



ORIGIN AND EVOLUTION OF THE EARTH

From Cosmic Beginnings to a Dynamic Planet



ORIGIN OF
THE SOLAR SYSTEM



FORMATION OF
THE EARTH



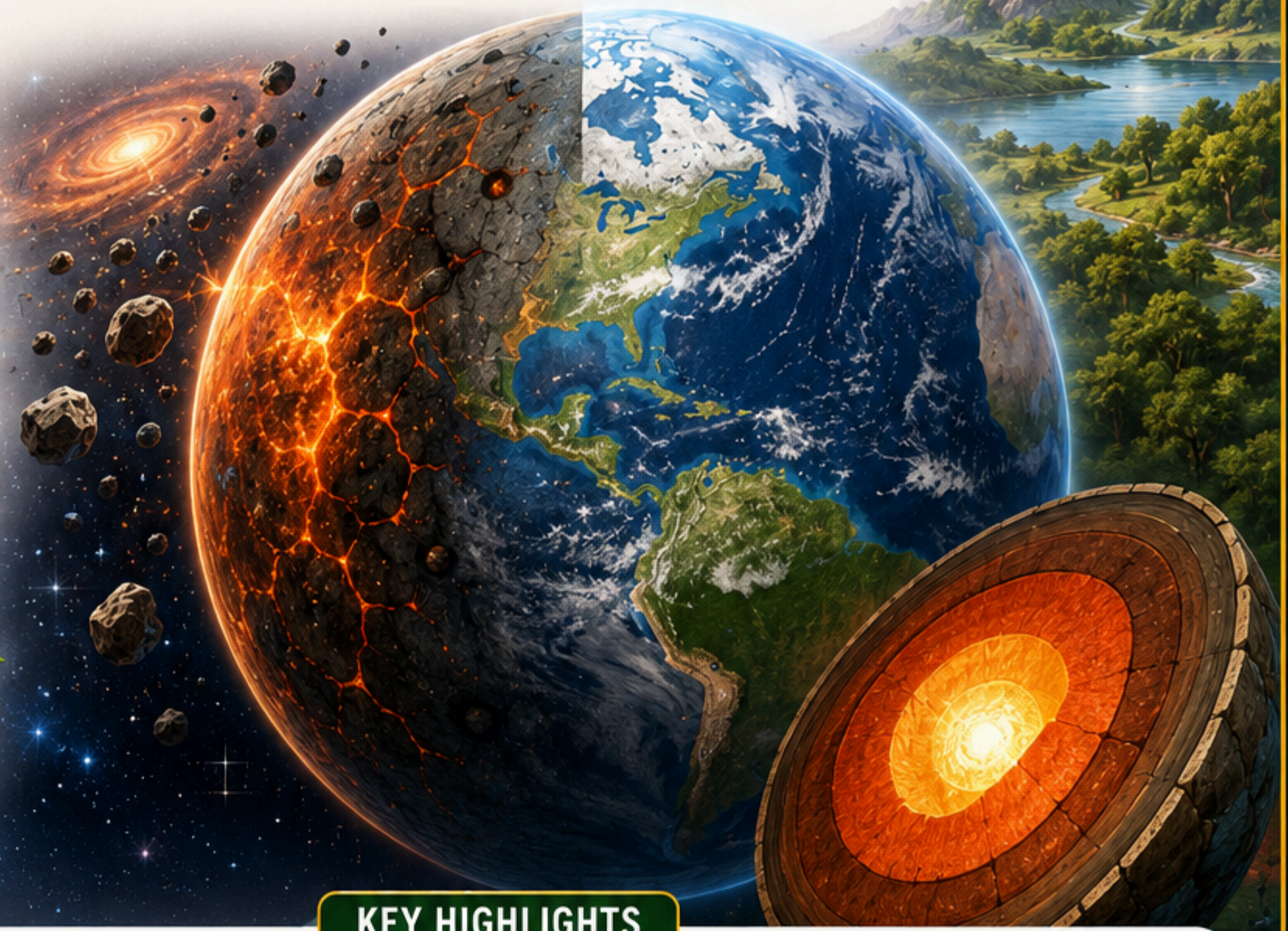
STRUCTURE &
DIFFERENTIATION



GEOLOGICAL
EVOLUTION



EMERGENCE
OF LIFE



KEY HIGHLIGHTS



Scientific
Theories



Geological
Processes



Rock Record &
Fossil Evidence



Plate Tectonics
& Continents



Life &
Environment





ORIGIN AND EVOLUTION OF THE EARTH

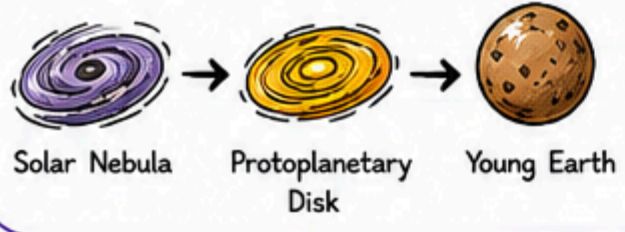


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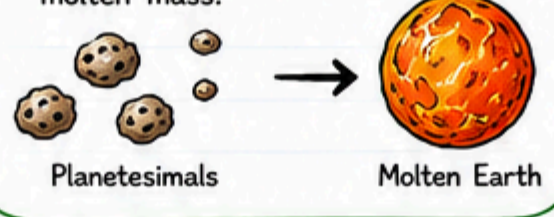
1 ORIGIN OF THE EARTH

- The Earth originated about **4.54 billion years ago**.
- It formed from the solar nebula – a giant cloud of gas and dust.
- The **Nebular Hypothesis** (Kant-Laplace Theory) explains its origin.



