Unit I:

Universe – Galaxy – Solar system – Earth - Movements – Latitudes – Longitude International Date Line

Origin of Life on Earth

- The universe is very old. Huge clusters of galaxies comprise the universe.
- The Big Bang Theory attempts to explain to us the origin of universe. It talks of a singular huge explosion unimaginable in physical terms.
- The universe expanded and hence, the temperature came down. Hydrogen and Helium formed sometime later.
- The gases condensed under gravitation and formed the galaxies of the present day universe.
- In the solar system of the milkyway galaxy, earth was supposed to have been formed about 5 billion years back.
- There was no atmosphere on early earth. Methane, carbondioxide and ammonia released from molten mass covered the surface.
- The UV rays from the sun brokeup water into Hydrogen and Oxygen and the lighter H2 escaped. Oxygen combined with ammonia and methane to form water, CO2 and others.
- The ozone layer was formed. As earth cooled, the water vapor fell as rain, to fill all the depressions and form oceans.
- Life appeared 500 million years after the formation of earth, i.e., almost four billion years back. Some scientists believe that the life came from outerspace.
- The first non-cellular forms of life could have originated 3 billion years back. They would have been giant molecules. These capsules reproduced their molecules perhaps.
- The first cellular form of life did not possibly originate till about 2000 million years ago. These were probably single-cells. All life forms were in water environment only.
- The version of a biogenesis, i.e., the first form of life arose slowly through evolutionary forces from non-living molecules is accepted by majority.
- However, once formed, how the first cellular forms of life could have evolved into the complex biodiversity of today is the fascinating story that will be discussed below.

- The end result of the ability to adapt and get selected by nature.

Formation of the Solar System: Nuclear Disc Model (neo-Laplacian model)

- Nebular Theory of Laplace (1796) tried to explain the formation of the solar system. But it had many drawbacks as the theory was based on scientifically erroneous assumptions.
- But one assumption it got right was that the solar system was born from a giant gas of dust called as **nebula**.
- A giant interstellar cloud known as the **solar nebula (a vast, swirling cloud of gas and dust)** gave birth to our solar system and everything in it.
- The nebula started its collapse and core formation some 5-5.6 billion years ago and the Sun and the planets were formed about **4.6 billion years ago**.

Formation of the Sun

- The nebula began to collapse (**gravitational collapse**) in on itself after becoming gravitationally unstable.
- This was possibly because of a nearby **supernova sending shock waves** rippling through space.
- Gravity then caused dust and gas to coalesce to the centre of the nebular cloud.
- As more matter got pulled in, the centre got denser and hotter, increasing the gravity and pulling even more dust inwards causing a **snowball effect**.
- About **99.9%** of the material fell into the centre and became the **protosun** (no sunlight yet).
- Once the centre of the cloud became hot enough it triggered **nuclear fusion,** and the Sun was born.

The formation of planets

- The **0.1%** of matter that remained orbited around the Sun, causing the randomly shaped gas cloud to form a flat disc shape.
- This flat disc, called the **protoplanetary disc**, was where the planets formed.
- Within the solar nebula, the dust particles in the gas occasionally collided and clumped together.
- Through this process called **accretion**, the microscopic particles formed larger bodies that eventually became **planetesimals** (infant stage of a planet) with sizes up to a few kilometres across.
- As the disc continued to cool, the planetesimals grew in size through accretion to form **protoplanets**.
- Gradually they got larger and larger, sweeping up all the leftover dust, other protoplanets, planetesimals until they grew into the **planets**.
- In the inner, hotter part of the solar nebula, planetesimals were composed mostly of silicates and metals.
- In the outer, cooler portion of the nebula, water ice was the dominant component.
- The hot, rocky material near the centre of the solar system gave rise to **terrestrial planets** with **metal cores** (mostly composed of iron and nickel): Mercury, Venus, Earth and Mars.
- And on the cool edges, the gas and ice giants were born: Saturn, Jupiter, Neptune, and Uranus.
- Rocks that escaped the pull of planets were left as **asteroids**, scattered through the solar system.
- Many of these rocks orbit the Sun in an area **between Mars and Jupiter** known as the asteroid belt.

