GEOGRAPHY MIND MAP 11.4.2024

11 April 2024 09:19

Mind Mapping

Physical-Geography-...

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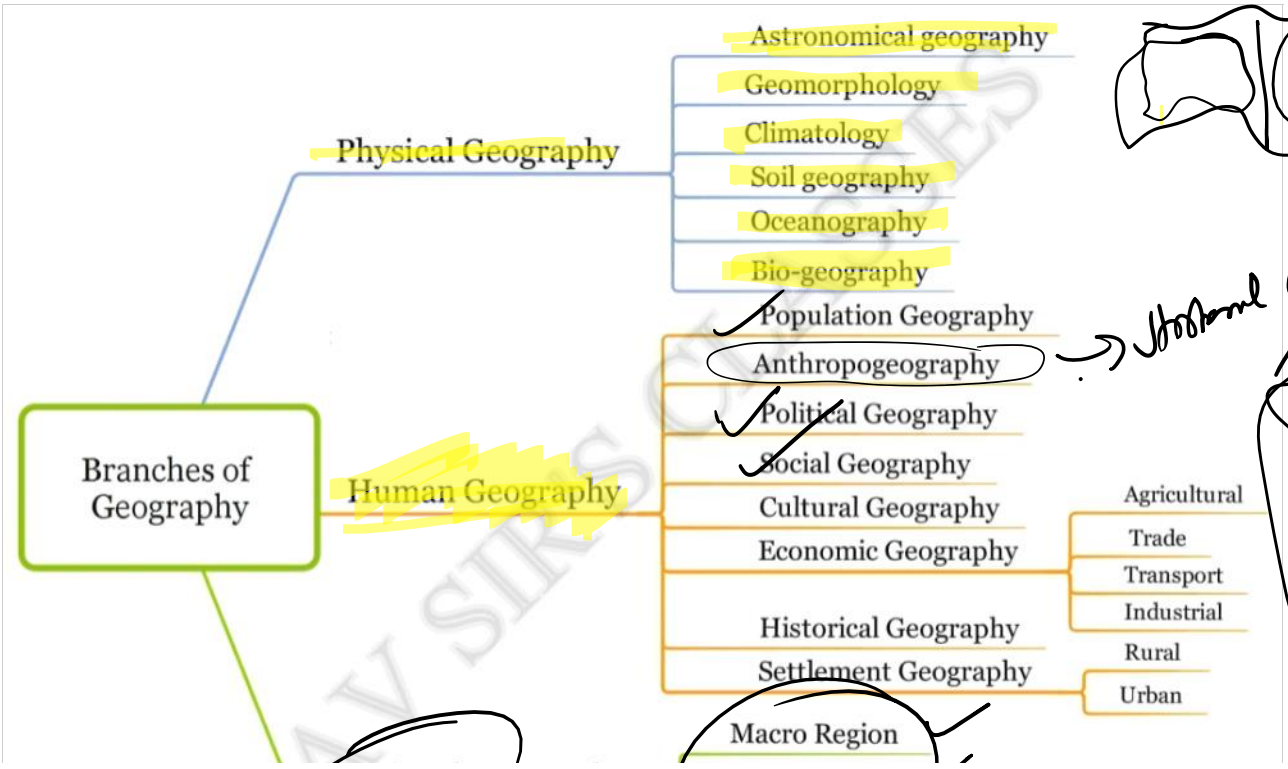

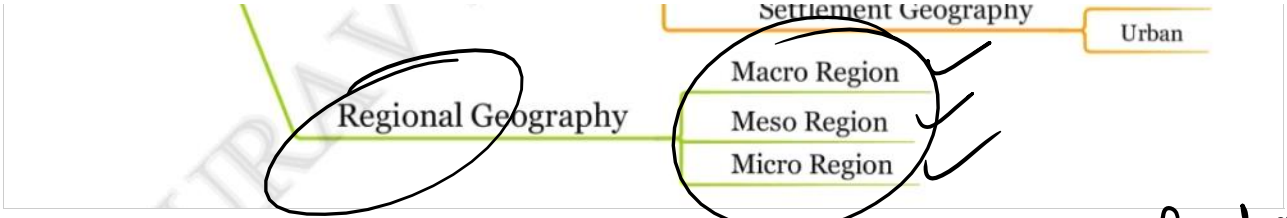
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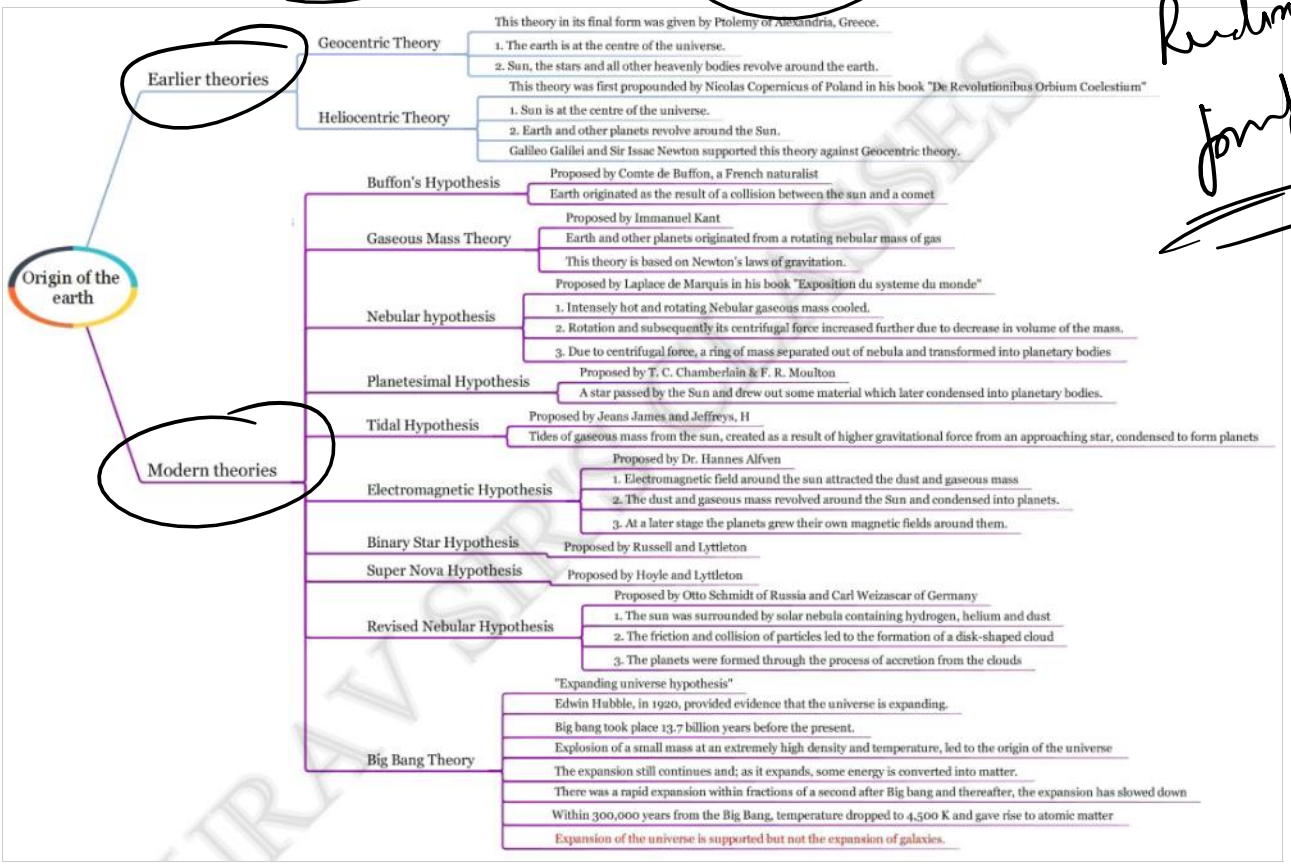
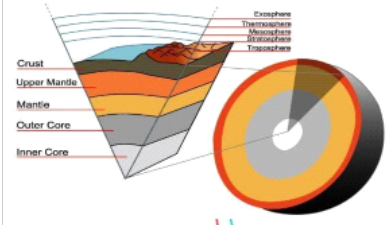
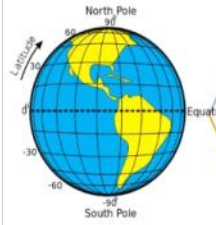

Origin of the earth
Earlier theories
Geocentric Theory
This theory in its final form was given by Ptolemy of Alexandria, Greece.
1. The earth is at the centre of the universe.
2. Sun, the stars and all other heavenly bodies revolve around the earth.
Heliocentric Theory
This theory was first propounded by Nicolas Copernicus of Poland in his book "De Revolutionibus Orbium Coelestium"
1. Sun is at the centre of the universe.
2. Earth and other planets revolve around the Sun.
Galileo Galilei and Sir Issac Newton supported this theory against Geocentric theory.
Modern theories
Buffon's Hypothesis
Proposed by Comte de Buffon, a French naturalist
Earth originated as the result of a collision between the sun and a comet
Gaseous Mass Theory
Proposed by Immanuel Kant
Earth and other planets originated from a rotating nebular mass of gas
This theory is based on Newton's laws of gravitation.
Nebular hypothesis
Proposed by Laplace de Marquis in his book "Exposition du systeme du monde"
1. Intensely hot and rotating Nebular gaseous mass cooled.
2. Rotation and subsequently its centrifugal force increased further due to decrease in volume of the mass.
3. Due to centrifugal force, a ring of mass separated out of nebula and transformed into planetary bodies
Planetesimal Hypothesis
Proposed by T. C. Chamberlain & F. R. Moulton
A star passed by the Sun and drew out some material which later condensed into planetary bodies.
Tidal Hypothesis
Proposed by Jeans James and Jeffreys, H
Tides of gaseous mass from the sun, created as a result of higher gravitational force from an approaching star, condensed to form planets
Electromagnetic Hypothesis
Proposed by Dr. Hannes Alfven
1. Electromagnetic field around the sun attracted the dust and gaseous mass
2. The dust and gaseous mass revolved around the Sun and condensed into planets.
3. At a later stage the planets grew their own magnetic fields around them.
Binary Star Hypothesis
Proposed by Russell and Lyttleton
Super Nova Hypothesis
Proposed by Hoyle and Lyttleton
Revised Nebular Hypothesis
Proposed by Otto Schmidt of Russia and Carl Weizascar of Germany
1. The sun was surrounded by solar nebula containing hydrogen, helium and dust
2. The friction and collision of particles led to the formation of a disk-shaped cloud
3. The planets were formed through the process of accretion from the clouds
Big Bang Theory
"Expanding universe hypothesis"
Edwin Hubble, in 1920, provided evidence that the universe is expanding.
Big bang took place 13.7 billion years before the present.
Explosion of a small mass at an extremely high density and temperature, led to the origin of the universe
The expansion still continues and; as it expands, some energy is converted into matter.
There was a rapid expansion within fractions of a second after Big bang and thereafter, the expansion has slowed down
Within 300,000 years from the Big Bang, temperature dropped to 4,500 K and gave rise to atomic matter
Expansion of the universe is supported but not the expansion of galaxies.

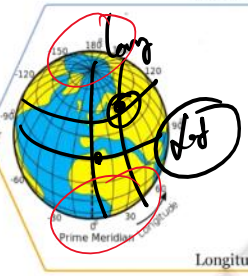
- shape of the earth
  - Oblate spheroid
    - slightly flattened at the poles and bulging at the equator.
- Layers of the Earth
  - 1. Crust
    - Outermost layer of the Earth
      - 1. Continental crust
      - 2. Oceanic crust
    - Composition
      - made of solid rocks
      - made of the lighter elements
        - silicon, aluminium and oxygen
        - known as **sial or felsic**.
      - Elements by percentage
        - 1. Oxygen 47%
        - 2. Silicon 28%
        - 3. Aluminium 8%
        - 4. Iron 5%
        - 5. Calcium 3.5%
      - Compounds by percentage
        - 1. Silica
        - 2. Alumina
        - 3. Lime
  - 2. Mantle
    - layer below the crust
    - Composition
      - Made of
        - silicon, oxygen and Magnesium
        - known as **sima or mafic**.
      - The density of the Mantle increases gradually with depth.
    - Layers
      - 1. Upper mantle
        - solid base of the crust
        - made of the heavy rock peridotite.
      - 2. Upper aesthenosphere
        - layer is fluidic due to high pressure and temperature
        - leads to movement of continental plates
      - 3. Lower aesthenosphere
      - 4. Lower mantle
  - 3. Core
    - Innermost layer of the earth
    - Composition
      - core is made of solid iron and nickel
      - known as **nife**
    - Layers
      - 1. Outer core
        - molten layer below the mantle
      - 2. Inner core
        - Solid
        - due to high pressure
- Discontinuities
  - are the boundaries between layers of earth
    - found by analysis of the seismic waves
  - 1. Conrad discontinuity
    - Between Upper crust and Lower crust
    - named after Victor Conrad
  - 2. Mohorovicic discontinuity
    - Between Crust and Aesthenosphere
    - named after Andrija Mohorovicic
    - It lies at a depth of about
      - 20 miles under the continents
      - 4 to 6 miles under the oceans.
  - 3. Repetti discontinuity
    - Between the upper mantle and the lower mantle
  - 4. Gutenberg discontinuity
    - Between lower mantle and the core
  - 5. Lehman discontinuity
    - Between outer core and the inner core
- Important points
  - Lithosphere = Crust + Upper mantle
    - Oceanic lithosphere
    - Continental lithosphere
  - Thickness of continental crust is higher than oceanic crust
  - Mantle is the largest layer by mass and volume, followed by crust and core respectively
  - Earth's density increases gradually from crust to core
  - Oceanic crust is denser than continental crust



Rotation of the Earth

- Movement
  - Earth rotates on its axis from west to east
    - the reason for the apparent motion of the sun from east to west
  - Earth rotates once in every 23 hours, 56 minutes, 4.0916 seconds
- Apparent rotations
  - From the North Pole, the direction of Earth's rotation is perceived as counterclockwise or anticlockwise direction.
  - From the South Pole, the direction of Earth's rotation is perceived as clockwise direction.
- Velocity of the rotations
  - The rotational velocity at the poles is almost equal to zero
  - The greatest rotational velocity is found at the Equator
  - The rotational velocity at the 60° latitudes is equal to half of the velocity found at the equator
- Effects
  - 1) Day and night
    - Part of earth facing the sun experiences day
    - Part of earth facing away from the sun experiences Night
    - The line around the Earth separating the light and dark halves is called "The circle of illumination"
  - 2) Circulations
    - Atmospheric circulation
      - Circulation of atmosphere along its layers
      - Coriolis force
    - Oceanic circulation
      - Movement of waters in ocean
      - Ocean cycle
        - takes 10,000 years to complete a cycle





- Latitudes are imaginary lines around the Earth parallel to the equator — also called as 'parallels'
  - Characteristics
    - Latitudes gradually decrease in size from the equator(Great circle) towards the pole
    - Degree of latitude is greater at the pole(111.7 km) than at the equator(110.7 km)
  - Measurements
    - Latitude of a place is the angular distance measured either north or south from the equator
    - Distance between the latitudes are constant
    - The length of 60° latitude is half the length of the Equator.
    - The length of 75° latitude is 1/4th of the length of the Equator.
  - Important Latitudinal lines
    - Arctic circle - 66 1/2° N
    - Tropic of cancer - 23 1/2° N
    - Equator - 0° — largest of all latitudes — also called as zero degree latitude
    - Tropic of Capricorn - 23 1/2° S
    - Antarctic circle - 66 1/2° S
  - Sample Calculation
    - What is the distance 12 degrees north of equator?
    - Solution: 12 x 111.044(average value of a degree latitude) = 1332.5 km
- Longitudes are series of semi-circles passing from north to south direction crossing the equator — also known as Meridians
  - Characteristics
    - All meridians are equal in length
    - Meridians extend up to 180° from the east and west of Prime meridian
    - All meridians cross the equator at right angle
    - Degree of longitude is greater at the equator(111.3 km) and decreases gradually towards the Pole(0 km)
  - Zero degree meridian or Prime Meridian
    - Chosen in 1884
    - Prime meridian divides the sphere into two hemispheres
    - Passes through the Royal Astronomical Observatory at Greenwich, London
    - Greenwich Meridian has been adopted internationally as the Standard meridian.
  - Measurements
    - Longitude of a place is the angular distance between a point on any meridian and the prime meridian at Greenwich
    - Longitude of a place is measured either east or west from the Prime meridian
    - Positive longitudes - Longitudes counted west of Prime meridian are called positive longitudes.
    - Negative longitudes - Longitudes counted east of Prime meridian are called negative longitudes.