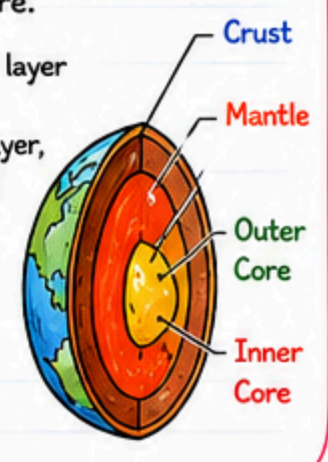
2 FORMATION OF THE EARTH

- Dust and gas particles collided and clumped together.
- These formed planetesimals, which combined to form the Earth.
- Intense heat was generated due to collisions and radioactive decay.
- Early Earth was a hot, molten mass.



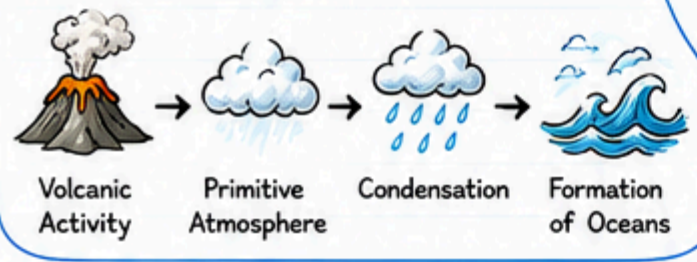
3 STRUCTURE OF THE EARTH

- The Earth has a layered structure.
- **Crust** : Thin outer layer
- **Mantle** : Thickest layer, hot and semi-solid
- **Core** : Central part (outer core liquid, inner core solid)



4 EARLY EVOLUTION OF THE EARTH

- The Earth gradually cooled.
- The crust solidified.
- Volcanic activity released gases, forming the primitive atmosphere.
- Water vapour condensed to form oceans.



ORIGIN AND EVOLUTION OF THE EARTH

5 GEOLOGICAL TIME SCALE

- Earth's history is divided into major eons and eras.
- **Hadean Eon** (4.6 – 4.0 billion years ago)
- **Archaean Eon** (4.0 – 2.5 billion years ago)
- **Proterozoic Eon** (2.5 billion – 541 million years ago)
- **Phanerozoic Eon** (541 million years ago – Present)



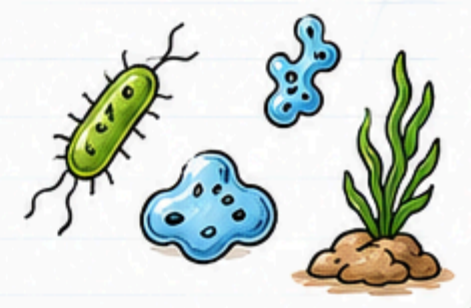
6 MAJOR EVENTS IN EARTH'S EVOLUTION

- Cooling of the Earth
- Formation of crust and oceans
- Development of atmosphere
- Emergence of life
- Continents formed and drifted
- Ice ages and climatic changes



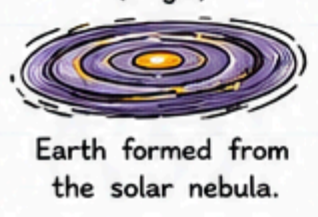
7 ORIGIN OF LIFE

- Life appeared about 3.5 – 3.8 billion years ago.
- First life forms were simple and microscopic.
- Gradually, complex life forms evolved.



8 KEY THEORIES RELATED TO EARTH'S EVOLUTION

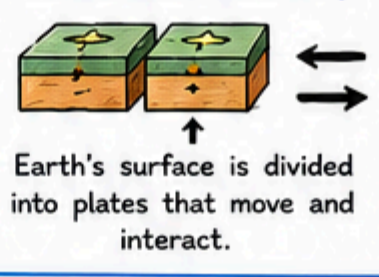
- **Nebular Hypothesis** (Origin)



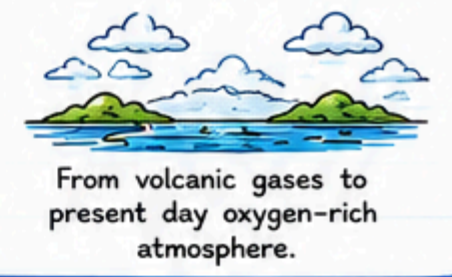
- **Continental Drift Theory** (Wegener)



- **Plate Tectonics Theory**



- **Evolution of Atmosphere**



9 IMPORTANCE OF STUDYING ORIGIN AND EVOLUTION



Helps us understand the Earth's past and present.



Explains natural processes and resources.



Useful in predicting climatic changes and hazards.



Provides a basis for geography, geology and life sciences.



EARLY HYPOTHESES ON THE SOLAR SYSTEM

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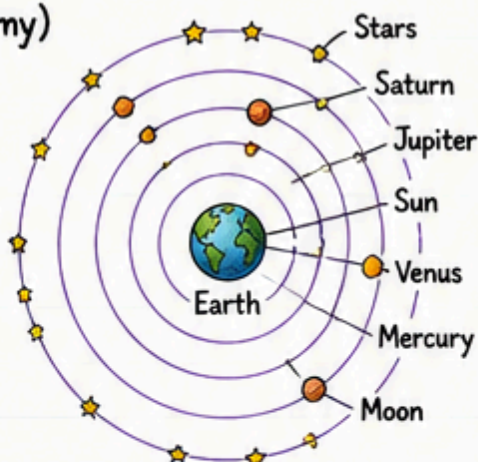
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1 GEOCENTRIC THEORY

(Aristotle & Ptolemy)

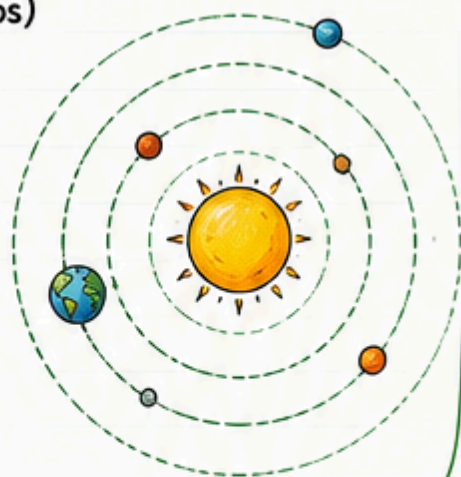
- Earth is at the center of the universe.
- Sun, Moon, planets and stars revolve around the Earth.
- Based on observation with naked eye.
- Accepted for more than 1400 years.



