ENSHINE IAS ACADEMY

THE ONE SOLUTION FOR YOUR PREPARATION

ONE LINER

PHYSICAL GEOGRAPHY

UNIVERSE & SOLAR SYSTEM

1. The **Big Bang Theory** explains the origin of the universe.
2. The **Milky Way** is our galaxy, containing over 100 billion stars.
3. The **Sun** is a medium-sized star at the center of our solar system.
4. The **solar system** formed about **4.6 billion years ago** from a giant molecular cloud.
5. There are **8 planets** in our solar system (Pluto is a dwarf planet).
6. **Mercury** is the smallest and closest planet to the Sun.
7. **Venus** is the hottest planet due to its thick CO_2 atmosphere (Greenhouse Effect).
8. **Earth** is the only planet known to support life.
9. **Mars** is called the **"Red Planet"** because of iron oxide on its surface.
10. **Jupiter** is the largest planet and has the **Great Red Spot** (a giant storm).
11. **Saturn** has the most prominent **ring system** made of ice and dust.
12. **Uranus** rotates on its **side** (axis tilted at 98°).
13. **Neptune** is the **coldest and windiest planet**.
14. The **Asteroid Belt** lies between **Mars and Jupiter**.
15. **Comets** are icy bodies that develop tails when near the Sun (e.g., Halley's Comet).
16. **Meteors** (shooting stars) are space rocks burning up in Earth's atmosphere.
17. **Meteorites** are meteors that reach Earth's surface.

Earth & Moon

18. Earth is **not a perfect sphere** (slightly flattened at the poles).
19. **Moon** is Earth's only natural satellite.
20. **Neil Armstrong** was the first man on the Moon (Apollo 11, 1969).
21. A **solar eclipse** occurs when the **Moon blocks the Sun** (New Moon phase).
22. A **lunar eclipse** occurs when the **Earth blocks sunlight from reaching the Moon** (Full Moon phase).

Space Missions

23. **Chandrayaan-1** (2008) was India's first Moon mission.
24. **Mangalyaan** (2013) made India the first Asian nation to reach Mars.
25. **Aditya-L1** (2023) is India's first solar mission.

STRUCTURE OF THE EARTH (CRUST, MANTLE, CORE)

Earth's Layers

1. The Earth is made up of **three main layers**: Crust, Mantle, and Core.
2. The **Crust** is the outermost and thinnest layer (5-70 km thick).
3. The **continental crust** is thicker but less dense than oceanic crust.
4. The **Mantle** extends from the crust to about 2,900 km depth.
5. The **upper mantle** contains the **asthenosphere** (partially molten rock).
6. The **lower mantle** is solid due to high pressure.
7. The **Core** is divided into the **outer core** (liquid) and **inner core** (solid).
8. The **inner core** is made of solid iron and nickel, despite extreme heat.
9. The **outer core** generates Earth's **magnetic field** due to convection currents.

Lithosphere & Asthenosphere

10. The **Lithosphere** includes the crust and uppermost solid part of the mantle.
11. The **Asthenosphere** is a semi-fluid layer below the lithosphere (allows tectonic plate movement).
12. **Tectonic plates** float on the asthenosphere.

Rocks & Minerals

13. The **three types of rocks** are **igneous, sedimentary, and metamorphic**.
14. **Igneous rocks** form from cooled magma (e.g., basalt, granite).
15. **Sedimentary rocks** form from compressed sediments (e.g., sandstone, limestone).
16. **Metamorphic rocks** form under heat and pressure (e.g., marble, slate).
17. The **Mohorovičić discontinuity (Moho)** separates the crust from the mantle.
18. The **Gutenberg discontinuity** separates the mantle from the core.
19. The **Lehmann discontinuity** separates the outer and inner core.

Earthquakes & Volcanoes

20. **Earthquakes** occur due to the sudden movement of tectonic plates.
21. The **focus** is the origin point of an earthquake inside the Earth.
22. The **epicenter** is the point on the surface directly above the focus.
23. **Seismic waves (P-waves, S-waves, L-waves)** help study Earth's interior.
24. **P-waves** can travel through solids and liquids, while **S-waves** only through solids.
25. **Volcanoes** form when magma escapes through Earth's crust.

LATITUDES & LONGITUDES

Basic Concepts

1. **Latitudes** are horizontal circles parallel to the Equator, measuring distance north/south in degrees (0°-90°).
2. The **Equator (0° latitude)** divides Earth into Northern & Southern Hemispheres.
3. **Longitudes** are vertical semicircles connecting the poles, measuring east/west positions (0°-180°).
4. The **Prime Meridian (0° longitude)** passes through Greenwich, England.

Important Latitudes

5. **Tropic of Cancer (23.5°N)** passes through India (Gujarat to Mizoram).
6. **Tropic of Capricorn (23.5°S)** marks the southernmost point where the Sun is overhead.
7. **Arctic Circle (66.5°N)** and **Antarctic Circle (66.5°S)** define polar day/night regions.

Time & Longitude

8. Earth rotates **360° in 24 hours**, so **1° longitude = 4 minutes** of time difference.
9. **Indian Standard Time (IST)** is based on **82.5°E longitude** (Mirzapur, UP).
10. The **International Date Line (180° longitude)** marks calendar change (east/west travel).

Special Features

11. **All longitudes are equal in length**, unlike latitudes.
12. **180°E and 180°W** are the same line (International Date Line).
13. **Local time** varies with longitude, but **standard time** is fixed for a region.

Exam-Focused Facts

14. **Total latitudes**: 181 (including Equator); **total longitudes**: 360.
15. **Kanyakumari** is India's only location where the **Arabian Sea, Bay of Bengal, and Indian Ocean** meet.

EARTH'S ROTATION & REVOLUTION

Rotation (Day & Night)

1. Earth completes **one rotation in 24 hours**, causing day and night.
2. Rotation speed is **fastest at the Equator (1670 km/h)** and zero at poles.
3. The **Coriolis Effect** (deflection of winds/ocean currents) is caused by rotation.

Revolution (Seasons & Year)

4. Earth takes **365.25 days** to complete one revolution around the Sun.

5. **Leap year (366 days)** occurs every 4 years to adjust the extra 0.25 days.
6. Earth's **axial tilt (23.5°)** is responsible for seasons.

Solstices & Equinoxes

7. **Summer Solstice (June 21)**: Longest day in Northern Hemisphere (Sun overhead at Tropic of Cancer).
8. **Winter Solstice (Dec 22)**: Shortest day in Northern Hemisphere (Sun overhead at Tropic of Capricorn).
9. **Equinoxes (March 21 & Sept 23)**: Equal day/night globally (Sun overhead at Equator).

Effects of Revolution

10. **Perihelion** (Earth closest to Sun: ~Jan 3) and **Aphelion** (farthest: ~July 4).
11. The **midnight Sun** phenomenon occurs near poles during summer solstices.

Exam-Focused Facts

12. Earth's rotation direction: **West to East** (sun rises in the east).
13. **Speed of revolution**: ~30 km/s (108,000 km/h).
14. **Gregorian calendar** aligns with Earth's revolution (365 days + leap year).
15. **Chandrayaan-3** confirmed Earth's rotation by tracking from the Moon.

Why does a leap year have 366 days? → To compensate for Earth's 365.25-day revolution.
Which motion causes the apparent movement of the Sun? → Earth's rotation.
When does the Sun shine vertically on the Equator? → During equinoxes.

ECLIPSES (SOLAR & LUNAR)

Solar Eclipse

1. Occurs when the **Moon blocks sunlight** from reaching Earth (New Moon phase).
2. **Total Solar Eclipse** happens when the Moon completely covers the Sun (umbra shadow).
3. **Partial Solar Eclipse** occurs when only part of the Sun is obscured (penumbra shadow).
4. **Annular Solar Eclipse** ("Ring of Fire") happens when the Moon is too far to fully cover the Sun.
5. Solar eclipses are visible only from a **small geographic area** (path of totality).