Revolution of the Earth

- Movement
  - Earth revolves round the sun once in every 365.256363004 days
  - Plane of Ecliptic
    - Earth revolves around the sun in an elliptical orbit called "Plane of ecliptic"
    - Earth's equator makes an angle of 23 and 1/2 degrees with the plane of the ecliptic. — responsible for change in seasons
    - Earth's axis is inclined at an angle of 66 and 1/2 degrees with the plane of the ecliptic
  - The speed of the Earth revolution along its orbit is 107,000 kph or 29·72 km/s.
- Effects
  - 1) Variations in length of day and night
    - Poles experience 6 months of days and 6 months of nights
    - Tropics experience almost equal length of day and night
  - 2) Change of seasons — four divisions of the year into spring, summer, autumn, and winter marked by particular weather patterns and daylight hours
  - 3) Distance between Earth and Sun
    - The distance between Earth and Sun varies, due to the elliptical shape of the Earth's orbit around the sun
    - a) Perihelion(3rd January) - The Earth is closest to the sun(≈147 million km)
    - b) Aphelion(4th July) - The Earth is farthest from the sun(≈152 million km) .
    - Change in distance between the Earth and the Sun does not cause any change in the length of day or night.
  - 4) Equinoxes
    - Two days, where the sun is vertically overhead at the equator.
    - 1) Vernal Equinox(21st or 22nd March) - Sun starts to move towards Tropic of cancer
    - 2) Autumnal Equinox(22nd or 23rd September) - Sun starts to move towards tropic of Capricorn
    - Insolation energy is equal in both hemispheres
  - 5) Solstices
    - Either of the two times of the year when the sun is at its greatest distance from the celestial equator
    - 1) Summer solstice
      - Falls on June 21st or 22nd
      - Sun is vertically overhead at the tropic of cancer
      - Longest day and shortest night at Northern hemisphere
      - Insolation energy is greater in Northern hemisphere
    - 2) Winter solstice
      - Falls on December 21 or 22
      - Sun is vertically overhead at the tropic of Capricorn
      - Longest day and shortest night at Southern hemisphere
      - Insolation energy is greater in Southern hemisphere
  - 6) Leap Year
    - Earth takes 365 and 1/4 days to complete one revolution = 365 days and 6 hours
    - Every 4th year the fraction of 6 hours from the previous 3 years is cumulated and added as 29th of February to form the leap year(366 days).

Time and International date line

- International Date line
  - It is the 180° longitude line where the date changes by one day when crossed.
  - Adopted at the International Meridian Conference held in Washington in 1884
  - A day is
    - gained when crossed from west to east
    - lost when crossed from east to west
- Time
  - Time advances in eastward direction and decreases in westward direction
  - Places east of Greenwich gain time and places west of Greenwich lose time
  - Units
    - 1 Revolution of earth = 360° or 24 hours
    - 15° = 1 hour
    - 1° = 4 minutes
  - Time zones
    - World is divided into 24 Standard Time Zones
    - Each zone differs by 15°(1 hour)
    - Countries with highest number of time zones
      1. France - 12 time zones
      2. Russia - 11 time zones
      3. UK = 9 time zones
      4. Australia = 8 time zones
      5. Canada = 6 time zones
- Kinds
  - Sidereal Time
    - Sidereal time is the time measured by the diurnal motion of stars
    - The Sidereal day is also divided into 24 hours, each hour into 60 minutes and each minute into 60 seconds.
  - Apparent Solar Time
    - Apparent solar time is the time as measured by the apparent position of the sun in the sky
    - Sun dial is used to measure the apparent solar time.
    - Apparent solar day is not of uniform length and hence, it is not synchronous with regular clock speed
  - Mean solar time
    - Time measured based on the diurnal motion of the mean sun is called 'Mean solar time' or Mean Time
    - Mean sun is an imaginary sun moving uniformly along the celestial equator to make a solar day of uniform length
    - Mean solar time was devised to rectify the drawback in Apparent solar time.
    - Mean solar day is divided into 24 hours, each hour into 60 minutes and each minute into 60 seconds
    - Two systems
      - Civil time
        - Ante Meridian - From midnight to noon
        - Post Meridian - From noon to midnight
      - Astronomical time — Starts at zero hours and ends at 24th hour.
    - Since 1st January 1925, Mean Solar Day began at midnight which was at noon prior to that.
  - Standard time
    - It is the uniform time for places in approximately the same longitude, established in a country or region by law
    - India Standard Time(IST) = 82.5° east = UTC+05:30 (Universal Time Coordinated.) .
    - IST location: 82.5° E longitude, in Shankargarh Fort mirzapur ,(25.15°N 82.58°E), Allahabad, U.P.
    - Local mean time of the places on the — eastern side of Prime meridian is later than standard time

- Standard time
  - It is the uniform time for places in approximately the same longitude, established in a country or region by law
  - India Standard Time(IST) = 82.5° east = UTC+05:30 (Universal Time Coordinated.) .
  - IST location: 82.5° E longitude, in Shankargarh Fort mirzapur ,(25.15°N 82.58°E), Allahabad, U.P.
  - Local mean time of the places on the
    - eastern side of Prime meridian is later than standard time
    - western side of Prime meridian is earlier than standard time

- Classification of rocks
  - 1) Igneous rocks
    - Formation
      - Through cooling and solidification of molten rock(magma)
      - Magma, after reaching the surface is called as Lava
    - Properties
      - Igneous rocks are crystalline in texture
    - Types
      - Based on chemical composition
        - 1) Acidic
          - High proportion of silica
          - less dense and lighter in colour
        - 2) Basic
          - Higher proportion of basic oxides(Fe, Al)
          - denser and darker in colour
      - Based on their origin
        - 1) Intrusive rocks or Plutonic rocks
          - Formed inside the crust
          - plutonic or crystalline rocks are formed by slower cooling process
          - vast formations of plutonic rocks are called as **Batholith**
          - Types
            - Granite
            - Gabbros
        - 2) Extrusive rocks or Volcanic rocks
          - Formed by cooling of molten rocks(lava) from the volcano
          - Solidifies rapidly under the atmosphere
          - Types of formations
            - Lava flows
            - Lava sheets
            - Lava plateaus e.g. Deccan Plateau
          - Types
            - Basalt
            - Rhyolite
  - 2) Sedimentary rocks
    - Formation
      - Formed through sedimentation process
      - Transformation of sediments into rocks by the processes of compaction and cementation is called Lithification.
    - Properties
      - they are non-crystalline and layered in structure
      - there are both hard and soft forms of sedimentary rocks
      - fossils are formed in this rock
    - Types
      - 1) Clastic rocks
        - rocks formed by the accumulation of older rocks
        - composed of silicate minerals and rock fragments
        - Types
          - Sandstones
          - Shale
      - 2) Chemical rocks
        - rocks formed by chemical precipitation of mineral constituents in a solution
        - Types
          - Gypsum
          - Nitrates
          - Barites
      - 3) Organic or Biochemical rocks
        - formed by the accumulation of remains of organic matter
        - formed under high pressure
        - Types
          - Coal
          - Limestone
          - Chalk
  - 3) Metamorphic rocks
    - Formation
      - Igneous and Sedimentary rocks transform into metamorphic rocks under high temperature and pressure
      - Important metamorphic rocks
        - Clay --> Slate
        - Coal --> Graphite
        - Limestone --> Marble
        - Granite --> Gneiss
        - Sandstone --> Quartzite
        - Shale --> Schist
    - Types
      - 1) Foliated rocks
      - 2) Non-foliated rocks

Mountains

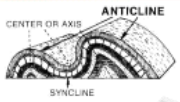
Orogeny

- Orogenesis refers to the forces and events leading to a large structural deformation of the Earth's lithosphere due to tectonic plates.
- Continental plate is crumpled and pushed upwards to form mountain ranges
- Orogenesis involves
  - Folding, faulting, volcanic activity, igneous intrusion and metamorphism to form mountains
- Forms of mountains
  1. Mountain ridge
     - chain of mountains or hills that form a continuous elevated crest for some distance
  2. Mountain range/barrier/belt/chain/system
     - geographic area containing numerous geologically related mountains
     - e.g. Himalayas, Alps, Andes etc...

Types

1) Fold Mountains

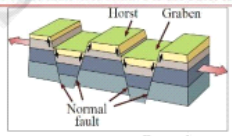
- Continental crust floating above the mantle is forced upward to form hills, plateaus or mountains
- Fold mountains are formed when
  - two plates collide under stress
  - there is an imbalance in weight of overlying rocks
  - there are variations in mantle flow
  - there is an intrusion of magma
- Fold mountains are formed under compressive forces



- Crust is folded into
  - 1) Syncline — Trough or Downfold of the crust
  - 2) Anticline — Crest or Upfold of the crust
- Many active volcanoes are found in fold mountains
- Major fold mountains
  - Himalayas in Asia
  - Alps in Europe
  - Andes in South America
  - Rockies in North America
  - Urals in Russia

2) Block or Fault mountains

- Block mountains are formed when the crust rifts or faults
- Block mountains are formed under both tension and compressive forces
- One side of the fault rises relative to the other forming a mountain



- Formations
  - The uplifted blocks form block mountains or horsts
  - The dropped blocks form graben and rift valleys
- Major Block mountains
  - Rift valley in Africa
  - Narmada river Valley in India between the Vindhya and Satpura horsts.
  - Rhine valley in Europe
  - Vosges mountains in France
  - Black forest in Germany

3) Volcanic mountains

- Formed when molten rock or lava erupts, and piles upon the surface
- Types
  - Shield Volcano
  - Strato volcano
  - Dome mountains
- Major Volcano mountains
  - Mount Fuji in Japan
  - Mount Pinatubo in the Philippines
  - Navajo Mountain in the United States
  - Mount Catopaxi in Ecuador

4) Plateau or Erosion mountains

- Formed by denudation or weathering forces
- Large mountains are subjected to the agents of erosion (water, wind, ice, and gravity) which results in plateaus
- Major plateaus of erosion
  - Deccan plateau

Plateau

Basics

- A relatively flat highland is called as plateau
- Plateaus are also known as tablelands

Types

1. Continental plateau

- Also known as Tectonic or Intermontane plateau
- Formed by the upliftment of earth due to plate tectonics
- They are vast and have almost uniform altitude
- Plateau enclosed by fold mountains are called intermont plateau
- e.g. Tibetan plateau is enclosed by Himalayas and Kunlun mountains

2. Volcanic or lava plateau

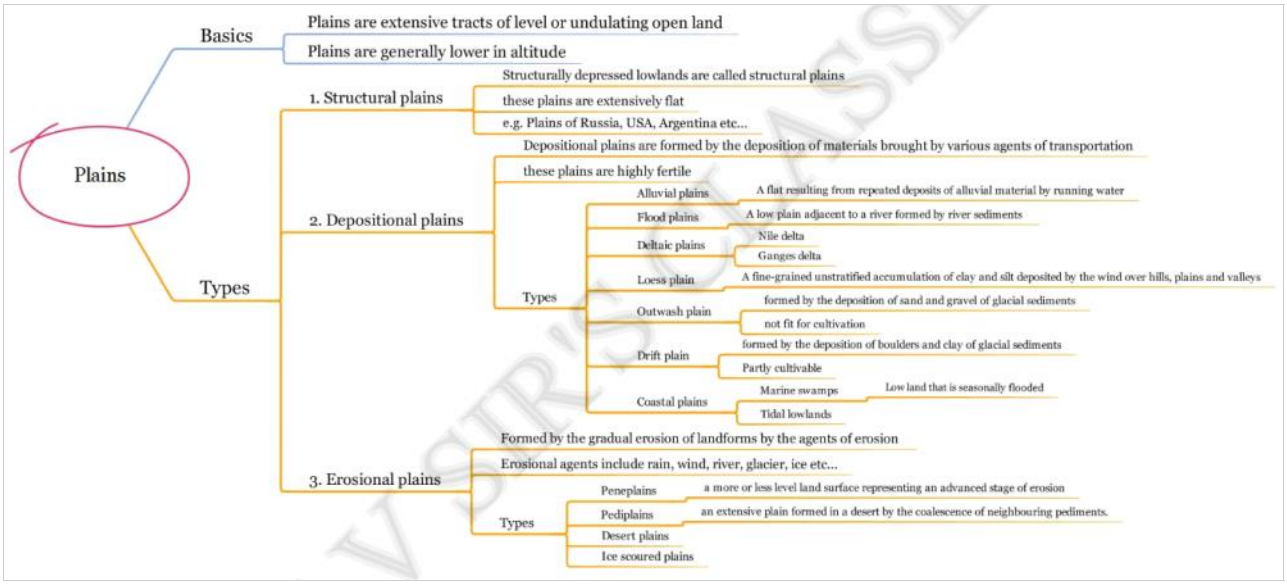
- lava flows in the form of successive layers of sheets and cools to form volcanic plateau
- Important lava plateau
  - Deccan plateau
  - Columbian plateau

