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Union Public Service Commission

GS PAPER - 1

VOLUME - 6

Indian Geography

SIERRA INNOVATIONS

INDEX

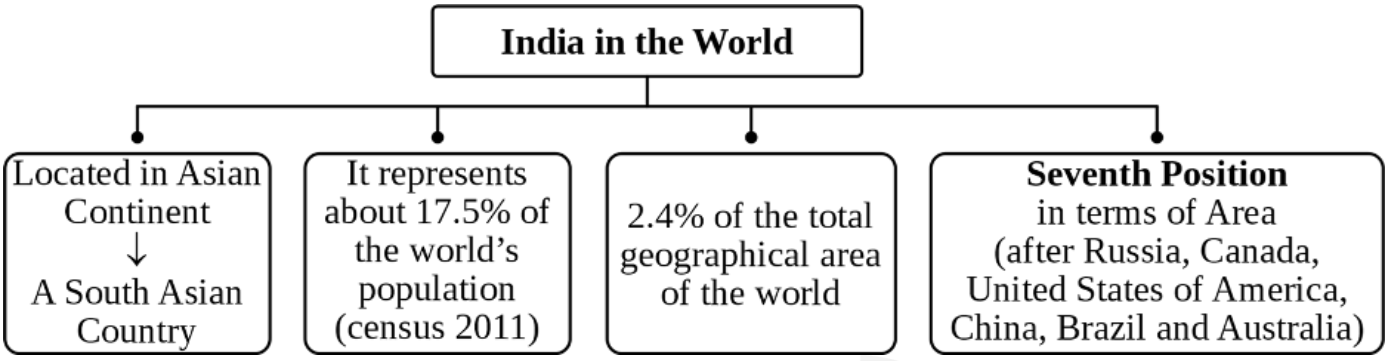
Previous Year Questions

Year	Questions
2013	Analyze the factors for highly decentralized cotton textile industry in India
2013	Do you agree that there is a growing trend of opening new sugar mills in the Southern states of India? Discuss with justification
2014	Why did the Green Revolution in India virtually by-pass the eastern region despite fertile soil and good availability of water?
2014	Account for the change in the spatial pattern of the Iron and Steel industry in the world.
2014	Whereas the British planters had developed tea gardens all along the Shivaliks and Lesser Himalayas from Assam to Himachal Pradesh, in effect they did not succeed beyond the Darjeeling area. Explain.
2015	Explain the factors responsible for the origin of ocean currents. How do they influence regional climates, fishing and navigation?
2017	Petroleum refineries are not necessarily located nearer to crude oil producing areas, particularly in many of the developing countries. Explain its implications.
2018	What is the significance of Industrial Corridors in India? Identify industrial corridors, explain their main characteristics.
2018	Define blue revolution, explain the problems and strategies for pisciculture development in India.
2019	Discuss the factors for localization of agro-based food processing industries of North-West India.
2020	Account for the present location of iron and steel industries away from the source of raw material, by giving examples.
2021	Despite India being one of the countries of the Gondwanaland, its mining industry contributes much less to its Gross Domestic Product (GDP) in percentage. Discuss.
2022	What are the forces that influence ocean currents? Describe their role in fishing Industry of the world.
2022	Mention the significance of straits and isthmus in international trade.
2023	From being net food importer in 1960s, India has emerged as a net food exporter to the world. Provide reasons.
2025	How can Artificial Intelligence (AI) and drones be effectively used along with GIS and RS techniques in locational and areal planning?
2025	How do account for the growing food industry's links with increased health concerns in modern society? Illustrate your answer with the Indian experience.
2025	What are non-farm primary activities? How are these activities related to physiographic features in India? Discuss with suitable examples.
2025	Give a geographical explanation of the distribution of off-shore oil reserves of the world. How are they different from the on-shore occurrences of oil reserves?

1 CHAPTER

Geographical Setting of India

India is located in South Asia, stretching from the Himalayas in the north to the Indian Ocean in the south. Its diverse geographical features include mountains, plains, plateaus, deserts, and coastal areas, contributing to rich ecological and cultural variety.



India as a Geographical Unit

1. **Geographical Extent**
   - ✓ **Latitudinal Spread:** 8° 4′ N (southern tip) to 37° 6′ N (northern edge).
   - ✓ **Longitudinal Spread: 68° 7′ E** (western edge) **to 97° 25′ E** (eastern edge).
   - ✓ **North-South distance:** 3214 km
   - ✓ **East-west distance:** 2973 km
   - ✓ Comprises 28 states and 8 Union territories.
2. **Extreme Points of India**
   - ✓ **Northernmost Point:** Indira Col, located in the **Siachen Glacier** (J&K)
   - ✓ **Southernmost Point:**
     - Indira Point, **Great Nicobar Island** (Andaman Sea)
     - Kanyakumari, Southernmost point of **mainland India**
   - ✓ **Easternmost Point:** Kibithu, a remote town in **Arunachal Pradesh**
   - ✓ **Westernmost Point:** Ghuar Moti, situated in **Kutch district**, Gujarat
3. **Border Details**
   - ✓ **Total Land Border Length:** 15,106.7 km shared with neighbouring countries.
   - ✓ **Total Coastline Length:**
     - Approx. 7,516.6 km along the mainland, islands, and bays.
     - Revised coastline (including tidal inlets): 11,098 km.
     - Territorial Waters: Extend 12 nautical miles (22.2 km) from the coast.
   - ✓ **Total International Neighbours:** 7 (land); 9 (including maritime)
   - ✓ **Longest Border:** With Bangladesh
   - ✓ **Shortest Border:** With Afghanistan (via PoK)

Neighbouring Countries of India & Bordering States

Country	Border States
Bangladesh	West Bengal, Assam, Meghalaya, Tripura, Mizoram
China	J&K, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh
Pakistan	Jammu & Kashmir, Punjab, Rajasthan, Gujarat, Ladakh
Nepal	Bihar, Uttarakhand, Uttar Pradesh, Sikkim, West Bengal
Myanmar	Arunachal Pradesh, Nagaland, Manipur, Mizoram
Bhutan	Sikkim, Arunachal Pradesh, Assam, West Bengal
Afghanistan	Ladakh (POK)