Lunar Eclipse

6. Occurs when **Earth blocks sunlight** from reaching the Moon (Full Moon phase).

7. **Total Lunar Eclipse** turns the Moon reddish ("Blood Moon") due to Rayleigh scattering.
8. **Partial Lunar Eclipse** happens when only part of the Moon enters Earth's umbra.
9. Lunar eclipses are visible from **anywhere on Earth's night side**.

Key Differences

10. Solar eclipses last **minutes**, while lunar eclipses last **hours**.
11. **Never look directly at a solar eclipse** (can damage eyes); lunar eclipses are safe to view.
12. Solar eclipses are more **rare** than lunar eclipses at any given location.

NCERT Facts

13. **Saros Cycle**: Eclipses repeat every ~18 years due to orbital alignments.
14. Ancient Indian astronomers (Aryabhata) accurately predicted eclipses.

Why does the Moon turn red during a total lunar eclipse? → **Earth's atmosphere scatters blue light, allowing red light to reach the Moon.**
Which eclipse requires special eye protection? → **Solar eclipse.**
What phase must the Moon be in for a solar eclipse? → **New Moon.**

"SUN-Moon-Earth" for solar eclipse order and **"SUN-Earth-Moon"** for lunar eclipse!

IMPORTANT PARALLELS

1. **Equator (0° latitude)** - Divides Earth into Northern & Southern Hemispheres.
2. **Tropic of Cancer (23.5°N)** - Passes through India
3. **Tropic of Capricorn (23.5°S)** - Marks the southernmost point where the Sun is directly overhead.
4. **Arctic Circle (66.5°N)** - Boundary of the **24-hour daylight/darkness** in Northern summers/winters.
5. **Antarctic Circle (66.5°S)** - Same as Arctic Circle but in the Southern Hemisphere.
6. **North Pole (90°N) & South Pole (90°S)** - where all longitudes meet.
7. **Prime Meridian (0° longitude)** - GMT, passes through Greenwich, UK.
8. **International Date Line (180° longitude)** - Marks calendar change when crossed.
9. **Indian Standard Meridian (82.5°E)** - Determines IST, passes through Mirzapur (UP).
10. **Torrid Zone** (between Tropics) - Receives **maximum heat** due to direct sunlight.

Which Indian states does Tropic of Cancer pass through?
→ **8 states**: Gujarat, Rajasthan, MP, Chhattisgarh, Jharkhand, WB, Tripura, Mizoram.

GEOMORPHOLOGY

Plate Tectonics (Continental Drift Theory, Seafloor Spreading)

Continental Drift Theory (Alfred Wegener, 1912)

1. Proposed Earth had a supercontinent **Pangaea** (meaning "all Earth") 250 million years ago.
2. Pangaea split into **Laurasia (North)** and **Gondwana (South)** during Jurassic period.
3. Evidence: **Jigsaw fit** of continents (e.g., Africa & South America).
4. **Fossil evidence**: Similar plant/animal fossils (Glossopteris, Mesosaurus) across continents.
5. **Rock match**: Same mountain ranges (Appalachians & Caledonians) on different continents.
6. **Coal deposits** in Antarctica prove it was once near equator (tropical climate).
7. Rejected initially due to lack of mechanism explaining "how" continents moved.

Seafloor Spreading (Harry Hess, 1960s)

8. Discovered **mid-ocean ridges** (e.g., Mid-Atlantic Ridge) where magma rises.
9. New oceanic crust forms at ridges, pushing older crust sideways (like a conveyor belt).
10. Evidence: **Youngest rocks** at ridges, **oldest** near continents (dating via radiometry).
11. **Magnetic stripes**: Symmetrical patterns of magnetic reversals recorded in oceanic crust.
12. **Ocean trenches**: Where old crust sinks (subducts) into mantle (e.g., Mariana Trench).

Plate Tectonics Theory

13. Earth's lithosphere divided into **7 major plates** (e.g., Eurasian, Pacific).
14. **Convergent boundary**: Plates collide → Himalayas (India-Eurasia).
15. **Divergent boundary**: Plates separate → Mid-Atlantic Ridge.
16. **Transform boundary**: Plates slide past → San Andreas Fault (USA).
17. **Indian Plate** moves **5 cm/year** northward, causing earthquakes in Himalayas.

Key Terms

18. **Asthenosphere**: Semi-fluid layer below lithosphere where plates "float".

19. **Subduction zone**: Oceanic plate sinks under continental plate (e.g., Andes).
20. **Rift Valley**: Forms at divergent boundaries (e.g., East African Rift).
21. **Benioff Zone**: Earthquake zone along subducting plate.

Volcanoes & Earthquakes

22. **Ring of Fire**: Pacific Ocean's volcanic/earthquake belt (75% of world's volcanoes).
23. **Shield volcanoes**: Gentle slopes (Hawaii); **Composite cones**: Steep (Mt. Fuji).
24. **Focus**: Earthquake's origin point; **Epicenter**: Surface directly above it.

NCERT Specials

25. **Deccan Traps** (India) formed by **Reunion hotspot** 66 million yrs ago.
26. **Chile Rise**: Rare **ridge-trench collision** (Nazca Plate meets Antarctic Plate).
27. **Slab Pull**: Main force driving plate movement (subducting plate's weight).
28. **Oldest oceanic crust**: ~200 million yrs (Mediterranean); **continental crust**: ~4 billion yrs.
29. **San Andreas Fault**: Transform boundary (Pacific & North American Plates).
30. **Himalayas** still rising (~1 cm/year) due to ongoing collision.

Earthquakes & Volcanoes

Earthquakes

1. Earthquakes are caused by sudden release of energy along faults in Earth's crust
2. The point of origin inside Earth is called **focus/hypocenter**
3. The point directly above focus on surface is **epicenter**
4. Seismic waves are recorded by **seismograph**
5. **Richter Scale** measures earthquake magnitude (logarithmic scale)
6. **Mercalli Scale** measures earthquake intensity (damage observed)
7. **P-waves** (Primary) are fastest seismic waves (travel through solids+liquids)
8. **S-waves** (Secondary) travel only through solids
9. **L-waves** (Surface waves) cause most destruction
10. India's most earthquake-prone zones: **Himalayas, Northeast, Rann of Kutch**
11. **Zone V** is India's highest risk seismic zone (includes entire Northeast)
12. **Tsunami** is caused by undersea earthquakes/volcanic eruptions
13. 2004 Indian Ocean tsunami originated near **Sumatra, Indonesia**
14. **Liquefaction** occurs when soil loses strength during quakes

15. **Foreshocks** are smaller quakes before main shock
16. **Aftershocks** occur after main quake due to crust adjustment
17. **Interplate quakes** occur at plate boundaries (most destructive)
18. **Intraplate quakes** occur within plates (rarer but dangerous)
19. **Elastic Rebound Theory** explains earthquake mechanism
20. **Seismic gaps** are locked fault segments due for future quakes
21. **Bhimashankar fault** is near Mumbai (moderate risk zone)
22. **IS 1893** is India's earthquake resistant construction code
23. **Drop, Cover, Hold** is recommended during quakes
24. **National Centre for Seismology** monitors Indian earthquakes
25. **Latur 1993** (6.4 magnitude) was deadly intraplate quake

Volcanoes

1. Volcanoes are openings in Earth's crust emitting lava/gases
2. **Magma** is molten rock below surface; **lava** is above surface
3. **Active volcanoes** erupt regularly (e.g., Kilauea, Hawaii)
4. **Dormant volcanoes** are inactive but may erupt (e.g., Mt. Fuji)
5. **Extinct volcanoes** won't erupt again (e.g., Deccan Traps)
6. **Shield volcanoes** have gentle slopes (basaltic lava)
7. **Composite volcanoes** are steep (alternate lava+ash layers)
8. **Caldera** forms when volcano collapses after eruption
9. **Ring of Fire** has 75% of world's volcanoes (Pacific rim)
10. **Hotspots** are fixed magma sources (e.g., Hawaii, Réunion)
11. **Pyroclastic flow** is deadly fast-moving hot gas+ash
12. **Lahar** is volcanic mudflow (melting snow+ash)
13. **Volcanic bombs** are ejected molten rock blobs
14. **Fissure eruptions** occur through cracks (e.g., Deccan Traps)
15. **Barren Island** is India's only active volcano (Andamans)

