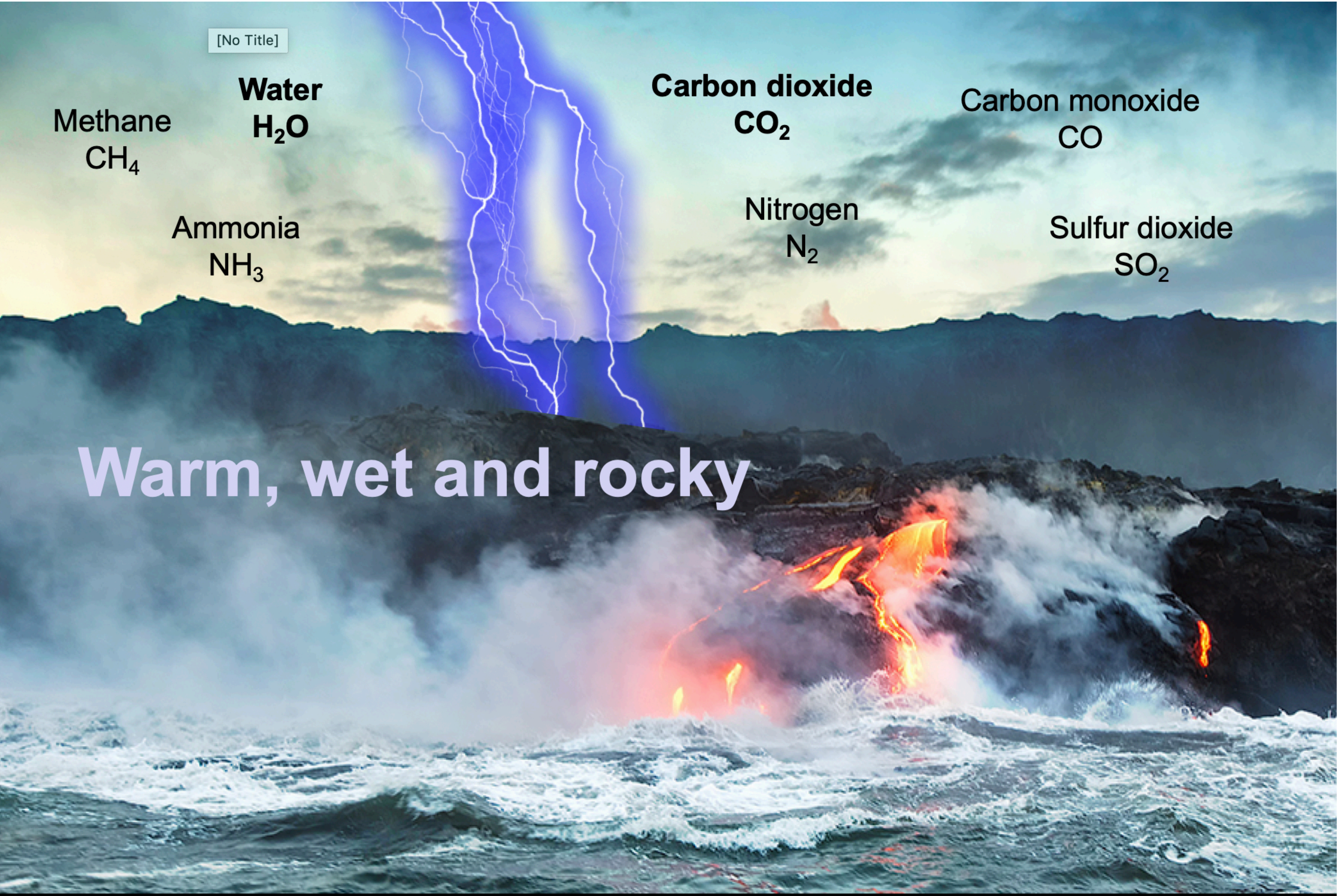
The CHEMICAL ORIGINS of LIFE

Dr Tim Hooker
BRLSI Science co-convenor

SCIENCE GROUP


[No Title]
Methane CH_4
Water H_2O
Ammonia NH_3
Carbon dioxide CO_2
Carbon monoxide CO
Nitrogen N_2
Sulfur dioxide SO_2
Warm, wet and rocky

The earliest evidence for life on Earth comes from fossilized cyanobacteria called **stromatolites** in Greenland that are about 3.7 billion years old.

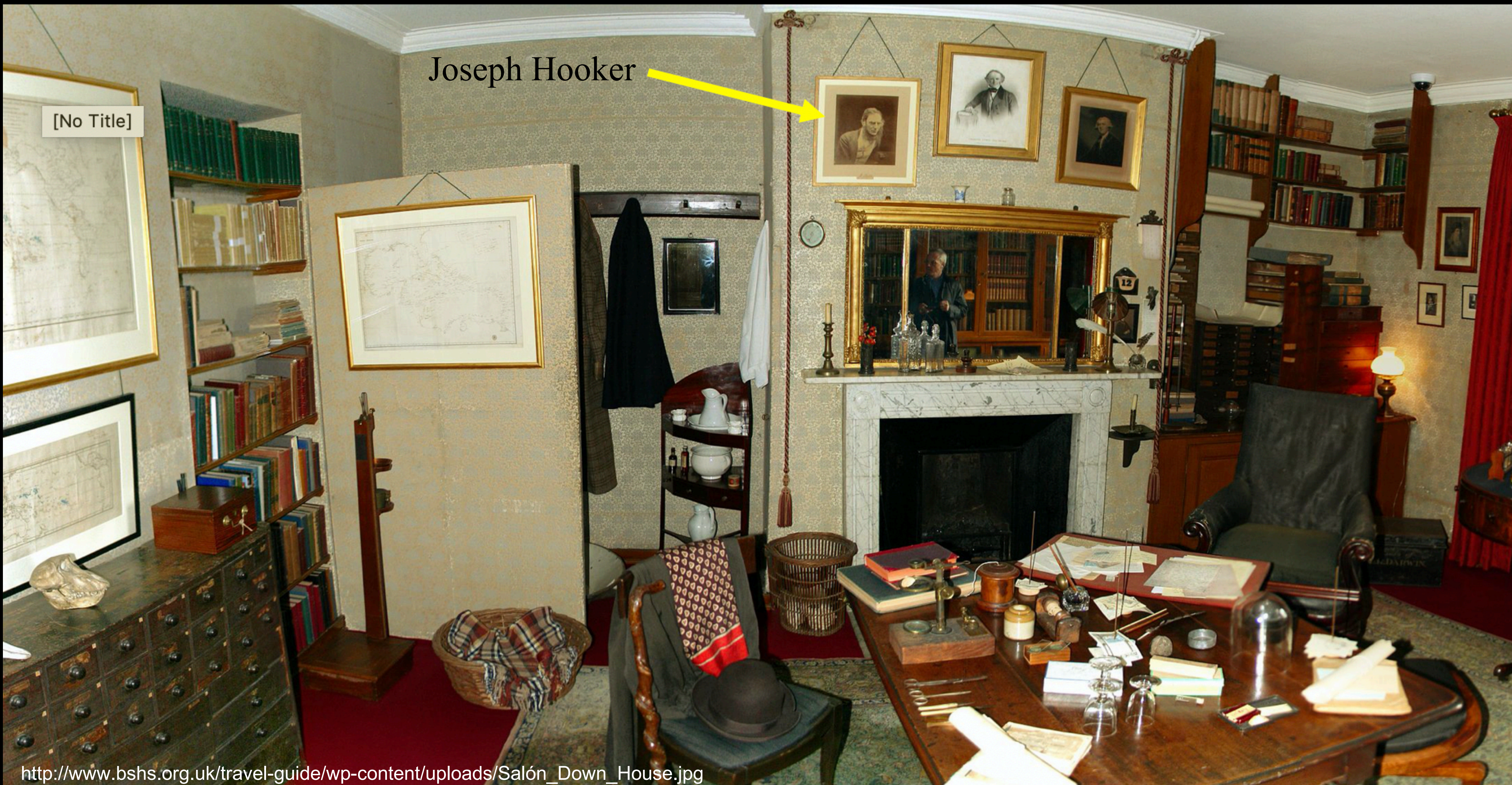
Since those bacteria were already biologically complex — with cell walls protecting their DNA — life must have begun even earlier.

https://www.worldatlas.com/

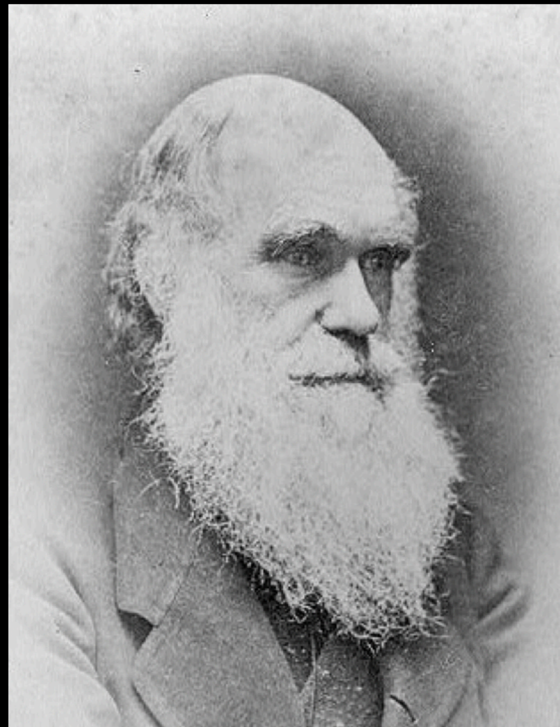
29th March 1863

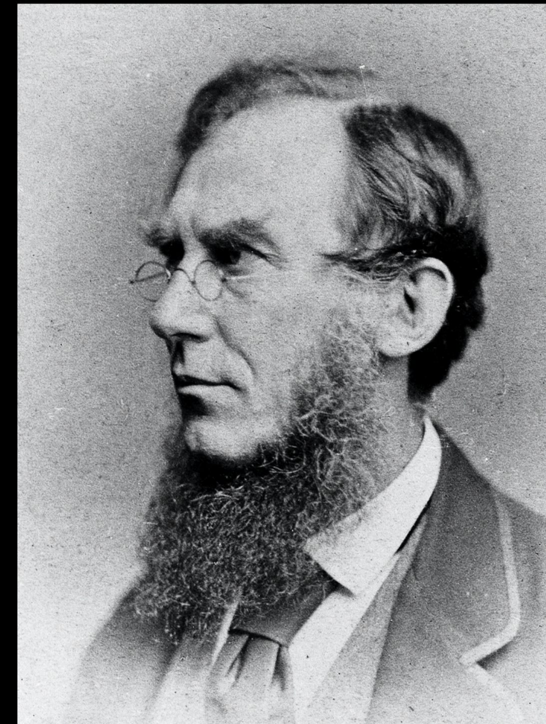
Down House, Downe, Bromley (then in Kent). Home of Charles Darwin

29th March 1863



Charles Darwin's Study





One of the first speculations on the origin of life was made by **Charles Darwin** in 1863 in a letter to **Joseph Hooker** stating: "*It is mere rubbish, thinking at present of the origin of life; one might as well think of the origin of matter.*"

In 1871 Darwin wrote again to Hooker suggesting that the original spark of life may have begun in a "*warm little pond, with all sorts of ammonia and phosphoric salts, light, heat, electricity, &c., present, that a protein compound was chemically formed ready to undergo still more complex changes.*"

"*at the present day such matter would be instantly devoured or absorbed, which would not have been the case before living creatures were formed.*"

Footnote

Sir Joseph Dalton Hooker OM, GCSI, CB, PRS. (1817 – 1911) was a British botanist and explorer in the 19th century. He was a founder of geographical botany and Charles Darwin's closest friend. For twenty years he served as director of the Royal Botanical Gardens, Kew, and was awarded the highest honours of British science.[1]

Darwin mentioned his early ideas on the transmutation of species and natural selection to Hooker in 1844.[2] In 1847 Hooker agreed to read Darwin's "Essay" explaining the theory,[3] and responded with notes giving Darwin calm critical feedback.[4] Their correspondence continued throughout the development of Darwin's theory and in 1858 Darwin wrote that Hooker was "*the one living soul from whom I have constantly received sympathy*".[5]

References.

1. Huxley, Leonard, ed. (1918). Life and Letters of Sir Joseph Dalton Hooker O.M., G.C.S.I. Vol. II. London: John Murray).
2. Darwin Correspondence Project – Letter 729.
3. Darwin Correspondence Project – Letter 1058.
4. Darwin Correspondence Project – Letter 1066.
5. Darwin Correspondence Project – Letter 2345.

Definition of life is controversial

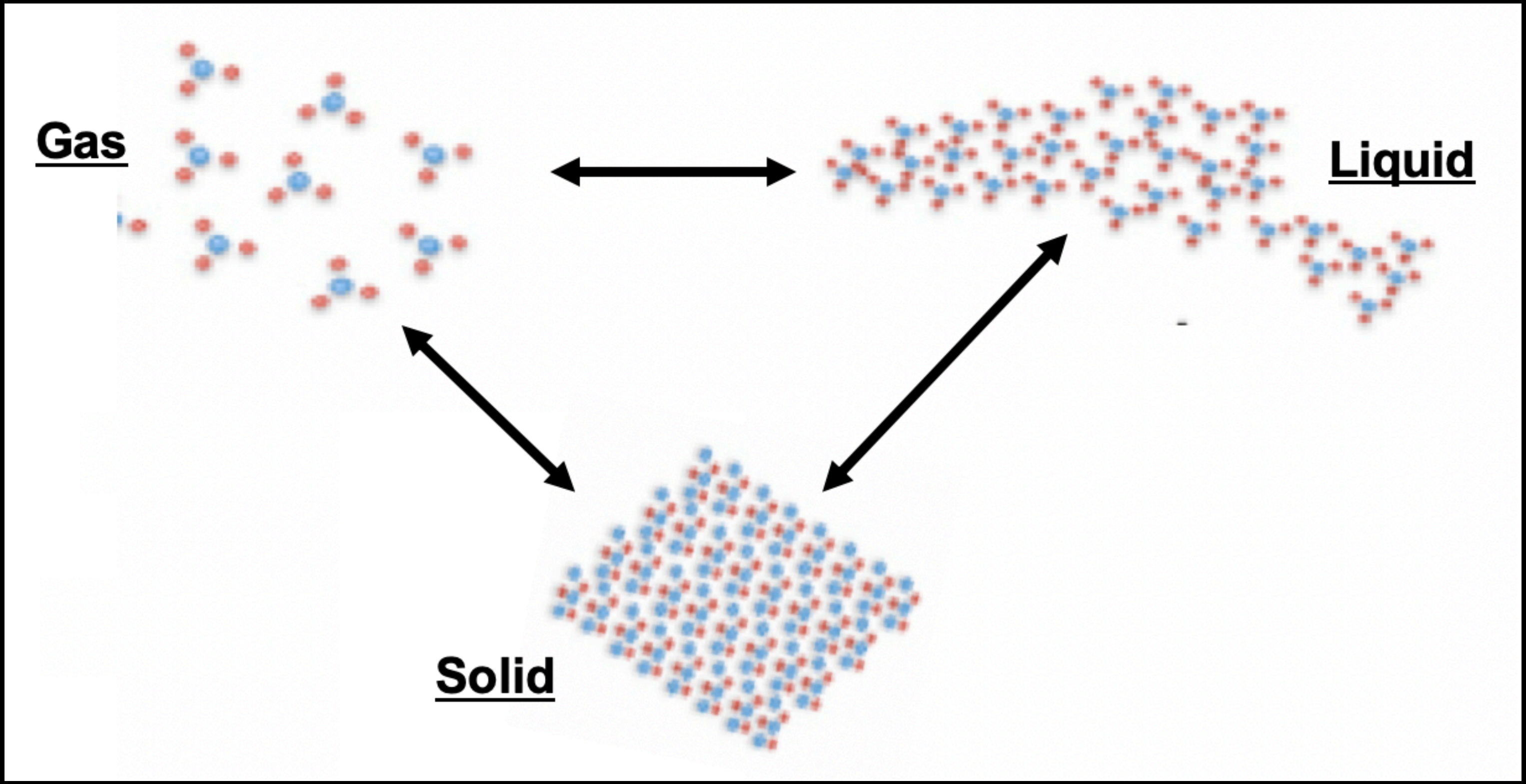
- **Cellular**
  (or based on cellular structure)
- **Undergo metabolism**
  (nutrition, respiration, excretion)
- **Maintain homeostasis**
  (temperature, water, salts, acidity)
- **Grow**
- **Reproduce**
- **Respond to stimuli**
- **Adapt to their environment**

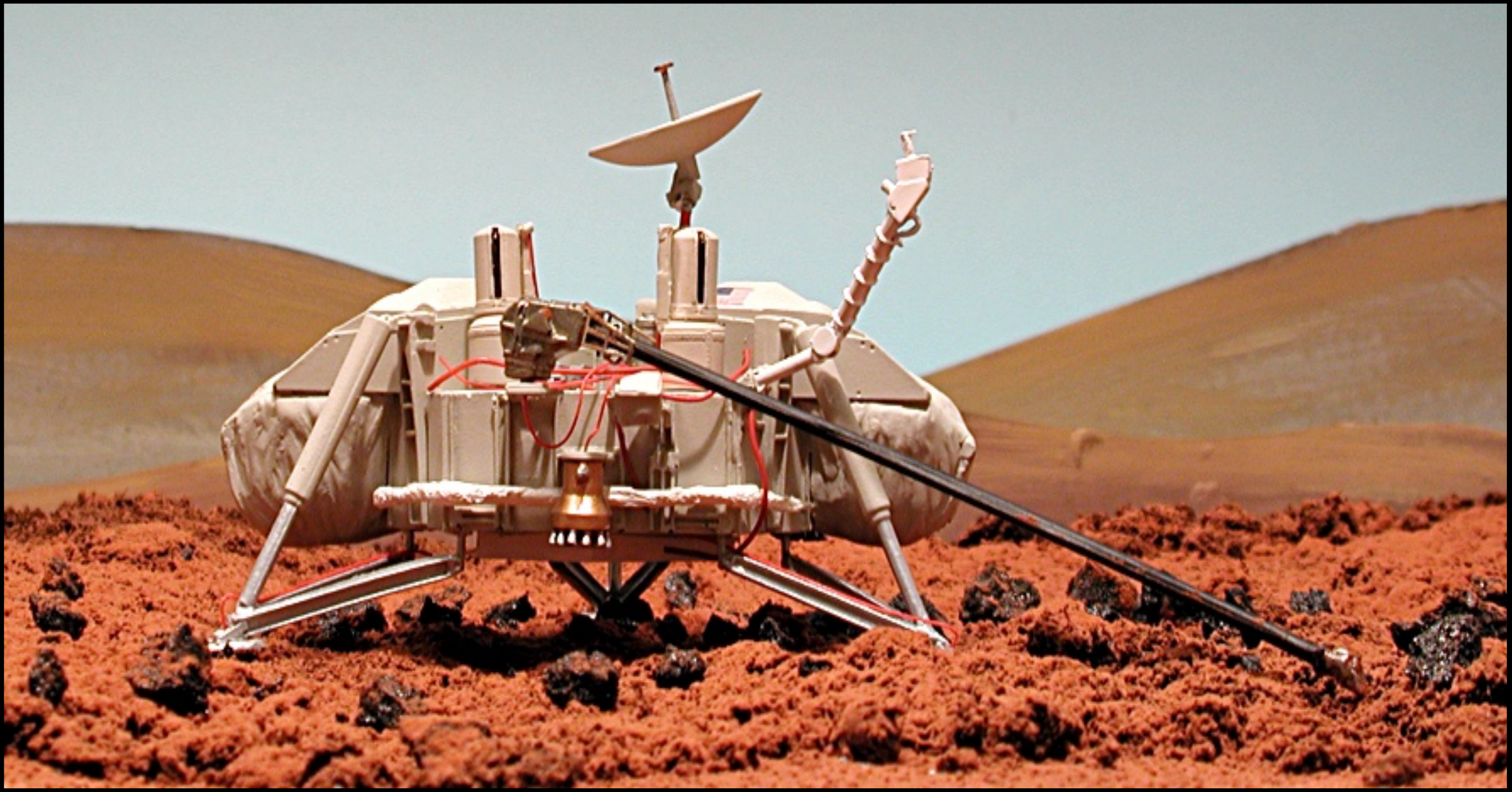
?

- Viruses
- Seed dormancy
- Suspended animation
- Death
- Organ transplants

Origin of Life

To qualify as a living thing, an organism must meet some degree of <u>all</u> those criteria. For example, a crystal can grow, reach equilibrium, and even move in response to stimuli, but it lacks what could be thought of as a metabolism.





In 1964, **James Lovelock** (Gaia Hypothesis) was among a group of scientists requested by NASA to propose a theoretical life detection system to look for life on Mars during the upcoming Viking mission (1975).

To Lovelock, the basic question was:
"What is life, and how should it be recognized?"
When asked what he would do to look for life on Mars he replied:
"***I'd look for an entropy reduction, since this must be a general characteristic of life***".

Why is entropy important?

Entropy is a measure of the disorder or randomness of a system.

The **Second Law of Thermodynamics** says that, in an "isolated system", total **entropy** increases over time.

e.g. wood burns and becomes disordered into ash, smoke and gases.

A room is a system, with lots of objects. Over time, it gets messy (disordered).

Living things take energy out of their environment and use it to reduce their entropy by growing and metabolising and becoming more orderly.

Living versus Dead

When living things cease to be alive, their bodies wither, decay and lose coherence

Their state of disorder increases

Their ENTROPY increases

Physical matter

Increasing entropy

Energy dispersed

Order ← **Origin of Life** — **Disorder**

Biological matter

Decreasing entropy

Energy incorporated

Models of life

***All life is cellular*. Without structural mechanisms for isolating the different metabolic systems within the cell, the lack of coordination would be chaotic and lethal.**

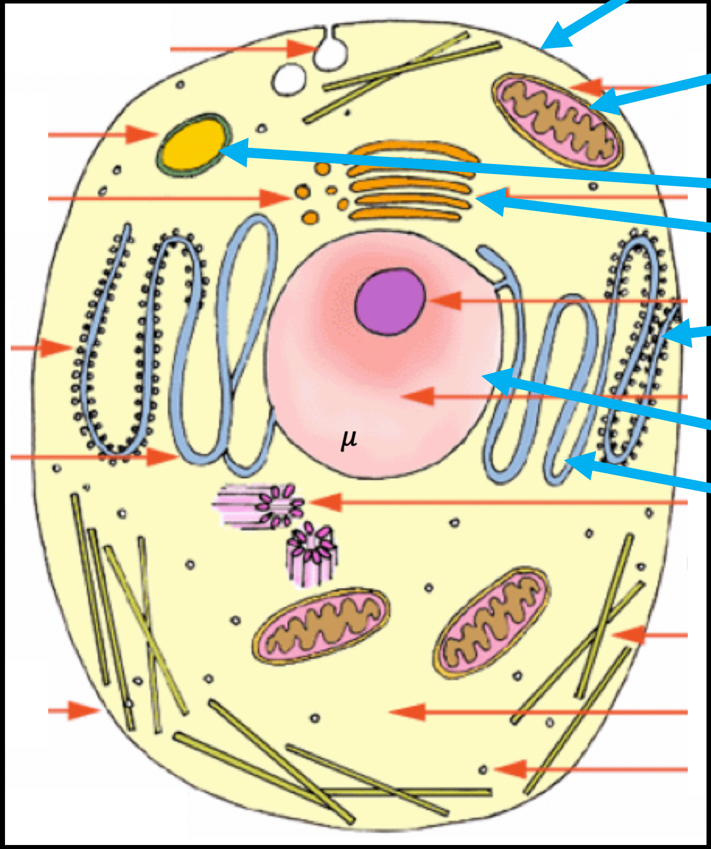
There must have been naturally arising boundary states that could have facilitated pre-biotic states on which natural selection was able to operate.

"It has been possible to duplicate practically all the activities of an amoeba with (non-living) mechanical models. Amoeboid movements are produced by injecting a little alcohol into a droplet of clove oil in water. The alcohol changes the surface film of the oil droplet and causes it to send out pseudopods and to flow about like an amoeba. A drop of chloroform in water appears to be quite as 'finicky' in its 'eating habits' as an amoeba. When offered small pieces of various substances, such a drop will 'refuse' sand, wood and glass and will even eject them if they are forcibly introduced. On the other hand, bits of shellac or paraffin are 'eagerly' enveloped. If we play a trick on the chloroform drop by feeding it a piece of glass coated with shellac, it will engulf this 'delicacy', dissolve the shellac, and then eliminate the glass. An important difference is that the behaviour of the amoeba is adaptive".

Ralph Bauchsbaum, 1938, "Animals without backbones: 1", p.30. Pub. Penguin (Pelican).

Structure of cells

All life is based on a cellular structure. Without some structural isolation and coordination of metabolic systems the resulting chaos would be fatal.