4. Key Parallels and Meridians

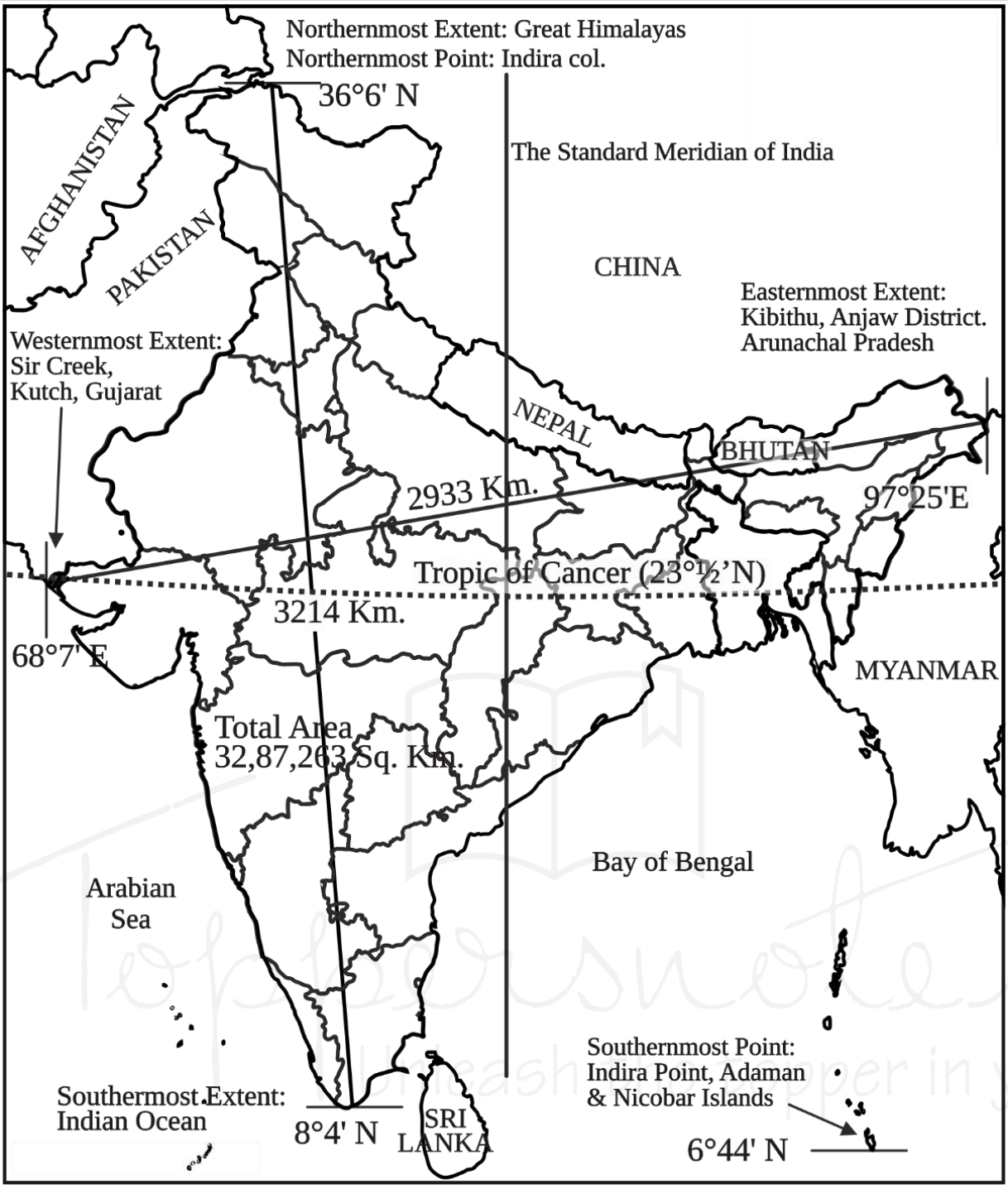
- ✓ **Tropic of Cancer:**
  - Divides India into 2 climatic zones
    - ☞ Tropical Zone: South of the tropic
    - ☞ Subtropical Zone: North of the Tropic
  - Passes through 8 states → Gujarat, Rajasthan, MP, Chhattisgarh, Jharkhand, West Bengal, Tripura & Mizoram
- ✓ **Standard Meridian:**
  - Defines Indian Standard Time.
  - It crosses UP, Chhattisgarh, Odisha, MP & Andhra Pradesh.
  - Despite India's wide east–west spread, the entire country follows a single time zone for administrative convenience and uniformity.

The Greenwich Meridian, or 0° longitude:

- ➢ It does not pass through India. Instead, India follows its own Standard Meridian located at 82.5° East longitude, which passes near Mirzapur in Uttar Pradesh.
- ➢ This meridian is used to determine Indian Standard Time (IST), which is 5 hours and 30 minutes ahead of Greenwich Mean Time (GMT+5:30).
- ➢ Despite India's wide east-west geographical spread, the country maintains a single time zone for administrative convenience.
- ➢ This standardization helps ensure uniform time across all states and union territories.

Important International Boundary lines

Boundary Line	Between Countries
Radcliffe Line	India and Pakistan
MacMohan Line	India and China
Durand Line	Pakistan and Afghanistan
49th Parallel	USA and Canada (longest border)
38th Parallel	North Korea and South Korea
Hindenburg Line	Germany and Poland
Maginot Line	France and Germany
Oder-Neisse Line	Germany and Poland



From snow-capped mountains to sun-kissed beaches, India's geography is as diverse as its people, defining both its natural beauty and its strategic importance in South Asia.

2 CHAPTER

Structure and Physiography of India

India's physical landscape is shaped by diverse geological structures and physiographic divisions formed over millions of years. This varied terrain influences climate, agriculture, biodiversity & human settlement patterns.

Earth Evolution & Indian Plate

1. **Age and Evolution of Earth**
   - ✓ Earth is approximately 4600 million years old.
   - ✓ Over time, it has undergone major changes due to:
     - **Endogenic forces:** These come from inside the Earth, like tectonic movements (plates shifting) and volcanic activity. They cause things like mountain building, earthquakes, and new landforms.
     - **Exogenic forces:** These come from outside, such as weathering (breaking down of rocks), erosion (movement of sediments by wind, water), and deposition.
   - ✓ These forces shaped various surface and subsurface features of the Earth.
2. **Movement of Indian Plate**
   - ✓ Originally located south of the equator, once part of a larger plate including Australia.
   - ✓ Broke away and moved northward, while the Eurasian Plate moved southeast.
   - ✓ The northward movement of the Indian Plate continues even today.
   - ✓ This ongoing movement has major consequences:
     - Formation & uplift of Himalayas.
     - Frequent earthquakes in the Himalayan region.
3. **Forces Shaping the Subcontinent**
   - ✓ Interaction of endogenic and exogenic forces with plate movements.
   - ✓ Led to the formation of major landforms and geological structures across India.
   - ✓ Drives ongoing geomorphological processes such as mountain-building, erosion, and sedimentation.

Geological Divisions of India

1. **The Peninsular Block:**
   - ✓ The Peninsular Block is the oldest and most stable part of India's geology.
   - ✓ **Extension**: Northern boundary runs from Kachchh (Gujarat) → Aravalli (Delhi) → Yamuna-Ganga plains → Rajmahal Hills → Ganga Delta.
   - ✓ It includes Karbi Anglong, Meghalaya Plateau (NE India) and Rajasthan Plateau (West).
   - ✓ A major geological feature, the Malda Fault in West Bengal, separates it from the Chotanagpur Plateau.

Formation & Features:

- ✓ Made of very old rocks such as gneisses and granites, which date back to the ancient supercontinent Gondwana, showing its great geological age.
- ✓ The block has undergone vertical movements and faulting, creating rift valleys like those of the Narmada, Tapi, and Mahanadi rivers. These valleys formed where blocks of land sank between faults.
- ✓ Contains relict/residual hills: Aravali, Nallamala, Javadi, Veliconda, Palkonda, Mahendragiri.
- ✓ River valleys are shallow with gentle gradients.
- ✓ Major east-flowing rivers form deltas (e.g., Mahanadi, Godavari, Krishna, Kaveri).