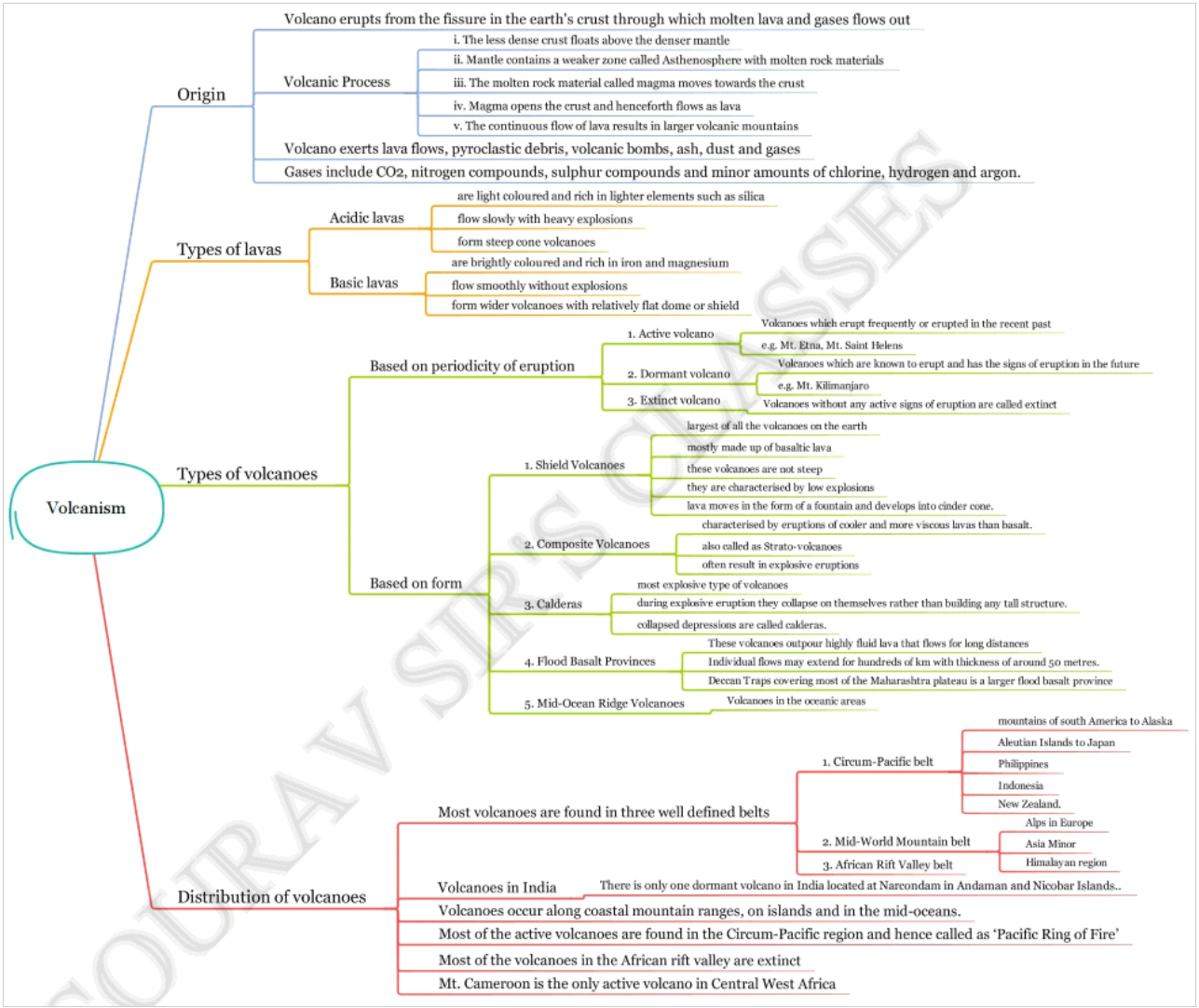
3. Border plateau

- Formed along the borders of Mountain ranges
- e.g. Piedmont plateau, Colorado plateau

4. Dissected or erosional plateau

- Plateaus are worn down by the weathering processes to form the dissected plateau
- e.g. Scottish islands





Seismic waves

Basics

- Waves generated by the earthquake are called seismic waves
- Study of earthquake is called Seismology.
- Speed of seismic waves
  - in crust is around 2-8 Km per second
  - in mantle is around 8-13 Km per second
- Instruments used to measure seismic waves
  - Seismograph
  - Accelerometer
  - Geophone
  - Hydrophone

Earthquake Waves

Characteristics

- The velocity of waves changes as they travel through materials with different densities.
- Waves travel with higher velocity in denser materials
- Waves change their direction as they reflect or refract across materials with different densities.

1. Body waves

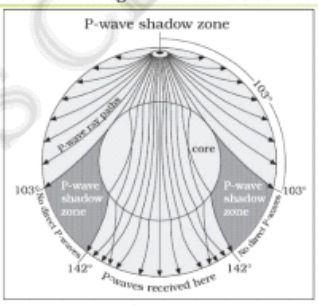
- generated due to the release of energy at the focus
- Body waves travel through the body of earth in all directions
- Two types
  - P-waves
    - P-waves are faster and are the first to arrive at the surface
    - also called as primary waves
    - P-waves are similar to sound waves
    - They vibrate parallel to the direction of waves
    - They travel through gaseous, liquid and solid materials
  - S-waves
    - S-waves arrive at the surface with some time lag
    - also called as secondary waves
    - they can travel only through solid materials
    - S-waves vibrates in the direction perpendicular to the wave direction
    - S-waves are more destructive than P-waves
    - used by scientists to understand the structure of the interior of the earth.

2. Surface waves

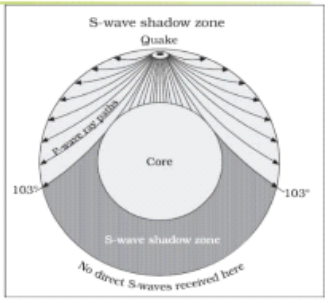
- body waves interact with the surface rocks and generate new set of waves called surface waves.
- Surface waves travel along the surface.

Shadow Zone

- areas where the earthquake waves are not reported
- for each earthquake, there exists an altogether different shadow zone.



1) shadow zones of P-waves



2) shadow zones of S-waves

- observations
  - seismographs located within 105° from the epicentre, recorded the arrival of both P and S-waves.
  - seismographs located beyond 145° from epicentre, recorded P-waves, but not S-waves.
  - zone between 105° and 145° from epicentre is the shadow zone for both the types of waves.
  - entire zone beyond 105° does not receive S-waves
  - The shadow zone of S-wave is much larger than that of the P-waves.

Earthquake

Origin

- Shaking and vibration at the surface of the earth is called earthquake
- Earthquake releases energy, which generates waves that travel in all directions.
- Earthquake results from the underground movement along a fault plane or from volcanic activity

Process

i. Rocks along a fault tend to move in opposite directions.
ii. But the overlying rock strata presses and locks them together
iii. at some point they overcome the friction and the blocks get deformed and slide past one another abruptly
iv. This results in the release of energy, and the energy waves travel in all directions

Terms

- Focus/Hypocentre — The point where the energy is released is called the focus of an earthquake or hypocentre.
- Epicentre — The point on the surface, nearest to the focus, is called epicentre.
  - It points directly above the focus.
  - It is the first point to experience the waves.
- Magnitude of earthquake — Quantitative measure of the size of the earthquake at its source
- Intensity of earthquake — severity of earthquake shaking
  - intensity is variable over the area affected by the earthquake
    - high intensities near the epicentre
    - lower intensities away from the epicentre

Types of Earthquakes

1. Tectonic earthquakes — due to sliding of rocks along a fault plane.
2. Volcanic earthquakes — confined to areas of active volcanoes
3. Collapse earthquakes — due to intense mining activity
4. Explosion earthquakes — due to the explosion of chemical or nuclear devices.
5. Reservoir induced earthquakes — earthquakes that occur in the areas of large reservoirs

Measurement of earthquakes

Earthquakes are measured using a device called Seismograph
Earthquakes are scaled either according to the magnitude or intensity of the shock.

1) Magnitude scale

known as the Richter scale.
Richter Magnitude Scale measures the amount of seismic energy released by an earthquake.
Richter scale is a base-10 logarithmic scale developed by Charles Richter and Beno Gutenberg
magnitude is expressed in absolute numbers, 0-10.

2) Intensity scale

intensity is assessed using a descriptive scale called Modified Mercalli Intensity Scale.
The intensity scale takes into account the visible damage caused by the event.
The range of intensity scale is from 1-12.

Earthquakes in India

Causes

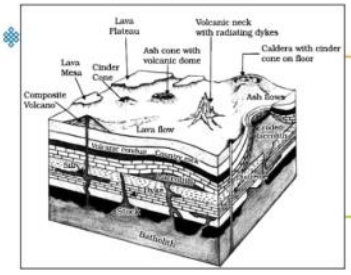
Movement of Indian plate towards the Asian continental plate at the rate of 45 mm per year
Rotation of Indian plate in anticlockwise direction.
Convergence of Indian plate with Tibetan plate

Seismic zones of India

Four zones

- Zone - II - Low damage risk zone
- Zone - III - Moderate damage risk zone
  - Andaman and Nicobar islands
  - parts of Kashmir
  - Western Himalayas
- Zone - IV - High damage risk zone
  - Delhi
  - Bihar
  - Indo-Gangetic plain
  - Jammu
  - Kashmir
- Zone - V - Highest risk zone
  - Punjab
  - Himalayas
  - Northeastern states
  - Rann of Kutchch
- Zone I has been removed

Volcanic landforms



Intrusive Forms

- Sill — a flat (usually horizontal) mass of igneous rock between two layers of older sedimentary rock
- Dyke — a vertical intrusion of igneous rock cutting across existing layers of rocks
- Laccolith — a mass of igneous rock, typically lens-shaped, that has been intruded between rock strata causing uplift in the shape of a dome
- Lopolith — a large saucer-shaped intrusion of igneous rock.
- Phacolith — A small lenticular igneous intrusion, shaped by folding in an anticline
- Batholith — Large mass of intrusive igneous rock believed to have solidified deep within the earth

Extrusive forms

- Crater
- Cinder cones
- Ash flows
- Lava flows
- Crater lakes
- Calderas
- Parasitic cones

Weathering

Basics

- Weathering is the gradual disintegration of rocks by the combined action of exogenic and endogenic forces of earth
- Weathering elements include wind, temperature, rainfall, frost, fog, ice etc...
- Weathering contributes significantly to soil formation
- Various processes of weathering helps in producing different colours and properties of soil

Types

1) Physical Weathering

disintegration of rocks without any chemical change

1. Block disintegration — disintegration of rocks by expansion and contraction of the rocks due to temperature variations
   - high diurnal range of temperature causes successive expansion and contraction of the rocks
2. Exfoliation — peeling of rocks due to intense heating of outer layers of the rock
3. Frost Action — alternate freezing and melting of water inside the joints of the rocks, splits them into fragments

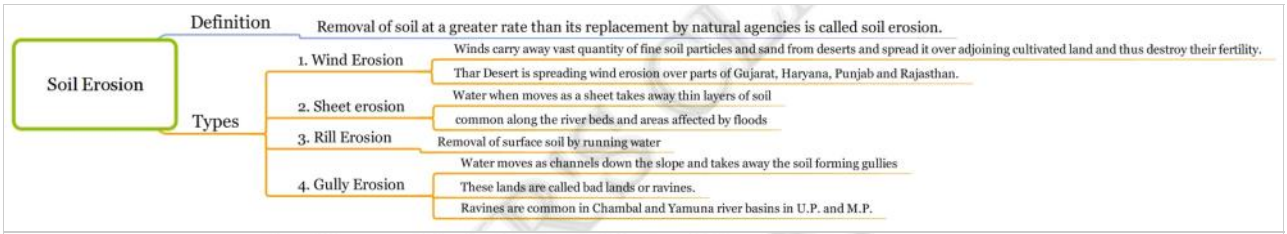
2) Chemical weathering

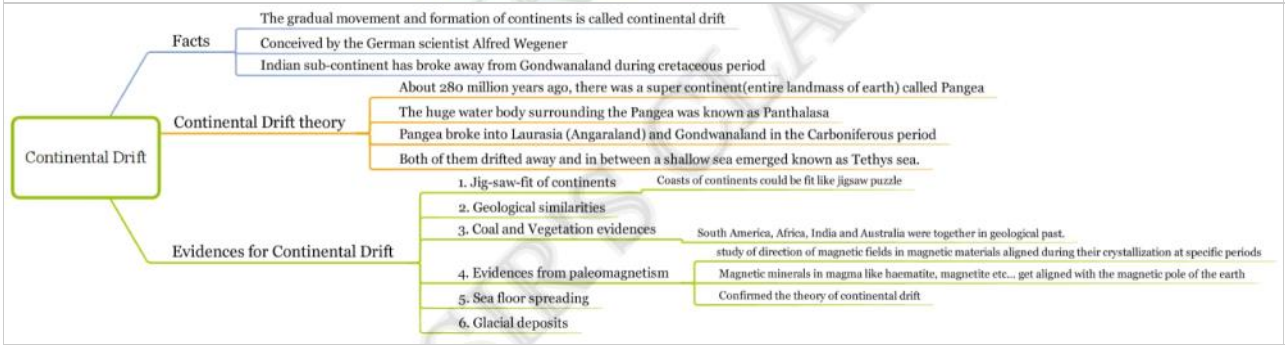
change in the rocks through formation of new compounds
Chemical processes include oxidation, hydrolysis, and acid solution.

1. Oxidation — atmospheric oxygen reacts with the rock to produce oxides.
2. Carbonation — removal of rocks through carbonic acid
3. Hydration — absorption of water by the minerals of the rock
   - volume of the rock increases and the grains lose their shape
4. Solution — dissolution of minerals in water

3) Biotic weathering

1. Plants
   - Plants contribute to both mechanical and chemical weathering
   - Growth of roots disintegrates the rocks
2. Animals
   - Hooves of animals break the soil and thus assist soil erosion
   - Burrowing animals like earthworms, rats, rabbits, termites and ants breakdown the rocks
   - Earthworms can convert 10 to 15 tonnes of rock mass into good soil and bring it to the surface
3. Man — Man breaks lot of rocks for construction, agriculture and mining activities


Soil Erosion
Definition
Removal of soil at a greater rate than its replacement by natural agencies is called soil erosion.
Types
1. Wind Erosion
Winds carry away vast quantity of fine soil particles and sand from deserts and spread it over adjoining cultivated land and thus destroy their fertility.
Thar Desert is spreading wind erosion over parts of Gujarat, Haryana, Punjab and Rajasthan.
2. Sheet erosion
Water when moves as a sheet takes away thin layers of soil
common along the river beds and areas affected by floods
3. Rill Erosion
Removal of surface soil by running water
4. Gully Erosion
Water moves as channels down the slope and takes away the soil forming gullies
These lands are called bad lands or ravines.
Ravines are common in Chambal and Yamuna river basins in U.P. and M.P.