1. **Boundary membranes**
   Selectively permeable for controlling absorption, excretion, & containment.

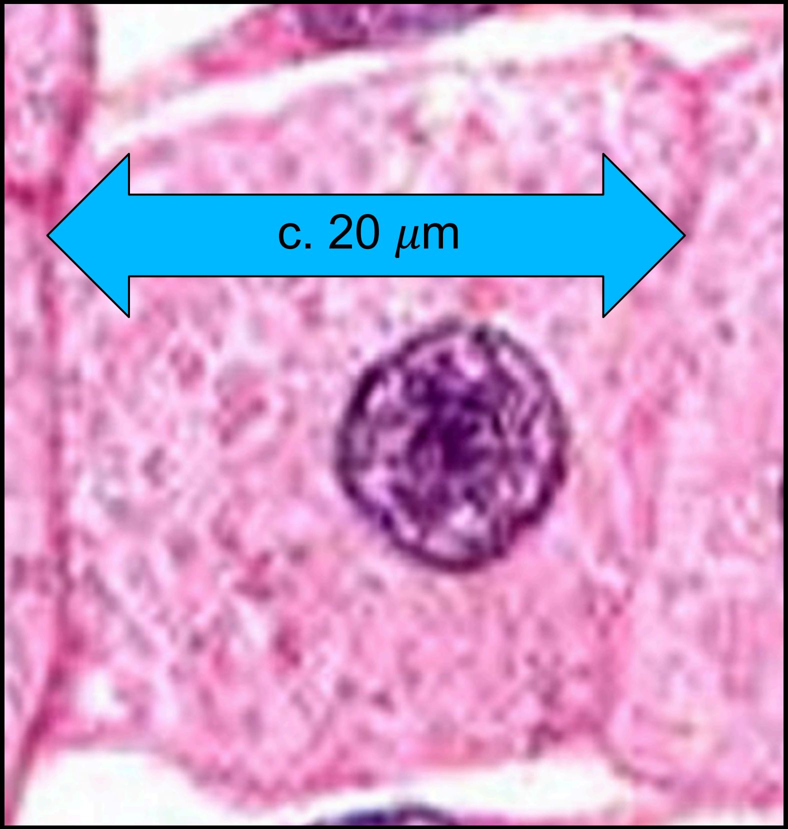
2. **Utilisation of energy**
   Chloroplasts : photosynthesis.
   Mitochondria : respiration.

3. **Metabolic organisation**
   Lysosomes : breakdown & recycling.
   Golgi Body : packaging.
   Ribosomes : synthesis of new proteins.

4. **Coordination mechanisms**
   Nucleus : contains genetic codes
   Reticulum : manufacture & transport

5. **Sensitivity to environmental change**.

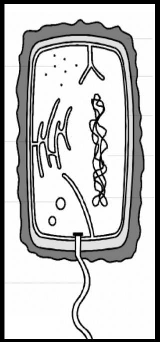
Liver cell

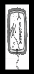


$1{,}000\ \mu m = 1\ mm$

50 liver cells / mm

Bacteria cells



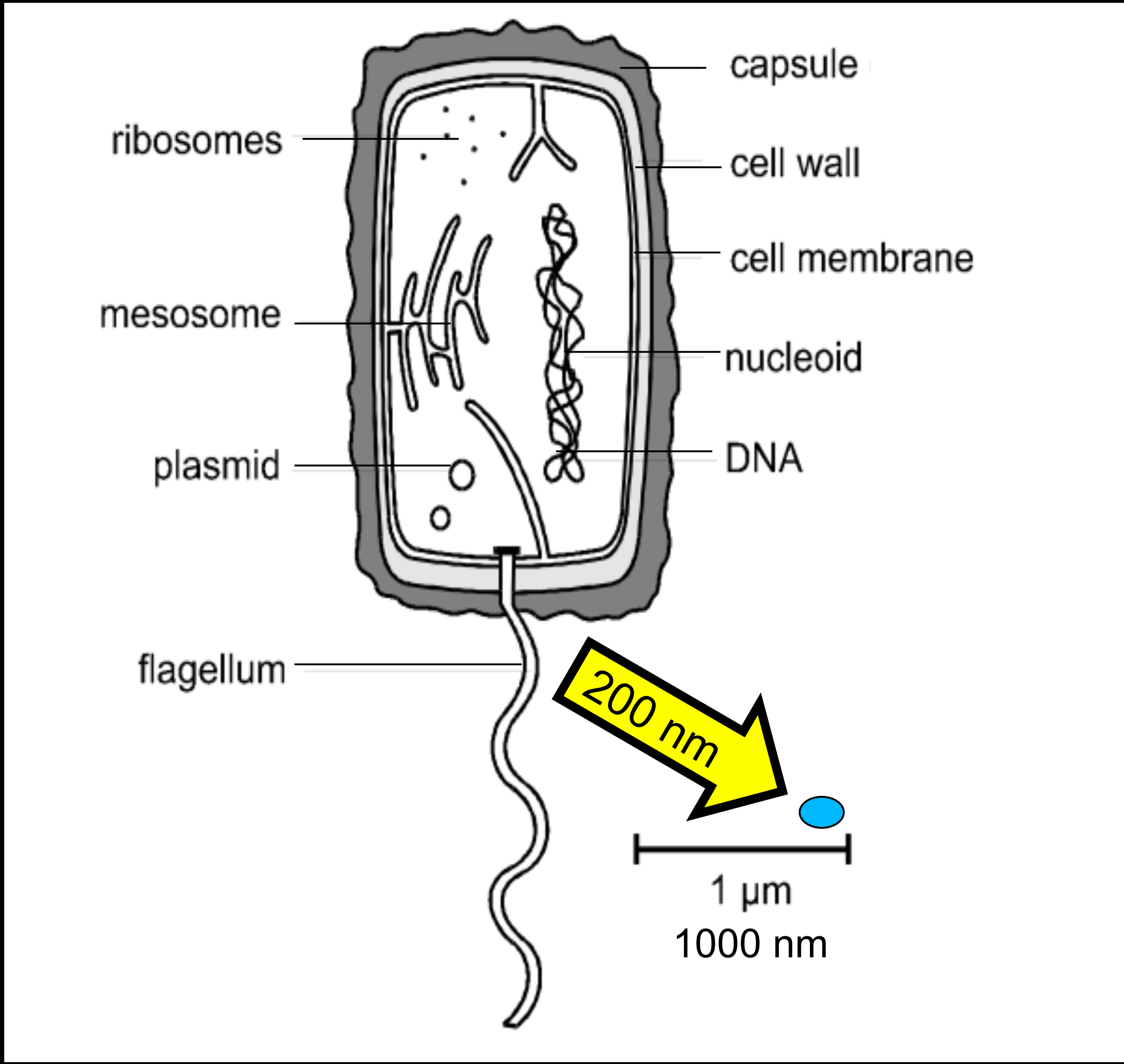


5.0 μm

0.5 μm

200 - 2000 bacteria / mm

Bacteria


capsule
ribosomes
cell wall
cell membrane
mesosome
nucleoid
plasmid
DNA
flagellum
200 nm
1 μm
1000 nm

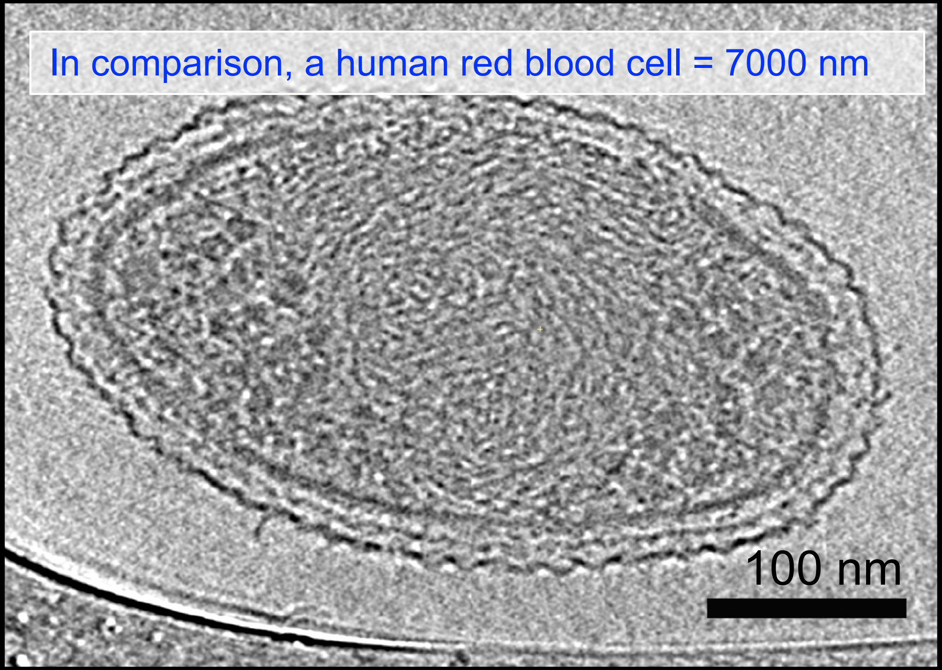
Nanobacteria (Ultra-small bacteria)

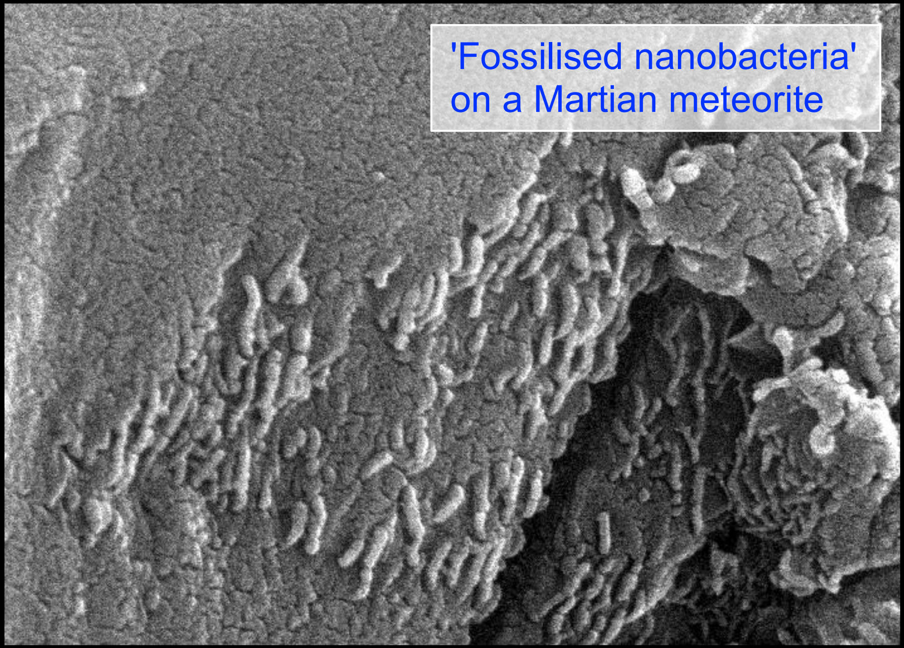
The generally accepted lower limit for bacterial life is about 200 nm. (5,000 / mm)

Cells of this size exist in deep rocks and appear to replicate in some way, ranging from 400 – 50 nm.

There are suggestions that some examples may may be non-living crystallizations of minerals and organic molecules.

Some culturable organisms on earth are the same 50nm size as the ‘fossilised nanobacteria’ found within a Martian meteorite. (20,000 / mm)





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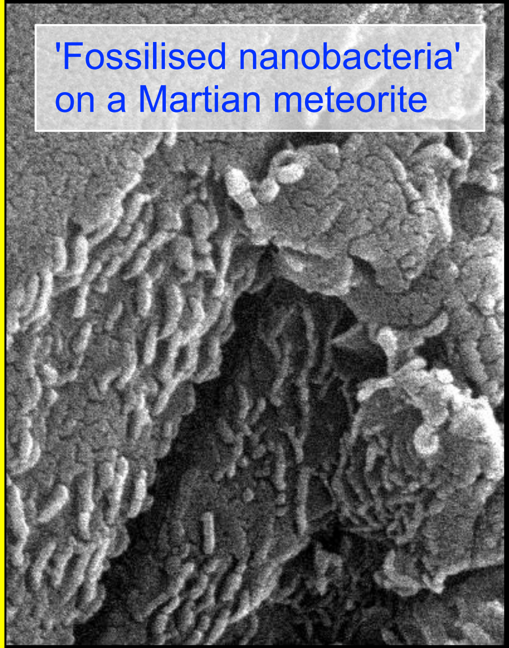
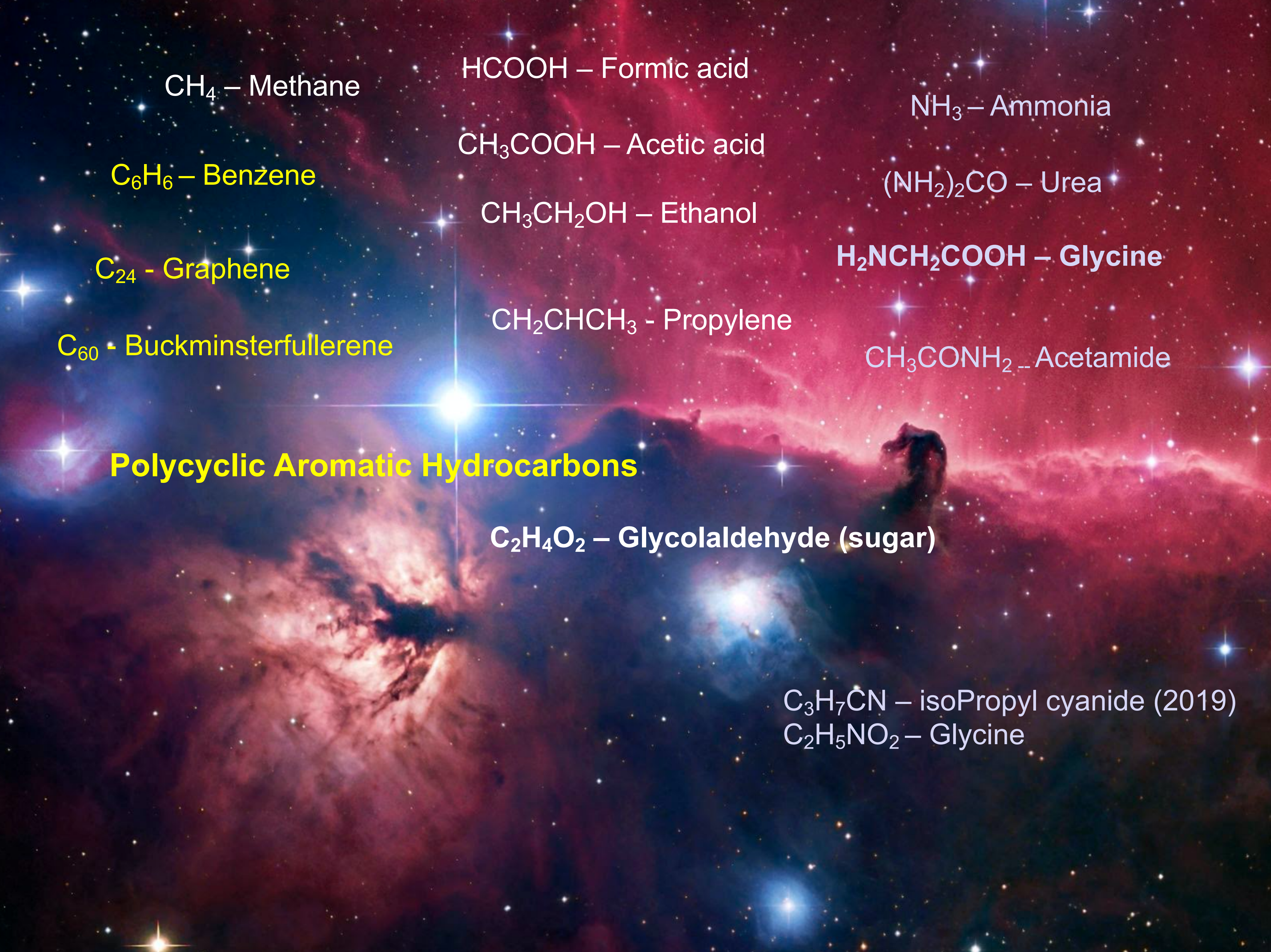
Martian 'fossils' contain:

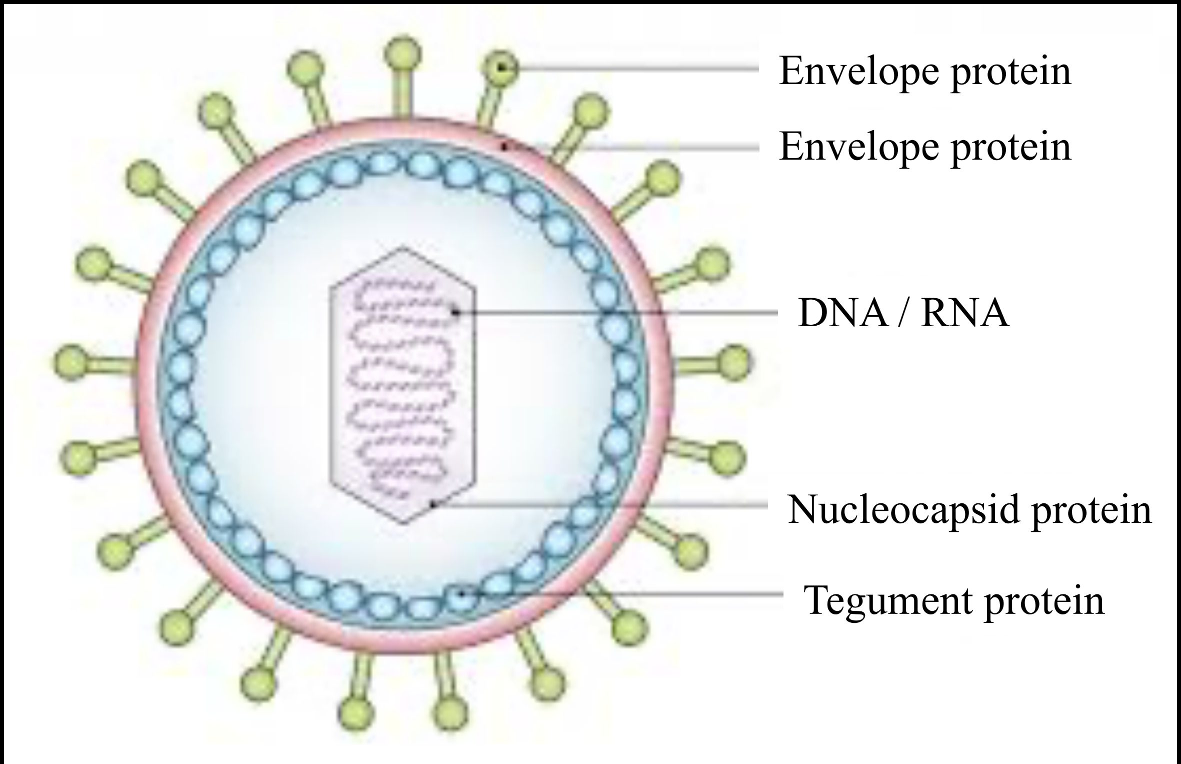
1. Magnetite crystals of a form only found in bacteria.
2. Carbonate globules containing Polycyclic Aromatic Hydrocarbons.
3. Those PAHs are:
   a) not laboratory contaminants
   b) did not enter the meteorite while it was in Antarctica
   c) are not like PAHs in other meteorites (which have nothing to do with life)
   d) are consistent with decomposition of simple bacteria.

PAHs are known to be abundant in interstellar space and comets;
Are assumed to have been abundant on the primordial Earth and to have played a major role in the **origin of life** by mediating the synthesis of **RNA**.




HCOOH – Formic acid
CH_4 – Methane
NH_3 – Ammonia
CH_3COOH – Acetic acid
C_6H_6 – Benzene
$(NH_2)_2CO$ – Urea
CH_3CH_2OH – Ethanol
H_2NCH_2COOH – Glycine
C_{24} - Graphene
CH_2CHCH_3 - Propylene
C_{60} - Buckminsterfullerene
CH_3CONH_2 – Acetamide
Polycyclic Aromatic Hydrocarbons
$C_2H_4O_2$ – Glycolaldehyde (sugar)
C_3H_7CN – isoPropyl cyanide (2019)
$C_2H_5NO_2$ – Glycine

Viruses : Non-living?



They do not:
- feed
- breathe
- excrete
- grow
- move
- reproduce themselves

BUT
- they have their own genes (DNA or RNA).
- they are sensitive (i.e. recognise their hosts).
- can be 'denatured' (by heat and chemicals).

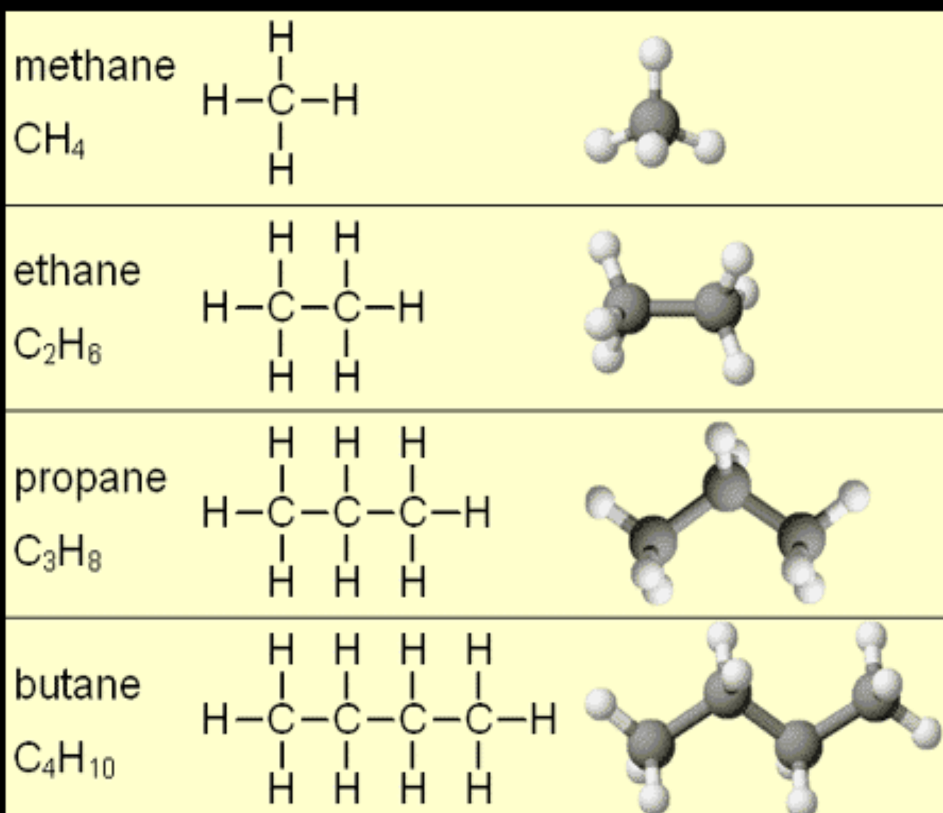
Size ranges from 400 - 20 nm (equivalent to nanobacteria).
Are they pre-cursors to life or degenerate bacteria?

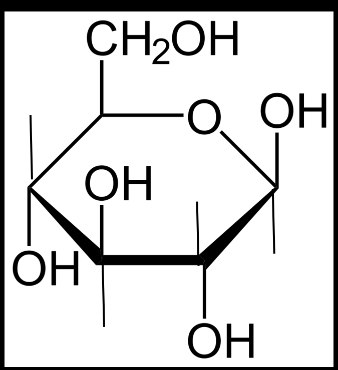
“We know less about viruses than any other life form”. (New Scientist : 11 January 2020)

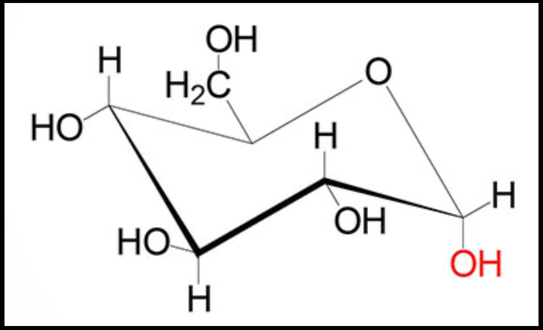
<u>Life needs carbon</u>

Life as we know it is based on carbon because its atoms not only freely bond with each other but also with the atoms of other chemical elements to produce an infinite variety and complexity of macromolecules.

The carbon atom has four bonds, giving it a tetrahedral shape that gives rise to crinkled chains and rings, providing even more variety to the shapes of **organic molecules**.







Organic molecules

Lipids : for **membranes**, e.g. fats and oils.
Carbon, Hydrogen and Oxygen.