2. The Himalayas & Other Peninsular Mountains

- ✓ **Geological Nature:** The Himalayas are young, tectonically active, and flexible, unlike the rigid Peninsular Block. This means they are still rising and changing today due to plate collision.
- ✓ **Rock types:** Metamorphic (schist, gneiss), igneous, & sedimentary.
- ✓ Located at altitudes between 3000–8000 meters, the Himalayas include some of the highest peaks on Earth, illustrating the power of tectonic uplift.
- ✓ **Geomorphological Features:**
  - Shaped by endogenic (internal) and exogenic (external) forces.
  - Formation of faults, folds, thrust planes.
  - Dissected by youthful rivers, creating gorges, V-shaped valleys, rapids, and waterfalls.

3. Indo-Ganga-Brahmaputra Plain

- ✓ **Formation & Evolution:** by alluvial deposits of Indus, Ganga, and Brahmaputra rivers → Initially a geo-synclinal depression, developed during the 3rd phase of Himalayan uplift (64 million years ago) → Gradually filled by sediments from Himalayan & Peninsular rivers.
- ✓ **Physiographic Significance:** Flat, fertile & densely populated. Reflects influence of both geological and geomorphological processes of the Indian subcontinent.

India as a Subcontinent

India is described as a **subcontinent** because of its distinct geographical, geological, and cultural features that clearly differentiate it from the rest of Asia. The term reflects its vast size, physical diversity, and a unique identity shaped by natural boundaries and tectonic evolution.

Geographical Distinctiveness

- ➢ **Natural isolation:**
  - ✓ Bounded by the **Himalayas** in the north, forming a strong natural barrier.
  - ✓ Surrounded by the **Arabian Sea** to the west, **Bay of Bengal** to the east, and the **Indian Ocean** to the south.
- ➢ **Major physiographic feature:**
  - ✓ The **Indo-Gangetic Plain**, formed by the **Indus, Ganga, and Brahmaputra** river systems, acts as a unifying physical and cultural region.

Geological Evolution

- ➢ **Plate tectonics:**
  - ✓ The Indian landmass was originally part of **Gondwanaland**.
  - ✓ The Indian Plate drifted northward at a speed of **9–16 cm per year**.
- ➢ **Mountain building:**
  - ✓ Collision with the **Eurasian Plate around 50 million years ago** resulted in the uplift of the **Himalayas**.
  - ✓ This process is ongoing and continues to influence the region's topography.

Cultural and Linguistic Diversity

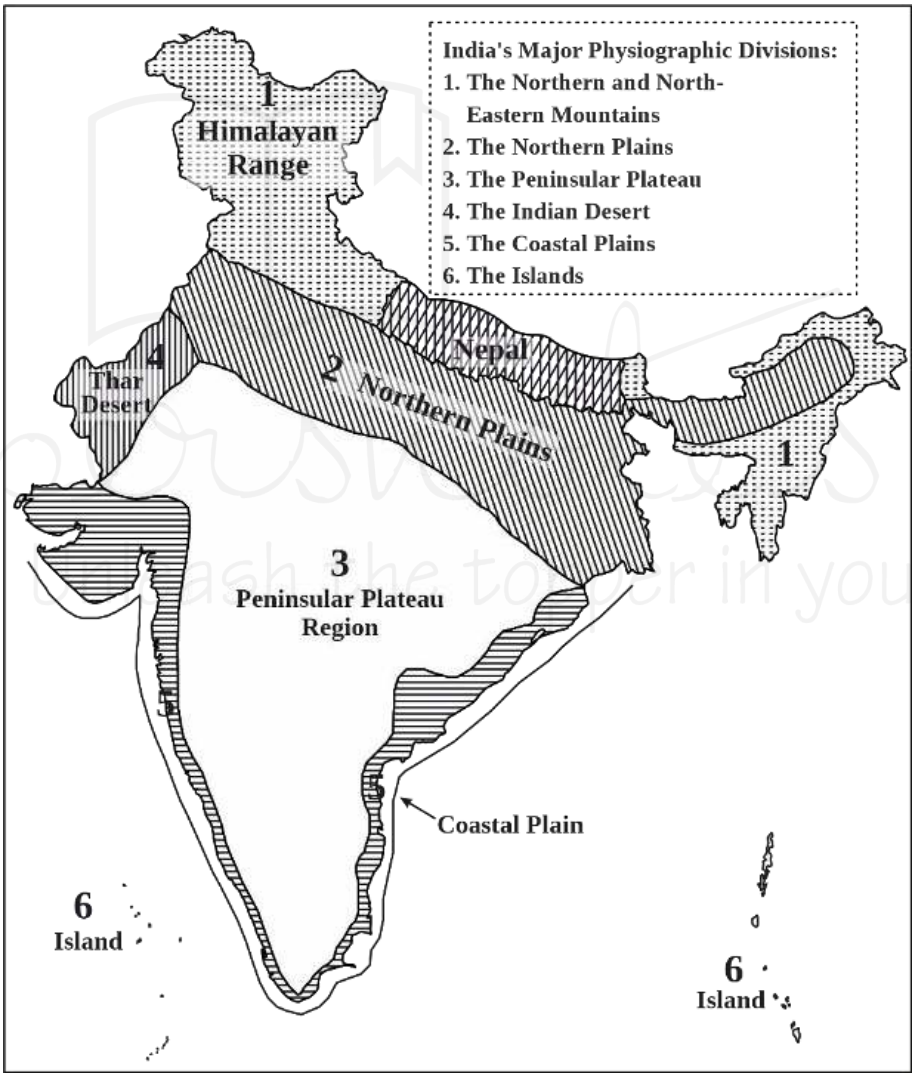
- **Linguistic richness:**
  - ✓ Home to over **1600 languages and dialects**, with **22 officially recognised languages**.
- **Cultural continuity:**
  - ✓ A long and continuous cultural history from ancient civilizations to the modern period.
- **Human–environment interaction:**
  - ✓ Diverse physical settings have supported varied lifestyles, traditions, and cultural practices.

Physical Features and Climate

- **River systems:**
  - ✓ Major peninsular rivers such as the **Godavari, Krishna, and Kaveri**.
- **Climatic diversity:**
  - ✓ Climate ranges from **tropical** in the south to **alpine** conditions in the Himalayas.
- **Physiographic divisions:**
  - ✓ Presence of distinct regions like the **Western Ghats, Eastern Ghats, and Deccan Plateau**

What is Physiography?

- **Meaning:** Refers to the physical geography or surface features of a region, describing its landforms and terrain characteristics.
- **Formation:** Shaped by the underlying geological structure, geomorphic processes (like erosion, deposition, tectonics), and various developmental stages over time.
- **India's Physiography:**
  - ✓ Shows major variations across the country.
  - ✓ **North:** Rugged, young folded mountains of the Himalayas.
  - ✓ **South:** Stable, ancient plateaus of the Peninsular block.
  - ✓ **Between:** Extensive, flat alluvial plains of the Indo-Ganga-Brahmaputra region.