Continental Drift
Facts
The gradual movement and formation of continents is called continental drift
Conceived by the German scientist Alfred Wegener
Indian sub-continent has broke away from Gondwanaland during cretaceous period
Continental Drift theory
About 280 million years ago, there was a super continent(entire landmass of earth) called Pangea
The huge water body surrounding the Pangea was known as Panthalasa
Pangea broke into Laurasia (Angaraland) and Gondwanaland in the Carboniferous period
Both of them drifted away and in between a shallow sea emerged known as Tethys sea.
Evidences for Continental Drift
1. Jig-saw-fit of continents
Coasts of continents could be fit like jigsaw puzzle
2. Geological similarities
3. Coal and Vegetation evidences
South America, Africa, India and Australia were together in geological past.
4. Evidences from paleomagnetism
study of direction of magnetic fields in magnetic materials aligned during their crystallization at specific periods
Magnetic minerals in magma like haematite, magnetite etc... get aligned with the magnetic pole of the earth
5. Sea floor spreading
Confirmed the theory of continental drift
6. Glacial deposits

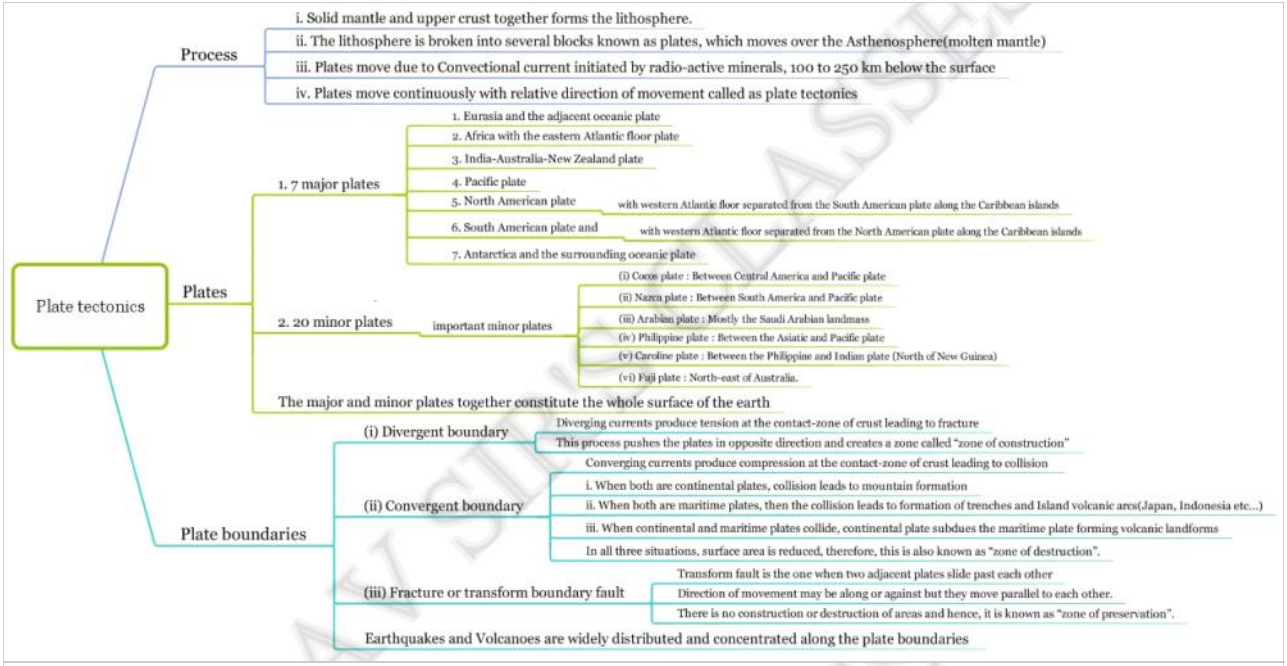
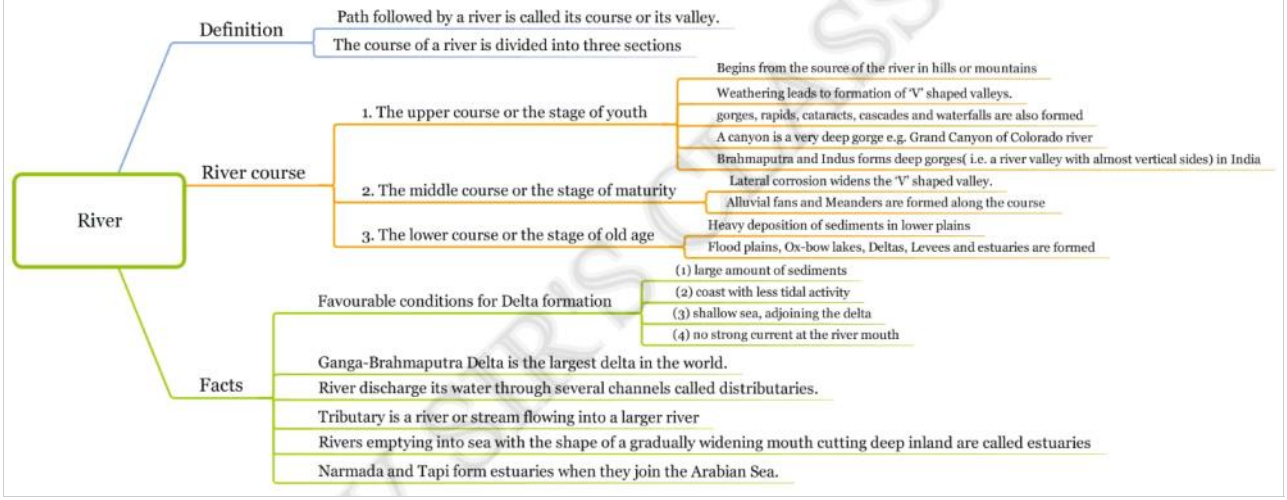
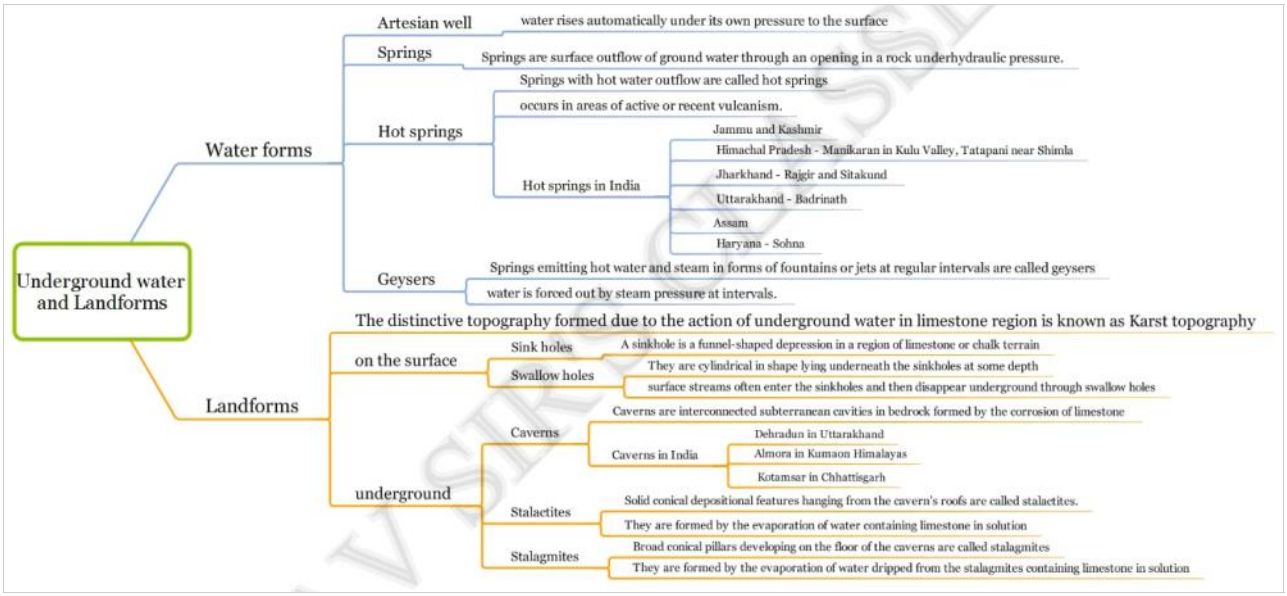
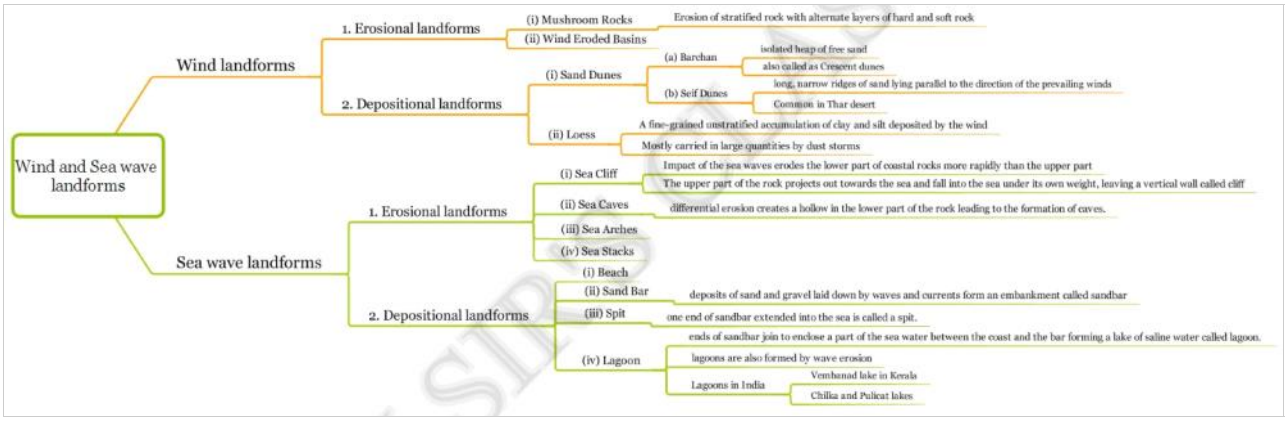
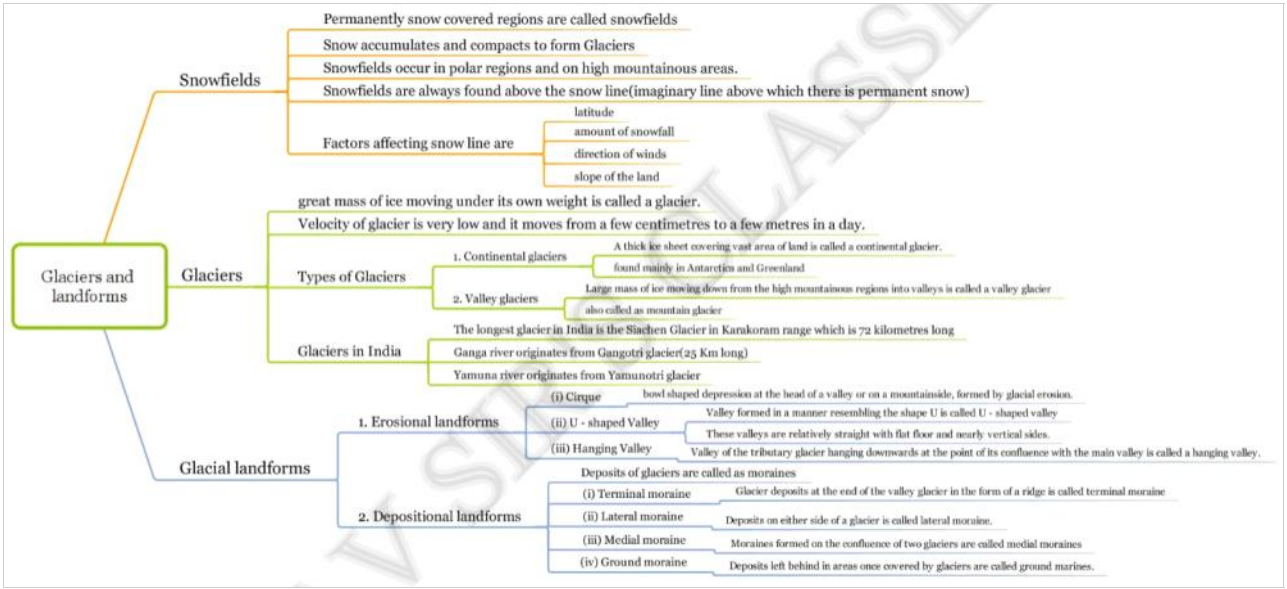