16. **Deccan Traps** formed from massive eruptions 66 mya
17. **Mt. Vesuvius** destroyed Pompeii (79 AD)
18. **Krakatoa** eruption (1883) caused global cooling
19. **Volcanic Explosivity Index (VEI)** measures eruption size
20. **Geysers** are hot springs erupting water/steam
21. **Black smokers** are undersea volcanic vents
22. **Pumice** is volcanic rock that floats on water
23. **Volcanic ash** fertilizes soil but damages engines
24. **Sulfur dioxide** from eruptions causes acid rain
25. **Early warning signs**: earthquakes, gas emissions, ground swelling

✔ Most active volcano in India? → **Barren Island**
✔ Instrument to measure earthquakes? → **Seismograph**
✔ Deadliest volcanic hazard? → **Pyroclastic flow**

Rocks & Minerals (Igneous, Sedimentary, Metamorphic)

1. Rocks are aggregates of **one or more minerals**
2. **Igneous rocks** form from cooling magma (intrusive) or lava (extrusive)
3. **Granite** is intrusive igneous; **basalt** is extrusive
4. **Sedimentary rocks** form from compaction/cementation of sediments
5. **Sandstone** forms from sand; **limestone** from shells/coral
6. **Metamorphic rocks** form under heat/pressure (marble from limestone)
7. **Rock cycle** shows interconversion of rock types
8. **Pumice** is the only rock that floats (volcanic origin)
9. **Coal** is organic sedimentary rock (fossilized plants)
10. **Laterite** is residual metamorphic rock (high in iron/aluminum)
11. **Gneiss** shows banding (metamorphosed granite)
12. **Quartzite** is metamorphosed sandstone
13. **Conglomerate** has rounded pebbles; **breccia** has angular fragments
14. **Chalk** is soft limestone (microscopic marine organisms)
15. **Deccan Traps** are world's largest volcanic basalt deposits

16. Minerals are **naturally occurring inorganic solids** with definite composition
17. **Silicate minerals** are most abundant (90% of crust)
18. **Quartz** (SiO_2) is hardest common mineral (7 on Mohs scale)
19. **Diamond** is hardest mineral (10 on Mohs scale)
20. **Talc** is softest mineral (1 on Mohs scale)
21. **Mica** splits into thin sheets (perfect basal cleavage)
22. **Bauxite** is ore of aluminum (laterite deposits)
23. **Hematite** and **magnetite** are iron ores
24. **India's major mineral belts**: Chota Nagpur, Odisha, Rajasthan
25. **Kolar mines** (Karnataka)- famous for gold

Rock Cycle

26. **Weathering** breaks rocks into sediments
27. **Lithification** converts sediments to rock (compaction+cementation)
28. **Metamorphism** changes rocks without melting

✔ Example of metamorphic rock?
→ **Marble/Slate**
✔ Most abundant mineral group?
→ **Silicates**
✔ Process forming sedimentary rocks?
→ **Lithification**

Weathering & Erosion

Weathering

1. Weathering is the **breakdown of rocks** at Earth's surface
2. **Mechanical weathering** physically breaks rocks without chemical change
3. **Frost action** (freeze-thaw) widens cracks in rocks
4. **Exfoliation** occurs when rock layers peel off due to expansion/contraction
5. **Salt crystallization** in rocks causes granular disintegration
6. **Chemical weathering** alters rock composition (hydrolysis, oxidation)
7. **Carbonation** dissolves limestone (forms karst landscapes)
8. **Laterite** forms in tropics through intense chemical weathering
9. **Spheroidal weathering** rounds rock edges (onion-peel effect)
10. **Biological weathering** involves roots/lichens/burrowing animals
11. **Temperature extremes** (deserts) accelerate mechanical weathering
12. **Wetting-drying cycles** break clay-rich rocks
13. **Abrasion** by wind-blown sand weathers rock surfaces
14. **Tafoni** are honeycomb weathering patterns in sandstones
15. **Weathering produces regolith** (layer of loose rock fragments)

Erosion & Deposition

16. Erosion is the **transport of weathered material**
17. **Water erosion** forms gullies → ravines → badlands (e.g., Chambal)
18. **Wind erosion** creates yardangs (streamlined ridges)
19. **Glacial erosion** carves U-shaped valleys & cirques
20. **Wave erosion** forms sea cliffs, arches & stacks
21. **Soil erosion** removes fertile topsoil (major threat in India)
22. **Sheet erosion** removes uniform soil layers (first stage)
23. **Rill erosion** creates small channels (second stage)
24. **Gully erosion** forms deep trenches (e.g., Chambal ravines)
25. **Deposition** occurs when erosional agents lose energy
26. **Alluvial fans** form at mountain bases (e.g., Himalayan foothills)
27. **Delta** deposition requires slow river flow + weak tides (e.g., Sundarbans)
28. **Loess** deposits are wind-blown silt (e.g., North China)
29. **Moraines** are glacial deposits (lateral/medial/terminal)
30. **Contour ploughing** and **terracing** prevent soil erosion

✔ Example of chemical weathering?
→ **Limestone dissolving in rainwater**
✔ Major erosional landform in deserts?
→ **Yardangs**
✔ Best method to prevent soil erosion?
→ **Afforestation/Contour bunding**

Major Landforms (Mountains, Plateaus, Plains, Deserts)

Mountains

1. **Fold Mountains** form when tectonic plates collide (e.g., Himalayas, Alps)
2. **Block Mountains** created by faulting (e.g., Vosges, Black Forest)
3. **Volcanic Mountains** built from lava (e.g., Mt. Fuji, Kilimanjaro)
4. **Himalayas** are youngest fold mountains (<50 million years old)
5. **Mt. Everest** (8,848m) is world's highest peak in Great Himalayas
6. **Karakoram Range** has K2 (world's 2nd highest peak)
7. **Western Ghats** are block mountains (older than Himalayas)
8. **Aravalli Range** is India's oldest fold mountains (Precambrian)
9. **Lhotse** and **Makalu** are other 8,000m+ peaks in Himalayas
10. **Shiwaliks** are outermost Himalayan foothills (prone to landslides)

11. **Andes** are longest continental mountain range (7,000km)
12. **Ural Mountains** divide Europe and Asia
13. **Appalachians** are eroded fold mountains (North America)
14. **Alps** formed by African-Eurasian plate collision
15. **Mountain passes**: Zoji La, Nathu La, Shipki La (important in Himalayas)

Plateaus

16. **Plateaus** are flat-topped highlands with steep sides
17. **Deccan Plateau** covers 5 Indian states (basaltic lava origin)
18. **Chota Nagpur Plateau** is India's mineral heartland
19. **Tibetan Plateau** is world's highest ("Roof of the World")
20. **Colorado Plateau** has Grand Canyon (USA)
21. **Brazilian Plateau** has world's largest iron ore reserves
22. **Peninsular Plateaus** are India's oldest landmass (Gondwana)
23. **Malwa Plateau** lies between Aravallis and Vindhyas
24. **Meghalaya Plateau** has Cherrapunji (wettest place)
25. **African Plateaus** have Victoria Falls (Zambezi River)
26. **Anatolian Plateau** in Turkey is seismic zone
27. **Columbia Plateau** (USA) formed by flood basalts
28. **Karewas** are glacial deposits in Kashmir Valley
29. **Bundelkhand Plateau** spans UP and MP
30. **Ladakh Plateau** is cold desert at 3,000-5,000m altitude

