JpGU Meeting 2023 : PPS08-P09

Origin of DNA and Origin of Genetic Code

May 21,2023, （English translation ）

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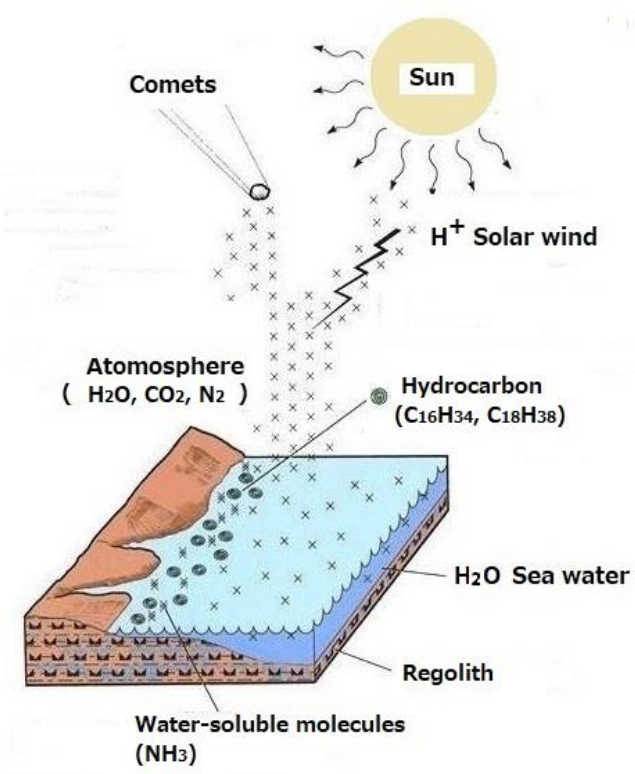

Fig.1. Formation of cell membranes in the early Earth

[Hydrocarbon molecules for cell membranes produced when the solar wind hits the primordial atmosphere]

The cell membrane of most of organisms consists of $C_{16}H_{34}$ or $C_{18}H_{38}$. Those hydrocarbons were synthesized in the sky due to the collision of the H^+ of the solar wind with CO_2 which had been the main component of the early Earth's atmosphere. Since small hydrocarbons have a low boiling point, the polymerization of those molecules had continued in the sky. $C_{16}H_{34}$ has a melting point of 20°C and a boiling point of 300°C, while $C_{18}H_{38}$ has a melting point of 27.8°C and a boiling point of 316.15°C. These molecules were suspended as the oil film on the water surface for a long time.

[Membrane of intermolecular bind were formed around the water surface]

There are spiral structures of water where vacant shafts exist. Fatty acids penetrate into the void holes perpendicular to the water surface. If a carboxyl group (COOH) attaches to a fatty acid as its tail, it does not penetrate the membrane. So, a cell membrane was formed by aligning perpendicular to the surface with the hydrophilic part outside. These fatty acids are found in large quantities in natural fats and oils.

The energy of thermal motion at 25°C is 0.6 kcal/mol, but the range of energy of thermal motion is large, and there are many molecules with kinetic energies that break the energy of hydrogen bonds.

Concurrent productions of proteins and RNA in cell membranes

A carbohydrate ($C_x(H_2O)_y$) is produced when H^+ is replaced by OH^- in a hydrocarbons of floating on the surface, and molecules of sugars are formed. There are systematic thermal motions of molecules in the spiral structure of water molecules where the movement of molecules from the water surface to inside of water is adjacent the inverse movement of molecules from the inside of water to surface concurrently. So, a long chain of carbohydrates consisting of D-type monosaccharide units swirling in contact with the invaded L-type amino acid region is added. Then, a molecular group of D-type sugars that carries an amino acid units became transport RNA (t-RNA).