- Earth's Crust and its surface are constantly evolving (changing) due to various forces emanating from below (**endogenic forces**) as well as above the surface of the earth (**exogenic forces**).
- These forces cause physical and chemical changes to the geomorphic structure (earth's surface).

- Some of these changes are imperceptibly slow (e.g. weathering, folding), some others are gradual (e.g. erosion) while the remaining are quite sudden (earthquakes, volcanic eruptions).
- **Geomorphic:** relating to the form of the landscape and other natural features of the earth's surface.
- **Geomorphic agents:** mobile medium (like running water, moving ice masses or glaciers, wind, waves, currents etc.) which removes, transports and deposits earth materials.
- **Geomorphic processes:** physical and chemical processes that take place on the earth's surface (folding, faulting, weathering, erosion, etc.) due to endogenic and exogenic forces.
- **Geomorphic movements:** large scale physical and chemical changes that take place on the earth's surface due to geomorphic processes.

Endogenic Geomorphic Movements

- The large-scale movements on the earth's crust or its surface brought down by the forces emanating from deep below the earth's surface are called as endogenic geomorphic movements or simply endogenic movements (endo: internal; genic: origin; geo: earth; morphic: form).
- The geomorphic processes that are driven by the forces emanating from deep below the earth's surface are called endogenic geomorphic processes (folding, faulting, etc.).

The force behind Endogenic Movements

- The ultimate source of energy behind forces that drive endogenic movements is **earth's internal heat**.
- Earth's internal heat is a result of mainly radioactive decay (50% of the earth's internal heat) and gravitation (causes pressure gradients).
- Differences in temperature and pressure (temperature gradients or geothermal gradients and pressure gradients) among various layers of the earth give rise to **density differences** and these density differences give rise to **conventional currents**.
- Convectional currents in the mantle drive the **lithospheric plates** (crust and upper mantle) and the **movement of the lithospheric plates** (**tectonics**) is the cause behind endogenic movements.
- The Earth's rotation (**Coriolis effect**) can influence where convection currents travel.
- The destination of convection currents determines the nature and location of the endogenic movements.

Watch the video for better and quick understanding

Classification of Endogenic movements

- Endogenic movements are divided into **diastrophic movements** and **sudden movements**.
- Diastrophism refers to **deformation** of the Earth's crust.
- Diastrophic movements are gradual and might stretch for thousands of years.

- On the other hand, sudden movements like earthquakes and volcanic eruptions occur in a very short period.
- Diastrophic movements are further classified into **epeirogenic movements (continent forming — subsidence, upliftment)** and **orogenic movements (mountain building — folding, faulting)**.

Diastrophism

- Diastrophism refers to deformation of the Earth's crust due to diastrophic movements (deforming movements) such as **folding, faulting, warping (bending or twisting of a large area) and fracturing**.
- All processes that move, elevate or build up portions of the earth's crust come under diastrophism. They include:
- **orogenic processes** involving mountain building through severe folding (crust is severely deformed into folds) and affecting long and narrow belts of the earth's crust;
- **epeirogenic processes** involving uplift or warping of large parts of the earth's crust (simple deformation);
- **earthquakes and volcanism** involving local relatively minor movements;
- **plate tectonics** involving horizontal movements of crustal plates.
- The most obvious evidence of diastrophic movement can be seen where sedimentary rocks have been bent, broken or tilted.

Epeirogenic or continent forming movements

- Epeirogenic or **continent forming** movements are **radial** movements (act along the radius of the earth).
- Their direction may be towards (subsidence) or away (uplift) from the centre.
- **They cause upheavals or depressions of land exhibiting undulations (wavy surface) of long wavelengths and little folding.**
- The broad central parts of continents are called cratons and are subject to epeirogeny, hence the name continent forming movements.