2 HELIOCENTRIC THEORY

(Aristarchus of Samos)

- Sun is at the center of the universe.
- Earth and planets revolve around the Sun.
- Earth also rotates on its own axis.
- His idea was not accepted at that time.



3 TYCHO BRAHE'S MODEL

(Geo-heliocentric)

- Proposed a compromise between the above two theories.
- Earth is fixed at the center.
- Sun revolves around the Earth.
- Other planets revolve around the Sun.

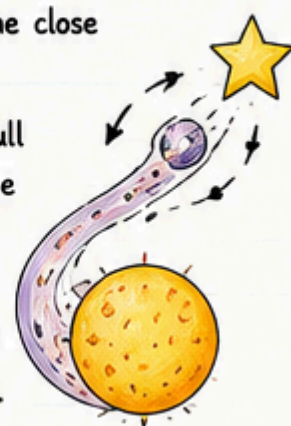


EARLY HYPOTHESES ON THE SOLAR SYSTEM

4 TIDAL THEORY

(James Jeans & Harold Jeffreys)

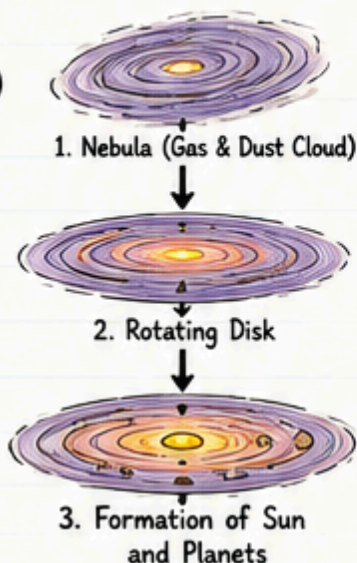
- A passing star came close to the Sun.
- Its gravitational pull raised a tidal bulge of gas and dust from the Sun.
- This material cooled and formed planets.



5 NEBULAR HYPOTHESIS

(Immanuel Kant & Pierre Laplace)

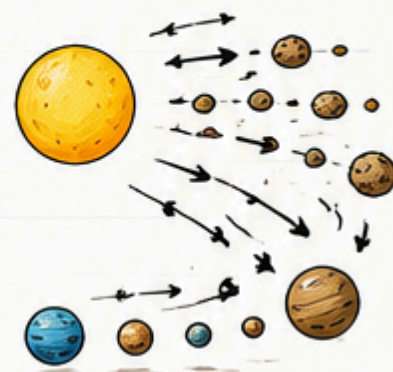
- A giant rotating cloud (nebula) of gas and dust existed.
- Due to gravity, it contracted and flattened into a disk.
- The Sun formed at the center.
- Remaining material in the disk condensed to form planets, moons and other bodies.



6 PLANETESIMAL HYPOTHESIS

(Chamberlin & Moulton)

- A star passed near the Sun.
- It pulled out numerous small solid bodies (planetesimals) from the Sun.
- These planetesimals collided and merged to form planets and other bodies.
- Explains irregular shapes and orbital inclinations.



KEY TAKEAWAYS



- ★ Early hypotheses were based on limited observations and imagination.
- ★ These theories laid the foundation for modern understanding of our Solar System.
- ★ Later, with better instruments and mathematics, the heliocentric view was proven correct.



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MODERN THEORIES: THE ORIGIN OF THE UNIVERSE

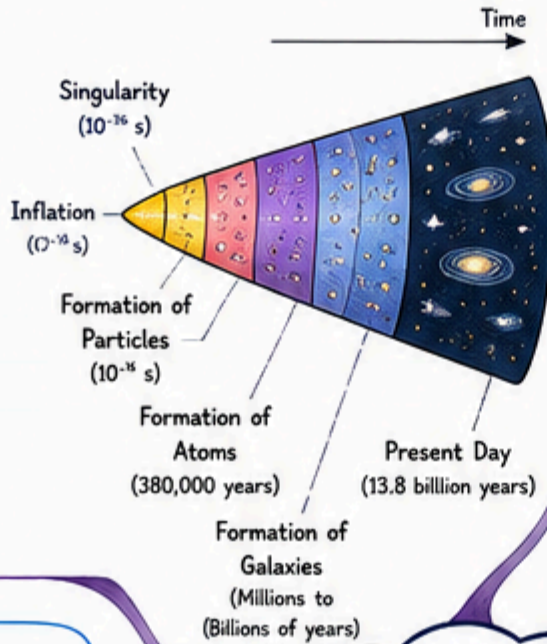
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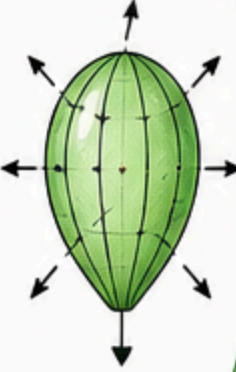
1 THE BIG BANG THEORY

- The most widely accepted theory.
- Universe began about 13.8 billion years ago from an extremely hot, dense point called a **singularity**.
- A rapid expansion (Big Bang) created space, time, matter and energy.
- Universe is still expanding and cooling.