Proteins : for **fibres, hormones, enzymes, pigments.**
Carbon, Hydrogen, Oxygen, Nitrogen and Sulphur

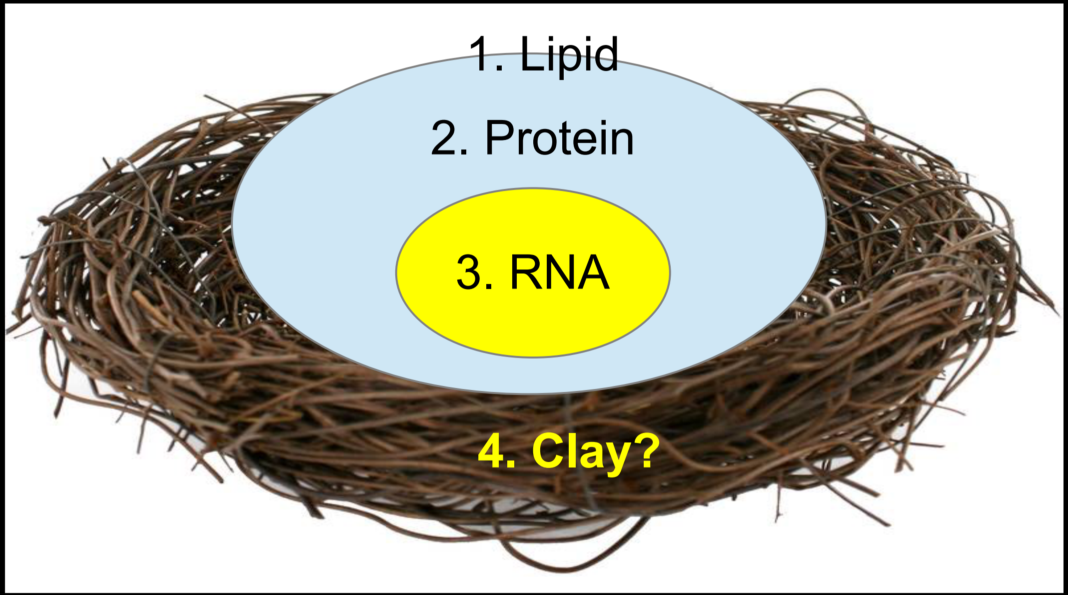
Nucleotides : for **energy transfer**, e.g. **ATP**
Carbon, Hydrogen, Oxygen, Nitrogen and Phosphorus.

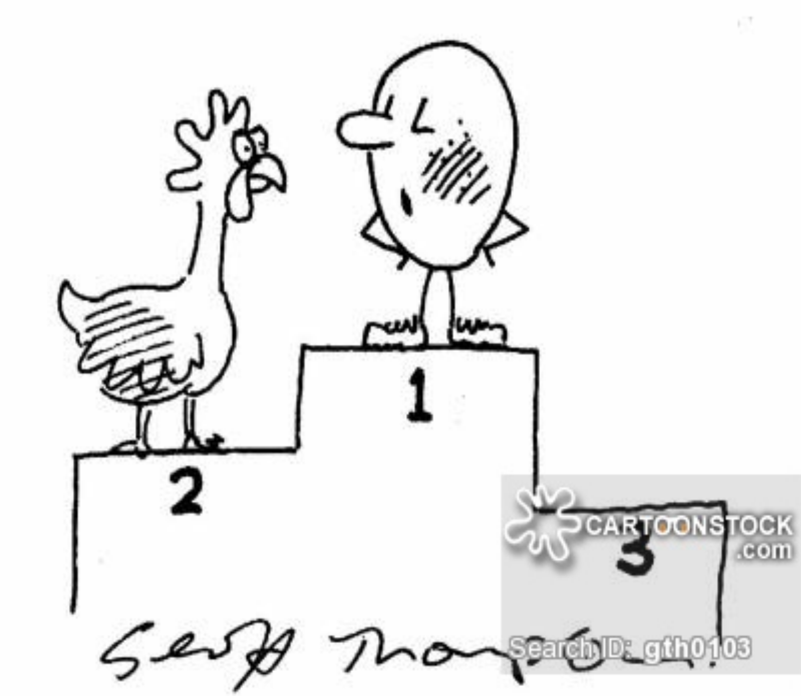
Nucleic Acids : **DNA** & **RNA** for **making proteins.**

<u>Three</u> major 'hurdles' to Life

So ....., in the origin of living cells, which came first:

1. Boundary membranes based on **lipids?**
2. Metabolism involving proteins based on **amino acids?**
3. Genetic codes for making proteins based on **RNA & DNA?**
4. Do eggs need an environment?

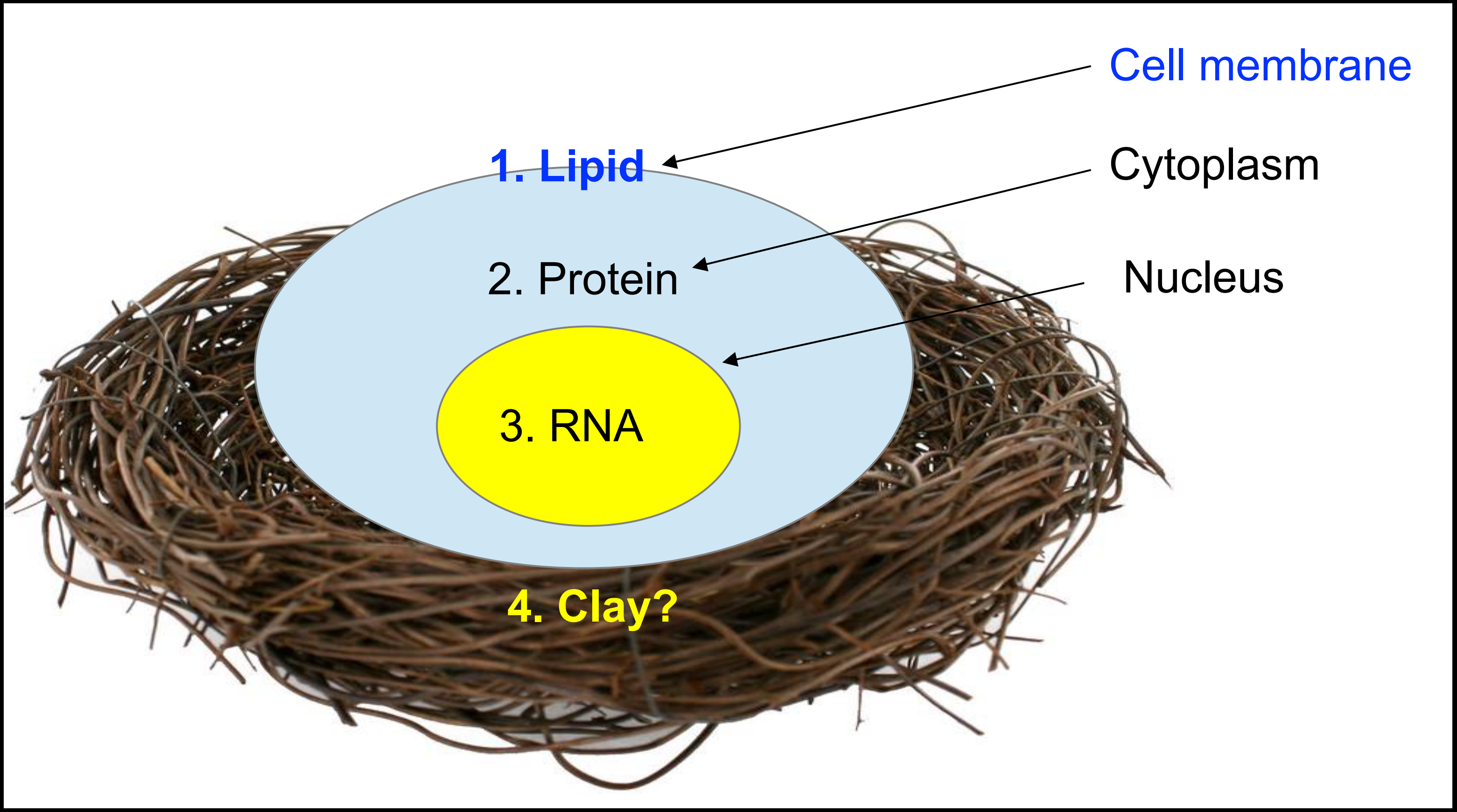




"I hope we're not going to have the same old argument."

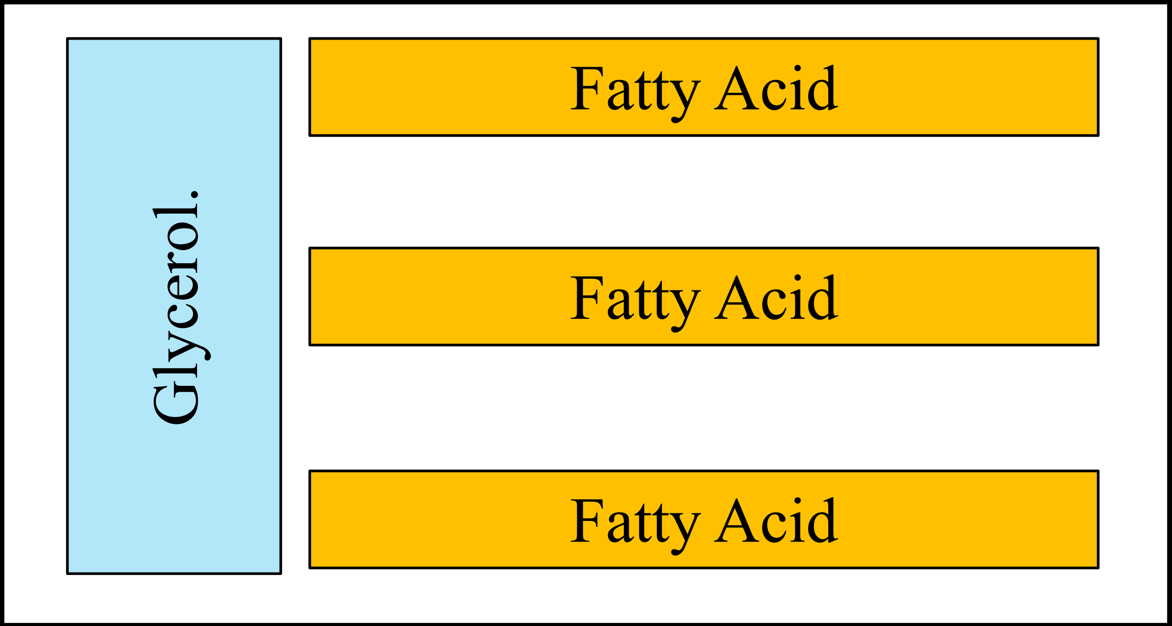
Lipids (fats/oils)

1. How were the first lipids produced from freely available hydrocarbon molecules?

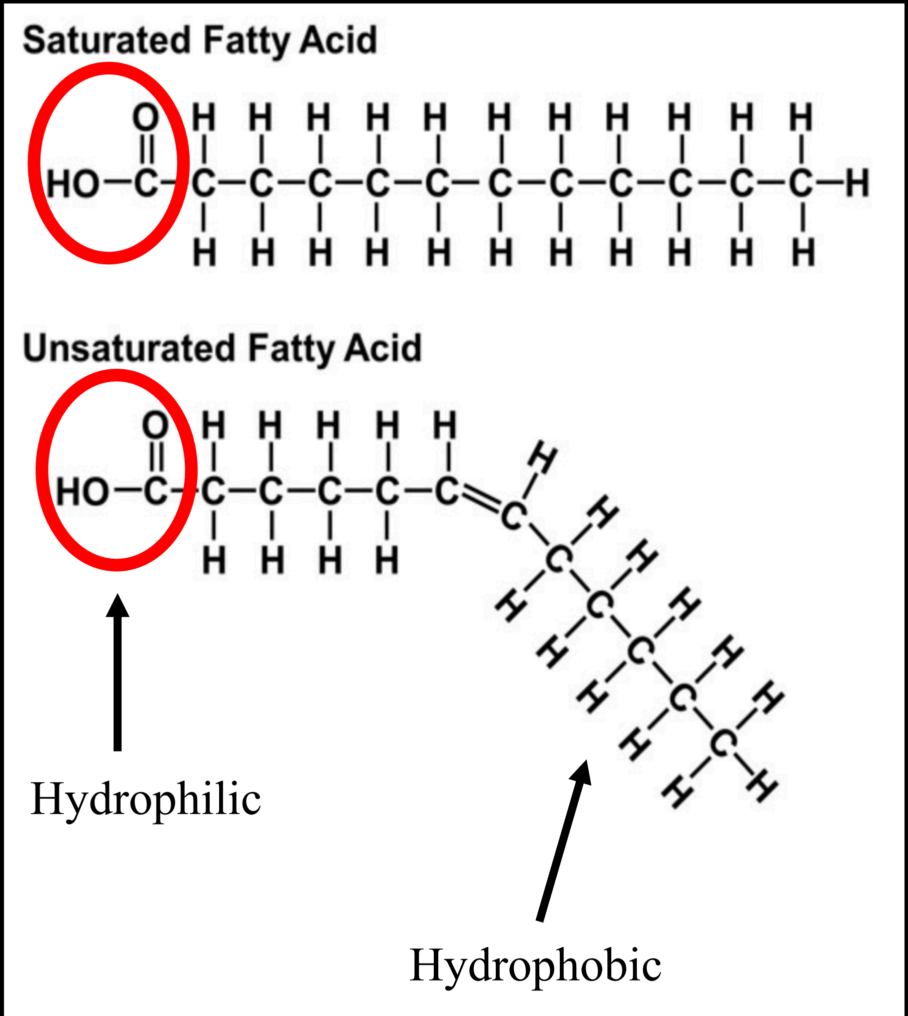


Lipids

They are composed of **Glycerol** (glycerine - a sugar alcohol) and three **Fatty Acids**.



Fatty acids



Fatty acids up to C12 have been synthesized from methane, ammonia and water vapour by:

- **Electric discharge**.
  (Allen and Ponnamperuma, 1967, Currents in Modern Biology, 1, pp. 24-28; Yuen et al., 1981, Journal of Molecular Evolution, 17, pp. 43-47) .
- **UV radiation**
  (Groth and Weyssenhoff, 1960, Planetary and Space Science, 2, pp. 79-85)
- **Shock heating mimicking a meteorite impact**
  (Furukawa et al., 2009, Nature Geoscience, 2, pp. 62-66).

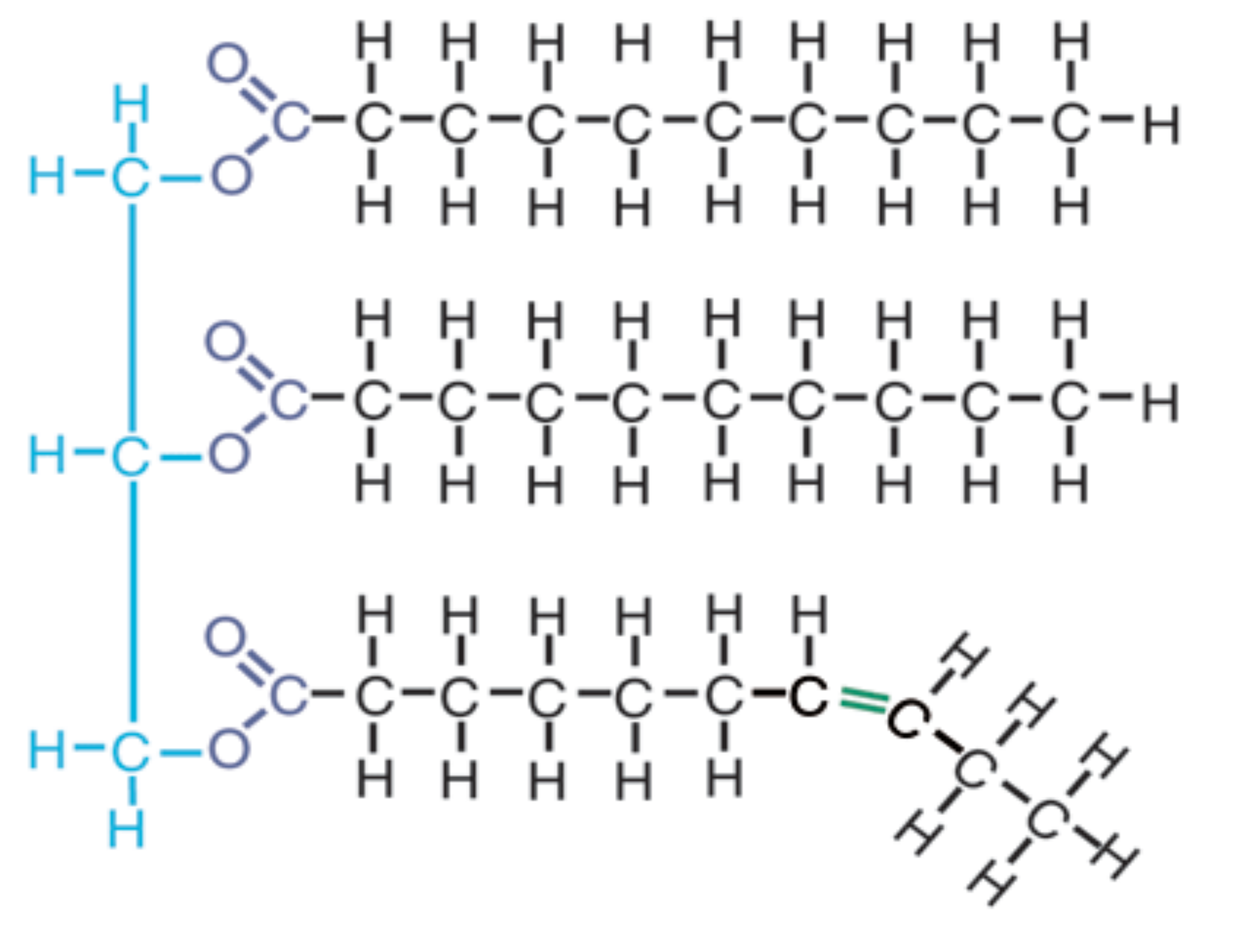
In the **Murchison meteorite** fatty acids are the most abundant compounds, around 58 times more abundant than Glycine, the most frequent amino acid.
(Pereira et al., 1975, Geochimica et Cosmochimica Acta, 39 (1975), pp. 163-172).

Lipids

They are composed of **Glycerol** (glycerine - a sugar alcohol) and three **Fatty Acids**.

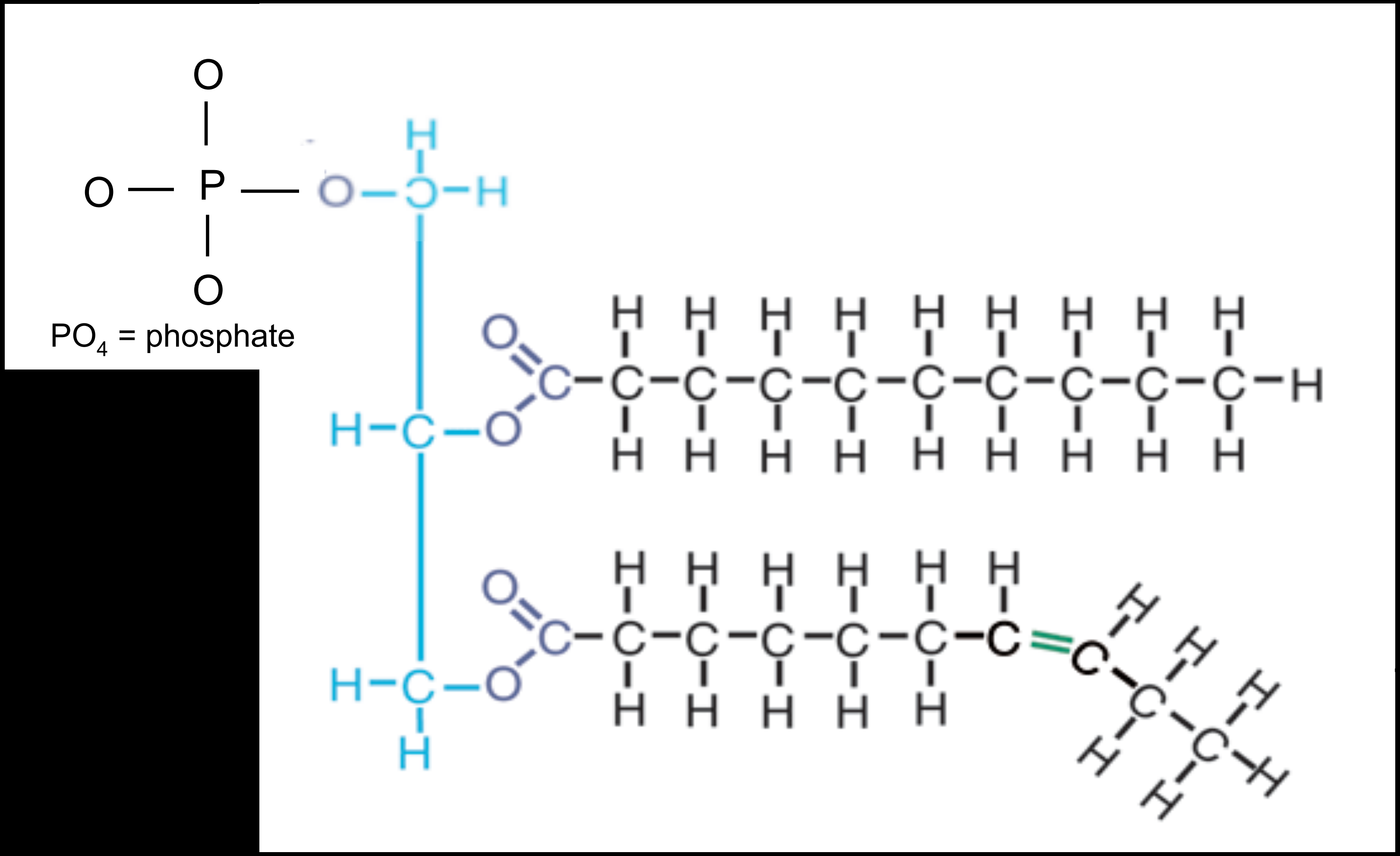
Hydrocarbons (oil & natural gas) are abundant on Earth.

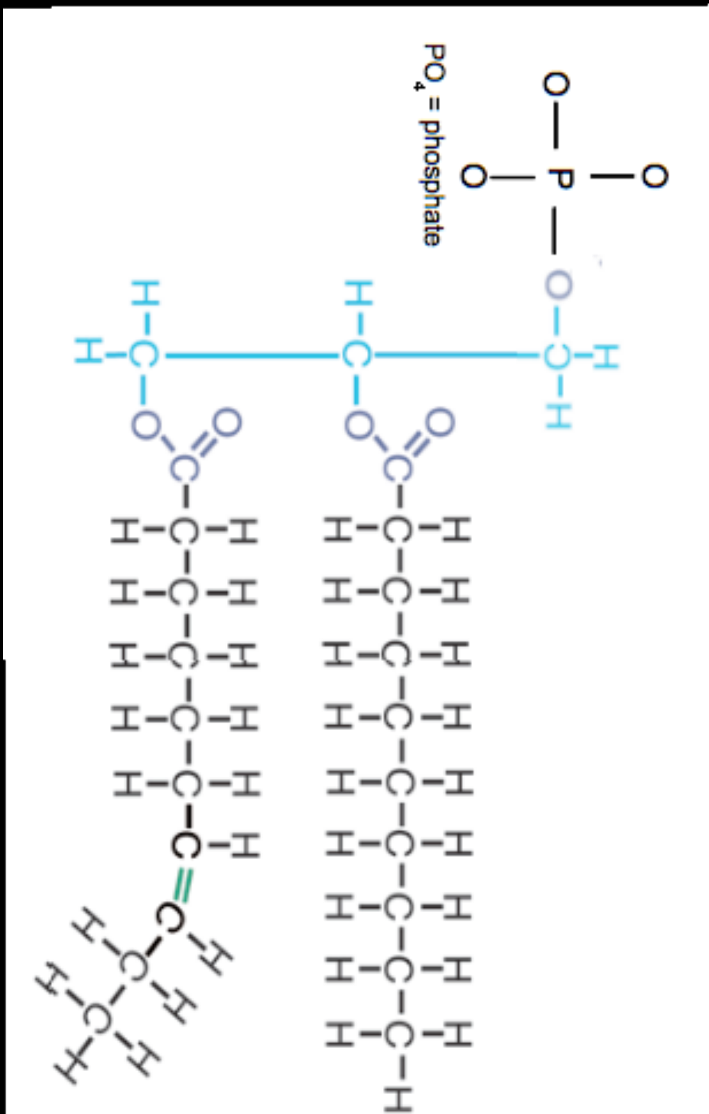
Glycerol has been found in meteorites

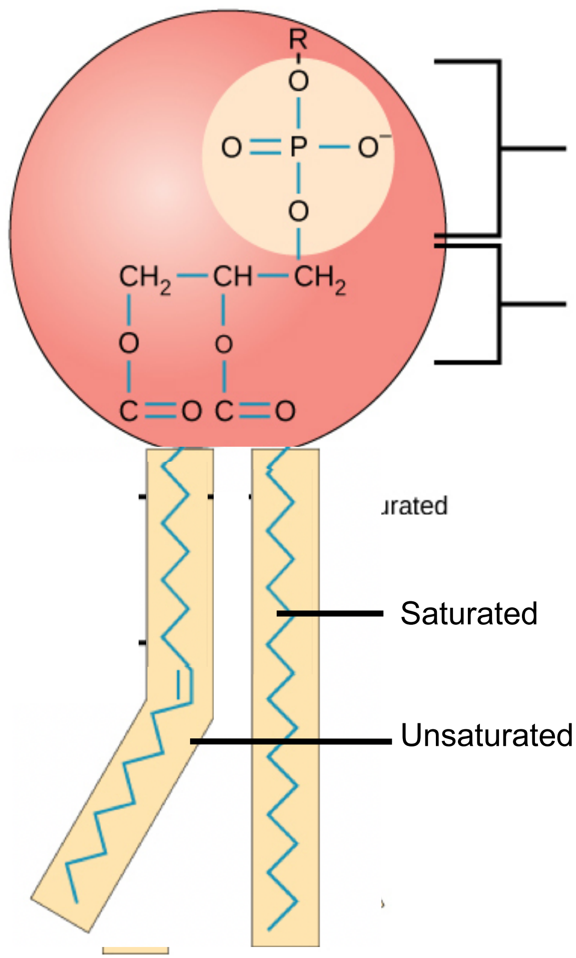


Phospho-lipid membranes

Substituting one of the fatty acids for a phosphate molecule (PO_4) produces a **Phospho-lipid**.



