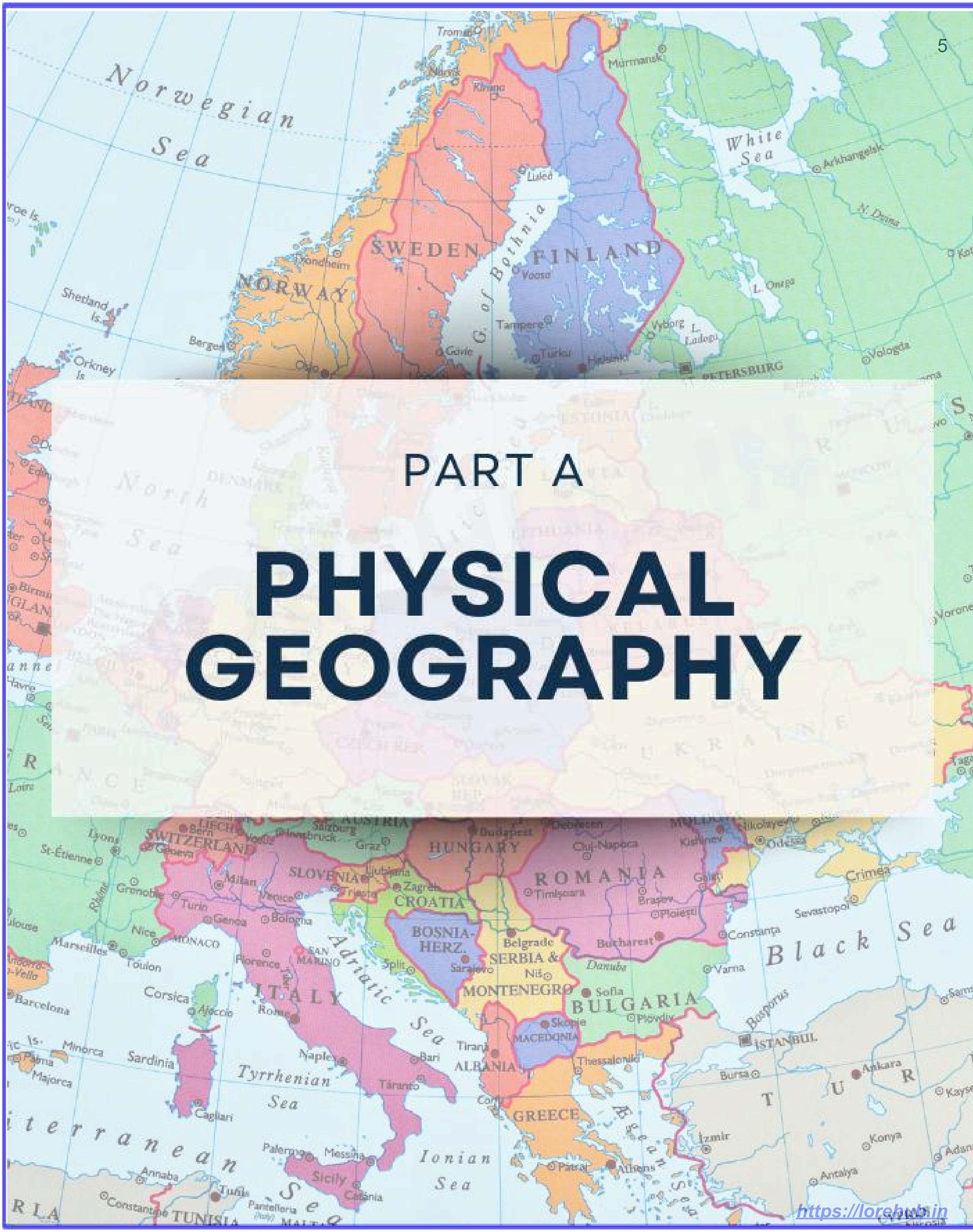


PART A

PHYSICAL GEOGRAPHY

Chapter 1 The Origin And Evolution Of The Earth And The Universe

EARLY THEORIES ON THE ORIGIN OF THE EARTH

1. Early Philosophical and Scientific Ideas

- The question of Earth's origin has been a subject of curiosity and debate for centuries. Various philosophers and scientists have proposed different theories over time to explain how Earth and the solar system came into existence.

2. Nebular Hypothesis

- One of the earliest and most influential theories was proposed by the German philosopher Immanuel Kant and later modified by the French mathematician Pierre-Simon Laplace in 1796.
- This theory is known as the Nebular Hypothesis.
- According to this hypothesis, the solar system formed from a large cloud of gas and dust, called a nebula, which was left over from a young, slowly rotating sun.
- As the nebula cooled, it began to contract and spin more rapidly, flattening into a disk. Through further cooling and condensation, rings of material separated from the central mass, which eventually condensed to form the planets.

3. Planetesimal Hypothesis (Chamberlain-Moulton Hypothesis)

- In the early 20th century (around 1900), Chamberlain and Moulton proposed the Planetesimal Hypothesis as an alternative to the Nebular Hypothesis.
- They suggested that a passing star came close to the sun and its gravity pulled out a long, cigar-shaped stream of material from the sun's surface.
- This ejected material, after the passing star moved away, remained in orbit around the sun. Over time, it cooled, condensed, and formed small bodies called planetesimals.
- These planetesimals collided and clumped together through accretion to form the planets.
- Scientists like Sir James Jeans and Sir Harold Jeffrey supported this view.
- Some versions of this theory considered the possibility of the sun having a companion star, leading to the development of binary star theories for planetary formation.

4. Modified Nebular Hypothesis (Accretion Theory)

- By the mid-20th century (around 1950), scientists such as Otto Schmidt (Russia) and Carl Weizsäcker (Germany) revisited the Nebular Hypothesis with some modifications.
- They proposed that the sun was surrounded by a solar nebula composed mainly of hydrogen, helium, and dust particles.
- Collisions and friction among these particles led to the formation of a flattened, disk-shaped cloud.
- Over time, these particles aggregated through the process of accretion, gradually forming planetesimals which eventually developed into planets.

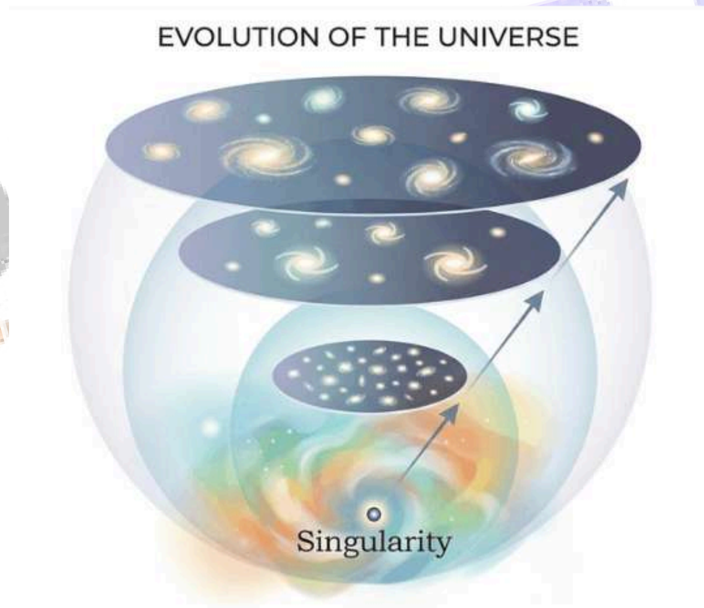
5. Shift to Broader Cosmological Questions

- As scientific knowledge progressed, the focus shifted from the origin of the Earth and solar system to the origin of the universe itself.