Uplift

- Raised beaches, elevated wave-cut terraces, sea caves and fossiliferous beds above sea level are evidence of upliftment.

Uplifted landforms

- In India, raised beaches occur at several places along the **Kathiawar, Nellore, and Tirunelveli coasts**.
- Several places which were on the sea some centuries ago are now a few miles inland due to upliftment.
- For example, Coringa near the mouth of the Godavari, Kaveripattinam in the Kaveri delta and Korkai on the coast of Tirunelveli, were all flourishing seaports about 1,000 to 2,000 years ago.

Subsidence

- Submerged forests and valleys, as well as buildings, are evidence of subsidence.
- In 1819, a part of the Rann of Kachchh was submerged as a result of an earthquake.
- Presence of peat and lignite beds below the sea level in Tirunelveli and the Sundarbans is an example of subsidence.
- The Andamans and Nicobars have been isolated from the Arakan coast by submergence of the intervening land.

  On the east side of **Bombay island**, trees have been found embedded in the mud about 4 m below low water mark. A similar submerged forest has also been noticed on the Tirunelveli coast in Tamil Nadu.

- A large part of the Gulf of Mannar and Palk Strait is very shallow and has been submerged in geologically recent times. A part of the former town of Mahabalipuram near Chennai is submerged in the sea.

Orogenic or the mountain-forming movements

- In contrast to epeirogenic movement, the orogenic movement is a **more complicated deformation** of the Earth's crust, associated with **crustal thickening** (due to the convergence of tectonic plates).

- Such plate convergence forms orogenic belts that are characterised by "the folding and faulting of layers of rock, by the intrusion of magma, and by volcanism.
- Orogenic or the mountain-forming movements act tangentially to the earth surface, as in plate tectonics.
- Tension produces fissures (since this type of force acts away from a point in two directions), and compression produces folds (because this type of force acts towards a point from two or more directions).

Sudden Movements

- Sudden geomorphic movements occur mostly at the **lithospheric plate margins** (tectonic plate margins).
- The plate margins are highly unstable regions due to pressure created by pushing and pulling of magma in the mantle (**convectional currents**).
- These movements cause considerable deformation over a short period.

Earthquakes

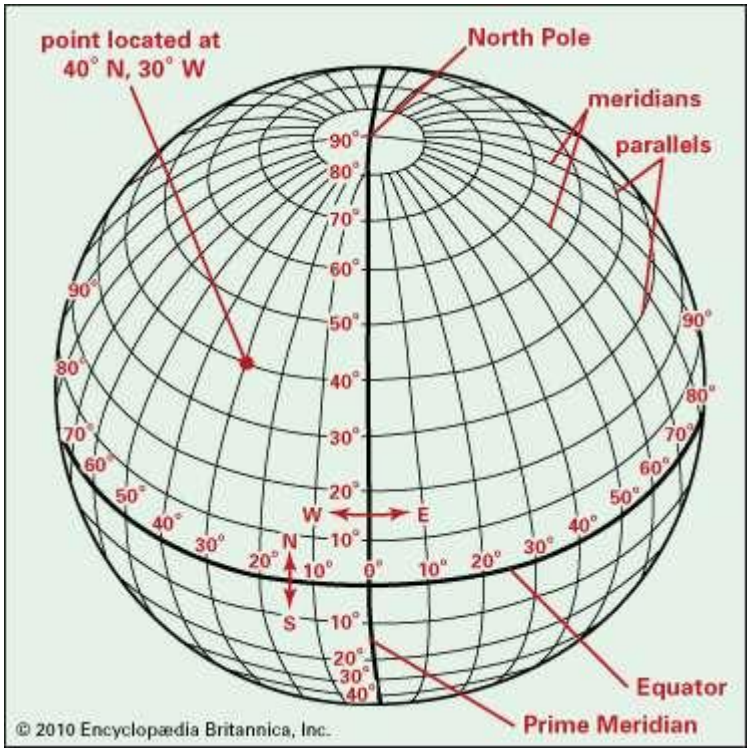
- Earthquakes occur when the surplus accumulated stress in rocks in the earth's interior due to folding, faulting or other physical changes is relieved through the weak zones over the earth's surface in the form of kinetic energy (seismic waves).
- Such movements may result in uplift or subsidence in coastal areas.
- An earthquake in Chile (1822) caused a one-metre uplift in coastal areas.
- An earthquake in New Zealand (1885) caused an uplift of up to 3 metres.
- An earthquake in Japan (1891) caused subsidence of up to 6 metres.
- Earthquakes may cause a change in contours, change in river courses, shoreline changes, glacial surges (as in Alaska), landslides, soil creeps, mass wasting etc.