2 INFLATION THEORY

- A fraction of a second after the Big Bang, the universe underwent exponential expansion.
- Solves problems of the Big Bang Theory:
 1. **Horizon Problem** – regions were never in contact but have same properties.
 2. **Flatness Problem** – universe appears flat with great precision.
 3. **Monopole Problem** – predicts why we don't see magnetic monopoles.



3 STEADY STATE THEORY (1948)

- Proposed by Bondi, Gold & Hoyle.
- Universe is eternal – no beginning, no end.
- As universe expands, new matter is continuously created to keep the density constant.
- Does not agree with the discovery of cosmic microwave background radiation.

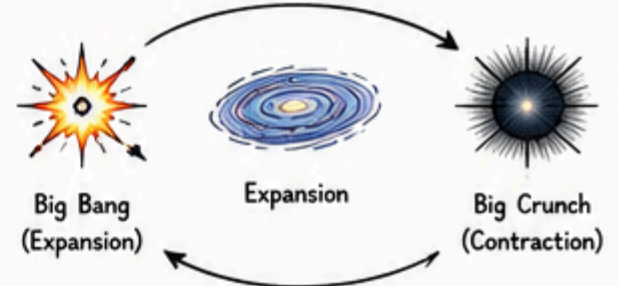


Continuous creation of matter as universe expands

MODERN THEORIES: THE ORIGIN OF THE UNIVERSE

4 OSCILLATING (CYCLIC) UNIVERSE THEORY

- Universe goes through endless cycles of expansion and contraction.
- After the Big Bang (expansion), gravity eventually slows it down and causes contraction (Big Crunch).
- Cycle repeats again.



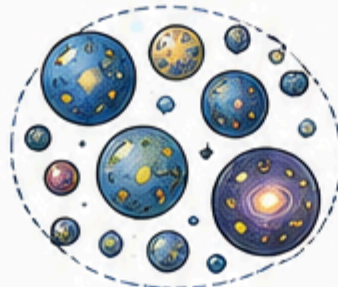
5 QUASI-STEADY STATE THEORY (1990)

- Modified version of Steady State Theory.
- Universe is expanding, but the rate of matter creation decreases with time.
- Attempts to support both Big Bang and Steady State ideas.



6 MULTIVERSE THEORY

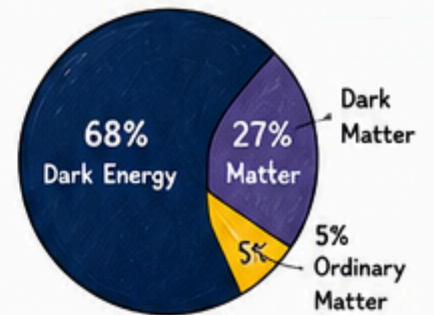
- Our universe may be one of many universes.
- Other universes may have different physical laws, dimensions or constants.
- Arises from inflation theory and quantum mechanics.



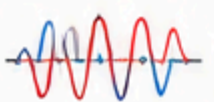
Many universes exist in a 'multiverse'

7 DARK ENERGY & THE EXPANDING UNIVERSE

- Observations show that the expansion of the universe is accelerating.
- Caused by a mysterious force called Dark Energy.
- About 68% of the universe is made of dark energy.
- Important in understanding the future of the universe.



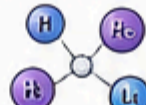
8 EVIDENCES SUPPORTING MODERN THEORIES



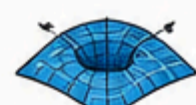
Cosmic Microwave Background Radiation (Discovered in 1965)



Red Shift of Galaxies (Universe is expanding)



Abundance of Light Elements (H, He, Li) formed in early universe



Large Scale Structure of the Universe is consistent



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THE STRUCTURAL EVOLUTION OF THE EARTH

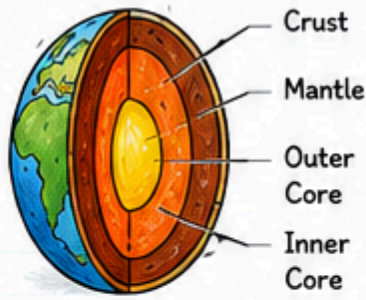
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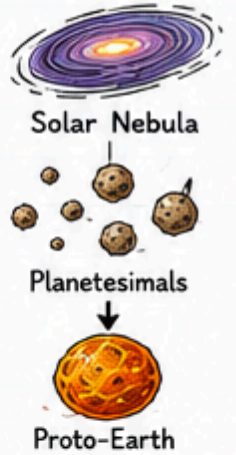
1 WHAT IS STRUCTURAL EVOLUTION?

- Structural evolution refers to the gradual changes in the internal structure of the Earth over geological time.
- These changes resulted from cooling, differentiation, solidification and tectonic processes.



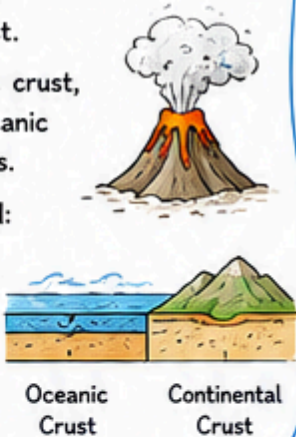
2 FORMATION OF THE EARTH (~4.54 BILLION YEARS AGO)

- Earth formed from solar nebula – a giant cloud of gas and dust.
- Accretion of planetesimals led to the formation of proto-Earth.
- Intense heating due to collisions and radioactive decay.
- Earth was initially a hot, molten mass.



