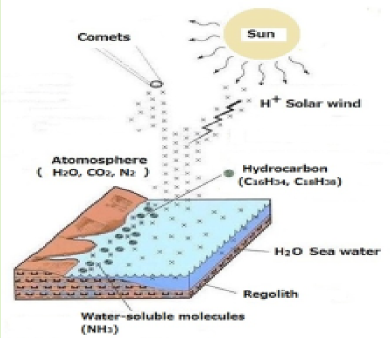
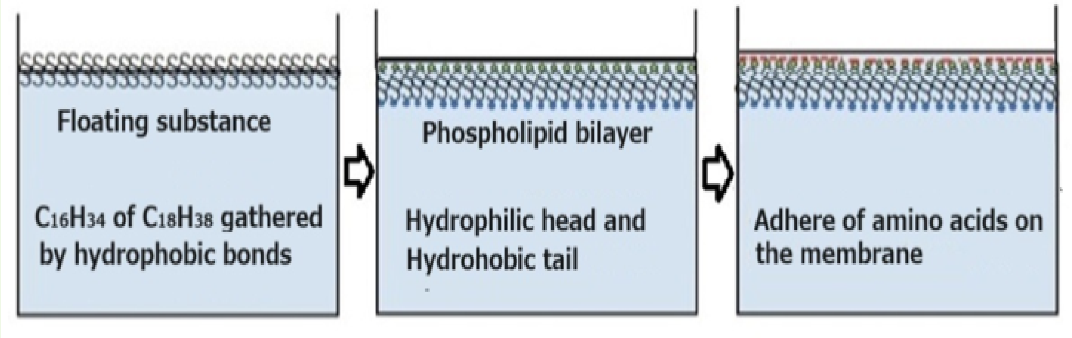
–The origin of life that spelled out in images–
The first life by self-assembly of tetrahedral molecules.

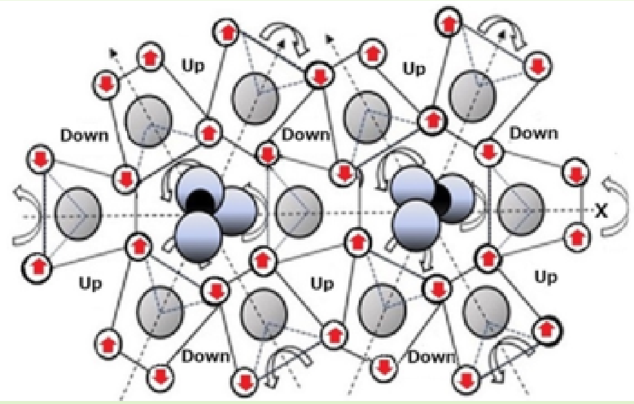
1. The environment that gave birth of the first life



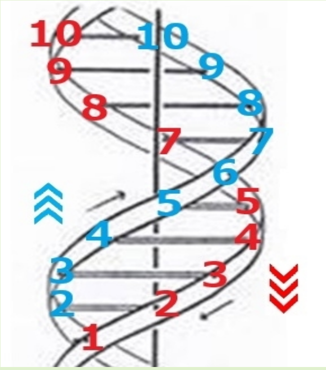
2. Processes those formed the firs membrane

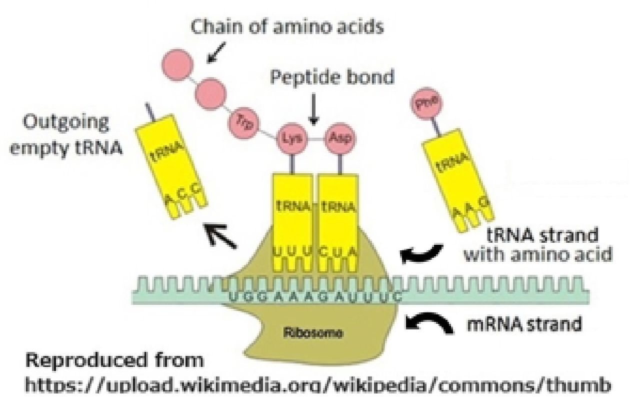


3.Systematic thermal motion of water molecules.



4. Protein replication by using chiral molecules





1.1 Formation of the Earth

Small interstellar mediums first bonded at the point of contact by the Coulomb force to form a clump, which combined to form planetesimals, and then those grew into planet. Fig. 1 shows a new model of the early formation of the solar system [1],[2].

[1]Karasawa S (2023) Formation of Planetesimals by Chemical Reactions at Contact Points between Solids", Geol Earth Mar Sci Volume 5(2): 1-6 .
https://doi.org/10.31038/gems.2023522
[2] Karasawa, S. (2023), "How planets were formed ". https://www7b.biglobe.ne.jp/~shinji-k/Jp%20planetology%20cover.htm .

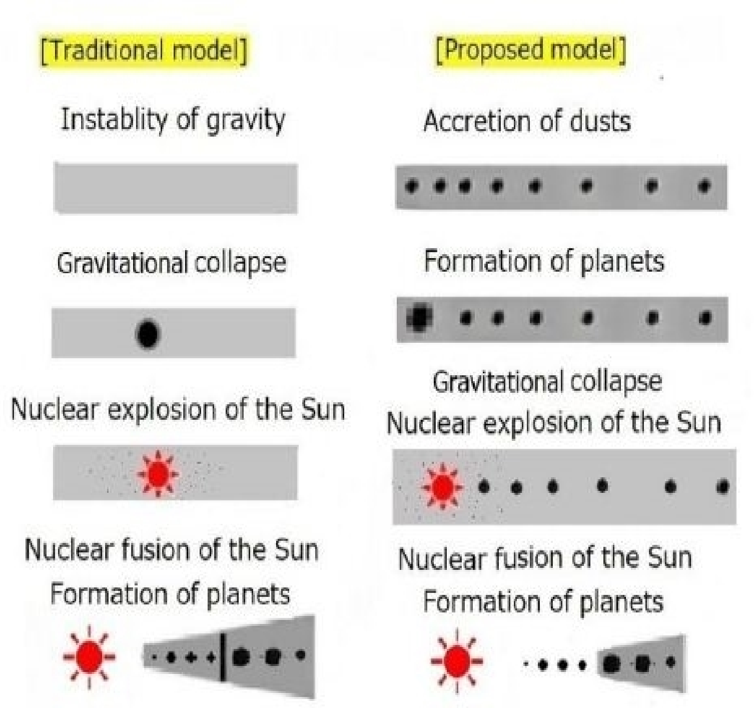


Fig.1 Formation model of the solar system [1]

[1] https://doi.org/10.31038/gems.2023522

[A planet was formed from materials orbiting the same orbit]

According to **Kepler 's third law**, the ratio between the square of the orbital period (**T^2**) and the cube of the semi-major axis (**a^3**) is a constant value **($k = T^2/a^3$).** Therefore, interstellar goods orbit in the same orbit from the beginning, regardless of the size of the mass. The **Sun** makes up **99.8%** of the total mass of the solar system. The remaining **0.002%** is orbiting near the ecliptic plane of the **Sun**. Incidentally, rings exist around the geostationary orbit of the outer planet [3].