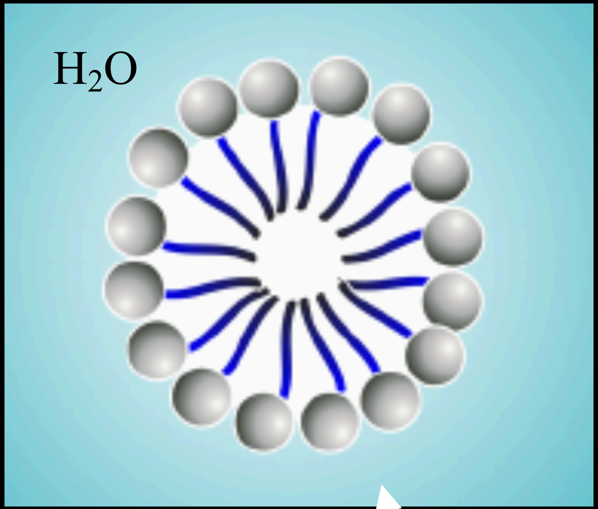


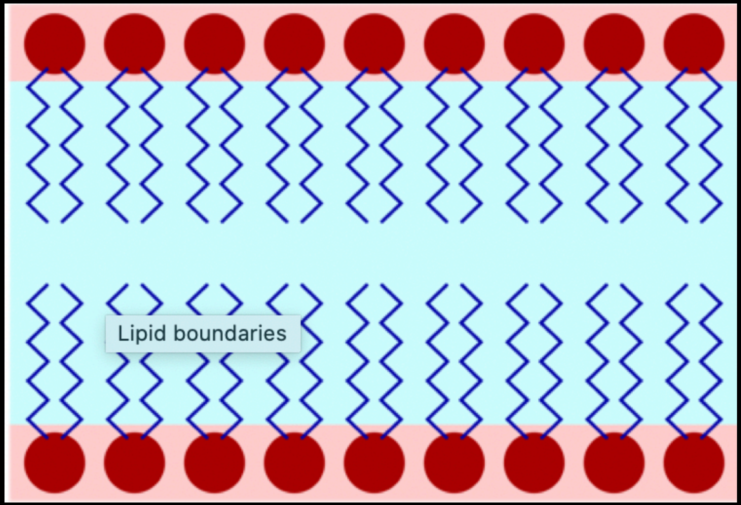


The head is deficient in hydrogen atoms, making it attractive to water.
It is **hydrophilic.**

The tails are surrounded by hydrogen atoms, which repel water.
They are **hydrophobic.**

Lipid boundaries



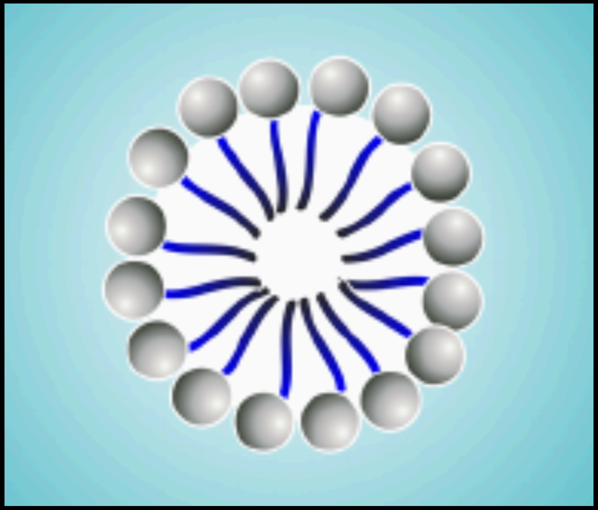


In aqueous solutions lipids with **one fatty acid tail** will spontaneously arrange themselves in spherical <u>micelles</u>.

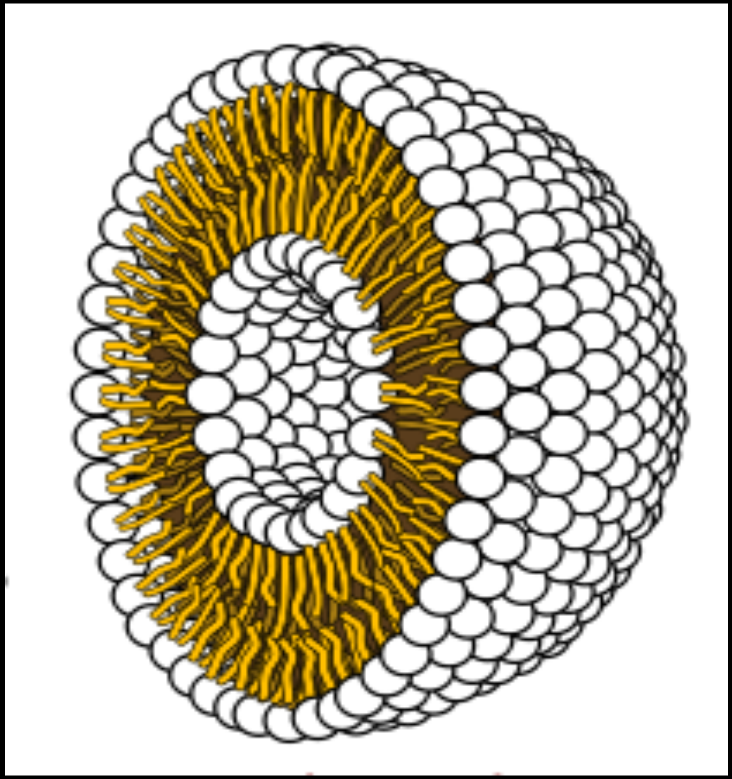
Two fatty acid chains are too big and bulky to fit into the interior of a micelle. They adopt the preferred bilayer sheet of cell membranes.

Experiments that simulated conditions of the early Earth have led to the formation of lipids and these can spontaneously form <u>double-walled vesicles</u> called **liposomes** which can reproduce themselves.

(Ref. Garwood, Russell J. (2012). "Patterns on Palaeontology: The first 3 billion years of evolution", *Palaeontology Online*. **2** (11): 1–14.).

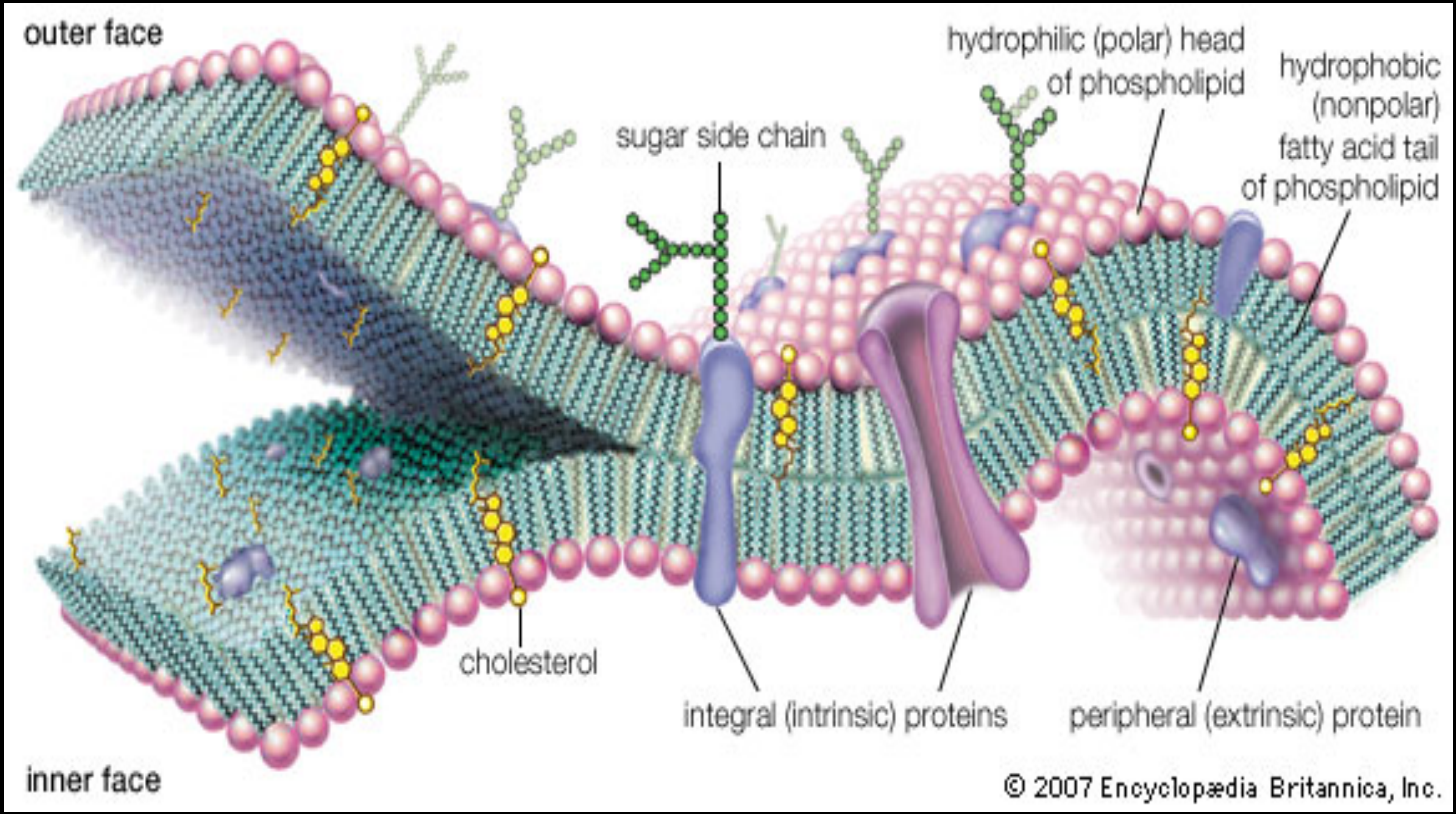


Single-walled micelle



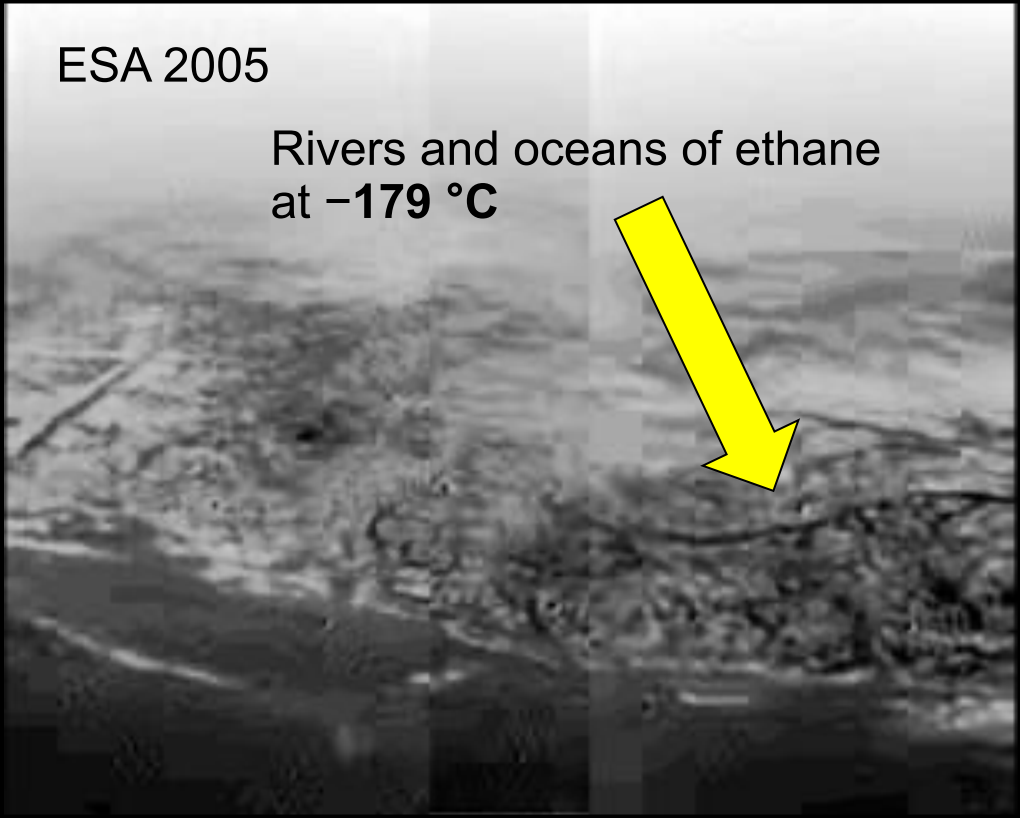
Double-walled liposome

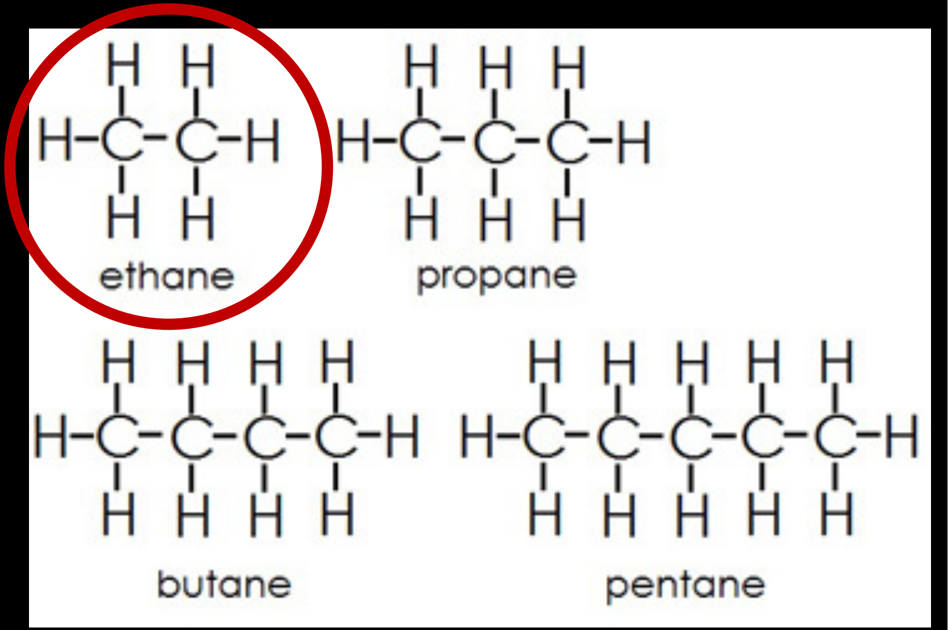
Dynamic cell membrane

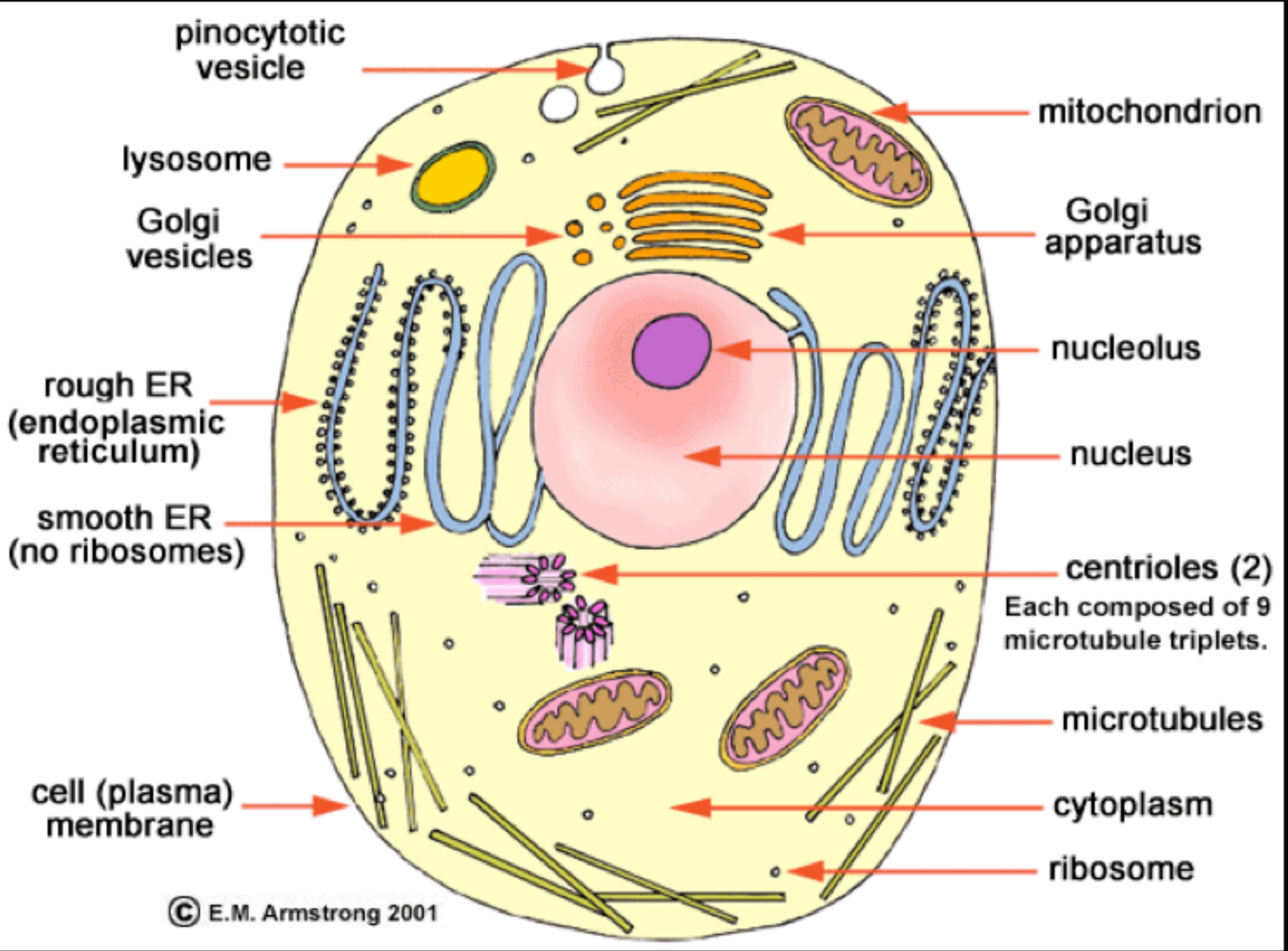



Saturn


Titan
Our Moon


ESA 2005
Rivers and oceans of ethane
at **−179 °C**


ethane
propane
butane
pentane


pinocytotic vesicle
lysosome
Golgi vesicles
rough ER (endoplasmic reticulum)
smooth ER (no ribosomes)
cell (plasma) membrane
mitochondrion
Golgi apparatus
nucleolus
nucleus
centrioles (2)
Each composed of 9 microtubule triplets.
microtubules
cytoplasm
ribosome
© E.M. Armstrong 2001

The importance of proteins

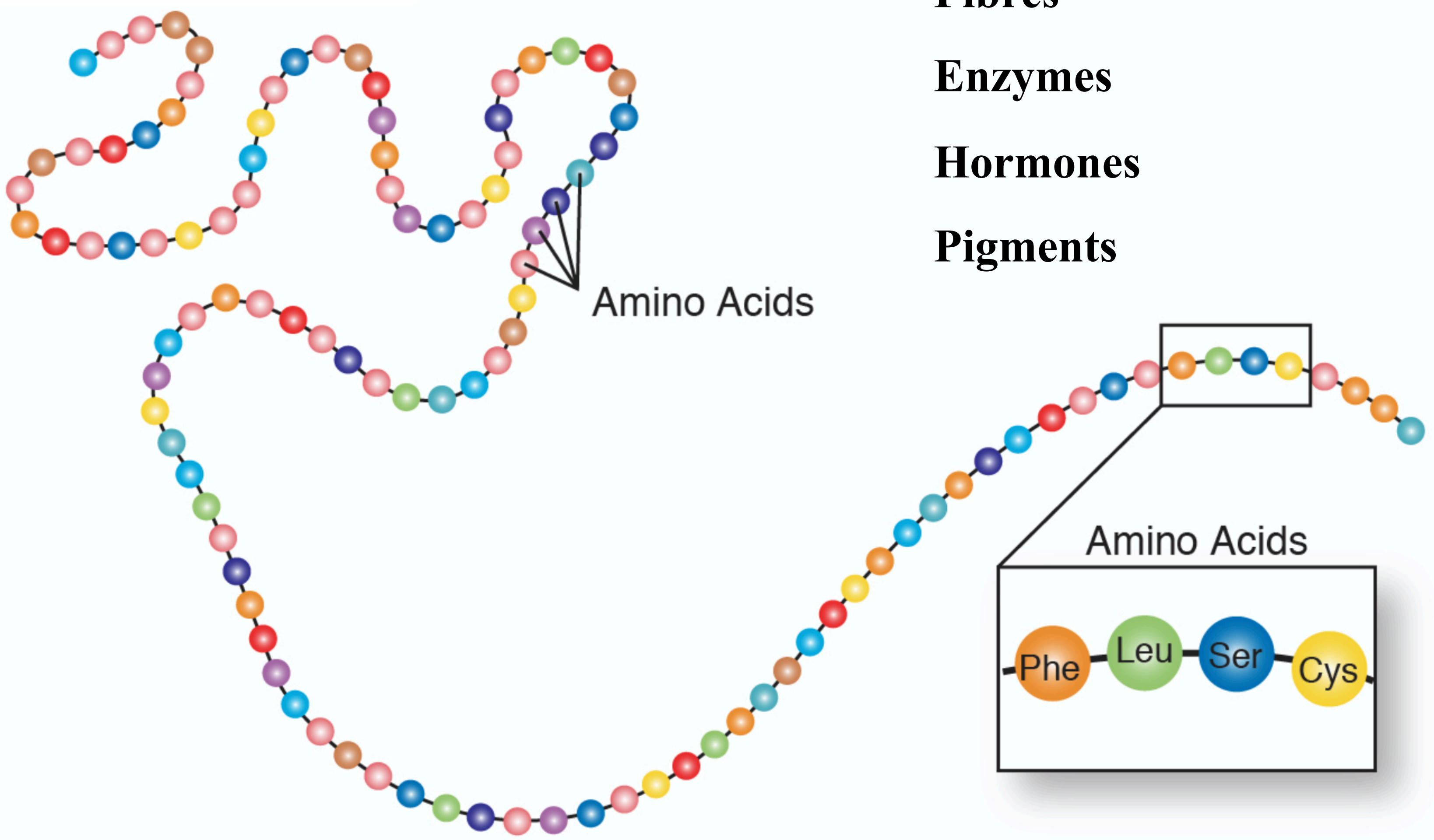
2. How were the first amino acids produced?