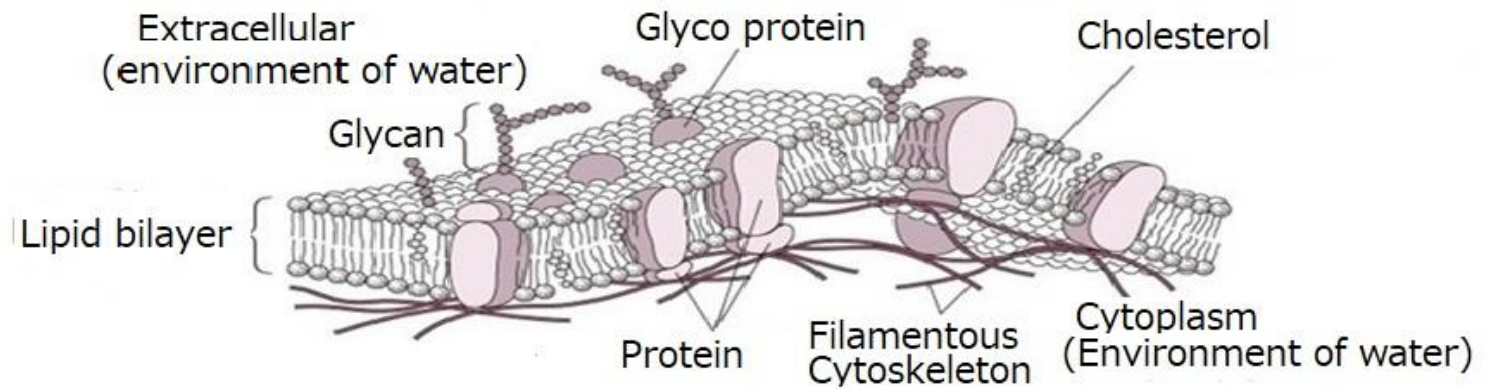

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Fig.2 Structure of cell membranes where biomolecules are produced

How proteins replicate by using DNA

Many t-RNAs for a protein were connected in order to form messenger RNA (m-RNA), which specifies the amino acid sequence of the protein. Since this m-RNA has a short lifespan, the helical sugar of L-type m-RNA forms stable DNA by dehydration binding.

DNA is separated at the hydrogen bond of a double spiral base pair, converted into a single strand of t-RNA and m-RNA. Here t-RNA is D-type, and m-RNA is L-type as shown in Fig.3. When synthesizing proteins, proteins are synthesized in the opposite direction.