. Reference [3] Karasawa S, How rings of outer planets formed and why the rotating axis of icy planets tilted, Academia Letters(2022) 1 April.

[How H_2O and CO_2 had been captured in the early Earth]

Since the **Earth** is currently **inside the ice line**, **H_2O** becomes a gas, and the solar wind blows it, so the Earth's seawater cannot form. Therefore, it is thought that **H_2O is ice,** and **CO_2 is dry ice** when planets are formed. These solids are combined and taken into the interior during the growth of planets. Planets such as **the Earth** began to form at about the same time as the Sun, but the Sun, which was in the center of the solar system, grew faster and became huge. When the Sun exploded with nuclear fusion 4.6 billion years ago, fragments of the core that made up the core of the Sun were ejected and became a large amounts of meteorites. The fall of the meteorite heated the Earth's surface, and the **H_2O** and **CO_2** contained in the crust were degassed to form the primordial atmosphere..

1.2 Atmosphere and oceans in the early Earth

[Formation of Earth's early atmosphere and primordial oceans]

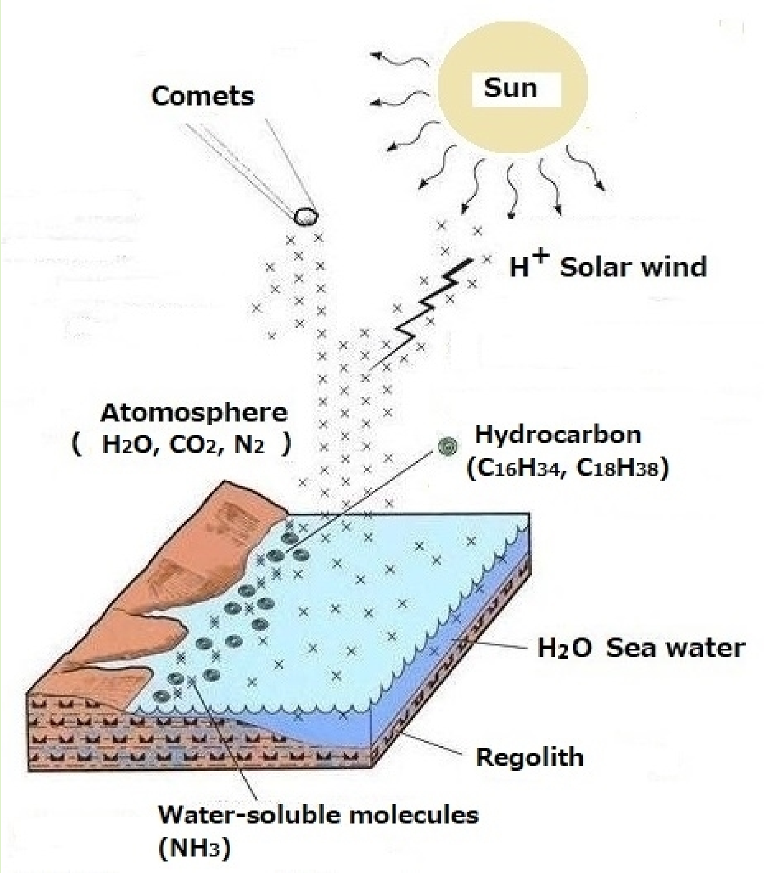


図2 Synthesis of long-chain hydrocarbon molecules in early Earth [5]。

Layered structure progressed inside of large planets. A large amounts of meteorites from fragments of the Sun's core collided with the surface layer of the Earth, causing the crust to become hot, and **H_2O** and **CO_2** were degassed to form the early atmosphere. The total amount is estimated to be 300 atmospheres for water vapor **(H_2O)** and 40–100 atmospheres for carbon dioxide **(CO_2)** based on the current abundance of limestone and other substances in the Earth's crust.

As the temperature of the Earth's surface dropped, water vapor in the atmosphere condensed, heavy rainfall and the formation of primordial oceans. And CO2 remained in the atmosphere where the water vapor was removed.

[Chemical reactions between CO_2 and Ca^{+2} or Fe^{+2} in the sea.]

The Earth's atmosphere today contains less than 0.0001 atmospheres of **CO_2**, but it is estimated that 3.8 billion years ago it had about 1 atmosphere. Since the atmospheric **CO_2** is dissolved in water, the early ocean became a sea of carbonated water, and the calcium ions (Ca^{+2}) in the water and CO_2 combined to form limestone (**$CaCO_3$**), forming a lithosphere. The iron ions (Fe^{+2}) emitted by submarine volcanoes eventually became iron oxide (**Fe_2O_3**), and resulted **Banded Iron Formation、BIF** [4],[5].

[4] Karasawa S, " Prebiotic reactions in the bubble that was formed in carbonated water by iron atoms" Viva Origino, Vol .42,No3, p.12-17, .(2014). https://doi.org/10.50968/vivaorigino.42.3_12

[5] Karasawa S (2022), "Earliest BIF and Life Produced via Submarine Volcanism in Carbonated Seawater". *Geol Earth Mar Sci* Volume 4(2): p.1-5. https://doi.org/10.31038/gems.2022424

2.1 How the first cell membrane had been produced.

[Formation of hydrocarbon by impact of H^+ of solar wind with CO_2 in the early atmosphere]

About 4 billion years ago, CO_2 was the main component of the Earth's atmosphere, and the concentration of **CO_2** in the atmosphere was 10^4 times higher than today. The solar wind of 10^9 kg/s of hydrogen ions (H^+) emitted from the Sun. were collided to CO_2 in the atmosphere at the speed of more than 500 km/s. The H^+ of the solar wind, which has high kinetic energy, collided with CO_2 molecules and H_2O in the Earth's atmosphere. Here, the average free path of the collision of gas molecules at 1 atmosphere is 10^{-6} m,. So, the solar wind does not reach to the ground due to repeated collisions. In the atmosphere of the early ancient period, the H^+ of the solar wind collided with the CO_2 molecules of the atmosphere, producing hydrocarbons (**C_nH_{2n+2}**) and (**H_2O**). The hydrocarbons produced, such as methane (**CH_4**), remained in the upper sky and underwent polymerization reactions. In the polymerization reaction, long-chain hydrocarbons were produced by repulsion between hydrogen ions in the hydrocarbon molecules. As shown in **Table 1**, **$C_{16}H_{34}$** or **$C_{18}H_{38}$** were in a liquid state at surface temperatures of the Earth. Since those molecules are hydrophobic, those were suspended as oil films on the surface of the water.