4 FORMATION OF THE CRUST (~4.0 – 3.8 BILLION YEARS AGO)

- The outer layer cooled and solidified to form the crust.
- Initially a thin and unstable crust, constantly modified by volcanic activity and meteor impacts.
- Two types of crust formed:
 - Continental Crust (thicker, less dense)
 - Oceanic Crust (thinner, denser)

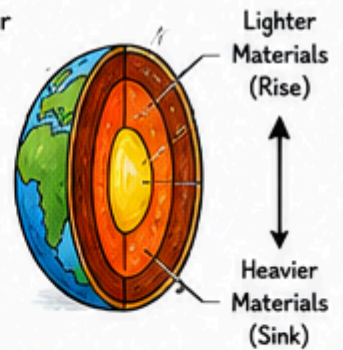


THE STRUCTURAL EVOLUTION OF THE EARTH



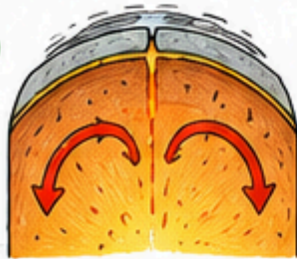
3 DIFFERENTIATION (~4.5 – 4.0 BILLION YEARS AGO)

- As the Earth cooled, heavier materials sank while lighter materials rose.
- This process formed distinct layers:
 - Core (iron & nickel)
 - Mantle (silicate rocks)
 - Crust (lighter rocks)



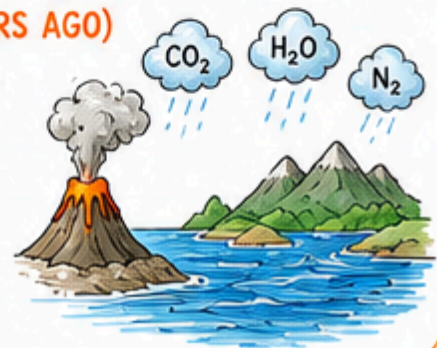
6 DEVELOPMENT OF THE MANTLE (~4.5 BILLION YEARS AGO ONWARDS)

- Mantle is the largest layer.
- Convection currents within the mantle drive tectonic activity.
- Responsible for movement of lithospheric plates.



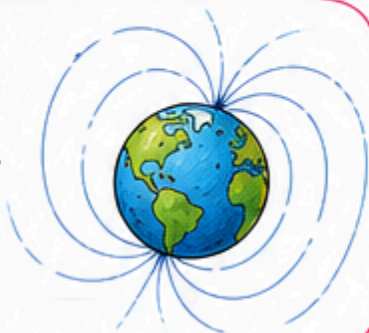
5 EARLY ATMOSPHERE AND OCEANS (~4.0 – 3.5 BILLION YEARS AGO)

- Volcanic outgassing released gases like H₂O, CO₂, N₂, SO₂, CH₄.
- Water vapour condensed to form oceans.
- No free oxygen at this stage.
- Atmosphere was primitive and supported no life.



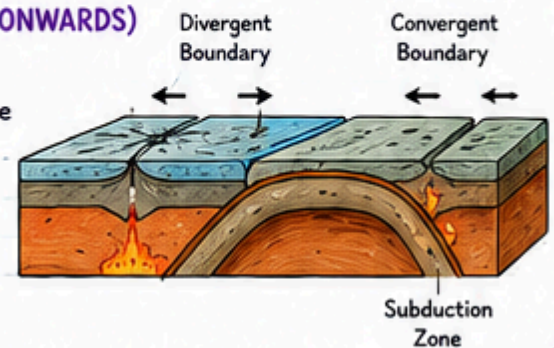
8 COOLING OF THE EARTH (CONTINUES EVEN TODAY)

- Earth continues to lose heat gradually.
- Formation of magnetic field due to liquid outer core.
- Protects Earth from solar winds.



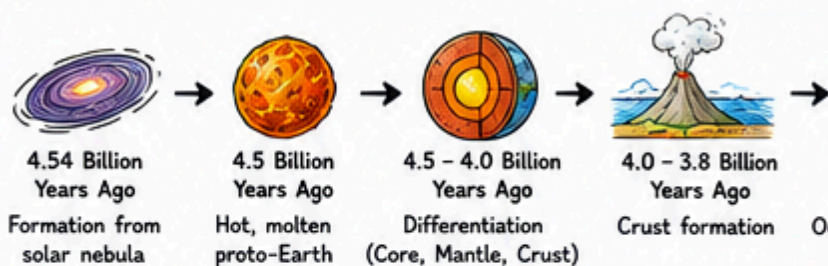
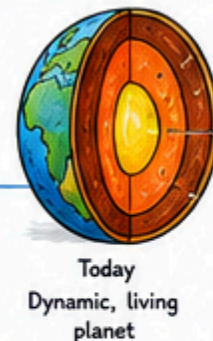
7 TECTONIC EVOLUTION (~3.0 BILLION YEARS AGO ONWARDS)

- Lithosphere broke into plates.
- Plate tectonics began to shape the Earth's surface.
- Processes include:
 - Continental drift
 - Seafloor spreading
 - Subduction
 - Mountain building



9 PRESENT STRUCTURE OF THE EARTH

- Crust (5 – 70 km thick)
- Mantle (up to 2900 km thick)
- Outer Core (liquid, 2250 km thick)
- Inner Core (solid, ~1220 km radius)



KEY TAKEAWAY

- Earth's structure evolved through cooling, differentiation and tectonic processes.
- Internal heat drives geological activity even today.
- These processes have made Earth a unique planet capable of sustaining life.



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ORIGIN AND EVOLUTION OF THE EARTH

QUICK EXAMINATION

FACTS



REMEMBER

- Small facts
- Build strong memory
- High scores!

EARTH FORMED ABOUT 4.54 BILLION YEARS AGO
FROM SOLAR NEBULA – EVOLVED THROUGH GEOLOGICAL TIME.
DYNAMIC PLANET – CONTINUOUSLY CHANGING.