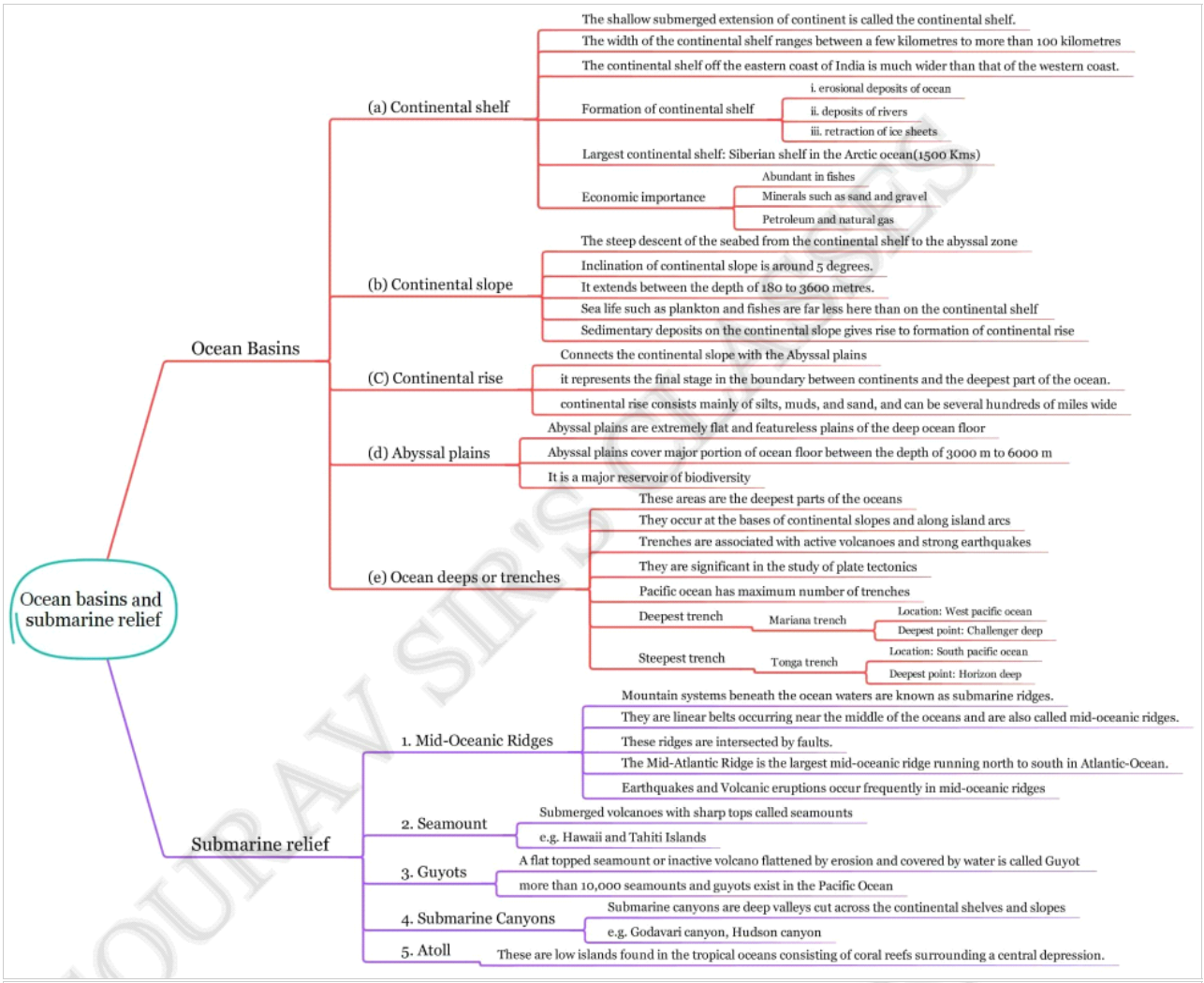
Plate tectonics
Process
i. Solid mantle and upper crust together forms the lithosphere.
ii. The lithosphere is broken into several blocks known as plates, which moves over the Asthenosphere(molten mantle)
iii. Plates move due to Convectional current initiated by radio-active minerals, 100 to 250 km below the surface
iv. Plates move continuously with relative direction of movement called as plate tectonics
Plates
1. 7 major plates
1. Eurasia and the adjacent oceanic plate
2. Africa with the eastern Atlantic floor plate
3. India-Australia-New Zealand plate
4. Pacific plate
5. North American plate
with western Atlantic floor separated from the South American plate along the Caribbean islands
6. South American plate and
with western Atlantic floor separated from the North American plate along the Caribbean islands
7. Antarctica and the surrounding oceanic plate
2. 20 minor plates
important minor plates
(i) Cocos plate : Between Central America and Pacific plate
(ii) Nazca plate : Between South America and Pacific plate
(iii) Arabian plate : Mostly the Saudi Arabian landmass
(iv) Philippine plate : Between the Asiatic and Pacific plate
(v) Caroline plate : Between the Philippine and Indian plate (North of New Guinea)
(vi) Fiji plate : North-east of Australia.
The major and minor plates together constitute the whole surface of the earth
Plate boundaries
(i) Divergent boundary
Diverging currents produce tension at the contact-zone of crust leading to fracture
This process pushes the plates in opposite direction and creates a zone called "zone of construction"
(ii) Convergent boundary
Converging currents produce compression at the contact-zone of crust leading to collision
i. When both are continental plates, collision leads to mountain formation
ii. When both are maritime plates, then the collision leads to formation of trenches and Island volcanic arcs(Japan, Indonesia etc...)
iii. When continental and maritime plates collide, continental plate subdues the maritime plate forming volcanic landforms
In all three situations, surface area is reduced, therefore, this is also known as "zone of destruction".
(iii) Fracture or transform boundary fault
Transform fault is the one when two adjacent plates slide past each other
Direction of movement may be along or against but they move parallel to each other.
There is no construction or destruction of areas and hence, it is known as "zone of preservation".
Earthquakes and Volcanoes are widely distributed and concentrated along the plate boundaries

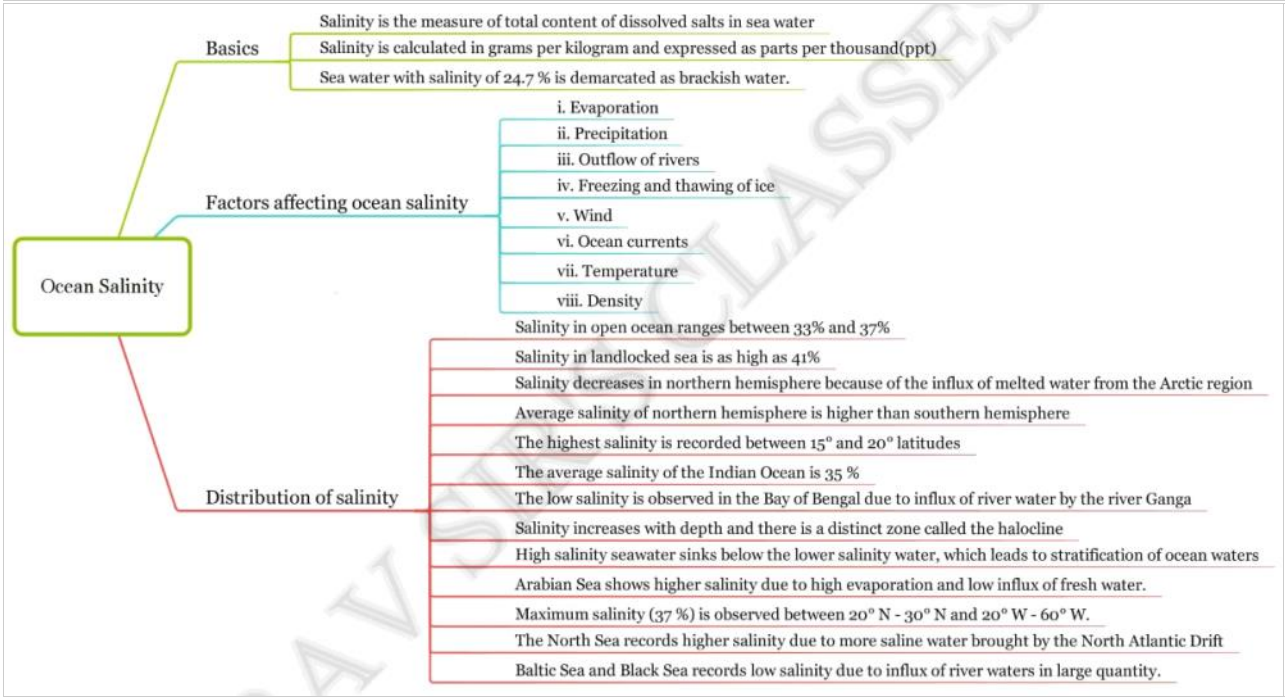

River
Definition
Path followed by a river is called its course or its valley.
The course of a river is divided into three sections
River course
1. The upper course or the stage of youth
Begins from the source of the river in hills or mountains
Weathering leads to formation of 'V' shaped valleys.
gorges, rapids, cataracts, cascades and waterfalls are also formed
A canyon is a very deep gorge e.g. Grand Canyon of Colorado river
Brahmaputra and Indus forms deep gorges(i.e. a river valley with almost vertical sides) in India
2. The middle course or the stage of maturity
Lateral corrosion widens the 'V' shaped valley.
Alluvial fans and Meanders are formed along the course
3. The lower course or the stage of old age
Heavy deposition of sediments in lower plains
Flood plains, Ox-bow lakes, Deltas, Levees and estuaries are formed
Facts
Favourable conditions for Delta formation
(1) large amount of sediments
(2) coast with less tidal activity
(3) shallow sea, adjoining the delta
(4) no strong current at the river mouth
Ganga-Brahmaputra Delta is the largest delta in the world.
River discharge its water through several channels called distributaries.
Tributary is a river or stream flowing into a larger river
Rivers emptying into sea with the shape of a gradually widening mouth cutting deep inland are called estuaries
Narmada and Tapi form estuaries when they join the Arabian Sea.

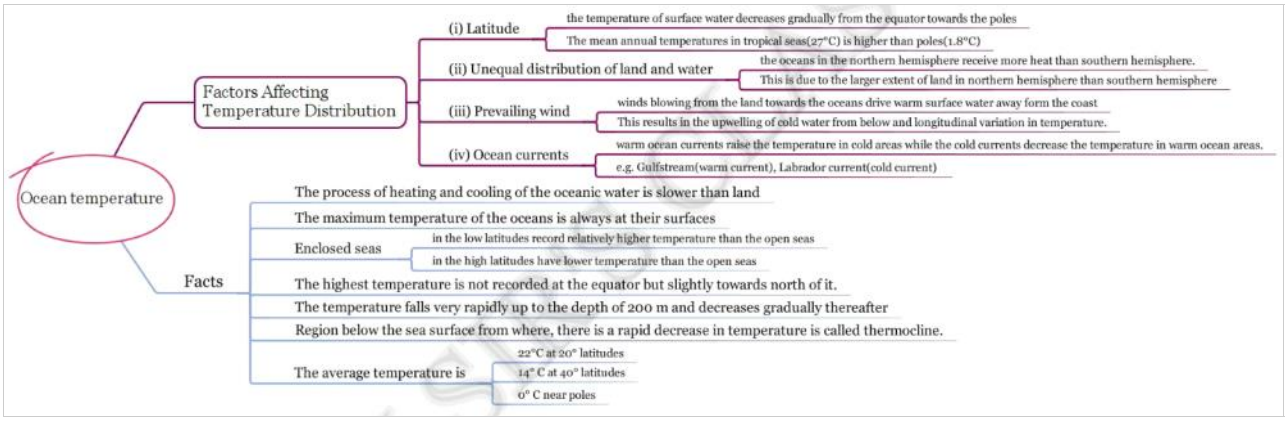

Underground water and Landforms
Water forms
Artesian well
water rises automatically under its own pressure to the surface
Springs
Springs are surface outflow of ground water through an opening in a rock underhydraulic pressure.
Hot springs
Springs with hot water outflow are called hot springs
occurs in areas of active or recent vulcanism.
Hot springs in India
Jammu and Kashmir
Himachal Pradesh - Manikaran in Kulu Valley, Tatapani near Shimla
Jharkhand - Rajgir and Sitakund
Uttarakhand - Badrinath
Assam
Haryana - Sohna
Geysers
Springs emitting hot water and steam in forms of fountains or jets at regular intervals are called geysers
water is forced out by steam pressure at intervals.
Landforms
The distinctive topography formed due to the action of underground water in limestone region is known as Karst topography
on the surface
Sink holes
A sinkhole is a funnel-shaped depression in a region of limestone or chalk terrain
Swallow holes
They are cylindrical in shape lying underneath the sinkholes at some depth
surface streams often enter the sinkholes and then disappear underground through swallow holes
underground
Caverns
Caverns are interconnected subterranean cavities in bedrock formed by the corrosion of limestone
Caverns in India
Dehradun in Uttarakhand
Almora in Kumaon Himalayas
Kotamsar in Chhattisgarh
Stalactites
Solid conical depositional features hanging from the cavern's roofs are called stalactites.
They are formed by the evaporation of water containing limestone in solution
Stalagmites
Broad conical pillars developing on the floor of the caverns are called stalagmites
They are formed by the evaporation of water dripped from the stalagmites containing limestone in solution

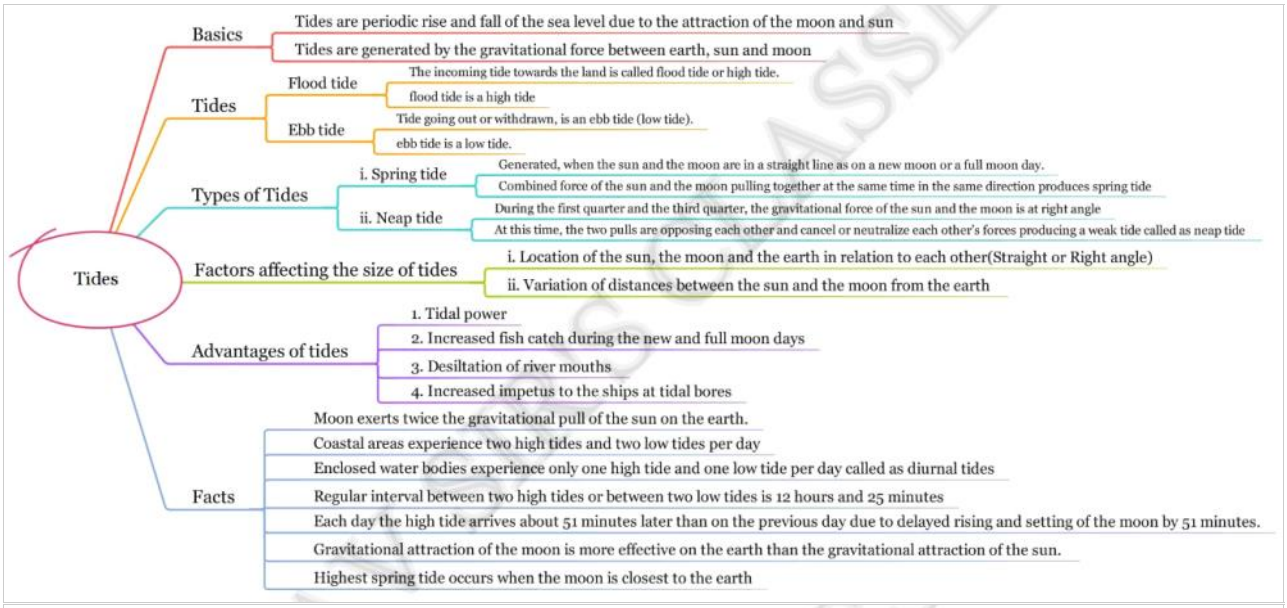

Wind and Sea wave landforms
Wind landforms
1. Erosional landforms
(i) Mushroom Rocks
Erosion of stratified rock with alternate layers of hard and soft rock
(ii) Wind Eroded Basins
2. Depositional landforms
(i) Sand Dunes
(a) Barchan
isolated heap of free sand
also called as Crescent dunes
(b) Seif Dunes
long, narrow ridges of sand lying parallel to the direction of the prevailing winds
Common in Thar desert
(ii) Loess
A fine-grained unstratified accumulation of clay and silt deposited by the wind
Mostly carried in large quantities by dust storms
Sea wave landforms
1. Erosional landforms
(i) Sea Cliff
Impact of the sea waves erodes the lower part of coastal rocks more rapidly than the upper part
The upper part of the rock projects out towards the sea and fall into the sea under its own weight, leaving a vertical wall called cliff
(ii) Sea Caves
differential erosion creates a hollow in the lower part of the rock leading to the formation of caves.
(iii) Sea Arches
(iv) Sea Stacks
2. Depositional landforms
(i) Beach
(ii) Sand Bar
deposits of sand and gravel laid down by waves and currents form an embankment called sandbar
(iii) Spit
one end of sandbar extended into the sea is called a spit.
(iv) Lagoon
ends of sandbar join to enclose a part of the sea water between the coast and the bar forming a lake of saline water called lagoon.
lagoons are also formed by wave erosion
Lagoons in India
Vembanad lake in Kerala
Chilka and Pulicat lakes