MODERN THEORIES ON THE ORIGIN OF THE UNIVERSE

1. The Big Bang Theory (Expanding Universe Hypothesis)

- The Big Bang Theory is the most widely accepted explanation for the origin of the universe.
- Also referred to as the expanding universe hypothesis, it gained prominence in the 1920s due to the work of astronomer Edwin Hubble.
- Hubble's observations showed that galaxies are moving away from each other, indicating that the universe is expanding.



THE BIG BANG

2. Understanding Expansion: Balloon Analogy

- The expansion of the universe can be visualized by imagining dots marked on the surface of a balloon. As the balloon inflates, the dots move farther apart. Similarly, as the universe expands, galaxies move away from each other.
- However, unlike the dots on a balloon, real galaxies themselves do not expand; only the space between them increases.

3. Sequence of Events in the Big Bang Theory

(i) Initially, all the matter and energy in the universe were concentrated in a single, extremely small and dense point, often described as a “primordial atom” with infinite temperature and density (a singularity).
(ii) Around 13.7 billion years ago, this singularity underwent a massive explosion known as the Big Bang. The universe began to expand rapidly.

- Some of the energy from this explosion was converted into matter.
- During the first few seconds, the universe expanded at an enormous rate (inflation), followed by a slower rate of expansion.
- Within three minutes, the first atomic nuclei formed.

(iii) Approximately 300,000 years after the Big Bang, the universe cooled down to about 4,500 Kelvin, allowing atoms to form and making the universe transparent to radiation.

4. Competing Theory: Steady State Theory

- The Steady State Theory, proposed by Fred Hoyle and others, suggested that the universe has always existed in a similar state and new matter is continuously created as the universe expands.
- However, accumulating evidence for an expanding universe led most scientists to reject the steady state theory in favor of the Big Bang Theory.

FORMATION OF STARS AND GALAXIES

1. Initial Conditions after the Big Bang

- In the early universe, matter and energy were not evenly distributed. Certain regions had slightly higher concentrations of matter, while others had less.
- These density fluctuations allowed gravity to pull matter together in the denser regions.

2. Formation of Galaxies

- Galaxies are vast systems containing billions of stars and span thousands of light-years in diameter (typically between 80,000 and 150,000 light-years).
- To form galaxies, vast amounts of hydrogen gas accumulated in enormous clouds known as nebulae.
- Over time, regions within these nebulae became denser, leading to the formation of clumps of gas.

3. Formation of Stars

- The denser clumps within nebulae continued to attract more matter, increasing in mass and density.
- As these clumps grew, their gravitational pull caused them to collapse further, eventually leading to the birth of stars through nuclear fusion.
- Scientists estimate that star formation began around 5 to 6 billion years ago.

Light Year

A light year is a unit of distance, not time. It refers to how far light can travel in one year. Since light travels at a speed of about 300,000 kilometers per second, in a year, it covers approximately 9.46 trillion kilometers. To put this in perspective, the average distance between the Earth and the Sun is about 149.6 million kilometers. Light from the Sun takes just over eight minutes to reach Earth, highlighting the immense speed at which light travels and the vast distances involved in space.

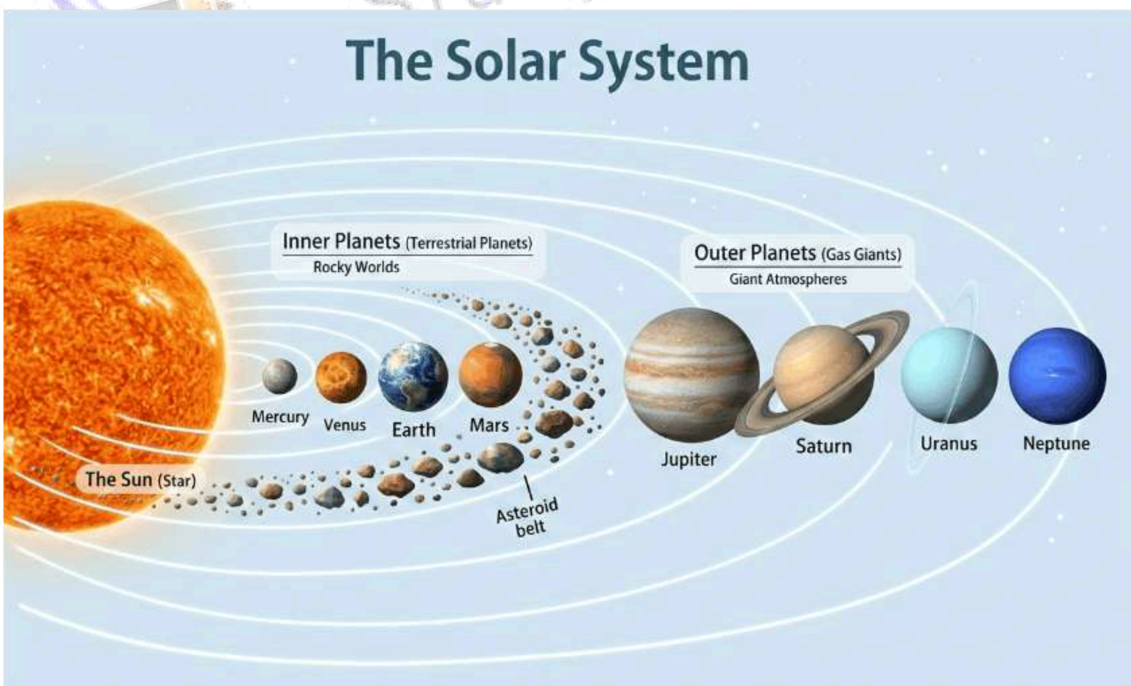
Formation of Planets

Planets are formed through a multi-stage process that begins in a nebula, which is a large cloud of gas and dust in space. The process involves the following steps:

1. **Star Formation:** Stars originate as dense clumps within a nebula. Gravity causes these clumps to collapse inward, forming a dense core. Around this core, a large spinning disc of gas and dust accumulates.
2. **Condensation and Formation of Planetesimals:** The gas and dust in the disc begin to condense, forming small, round solid objects. These objects stick together due to cohesion and gradually build up into larger bodies called planetesimals. Planetesimals are essentially many small solid objects that collide and stick together, growing in size due to the force of gravity.
3. **Growth into Planets:** Over time, these planetesimals merge with each other through successive collisions, forming fewer but much larger celestial bodies—these become the planets.

Our Solar System

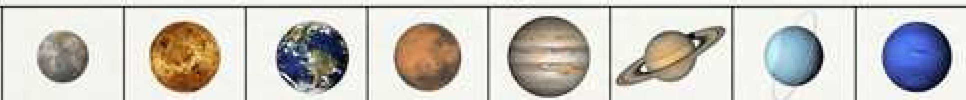
The solar system as we know it consists of the Sun at its center, eight planets, their moons, millions of smaller objects such as asteroids and comets, and a significant amount of dust and gases. The formation of the solar system began with the collapse of a nebula about 5 to 5.6 billion years ago, leading to the formation of the solar system's core. The planets themselves took shape around 4.6 billion years ago.
(Asteroids are primarily found within the main asteroid belt, which is located between the orbits of Mars and Jupiter.)



