Life on Earth

Part 1

Analysis of the oldest sedimentary rocks provides evidence for the origin of life.



* ***identify the relationship between the conditions on early Earth and the origin of organic molecules***



Conditions of early Earth:

* + - Massive oceans existed
		- Only small landmasses above the surface of the water
		- No ozone layer
		- Large amounts of radiation reached the Earth
		- No free oxygen in the air
		- Large amounts of volcanic activity; heat, ash, dust and gases into atmosphere
		- Violent electric storms common
		- Atmosphere contained some water vapour (H2O), hydrogen (H2), hydrogen cyanide (HCN), a lot of carbon dioxide (CO2), nitrogen (N2), possibly ammonia (NH3) and methane (CH4).
	+ The chemicals of life are contained within the following basic organic compounds: water, carbohydrates, lipids, proteins, and nucleic acids.
	+ These compounds are made up of hydrogen (H), oxygen (O), carbon (C), nitrogen (N) and some other common elements.
	+ The elements needed to create the basic organic compounds were already present in the atmosphere; i.e., H, O, C and N were already there.
	+ The lack of an ozone layer, the frequent violent electric storms, and the volcanic activity of early Earth could have provided the energy for molecules to be formed.
* ***discuss the implications of the existence of organic molecules in the cosmos for the origin of life on Earth***

For life to have originated, the following events need to have happened:

* + - The required chemicals need to have been formed.
		- These chemicals need to have come together in a self-replicating body.
		- This body would need to have a form of protection for its contents.
		- It had to be able to use an energy source to replicate itself.
	+ The first step needed for life to be formed would be that the organic molecules needed for life would have to be present
	+ These organic molecules could have been formed here on Earth, or come from Earth from outer space (the cosmos).
	+ ***describe two scientific theories relating to the evolution of the chemicals of life and discuss their significance in understanding the origin of life***

Theory 1: The chemicals for life came from outer space:

* + - Before an atmosphere was formed, nothing stopped meteorites hitting the Earth
		- Scientists believe Earth was heavily bombarded with meteorites during formation
		- Certain types of meteorites, called carbonaceous chondrites, have been found, which contain organic molecules, like amino acids
		- This provided evidence of organic molecules somewhere else in the universe
		- This means that the chemicals for life could have come from outer space

Theory 2: The chemicals for life were formed on Earth:

* + - Haldane and Oparin suggested that early Earth contained all the basic chemical components necessary for life
		- They hypothesised that complex organic molecules, like nucleic acids and carbohydrates, could have been created using inorganic molecules through slow reactions using energy from lightning or UV rays.
		- These complex organic molecules could have collected together on the surface of the oceans, forming an organic “soup”, which later could have formed cells
		- The theory was untested until the 1950s, when Urey and Miller tested it in the lab
	+ ***discuss the significance of the Urey and Miller experiments in the debate on the composition of the primitive atmosphere***

Urey and Miller performed the following experiment to prove Haldane and Oparin’s theory:

* + - A closed system was set up and powerful electrical sparks were passed through a chamber containing ammonia, hydrogen, and methane.
		- These chemicals were used because the scientists wanted to recreate the atmosphere of early Earth.
		- Steam was recycled and passed through the chemicals
		- After a week, the steam collected was red and turbid. When this water was tested, it was found to contain some amino acids.
	+ This experiment proved that, if early Earth did contain those chemicals, life could have formed from inorganic molecules.



* + ***identify changes in technology that have assisted in the development of an increased understanding of the origin of life and evolution of living things***
	+ The Urey/Miller experiment has been improved using modern technology
	+ UV radiation and carbon dioxide is used instead of electricity and ammonia and methane, to make the conditions in the closed chamber more like that of early Earth.
	+ Advances in technology that has increased our knowledge of the origin of life and evolution are the changes in chemical analysis, biochemistry particularly of DNA and molecular biology.
	+ Other technological advances:

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| --- | --- |
| **Technology** | **Uses** |
| Microscope | Enabled the discovery or micro-organisms |
| Radiometric Dating | Can assign absolute dates to rocks/fossils Has established age of the Earthas 4.5 billion years old |
| Electron Microscopy | Remains of microbes and mineral nature of rocks can be studied in detail |
| Gas and Liquid Chromatography Radioactive TracingAmino Acid and Nucleotide Sequencing Spectrophotometry | Enabled the comparisons between ancient organic material and biological materialtoday |

* ***gather information from secondary sources to describe the experiments of Urey and Miller and use the available evidence to analyse the:***
* ***reason for their experiments***
* ***result of their experiments***
* ***importance of their experiments in illustrating the nature and practice of science***
* ***contribution to hypotheses about the origin of life***

Reason for the experiment:

* To test the hypothesis of Haldane and Oparin
* i.e. organic molecules could have been created on the surface of early Earth, from inorganic molecules using energy from UV rays and lightning

Result for their experiment:

* After a week of electrical discharge and recycling steam through their apparatus, they analysed the condensed liquid
* It was found to contain amino acids, the building blocks of proteins

Importance of their experiment in illustrating the nature and practice of science:

- It showed that hypotheses and theories are welcomed in science, but are only accepted when backed up with scientific proof, that is, experiments.

Contribution to hypotheses about the origin of life:

* The results supported Haldane and Oparin’s theory that early Earth contained the basic chemical components for life
* It proved that complex organic molecules can be produced from basic chemical components or inorganic molecules