Fibres

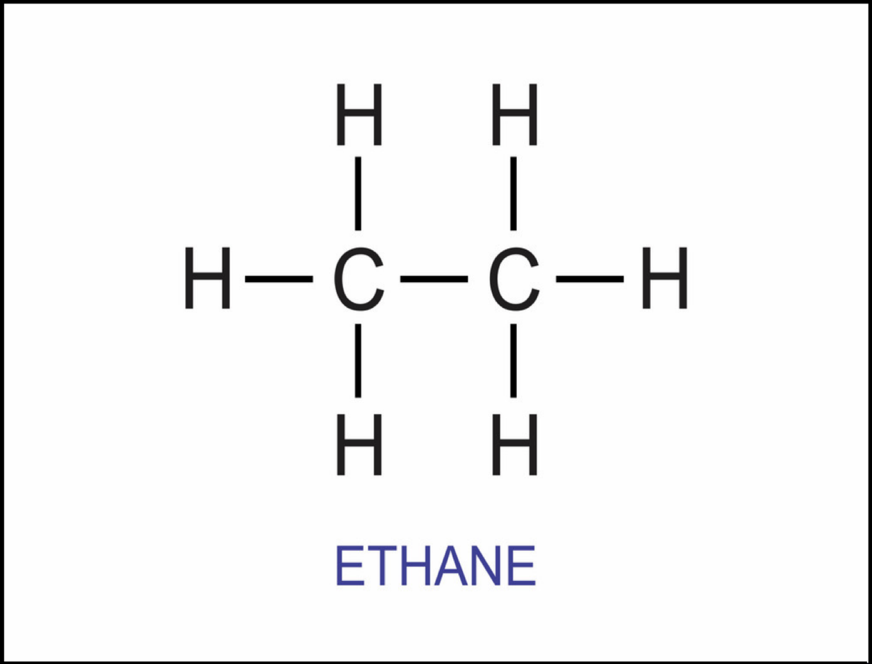
Enzymes

Hormones

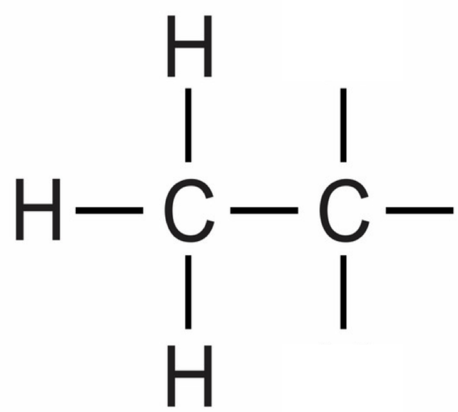
Pigments



How to make an Amino Acid

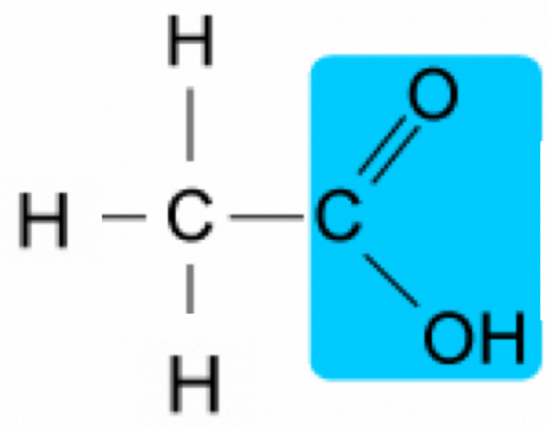


How to make an Amino Acid



ETHANE

How to make an Amino Acid

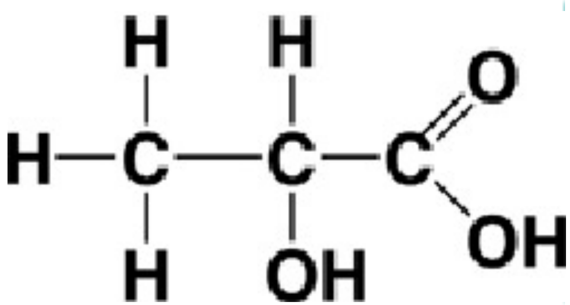


Carboxylic **Acid Group**

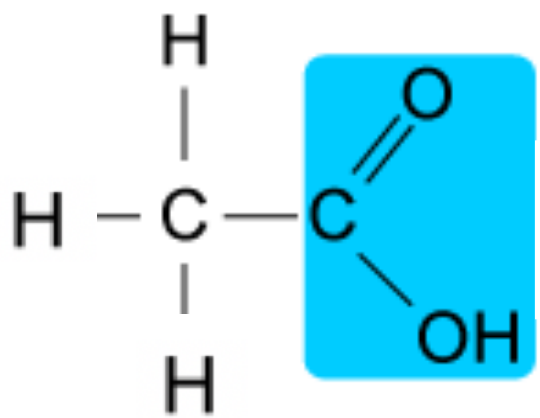
Acetic Acid

Vinegar

How to make an Amino Acid



Lactic Acid
$C_2H_4OH\text{-}COOH$

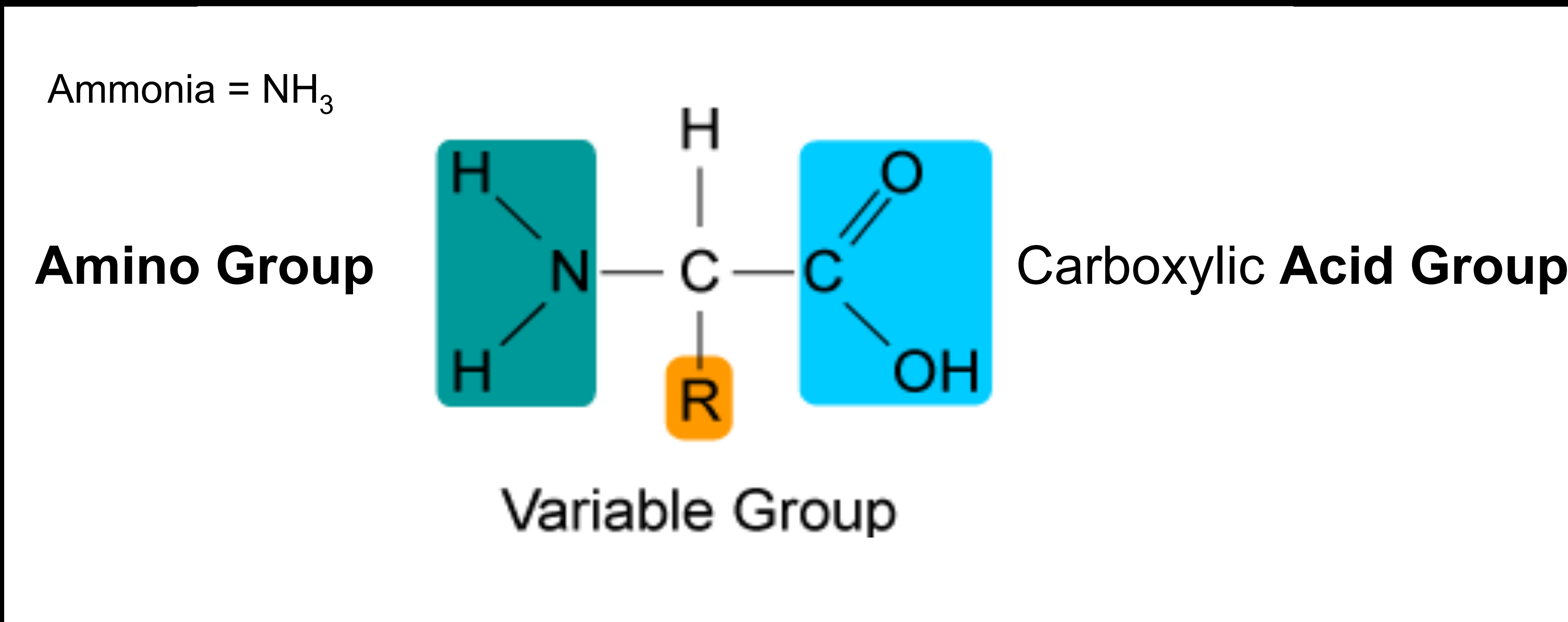


Carboxylic **Acid Group**

Acetic Acid

Vinegar

Basic structure of Amino Acids



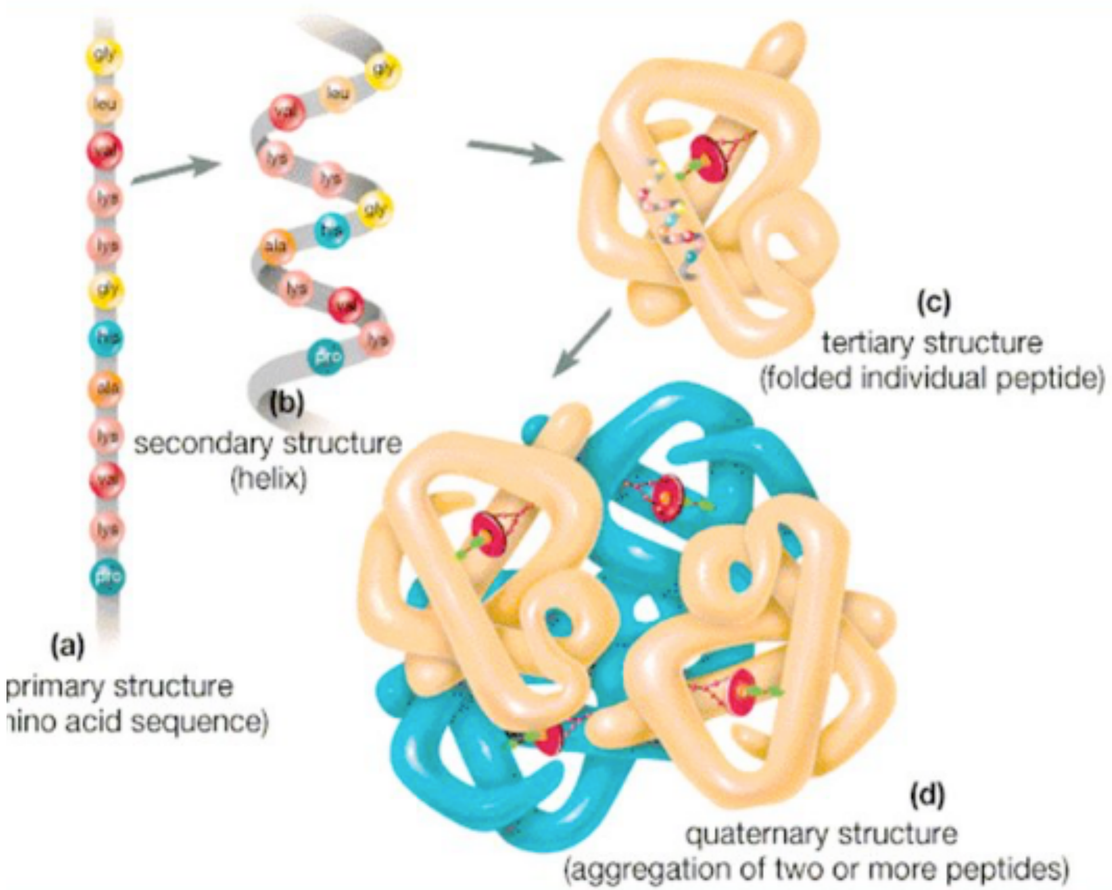
There are about 500 naturally occurring amino acids but only 20 'standard' ones that occur in the proteins of all plants and animals.

Protein structure

20 different amino acids…

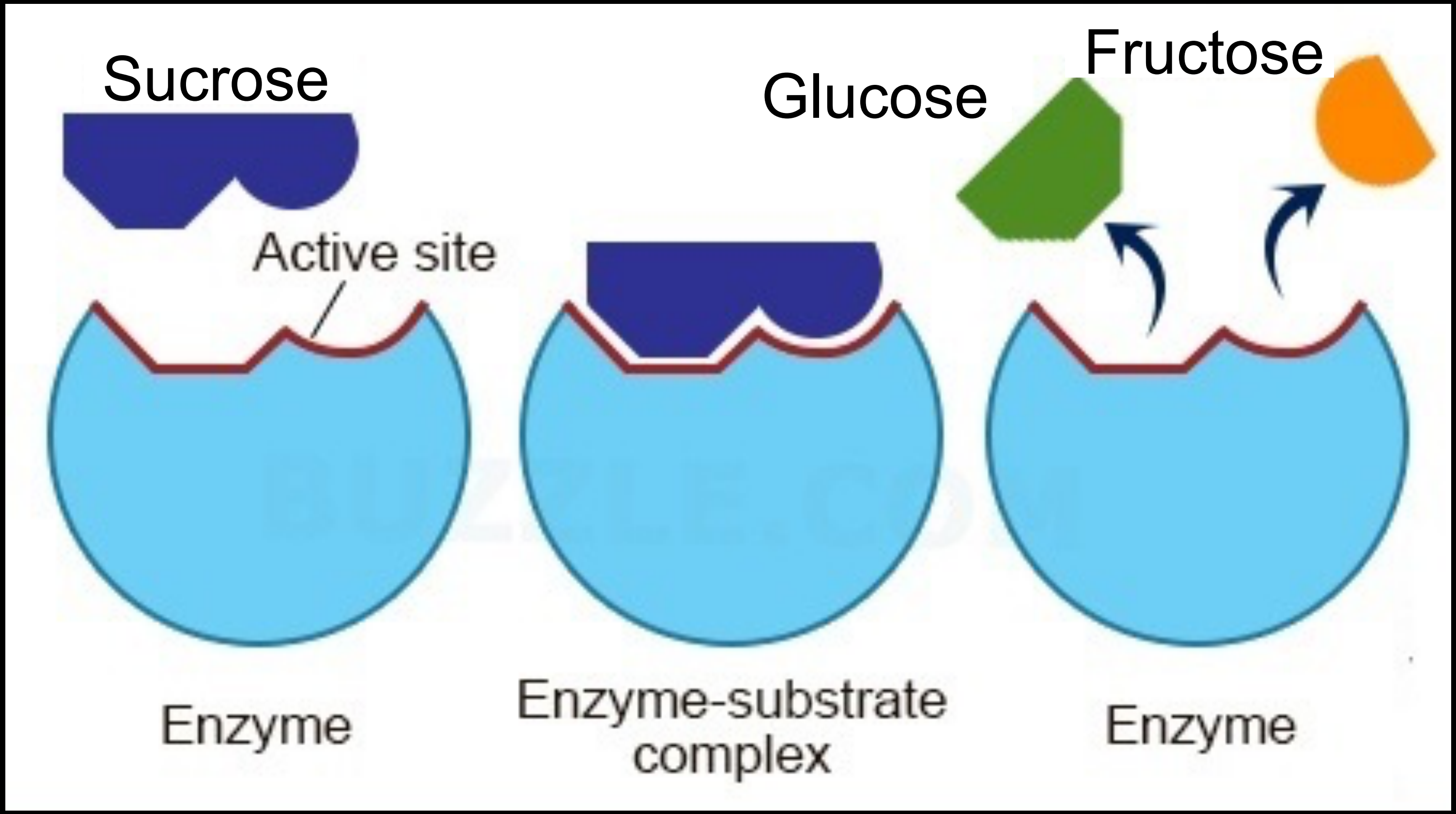
- arranged in any order,
- into chains of any length,
- even up to 33,000 units,
- which may be branched,
- and variously folded,
- and combined with others,

An astronomical number of different proteins provides the necessary variety and complexity for a self-sustaining living metabolism.



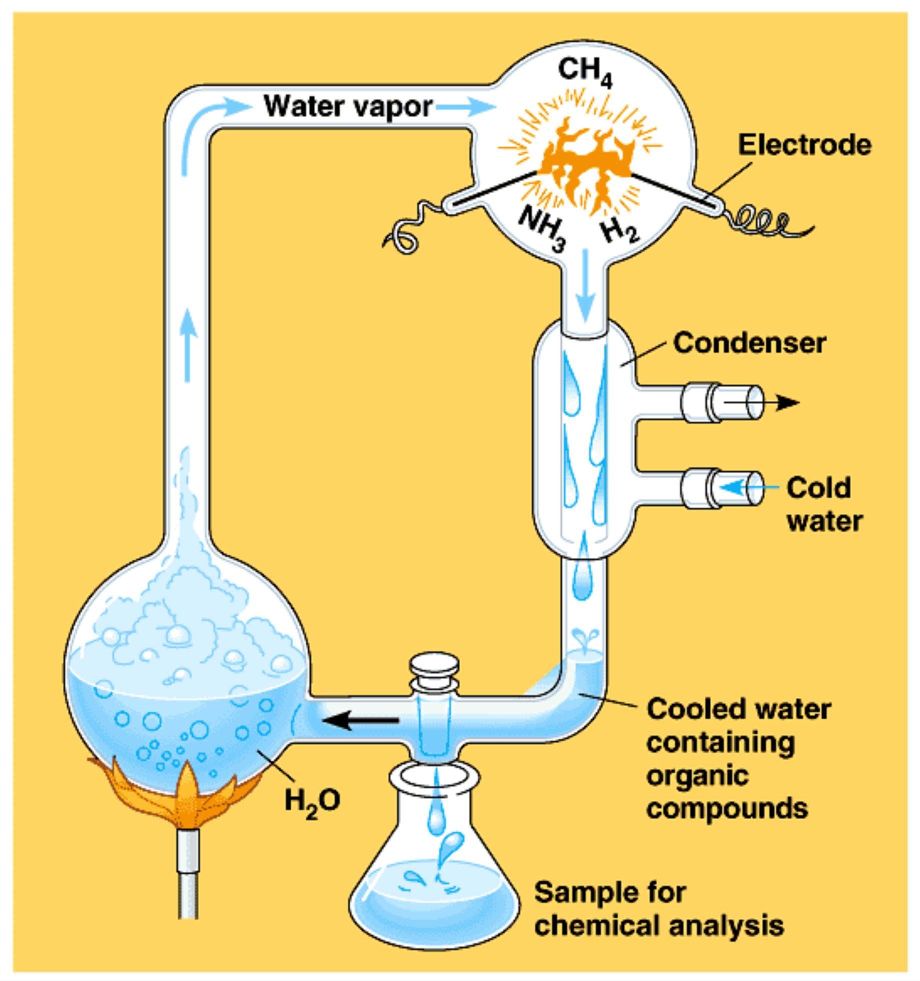
The shape of the protein determines what it will react with in metabolism.

The importance of protein shape



Abiogenic amino acids

2. How were the first amino acids produced from freely available simple inorganic molecules?



1924 : **Oparin** (USSR) put forward a hypothesis suggesting that life developed through gradual chemical evolution of carbon-based molecules.

1929 : **Haldane** (UK) introduced the "primordial soup theory". It became the foundation for the chemical origin of life.

1952 : **Miller and Urey** (USA) simulated the conditions thought to be present on the early Earth. A mixture of water (H_2O), methane (CH_4), ammonia (NH_3), and hydrogen (H_2) were subjected to continuous electrical sparks to simulate lightning in the Earth's primitive atmosphere. **After one week, 5 amino acids had been produced**.

1996 : **Miller** said that "Just turning on the spark in a basic pre-biotic experiment will yield 11 out of 20 amino acids."

Abiogenic proteins

1950s and 1960s

Sidney Fox (LA) studied the spontaneous formation of small chains of amino acids (peptides) under conditions plausibly to have existed early in Earth's history.

Amino acids derived from **methane**, **ammonia** and **water** were allowed to dry out as if from a warm puddle in prebiotic conditions, or baked over hot lumps of lava for a few hours.

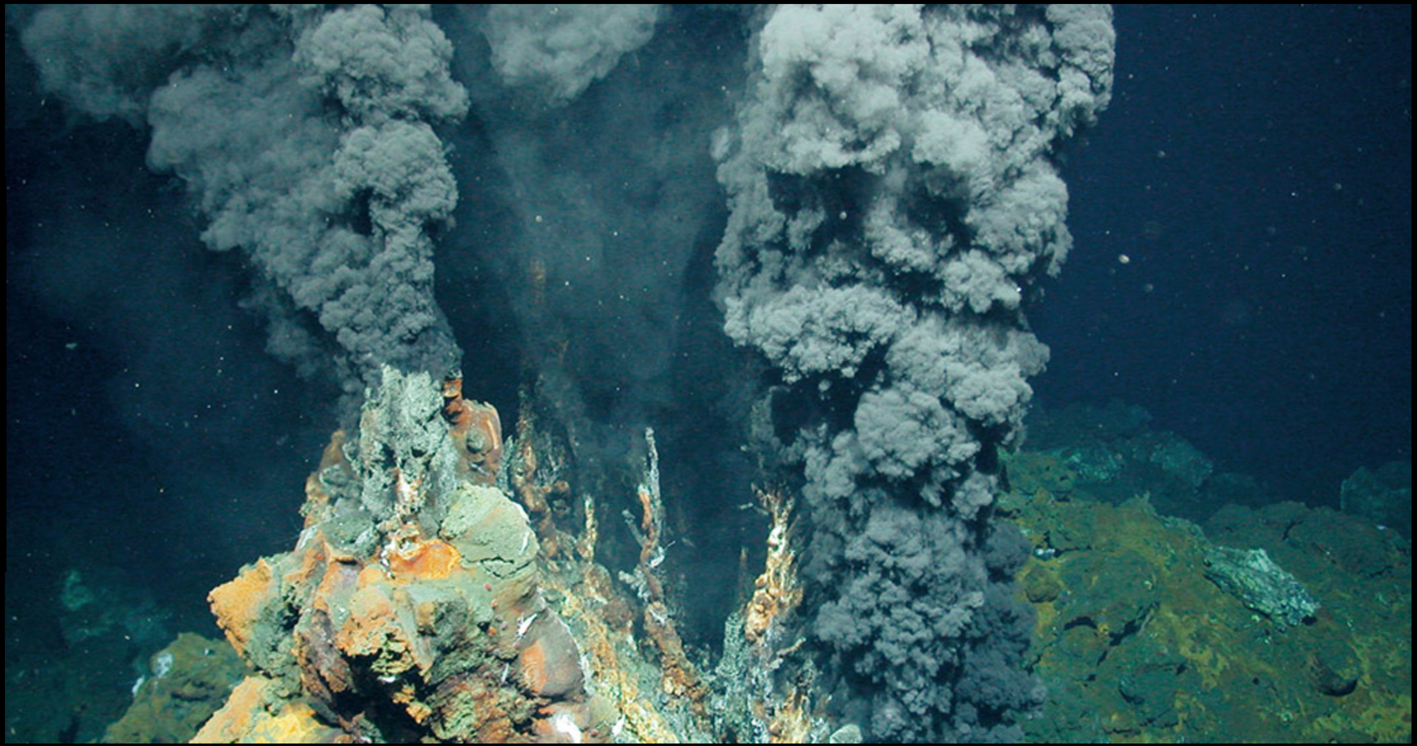
As they dried, they formed long, often cross-linked threads of sub-microscopic "**proteinoid microspheres**".

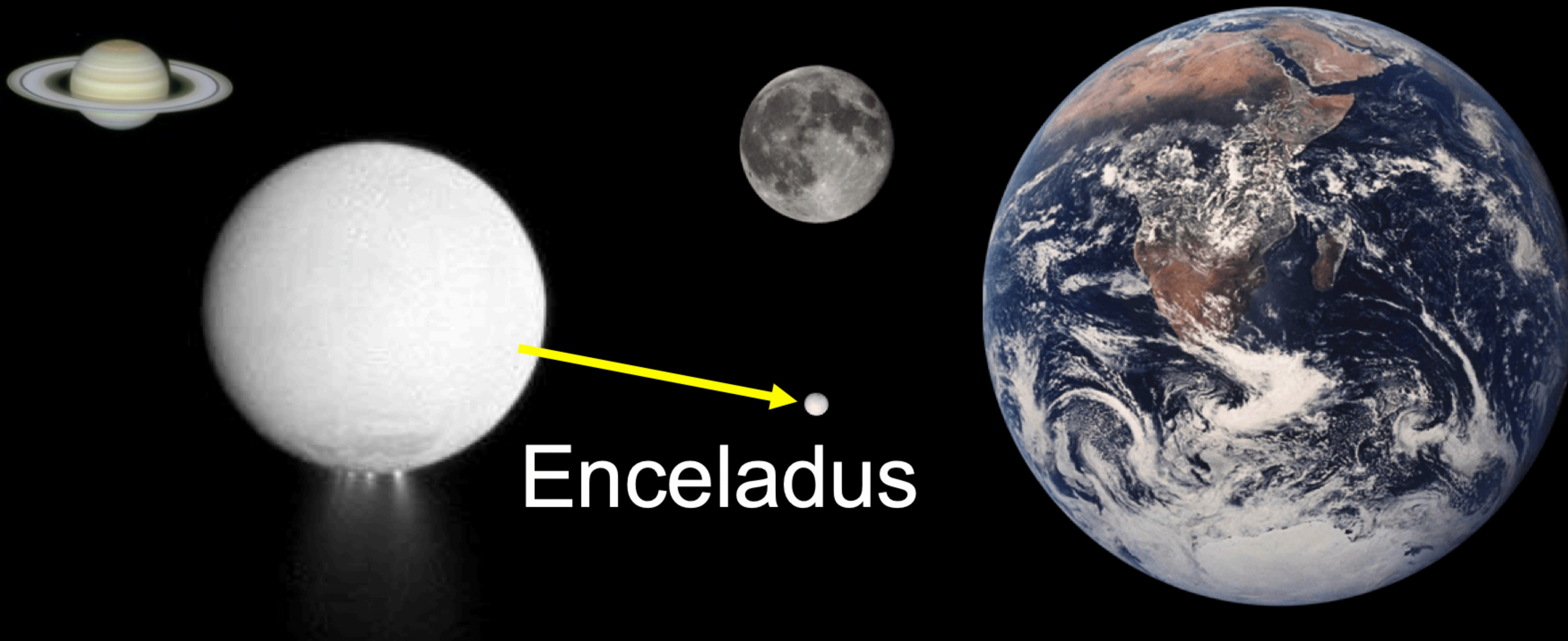
Abiogenic amino acids

1997 : **Wachtershauser** showed that early stages in the formation of proteins could be achieved from inorganic materials including **carbon monoxide** (CO) and **hydrogen sulphide** (H_2S) using metal sulphides as catalysts.