Plains

31. **Plains** are flat/low-lying lands (<200m elevation)
32. **Indo-Gangetic Plain** is world's most fertile alluvial plain
33. **Northern Plains** formed by Indus, Ganga, Brahmaputra
34. **Bhabar** - Porous foothill zone (Shiwaliks)
35. **Terai** - Swampy/marshy zone south of Bhabar
36. **Bhangar** - Older alluvial soil (contains calcareous nodules)
37. **Khadar** - Younger alluvial soil (renewed every flood)
38. **Mississippi Plain** is North America's largest
39. **Pampas** are fertile South American grasslands
40. **Coastal Plains** include Coromandel and Malabar coasts

Deserts

41. **Deserts** receive <25cm annual rainfall
42. **Thar Desert** covers Rajasthan and parts of Pakistan

43. **Sahara** is world's largest hot desert (9.2 million km²)
44. **Atacama** is driest desert (Chile, <1mm rain/year)
45. **Gobi Desert** is cold desert (Mongolia/China)
46. **Kalahari** has red sand and drought-resistant plants
47. **Antarctica** is world's largest cold desert
48. **Sand dunes** include barchans (crescent-shaped)
49. **Oasis** forms where groundwater reaches surface
50. **Luni** is only significant river in Thar Desert

✔ Youngest mountains in India?
→ **Himalayas**
✔ Plateau known as 'Mineral Storehouse'?
→ **Chota Nagpur**
✔ River forming Sundarbans delta?
→ **Ganga-Brahmaputra**

Fluvial (River) Landforms

1. **V-shaped valleys** form in upper river courses through vertical erosion
2. **Waterfalls** occur where hard rock overlies soft rock (e.g., Jog Falls)
3. **Potholes** are circular depressions drilled by swirling pebbles
4. **Meanders** are sinuous bends in mature rivers (e.g., Ganga plains)
5. **Oxbow lakes** form when meander loops get cut off
6. **Floodplains** are flat lands built by periodic flooding
7. **Natural levees** are raised banks deposited during floods
8. **Delta** forms where river deposits exceed erosion (e.g., Sundarbans)
9. **Estuary** forms where tidal erosion dominates (e.g., Narmada)
10. **Alluvial fans** are cone-shaped deposits at mountain bases
11. **Canyons** are deep gorges (e.g., Grand Canyon)
12. **Rapids** occur where river gradient suddenly increases
13. **Braided streams** have multiple channels (e.g., Brahmaputra)
14. **Terrace** is a former floodplain now elevated
15. **Peneplain** is final stage of fluvial erosion (near-flat surface)

Aeolian (Wind) Landforms

16. **Yardangs** are streamlined ridges carved by wind (Egypt)
17. **Zeugen** are mushroom-shaped rocks in deserts
18. **Ventifacts** are wind-polished rocks with flat faces
19. **Sand dunes** migrate downwind (5 types: barchan, transverse, etc.)
20. **Barchans** are crescent-shaped dunes (common in Thar)

21. **Loess** is wind-deposited silt (e.g., North China Plains)
22. **Desert pavement** forms when fine particles blow away
23. **Playas** are temporary desert lakes (Rann of Kutch)
24. **Mesa** and **butte** are flat-topped erosional remnants
25. **Blowouts** are wind-scoured depressions

Coastal Landforms

26. **Sea cliffs** form by wave undercutting
27. **Wave-cut platforms** are flat surfaces at cliff base
28. **Sea caves** form where weak rock is eroded
29. **Arches** develop when caves break through headlands
30. **Stacks** are isolated pillars (e.g., Needles, UK)
31. **Beaches** are wave-deposited sand/pebble accumulations
32. **Spits** are linear deposits attached at one end (e.g., Chilika)
33. **Tombolo** connects island to mainland (e.g., Adam's Bridge)
34. **Barrier islands** parallel to coast (e.g., Havelock)
35. **Atolls** are circular coral reefs on submerged volcanoes

Glacial Landforms

36. **Cirque** is bowl-shaped valley head (origin of glacier)
37. **Arête** is sharp ridge between cirques
38. **Horn** is pyramidal peak (e.g., Matterhorn)
39. **U-shaped valley** carved by glacial erosion
40. **Fjords** are glacial valleys flooded by sea (Norway)
41. **Moraines** are glacial debris (lateral/medial/terminal)
42. **Drumlins** are streamlined hills of glacial till
43. **Eskers** are sinuous ridges of glacial meltwater deposits
44. **Kame** is small mound of stratified drift
45. **Roche moutonnée** is asymmetrical rock knob

Karst Landforms

46. **Limestone** dissolves to form karst landscapes
47. **Sinkholes** are funnel-shaped collapse features
48. **Caves** form by groundwater dissolution (e.g., Borra Caves)
49. **Stalactites** hang from cave roofs; **stalagmites** rise from floor
50. **Polje** is large flat-floored karst depression

✔ **Chambal ravines** are **fluvial** badland erosion

✔ **Thar Desert** has **barchan** dunes

✔ **Andaman Islands** have **atolls**

CLIMATOLOGY (ATMOSPHERE & WEATHER)

Layers of the Atmosphere

1. The atmosphere is divided into five main layers: **troposphere, stratosphere, mesosphere, thermosphere, and exosphere**.
2. The **troposphere** is the lowest layer, extending up to about 8-18 km.
3. Most weather phenomena like rain and storms occur in the **troposphere**.
4. The **stratosphere** contains the **ozone layer**, which absorbs harmful UV rays.
5. The **mesosphere** is where most meteors burn up upon entry.
6. The **thermosphere** helps in radio transmission by reflecting radio waves.
7. The **exosphere** is the outermost layer, merging into space.
8. The **troposphere** is thicker at the equator than at the poles.
9. The **stratosphere** has almost no weather disturbances, making it ideal for jet flights.
10. Temperature decreases with height in the **troposphere**.
11. Temperature increases in the **stratosphere** due to ozone absorption.
12. The **mesosphere** is the coldest layer, with temperatures dropping to -90°C.
13. The **thermosphere** has extremely high temperatures (up to 1500°C) due to solar radiation.
14. The **ionosphere**, a part of the thermosphere, aids in long-distance communication.
15. The **ozone layer** is found between 15-35 km in the stratosphere.
16. The **Kármán line** (100 km above sea level) marks the boundary between Earth and space.
17. Almost 75% of the atmosphere's mass lies in the **troposphere**.
18. The **exosphere** consists mainly of hydrogen and helium gases.
19. Air pressure decreases as we move higher in the atmosphere.
20. The **stratopause** is the boundary between the stratosphere and mesosphere.

Wind Systems (Trade Winds, Westerlies, Jet Streams)

Trade Winds

1. Trade winds blow from the **subtropical high-pressure belts** (30° N & S) towards the **equatorial low-pressure belt**.
2. In the Northern Hemisphere, trade winds blow as **northeast trade winds**.
3. In the Southern Hemisphere, trade winds blow as **southeast trade winds**.

4. Trade winds are named so because they helped **sailing ships in trade routes** during ancient times.
5. The **Intertropical Convergence Zone (ITCZ)** is where trade winds from both hemispheres meet.

Westerlies

6. **Westerlies** blow from the **subtropical high-pressure belts** (30° N & S) towards the **subpolar low-pressure belts** (60° N & S).
7. In the Northern Hemisphere, westerlies blow as **southwest winds**.
8. In the Southern Hemisphere, westerlies blow as **northwest winds**.
9. Westerlies are stronger in the **Southern Hemisphere** due to fewer landmasses.
10. **Roaring Forties, Furious Fifties, and Shrieking Sixties** are names for strong westerlies in the Southern Ocean.

Polar Winds

11. **Polar easterlies** blow from the **polar high-pressure zones** towards the **subpolar low-pressure zones**.
12. Polar winds are **cold and dry** due to their origin in polar regions.