CLASSIFICATION OF PLANETS

The eight planets are divided into two groups based on their characteristics and positions:

The Solar System



	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Distance*	0.387	0.723	1.000	1.524	5.203	9.539	19.182	30.058
Density@	5.44	5.245	5.517	3.945	1.33	0.70	1.17	1.66
Radius#	0.383	0.949	1.000	0.533	11.19	9.460	4.11	3.88

* Distance from the sun in astronomical unit i.e. average mean distance of the earth is 149,598,000 km = 1
@ Density in gm/cm^3
\# Radius: Equatorial radius 6378.137 km = 1

1. Terrestrial (Inner) Planets:

- Mercury, Venus, Earth, and Mars are called inner or terrestrial planets.
- They are located between the Sun and the asteroid belt.
- Terrestrial planets are characterized by rocky surfaces, high density, and metal-rich compositions.
- They are relatively small compared to the outer planets.

2. Jovian (Outer) Planets:

- Jupiter, Saturn, Uranus, and Neptune are known as outer or Jovian planets (Jovian means Jupiter-like).
- They are much larger than terrestrial planets.
- Jovian planets have thick atmospheres composed mainly of hydrogen and helium.
- They formed farther from the Sun, where temperatures were low enough for gases to condense.

All eight planets formed around the same time, about 4.6 billion years ago. Pluto, initially considered the ninth planet, was reclassified as a dwarf planet by the International Astronomical Union in August 2006, along with other similar objects like 2003 UB313.

Differences between Terrestrial and Jovian Planets

- **Location of Formation:** Terrestrial planets formed close to the Sun where it was too hot for gases to condense into solids, whereas Jovian planets formed farther from the Sun where it was cooler.
- **Influence of Solar Wind:** The solar wind was strongest near the Sun, blowing away much of the gas and dust from the terrestrial planets. In contrast, the solar wind was weaker farther out, allowing Jovian planets to retain their thick gaseous envelopes.
- **Size and Gravity:** Terrestrial planets are smaller and their weaker gravity could not retain light gases, while Jovian planets are massive and can hold onto their atmospheres.

THE MOON

Earth has one natural satellite: the Moon. The origin of the Moon has long been a subject of scientific inquiry. In 1838, Sir George Darwin proposed that the Earth and the Moon were once a single rapidly spinning body that eventually split apart, with the material that formed the Moon coming from what is now the Pacific Ocean. However, this theory is no longer accepted by the scientific community.

MOON

The currently accepted theory is the Giant Impact Hypothesis, also known as "the big splat." According to this theory, shortly after the Earth formed, a Mars-sized body collided with Earth. This massive impact ejected a large amount of material into space, which began orbiting Earth. Over time, this debris coalesced and formed the Moon, an event estimated to have occurred about 4.44 billion years ago.

THE EVOLUTION OF EARTH

Earth has undergone significant transformations since its formation about 4.6 billion years ago. Initially, the planet was a hot, barren, and rocky mass, enveloped in a thin atmosphere mainly composed of hydrogen and helium. This early stage looked nothing like the Earth we see today, indicating that a series of extensive geological and atmospheric changes occurred to convert this lifeless body into a planet with water, a stable atmosphere, and diverse life forms.

EARTH

STRUCTURE OF THE EARTH

Earth is not uniform in composition. Instead, it is made up of several distinct layers, each with its own properties. From the outermost atmosphere to the core, the materials become increasingly dense as one moves inward. The surface is covered by a relatively thin crust, beneath which lies the denser mantle, followed by the even denser outer and inner cores. The atmosphere itself is the lightest and forms the outermost layer, while the innermost core is the densest.

EVOLUTION OF THE LITHOSPHERE

In its early stages, Earth was extremely hot and chaotic. As the internal density increased, the planet's temperature also rose, causing the materials inside to separate according to their densities. Heavier elements like iron and nickel sank towards the center, forming the core, while lighter materials rose and accumulated near the surface. This process of differentiation led to the formation of distinct layers: the crust, mantle, and core.

A major event in Earth's history was the formation of the Moon, which is believed to have resulted from a massive collision between Earth and another celestial body. This impact reheated the Earth and contributed to further differentiation and restructuring of the planet's layers. Over time, as the planet cooled, the outermost layer solidified into a rigid crust, giving rise to the lithosphere. The deeper the layer, the greater its density.

EVOLUTION OF THE ATMOSPHERE AND HYDROSPHERE

Earth’s atmosphere has evolved through three primary stages. Initially, Earth possessed a hydrogen-helium atmosphere, inherited from the solar nebula. However, this primordial atmosphere was stripped away by strong solar winds—a fate shared by the other rocky planets.

The second stage began as the Earth cooled and volcanic activity released gases in a process called degassing. Volcanic eruptions contributed water vapor, nitrogen, carbon dioxide, methane, ammonia, and only minimal amounts of free oxygen to the atmosphere. This accumulation of gases built a denser and more complex atmosphere over time.

As the planet’s surface temperature dropped, water vapor started to condense, leading to rainfall. Rain dissolved atmospheric carbon dioxide, which further reduced the temperature and allowed more water vapor to condense. Over time, this continuous process led to the accumulation of water in low-lying areas, forming the first oceans. Earth’s oceans are estimated to have formed around 4 billion years ago, only about 500 million years after the planet itself formed.

DEVELOPMENT OF LIFE AND OXYGENATION

Life began in the newly formed oceans relatively soon after their appearance. The earliest known life forms emerged around 3.8 billion years ago. For a long period, all life remained aquatic.