Some of the reactions required temperatures of about 250 °C and a pressure equivalent to that found under 7 kilometres of rock.

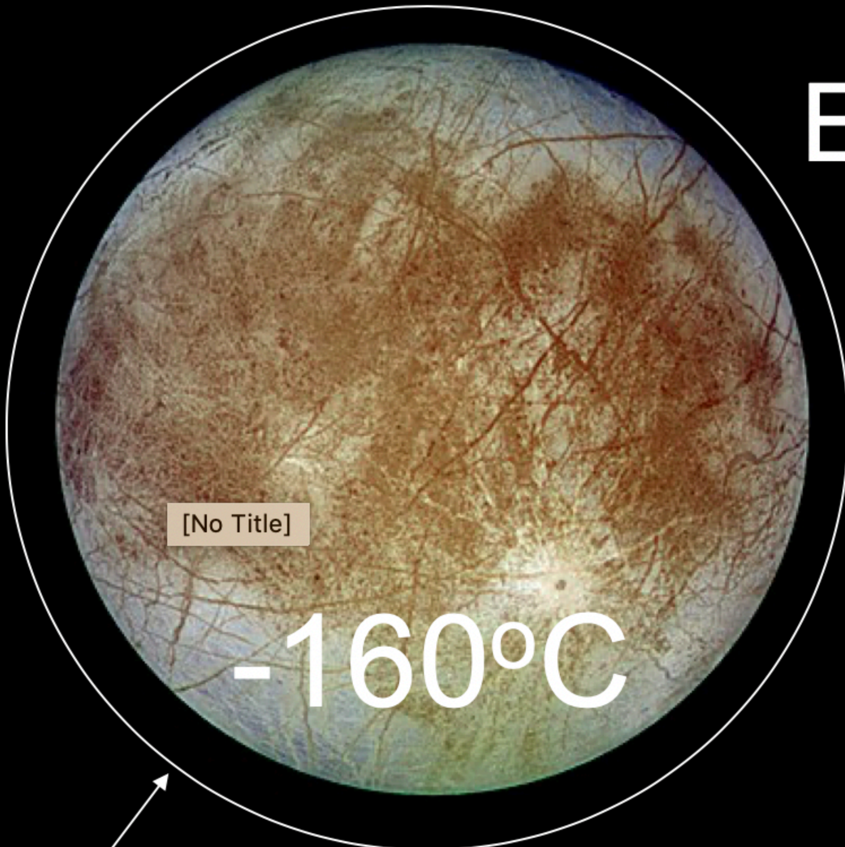
Hence it was suggested that self-sustaining synthesis of proteins could have occurred near deep ocean hydrothermal vents – ‘black smokers’.



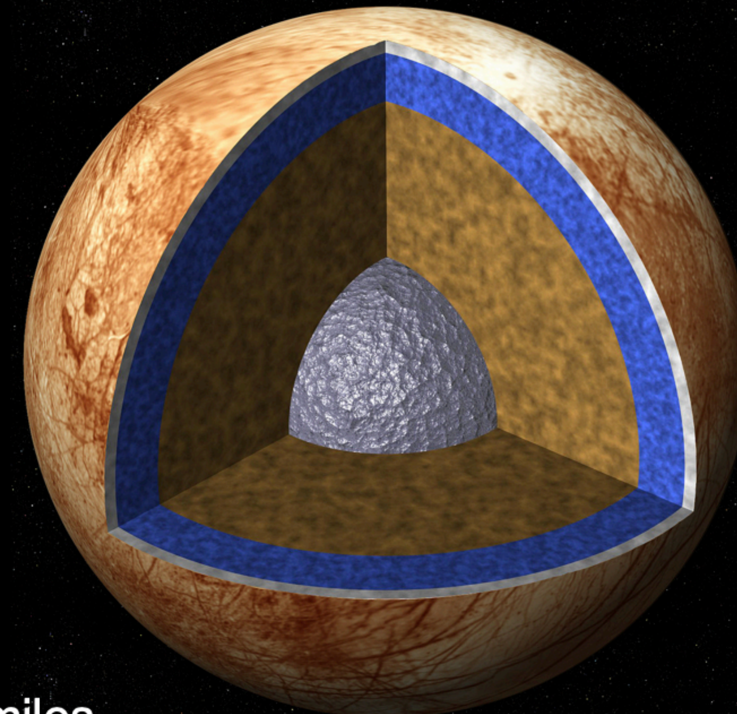


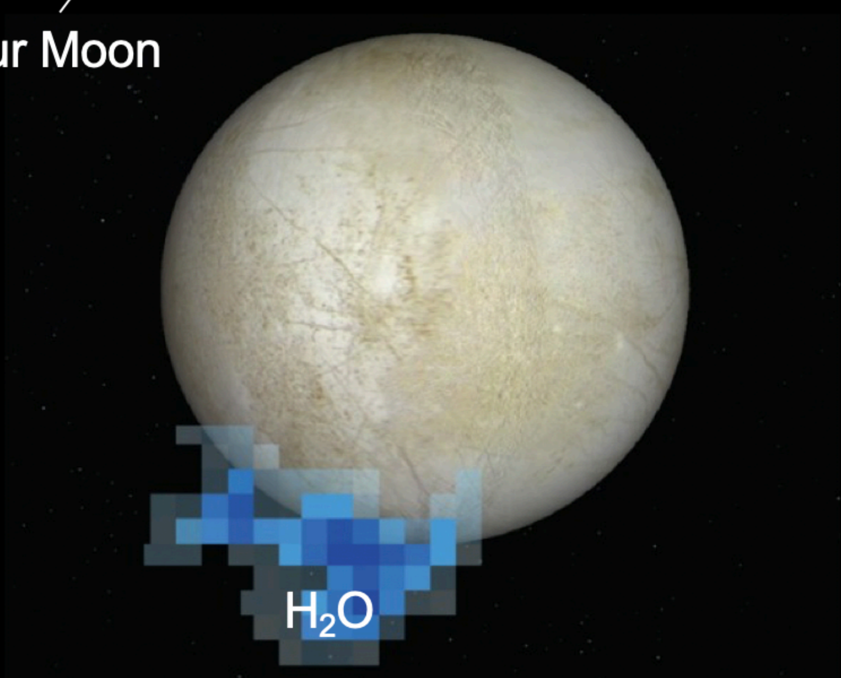
Water vapour	H_2O
Salt	NaCl
Carbon Dioxide	CO_2
Nitrogen	N_2
Hydrogen	H_2
Methane	CH_4
Propane	C_3H_8
Acetylene	C_2H_2
Formaldehyde	CH_2O

Europa

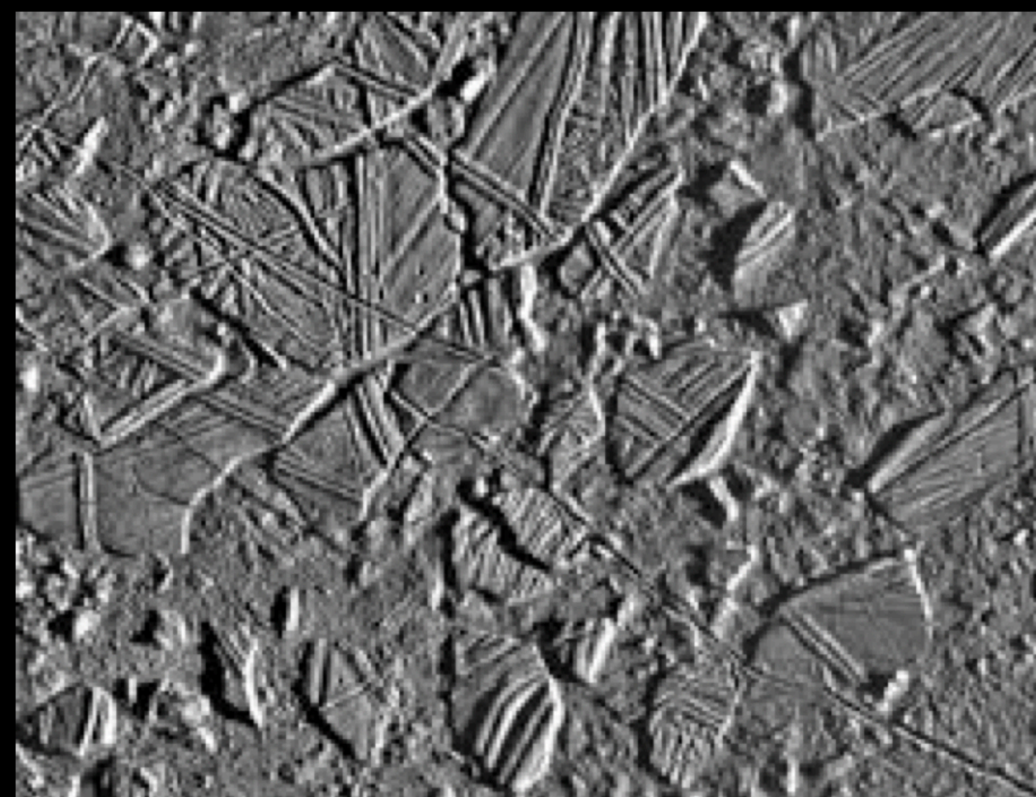


Our Moon





21 x 26 miles



Extra-terrestrial amino acids

Carbonaceous chondrites are stony meteorites that are rich in organic molecules.

The **Murchison meteorite** (Australia, 1969) contained 88 different **amino acids**, 15 of which have been synthesised in the laboratory by electric discharge on a mixture of methane, nitrogen, water and ammonia.

It also contained a mixture of other hydrocarbons, including >300 **carboxylic acids**.

Amino acids have also been found in samples of Comet Wild 2 from NASA’s Stardust mission, returned to Earth in 2006.

Part of the Murchison meteorite

Protein Summary

All metabolism is co-ordinated by enzymes.

Every reaction has its own specific enzyme.

Enzymes are proteins.

Proteins are made up of assembled amino acids.

Amino acids exist abiotically in nature.

BUT

Amino acids do NOT easily assemble into proteins by themselves.

Living organisms use enzymes to speed up that reaction … which are proteins!

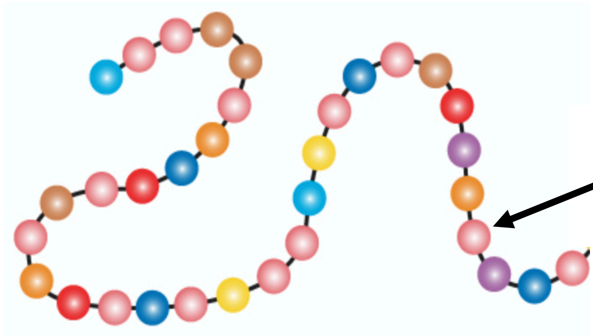
AND

There needs to be a code to assemble the right amino acids in the right order.

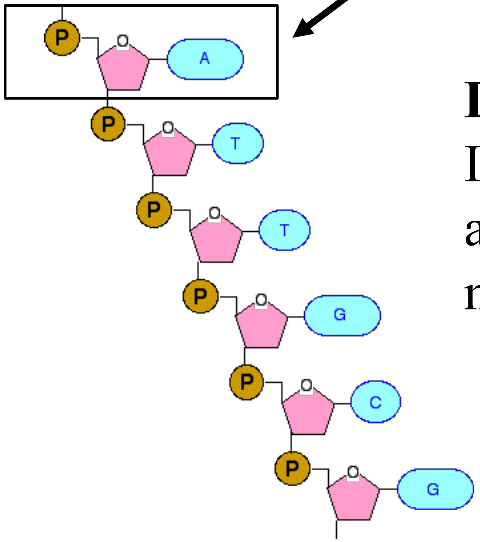
Those codes are made of Nucleic Acids called DNA and RNA.

Nucleic Acids – DNA / RNA

In the same way that Proteins are composed of units called **Amino Acids**



Nucleic acids are composed of units called **Nucleotides**.

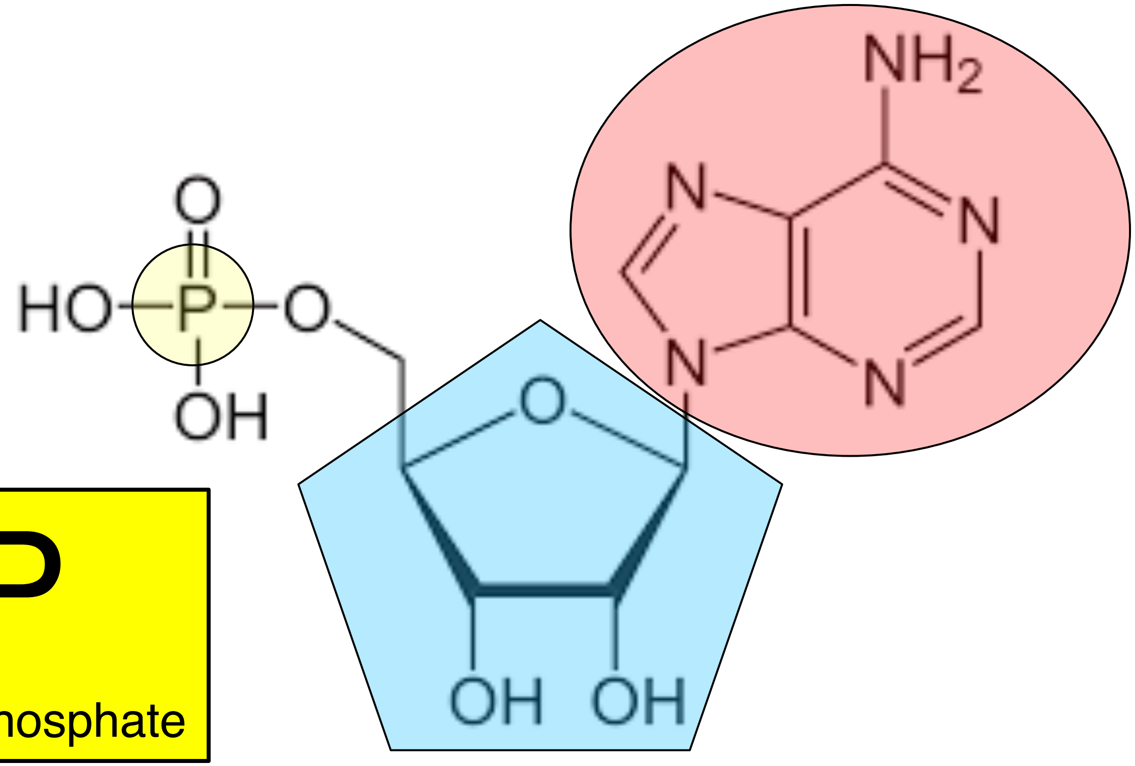


DNA is a nucleic acid.
It holds the code for assembling amino acids in the right order to make all the different proteins.

Nucleotides

3. How were the first **nucleotides** produced from freely available complex organic molecules?

Phosphate + Ribose Sugar + Nitrogenous Base



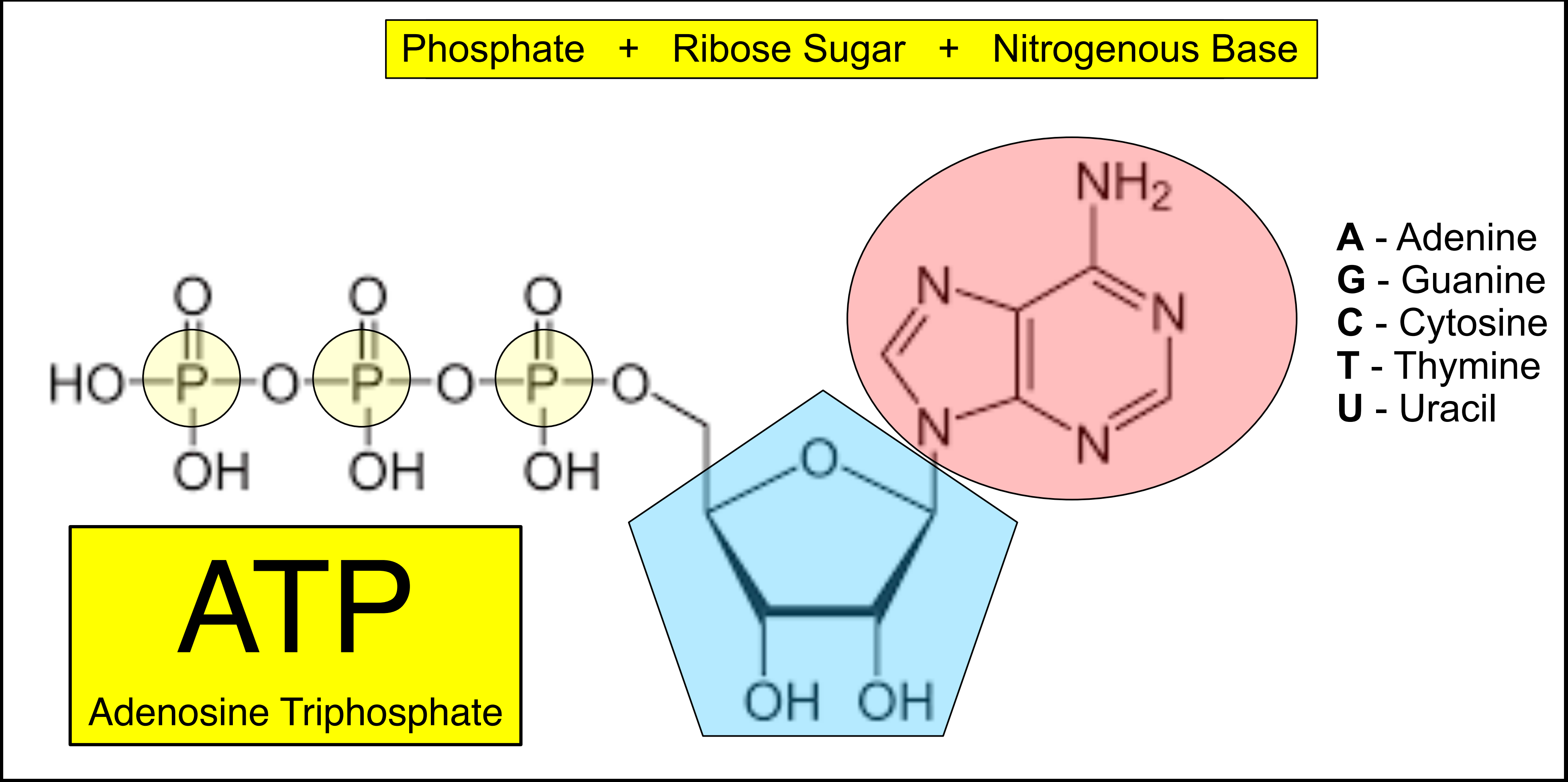
A - Adenine
G - Guanine
C - Cytosine
T - Thymine
U - Uracil

