

1.5. THE ORIGIN OF CELLS

CELL DIVISION AND THE ORIGIN OF CELLS

- cells can only be formed from pre-existing cells - cell theory.
- each cell was formed from an existing cell which divided into two.
- the genetic material in the nucleus gets copied before the division as both the cells formed should have a nucleus with a full complement of genes.

Sperm and egg cells

- sperm and egg cells were produced by cell division in our parents.
- these sperm and egg cells fuse together to form a zygote that marks the start of our lives.

Spontaneous generation and the origin of cells

- Spontaneous generation is the formation of living organisms from non-living matter.

Examples given by

Theophrastus - silphium had sprung up from the soil

Aristotle - insects being formed from the dew falling on leaves / from the hair, flesh or faces of animals.

Paracelsus - spontaneous generation of mice, frogs & eels from water, air or decaying matter.

Pasteur's experiments regarding spontaneous generation

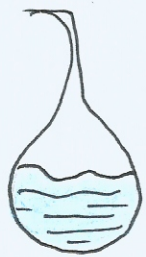
Two flasks - A and B

FLASK-A

Broth water containing yeast and sugar is kept in a sealed flask.

FLASK-B

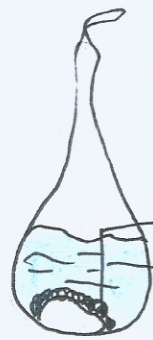
Air was passed through a pad of cotton wool in a tube and the cotton was then placed in the flask with the broth.



- sealed flask with broth

FLASK-A

no fungi or any micro-organisms.



cotton with mould on its surface

FLASK-B

mould on the cotton and a lot of micro-organisms

No spontaneous generation occurred in Flask-A as no air could get inside the flask. This discarded the theory that all living cells come from non-living things.

Reasons for believing that cells come from pre-existing cells:-

- A cell is a highly complex structure and no natural mechanism has been suggested for producing cells from simpler sub-units.
- No example is known of increasing the number of cells without causing cell division.
- Viruses are produced from simpler sub-units but do not consist of cells and they can only be produced inside the host cells that they have infected.

ORIGIN OF THE FIRST CELLS

It has been argued that complex structures cannot arise by evolution, but there is evidence that this can happen in a series of stages over a long period of time.

Some of the hypotheses are:-

1. Production of carbon compounds such as sugars and amino acids:

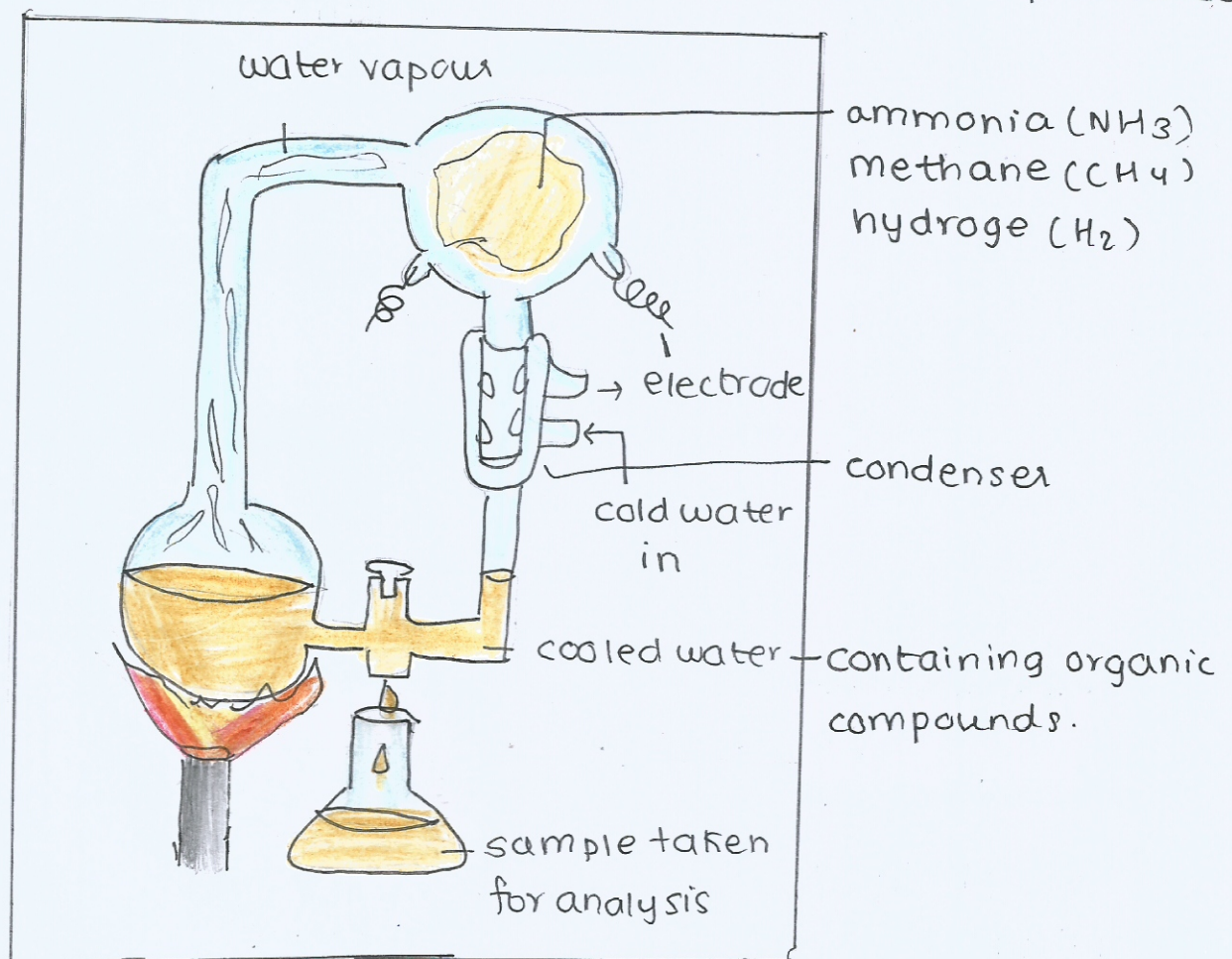
→ Stanley miller and Harold urey passed steam through a mixture of methane, hydrogen and ammonia.