Table 1: **$C_{16}H_{34}$** or **$C_{18}H_{38}$** was liquid state at the early Earth's surface

Molecue	Melting point [℃]	Boiling point [℃]	Specific gravity [℃]
Hexadecane $C_{16}H_{34}$	18	287	0.773~0.776
Octadecane $C_{18}H_{38}$	28~30	317	0.777

[Long-chain of hydrocarbons formed the cell membranes of living organisms on Earth]

Long-chain hydrocarbons are not synthesized by biochemical reactions. Among these molecules, $C_{16}H_{34}$ and $C_{18}H_{38}$ are in a liquid state at the temperature of the Earth's surface, as shown in Table 1. Since $C_{16}H_{34}$ and $C_{18}H_{38}$ in the liquid state are hydrophobic organic molecules, they float on the surface of the water and collect as an oil film.

The oil films of $C_{16}H_{34}$ and $C_{18}H_{38}$ those were suspended on the surface of the water self-assembled and became the main components of the cell membranes of organisms on the Earth. References[6].

[6] Karasawa S (2023) Origin of Life in the Water of the Earth. *Geol Earth Mar Sci* Volume 5(1): 1-7. https://doi.org/10.31038/gems.2023511

2.2 Systematic movement of atoms in the liquid water

[Observation of water clusters in the vicinity of ice that is formed of carbonated water]

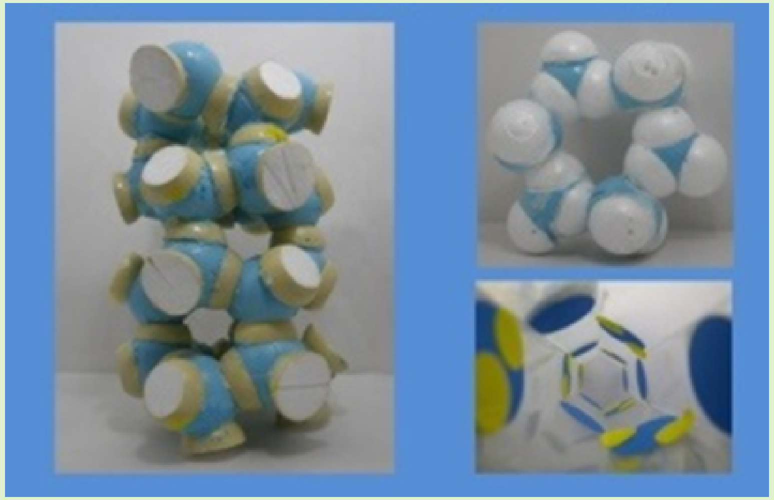


Fig.3 Lattice structure of liquid water

At the end of the ice thaw, we were able to observe incompletely interlocked water clusters around the ice at a maximum shutter speed of 1/1500 of a second. Observation at 30 video views per second shows that clusters of water molecules fluctuate in conjunction with the ice. The water clusters were larger than the small particles of camera flicker noise by slow play back.

This video is evidence that carbonated water at 0° C has a molecular structure of clusters of water. That is, a cluster of water with a structure similar to ice is formed in the vicinity of carbonated water ice at 0° C. This water cluster is flexible enough to adapt to the situation.. As shown in the lower right of Fig.3, a helical structure has a void shaft. The CO_2 molecule is a linear molecule made up of large oxygen atoms, and water molecules assemble the helical structure around the CO_2 molecule [7].

[7] Observation of water clusters in the vicinity of thawing carbonated water ice. "https://youtu.be/lXsahL_k3fw".

[Observation of Brownian motion on fat globules in processed milk]

The thermal motion of liquid water molecules is known as Brownian motion. However, the observed motion of the fat globules of processed milk is different from random movements seen at molecules of gas state [8].

[8] "Video of Brownian motion at different frame rates (2010) http://www.youtube.com/watch?v=3ar1bY2SP_c
This reference video was taken with a digital camera with a 12x magnification of an image of a 20×8x optical microscope. The first half is shot at 30 frames per second for 8 seconds, followed by 1 second at 240 frames per second, them play back at frames of 30/s.
In the second half, the time is stretched 8 times and regenerated, so the movement of fat globules seems to slow.

Fat globules are the size of microns. In contrast, the size of a molecule in liquid water is about 3 Å. They are less than 1/3,000 of the observed fat globules. When the water molecules collide with the fat globules from different directions, the impact force is averaged. On the other hand, there are thermal motions of water clusters about the same size as the fat globules. It is must be that the thermal motion of a mass of water same size as the fat globules drives Brownian motion..

3.1 Helical structure formed instantaneously in liquid water

[Helical structure of SiO_2 and the lowest energy state of lattice structure in carbonated water]

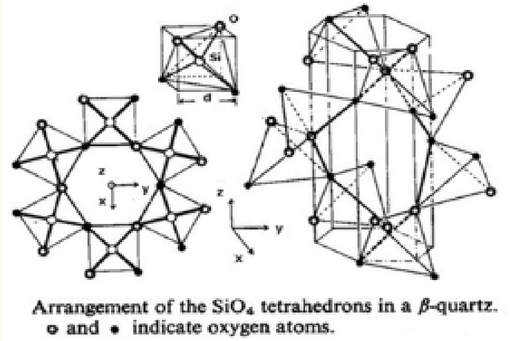


Fig. 4 Helical structure of SiO_2

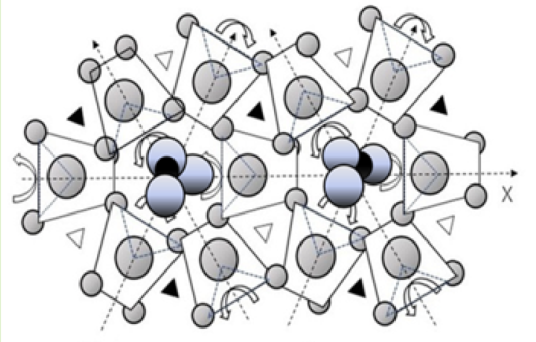


Fig.5 Helical structure of molecules in carbonated water

The oxygen atom in the liquid water is deviated from the center of the tetrahedron. This deformation can be explained by the Jhan-Teller-Effect. This effect avoids quantum resonance between ionic bonds with central symmetry and covalent bonds with central symmetry. That is, although a resonating state is the lower energy, the degenerate state makes the lowest energy state by splitting the level.