QUICK EXAMINATION FACTS

- Age of the Earth – 4.54 billion years



- Origin – Solar Nebula Theory (Kant-Laplace Hypothesis)



- Formed by accretion of dust and gas particles



- Proto-Earth – hot molten mass



- Differentiation – separation of materials by density



- Layers (outside to inside) – Crust, Mantle, Outer Core, Inner Core



- Crust – thin, solid, outermost layer



- Mantle – thickest layer, semi-solid (magma)



- Outer Core – liquid (iron & nickel)



- Inner Core – solid (iron & nickel)



- Cooling of Earth – began about 4.0 billion years ago



- Water vapour condensed – formed oceans



- Primitive atmosphere – H_2O , CO_2 , N_2 , CH_4 , NH_3 (no free oxygen)



- Oxygen appeared – much later (Great Oxygenation Event)



- Magnetic field generated by liquid outer core



- Moon formed – giant impact (Theia hypothesis)



- Length of day – gradually increased (Earth's rotation slows)



- Continental formation – from crustal movement and cooling



- Plate Tectonics – began about 3.0 billion years ago



- Supercontinent (Pangaea) – existed about 250 million years ago



- Rocks record Earth's history



- Oldest rocks found – about 4.0 billion years old



- Oldest minerals – Zircon crystals (~4.4 billion years old)



- Fossils provide evidence of life evolution



- First life appeared – about 3.5 to 3.8 billion years ago



- Life remained simple for billions of years



- Mass extinction events shaped life evolution



- Ice ages occurred repeatedly



- Earth is a dynamic planet – continues to change



- Supports life due to favourable conditions



ONE LINE MEMORY TRICKS



Solar Nebula (Origin)



Molten Proto-Earth



Differentiation (Layers Formed)



Cooling & Oceans Formed



Crust & Continents



Life Appeared



Dynamic Earth Today



ORIGIN AND EVOLUTION OF THE EARTH

MULTIPLE CHOICE QUESTIONS (MCQs)

Page 1

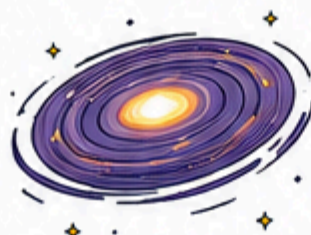
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- 1 According to the Nebular Hypothesis, the solar system, including the Earth, originated from:

- A. A supernova explosion
- B. A giant molecular cloud (solar nebula)
- C. A collision between two stars
- D. A black hole



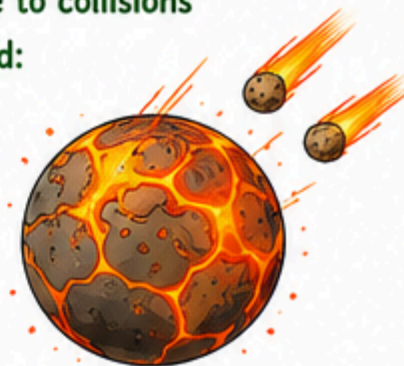
EXPLANATION

The Nebular Hypothesis (Kant-Laplace Hypothesis) states that the solar system formed from a giant rotating cloud of gas and dust called the solar nebula. Gravitational attraction caused the particles to come together and form the Sun and planets.

ANSWER: B

- 2 The process in which the early Earth was heated to a molten state due to collisions and radioactive decay is called:

- A. Volcanism
- B. Differentiation
- C. Accretion
- D. Weathering



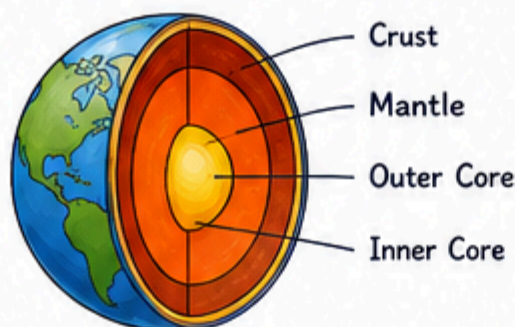
EXPLANATION

Accretion is the process by which small particles (dust, gas, planetesimals) came together due to gravity to form larger bodies. These collisions released tremendous heat, making the early Earth hot and molten.

ANSWER: C

- 3 Which of the following layers is the thickest layer of the Earth?

- A. Crust
- B. Mantle
- C. Outer Core
- D. Inner Core



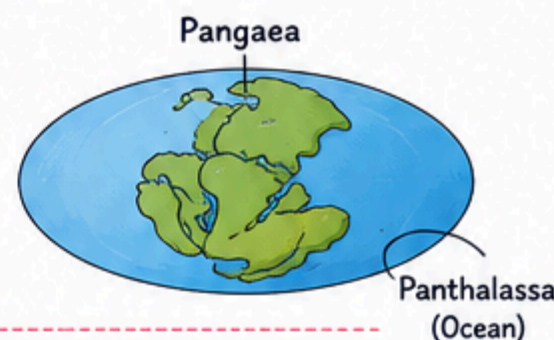
EXPLANATION

The mantle is the thickest layer of the Earth, extending from the base of the crust to the outer core. It is made up of semi-solid rocks called magma.

ANSWER: B

- 4 The supercontinent that is believed to have existed about 250 million years ago is called:

- A. Laurasia
- B. Gondwana
- C. Pangaea
- D. Rodinia



EXPLANATION

Pangaea was a supercontinent formed by the assembly of all the present-day continents. It started breaking apart about 200 million years ago.

ANSWER: C

- 5 Which of the following is NOT considered as a major source of heat in the Earth's early evolution?

- A. Accretion of planetesimals
- B. Radioactive decay
- C. Solar radiation
- D. Gravitational compression



EXPLANATION

The early Earth's heat came mainly from accretion of planetesimals, radioactive decay of elements (like U, Th, K), and gravitational compression. Solar radiation is external and was not a major source of internal heat.