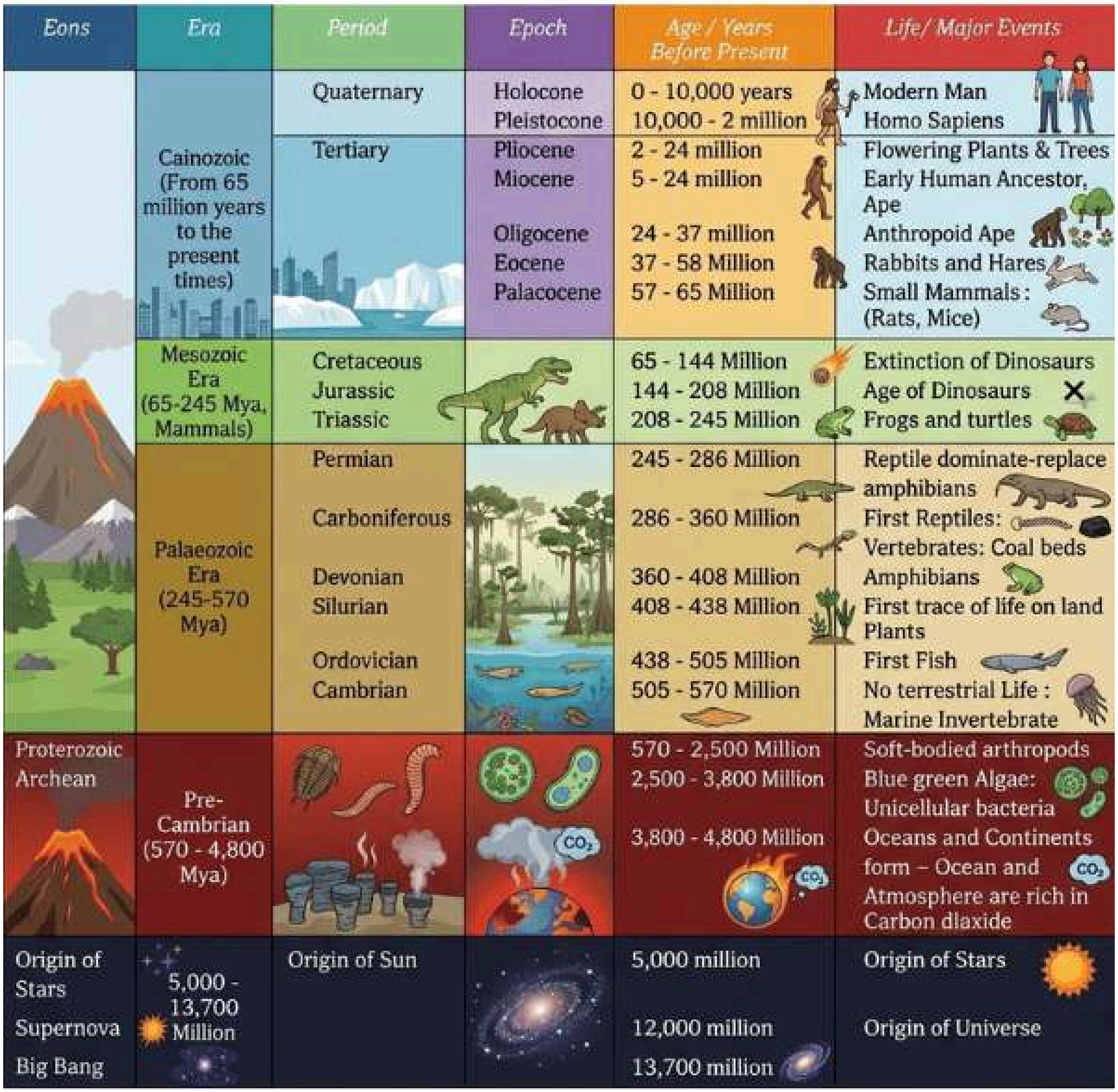
A major turning point occurred between 2.5 and 3 billion years ago with the evolution of photosynthesis. Simple organisms developed the ability to convert sunlight into energy, releasing oxygen as a byproduct. Initially, this oxygen accumulated in the oceans. Once the oceans became saturated, excess oxygen began to enter the atmosphere around 2 billion years ago. This rise in atmospheric oxygen dramatically altered the planet’s environment and paved the way for the evolution of more complex life forms.

ORIGIN OF LIFE

The emergence of life on Earth represents a fundamental chapter in its history. Early Earth and its atmosphere were inhospitable to life as we know it. Scientific evidence suggests that life originated through a series of chemical reactions that produced increasingly complex organic molecules. Over time, some of these molecules organized themselves in ways that enabled them to exhibit the characteristics of living organisms.

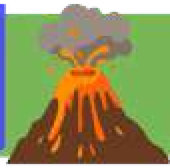
The study of ancient rocks has revealed fossil evidence of some of the earliest life forms. Fossils resembling today’s blue-green algae (cyanobacteria) have been discovered in rocks over 3 billion years old, indicating that life on Earth began at least 3.8 billion years ago.

ILLUSTRATED GEOLOGICAL TIME SCALE & LIFE FORMS



Eons	Era	Period	Epoch	Age / Years Before Present	Life/ Major Events
	Cainozoic (From 65 million years to the present times)	Quaternary	Holocene Pleistocene	0 - 10,000 years 10,000 - 2 million	Modern Man Homo Sapiens
		Tertiary	Pliocene Miocene Oligocene Eocene Palacocene	2 - 24 million 5 - 24 million 24 - 37 million 37 - 58 Million 57 - 65 Million	Flowering Plants & Trees Early Human Ancestor, Ape Anthropoid Ape Rabbits and Hares Small Mammals : (Rats, Mice)
	Mesozoic Era (65-245 Mya, Mammals)	Cretaceous Jurassic Triassic		65 - 144 Million 144 - 208 Million 208 - 245 Million	Extinction of Dinosaurs Age of Dinosaurs Frogs and turtles
	Palaeozoic Era (245-570 Mya)	Permian Carboniferous Devonian Silurian Ordovician Cambrian		245 - 286 Million 286 - 360 Million 360 - 408 Million 408 - 438 Million 438 - 505 Million 505 - 570 Million	Reptile dominate-replace amphibians First Reptiles: Vertebrates: Coal beds Amphibians First trace of life on land Plants First Fish No terrestrial Life : Marine Invertebrate
Proterozoic Archean	Pre-Cambrian (570 - 4,800 Mya)			570 - 2,500 Million 2,500 - 3,800 Million 3,800 - 4,800 Million	Soft-bodied arthropods Blue green Algae: Unicellular bacteria Oceans and Continents form – Ocean and Atmosphere are rich in Carbon dlaxide
Origin of Stars Supernova Big Bang	5,000 - 13,700 Million	Origin of Sun		5,000 million 12,000 million 13,700 million	Origin of Stars Origin of Universe

Chapter 2



Interior of the Earth

No human has ever reached the center of the Earth, and it is extremely unlikely that anyone ever will. The depths of the planet are simply inaccessible with current technology. As a result, all knowledge about the Earth's inner structure is based on indirect evidence and observations rather than direct exploration. Despite these limitations, understanding the Earth's interior is crucial. The processes occurring deep within the planet have a significant impact on the Earth's surface features and phenomena. Both external forces like wind and rain, and internal forces such as earthquakes and volcanic eruptions, are constantly at work shaping the planet. Ignoring the underground dynamics would mean missing a major part of the story regarding the Earth's landscape, which affects human settlements, agriculture, and even urban development. To fully understand natural disasters like earthquakes and tsunamis, it is essential to study what happens inside the Earth.

SOURCES OF INFORMATION ABOUT THE INTERIOR OF THE EARTH

The Earth has a radius of about 6,370 kilometers from the surface to the center. Reaching these depths is beyond current human capability. Therefore, scientists rely on a combination of direct and indirect sources of information to study the Earth's interior.

Direct Sources

1. **Surface Rocks and Soil:** The most accessible materials for study are present at the Earth's surface. Scientists examine rocks, soils, and materials obtained from mines to gather information about the composition and characteristics of the uppermost layers.

2. **Mining:** Deep mining operations, such as gold mines in South Africa, reach depths of around 3 to 4 kilometers. However, these depths are limited by extreme heat and pressure, making it impossible to go much further.

3. **Drilling Projects:** To probe deeper, scientists have initiated large-scale drilling projects. Notable examples include the Deep Ocean Drilling Project (DODP) and the Integrated Ocean Drilling Project (IODP), which aim to extract samples from beneath the ocean floor. The deepest drilling achieved so far is the Kola Superdeep Borehole near the Arctic Ocean, which reached approximately 12 kilometers below the surface. Despite this achievement, it is still only a tiny fraction compared to the full distance to the Earth's center.

4. **Volcanic Eruptions:** Volcanic activity provides another direct source of information. During eruptions, magma from inside the Earth reaches the surface, solidifies as lava, and can be collected and analyzed. However, it is not always possible to determine the exact depth from which the magma originated.

Indirect Sources

1. **Geothermal Gradient:** Observations from mining and drilling reveal that both temperature and pressure increase with depth. Material density also rises as you go deeper. By carefully measuring these gradients and combining this data with the Earth's overall size, scientists can estimate temperature, pressure, and density profiles throughout the planet's interior.

2. **Meteorites:** Occasionally, meteorites—rocks from space—fall to Earth. Although they are not fragments of our planet, their composition is considered similar to the material that formed the Earth. Studying meteorites provides valuable clues about the probable internal composition of the Earth.