A typical substance with distorted tetrahedron is silicate (**SiO_2**), which has multiple crystal structures. **Fig.4** shows the helical structure, which is the smallest size and lowest energy state of SiO_2. CO_2 molecules in carbonated water, fit to the through holes and the helical structure is maintained as shown in **Fig.5**,

[Lattice structure that causes the behavior of bubbles in melting ice of carbonated water[9]]

[9] "Interaction between bubbles of CO2 seen in the final stage of ice melting in carbonated water", https://youtu.be/BbaMVCgKrA8

The solubility of CO_2 is high in water at low temperatures. The dissolution of CO_2 in liquid water at low temperatures is due to the lattice structure of H_2O in the liquid arranged at low temperatures. The smallest lattice structure with distorted asymmetric tetrahedra connected is a α-quartz typed structure. The distorted asymmetric tetrahedron of liquid water molecules is connected by hydrogen bonds, and the three-fold symmetrical electrical axis is aligned with the axis of rotation, resulting in a helical structure with the smallest and lowest energy. The through holes contain CO_2 molecules, as shown in **Fig.5**, and the helical structure is preserved. In this self-assembled helical structure, alternating thermal motion with the electric axis as the axis of rotation is accompanied by expansion and contraction. [10]. When the helical structure vibrates thermally, the atoms in the △ region of Fig.5 work upward in the Z direction, and the atoms in the ▲ region downward

[10] "The mechanism of liquid water that self-produces tissues of molecules", https://www.youtube.com/watch?v=NPNeZYUz6N4&t=335s

3.2 Systematic thermal motions of atoms in liquid water.

[When the tetrahedral unit is rotated along X-axis, it projected on X-Y plane as a trapezoid]

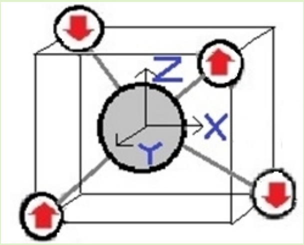


Fig. 6 Unit tetrahedron that is rotated around the X-axis

The coordinated movements of bubbles in carbonated water are observed. The coordinated motion of the water molecules is due to helical structure where tetrahedral of water molecules are connected by hydrogen bonds. The displacement of the phase from the β crystal type of hexagonal crystal to the α-quartz type of trigonal crystal can be explained by the angle of the connection. That is, angle of contracts between unit tetrahedrons are changed by alternating along the rotation axis of X, and the thermal motion of this change causes expansion and contraction movement.

When a unit tetrahedron as shown in iFig.6 is rotated around X axis, and it projected onto the X-Y plane, it becomes a trapezoidal [11]..

11] Karasawa S, "Origin of Piezoelectricity in an α-Quartz", JJAPP, Vol.13, No.5. 1974.

[Thermal motion in helical structure where ascending atoms and descending atoms exist]

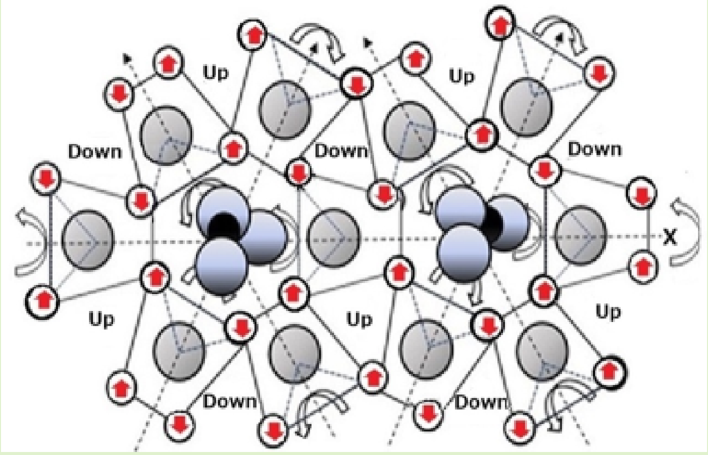


Fig. 7 Systematic thermal motion of hydrogen atoms in a helical structure.
(Up and down along Z axis.)

When the tetrahedral unit in the helical arrangement of carbonated water molecules alternately rotate around electric axis of X-axis, it accompanies with expansion and contraction as shown in **Fig.7**.The tetrahedral molecules in a helical structure of liquid water performs a systematic motion. When the vibrational of tetrahedrons turns to one directional rotation, transportational movement takes please. This phenomenon is able to explain the phenomenon of ″disk-shaped bubbles moving rapidly like a UFO″ that is often observed during the thawing of carbonated water ice [12].

[12] ″Conditions under which molecules in water spiral in the vicinity of thawing carbonated water ice in the vicinity of bubbles″, https://youtu.be/DK2izjAxTFY

There is a region of hydrogen atoms that rises and hydrogen atoms those descend around the through holes of the helical structure.. Due to this linked movement, when the same amino acids of L-type t and D-type are incorporated at the same time, the synthesis reaction can proceed to the next step.