AMP

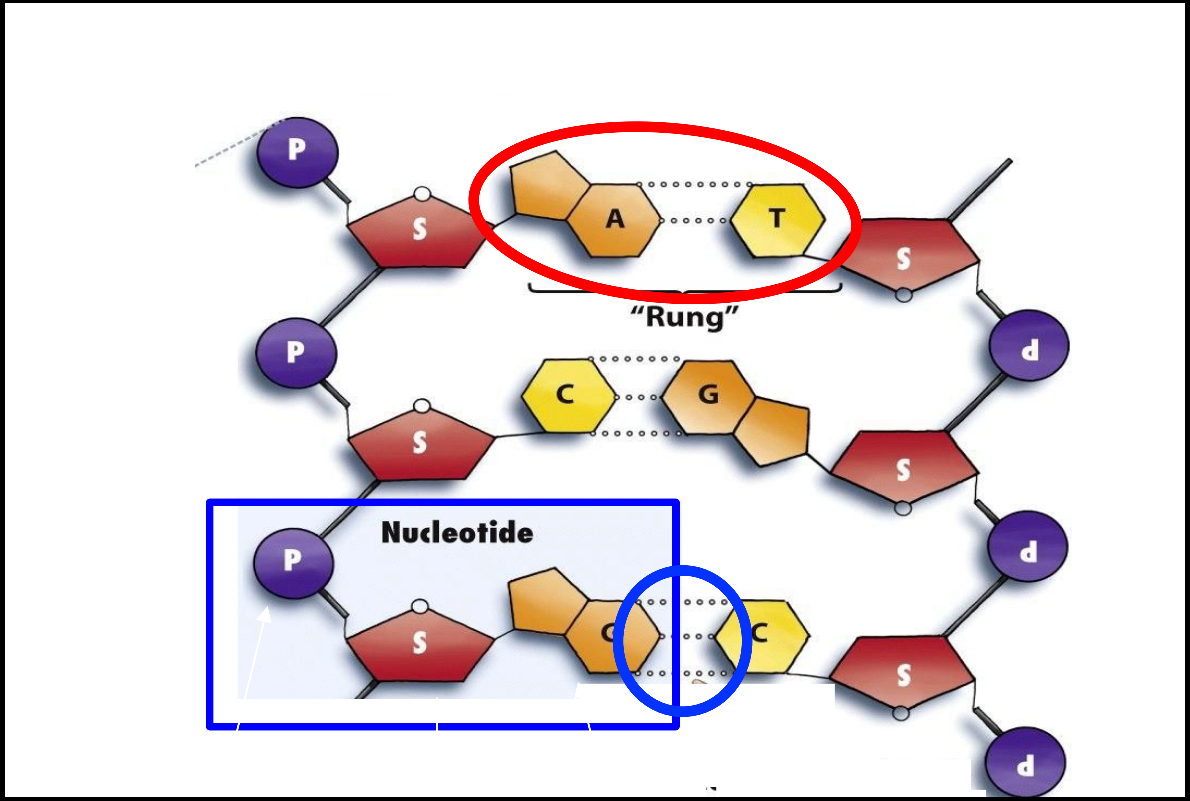
Adenosine Monophosphate

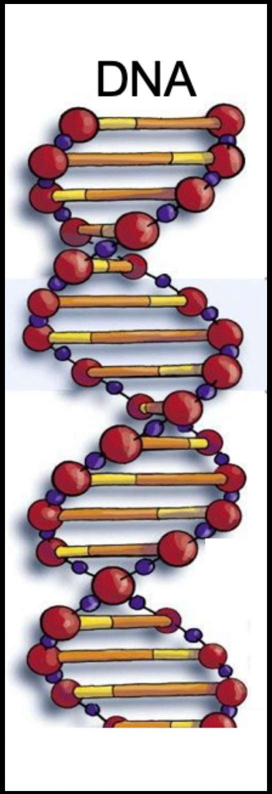
Nucleotides

3. How were the first **nucleotides** produced from freely available complex organic molecules?



Nucleotides

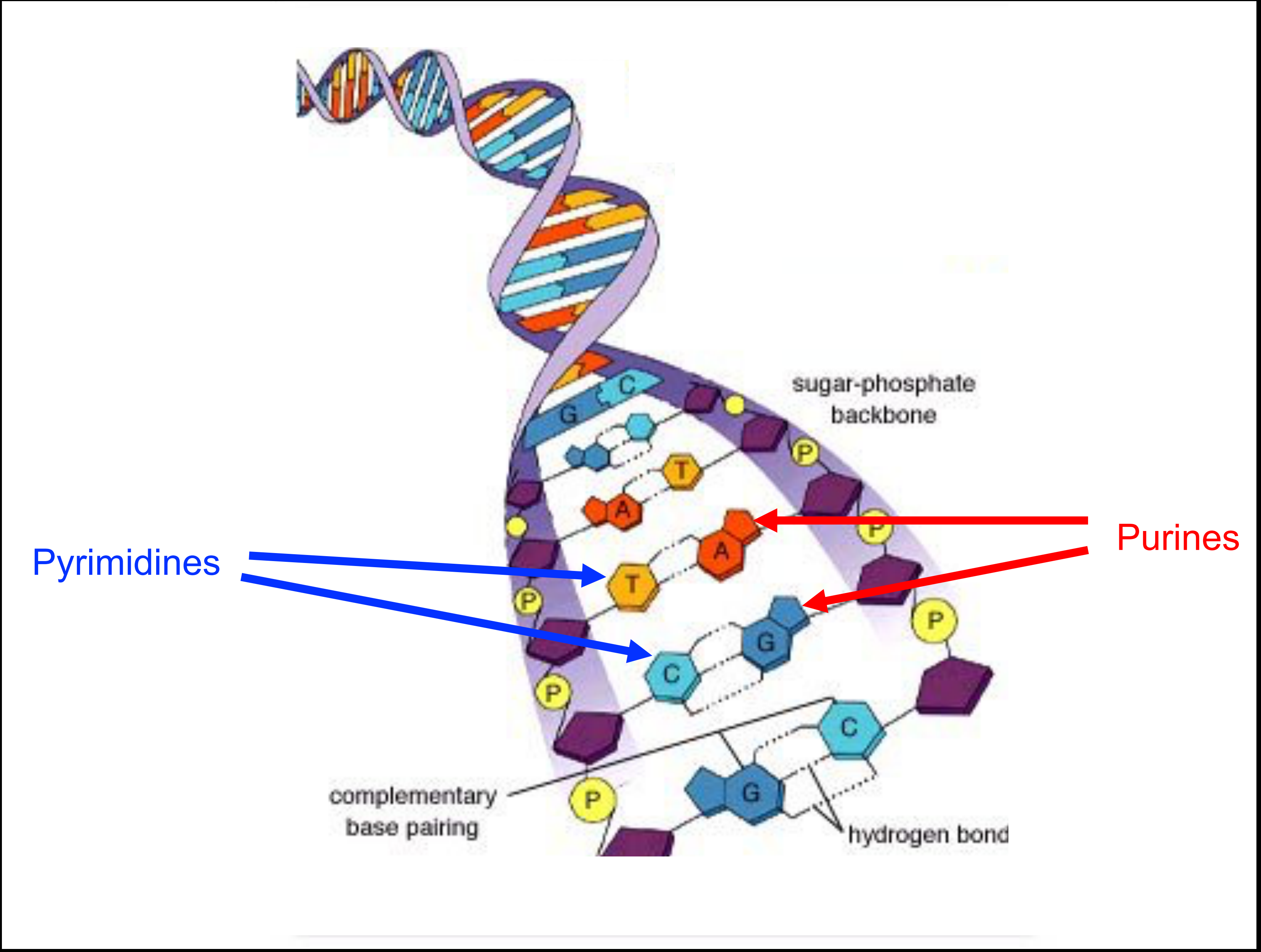




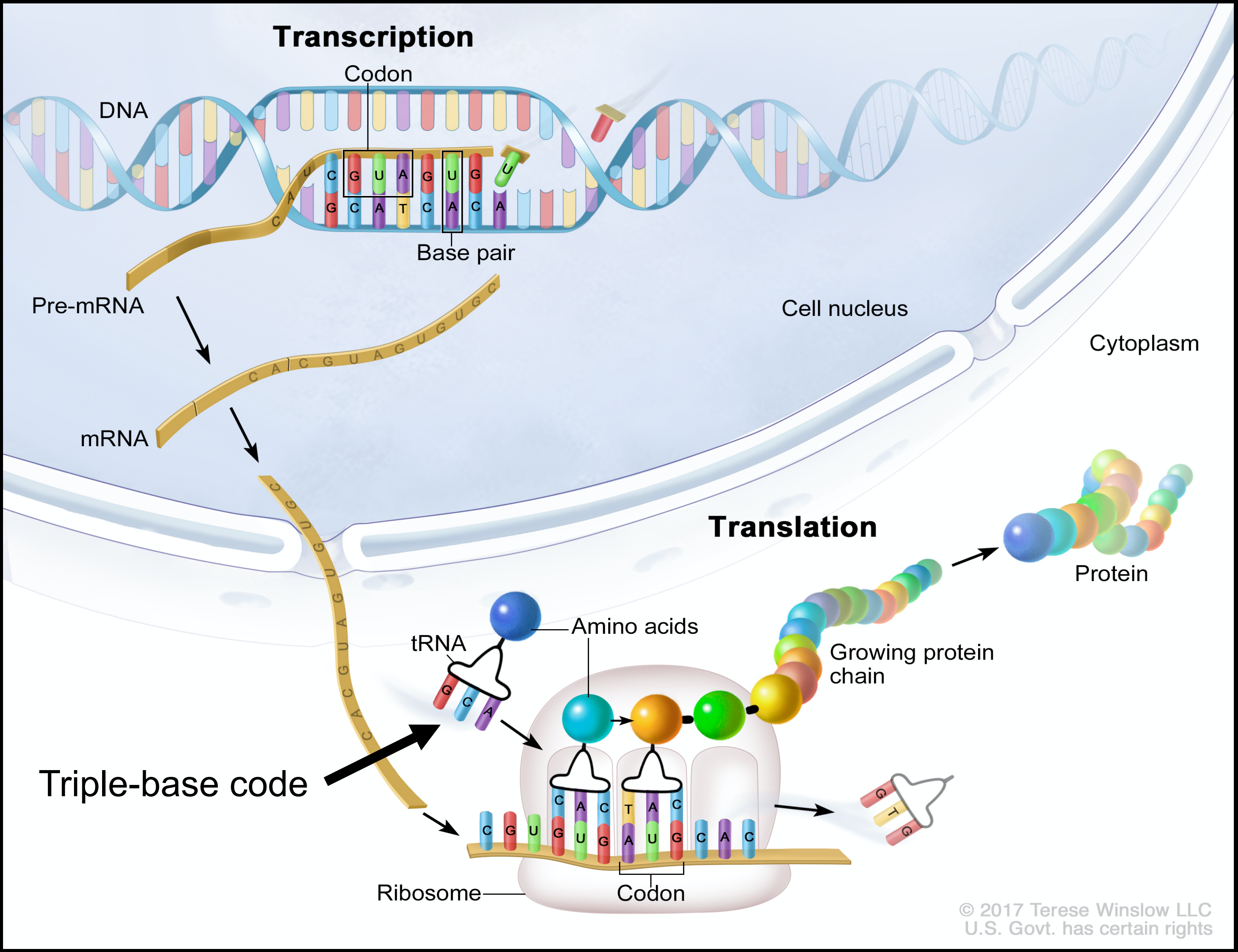
The order and arrangement of amino acids in protein chains is governed by the genetic code that is made up of their nitrogenous bases (A, T, C & G).

DNA is a double helix strand of approximately **3 billion** nucleotides.
Nanobacteria have about 300,000 nucleotides.

Nucleic Acids



DNA & protein synthesis



Abiogenic nucleotides

So.....

To make **proteins** from **amino acids**, a primitive living cell needs **RNA**.

RNA is constructed from **nucleotides**.

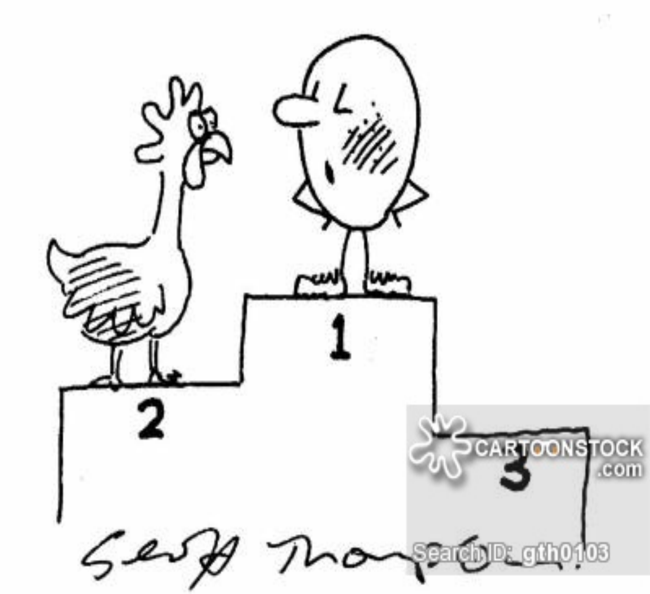
AND

To link together enough amino acids to make a protein requires **enzymes** (which are proteins).

SO….

In the same way that amino acids can abiotically form short chains called **peptides….**

Is it possible for nucleotides to link together abiotically?



"I hope we're not going to have the same old argument."

Abiogenic nucleotides

1950s : It was found that key intermediates in the synthesis of RNA nucleotides can form from prebiotic starting materials.

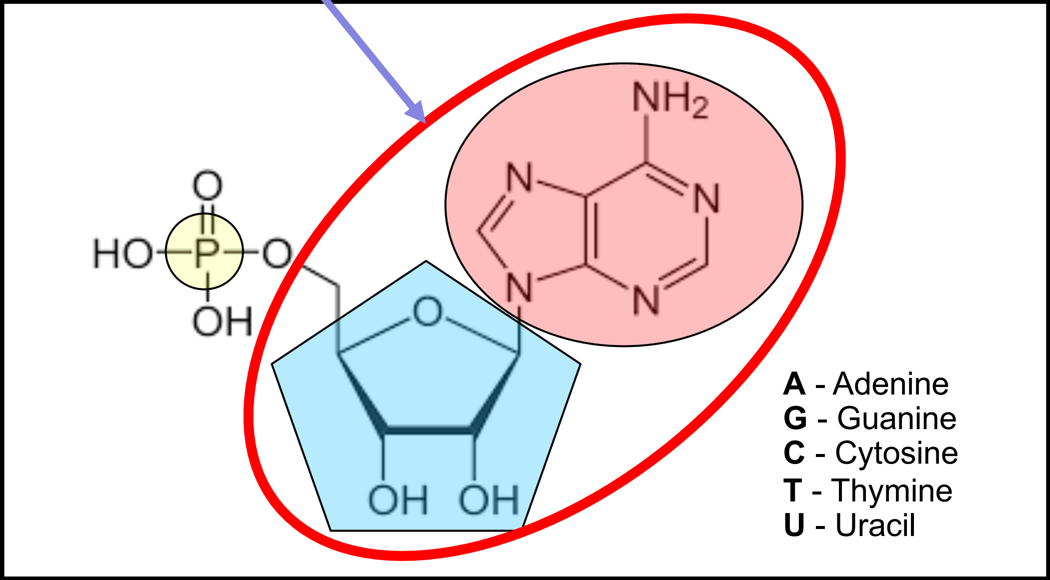
1961 : **Adenine** was made from hydrogen cyanide (HCN) and ammonia (NH_3) in an aqueous solution.
Later shown that the other nucleobases (T, C, G & U) could be obtained through simulated prebiotic chemistry in an oxygen-free atmosphere.

1968 : It was shown that **clays** can catalyse the formation of RNA molecules (at that time this idea was not universally accepted).

2001 : Short self-replicating RNA molecules (**ribozymes**) were artificially produced.

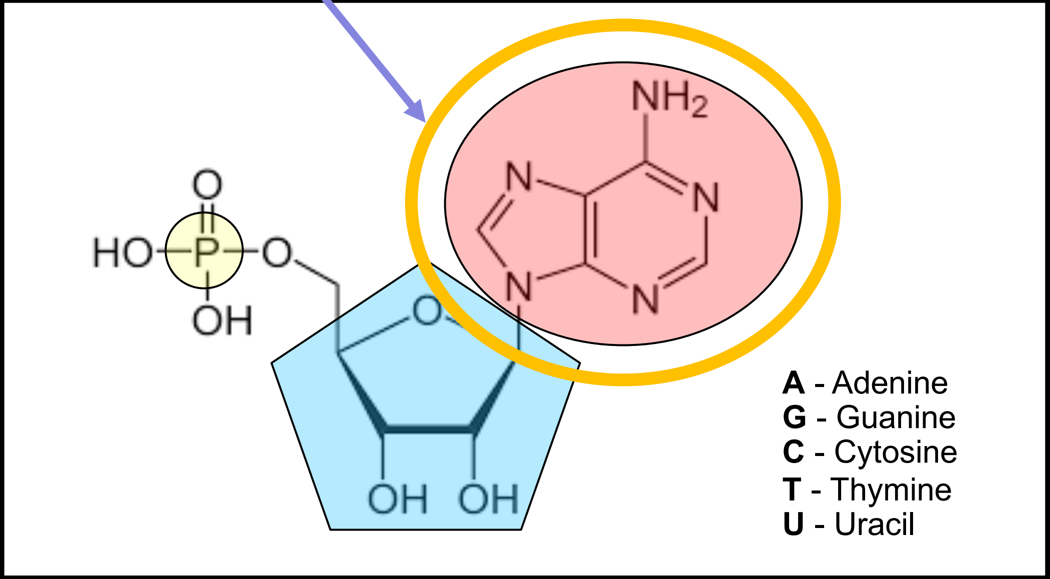
Abiogenic nucleotides

2002 : Russian artificial production of the nucleotide **AMP** was achieved by irradiating **Adenosine** and **inorganic phosphate** with high energy protons, UV and gamma radiation.
https://www.sciencedirect.com/science/article/pii/S0273117702005100

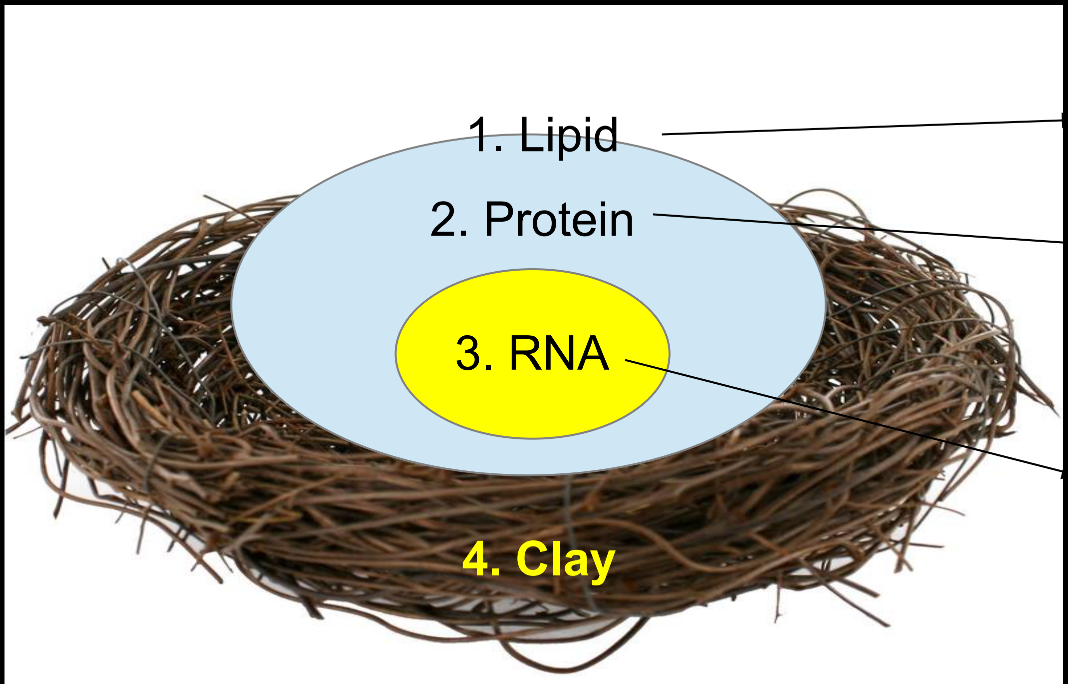


Abiogenic nucleotides

2008 : Extra-terrestrial nucleobases (**purines** and **pyrimidines**) were found in the Murchison meteorite (but not the A, T, C, G & U needed for DNA & RNA).



Natural components



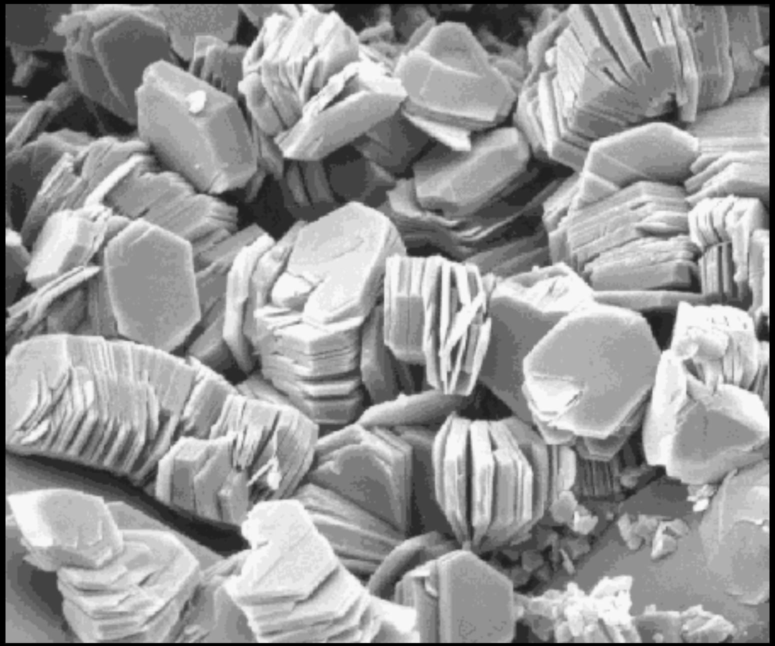
4. What is the importance of clay?

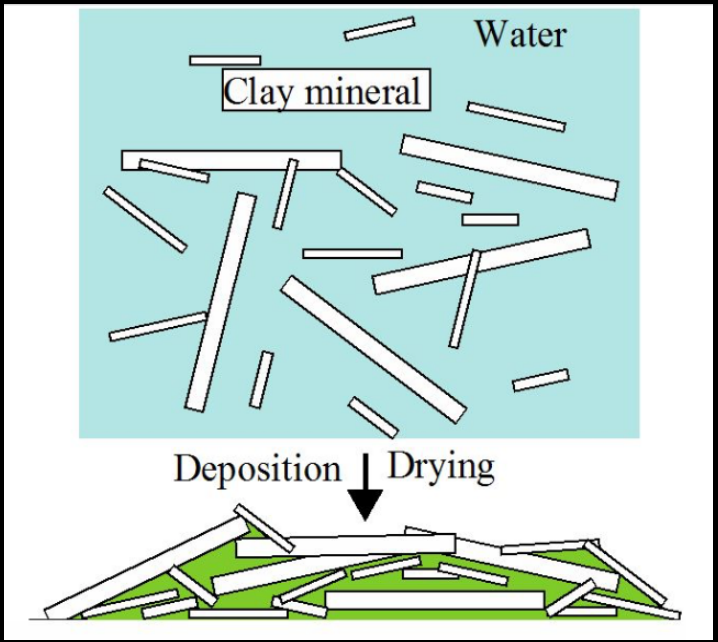
- Glycerol ✓
- Fatty acids ✓

Amino acids ✓

- Phosphate ✓
- Ribose sugar ?
- Nitrogenous bases ✓
- Nucleotides ?

The importance of clay





Some clays, notably **montmorillonite**, grow by self-replication of their crystalline pattern.

Water that is trapped between the clay crystals offers a habitat for chemical evolution.

The importance of clay

2003 : **Montmorillonite** was shown to accelerate the assembly of fatty acid **micelles** into vesicles that resemble membranes around many living cells.

Those micelles were stable in neutral-alkaline conditions but when exposed to more acidic conditions they spontaneously merged into larger lipid vesicles. However, they split up again into separate vesicles under alkaline conditions.

Might the first living cells may have evolved from these lipid vesicles?
(*Science* 24 Oct 2003: Vol. 302, Issue 5645, pp. 618-622).

The importance of clay

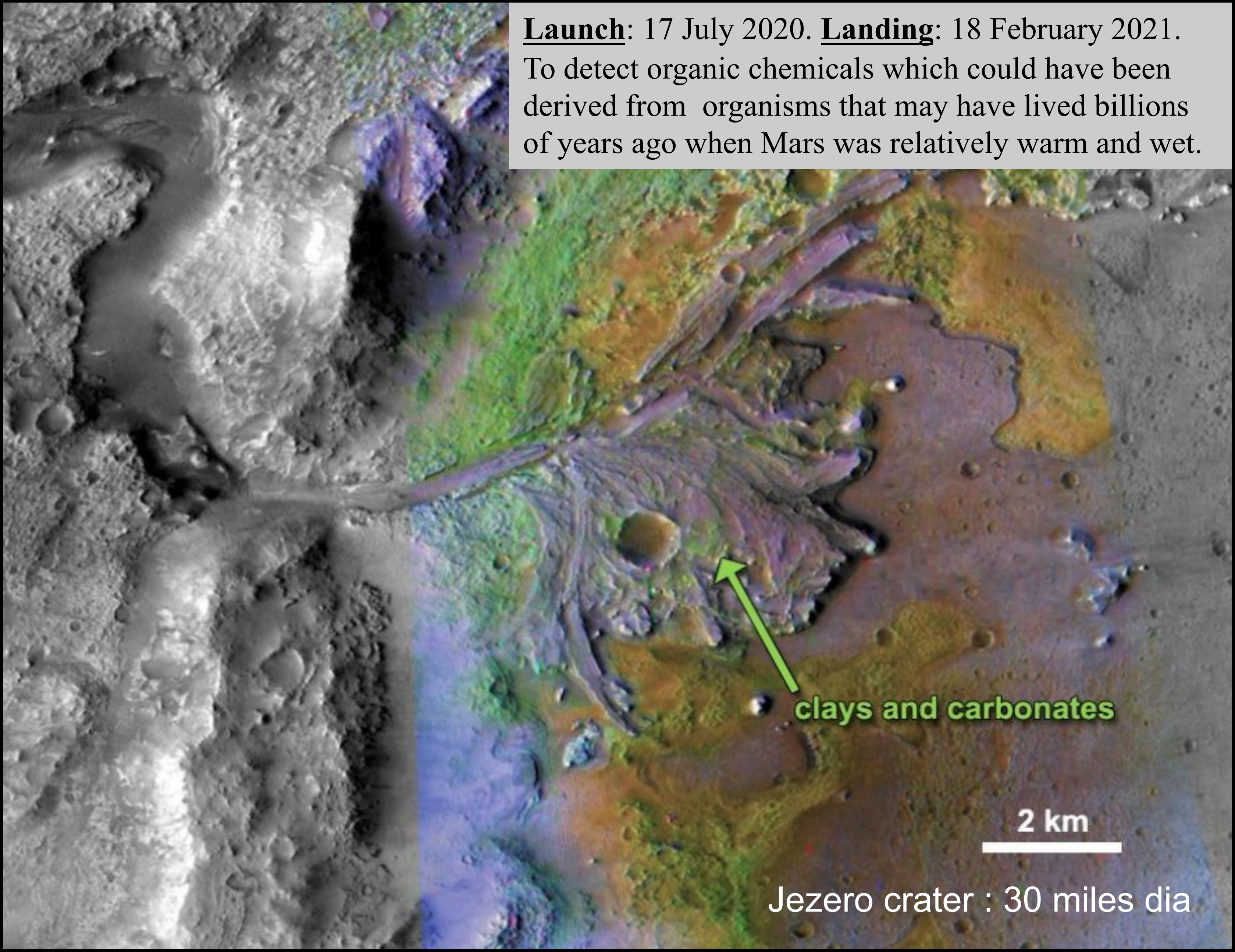
2003 : Prompted by earlier work (1968) that clays could
(a) catalyse the construction of nucleotides into RNA
(b) foster the formation of lipid vesicles
it was found that
(c) montmorillonite particles loaded with RNA became incorporated into lipid vesicles without leaking out.
(2003 : http://www.eurekalert.org/pub_releases/2003-10/hhmi-cmh102203.php).

Might this result mimic the primordial conditions that lead to the eventual evolution of living cells that could self-reproduce under fluctuating acid-alkaline conditions.