ANSWER: C



Accretion of Planetesimals



Radioactive Decay



Solar Radiation



Gravitational Compression

★ QUICK NOTES

- Earth formed ~4.54 billion years ago.
- Main layers: Crust, Mantle, Outer Core, Inner Core.

- Major processes: Accretion, Differentiation, Cooling, Plate Tectonics.
- Life appeared ~3.5 to 3.8 billion years ago.



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MULTIPLE CHOICE QUESTIONS (MCQs)

Page 2



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6 Which geological time period is known as the 'Age of Reptiles'?

- A. Paleozoic Era
- B. Mesozoic Era
- C. Cenozoic Era
- D. Precambrian Era



EXPLANATION

The Mesozoic Era, also called the 'Age of Reptiles', lasted from about 252 million to 66 million years ago. Dinosaurs thrived during this era. It is divided into Triassic, Jurassic and Cretaceous periods.

ANSWER: B

7 Which of the following events marked the formation of the Earth's crust?

- A. Formation of the core
- B. Cooling of the Earth
- C. Differentiation of layers
- D. Accretion of planetesimals



EXPLANATION

As the early Earth cooled, the outer molten layer solidified to form the crust. This process was part of the overall cooling and differentiation of the Earth.

ANSWER: B

8 Which of the following is a by-product of radioactive decay that causes heating of the Earth's interior?

- A. Water vapour
- B. Helium
- C. Heat energy
- D. Carbon dioxide



EXPLANATION

Radioactive decay of elements like Uranium, Thorium and Potassium in the Earth's interior releases heat energy, which has been a major source of internal heat since Earth's formation.

ANSWER: C

9 Which theory explains the origin of the Moon as a result of a collision with a Mars-sized body?

- A. Nebular Hypothesis
- B. Tidal Theory
- C. Giant Impact Theory
- D. Capture Theory



EXPLANATION

The Giant Impact Theory states that a Mars-sized object (Theia) collided with the early Earth, and the debris ejected formed the Moon.

ANSWER: C

10 Which of the following statements about the early Earth is INCORRECT?

- A. It had no free oxygen in the early atmosphere.
- B. Water condensed and formed oceans.
- C. The atmosphere was rich in nitrogen and methane.
- D. Life appeared immediately after the formation of oceans.



EXPLANATION

Life did not appear immediately after the formation of oceans. It took several hundred million years for life to evolve in forms such as microbes.

ANSWER: D



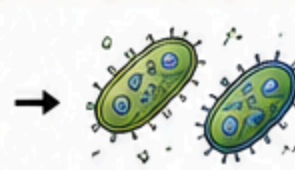
Hot early Earth



Water vapour condensed



Oceans formed



Life evolved much later (microbes)

★ QUICK NOTES

- Earth formed ~4.54 billion years ago.
- Main hypothesis: Nebular (Kant-Laplace).
- Major processes: Accretion → Differentiation → Cooling.
- Main layers: Crust, Mantle, Outer Core, Inner Core.
- Oceans formed ~4.0 billion years ago.
- Life appeared ~3.5 to 3.8 billion years ago.



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ORIGIN AND EVOLUTION OF THE EARTH

MULTIPLE CHOICE QUESTIONS (MCQs)

Page 3



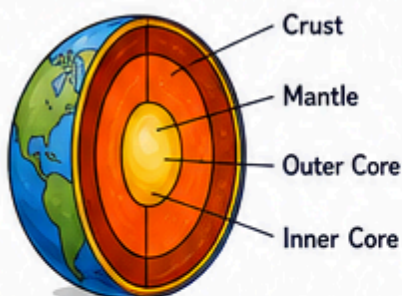
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11 Which of the following is the correct sequence of layers from outside to inside of the Earth?

- A. Crust, Mantle, Outer Core, Inner Core
- B. Crust, Outer Core, Mantle, Inner Core
- C. Mantle, Crust, Inner Core, Outer Core
- D. Inner Core, Outer Core, Mantle, Crust



EXPLANATION

The Earth has four main layers. From outside to inside, they are Crust (thin solid layer), Mantle (thick semi-solid layer), Outer Core (liquid layer), and Inner Core (solid layer).

ANSWER: A

12 The oldest known rocks on the Earth are approximately how many years old?

- A. 1.0 billion years
- B. 2.5 billion years
- C. 3.5 billion years
- D. 4.0 billion years



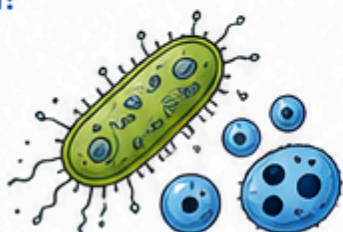
EXPLANATION

The oldest rocks found on Earth are about 4.0 billion years old. They are evidence of the Earth's early crust and provide important clues about its early history.

ANSWER: D

13 Which of the following was the first type of life that appeared on Earth?

- A. Dinosaurs
- B. Plants
- C. Bacteria (microbes)
- D. Humans



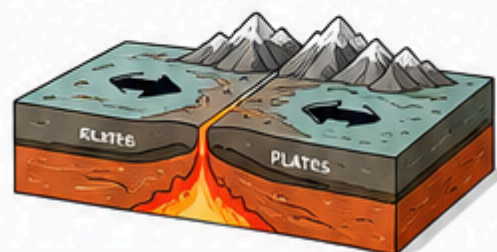
EXPLANATION

The first life on Earth was microscopic in the form of single-celled organisms called microbes or bacteria. They appeared about 3.5 to 3.8 billion years ago.