Jet Streams

13. **Jet streams** are fast-flowing, narrow air currents in the **upper troposphere or lower stratosphere**.
14. The **subtropical jet stream** flows near 30° N & S at about **12 km altitude**.
15. The **polar front jet stream** flows near 60° N & S and influences **temperate cyclones**.
16. Jet streams have speeds of **120–250 km/h** (sometimes exceeding **400 km/h**).
17. Jet streams help in **faster air travel** when flying eastward.
18. The **shift of jet streams** affects monsoon winds in India.

Monsoon Winds & Local Winds

19. **Monsoon winds** are seasonal winds that reverse direction between summer and winter.
20. **Sea breeze** occurs during the day when wind blows from sea to land.
21. **Land breeze** occurs at night when wind blows from land to sea.
22. **Mountain winds (Katabatic winds)** flow downhill at night.
23. **Valley winds (Anabatic winds)** flow uphill during the day.

Pressure Belts & Coriolis Effect

24. The **Coriolis force** deflects winds to the **right in the Northern Hemisphere** and **left in the Southern Hemisphere**.
25. **Doldrums** are calm, low-wind zones near the equator where trade winds converge.

PRESSURE BELTS

1. Earth has **four major pressure belts**: Equatorial Low, Subtropical High, Subpolar Low, and Polar High.
2. The **Equatorial Low-Pressure Belt** (0°-5° N/S) is also called the **Doldrums** due to calm winds.
3. The **Subtropical High-Pressure Belts** (30° N/S) are called **Horse Latitudes** due to weak winds.
4. The **Subpolar Low-Pressure Belts** (60° N/S) are zones of stormy weather and cyclones.
5. The **Polar High-Pressure Belts** (90° N/S) are cold and dry due to sinking air.
6. Pressure belts **shift north-south** with the apparent movement of the Sun.
7. The **Intertropical Convergence Zone (ITCZ)** is part of the Equatorial Low and shifts seasonally.
8. Subtropical Highs are regions of **descending air**, causing dry climates (e.g., deserts).
9. The **Coriolis force** deflects winds, creating trade winds and westerlies between pressure belts.
10. **Trade Winds** blow from Subtropical Highs (30°) to Equatorial Lows (0°).
11. **Westerlies** flow from Subtropical Highs (30°) to Subpolar Lows (60°).
12. **Polar Easterlies** move from Polar Highs (90°) to Subpolar Lows (60°).
13. Pressure belts are **weaker over oceans** due to uniform surfaces.
14. The **thermal factor** (heating/cooling) and **dynamic factor** (Earth's rotation) create pressure belts.
15. **Monsoon winds** are influenced by seasonal shifts in pressure belts.

Cyclones (Tropical & Temperate)

1. Tropical cyclones form over **warm ocean waters** (above 26.5°C) between **5°-30° latitudes**.
2. Temperate cyclones occur in **mid-latitudes** (30°-60°) due to interaction of **cold and warm air masses**.
3. In India, tropical cyclones mostly affect the **eastern coast** (Bay of Bengal region).
4. The **eye** of a tropical cyclone is a calm, low-pressure center surrounded by violent winds.
5. Tropical cyclones rotate **counter-clockwise** in Northern Hemisphere and **clockwise** in Southern Hemisphere.
6. Temperate cyclones are also called **extratropical cyclones** or **wave cyclones**.
7. The **Coriolis force** is essential for the rotation and formation of cyclones.
8. Tropical cyclones are called **hurricanes** in Atlantic, **typhoons** in Pacific, and **cyclones** in Indian Ocean.

9. Temperate cyclones bring **frontal rainfall** that can last for several days.
10. The **Saffir-Simpson scale** (Category 1-5) measures tropical cyclone intensity.
11. Tropical cyclones cause **storm surges** - rise in sea level that floods coastal areas.
12. **Jet streams** influence the movement and intensity of temperate cyclones.
13. Tropical cyclones weaken rapidly after landfall due to **loss of moisture source**.
14. The **ITCZ** (Intertropical Convergence Zone) shifts and affects tropical cyclone formation.
15. Temperate cyclones have **cold and warm fronts** that produce different weather patterns.
16. The **Bay of Bengal** experiences more cyclones than Arabian Sea due to higher sea temperatures.
17. Tropical cyclones need **low wind shear** to maintain their vertical structure.
18. **NDRF** (National Disaster Response Force) plays crucial role in cyclone disaster management.
19. Cyclone warnings in India are issued by **IMD** (India Meteorological Department).
20. Temperate cyclones can cause **blizzards** in winter and **thunderstorms** in summer.
21. The **fujiwhara effect** occurs when two cyclones orbit each other.
22. Tropical cyclones release energy through **latent heat of condensation**.
23. **Cyclogenesis** refers to the development and strengthening of cyclones.
24. The **eye wall** of tropical cyclone has the most violent winds and heaviest rainfall.
25. **Cyclone shelters** and early warning systems help reduce cyclone damage in coastal areas.

Monsoons in India (SW & NE Monsoon)

1. India's climate is dominated by the **Southwest (SW) Monsoon** (June-September) and **Northeast (NE) Monsoon** (October-December).
2. The **SW Monsoon** brings **75% of India's annual rainfall** and is crucial for agriculture.
3. The **NE Monsoon** affects mainly **Tamil Nadu, Andhra Pradesh, and parts of Karnataka**.
4. Monsoon winds reverse direction seasonally due to **differential heating** of land and sea.
5. The **SW Monsoon** originates from the **Mascarene High** (near Madagascar) in the Indian Ocean.
6. The **monsoon trough** is a low-pressure zone that shifts northward during SW Monsoon.

7. **Kerala** is the first state to receive SW Monsoon rains (around **June 1st**).
8. The **Arabian Sea branch** and **Bay of Bengal branch** are two arms of SW Monsoon.
9. The **Bay of Bengal branch** causes heavy rainfall in **Northeast India** (Cherrapunji/Mawsynram).
10. The **Arabian Sea branch** brings rain to **Western Ghats** and **West Coast**.
11. **Mumbai** receives heavy rain from the Arabian Sea branch, while **Kolkata** gets rain from Bay of Bengal branch.
12. **Monsoon breaks** are periods of reduced rainfall during the SW Monsoon season.
13. The **NE Monsoon** is also called **Retreating Monsoon** as winds withdraw from India.
14. **Tamil Nadu** receives **50% of its annual rainfall** from NE Monsoon (Oct-Dec).
15. The **Inter-Tropical Convergence Zone (ITCZ)** shifts northward in summer, triggering SW Monsoon.
16. **El Niño** weakens SW Monsoon, often causing **droughts** in India.
17. **La Niña** strengthens SW Monsoon, leading to **above-average rainfall**.
18. **Monsoon depressions** form in the Bay of Bengal and move inland, causing widespread rain.
19. The **onset of monsoon** is announced by IMD when **60% of stations report rainfall**.
20. **Western Disturbances** (winter) and **NE Monsoon** bring rain to North India in cold weather.
21. **Cherrapunji** (Meghalaya) receives the **highest rainfall in India** due to SW Monsoon.
22. The **Thar Desert** remains dry as the **Aravalli Range** blocks monsoon winds.
23. The **burst of monsoon** refers to sudden heavy rainfall when monsoon arrives.
24. **Andaman & Nicobar Islands** receive monsoon rains **15-20 days before mainland India**.
25. The **monsoon withdrawal** begins from **Rajasthan** in September and completes by December.

El Niño & La Niña

1. **El Niño** refers to the periodic warming of sea surface temperatures in the central/eastern **Pacific Ocean**.
2. **La Niña** is the cooling phase with unusually cold ocean temperatures in the same region.
3. Together, El Niño and La Niña form the **El Niño-Southern Oscillation (ENSO)** cycle.
4. El Niño typically occurs every **2-7 years** and lasts **9-12 months**.
5. During El Niño, **trade winds weaken** or reverse direction over the Pacific.

