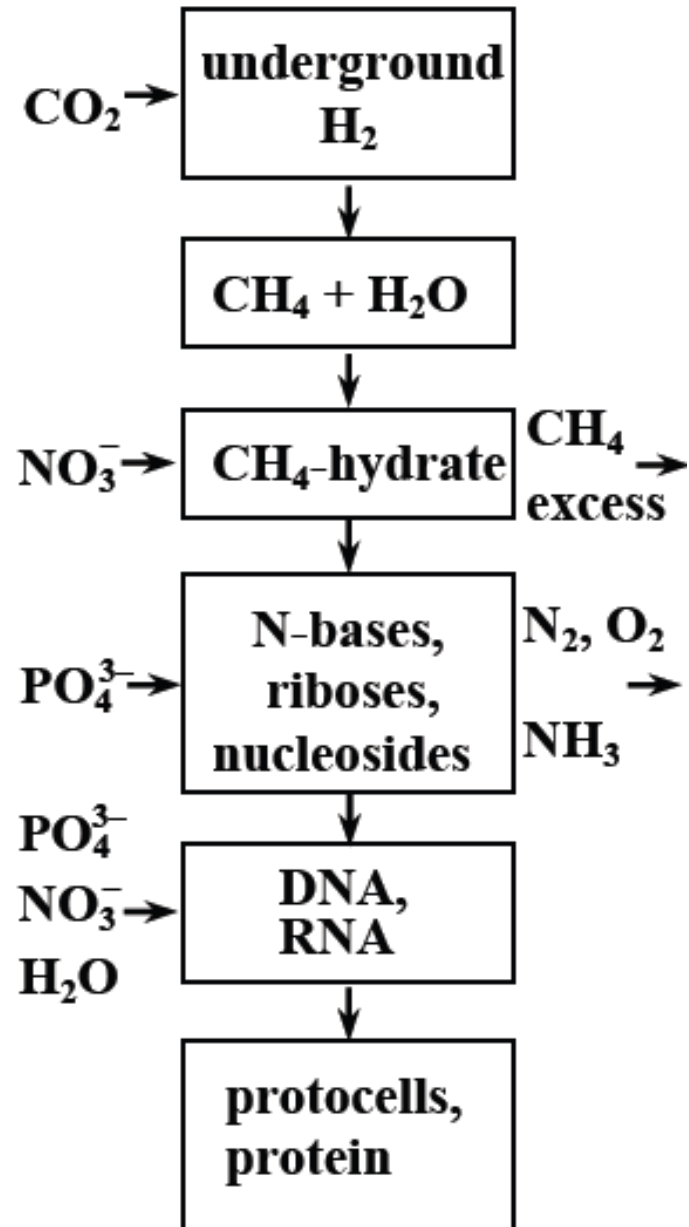


(8) Authors of the previous hypotheses considered origin of life as an occasional phenomenon. According to their hypotheses, the process of formation of individual components of DNAs and RNAs and their self-assembling is extremely improbable.

Meanwhile, it is now evident that living matter occurred repeatedly; for example, multicellular organisms appeared independently in the Earth history no less than 24 times.

The recurrence of formation of living cells in different time periods and in different matrix CH₄-hydrate localizations is in line with this conclusion.

Scheme of living-matter origination



(9) Conclusive remark. No alternative living-matter origination hypothesis gives answers to the following questions:

- (i)** Why do only five chemical elements and five different N-bases enter the principal composition of the DNA and RNA molecules?
- (ii)** Why are N-bases limited in their sizes and in the number of the substituting groups?
- (iii)** Whence did riboses and phosphates come?
- (iv)** What is the motive behind the arrangement of the N-bases, riboses, and PO_4^{3-} groups in strong sequences?
- (v)** Why are these sequences not random but implicate some sense?
- (vi)** What is the source of the monochirality?
- (vii)** What is the mechanism of formation of cells.

None of these questions can be answered without the notion of living matter origination inside a mineral matrix, and just CH_4 -hydrate is the most appropriate matrix for this natural triumph.



Our recent detailed open-access paper not referred in the abstract:

Victor Ostrovskii, Elena Kadyshevich

«Life Origination Hydrate Hypothesis (LOH-Hypothesis): Original Approach to Solution of the Problem»

Global Journal of Science Frontier Research : A; Physics and Space Science, 12 (2012) (6), 1-36.

Acknowledgements

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Thank you for your interest!