ANSWER: C

14 Which process is responsible for the movement of continents over the Earth's surface?

- A. Weathering
- B. Erosion
- C. Plate Tectonics
- D. Deposition



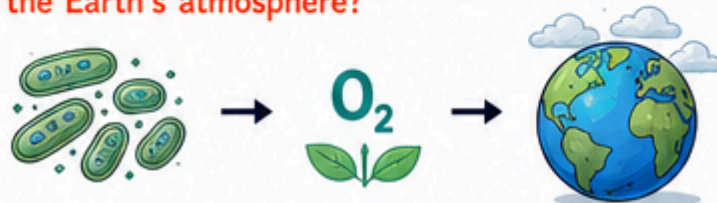
EXPLANATION

Plate Tectonics is the theory that the Earth's outer layer (lithosphere) is divided into plates that move over the mantle. This causes the continents to drift, collide, or separate.

ANSWER: C

15 Which event is considered the main reason for the Great Oxygenation in the Earth's atmosphere?

- A. Volcanic eruptions
- B. Appearance of photosynthetic organisms
- C. Formation of mountains
- D. Increase in solar radiation



EXPLANATION

The Great Oxygenation occurred when cyanobacteria (blue-green algae) started photosynthesis, releasing oxygen into the atmosphere. This event happened about 2.4 billion years ago and changed Earth's environment forever.

ANSWER: B

★ QUICK NOTES



Earth formed ~4.54 billion years ago.



Formed by accretion of dust and gas (Solar Nebula).



Main layers: Crust, Mantle, Outer Core, Inner Core.



Heat sources: Accretion, Radioactive decay, Gravitational compression.



Life appeared ~3.5 to 3.8 billion years ago (first microbes).



Plate Tectonics drives geological and climatic changes.



Oceans formed ~4.0 billion years ago.



Great Oxygenation ~2.4 billion years ago.



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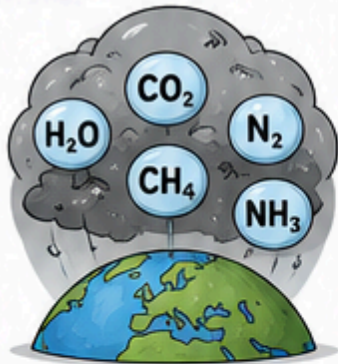
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16 What was the primary composition of the early Earth's primitive atmosphere?

- A. Oxygen and Nitrogen
- B. Nitrogen and Methane
- C. Water vapour, Carbon dioxide, Nitrogen, Methane and Ammonia
- D. Oxygen and Carbon dioxide



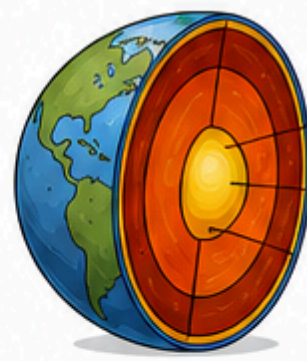
EXPLANATION

The primitive atmosphere was reducing in nature and contained water vapour, carbon dioxide, nitrogen, methane and ammonia. It had almost no free oxygen.

ANSWER: C

17 Which of the following best describes the process of differentiation?

- A. Formation of oceans
- B. Breakdown of rocks
- C. Sorting of materials inside the Earth based on density
- D. Movement of plates on the surface



EXPLANATION

Differentiation is the process in which denser materials like iron and nickel sank to the center to form the core, while lighter materials moved upward to form the mantle and crust.

ANSWER: C

18 Which evidence supports the idea that the Earth has undergone continuous changes over time?

- A. Shape of the Earth
- B. Presence of fossils in rocks
- C. Day and night
- D. Seasons



EXPLANATION

Fossils found in different rock layers show gradual changes in life forms over millions of years, proving that the Earth has undergone continuous change.

ANSWER: B

19 Which era is known for the appearance of the first flowering plants?

- A. Paleozoic Era
- B. Mesozoic Era
- C. Cenozoic Era
- D. Precambrian Era



EXPLANATION

Flowering plants (angiosperms) first appeared in the Mesozoic Era, during the Cretaceous period, and then diversified widely.

ANSWER: B

20 Which of the following is an effect of plate tectonics on the Earth?

- A. Formation of volcanoes
- B. Drift of continents
- C. Occurrence of earthquakes
- D. All of the above



EXPLANATION

Plate tectonics leads to the movement of plates which causes continental drift, formation of volcanoes, and occurrence of earthquakes. Hence, all the above are effects.

ANSWER: D



★ QUICK NOTES



Earth formed ~4.54 billion years ago.



Origin: Solar Nebula Hypothesis (Kant-Laplace).



Layers: Crust, Mantle, Outer Core, Inner Core.



Early Earth was hot and molten.



Water vapour condensed to form oceans.



Oldest rocks are about 4.0 billion years old.



Life appeared ~3.5 to 3.8 billion years ago (microbes).



Great Oxygenation occurred ~2.4 billion years ago.



Plate Tectonics drives mountain building, quakes and volcanism.



Earth continues to evolve even today.





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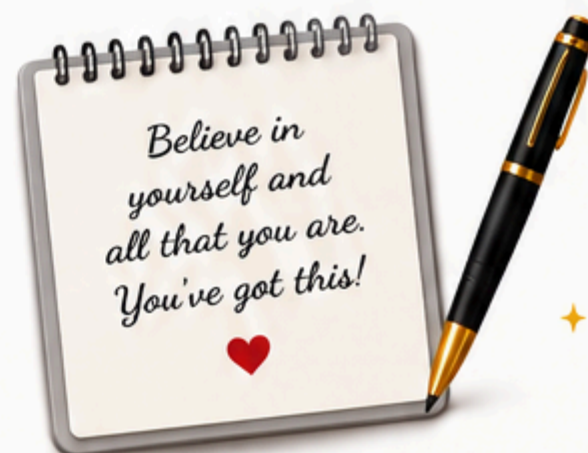
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