Evolution

V Semester B.Sc. Zoology – Core Course VII

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EMERGENCE OF LIFE

Origin of life

- Theory of Spontaneous Generation
- Theory of Biogenesis
- Theory of Special Creation
- Cosmic Creation or Theory of Panspermia
- Biochemical Origin of Life

Theory of Spontaneous Generation

- Abiogenesis – Aristotle – (384-322 BC)
- Oldest theory about origin of life
- Life originated spontaneously from non-living components of the environment by natural process.
- Life arose *de novo*
- Ancient people believed life arose from mud of Nile river when warmed by sun

Theory of Biogenesis

- Life originated from pre-existing life by reproduction – biogenesis
- Francisco Redi(1621-1697), Lazzaro Spallanzani (1632-1723), Louis Pasteur (1822-1895)
- Conducted different experiment and proved life originated from pre-existed life
- But failed to prove origin of first life

Theory of Special Creation

- First chapter of Genesis – Biblical version – God created all species in 6 days' time
- Spanish priest Father Saurez (1548-1617)
- Hindu mythology – Brahma is the God of creation

Cosmic Creation or Theory of Panspermia

- Ritcher 1865
- Original spores of life (cosmozoa) reached earth accidently from some other planets of the universe
- Spores – either floating in atmosphere of through meteorites
- Unsatisfactory theory

Biochemical Origin of Life

- Modern concept – A. I. Oparin
- Oparin's Concept – 1936 – book "The Origin of Life on Earth"
- Involved a step by step procedure
- 9 steps

Origin of earth

- 4.5 billion years old. (45,000,000,00 years)
- 1 billion is 1,000,000,000.
- Earth was a ball of hot gases and vapours of various elements
- Gradually began to cool down – different elements sorted out according to their weight
- Heavy metals – Nickel & Iron – sank to centre – solid core of earth
- Lighter elements – Silicon & Aluminium – middle shell
- Helium, hydrogen, oxygen, nitrogen, carbon – gaseous atmosphere

Formation of ammonia, methane and water

- Hydrogen excess
- Combined with carbon – methane
- Combined with nitrogen – ammonia
- Combined with oxygen – water vapour
- High temp all in gasous state
- 4 simple gases -

Formation of rain, rivers and oceans

- Years passed temp came down
- Gases liquefied
- Some turned to solids
- Water vapour – water – rain
- Earth still hot - Droplets on reaching earth evaporated and returned to atmosphere -
- Earth cooled to hold water – river, lakes, valleys, seas and oceans
- 3000 million years

Formation of simple organic molecules

- Methane played major role
- Unusual bonding of carbon atom it combined with other compounds – ethane, propane, acetic acid, glycerol, fatty acids and monosaccharide
- Ammonia – nitrogenous compounds – amino acids, purines, pyrimidines, etc.
- Active – AMP, ADP, ATP

Formation of complex organic molecules

- Seas full of organic molecules of several kinds
- Hot ‘organic soup’
- New macromolecules formed
- Polysaccharides, lipids, proteins, nucleic acids, nucleoproteins
- Polymerization

Formation of nucleic acids & nucleoproteins

- Macromolecule – nucleic acid
- Chain of nucleotides
- Nucleic acids –DNA RNA – naked genes
- Ability for self duplication and mutation
- Nucleic acids + proteins – nucleoproteins
- Energy sources – UV and ionizing radiation from sun, electrical discharge during lightening, high temperatures and heat from volcanoes

Formation of Coacervates

- Macromolecules aggregate and precipitate in primitive oceans
- Colloidal particles of organic materials – Coacervates – Coacervation
- Contain protein, nucleic acids and organic and inorganic compounds
- Remained as distinct bodies
- Unstable structures – not protocell

Formation of first living cell - Protocell

- Protocell – spherical and enveloped by a double layered membrane without nucleus
- Occurred probably by spontaneous combining of various compounds in such a way s to produce a stable and integrated chemical system capable of releasing energy and replicating itself.
- Respiration anaerobic – no oxygen – fermentation of organic compound
- Feeding – heterotrophically from organic soup
- Reproduction – asexual process – replication of macromolecules or budding

From protocell to full fledged living organism

- Sugars and amino acids became scarce, CO_2 abundant due to fermentation – Cholorphyll molecules arose.
- Heterotrophic – autotrophic
- Slowly atmosphere filled with large amounts of oxygen – photosynthesis
- Aerobic organism – autotrophs and heterotrophs

Major steps

- **Primitive Earth**
- **Gases of the primitive earth** (CO, NH_3,CH_4,HCH,H_2O)
- **Simple organic molecules** (Micromolecules – sugars ,fatty acids, glycerol, aminoacids, purines, pyrimidines)
- **Complex organic molecules** (macromolecules – polysaccharides, lipids, proteins, nucleic acids, etc)
- **Nucleoproteins**
- **Coacervates** – Microspheres (Colloidal organic droplets)
- **Protocell** (first living cell)
- **Cell** (full fledged living cell)

Urey – miller experiment

- The experiment used water (H_2O), methane (CH_4), ammonia (NH_3), and hydrogen (H_2).
- The chemicals were all sealed inside a sterile 5-liter glass flask connected to a 500 ml flask half-full of liquid water.
- The liquid water in the smaller flask was heated to induce evaporation, and the water vapour was allowed to enter the larger flask.

Urey – miller experiment

- Continuous electrical sparks were fired between the electrodes to simulate lightning in the water vapour and gaseous mixture, and then the simulated atmosphere was cooled again so that the water condensed and trickled into a U-shaped trap at the bottom of the apparatus.
- After a day, the solution collected at the trap had turned pink in colour.

Urey – miller experiment

- At the end of one week of continuous operation, the boiling flask was removed, and mercuric chloride was added to prevent microbial contamination.
- The reaction was stopped by adding barium hydroxide and sulfuric acid, and evaporated to remove impurities.
- Using paper chromatography, Miller identified five amino acids present in the solution: glycine, α-alanine and β-alanine were positively identified, while aspartic acid and α-aminobutyric acid (AABA) were less certain, due to the spots being faint.

Urey – miller experiment