3. **Gravity Measurements:** Gravity is not uniform across the Earth's surface. It is generally stronger at the poles and weaker at the equator due to the planet's equatorial bulge. Variations in subsurface material, such as the presence of dense rock bodies, affect local gravity readings. Unexpected deviations in gravity, called gravity anomalies, suggest the existence of unusual features or materials beneath the surface.

4. **Magnetic Surveys:** The Earth's magnetic field also provides indirect information. By mapping variations in magnetic intensity, scientists can infer the distribution and types of magnetic rocks underground.

5. **Seismic Waves:** The most important and detailed information about the Earth's interior comes from the study of seismic waves generated by earthquakes. These waves travel through the Earth and are detected by seismographs around the globe. Their speed and direction change depending on the properties of the materials they pass through. By analyzing the way seismic waves travel, reflect, and refract, scientists have been able to construct models of the Earth's internal structure, identifying distinct layers such as the crust, mantle, and core.

EARTHQUAKE

An earthquake is a natural phenomenon characterized by the shaking of the ground. This shaking occurs when energy stored underground is suddenly released, sending seismic waves in all directions. By studying seismic waves, scientists can better understand the processes occurring within the Earth.

Causes of Earthquakes

The primary cause of an earthquake is the sudden release of energy along a fault—a fracture or crack in the Earth's crust. Rocks on either side of a fault are subjected to forces that make them want to move in opposite directions, but friction and the weight of overlying rocks keep them locked together. Over time, pressure builds up until it exceeds the strength of the rocks and frictional resistance, causing the rocks to slip suddenly. This slip releases energy, which radiates outward in the form of seismic waves.

Key Terms

- **Focus (Hypocentre):** The point beneath the Earth's surface where the earthquake originates and energy is released.

PART B

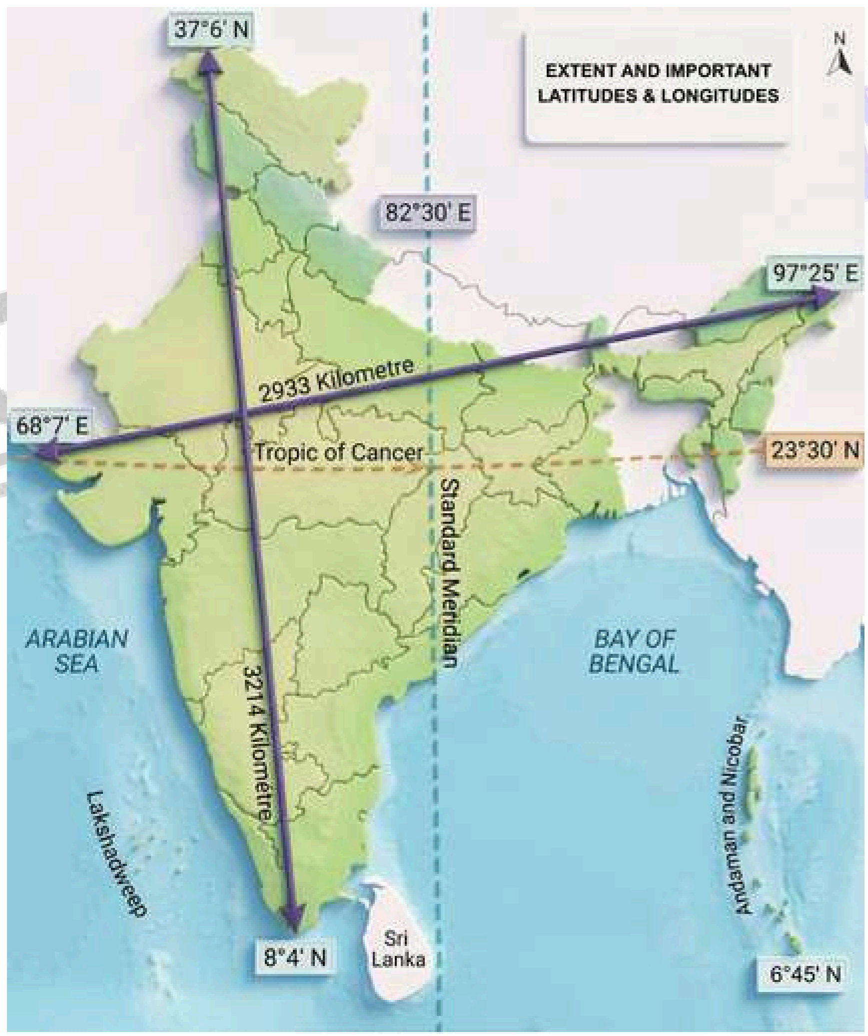
INDIA


Norwegian Sea
White Sea
Murmansk
Arkhangelsk
SWEDEN
FINLAND
NORWAY
G. of Bothnia
Luleå
Trondheim
Shetland Is.
Orkney Is
Bergen
Tampere
Turku
Helsinki
Vyborg
L. Ladoga
L. Onega
ST PETERSBURG
Vologda
AUSTRIA
SWITZERLAND
HUNGARY
Budapest
ROMANIA
SLOVENIA
CROATIA
BOSNIA-HERZ.
SERBIA &
MONTENEGRO
BULGARIA
MACEDONIA
ALBANIA
GREECE
ITALY
Adriatic Sea
Tyrrhenian Sea
Ionian Sea
Black Sea
Crimea
Sevastopol
ISTANBUL
Ankara
Sicily
Sardinia
Corsica
Majorca
Minorca
Barcelona
Marseilles
Toulon
Nice
MONACO
Genoa
Milan
Turin
Venice
Bologna
Florence
Rome
Naples
Bari
Taranto
Palermo
Messina
Catania
Cagliari
Belgrade
Sarajevo
Split
Zagreb
Ljubljana
Trieste
Sofia
Skopje
Tirana
Thessaloniki
Athens
Patrai
Bucharest
Timişoara
Cluj-Napoca
Braşov
Ploieşti
Galaţi
Constanţa
Varna
Plovdiv
Niš
Debrecen
Kishinev
Odessa
Nikolayev
Bosporus
Bursa
İzmir
Konya
Antalya
Adana
Kayseri
Samsun
TUNISIA
Tunis
Annaba
Constantine
Pantelleria
Graz
Salzburg
Innsbruck
Geneva
Bern
Lyons
St-Étienne
Grenoble
Ajaccio
Corfu
Mediterranean Sea

Chapter 1

India - Location and Geographical Extent

India sits between 8°4' and 37°6' north latitude and stretches from 68°7' to 97°25' east longitude. On a map, though, the country doesn't look like a perfect rectangle. If you measure it out, the journey from Kashmir in the north all the way down to Kanniyakumari at the southern tip is around 3,214 km—actually longer than the width from the Rann of Kachchh in the west to Arunachal Pradesh in the east, which measures about 2,933 km. That's because lines of longitude bunch up as you head toward the poles, while latitude lines keep their distance no matter where you are. If you go even farther south, India's territory actually dips down to Indira Point in the Andaman and Nicobar Islands at 6°45' north latitude. And if you look out to sea, India's boundary stretches 12 nautical miles—about 21.9 km—from the coast.



There's a 30-degree gap in longitude between Saurashtra in the west and Arunachal Pradesh in the east. Since Earth spins 360° in 24 hours, every single degree of longitude marks a four-minute difference in local time. So, when it's sunrise in Saurashtra, Arunachal Pradesh has already been awake for a couple of hours—the sun's high in the sky there.