3.3 Formation of cell membrane at water surface

[Formation of cell membranes]

The helical structure of liquid water has a systematic thermal motion, and various molecular arrangements have been attempted. Reference video [13]
13]" Formation of the helix by hydrogen bonds in liquid water and the swirling motion of the structure.", https://youtu.be/azcacA97Qbk

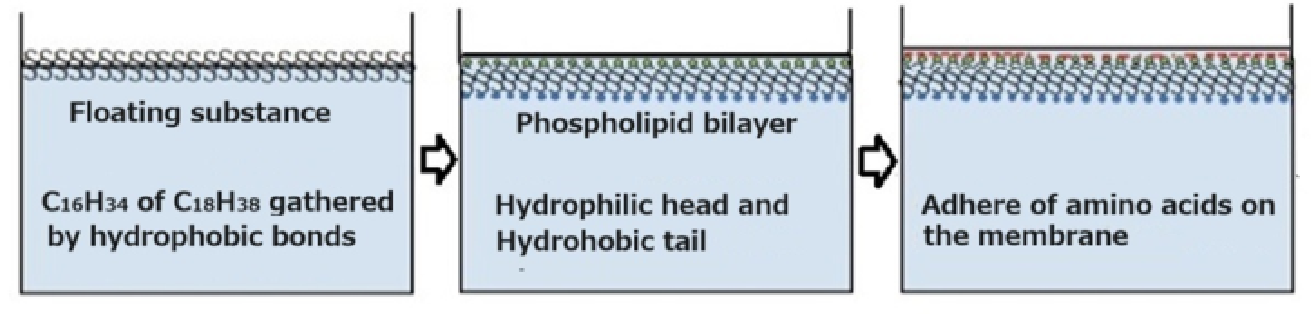


Fig. 8 Formation of cell membranes based on hydrocarbon molecules

Fig.7 shows the process by which lipid cell membranes were generated from oil films of long-chain hydrocarbon molecules. The process is explained in the reference video [14].
[14] "-The origin of biochemical reactions – the interaction of bubbles due to the formation of the helical structure of the molecular group of water", https://youtu.be/rgfwzLy-H6A .

[Structure of phospholipid cell membrane]

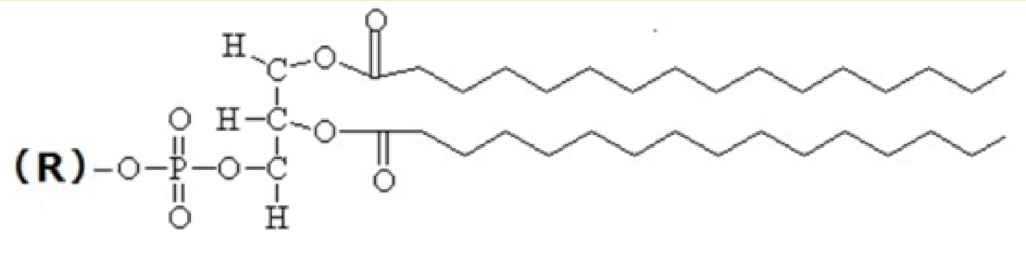


Fig. 9 Structure of a phospholipid cell membrane

The cell membrane of most of creature lives in the Earth is composed of fatty acids of 16 or 18 carbon atoms. The membrane structure in a liquid crystal state is maintained by the hydrophobic interaction of the tail of the cell membrane.

Since unsaturated fat makes a crooked structure, it weakens the hydrophobic bonds and increases their fluidity.

4.1 The first protein was produced by self-assembling

[Protein is formed by peptide bond of amino acids with the same chirality]

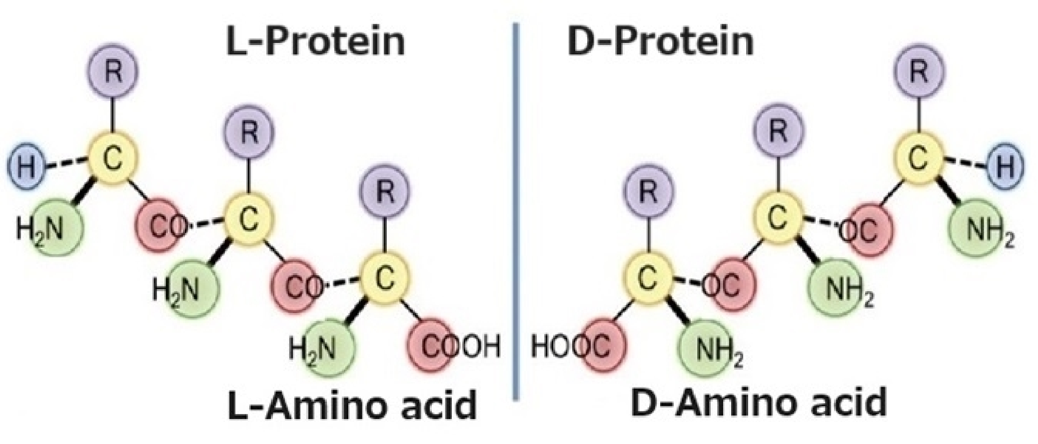


Fig. 10 Formation of L-protein and D-protein

Peptide bonds form a protein in the sea water near neutral acidity. The amino acid is consisted of a carboxyl group **(–COOH)**, an amino group **(–NH_2)**, a side chain **(R)**, and a hydrogen atom **(H)**. As shown in **Fig.10,** amino acids of the same chirality are peptide bonded to form a protein with a helical structure. Here**, L-type proteins cannot be mixed with D-type proteins**.

Since the R group of amino acid is difficult to adapt to water, protein molecules attach to cells and become **structural proteins**. When protein molecules are combined along a chain reaction that occurs in the cell membrane, they become **enzyme proteins** that memorize the chain reaction.

[The first protein replication was carried out by self-organization]

The probability of obtaining structural and enzymatic proteins that are useful for cells in a random process is extremely small. Therefore, a mechanism for protein replication was created using long-lived cells equipped with useful proteins. In the process of replicating the match, proteins with different chirality were used.

The life was born by self-assembly of proteins about 3.8 billion years ago [15].

[15] "Birth and Early Evolution of Life in Cell Membranes.mp4" https://youtu.be/6Lctlf-xLGs

4.2 Role of chirality in replication of protein

[How to matching of an amino acid on new protein with amino acid to be referred protein]

Since protein is a helical structure, the replication of protein is performed by each amino acid as the unit of processing. The check of collation shifts the two amino acid arrangements like meshing gears shown on **the left side in Fig.11**. If we use the reverse screw as shown in **Fig.11 right side**, the it can proceed in the opposite direction by the same rotation. Therefore, the protein replication is performed by matching L-type and D-type amino acid molecules for each amino acid molecule

[Synthesis proceeds when L- amino acids and D-amino acids are attached concurrently]

L and D types of the same amino acid are separated by the same size, and under the condition that the matching is successful, the vertical movement of the linkage described in **Section 3.2** occurs and moves to the next match. Therefore, the molecules of the amino acid sequence of the L chirality are used to make the protein of the D chirality, and the protein of the D chirality is used to make the molecules of the original L chirality protein.