6. La Niña features **stronger-than-normal trade winds** pushing warm water westward.
7. El Niño causes **droughts in Australia/SE Asia** but **heavy rains in South America**.
8. La Niña brings **above-average rainfall to Australia/Indonesia** and **drier conditions to Americas**.
9. In India, El Niño is associated with **weaker monsoon rains** and drought conditions.
10. La Niña years often see **stronger Indian monsoons** with above-average rainfall.
11. The **1997-98 El Niño** was one of the strongest recorded events in history.
12. ENSO events impact **global weather patterns**, agriculture and economies worldwide.
13. El Niño was named ("The Christ Child") by Peruvian fishermen noticing warm waters around Christmas.
14. During El Niño, the **thermocline deepens** in eastern Pacific, reducing upwelling.
15. La Niña enhances **upwelling of nutrient-rich waters**, benefiting fisheries.
16. The **Southern Oscillation Index (SOI)** measures pressure differences between Tahiti and Darwin.
17. **Walker Circulation** weakens during El Niño and strengthens during La Niña.
18. El Niño can cause **coral bleaching** due to warmer ocean temperatures.
19. La Niña winters are typically **colder and snowier** in northern U.S. and Canada.
20. The **2015-16 El Niño** contributed to record global temperatures and droughts.
21. ENSO events affect **tropical cyclone formation** in Atlantic and Pacific basins.
22. El Niño reduces **hurricane activity** in Atlantic but increases in Pacific.
23. **Indian Ocean Dipole (IOD)** sometimes interacts with ENSO to affect Indian monsoon.
24. Scientists use **buoys, satellites and climate models** to predict ENSO events.
25. The **IMD monitors ENSO conditions** to forecast Indian monsoon performance.

Global Climate Change

1. **Global warming** refers to the long-term rise in Earth's average surface temperature.
2. The **greenhouse effect** is natural but enhanced by human activities increasing GHG concentrations.
3. Major greenhouse gases (GHGs) include **CO_2, methane (CH_4), nitrous oxide (N_2O), and CFCs**.
4. **CO_2 levels** have increased from 280 ppm (pre-industrial) to over 420 ppm today.
5. **Methane** is 25 times more potent than CO_2 as a greenhouse gas (over 100 years).

6. **Human activities** like burning fossil fuels, deforestation, and industries are primary causes.
7. **Natural factors** like volcanic eruptions and solar variations also influence climate.
8. **IPCC** (Intergovernmental Panel on Climate Change) assesses climate change science.
9. Global temperature has risen by **~1.1°C since pre-industrial times**.
10. **Paris Agreement (2015)** aims to limit global warming to **well below 2°C**, preferably 1.5°C.
11. **Climate change impacts** include rising sea levels, melting glaciers, and extreme weather events.
12. **Himalayan glaciers** are retreating at alarming rates due to warming.
13. **Sea levels** have risen by ~20 cm since 1900 due to thermal expansion and ice melt.
14. **Ocean acidification** occurs as oceans absorb excess CO_2, harming marine life.
15. **Coral bleaching** increases due to warmer and more acidic oceans.
16. **Permafrost thawing** releases trapped methane, creating a feedback loop.
17. **Deforestation** contributes ~15% of global CO_2 emissions annually.
18. **Renewable energy** (solar, wind) helps reduce reliance on fossil fuels.
19. **Kyoto Protocol (1997)** was the first international treaty to limit GHG emissions.
20. **Carbon footprint** measures total GHG emissions caused by an individual/activity.
21. **Mitigation** strategies include afforestation, clean energy, and energy efficiency.
22. **Adaptation** measures include building resilient infrastructure and early warning systems.
23. **Climate justice** emphasizes equitable solutions for vulnerable nations.
24. **India's INDC** targets 40% non-fossil fuel energy capacity by 2030 under Paris Agreement.
25. **Sustainable development** balances economic growth with environmental protection.

OCEANOGRAPHY

HYDROSPHERE

1. The **hydrosphere** includes all water bodies on Earth - oceans, seas, rivers, lakes, groundwater, and glaciers.
2. **97% of Earth's water** is saline (oceans) while only **3% is freshwater**.
3. Of freshwater, **68.7% is locked in glaciers**, **30.1% is groundwater**, and just **1.2% is surface water**.
4. The **Pacific Ocean** is the largest and deepest ocean, covering about **1/3 of Earth's surface**.
5. **Ocean currents** are driven by winds, Earth's rotation (Coriolis effect), and water density differences.
6. **Tides** are caused by the gravitational pull of the Moon and Sun on Earth's waters.
7. **Spring tides** (highest tides) occur during full moon and new moon phases.
8. **Neap tides** (lowest tides) occur during quarter moon phases.
9. **Waves** are generated by wind transferring energy to water surface.
10. The **continental shelf** is the shallow, biologically rich extension of continents underwater.
11. **Ocean salinity** averages 35 parts per thousand (ppt), highest in the Red Sea (~40ppt).
12. The **Mariana Trench** in Pacific Ocean is the deepest known point on Earth (~11km deep).
13. **Tsunamis** are giant waves caused by underwater earthquakes or volcanic eruptions.
14. **El Niño** affects ocean temperatures and currents in the Pacific, impacting global weather.
15. The **water cycle** shows continuous movement of water between atmosphere, land, and oceans.
16. **Groundwater** is stored in aquifers - porous rock layers that hold water.
17. **Water table** is the upper level of groundwater saturation in soil/rock.
18. **Artesian wells** occur when water rises to surface under natural pressure.
19. **Cryosphere** refers to frozen water parts - glaciers, ice caps, and permafrost.
20. **Glaciers** store about **69% of world's freshwater** and are important freshwater sources.
21. The **Gangotri Glacier** is source of River Ganga, retreating due to climate change.
22. **Ocean pollution** from plastic waste, oil spills, and chemicals threatens marine life.
23. **Coral reefs** (like Great Barrier Reef) are marine biodiversity hotspots facing bleaching threats.
24. **Estuaries** where rivers meet oceans are highly productive ecosystems.

25. **UN Sustainable Development Goal 14** aims to conserve and sustainably use oceans and marine resources

Ocean Currents (Warm & Cold)

1. **Ocean currents** are continuous, directional movements of seawater driven by wind, Earth's rotation, and water density differences.
2. **Warm currents** flow from equatorial regions towards poles (e.g., Gulf Stream), while **cold currents** move from polar regions towards equator (e.g., Labrador Current).
3. The **Gulf Stream** is a powerful warm current in the Atlantic Ocean that influences Europe's climate.
4. The **Kuroshio Current** is a warm Pacific current similar to the Gulf Stream.
5. Cold **Benguela Current** (Atlantic) and **Peru Current** (Pacific) create coastal deserts by reducing rainfall.
6. The **North Atlantic Drift**, an extension of Gulf Stream, keeps western Europe warmer than similar latitudes.
7. **Upwelling** occurs when cold, nutrient-rich waters rise to surface (e.g., Peru Current), supporting rich fisheries.
8. The **West Wind Drift** (Antarctic Circumpolar Current) is the only current that circles Earth uninterrupted.
9. **El Niño** weakens the cold Peru Current, causing warm water to spread along South American coast.
10. The **Coriolis Effect** deflects currents right in Northern Hemisphere and left in Southern Hemisphere.
11. **Cold Oyashio Current** flows southward along Russia's east coast in the Pacific.
12. The **Agulhas Current** is a warm western boundary current in Indian Ocean.
13. **California Current** is a cold current along USA's west coast that creates foggy conditions.
14. Warm **Brazil Current** meets cold **Falkland Current** off Argentina, creating rich fishing grounds.
15. The **East Australian Current** (warm) influences Great Barrier Reef's tropical ecosystem.
16. **Monsoon currents** in Indian Ocean reverse direction seasonally with wind patterns.
17. The **Canary Current** (cold) flows south along northwest Africa, contributing to Sahara's dryness.
18. **Labrador Current** (cold) brings icebergs into North Atlantic shipping lanes.
19. Currents help **distribute heat globally** - warm currents carry heat poleward, cold currents bring cool water equatorward.
20. The **Sargasso Sea** is a calm region in Atlantic surrounded by currents, known for floating seaweed.