To avoid confusion, India goes by a single time zone: Indian Standard Time, which is set at 82°30' east longitude. That puts IST 5 hours and 30 minutes ahead of Greenwich Mean Time (GMT). The choice is actually pretty straightforward; most countries pick standard meridians in multiples of 7°30' so the math stays simple—time differences are easy to figure out in half-hour steps. Thanks to IST, everyone in India sets their clocks the same way, even though sunrise comes much earlier in the northeast than in places like Jaisalmer.

India covers 3.28 million square kilometers, which is about 2.4% of the world's land area. That makes it the seventh largest country, right after Russia, Canada, China, the USA, Brazil, and Australia. The Tropic of Cancer runs right through the middle.

On land, India shares a border of 15,106 km with its neighbors: Bangladesh,Myanmar,China, Nepal,Bhutan,Pakistan and Afghanistan.

Except for Madhya Pradesh, Chhattisgarh, Jharkhand, Delhi, Haryana, and Telangana, every other state in India either has an international border or is coastal. So, most states actually count as frontline states when it comes to border management.

India shares its longest border with *Bangladesh* and its shortest with *Afghanistan*.

BORDERING COUNTRIES OF INDIA

Name of the country	Length of the border (in Km)
Bangladesh	4,096.7
China	3,488
Pakistan	3,323
Nepal	1,751
Myanmar	1,643
Bhutan	699
Afghanistan	106
Total	15,106.7

The India-Bangladesh Border

India's border with Bangladesh stretches for 4,096 kilometers—the longest international boundary India has. This line was drawn during the partition of Bengal under the Radcliffe Award.

Five Indian states border Bangladesh. West Bengal accounts for the largest share, around 2,216.7 kilometers. Assam, Meghalaya, Tripura, and Mizoram make up the rest.

Border with China

India's border with China comes in second in terms of length, just after the Bangladesh boundary. Five states touch this border: Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh.

The India-Nepal Boundary

Five Indian states—Uttarakhand, Uttar Pradesh, Bihar, West Bengal, and Sikkim—share a boundary with Nepal. People and goods move pretty freely across this border, with few restrictions.

India-Myanmar Boundary

The India-Myanmar border mostly follows the watershed between the Brahmaputra and Irrawaddy rivers. Four states line this 1,643-kilometer boundary: Arunachal Pradesh, Nagaland, Manipur, and Mizoram.

The India-Bhutan Boundary

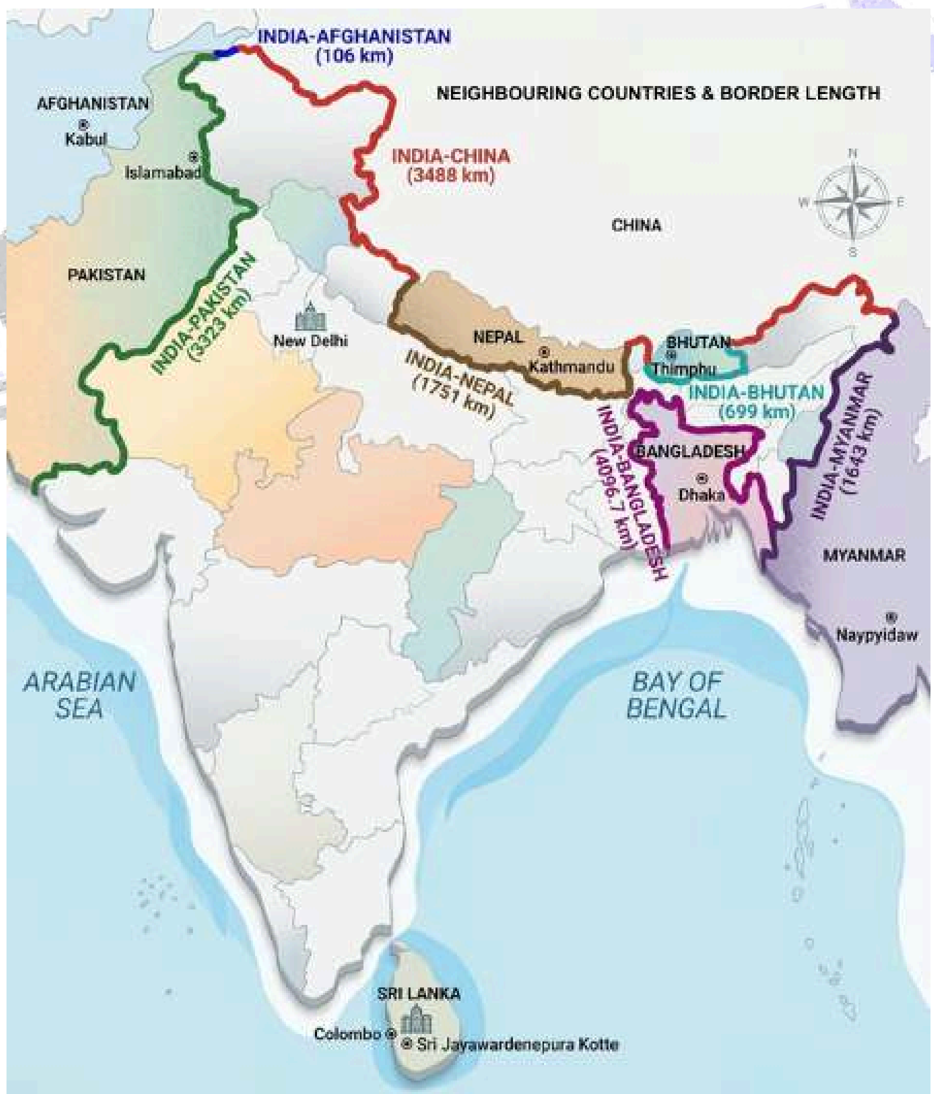
India and Bhutan share a 699-kilometer border, touching Assam, Arunachal Pradesh, West Bengal, and Sikkim.

The Indo-Pakistan Boundary

This border came out of the 1947 partition, marked by the Radcliffe Award with Sir Cyril Radcliffe in charge. The border runs along Gujarat, Rajasthan, Punjab, Jammu & Kashmir, and Ladakh.

The Indo-Afghanistan Boundary

Only Ladakh, a Union Territory, shares a border with Afghanistan. It's the shortest of all India's international boundaries.



India's sheer size gives it a wild mix of landscapes. Up north, you've got those towering mountains. The big rivers—Ganga, Brahmaputra, Mahanadi, Krishna, Godavari, Kaveri—snake their way through the land. In the northeast and down south, the hills are thick with forests, while Rajasthan's Marusthali is all endless, golden sand.

Look at a map and you'll see how India is boxed in: the Himalayas stand guard in the north, with the Hindukush and Sulaiman ranges off to the northwest, and the Purvachal hills over in the northeast. The Indian Ocean spreads out to the south, wrapping it all up. Together, these borders form what we call the Indian subcontinent. It's not just India—Pakistan, Nepal, Bhutan, and Bangladesh are all part of it too.

For ages, the Himalayas and other ranges were more than just a backdrop. They were walls. Only a handful of mountain passes—like Khyber, Bolan, Shipkila, Nathula, Bomdila—let people through. Getting across wasn't easy. All these natural borders helped shape the distinct identity of the subcontinent, setting it apart from the lands beyond.

India's peninsula stretches out into the Indian Ocean, giving the country a long stretch of coastline—about 6,100 km along the mainland, and around 7,500 km when you count the islands too. The Andaman and Nicobar Islands sit out in the Bay of Bengal, while Lakshadweep lies in the Arabian Sea. With all this, India's landscape is incredibly diverse, which means the country is packed with all sorts of different resources.