DNA was formed in order to memorize replication of proteins. It was achieved by producing L-type and D-type amino acid molecules for each amino acid molecule and combining them into a double helical structure as shown in **Fig.12**。[16]..

[16] " Evolution of intelligence of living organisms through the synthesis of proteins.mp4".] (2024), https://youtu.be/YmHWsqtTUq4

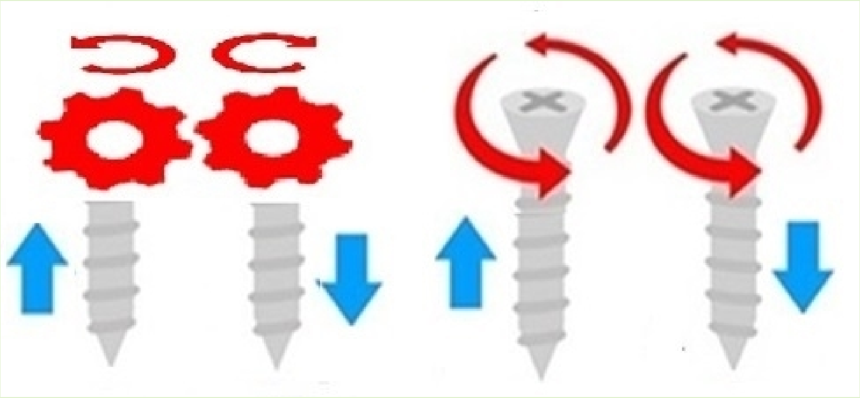


Fig. 11 Matching of amino acids in protein replication

Fig.12 Matching of L-type proteins and D-type proteins is carried out by amino acid units in a double helical structure.

4.3 Double helical structure of a DNA

[Progress of the sequence of atoms in the double helical structure of DNA].

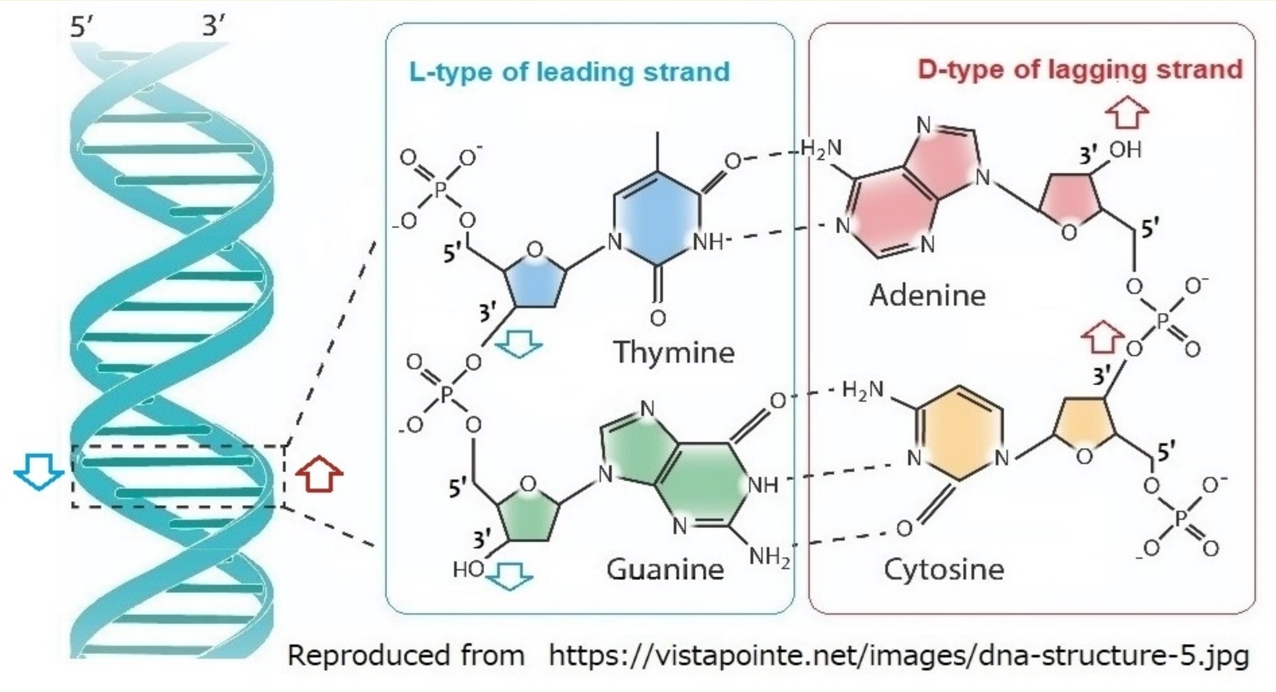


Fig.14. Matching of different chiral typed amino acids at the intersection of molecular strings. References[17]

Fig.14 shows the arrangement of atoms in the **double helix of DNA.** In the synthesis of DNA, both leading and lagging strands progress from 5' to 3'. Therefore, the progression of the chain-like molecular sequence proceeds in the opposite direction.

Amino acid molecules are the same size and length even if they are reversed vertically, but the arrangement of amino acid atoms differs when the orientation is reversed.

As a result of evolution, codons were incorporated into mRNA and anticodons were incorporated into tRNA.

The code composed of three nucleosides when synthesizing DNA.

[17] Karasawa S. (2023) Function Inspired Structures of Proto-Ribosome and the First Aminoacyl-tRNA Synthetase: Origin of life in the water of the Earth (III). *Geol Earth Mar Sci* Volume 5(8): 1-3. https://doi.org/10.31038/gems.2023581

5.1 Permeability of chiral molecules in cell membranes

[Why the chirality of molecule to control different from to be controlled molecules]

The different chirality it is necessary to separate what is controlled from what is controlled [15]. The chirality of amino acids that make up living organisms in the Earth are left-handed, while the chirality of the sugars that make up the nucleic acids that carry genetic information are right-handed type.