India's Major Physiographic Divisions:

1. **The Northern and North-Eastern Mountains**
2. **The Northern Plains**
3. **The Peninsular Plateau**
4. **The Indian Desert**
5. **The Coastal Plains**
6. **The Islands**

1. The Northern and North-Eastern Mountains

- ✓ Comprise the **Himalayas** and **North-Eastern Hills**.
- ✓ Himalayas:
  - Comprising parallel ranges: Trans-Himalaya, Greater Himalaya (Himadri), Middle Himalaya (Himachal), Shiwalik.
  - **Orientation:** NW–SE (main ranges), E–W (Sikkim), N–S (Nagaland, Mizoram).
  - Act as climatic, physical, drainage, and cultural barriers.
- ✓ **Subdivision-**

A. North–South Division of the Himalayas

- **Great Himalayas (Inner Himalayas)**
  - ☞ **Composition**: Central crystalline core of granite and gneiss topped by metamorphosed sedimentary layers.
  - ☞ **Characteristics**:
    i. Highest, most continuous belt (mean elevation ~6,100 m)
    ii. steep south face; asymmetrical fold structure
    iii. convex profile ending abruptly at Nanga Parbat (8,126 m) in the west and Namcha Barwa (7,782 m) in the east.
  - ☞ **Major Peaks**: Everest (8,848 m), Kanchenjunga (8,586 m), Lhotse, Makalu, Dhaulagiri, Nanda Devi, Trishul, etc.
  - ☞ **Principal Passes**:
    i. Zoji La, Burzil Pass - Jammu & Kashmir
    ii. BaraLacha La, Shipki La - Himachal Pradesh
    iii. Niti Pass, LipuLekh - Uttarakhand
    iv. Nathu La, Jelep La - Sikkim.
  - ☞ **Other Features**:
    i. Hosts world's largest non-polar glaciers (Siachen, Baltoro).
    ii. Deep valleys such as the Kashmir Valley.
- **Lesser Himalayas (Middle Himalayas)**
  - ☞ **Composition**: Predominantly sedimentary & volcanic rocks (Pir Panjal range).
  - ☞ **Characteristics**:
    i. Elevations between 3,500 m & 4,500 m
    ii. Rugged uplands interspersed with large valleys (Kashmir, Kullu, Kangra).
  - ☞ **Key Peaks**: Nag Tibba, Mahabharat Lekh.
  - ☞ **Key Passes**: Banihal, Pir Panjal, Golaghat.
  - ☞ **Other Features**:
    i. Popular hill stations (Shimla, Mussoorie, Dharamshala)
    ii. Major river-gorges of the Jhelum, Beas & Chenab rivers.
- **Shiwaliks (Outer Himalayas)**
  - ☞ **Composition**: Mio-Pleistocene deposits, sands, gravels, conglomerates.
  - ☞ **Characteristics**:
    i. Low relief (900–1,100 m)
    ii. Broad alluvial tracts known as duns (Dehradun, Kotli Dun) crossed by seasonal streams (chos).
  - ☞ **Peaks & Passes**: No significant summits or passes.
  - ☞ **Other Features**: Form youngest Himalayan foothills; dissected by scarps and anticlines.

B. East–West Division of the Himalayas

- **Kashmir / Northwestern Himalayas**
  - ☞ Key Ranges: Karakoram, Ladakh, Zaskar, Pir Panjal.
  - ☞ **Major Peaks**: K2 (8,611 m), Nanga Parbat, Gasherbrum, Rakaposhi.
  - ☞ **Principal Passes**: Zoji La, Banihal, Khardung La, Photu La.
  - ☞ **Other Features**:
    i. Kashmir Valley (Tectonic) with Dal and Wular lakes
    ii. Pangong Tso in Ladakh
    iii. Karewas (lacustrine benches) famous for saffron cultivation
    iv. Baltoro and Siachen glaciers north of Nubra Valley
    v. Changpa pastoralists of the Changthang plateau, rearing Pashmina goats & recognized as a Scheduled Tribe
    vi. Pilgrimage at Vaishno Devi and Hazratbal Shrine in Srinagar.
- **Himachal & Uttarakhand Himalayas**
  - ☞ **Key Ranges**: Great Himalayas, Dhauladhar, Nag Tibba subranges & Shiwaliks.
  - ☞ **Major Peaks**: Kamet, Nanda Devi, Kedarnath, Trishul, Bandarpunch.
  - ☞ **Principal Passes**: Lipu Lekh, Niti Pass, BaraLacha La.
  - ☞ **Other Features**:
    i. Valley of Flowers
    ii. Hill stations like Shimla, Ranikhet, Mussoorie
    iii. Sacred sites Badrinath and Kedarnath.
- **Nepal Himalayas**
  - ☞ **Key Ranges**: Mahabharat and Churia ranges.
  - ☞ **Major Peaks**: Everest, Annapurna, Dhaulagiri, Makalu.
  - ☞ **Passes**: No major trans-Himalayan passes.
  - ☞ **Other Features**:
    i. Highest continuous Himalayan section
    ii. Renowned tea gardens along the southern foothills.
- **Darjeeling & Sikkim Himalayas**
  - ☞ **Key Ranges**: Kanchenjunga, adjacent folds of the Mahabharat range.
  - ☞ **Major Peak**: Kanchenjunga (8,586 m).
  - ☞ **Principal Passes**: Jelep La, Nathu La.
  - ☞ **Other Features**:
    i. Famous tea plantations
    ii. Exceptional orchid diversity
    iii. Home to the Lepcha tribe.
- **Arunachal Himalayas**
  - ☞ **Key Ranges**: Patkai Bum, Naga Hills, Abor Hills.
  - ☞ **Major Peaks**: Namcha Barwa, Kangtu.
  - ☞ **Principal Pass**: Diphu Pass.
  - ☞ **Other Features**:
    i. Inhabited by Monpa, Abor and Mishmi tribes
    ii. Practice of jhum (shifting) cultivation.

C. Purvanchal himalayas

- The eastern extension of the Himalayas in Northeast India, curving southward beyond the Dihang Gorge, forming a series of hill ranges running mostly north–south.
- Composed of folded, uplifted sedimentary layers, with dense forests and complex relief.

Sub-Range	Composition & Structure	Characteristics & Uses	Highest Peak	Other Features
Patkai Bum	Highly dissected hills cloaked in dense rainforest	Forms international boundary between Arunachal Pradesh & Myanmar	—	Biodiversity hotspot
Naga Hills	Predominantly igneous and metamorphic rocks	Acts as watershed between India and Myanmar	Mount Saramati	Jhum cultivation by indigenous Naga tribes
Manipur Hills	Sedimentary layers with clay deposits	Southward continuation of the Naga range	—	—
Barail Range	Folded deposits separating it from Naga Hills	Characterized by narrow valleys and mid-elevations	Mount Tempu (Manipur)	—
Mizo (Lushai) Hills	Unconsolidated sediments of the molasse basin	Known locally as "Blue Mountain" region	Phawngpui (2,157 m)	Rich tribal cultures and continuous jhum farming