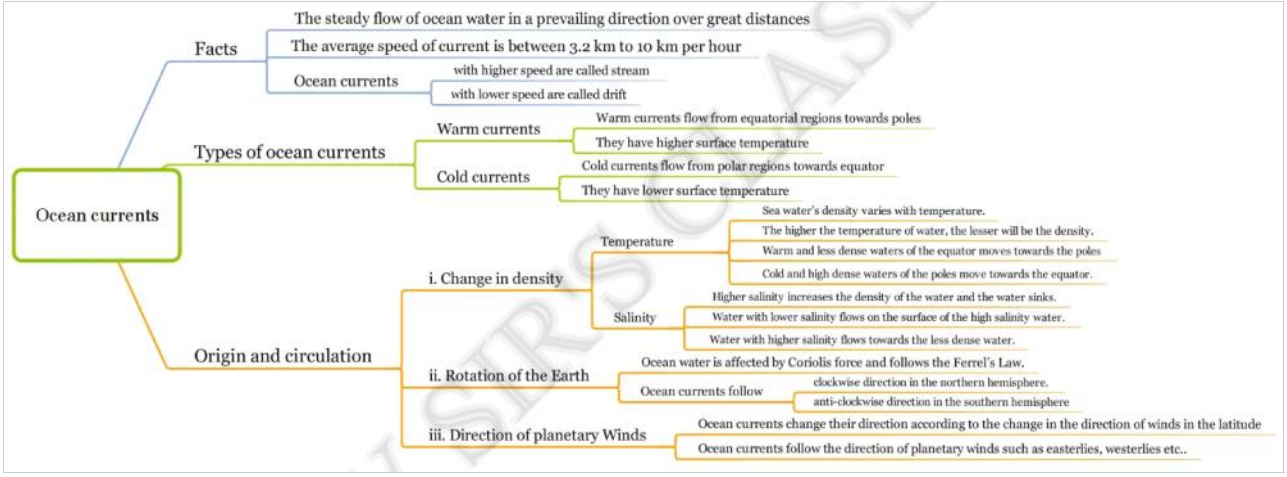

Glaciers and landforms
Snowfields
Permanently snow covered regions are called snowfields
Snow accumulates and compacts to form Glaciers
Snowfields occur in polar regions and on high mountainous areas.
Snowfields are always found above the snow line(imaginary line above which there is permanent snow)
Factors affecting snow line are
latitude
amount of snowfall
direction of winds
slope of the land
Glaciers
great mass of ice moving under its own weight is called a glacier.
Velocity of glacier is very low and it moves from a few centimetres to a few metres in a day.
Types of Glaciers
1. Continental glaciers
A thick ice sheet covering vast area of land is called a continental glacier.
found mainly in Antarctica and Greenland
2. Valley glaciers
Large mass of ice moving down from the high mountainous regions into valleys is called a valley glacier
also called as mountain glacier
Glaciers in India
The longest glacier in India is the Siachen Glacier in Karakoram range which is 72 kilometres long
Ganga river originates from Gangotri glacier(25 Km long)
Yamuna river originates from Yamunotri glacier
Glacial landforms
1. Erosional landforms
(i) Cirque
bowl shaped depression at the head of a valley or on a mountainside, formed by glacial erosion.
(ii) U - shaped Valley
Valley formed in a manner resembling the shape U is called U - shaped valley
These valleys are relatively straight with flat floor and nearly vertical sides.
(iii) Hanging Valley
Valley of the tributary glacier hanging downwards at the point of its confluence with the main valley is called a hanging valley.
2. Depositional landforms
Deposits of glaciers are called as moraines
(i) Terminal moraine
Glacier deposits at the end of the valley glacier in the form of a ridge is called terminal moraine
(ii) Lateral moraine
Deposits on either side of a glacier is called lateral moraine.
(iii) Medial moraine
Moraines formed on the confluence of two glaciers are called medial moraines
(iv) Ground moraine
Deposits left behind in areas once covered by glaciers are called ground marines.

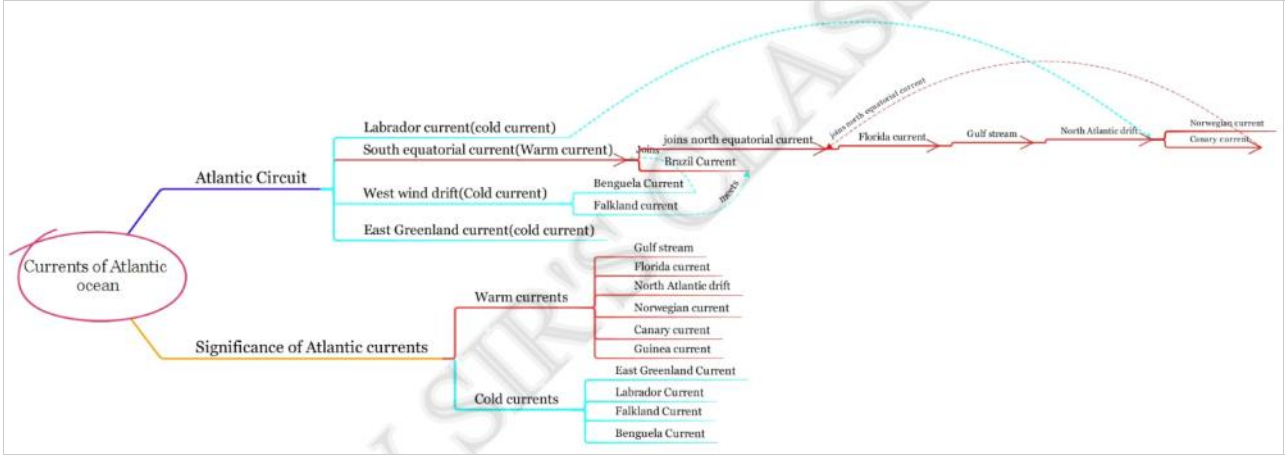

Ocean basins and submarine relief
Ocean Basins
(a) Continental shelf
The shallow submerged extension of continent is called the continental shelf.
The width of the continental shelf ranges between a few kilometres to more than 100 kilometres
The continental shelf off the eastern coast of India is much wider than that of the western coast.
Formation of continental shelf
i. erosional deposits of ocean
ii. deposits of rivers
iii. retraction of ice sheets
Largest continental shelf: Siberian shelf in the Arctic ocean(1500 Kms)
Economic importance
Abundant in fishes
Minerals such as sand and gravel
Petroleum and natural gas
(b) Continental slope
The steep descent of the seabed from the continental shelf to the abyssal zone
Inclination of continental slope is around 5 degrees.
It extends between the depth of 180 to 3600 metres.
Sea life such as plankton and fishes are far less here than on the continental shelf
Sedimentary deposits on the continental slope gives rise to formation of continental rise
(C) Continental rise
Connects the continental slope with the Abyssal plains
it represents the final stage in the boundary between continents and the deepest part of the ocean.
continental rise consists mainly of silts, muds, and sand, and can be several hundreds of miles wide
(d) Abyssal plains
Abyssal plains are extremely flat and featureless plains of the deep ocean floor
Abyssal plains cover major portion of ocean floor between the depth of 3000 m to 6000 m
It is a major reservoir of biodiversity
(e) Ocean deeps or trenches
These areas are the deepest parts of the oceans
They occur at the bases of continental slopes and along island arcs
Trenches are associated with active volcanoes and strong earthquakes
They are significant in the study of plate tectonics
Pacific ocean has maximum number of trenches
Deepest trench
Mariana trench
Location: West pacific ocean
Deepest point: Challenger deep
Steepest trench
Tonga trench
Location: South pacific ocean
Deepest point: Horizon deep
Submarine relief
1. Mid-Oceanic Ridges
Mountain systems beneath the ocean waters are known as submarine ridges.
They are linear belts occurring near the middle of the oceans and are also called mid-oceanic ridges.
These ridges are intersected by faults.
The Mid-Atlantic Ridge is the largest mid-oceanic ridge running north to south in Atlantic-Ocean.
Earthquakes and Volcanic eruptions occur frequently in mid-oceanic ridges
2. Seamount
Submerged volcanoes with sharp tops called seamounts
e.g. Hawaii and Tahiti Islands
3. Guyots
A flat topped seamount or inactive volcano flattened by erosion and covered by water is called Guyot
more than 10,000 seamounts and guyots exist in the Pacific Ocean
4. Submarine Canyons
Submarine canyons are deep valleys cut across the continental shelves and slopes
e.g. Godavari canyon, Hudson canyon
5. Atoll
These are low islands found in the tropical oceans consisting of coral reefs surrounding a central depression.


Ocean Salinity
Basics
Salinity is the measure of total content of dissolved salts in sea water
Salinity is calculated in grams per kilogram and expressed as parts per thousand(ppt)
Sea water with salinity of 24.7 % is demarcated as brackish water.
Factors affecting ocean salinity
i. Evaporation
ii. Precipitation
iii. Outflow of rivers
iv. Freezing and thawing of ice
v. Wind
vi. Ocean currents
vii. Temperature
viii. Density
Distribution of salinity
Salinity in open ocean ranges between 33% and 37%
Salinity in landlocked sea is as high as 41%
Salinity decreases in northern hemisphere because of the influx of melted water from the Arctic region
Average salinity of northern hemisphere is higher than southern hemisphere
The highest salinity is recorded between 15° and 20° latitudes
The average salinity of the Indian Ocean is 35 %
The low salinity is observed in the Bay of Bengal due to influx of river water by the river Ganga
Salinity increases with depth and there is a distinct zone called the halocline
High salinity seawater sinks below the lower salinity water, which leads to stratification of ocean waters
Arabian Sea shows higher salinity due to high evaporation and low influx of fresh water.
Maximum salinity (37 %) is observed between 20° N - 30° N and 20° W - 60° W.
The North Sea records higher salinity due to more saline water brought by the North Atlantic Drift
Baltic Sea and Black Sea records low salinity due to influx of river waters in large quantity.


Ocean temperature
Factors Affecting Temperature Distribution
(i) Latitude
the temperature of surface water decreases gradually from the equator towards the poles
The mean annual temperatures in tropical seas(27°C) is higher than poles(1.8°C)
(ii) Unequal distribution of land and water
the oceans in the northern hemisphere receive more heat than southern hemisphere.
This is due to the larger extent of land in northern hemisphere than southern hemisphere
(iii) Prevailing wind
winds blowing from the land towards the oceans drive warm surface water away form the coast
This results in the upwelling of cold water from below and longitudinal variation in temperature.
(iv) Ocean currents
warm ocean currents raise the temperature in cold areas while the cold currents decrease the temperature in warm ocean areas.
e.g. Gulfstream(warm current), Labrador current(cold current)
Facts
The process of heating and cooling of the oceanic water is slower than land
The maximum temperature of the oceans is always at their surfaces
Enclosed seas
in the low latitudes record relatively higher temperature than the open seas
in the high latitudes have lower temperature than the open seas
The highest temperature is not recorded at the equator but slightly towards north of it.
The temperature falls very rapidly up to the depth of 200 m and decreases gradually thereafter
Region below the sea surface from where, there is a rapid decrease in temperature is called thermocline.
The average temperature is
22°C at 20° latitudes
14° C at 40° latitudes
0° C near poles


Tides
Basics
Tides are periodic rise and fall of the sea level due to the attraction of the moon and sun
Tides are generated by the gravitational force between earth, sun and moon
Tides
Flood tide
The incoming tide towards the land is called flood tide or high tide.
flood tide is a high tide
Ebb tide
Tide going out or withdrawn, is an ebb tide (low tide).
ebb tide is a low tide.
Types of Tides
i. Spring tide
Generated, when the sun and the moon are in a straight line as on a new moon or a full moon day.
Combined force of the sun and the moon pulling together at the same time in the same direction produces spring tide
ii. Neap tide
During the first quarter and the third quarter, the gravitational force of the sun and the moon is at right angle
At this time, the two pulls are opposing each other and cancel or neutralize each other's forces producing a weak tide called as neap tide
Factors affecting the size of tides
i. Location of the sun, the moon and the earth in relation to each other(Straight or Right angle)
ii. Variation of distances between the sun and the moon from the earth
Advantages of tides
1. Tidal power
2. Increased fish catch during the new and full moon days
3. Desiltation of river mouths
4. Increased impetus to the ships at tidal bores
Facts
Moon exerts twice the gravitational pull of the sun on the earth.
Coastal areas experience two high tides and two low tides per day
Enclosed water bodies experience only one high tide and one low tide per day called as diurnal tides
Regular interval between two high tides or between two low tides is 12 hours and 25 minutes
Each day the high tide arrives about 51 minutes later than on the previous day due to delayed rising and setting of the moon by 51 minutes.
Gravitational attraction of the moon is more effective on the earth than the gravitational attraction of the sun.
Highest spring tide occurs when the moon is closest to the earth


Ocean currents
Facts
The steady flow of ocean water in a prevailing direction over great distances
The average speed of current is between 3.2 km to 10 km per hour
Ocean currents
with higher speed are called stream
with lower speed are called drift
Types of ocean currents
Warm currents
Warm currents flow from equatorial regions towards poles
They have higher surface temperature
Cold currents
Cold currents flow from polar regions towards equator
They have lower surface temperature
Origin and circulation
i. Change in density
Temperature
Sea water's density varies with temperature.
The higher the temperature of water, the lesser will be the density.
Warm and less dense waters of the equator moves towards the poles
Cold and high dense waters of the poles move towards the equator.
Salinity
Higher salinity increases the density of the water and the water sinks.
Water with lower salinity flows on the surface of the high salinity water.
Water with higher salinity flows towards the less dense water.
ii. Rotation of the Earth
Ocean water is affected by Coriolis force and follows the Ferrel's Law.
Ocean currents follow
clockwise direction in the northern hemisphere.
anti-clockwise direction in the southern hemisphere
iii. Direction of planetary Winds
Ocean currents change their direction according to the change in the direction of winds in the latitude
Ocean currents follow the direction of planetary winds such as easterlies, westerlies etc..