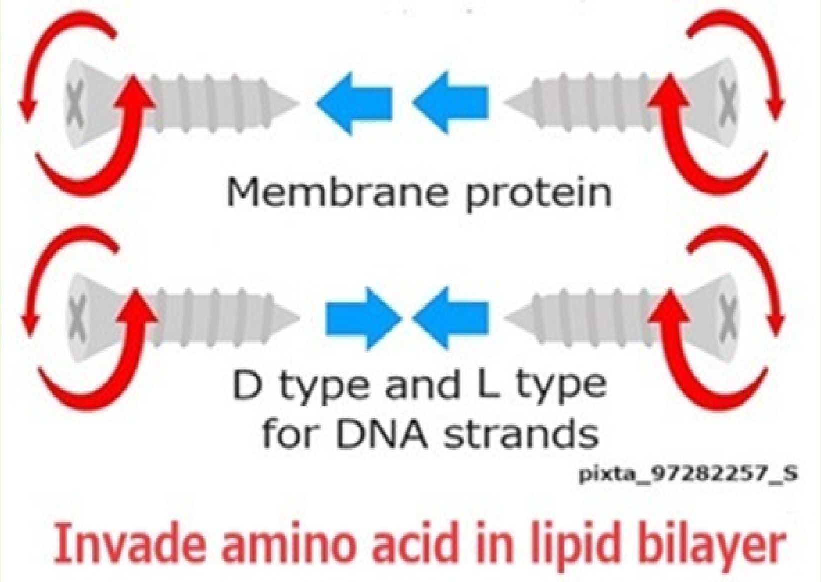


Fig.13 Structure of phospholipid bilayer cell membrane

[Permeability of chiral molecules in a cell membrane]

When a molecule with a helical structure invades the bilayer cell membrane, the input direction is reversed at the center and enters the opposite side, as shown at the top of Fig.13. So, protein passe through the bilayer membrane in one direction.

However, if the chirality of the molecules that invade the front and back sides of the double-layer cell membrane is different, a double-helix structure can be formed in the center without mixing, as shown at the bottom of Fig.13.

The cell membrane is a platform for formation of proteins or DNA.

5.2 Atomic arrangement of DNA

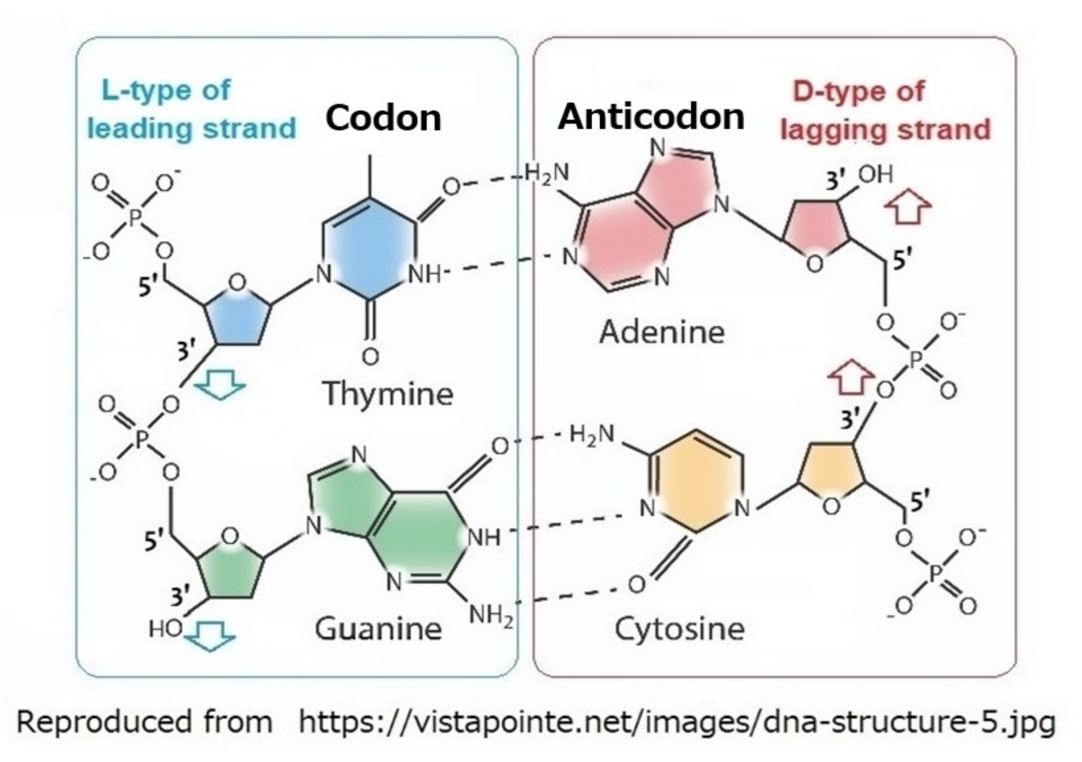


Fig.15. Atomic sequences that make up DNA

[Lagging strand and a leading strand in DNA]

The process of producing DNA must have started in the cell membrane to which the protein was attached, and DNA evolved in such a way that the fatty acid part of the cell membrane and the proteins attached to it were omitted from DNA.

As a result, as shown in Figure 15, the leading and lagging strands of DNA are connected by base pairs and are composed of amino acid units.

[Three base pairs as an amino acid label]

When replicating proteins, it is necessary to specify where and what type of amino acids the amino acids fit in the tRNA, which also carries molecules of individual amino acids in the mRNA of the precursor. Therefore, we incorporate pairs that replicate molecules of the same amino acid of mRNA and tRNA with three pairs of base pair codes, codons and anticodons. The base pairs that form the elements of the cipher are **adenine (A)** and **thymine (T)** or **guanine (G)** and **cytosine (C)**.

5.3 L-type and D-type of amino acid sequences

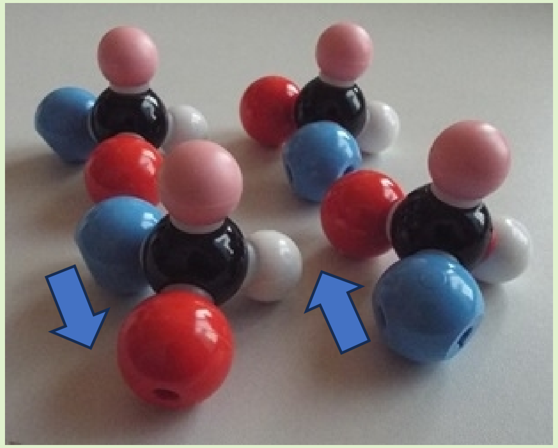


Fig.16 Heterochiral amino acids for DNA

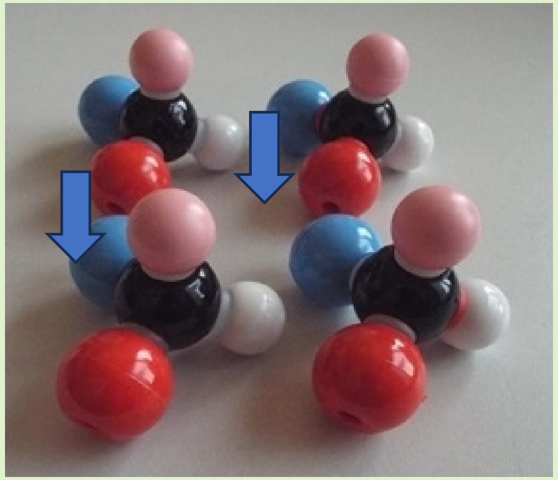


Fig.17 Amino acids chains with homochirality

[Matching of amino acid in a double helical structure.]