1. Prominent Himalayan Glaciers

Glacier Name	Location	Important Features
Siachen	Karakoram ranges	Nubra Valley of Himalayas; 2nd longest glacier outside Polar region
Biafo	Karakoram	Flows into the Shigar River
Gangotri	Uttarakhand	Origin below Chaukhamba Peak; also known as 'Gomukh'
Hispar	Gilgit-Baltistan	World's longest glacial system
Zemu	Sikkim/Nepal	Largest glacier of Eastern Himalaya; feeds River Teesta
Sonapani	Lahaul & Spiti, HP	Longest glacier in the Pir Panjal range. A glacier stream is a tributary to the Chandra River, which later merges with the Bhaga River to form the Chenab (Bara Shigri).
Milam	Uttarakhand	Major source of River Gori Ganga (Saryu); biggest glacier in Kumaon Himalaya
Chong Kumdan	Karakoram, Ladakh	Feeds Shyok River due to potential blocking
Diamir	POK	Known as the 'King of Mountains'
Rupal	Kashmir	In Greater Himalayas; flows northeastward

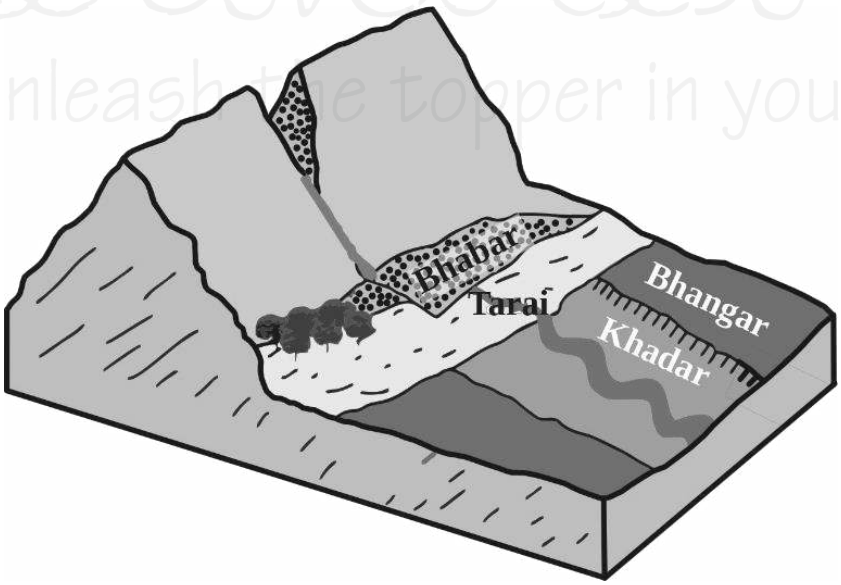
2. Prominent Himalayan Passes

Pass Name	State / UT	Location / Border	Importance
Zoji La	Jammu & Kashmir, Ladakh	Greater Himalayas	Connects Srinagar–Leh; vital for defence
Banihal Pass	Jammu & Kashmir	Pir Panjal Range	Jawahar Tunnel passes under this; Srinagar–Jammu link
Khardung La	Ladakh	Ladakh Range	Road to Siachen; one of highest motorable roads

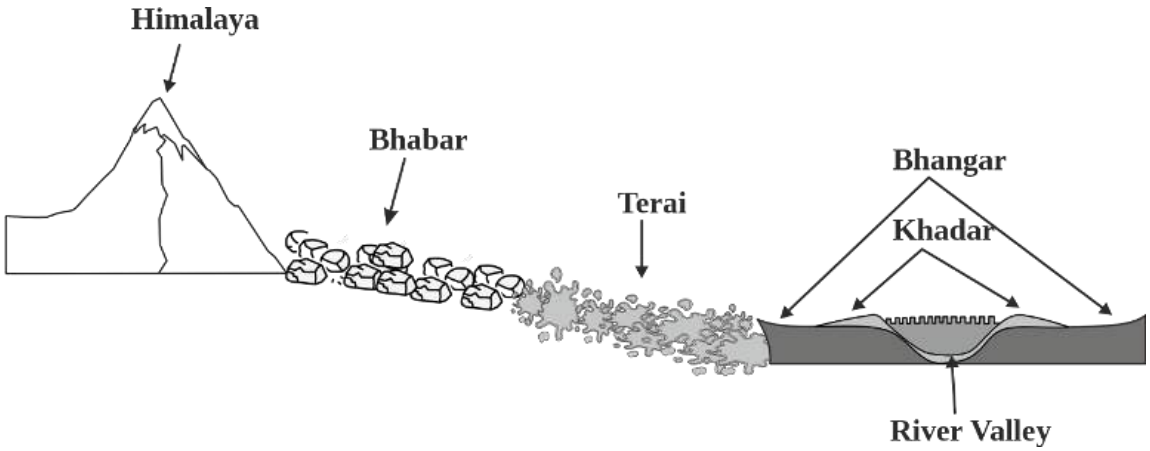
Chang La	Ladakh	Ladakh Range	Connects Leh to Pangong Lake
Fotu La	Ladakh	Zanskar Range	Highest point on Srinagar–Leh highway
Namika La	Ladakh	Zanskar Range	On Kargil–Leh route
Baralacha La	Himachal Pradesh	Zanskar Range	On Leh–Manali highway
Shipki La	Himachal Pradesh	India–Tibet Border (Kinnaur)	Historic trade route
Mana Pass	Uttarakhand	Chamoli District	Road to Kailash–Mansarovar; Indo-China route
Niti Pass	Uttarakhand	Chamoli District	Old trade route to Tibet
Lipulekh Pass	Uttarakhand	Pithoragarh District	Kailash–Mansarovar Yatra route; India–Nepal–Tibet tri-junction
Nathu La	Sikkim	Indo–China Border	Border trade post with China
Jelep La	Sikkim	Near Kalimpong	Trade route to Lhasa in historical times
Se La	Arunachal Pradesh	Tawang District	Connects Tawang to rest of state
Bum La	Arunachal Pradesh	Near Tawang	Indo–China sensitive military pass
Dipher Pass	Arunachal Pradesh	East Kameng	Eastern Himalayas, remote and strategic
Khunjerab Pass	(POK)	Gilgit–Baltistan (Pak-Occupied Kashmir)	On China–Pakistan border; on CPEC route
Lanak La	Ladakh (Disputed Border)	Aksai Chin region (Indo-China)	Disputed India–China border crossing
Lekhapani	Arunachal Pradesh	Eastern tip near Assam-Arunachal	Historic WW-II route via Stilwell Road; strategic for eastern sector