Volcanoes

- **Volcanism includes the movement of molten rock (magma) onto or towards the earth's surface through narrow volcanic vents or fissures.**
- A volcano is formed when the molten magma in the earth's interior escapes through the crust by vents and fissures in the crust, accompanied by steam, gases **(hydrogen sulphide, sulphur dioxide, hydrogen chloride, carbon dioxide** etc.) and pyroclastic material (cloud of ash, lava fragments carried through the air, and vapour).
- Depending on the chemical composition and viscosity of the lava, a volcano may take various forms.

Latitude and Longitude:

Latitude and longitude, Coordinate system by means of which the position or location of any place on Earth's surface can be determined and described.



latitude and longitude

Latitude is a measurement on a globe or map of location north or south of the Equator. Longitude is a measurement of location east or west of the prime meridian at Greenwich, the specially designated imaginary north-south line that passes through both geographic poles and Greenwich, London. Measured also in degrees, minutes, and seconds,

International Date Line:

The International Date Line, established in 1884, passes through the mid-Pacific Ocean and roughly follows a 180 degrees longitude north-south line on the Earth. It is located halfway round the world from the prime meridian—the zero degrees longitude established in Greenwich, England, in 1852.

The International Date Line functions as a "line of demarcation" separating two consecutive calendar dates.

A traveler going completely around the world while carrying a clock that he advanced or set back by one hour whenever he entered a new time zone and a calendar that he advanced by one day whenever his clock indicated midnight would find on returning to his starting point that the date according to his own experience was different by one day from that kept by persons who had remained at the starting point. The International Date Line provides a standard means of making the needed readjustment: travelers moving eastward across the line set their calendars back one day, and those traveling westward set theirs a day ahead.

How is time calculated through longitudes and latitudes:

When the earth is divided into imaginary lines of longitudes and latitudes, it forms a grid.

With the help of these girds, the longitude and latitudes are divided into degrees and time to find an exact location.

Each degree can be broken into 60 minutes, and each minute can be further divided into 60 seconds.

To be precise, there are 60 minutes in one degree and each degree has a distance of 111 kms. Each minute is divided into 60 seconds.

Each degree of latitude is approximately 111 kilometres apart.

The distance at the equator is 110.567 kilometres.

As we go towards east from the International Date Line, we are reducing one day from our prior location in the west. In short, every location falling on the east of this line is one day earlier in time if compared to the locations in the west.

How to calculate Indian time using International Date Line (IDL)

International Date Line is an imaginary irregular line that passes through pacific Ocean and it is 180°east of Prime Meridian. So this clears the fact that IDL and Prime meridian are not the same.

We know that earth rotates from West to East. Then we assume the day starts (i.e 12 am) from IDL.

Now coming to the question, since it is 12 pm in the IDL, it will be 12 am in the prime meridian.

IST is 5 and half hours ahead of GMT, So from 12 am we have to add 5 and half hours. The answer is 5 30 am.