21. **Density currents** form when cold, salty water sinks (e.g., in Arctic and Antarctic regions).
22. The **Great Ocean Conveyor Belt** is a global circulation system connecting all ocean basins.
23. **West Australian Current** is a cold current that moderates Australia's western climate.
24. Currents affect **navigation** - ships use favorable currents to save fuel and time.
25. **Ocean eddies** are circular currents that spin off main currents, influencing local marine life.

Tides (Spring & Neap)

1. **Tides** are periodic rise and fall of sea levels caused by gravitational pull of Moon and Sun.
2. **Spring tides** occur during **full moon and new moon** (Syzygy position) when Sun-Moon-Earth align.
3. **Neap tides** occur during **first and third quarter moons** (Quadrature position) when Sun and Moon form 90° angle.
4. Spring tides have **highest high tides and lowest low tides** due to combined gravitational pull.
5. Neap tides have **minimum tidal range** as Sun's pull counteracts Moon's pull.
6. The **time gap between two high tides** is approximately 12 hours 26 minutes.
7. **Tidal range** (height difference between high-low tide) varies by location and moon phase.
8. **Bay of Fundy** (Canada) has world's highest tidal range (up to 16 meters).
9. Tides help in **navigation** - ships enter/exit ports during high tide.
10. **Tidal energy** is harnessed as renewable energy in some coastal regions.
11. **Perigean spring tides** (when Moon is closest to Earth) cause extra-high tides.
12. **Apogean tides** (when Moon is farthest) produce weaker tidal effects.
13. Tides help in **mixing ocean waters**, bringing nutrients to surface.
14. **Mangrove ecosystems** depend on regular tidal flushing for survival.
15. India's **Gulf of Khambhat** has highest tidal range (11 meters) in Indian subcontinent.

Coral Reefs & Mangroves

1. **Coral reefs** are underwater ecosystems formed by calcium carbonate secretions from corals (marine invertebrates).
2. **Mangroves** are salt-tolerant trees/shrubs that grow in tropical coastal intertidal zones.
3. **Great Barrier Reef** (Australia) is the world's largest coral reef system, visible from space.

4. **Fringing reefs** grow directly from shorelines, while **barrier reefs** grow parallel to coasts with lagoons.
5. **Atolls** are ring-shaped coral reefs that encircle lagoons, often formed on submerged volcanoes.
6. Coral reefs thrive in **warm (20-28°C), shallow, clear, and sunlit tropical waters**.
7. **Zooxanthellae** (symbiotic algae) give corals color and provide 90% of their food via photosynthesis.
8. **Coral bleaching** occurs when stressed corals expel zooxanthellae due to warming, pollution, or acidification.
9. **Sundarbans** (India-Bangladesh) is the world's largest mangrove forest and a UNESCO World Heritage Site.
10. Mangroves have **pneumatophores** (aerial roots) to breathe in oxygen-poor muddy soils.
11. **Mangroves protect coasts** from erosion, tsunamis, and cyclones by reducing wave energy.
12. **Sundari tree** (Heritiera fomes) dominates Sundarbans and gives the region its name.
13. Coral reefs are called **"rainforests of the sea"** due to their high biodiversity (25% marine species).
14. **Gulf of Kutch** and **Gulf of Mannar** have India's major coral reef ecosystems.
15. Both coral reefs and mangroves are **threatened by climate change, pollution, and human activities** like coastal development.

Major Seas, Gulfs, and Straits

1. **Arabian Sea** - India's western maritime boundary, connecting to Persian Gulf via Gulf of Oman.
2. **Bay of Bengal** - World's largest bay, receiving waters from Ganga-Brahmaputra rivers.
3. **Mediterranean Sea** - Almost landlocked sea connecting Europe, Africa and Asia.
4. **Red Sea** - Separates Arabian Peninsula from Africa, known for high salinity.
5. **Persian Gulf** - Shallow marginal sea with world's largest oil reserves.
6. **Gulf of Mexico** - Ninth largest water body, hurricane-prone region.
7. **Strait of Hormuz** - Strategic chokepoint for 20% of world's oil shipments.
8. **Strait of Malacca** - Busiest shipping strait between Sumatra and Malaysia.
9. **Bering Strait** - 85 km wide passage between Asia and North America.
10. **Black Sea** - Anoxic basin connected to Mediterranean via Turkish Straits.
11. **Caspian Sea** - World's largest inland water body with oil and gas reserves.
12. **South China Sea** - Disputed waters with important shipping lanes.
13. **Gulf of Aden** - Connects Red Sea to Arabian Sea, piracy-affected zone.

14. **English Channel** - Narrow sea separating UK from continental Europe.
15. **Panama Canal** - Artificial 82 km waterway cutting across Central America.
16. **Suez Canal** - Artificial sea-level waterway connecting Mediterranean to Red Sea.
17. **Baltic Sea** - Northern Europe's brackish inland sea with low salinity.
18. **Caribbean Sea** - Tropical sea with world's second largest barrier reef.
19. **Andaman Sea** - Marginal sea of Indian Ocean east of Bay of Bengal.
20. **Bosphorus Strait** - Divides Istanbul and connects Black Sea to Marmara Sea.
21. **Dardanelles Strait** - Links Sea of Marmara to Aegean Sea.
22. **Babu el Mandeb** - Connects Red Sea to Gulf of Aden.
23. **Davis Strait** - Separates Greenland from Canada's Baffin Island.
24. **Torres Strait** - Passage between Australia and New Guinea.
25. **Palk Strait** - Narrow channel between India and Sri Lanka.

BIOGEOGRAPHY

Ecosystems & Biomes

1. **Ecosystem** - A functional unit where living organisms interact with their physical environment.
2. **Biome** - Large-scale community of plants/animals adapted to specific climate conditions.
3. **Tropical Rainforest** - Found near equator with high rainfall (2000mm+) and biodiversity.
4. **Deciduous Forest** - Moderate climate biome with trees shedding leaves annually.
5. **Grassland** - Dominated by grasses, found in both tropical (savanna) and temperate regions.
6. **Desert** - Receives <250mm annual rainfall, with specialized drought-resistant species.
7. **Taiga** - World's largest terrestrial biome with coniferous forests in cold climates.
8. **Tundra** - Treeless Arctic biome with permafrost and low-growing vegetation.
9. **Marine Ecosystem** - Covers 71% of Earth's surface with high salt concentration.
10. **Freshwater Ecosystem** - Includes lakes, rivers and wetlands with <1% salt content.
11. **Estuary** - Transition zone where rivers meet oceans, mixing fresh and saltwater.

12. **Food Chain** - Linear sequence of energy transfer from producers to consumers.
13. **Food Web** - Complex network of interconnected food chains in an ecosystem.
14. **Producers** - Autotrophs (plants/algae) that convert solar energy into food.
15. **Consumers** - Heterotrophs that obtain energy by eating other organisms.
16. **Decomposers** - Break down dead organic matter (bacteria/fungi) recycling nutrients.
17. **Energy Pyramid** - Shows 90% energy loss at each trophic level.
18. **Carbon Cycle** - Movement of carbon through atmosphere, organisms and Earth.
19. **Nitrogen Cycle** - Conversion of nitrogen between atmospheric and usable forms.
20. **Phosphorus Cycle** - Slow cycling of phosphorus through rocks, soil and organisms.
21. **Biodiversity** - Variety of life at genetic, species and ecosystem levels.
22. **Ecological Succession** - Gradual change in species composition over time.
23. **Keystone Species** - Organism that disproportionately impacts ecosystem structure.
24. **Endemic Species** - Found only in specific geographic location.
25. **Biosphere Reserves** - Protected areas for conservation and sustainable development.