2. The Northern Plains

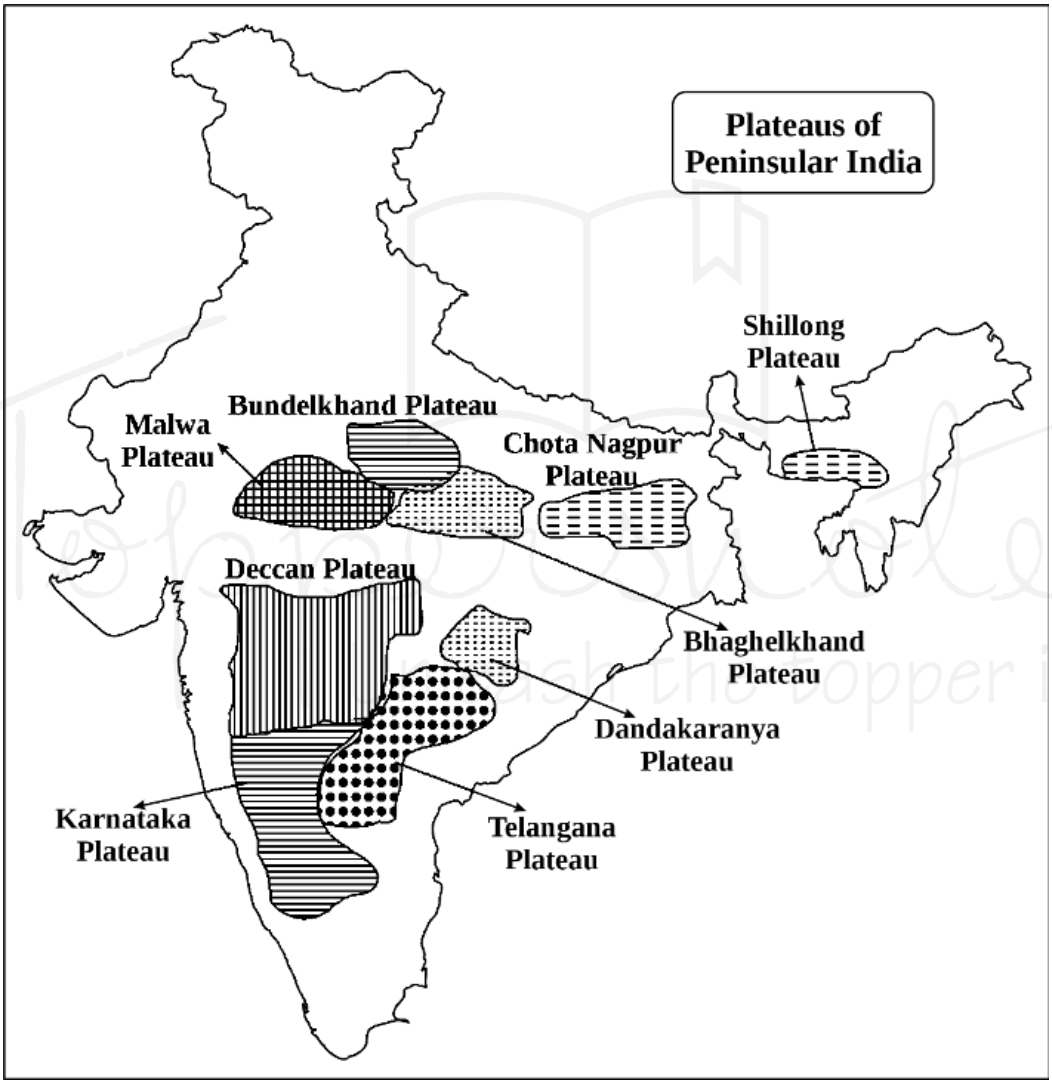
- ✓ Formed by alluvial deposition from Indus, Ganga & Brahmaputra.
- ✓ **Size:** About 3,200 km long and 150–300 km wide.
- ✓ **Significance:** One of the most fertile and densely populated regions of India.
- ✓ Divided into: (from north-south)
  - **Bhabar** (rocky, porous belt near base of Shiwaliks)
  - **Tarai** (marshy, re-emergent rivers- Dudhwa National park located)
  - **Alluvial Plains**:
    - ☞ **Khadar** – newer alluvium, floodplain deposits, fertile
    - ☞ **Bhangar** – older alluvium, calcareous in nature



- ✓ **Features:** Meanders, oxbow lakes, braided channels, sand bars.
- ✓ Brahmaputra Plain: prone to floods, home to riverine islands (Majuli).



3. The Peninsular Plateau



- ✓ Oldest landmass, stable, formed from Gondwanaland.
- ✓ **Elevation:** Ranges between 150–900 m.
- ✓ **Slope:** Tilts eastward, with black soil in the northwest.
- ✓ The Plateau's outer extent includes Delhi Ridge (northwest), Rajmahal Hills (east), Gir Range (west), and Cardamom Hills (south). Eastern extension seen in the Shillong & Karbi-Anglong Plateau.

- ✓ **Physiographic Forms:** Includes block mountains, rift valleys, tors, bare rock exposures.
- ✓ **Divisions:**
  - **Deccan Plateau**
    - ☞ **Western Ghats**:
      - ❖ Known locally as the Sahyadri (Maharashtra), the Nilgiri Hills (Karnataka and Tamil Nadu), and the Anaimalai and Cardamom Hills (Kerala's Malabar Coast).
      - ❖ Average height ~1,500 m; becomes higher and more continuous toward the south.

Resource Potential of the Deccan Trap

- ➢ **Mineral Resources**
  - ✓ **Basaltic Rocks:** Widely used in construction and road building due to their durability and abundance.
  - ✓ **Metallic Minerals:** The region contains deposits of bauxite (aluminium ore), iron ore, and smaller quantities of copper and manganese, supporting industrial growth.
  - ✓ **Zeolites:** Formed through hydrothermal alteration of basalt, these minerals are important for water purification, ion exchange, and catalytic processes.
- ➢ **Geothermal Energy Potential**
  - ✓ **Hot Spring Zones:** Recent studies (2023–2025) indicate geothermal potential in regions such as Sativli, Mandangad, Aravali, Anjaneri, and Rajapur in Maharashtra.
  - ✓ **Energy Prospects:** Residual heat from ancient volcanic activity offers opportunities for clean and renewable energy generation.
  - ✓ **Comparative Sites:** Similar geothermal explorations are underway in Puga–Chumathang–Panamik (Ladakh) and Tattapani (Central India).
- ➢ **Water Resources**
  - ✓ **Aquifer Characteristics:** Basaltic formations act as efficient aquifers, supporting groundwater storage and transmission.
  - ✓ **Hydrogeological Conditions:**
    - Phreatic conditions in weathered zones
    - Semi-confined conditions in fractures and fissures
    - Yield ranges from 1–10

- ➢ Spread across **Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra, Gujarat**.
- ➢ Eastern rain-shadow features mushroom rocks, dunes, oases, and ephemeral streams like the Luni ending in salt-rich playas for brine.
- ➢ Source of major rivers: **Godavari, Krishna, Kaveri**.
- ➢ Highest peaks: **Anamudi (2,695 m)**, **Doddabetta (2,637 m), Ooty (2,240 m)**, **Pushpagir (1,712 m)** in the Nilgiris.
- ➢ Famous hill stations: **Ooty**, **Munnar, Kodaikanal**.
- ➢ There is no formation of deltas by rivers of the Western Ghats.

Factors Preventing Delta Formation

Physiographic Characteristics

- ➢ The **Western Ghats run parallel and very close to the Arabian Sea**, leaving a narrow coastal plain that is unsuitable for delta development.

- West-flowing rivers are **short and steep**, resulting in high stream velocity that limits sediment deposition near the coast.
- The western coast is largely a **submerged coastline**, leading to the formation of natural harbours rather than deltaic plains, especially along the **Konkan and Malabar coasts**.

Hydrological Factors

- Rivers originating in the Western Ghats are **short, swift-flowing, and perennial**.
- The steep gradient enables rivers to retain strong **erosive power up to their mouths**, preventing sediment accumulation.
- The presence of **backwaters (Kayals)** along the Malabar coast traps sediments inland, further reducing the scope for delta formation.