Currents of Atlantic ocean
Atlantic Circuit
Labrador current(cold current)
South equatorial current(Warm current)
joins north equatorial current
Joins
Brazil Current
joins north equatorial current
Florida current
Gulf stream
North Atlantic drift
Norwegian current
Canary current
West wind drift(Cold current)
Benguela Current
Falkland current
meets
East Greenland current(cold current)
Significance of Atlantic currents
Warm currents
Gulf stream
Florida current
North Atlantic drift
Norwegian current
Canary current
Guinea current
Cold currents
East Greenland Current
Labrador Current
Falkland Current
Benguela Current

Composition of Atmosphere

1. Gases

- Atmosphere consists a mixture of different types of gases
- Composition
  - Nitrogen - 78.08%
  - Oxygen - 20.95%
  - Argon - 0.93%
  - Carbon dioxide - 0.036%
  - Neon - 0.002%
  - Helium - 0.0005%
  - Krypton - 0.001%
  - Xenon - 0.00009%
  - Hydrogen - 0.00005%
- Nitrogen and Oxygen together makeup 99% of the gases of atmosphere.
- 99% of the total mass of the atmosphere is confined to the height of 32 km from the earth's surface
- Carbon dioxide and water vapour are found only up to 90 km from the surface of the earth.
- Ozone
  - It is limited to the ozone layer found between 10 and 50 km above the earth's surface
  - acts as a filter and absorbs the ultra-violet rays radiating from the sun

2. Water vapour

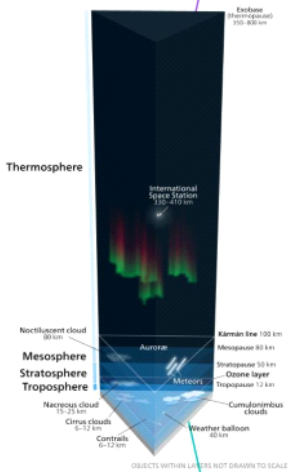
- Gaseous form of water present in the atmosphere is called water vapour.
- Water vapour is the source of all kinds of precipitation.
- Water vapour formation
  - Evaporation
    - oceans
    - seas
    - rivers
    - ponds
    - lakes
  - Transpiration
    - plants
    - trees
    - living beings
- Concentration
  - Its maximum amount in the atmosphere could be up to 4 percent.
  - Maximum amount of water vapour is found in hot-wet regions
  - Least amount is found in the dry regions
  - Amount of water vapour decreases gradually from low latitudes to high latitudes.
- Significance
  - It absorbs part of insolation from the sun and preserves the earth's radiated heat
  - It acts like a blanket allowing the earth neither to become too cold nor too hot.

3. Dust particles

- found in the lower layers of the atmosphere
- dust particles help in the condensation of water vapour to form droplets by sticking around these dust particles.

Basics

- Atmosphere is divided in to five layers based on their temperature and density
- 97% of the atmosphere is limited to the height of 30 kilometres.
- Kármán line, at 100 km (62 mi), or 1.57% of Earth's radius, is often used as the border between the atmosphere and outer space.



Layers

(a) Troposphere

- Lowest layer of the atmosphere
- Extends about 18 kms on the equator and 8 kms on the poles.
- The troposphere contains roughly 80% of the mass of Earth's atmosphere.
- Fifty percent of the total mass of the atmosphere is located in the lower 5.6 km of the troposphere
- Depth of Troposphere is maximum at equator than poles due to
  1. hot convection currents over the equator
  2. less dense air at the equator
  3. larger gravitational pull over the air at the poles than the equator
  4. larger centrifugal force at the equator
  5. increased water vapour due to insolation at the equator
- All kinds of weather changes takes place within this layer
- Temperature decreases gradually with increase in altitude
  - because, troposphere is mostly heated through energy transfer from the surface.
  - temperature decreases at the rate of 1°C for every 165 m of height.
- The average rate of temperature change is about 6.5°C per 1000 meters. This is called the average lapse rate
- The upper limit or Transition zone of the troposphere is called tropopause.
- Temperature at the tropopause is
  - -60°C over the equator
  - -45°C over the poles.
- Only layer that can be accessed by propeller-driven aircraft.

(b) Stratosphere

- Extends about 50 kms from the earth surface
- It is called as stratosphere due to its stratification into warm upper layers and cold lower layers.
- Ozone layer lies within the stratosphere
  - 90% of the ozone in Earth's atmosphere is contained in the stratosphere.
- Temperature
  - i. remains constant up to the height of 20 kms
  - ii. after 20 kms, it increases gradually(due to the presence of ozone) with increase in the height
  - This rise in temperature is caused by the absorption of ultraviolet radiation (UV) radiation from the Sun by the ozone layer
- The stratospheric temperature profile creates very stable atmospheric conditions
  - almost completely free of clouds and other forms of weather
  - Weather related incidents do not take place in this layer.
- The air blows horizontally without much turbulence and is ideal for flying of aircrafts
  - highest layer that can be accessed by jet-powered aircraft.

(c) Mesosphere

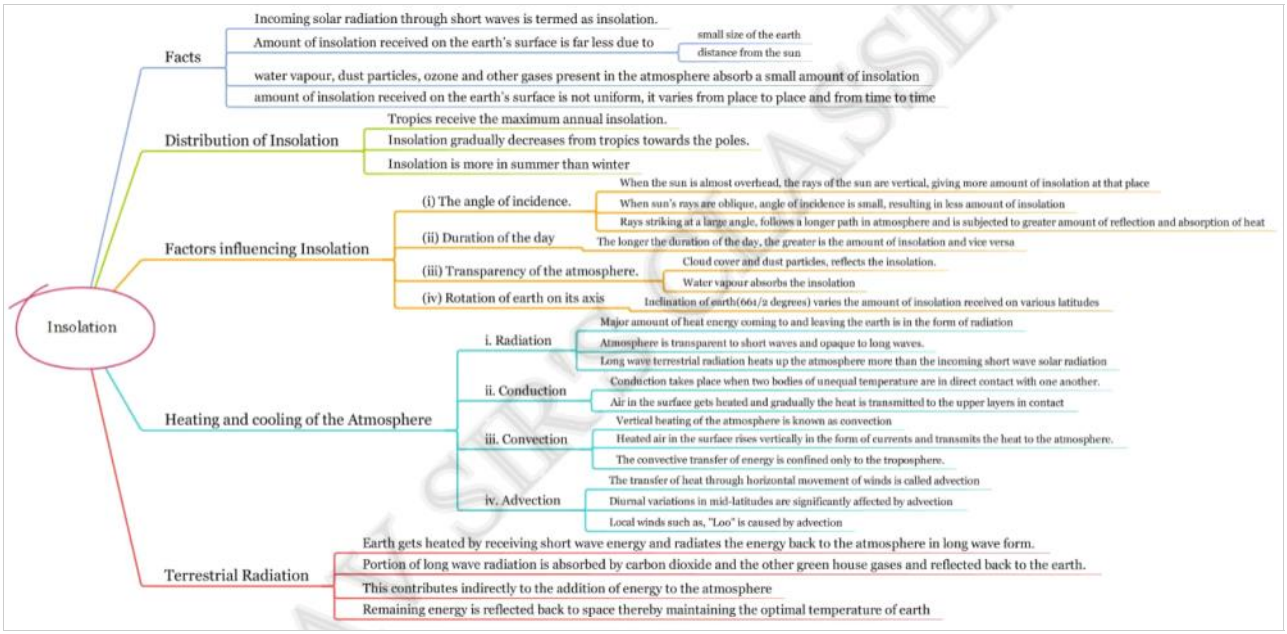
- Extends upto 30 kms from stratosphere
- Temperature goes on decreasing with increase in altitude.
- It is the coldest place on Earth and has an average temperature around −85 °C
- The upper limit of mesosphere is known as the mesopause
- Polar-mesospheric noctilucent clouds are the highest clouds in the atmosphere which are visible to the naked eye
- Meteors fall and burn in this layer.
- It is too high above Earth to be accessible to aircraft and balloons, and too low to permit orbital spacecraft.

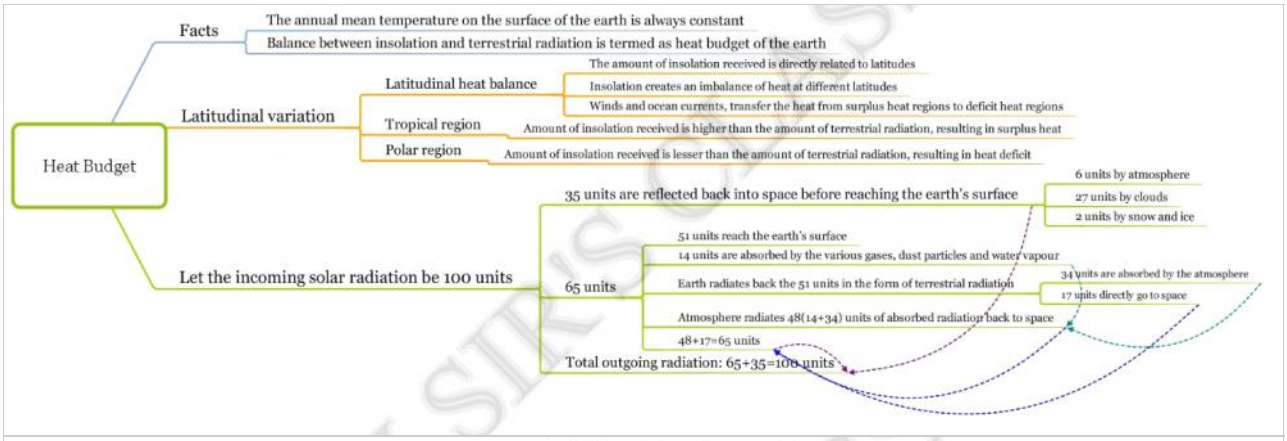
(d) Thermosphere

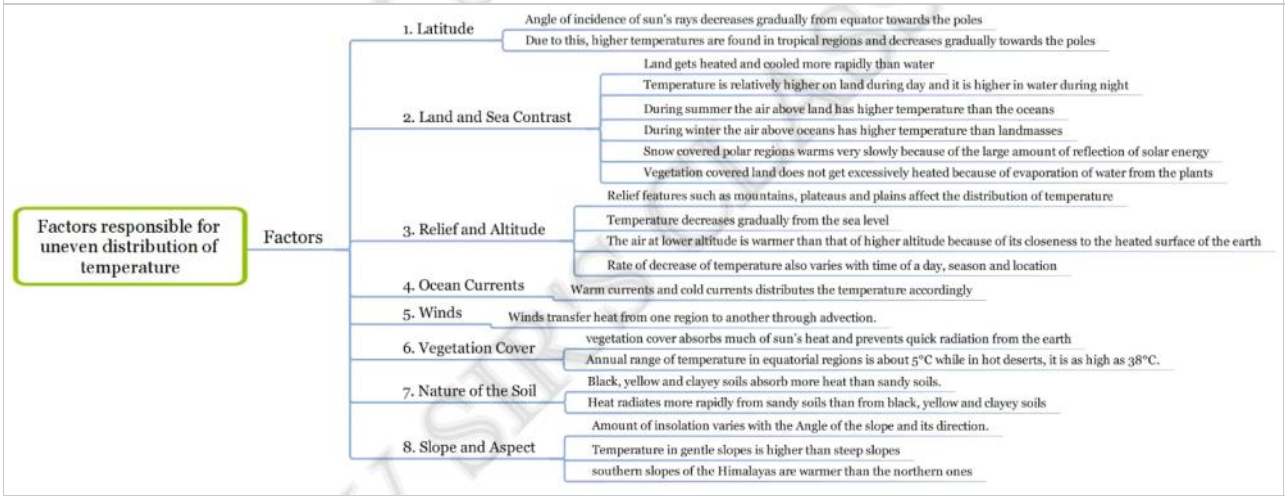
- Extends upto the height of 400 kms from the surface of the earth
- This layer is completely cloudless and free of water vapour.
- Temperature starts increasing again with increasing height in this layer
- Temperature inversion in the thermosphere occurs due to the extremely low density of its molecules.
- Lower part of the thermosphere, from 80 to 550 kilometres above Earth's surface, contains the ionosphere.
- Electrically charged currents flows in the air in this sphere and hence called as Ionosphere
- Radio waves are reflected back on the earth from this sphere
- aurora borealis and aurora australis are occasionally seen in the thermosphere.
  - formed due to the ionisation of atmosphere by solar radiation
  - ionization in the mesosphere largely ceases during the night
- International Space Station orbits in this layer, between 320 and 380 km