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Electrical charges were passed through it to stimulate lightning.

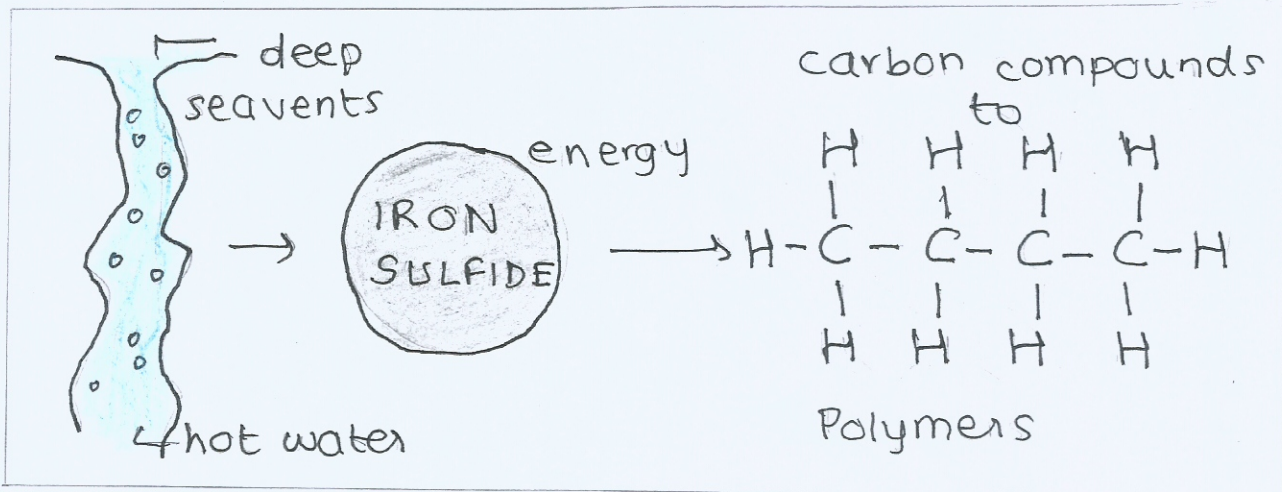
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They found that amino acids and other carbon compounds that are necessary for life were produced.