As shown in **Fig. 16**, when the molecular sequences of amino acids with different chirality proceed in opposite directions to each other, the points that intersect in amino acids shift to mesh with each other, so that the molecules of both amino acids can be matched.

[How DNA replicates]

When replicating DNA, unwound of the double helix by helicase is first. In the separated L-type molecular sequence, the D-type molecular sequence is continuously extracted, so the DNA is continuously replicated by polymerase. On the other hand, the D-type molecular sequence is taken out in the opposite direction, but since the formation proceeds in reverse due to chirality, it is duplicated in the reverse direction of the extracted molecular sequence.

[Protein synthesis]

When synthesizing L-type proteins, it is necessary to add L-type amino acids. When collating amino acids, D-type amino acids were used, but the process of generating tRNA carrying a newly added L-type amino acid molecule has not yet been elucidated.

At present, in the process of synthesizing protein molecules, there is a sequence of amino acids of L-type mRNA, and the molecules around it are L-type chirality. In a situation where the surrounding molecules are L-type, D-type amino acids dissipate, and L-type amino acid molecules are replaced, and L-type amino acids can be considered to be added to protein synthesis.

5.4 How to replicate protein

[Models for replicating proteins]

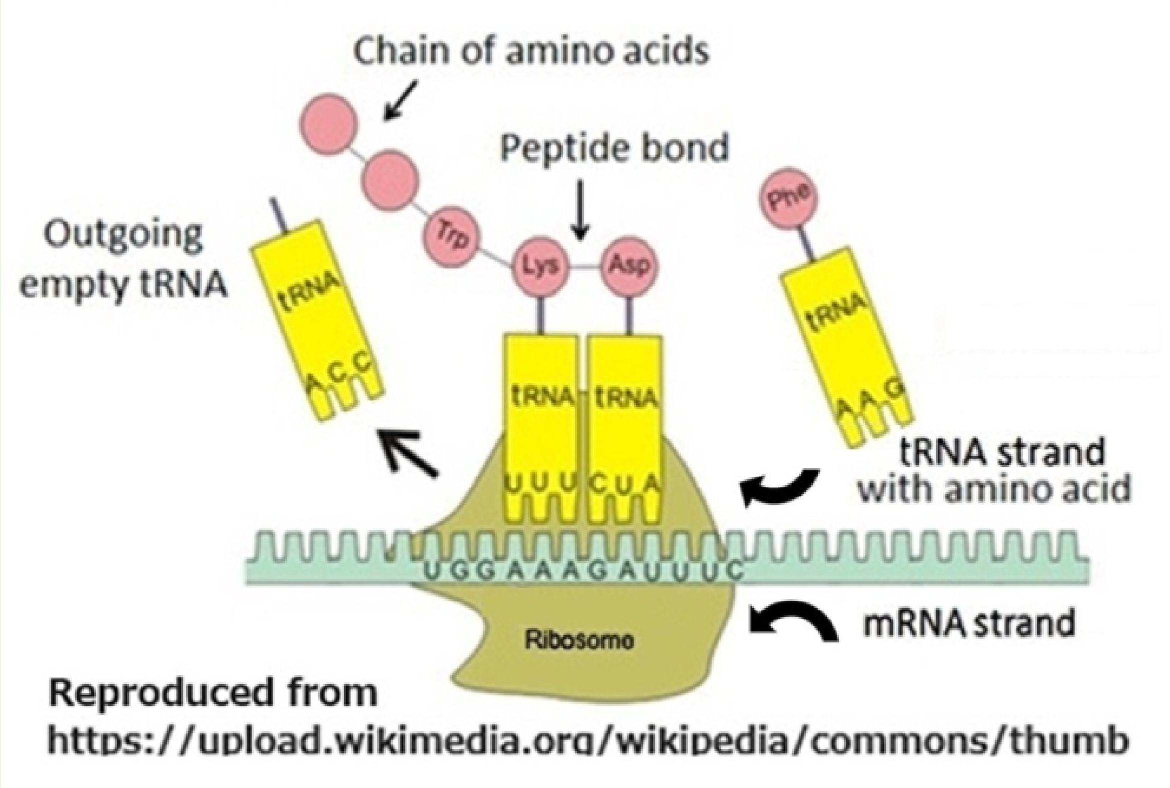


Fig.18. How ribosomes synthesize proteins

Figure 18 illustrates the current protein replication process.

When protein molecules are replicated by reproducing the sequence of amino acid units, mRNA is produced from the cell membrane to which the L-type protein is attached. Therefore, the separation of L-type amino acids labeled with codons is the same as that of tRNA and anticodon D-type amino acids, but the direction of rotation of helix is opposite. Therefore, the amino acids carried by the D-type of tRNA are intermittently matched with the amino acid sequence of the L-type of mRNA as if it is a gears mesh. In other words, the molecules of one amino acid are matched frame by frame as a single frame of a gear, and when they match, the frame of protein synthesis is shifted.

Since proteins are produced through cell membranes, the biomolecules of most living organisms on the Earth become chirality molecules. Therefore, the existence of homochirality molecules is one of the pieces of evidence that verifies whether organisms exist or have existed on the planet. Reference video[15].

Summary

In the elucidation of the origine of life, there is a tendency to prioritize thinking, but the recognition of facts is the foundation. Therefore, in this presentation, the detailed explanation is provided with images.

As a result of selection by natural selection, the activity of living organisms coincides with the purpose of sustaining life. **The life was born about 3.8 billion years ago by the self–assembly of proteins.** The new understanding of the origin of living organisms by studying them from a broad perspective, without ruling out a comprehensive and comprehensive consideration.

Thank you for your attention.

This presentation was produced by Shinji Karasawa.
For more information, please refer to the website
http://ss13005.stars.ne.jp .