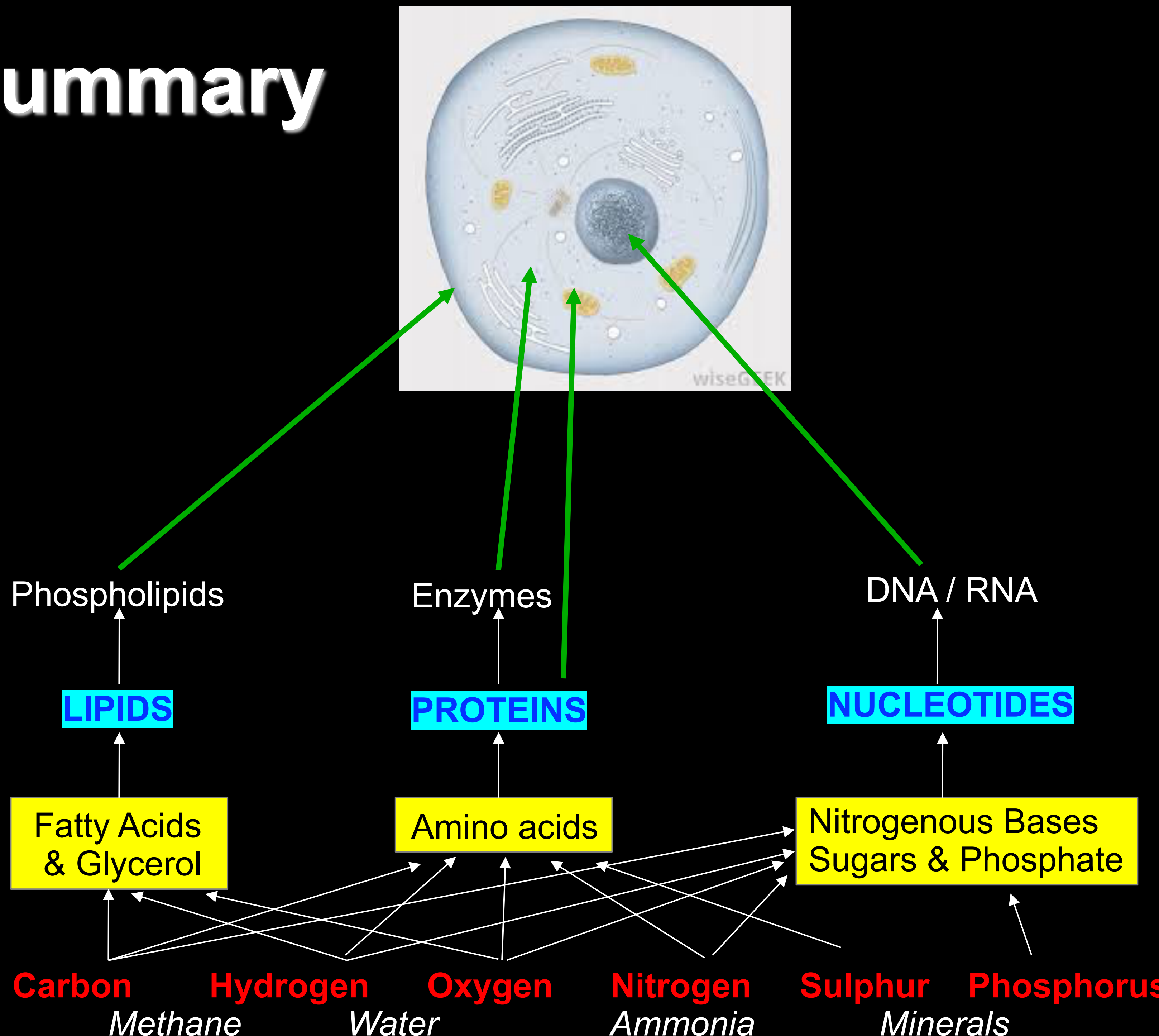
2013 : NASA's Rover "Opportunity" found minerals similar to montmorillonites on Mars.

Jezero Crater, Mars 2020 rover

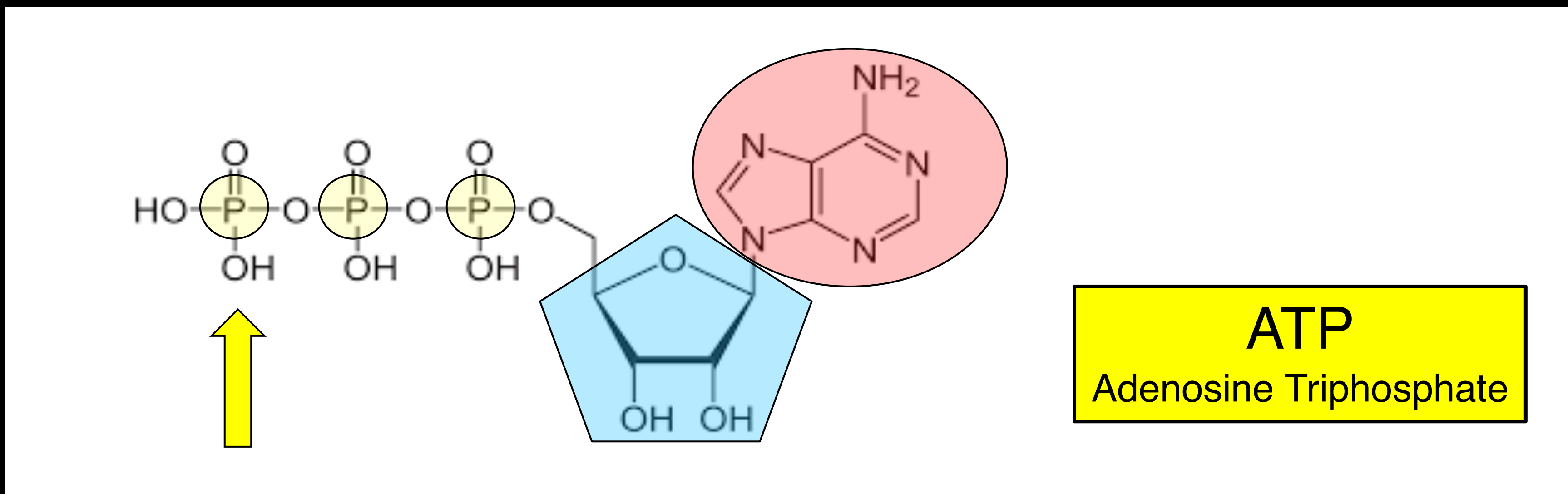
Launch: 17 July 2020. **Landing**: 18 February 2021. To detect organic chemicals which could have been derived from organisms that may have lived billions of years ago when Mars was relatively warm and wet.



Summary


Phospholipids
Enzymes
DNA / RNA
LIPIDS
PROTEINS
NUCLEOTIDES
Fatty Acids & Glycerol
Amino acids
Nitrogenous Bases Sugars & Phosphate
Carbon
Hydrogen
Oxygen
Nitrogen
Sulphur
Phosphorus
Methane
Water
Ammonia
Minerals

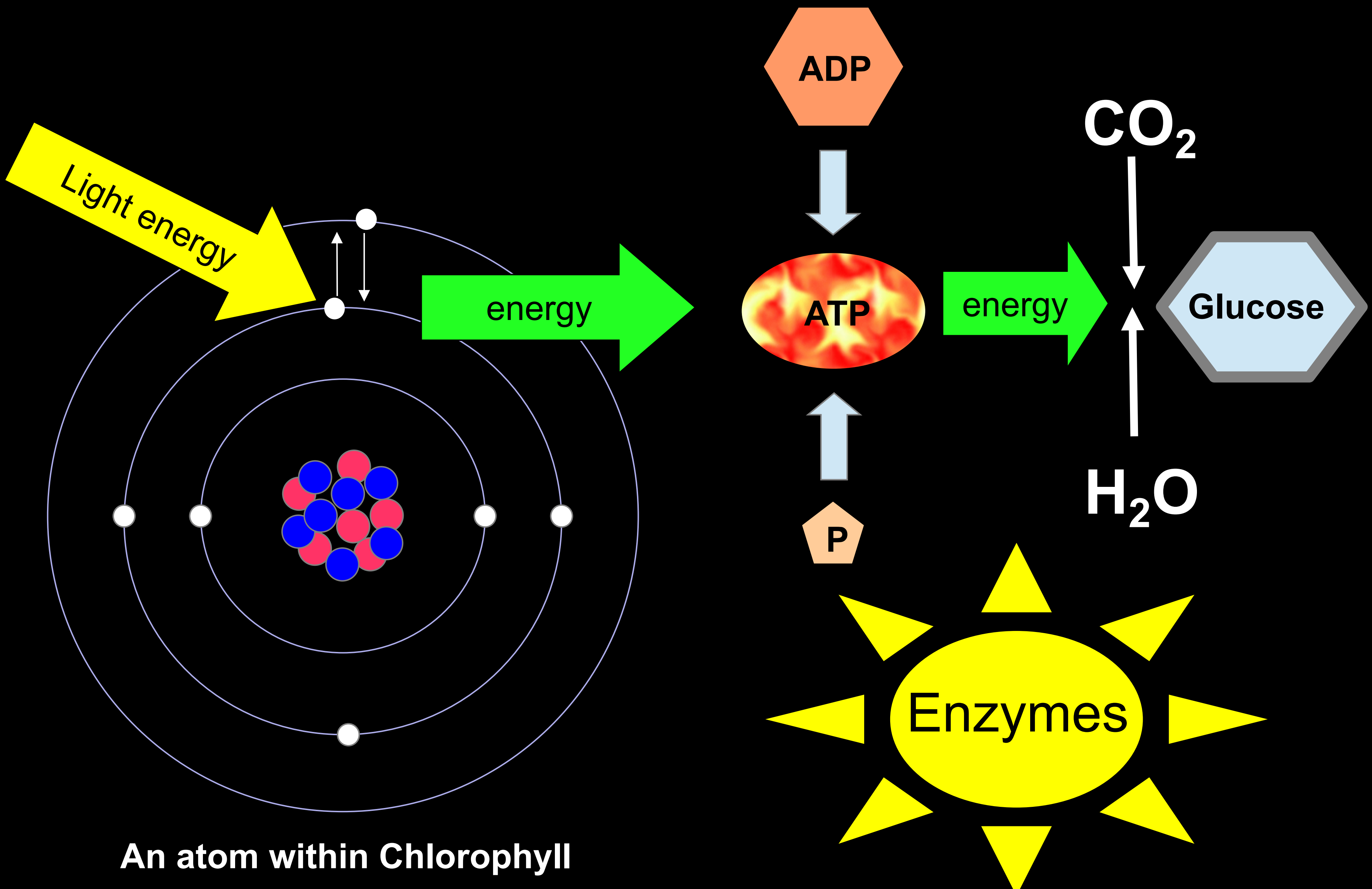
Life needs energy



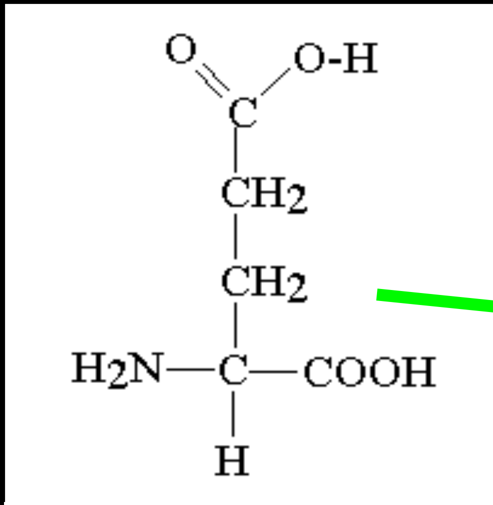
$$ADP + P + Energy \underset{ATPase}{\overset{ATP\ synthase}{\rightleftharpoons}} ATP$$

?

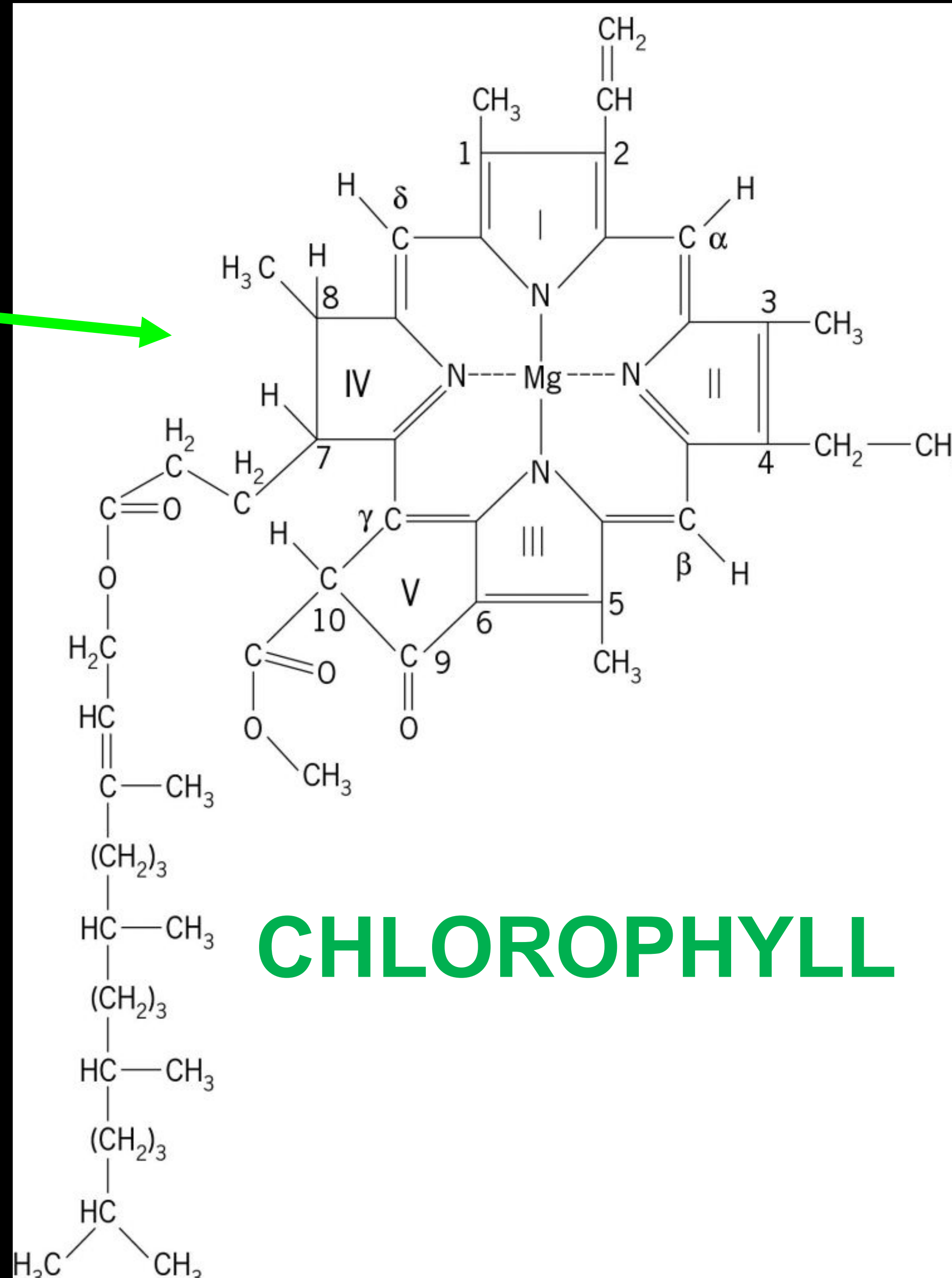
Photosynthesis



An atom within Chlorophyll



Glutamic acid
(Murchison meteorite)



CHLOROPHYLL

1) Glutamic acid

14 separate reactions needed to synthesis Chlorophyll

2) Glutamyl tRNA

Each step requires its own enzyme

3) Glutamate semialdehyde

4) 5-aminolaevulinic acid

Each enzyme defined by its own gene

5) Porphobilinogen (pyrrole ring)

6) Hyrdoxymethylbilane

Without mutation over 2-3 billion yrs

7) Uroporphyrinogen III

8) Coproporphyrinogen III

9) Protoporphyrinogen IX

10) Protoporphyrin IX

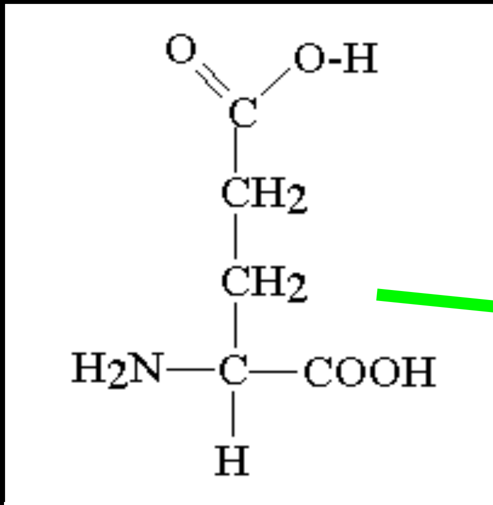
11) Mg-Protoporphyrin IX

12) Divinyl Protochlorophyllide

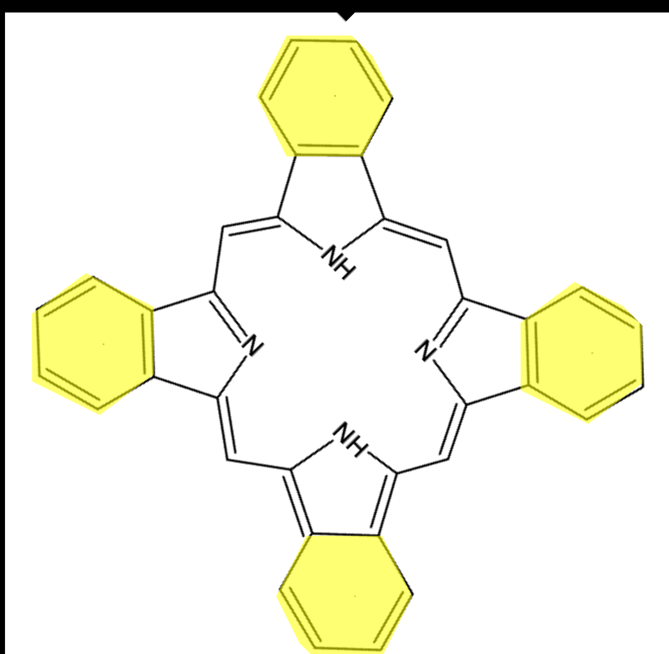
13) Protochorophyllide

14) Chlorophyllide a

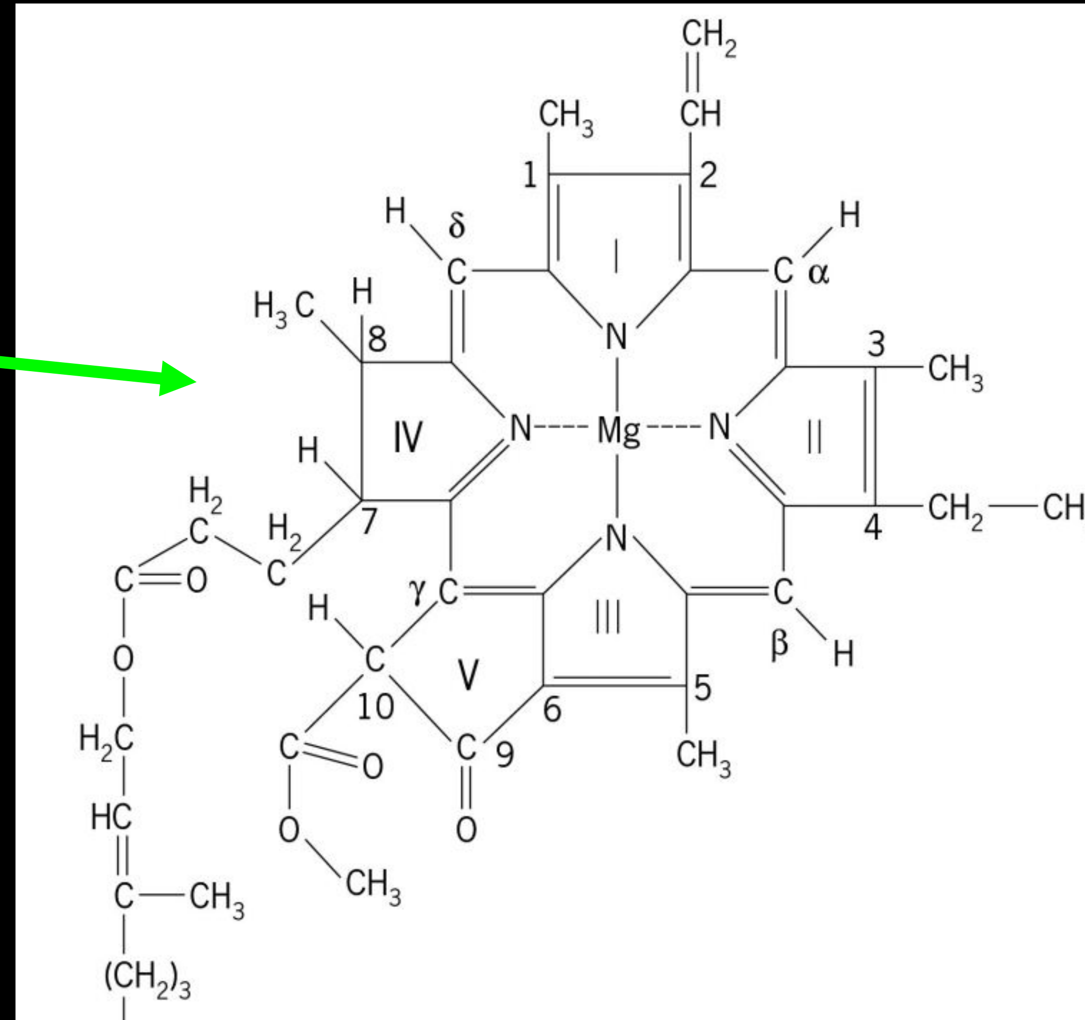
15) **CHLOROPHYLL**



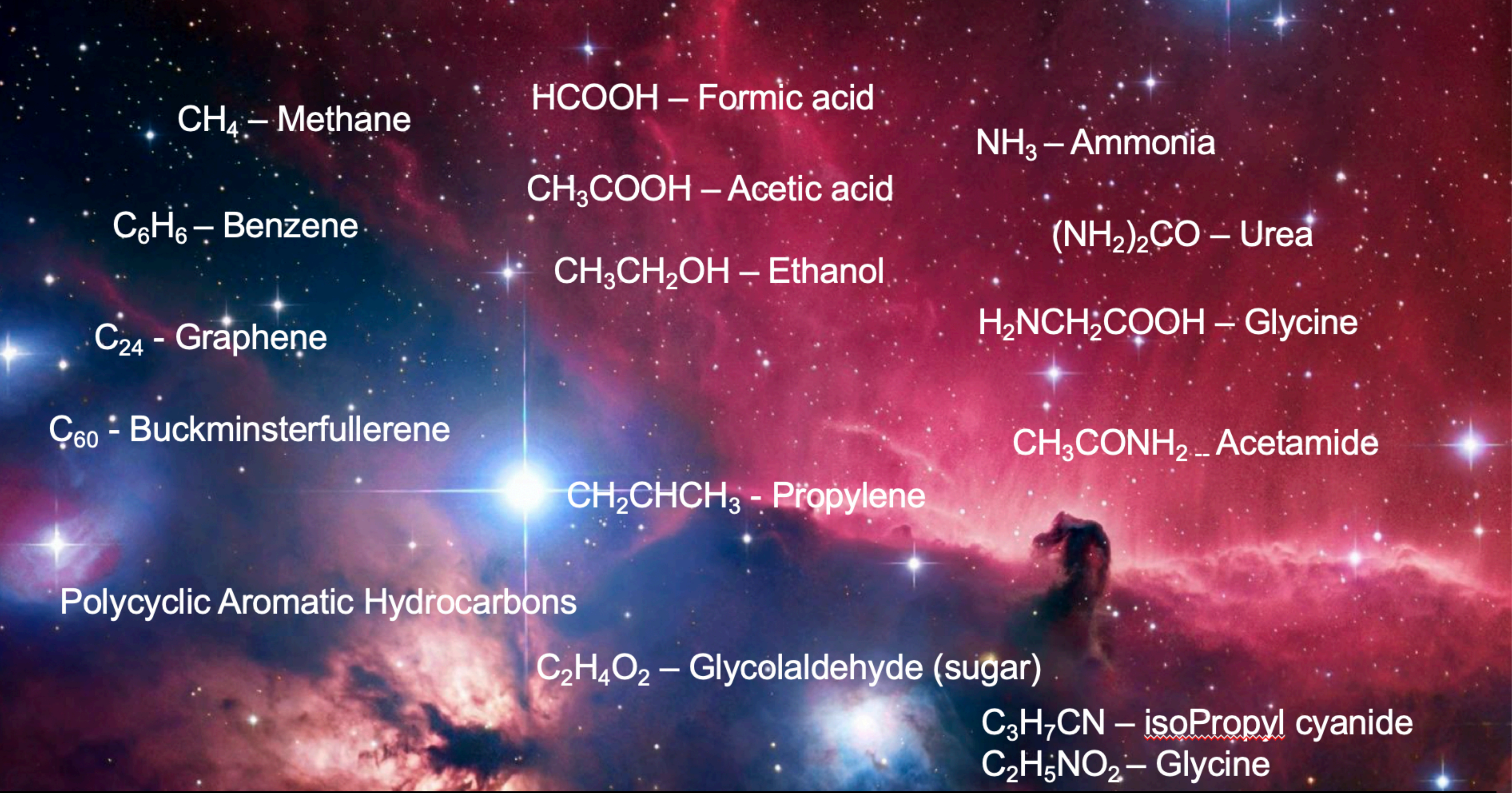
Glutamic acid
(Murchison meteorite)



Tetrabenzo porphyrin



CHLOROPHYLL



In 1989 Fred Hoyle and Chandra Wickramasinghe pointed out that more than 20 diffuse absorption bands in interstellar spectra could be interpreted to be derived from aromatic molecules. (F. Hoyle and N.C. Wickramasinghe, 1989, *Astrophys. Space Sci.* 154, p.143-147).

The strongest band was similar to **magnesium tetrabenzo porphyrin** – a molecule related to chlorophyll.
(F. Hoyle and N.C. Wickramasinghe, 1996, *Astrophys. Space Sci.* 235, p.343-347).

7.5 billion years ago

Murchison meteorite

‘Ingredients’

‘Recipe’

‘Kitchen’

‘Oven’

Is spontaneous generation conceivable?

Is it still happening?

1871 : “*at the present day such matter would be instantly devoured or absorbed, which would not have been the case before living creatures were formed.*” (Darwin to Hooker)

SCIENCE GROUP