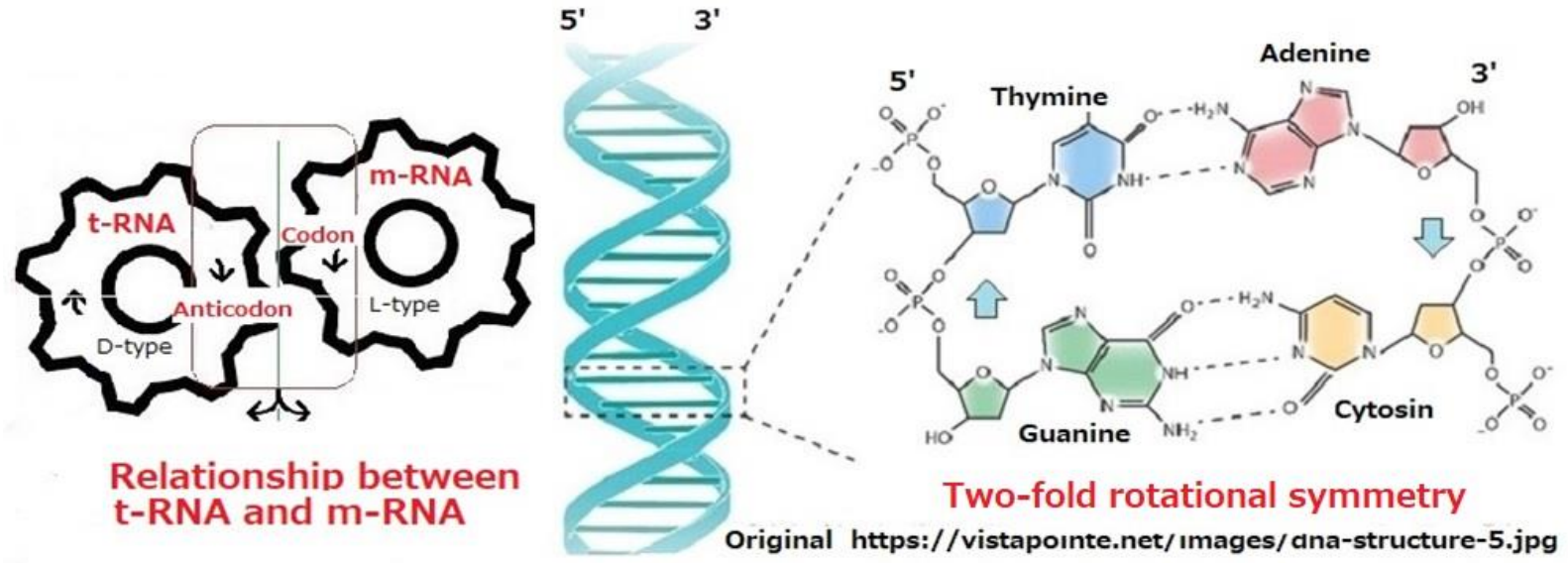

Fig.3 DNA is composed of two different rotationally symmetric base pairs of t-RNA and m-RNA

The relationship between m-RNA and t-RNA as shown by DNA

At each step of the m-RNA sequence, individual amino acids are compared to t-RNA, which is linked. The matching is done with codons in the genetic code, and the protein is replicated by t-RNA linked by m-RNA as shown in Fig.4.

When amino acids are physically bound to m-RNA, amino acid sequences are incorporated at random times, and proteins cannot be synthesized accurately.

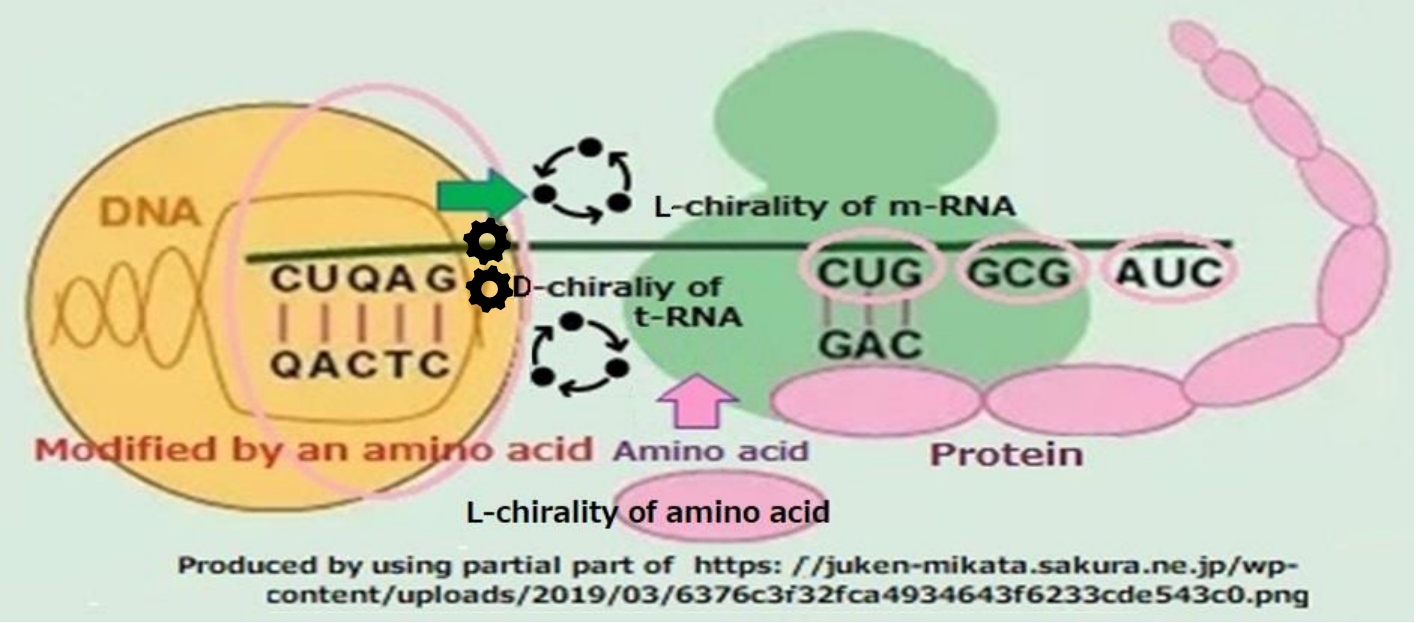

Fig.4 Mechanism of protein replication using DNA

References

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