Equatorial Biome

1. The **Equatorial Biome** is found near the **equator (0°-10° latitude)** with **year-round warmth (25°C-30°C)**.
2. It receives **heavy rainfall (2000mm+ annually)** with **no distinct dry season**.
3. **Tropical Rainforests** (Amazon, Congo, Indonesia) dominate this biome.
4. **High biodiversity** – home to **50% of Earth's plant and animal species**.
5. **Dense canopy structure** with **emergent, canopy, understory, and forest floor** layers.
6. **Evergreen trees** dominate due to constant growing conditions.
7. **Tall hardwood trees** (mahogany, teak, ebony) are common.
8. **Epiphytes** (air plants like orchids) grow on trees to access sunlight.
9. **Lianas** (woody vines) climb trees to reach sunlight.
10. **Buttress roots** support tall trees in shallow, nutrient-poor soils.
11. **Red & yellow laterite soils** are common but nutrient-deficient due to leaching.
12. **High decomposition rate** due to warm, moist conditions, recycling nutrients quickly.
13. **Major fauna** include jaguars, toucans, tree frogs, and insects like army ants.
14. **Deforestation** (logging, agriculture) is the biggest threat to this biome.

15. **Important for global oxygen production & carbon storage** ("Lungs of the Earth").

Deciduous Biome

1. **Deciduous forests** are found in **temperate zones (30°-50° latitude)** with **four distinct seasons**.
2. They experience **moderate rainfall (750-1500mm annually)** and **warm summers/cold winters**.
3. **Trees shed leaves in autumn** to conserve water during winter (*deciduous* = "*falling off*").
4. Dominant trees include **oak, maple, beech, and hickory**.
5. **Soil is fertile (brown forest soil)** due to leaf litter decomposition.
6. **Stratified layers**: Canopy, understory, shrub layer, and forest floor.
7. **Animals adapt to seasonal changes** (hibernation, migration).
8. Common fauna: **deer, foxes, squirrels, black bears, and migratory birds**.
9. **Eastern USA, Europe, and parts of China** have major deciduous forests.
10. **Less biodiversity** than rainforests but richer than boreal forests.
11. **Human impact**: Logging, agriculture, and urbanization threaten these forests.
12. **Autumn foliage** (color-changing leaves) is a distinctive feature.
13. **Found in India** in parts of the Himalayas and Eastern Ghats.
14. **More sunlight reaches the forest floor** compared to dense rainforests.
15. **Important for timber, tourism, and carbon sequestration**.

Coniferous Biome

1. **Coniferous forests** are found in **cold climates (50°-70° N latitude)** like Canada, Siberia & Scandinavia.
2. Also called **Taiga** or **Boreal Forest** – the **world's largest terrestrial biome**.
3. Dominated by **cone-bearing evergreen trees** (pine, spruce, fir, cedar).
4. Trees have **needle-like leaves** to reduce water loss in freezing winters.
5. **Winters are long/harsh** (-30°C to -50°C), while summers are short/cool.
6. **Low precipitation (300-900mm/year)**, mostly as snow.
7. **Thin, acidic podzol soil** with slow decomposition due to cold.
8. **Adaptations**: Trees have **pyramid shapes** to shed snow easily.
9. **Animals include moose, reindeer, wolves, bears, and migratory birds**.
10. **Limited undergrowth** due to poor sunlight penetration and acidic soil.
11. **Largest carbon sink** among forests due to vast tree cover.
12. **Logging for softwood** (paper, timber) is a major economic activity.

13. **Found in Himalayas** (India) at high altitudes (e.g., Kashmir, Himachal).
14. **Vulnerable to wildfires** due to dry summers and resin-rich trees.
15. **Slow nutrient cycling** because of cold temperatures and low microbial activity.

Desert Biome

1. **Deserts** are arid regions with **less than 250 mm annual rainfall** and extreme temperatures.
2. **Hot deserts** (Sahara, Thar) have scorching days (50°C+) and cold nights.
3. **Cold deserts** (Gobi, Ladakh) have freezing winters and mild summers.
4. **Soil is sandy/rocky** with low organic matter due to minimal vegetation.
5. **Plants like cacti** have **thick stems, waxy coatings, and deep/spread roots** to conserve water.
6. **Animals adapt via nocturnal habits** (active at night) and **water storage** (camels).
7. **Thar Desert** (India-Pakistan) is the most densely populated desert globally.
8. **Ladakh** is a cold high-altitude desert with sparse vegetation.
9. **Ephemeral plants** grow quickly after rare rains, completing life cycles in weeks.
10. **Kangaroo rats** survive without drinking water, extracting moisture from seeds.
11. **Sand dunes** are shaped by wind, reaching heights of 100+ meters.
12. **Oases** are fertile desert areas with groundwater access, supporting settlements.
13. **High evaporation rates** exceed rainfall, causing dry conditions.
14. **Human threats**: Overgrazing, deforestation, and unsustainable irrigation.
15. **Solar energy potential** is high due to clear skies and abundant sunlight.

TUNDRA BIOME

1. **Tundra** is the **coldest biome**, found in the **Arctic and high mountains** (Alaska, Siberia, Himalayas).
2. **Permafrost** (permanently frozen subsoil) prevents deep root growth and water drainage - **No trees**
3. **Extremely short summers** (2-6°C) and **long, harsh winters** (-30°C to -50°C).
4. **Low precipitation** (150-250 mm/year), mostly as snow.
5. **Treeless landscape** with only **low-growing plants** (mosses, lichens, grasses, dwarf shrubs).
6. **Growing season lasts just 50-60 days**, limiting plant diversity.
7. **Animals adapt with thick fur** (polar bears, Arctic foxes), **migration** (caribou), or **hibernation**.
8. **Birds like snowy owls** and **insects (mosquitoes)** thrive briefly in summer.

9. **Alpine tundra** exists on high mountains (e.g., Himalayas) below snowlines.
10. **Fragile ecosystem** with slow recovery due to cold and short growing periods.
11. **Midnight sun** (24-hour daylight in summer) and **polar night** (24-hour darkness in winter).
12. **Carbon sink**: Stores large amounts of CO_2 in permafrost, now threatened by melting.
13. **Indigenous communities** (Inuit, Sami) rely on hunting (seals, reindeer) for survival.
14. **Climate change impact**: Fastest-warming biome, causing permafrost thaw and habitat loss.

BIODIVERSITY HOTSPOTS

1. **Biodiversity hotspots** are regions with **high species richness** and **extreme habitat loss** (must have ≥1,500 endemic plants and ≤30% original vegetation).
2. **34 global hotspots** cover just **2.3% of Earth's land** but host **>50% of world's plant species** and **42% of terrestrial vertebrates**.
3. **Himalayas** – India's major hotspot with **endemic species like snow leopard, red panda, and rhododendrons**.
4. **Western Ghats & Sri Lanka** – Home to **Nilgiri tahr, lion-tailed macaque**, and **3,000+ endemic plants**.
5. **Indo-Burma** (NE India) – Rich in **orchids, river dolphins, and hoolock gibbons**.
6. **Sundaland** (Andaman & Nicobar) – Features **coral reefs, dugongs, and Nicobar megapode**.
7. **Criteria for hotspots**: **High endemism** + **>70% habitat destruction**.
8. **Madagascar** – 90% of its wildlife (e.g., lemurs) is **found nowhere else**.
9. **Atlantic Forest (Brazil)** – Only **7% remains** of its original cover.
10. **Philippines** – One of the **most threatened hotspots** (93% forest loss).
11. **Mediterranean Basin** – High plant diversity (**25,000 species**) but **degraded by agriculture**.
12. **Tropical Andes** – Most biodiverse hotspot with **1/6 of global plant species**.
13. **Mountains of Central Asia** – Habitat for **snow leopards and wild Bactrian camels**.
14. **New Caledonia (Pacific)** – 80% of its plants are **endemic**, e.g., **kauri trees**.
15. **Eastern Afromontane** – Home to **mountain gorillas and Ethiopian wolves**.
16. **Threats**: Deforestation, climate change, poaching, and invasive species.
17. **Conservation International** identifies and monitors these hotspots.
18. **India has 4 hotspots**: Himalayas, Western Ghats, Indo-Burma, Sundaland.

PAGE FOR NOTES