Marine Conditions

- The **Arabian Sea** is characterised by strong currents and a relatively high tidal influence, which continuously remove river-borne sediments.
- A **steep continental shelf** close to the coastline restricts sediment deposition.
- **Deep coastal waters** allow sediments to be rapidly dispersed into the sea rather than settling near the shore.

Sediment Characteristics

- Rivers such as the **Netravati, Chaliyar, Bharathapuzha, and Periyar** carry substantial sediment loads into the Arabian Sea.
- Sediment yield varies significantly between basins, with **exploited basins contributing nearly four times more sediment** than protected ones.
- Despite adequate sediment supply, **coastal morphology and marine dynamics** prevent delta formation.

✓ **Eastern Ghats:**

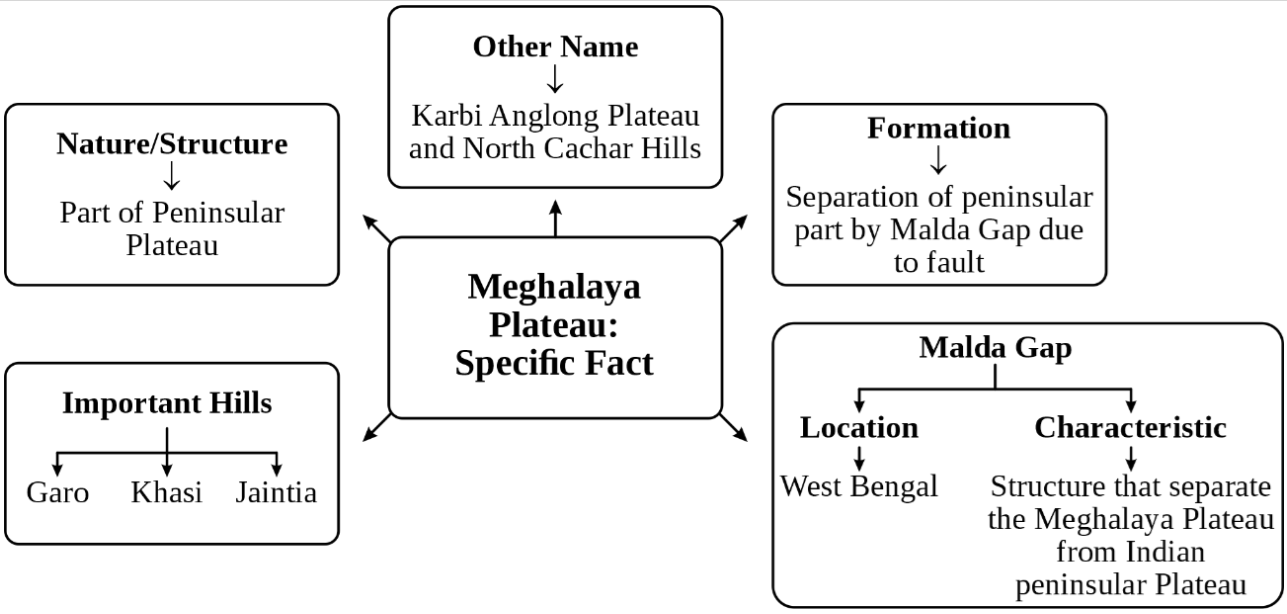
- Broken, lower, heavily eroded hill chain running through **Odisha, Andhra Pradesh, Tamil Nadu, Karnataka, Telangana**.
- Principal ranges (north to south): **Mahendragiri** (highest peak), **Nallamala Hills** (Srisailam temple), **Velikonda**, **Palkonda**, **Javadi**, **Shevaroy**, **Pachamalai**, **Sirumalai Hills**.
- Geologically isolated outliers: Amarkantak Hills (Vindhya–Satpura junction), Biligirirangana Hills (Karnataka), Seshachalam Hills (Andhra Pradesh).
- At the Nilgiris, Eastern and Western Ghats meet, forming a corridor with Sathyamangalam Tiger Reserve (Tamil Nadu).

✓ **Central Highlands**

- Bounded to the west by the Aravallis
- Formed by disjunctive ranges of Vindhya, Satpura ranges.
- Made of metamorphic rocks like marble, slate, gneiss, etc.

✓ **North-Eastern Plateau**

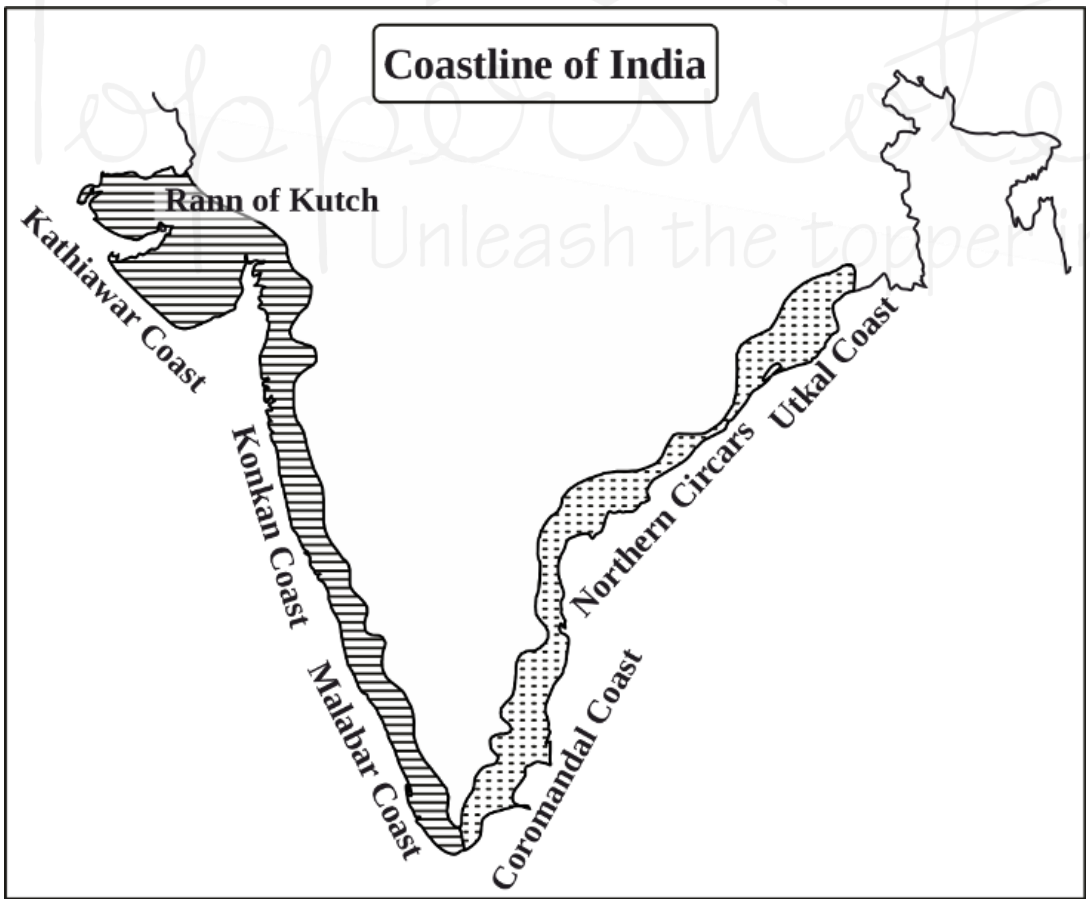
- Extension of Peninsular plateau Includes Chotanagpur, Shillong, Meghalaya (Garo, Khasi, Jaintia).
- Separated by a fault from the main block between the rajmahal hills & the meghalayan gap.
- **Features:** Rich in minerals, highly eroded (e.g., Mawsynram, Meghalaya,known for intense rainfall and rugged terrain).