India's coastline isn't what it used to be. Back in 1970, it measured 7,516 km. Fast forward to 2023-24, and it's jumped to 11,098 km—that's a 47.6% increase. So, what's behind this leap? Honestly, it's not that the land is stretching out. Scientists just started using new ways to measure all the twists, turns, and features along the shore.

Let's break it down by state and union territory. Gujarat stands out. Its coastline grew from 1,214 km to 2,340 km—the biggest jump in actual kilometers. It's still the state with the longest coastline in the country.

Now, West Bengal is interesting. The state's coastline increased sharply by 357%. It used to be just 157 km, and now it's 721 km. That's the biggest percentage jump of any state.

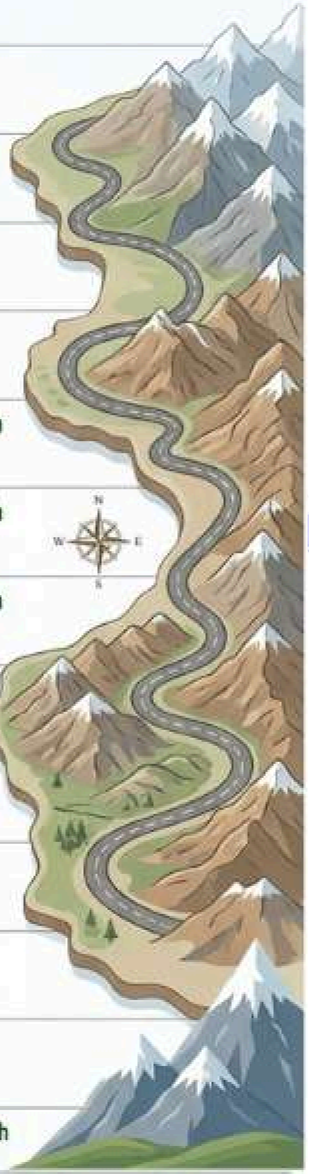
Tamil Nadu's numbers also changed. Its coastline now measures 1,068 km, up from 906 km. That's enough for Tamil Nadu to move ahead of Andhra Pradesh in the rankings.

Not everyone saw big changes. Kerala barely budged, adding just 30 km, which is only a 5% increase. Puducherry actually lost coastline—down 4.9 km, about a 10.4% drop. Erosion and more precise calculations are to blame.

So, while most states saw their numbers climb, Puducherry's coastline got a bit shorter, mostly thanks to erosion and updated measuring techniques. Across the rest of India, though, the trend is clear: with better tools, the coastline just keeps getting longer.

PASSES IN INDIA

Karakoram	Jammu Kashmir
Zoji La	Ladakh
Pir Panjal	Jammu Kashmir
Banihal	Jammu Kashmir
Burzil	Jammu Kashmir
Shipki La	Himachal Pradesh
Rohtang La	Himachal Pradesh
Baralacha La	Himachal Pradesh
Lipulekh	Uttarakhand
Mana	Uttarakhand
Niti	Uttarakhand
Nathu La	Sikkim
Jelep La	Sikkim
Bomdila	Arunachal Pradesh
Yangyap	Arunachal Pradesh
Diphu	Arunachal Pradesh
Tuju	Manipur



Chapter 2 Structure & Physiography

The landforms we see around us did not simply emerge all at once. Earth's been changing for ages—about 460 million years, give or take. Over all that time, it's been shaped by powerful forces from inside and outside the planet. These forces—endogenic and exogenic—have carved out everything from deep valleys to towering mountains, both above and below the surface.

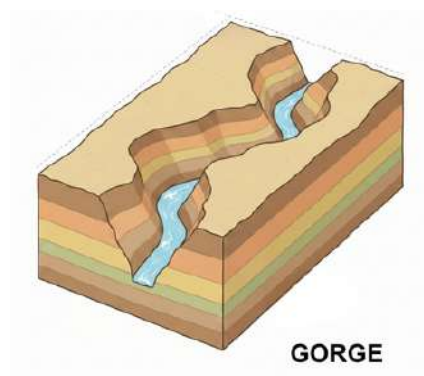
A long time ago, the Indian plate sat far south of the equator. It was huge back then, and the Australian plate was actually part of it. As millions of years passed, this massive plate split apart. The Australian plate drifted southeast, while the Indian plate pushed north. That northward trek? It's still happening, and it has a big impact on the Indian subcontinent's landscape.

So, thanks to the constant push and pull of these forces and the shifting plates, India's current landforms came to be. If you look at the country's geology, you can break it down into three big regions, each with its own features:

1. **The Himalayas.**
2. **The Indo-Ganga-Brahmaputra Plain.**
3. **The Peninsular Block.**

THE HIMALAYAS AND OTHER PENINSULAR MOUNTAINS

The Himalayas, together with other mountains in the Peninsula, are a different story. Unlike the solid, unyielding Peninsular Block, these mountains are young, geologically speaking. They're still weak and flexible. That means they're always changing, shaped by forces both inside and outside the Earth. This constant push and pull creates faults, folds, and thrust plains. These mountains shot up because of tectonic activity, and fast-flowing rivers—still in their wild, youthful stage—cut through them. That's why you see landforms like deep gorges, steep V-shaped valleys, rapids, and waterfalls all over this region.



The Himalayas

The Himalayas are a young set of fold mountains that formed when two giant tectonic plates bumped into each other. These mountains are a major feature of India, not just because of their height, but also because they protect the country like a natural barrier. The Himalayas separate the Tibetan Plateau in the north from India's plains in the south.

How did the Himalayas come to be? Millions of years ago, the Indo-Australian Plate collided with the Eurasian Plate. This huge crash caused the Himalayas to rise up.

From west to east, the Himalayas can be divided into three main parts:

1. **The Trans-Himalayas**
2. **The Main Himalayan Ranges**
3. **The Eastern Hills, also known as the Purvanchal**

The Trans-Himalayas

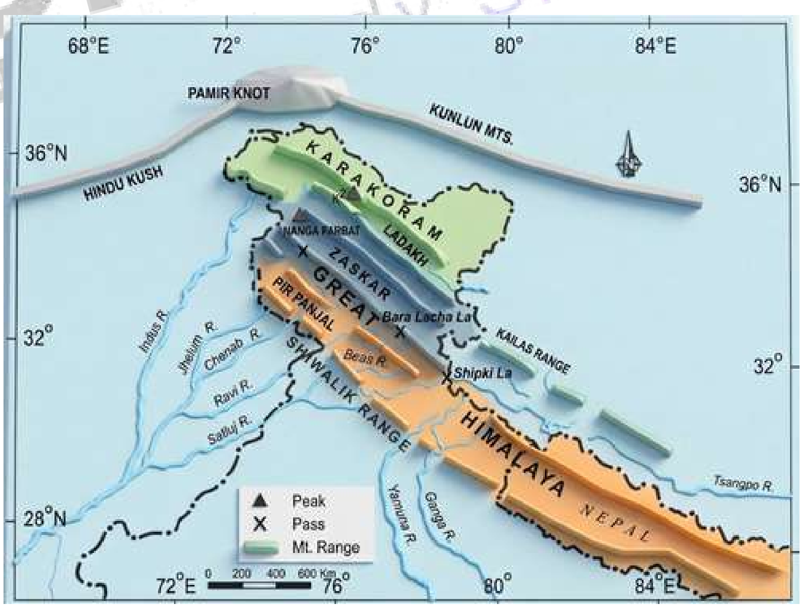
First, the Trans-Himalayas. This group lies just north of the main Himalayas and runs east to west for about 1,000 kilometers. These mountains are usually about 3,000 meters high. The main ranges here are the Karakoram, Ladakh, and Zaskar.

