



Last Universal Common Ancestor (LUCA)

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Why in News?

Recently, in a new study, scientists have said the [last universal common ancestor \(LUCA\)](#) could have **formed just 300 million years** after the earth formed.

What are the Recent Key Highlights of the Research?

▪ About:

- Researchers believe all three branches of life namely [bacteria](#), [archaea](#), and [eukarya](#) originated from a single cell, called the last universal common ancestor (LUCA).
- LUCA had a **small genome with about 2.5 million bases** and 2,600 proteins, sufficient for survival in its unique environment.
- LUCA's metabolites might have created a secondary ecosystem for other microbes to emerge, and it possibly had [immunity](#) genes to fight off viruses.
- Though there is no [fossil evidence](#) to support the existence of LUCA, modern genomes share so many features that provide some insights.
- However, the **theory of the molecular clock** allowed scientists to **reconstruct the 'tree of life'**.
 - As per **theory**, the rate at which **mutations are added or removed** from a population's genome is proportional to the **rate of acquiring new mutations**, which is constant.
 - The mutation rate varies between species.
 - Based on the findings, researchers created a method to estimate the time between evolutionary events by using known mutation rates and linking genomes to specific events like the evolution of the first mammal or the age of fossils as benchmarks.
- Based on the earlier **findings of fossils in the Pilbara Craton in Australia**, the earliest life forms were believed to be **date back to 3.4 billion years ago**.

▪ Significance of Findings:

- Overall, these findings are **crucial for understanding how life began** and evolved on Earth and for seeking similar life forms elsewhere in the universe.
- These evolutionary insights will **boost efforts to engineer synthetic organisms** for various processes on Earth and to create or manage ecosystems on other planets in the future.

What are Various Competing Theories of Life's Origin?

- **Oparin-Haldane Hypothesis:** In 1924 and 1929, Oparin and Haldane respectively suggested the **first molecules making up the earliest life forms gradually self-organised from a "primordial soup"** in a young earth's tempestuous, prebiotic environment. This idea is today called the Oparin-Haldane hypothesis.
- **Miller-Urey Experiment:** It showed that **in the right conditions, inorganic compounds could give rise to complex organic compounds**.
 - Under it methane, ammonia, and water were mixed and applied an electric current to produce amino acids, the building blocks of proteins.

- **Panspermia Hypothesis:** It suggests that meteorites could have brought life's building blocks to Earth, supported by discoveries of extraterrestrial organic material and amino acids on asteroids.
 - In 2019, French and Italian scientists reported **discovering extra-terrestrial organic material 3.3 billion years old.**
 - Japan's Hayabusa 2 mission to the asteroid Ryugu also indicated the presence of more than 20 amino acids there.

THEORIES OF EVOLUTION

The modification of living organisms during their descent, generation by generation from common ancestors.

Oparin-Haldane Theory of Origin of Life

- ↳ Also known as Materialistic theory
- ↳ Describes process of origin of life on early Earth as:

Physio-chemical processes of atoms → Organic compounds → Macromolecules → First living system or cells

Theory of Inheritance of Acquired Character (Lamarckism)

- ↳ First theory of organic evolution
- ↳ **Evolutionary ideas:**
 - ➔ Internal forces of life increase the size of organism
 - ➔ New structures appear because of an 'inner want'
 - ➔ Direct environmental effect over living organisms
 - ➔ Inheritance of acquired character
- ↳ **E.g.;** Long neck of giraffe due to gradual lack of surface vegetation

Theory of Natural Selection (Darwinism)

- ↳ Foundation of evolutionary biology
- ↳ **Elements:**
 - ➔ Universal occurrence of variation
 - ➔ Rapid multiplication
 - ➔ **The struggle for existence** - Intraspecific and interspecific
 - ➔ **Survival of the fittest (Natural Selection)**
 - ➔ Inheritance of useful variations; Elimination of non-useful variations
- ↳ **E.g.;** Survival of more dark-winged moths than white-winged ones in post-industrialisation period


Neo-Darwinism
Integration of Darwin's theory of evolution with Gregor Mendel's theory of genetics

Modern Synthetic Theory

- One of the proven theories of organic evolution
- Includes factors such as – Mutation, Variation /Recombination, Heredity, Natural Selection and Isolation

Mutation Theory (Hugo de Vries)

- ↳ Describes evolution as a jerky process where new varieties of species are formed by mutations (discontinuous variations)
- ↳ **Salient features:**
 - ➔ Mutation appears all of a sudden and becomes operational immediately
 - ➔ Same type of mutation in several individuals of a species
 - ➔ All mutations are inheritable
 - ➔ Useful mutations are selected and lethal ones are eliminated by nature



Drishti IAS

Read More: [Earth's Mantle and Evolution of Life](#)

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. Consider the following: (2013)

1. Electromagnetic radiation
2. Geothermal energy
3. Gravitational force
4. Plate movements
5. Rotation of the earth
6. Revolution of the earth

Which of the above are responsible for bringing dynamic changes on the surface of the earth?

- (a)** 1, 2, 3 and 4 only
- (b)** 1, 3, 5 and 6 only
- (c)** 2, 4, 5 and 6 only
- (d)** 1, 2, 3, 4, 5 and 6

Ans: (d)

Q. Which one of the following sets of elements was primarily responsible for the origin of life on the Earth? (2012)

- (a)** Hydrogen, Oxygen, Sodium
- (b)** Carbon, Hydrogen, Nitrogen
- (c)** Oxygen, Calcium, Phosphorus
- (d)** Carbon, Hydrogen, Potassium

Ans: (b)

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