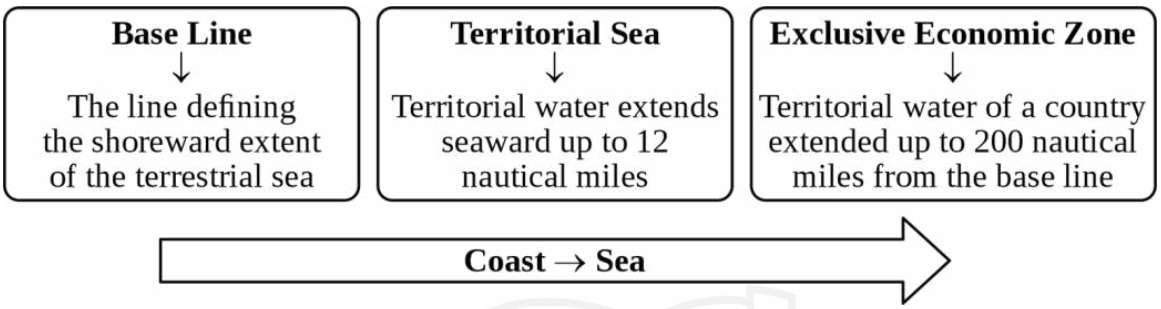
4. The Indian Desert

- ✓ **Location:** Lies northwest of the Aravalli Range; also called the Thar Desert.
- ✓ **Landscape:** Arid zone with sand dunes and barchans (crescent-shaped dunes), known locally as Marusthali.
- ✓ **Rainfall:** Very low, less than 150 mm annually; features inland drainage (no major rivers reaching the sea).
- ✓ **Rivers:** Luni River flows seasonally in the southern desert.
- ✓ **Other Features:** Presence of lakes and brackish playas, which are important sources of salt. Khadeen agriculture practiced.

5. The Coastal Plains

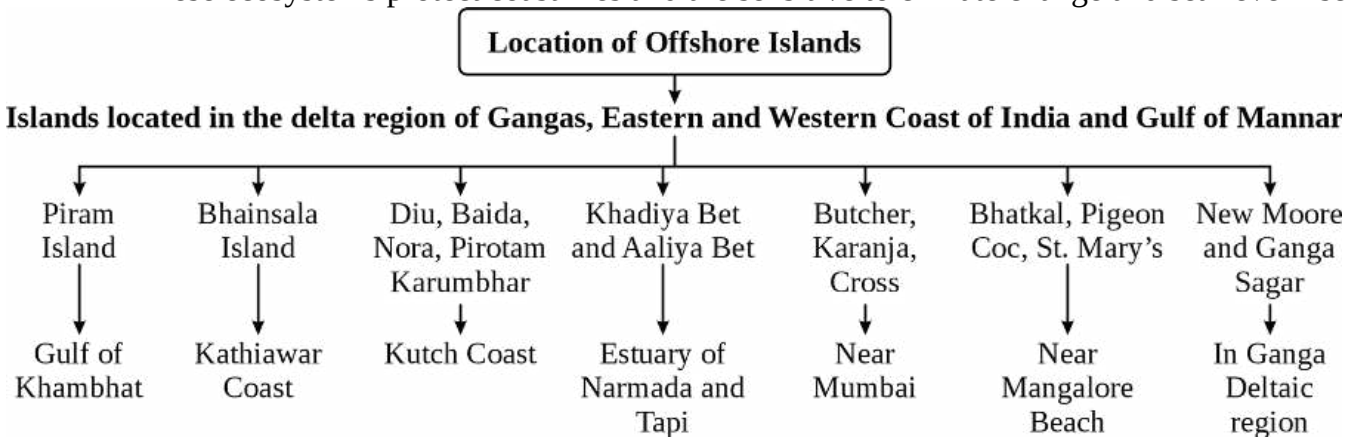


- ✓ **Western Coastal Plains:**
  - Submerged coast (city of Dwarka believed to be submerged); narrow & steep coastline.
  - **Ports:** Well-suited for natural harbours like Mumbai, Mangalore, Kochi.
  - **Divisions:** Kachchh-Kathiawar (Gujarat), Konkan (Maharashtra), Canara (Karnataka), Malabar (Kerala).
  - **Special Feature:** Kayals (backwaters) in Kerala's Malabar coast.
  - **Rivers:** Rivers here are short and swift because of the narrow coastal strip and steep slope. They flow quickly to the sea and do not form deltas, unlike the eastern side.
- ✓ **Eastern Coastal Plains:**
  - **Emergent coast**; broader, wide and flat, formed by marine regression.
  - Deltas well developed: Mahanadi, Godavari, Krishna, Kaveri. These deltas are fertile and densely populated.
  - **Ports:** Fewer ports due to the shallow continental shelf, making harbours less naturally deep.



6. The Islands

- ✓ **Andaman & Nicobar Islands (Bay of Bengal):**
  - **Number:** Comprising 836 islands with 38 of them being permanently inhabited.
  - **Origin:** Volcanic, with Barren Island being South Asia's only confirmed active volcano. Barren Island Volcano erupted first in 1787, the last major eruption in 1991.
  - **Geological Link:** Extension of the Arakan Yoma range of Myanmar.
  - **Climate & Vegetation:** Equatorial climate with dense tropical forests.
  - **Highest Peak:** Saddle Peak in North Andaman.
  - **Significance:** Strategic location for maritime security and biodiversity hotspot with many unique species of plants and animals.
  - Sumatra geographically closest to Great Nicobar.
- ✓ **Lakshadweep Islands (Arabian Sea):**
  - **Number:** Consist of 36 coral islands, comprising 12 atolls, three reefs, five submerged banks and ten inhabited islands.
  - Minicoy is the largest island. Known for its distinctive culture and lighthouse.
  - Divided by 11° Channel (Amini in north, Cannanore in south).
  - **Features:** Formed entirely of coral deposits, showcasing unique marine ecosystems.
  - These ecosystems protect coastlines and are sensitive to climate change and sea-level rise.



DID YOU KNOW?

India's most populous island is Salsette island, on which the city of Mumbai & a portion of Thane district is situated.

Prominent Maritime Channels

Channel	Division
8 degree channel	Minicoy and Maldives
9 degree channel	Minicoy Island and Lakshadweep Archipelago
10 Degree Channel	Andaman Islands and Nicobar Island
11 Degree Channel	Amindivi and Cannanore Island
Duncan Passage	South/Great Andaman and Little Andaman
St. George Channel	Little Nicobar and Great Nicobar
Grand Channel	Great Nicobar and Sumatra Island (Indonesia)
Coco strait	Middle of coco island (Myanmar) and Northern Andaman
Palk strait	Tamil Nadu (India) and Northern Sri Lanka

The structural and physiographic framework of India not only reflects its complex geological history but also plays a critical role in determining regional climates, river systems, and patterns of human settlement.