The Karakoram Range forms the northern border of the Trans-Himalayas in India, near Afghanistan and China. It's about 110 to 130 kilometers wide and is home to some of the highest peaks and largest glaciers in the world. K2, or Mount Godwin-Austen, is found here and is the second highest mountain in the world at 8,611 meters. The Siachen and Remo Glaciers are also located in this region.

The Ladakh Range starts near the mouth of the Shyok River in north Kashmir and heads southeast towards the border with Tibet. Some also include the Deosai Mountains in Pakistan-occupied Kashmir as part of this range, and the Kailash Range in Tibet is thought to be its westward extension.

Next is the Zaskar Range, which runs almost parallel to the main Himalayas. It stretches from the Suru River to the upper Karnali River. Kamet Peak is the highest here, reaching 25,446 feet.

The Main Himalayan Ranges



Now, the main Himalayan Range, also known as Himadri or Himavan, is the youngest mountain range on Earth. It mostly consists of sedimentary and metamorphic rocks that have been uplifted over time. The Karakoram and Hindu Kush are to its northwest, the Tibetan Plateau is to the north, and the Indo-Gangetic Plains are to the south. The southern side is easy to see because of its foothills, while the northern side blends into the Tibetan Plateau.

The main Himalayas extend for more than 2,400 kilometers, from the Indus Gorge in the west to the Brahmaputra Gorge in the east. They are wider in the west than in the east. On average, these mountains rise to about 6,100 meters. The western Himalayas rise gradually, but the eastern side climbs up very sharply.

The main Himalayas are divided into three smaller parts:

1. **The Greater Himalayas,**
2. **The Inner or Middle Himalayas,**
3. **The Shiwalik.**

1. The Greater Himalayas

The Greater Himalayas, also called the Himadri or Central Himalayas, are made up of old rocks like granite and gneiss. The direction of these mountains changes as they move through different areas—traveling southeast through northern Pakistan, northern India, and Nepal, then curving east in Sikkim and Bhutan, and finally turning northeast in Arunachal Pradesh. This area has some of the tallest peaks in the world, including Nanga Parbat, Mount Everest, Kanchenjunga, and Namcha Barwa. The northern slopes are very steep, while the southern slopes are more gentle.

2. The Inner or Middle Himalayas

Also known as the Lesser or Lower Himalayas, these mountains reach heights of about 3,500 to 5,000 meters and are around 60 to 80 kilometers wide. Well-known ranges in this area include Nag Tibba, the Mahabharat Range, Dhauladhar, Pir Panjal, and the Mussoorie Range. Important rivers, such as the Jhelum and Chenab, flow through these mountains.

Between the Pir Panjal and Zanskar ranges lies the Kashmir Valley, a famous region shaped by the Jhelum River. The Middle Himalayas are home to popular hill stations like Shimla, Chail, Ranikhet, Chakrata, Nainital, and Almora. Another key feature of this region is the presence of Karewas, which are thick deposits of layered sediment found especially between the Greater Himalayas and the Middle Himalayas near Pir Panjal.

3. The Shiwalik or Outer Himalayas

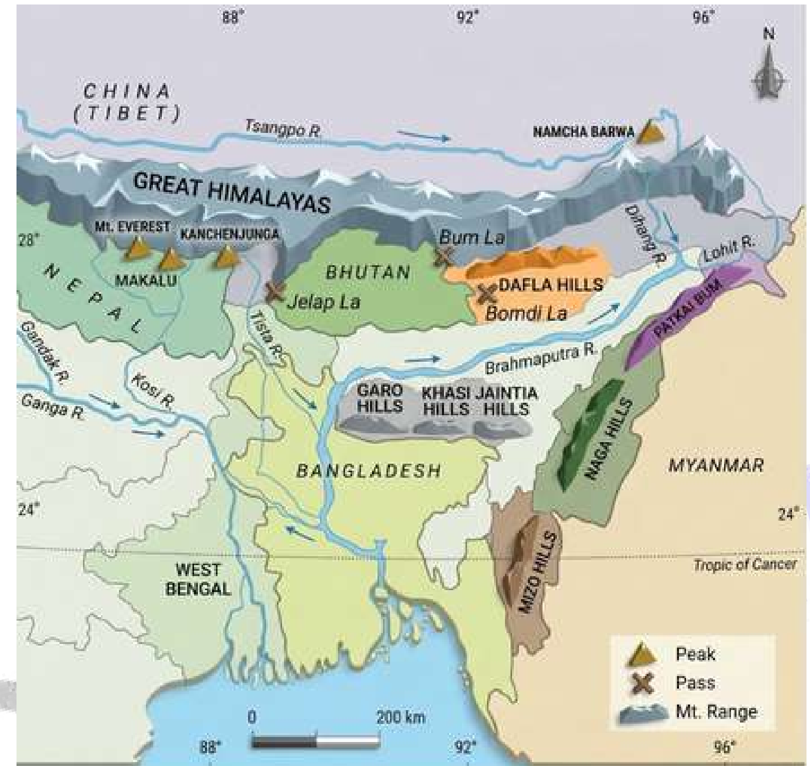
The Shiwalik Hills form the southernmost part of the Himalayas, lying between the Middle Himalayas and the Indo-Gangetic Plains. They rise sharply from the flat plains of the Indus and Ganges rivers and run parallel to the main Himalayan range, with valleys separating them from the larger mountains. In Nepal, these hills are called the Churia Range.

The Shiwaliks are wider in the west than in the east. A special feature of these hills is the creation of Doons and Duars. When the Shiwaliks were formed, they blocked river flow and created temporary lakes. Eventually, the rivers broke through, draining the lakes and leaving behind fertile alluvial soil. These areas are called Doons in the west and Duars in the east, both of which are excellent for tea cultivation.

EASTERN HILLS (PURVANCHAL) AND REGIONAL DIVISIONS OF THE HIMALAYAS

Eastern Hills or Purvanchal

At the Dihang Gorge, the Himalayas take a sharp turn to the south, forming what is called the Syntaxial Bend. After this bend, a series of lower hills called the Purvanchal extend through India's far eastern region. The Purvanchal stretches from Arunachal Pradesh in the north to Mizoram in the south, running along the border with Myanmar.



Main Ranges of Purvanchal:

- **Patkai Bum:** The northernmost range, located on the border between Arunachal Pradesh and Myanmar.
- **Naga Hills:** Found just south of Patkai Bum, both these ranges form the watershed between India and Myanmar.
- **Manipur Hills:** Located further south of the Naga Hills, separated from them by the Barail Range.
- **Mizo (Lushai) Hills:** The southernmost hills, lying below the Manipur Hills.

Regional Divisions of the Himalayas

When looking at the Himalayas from west to east, they can be divided into four main regions:

1. **Punjab Himalayas**
   - Stretch between the Indus River (west) and the Sutlej River (east).
   - Cover most of Jammu and Kashmir and Himachal Pradesh.
   - Also known as Kashmir and Himachal Himalayas.
   - Main ranges: Karakoram, Pir Panjal, Ladakh, Zanskar, and Dhauladhar.
   - Famous for high, snow-covered peaks, deep valleys, and difficult passes.

2. **Kumaon Himalayas**