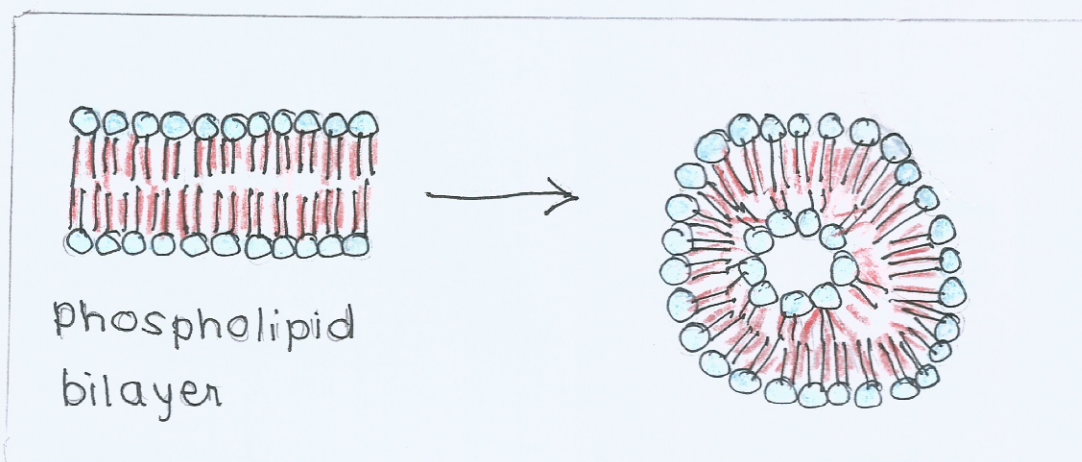
2. Assembly of carbon compounds into polymers:

- The possible site of the first carbon compounds is around the deep-sea vents.
- These are cracks in the earth characterized by gushing hot water carrying reduced inorganic chemicals such as iron sulphide.
- The chemicals represent readily accessible supplies of energy.
- This energy is used for the assembly of the carbon compounds into polymers.



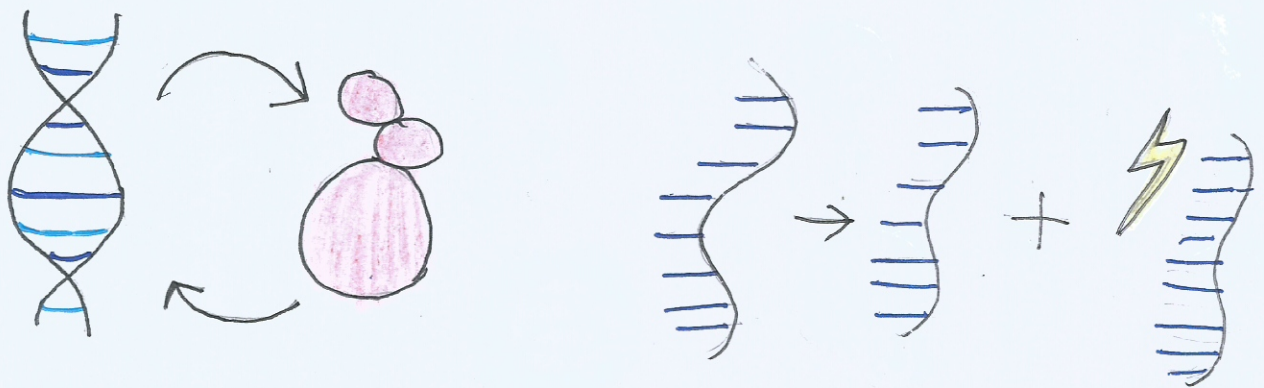
3. Formation of membranes:

- If phospholipids or any other amphipathic carbon compounds were among the first ones, they would have assembled into bilayers themselves.
- These bilayers readily form vesicles resembling the plasma membrane of the cell.



4. Development of a mechanism for inheritance.

- In living organisms, genes are made up of DNA and use enzymes as catalysts.
- Enzymes are needed to replicate DNA and for passing it on to the offspring.
- For the enzymes to be made, DNA is required which causes a conundrum.
- In earlier phase of evolution, RNA was the genetic material which could store information like DNA and could self replicate itself and can also act as a catalyst.



ENDOSYMBIOSIS

The origin of eukaryotic cells can be explained by the endosymbiotic theory.

- It states that mitochondria were once free-living prokaryotic organisms that used to respire ~~anaerobically~~ aerobically.
- The larger prokaryotes engulfed the mitochondria by endocytosis.
- Instead of killing and digesting the mitochondria, they allowed them to continue living in their cytoplasm.
- The larger prokaryotes and the smaller ones were in a symbiotic relationship in which both of them benefited. This is called mutualistic relationship.

Chloroplasts and mitochondria have features that suggest they evolved from independent prokaryotes.

- ▶ own genes, on a circular DNA molecule
- ▶ own 70s ribosomes of a shape & size typical of some prokaryotes
- ▶ they transcribe their DNA and use the RNA to synthesize proteins
- ▶ can only be produced by division of pre-existing mitochondria and chloroplasts.