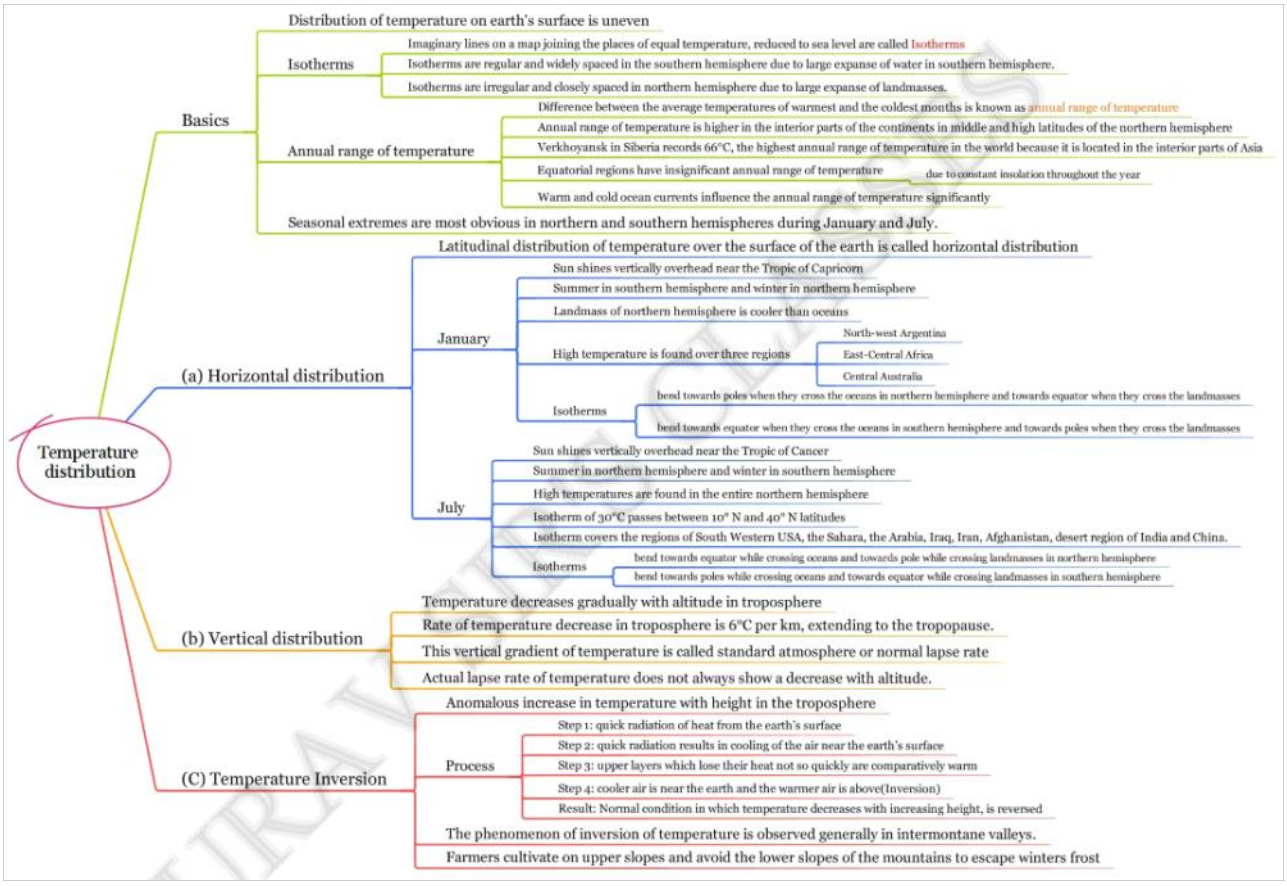
(e) Exosphere

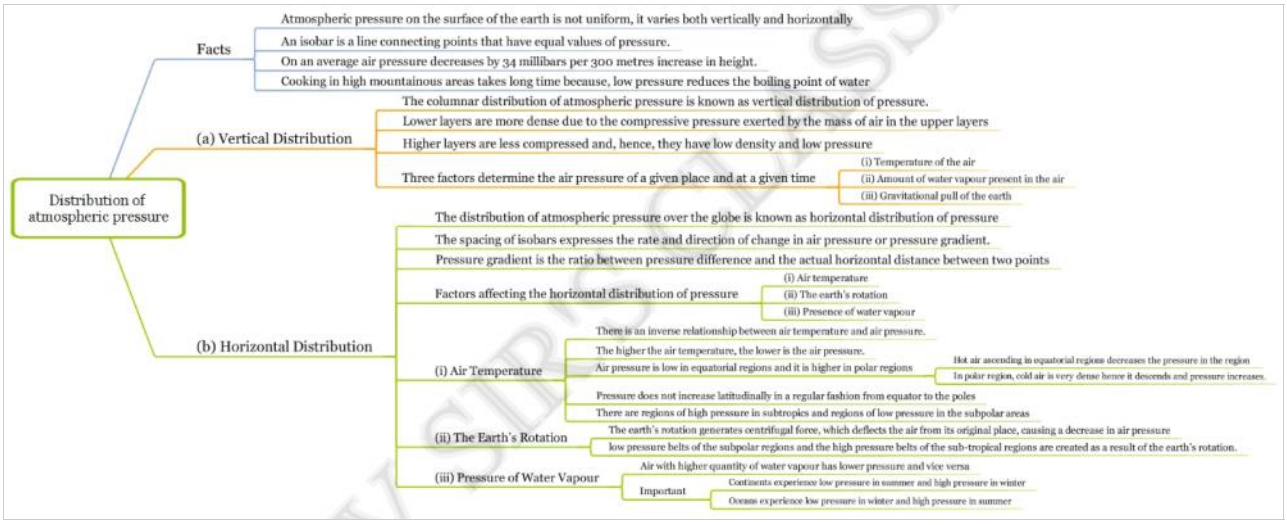
- last layer of the atmosphere located above ionosphere
- extends beyond 400 km above the earth(there is no boundary, merges with the outer space).
- Density of air is very sparse in the exosphere
- mainly composed of extremely low densities of hydrogen, helium and heavier molecules of nitrogen, oxygen and co2
- exosphere doesn't behave like a gas, and the particles constantly escape into space
- aurora borealis and aurora australis sometimes occur in the lower part of the exosphere
- exosphere contains most of the satellites orbiting Earth

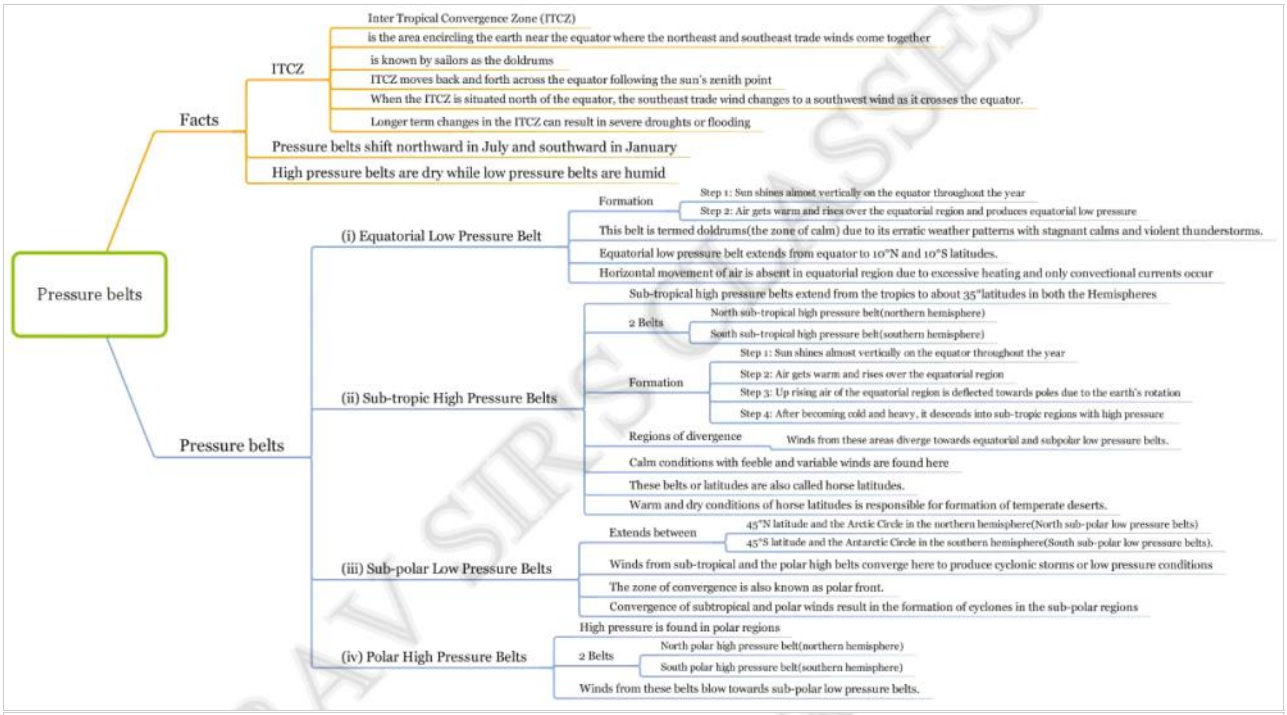

Insolation
Facts
Incoming solar radiation through short waves is termed as insolation.
Amount of insolation received on the earth's surface is far less due to
small size of the earth
distance from the sun
water vapour, dust particles, ozone and other gases present in the atmosphere absorb a small amount of insolation
amount of insolation received on the earth's surface is not uniform, it varies from place to place and from time to time
Distribution of Insolation
Tropics receive the maximum annual insolation.
Insolation gradually decreases from tropics towards the poles.
Insolation is more in summer than winter
Factors influencing Insolation
(i) The angle of incidence.
When the sun is almost overhead, the rays of the sun are vertical, giving more amount of insolation at that place
When sun's rays are oblique, angle of incidence is small, resulting in less amount of insolation
Rays striking at a large angle, follows a longer path in atmosphere and is subjected to greater amount of reflection and absorption of heat
(ii) Duration of the day
The longer the duration of the day, the greater is the amount of insolation and vice versa
(iii) Transparency of the atmosphere.
Cloud cover and dust particles, reflects the insolation.
Water vapour absorbs the insolation
(iv) Rotation of earth on its axis
Inclination of earth(66 1/2 degrees) varies the amount of insolation received on various latitudes
Heating and cooling of the Atmosphere
i. Radiation
Major amount of heat energy coming to and leaving the earth is in the form of radiation
Atmosphere is transparent to short waves and opaque to long waves.
Long wave terrestrial radiation heats up the atmosphere more than the incoming short wave solar radiation
ii. Conduction
Conduction takes place when two bodies of unequal temperature are in direct contact with one another.
Air in the surface gets heated and gradually the heat is transmitted to the upper layers in contact
iii. Convection
Vertical heating of the atmosphere is known as convection
Heated air in the surface rises vertically in the form of currents and transmits the heat to the atmosphere.
The convective transfer of energy is confined only to the troposphere.
iv. Advection
The transfer of heat through horizontal movement of winds is called advection
Diurnal variations in mid-latitudes are significantly affected by advection
Local winds such as, "Loo" is caused by advection
Terrestrial Radiation
Earth gets heated by receiving short wave energy and radiates the energy back to the atmosphere in long wave form.
Portion of long wave radiation is absorbed by carbon dioxide and the other green house gases and reflected back to the earth.
This contributes indirectly to the addition of energy to the atmosphere
Remaining energy is reflected back to space thereby maintaining the optimal temperature of earth

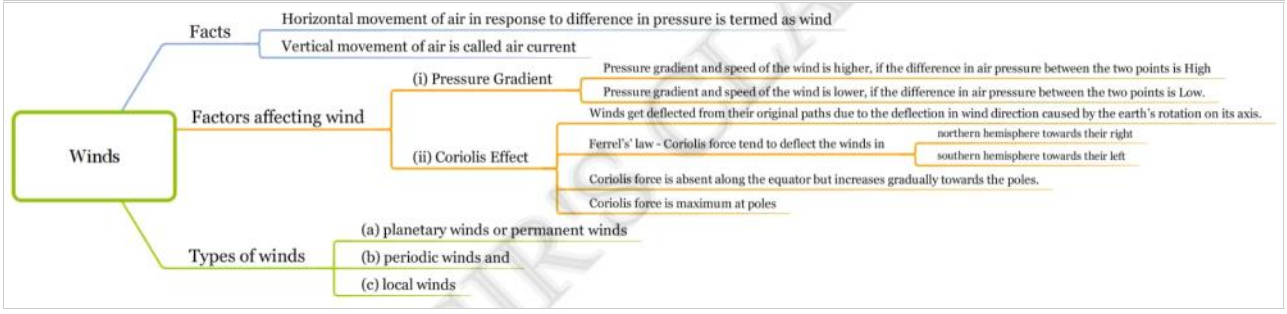

Heat Budget
Facts
The annual mean temperature on the surface of the earth is always constant
Balance between insolation and terrestrial radiation is termed as heat budget of the earth
Latitudinal variation
Latitudinal heat balance
The amount of insolation received is directly related to latitudes
Insolation creates an imbalance of heat at different latitudes
Winds and ocean currents, transfer the heat from surplus heat regions to deficit heat regions
Tropical region
Amount of insolation received is higher than the amount of terrestrial radiation, resulting in surplus heat
Polar region
Amount of insolation received is lesser than the amount of terrestrial radiation, resulting in heat deficit
Let the incoming solar radiation be 100 units
35 units are reflected back into space before reaching the earth's surface
6 units by atmosphere
27 units by clouds
2 units by snow and ice
65 units
51 units reach the earth's surface
14 units are absorbed by the various gases, dust particles and water vapour
Earth radiates back the 51 units in the form of terrestrial radiation
34 units are absorbed by the atmosphere
17 units directly go to space
Atmosphere radiates 48(14+34) units of absorbed radiation back to space
48+17=65 units
Total outgoing radiation: 65+35=100 units

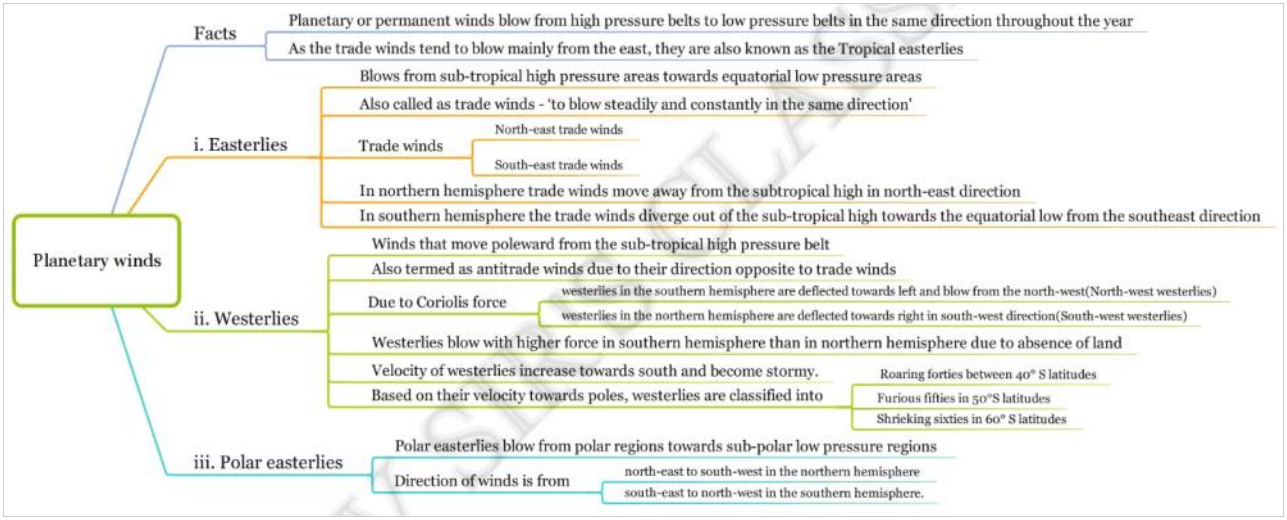

Factors responsible for uneven distribution of temperature
Factors
1. Latitude
Angle of incidence of sun's rays decreases gradually from equator towards the poles
Due to this, higher temperatures are found in tropical regions and decreases gradually towards the poles
2. Land and Sea Contrast
Land gets heated and cooled more rapidly than water
Temperature is relatively higher on land during day and it is higher in water during night
During summer the air above land has higher temperature than the oceans
During winter the air above oceans has higher temperature than landmasses
Snow covered polar regions warms very slowly because of the large amount of reflection of solar energy
Vegetation covered land does not get excessively heated because of evaporation of water from the plants
3. Relief and Altitude
Relief features such as mountains, plateaus and plains affect the distribution of temperature
Temperature decreases gradually from the sea level
The air at lower altitude is warmer than that of higher altitude because of its closeness to the heated surface of the earth
Rate of decrease of temperature also varies with time of a day, season and location
4. Ocean Currents
Warm currents and cold currents distributes the temperature accordingly
5. Winds
Winds transfer heat from one region to another through advection.
6. Vegetation Cover
vegetation cover absorbs much of sun's heat and prevents quick radiation from the earth
Annual range of temperature in equatorial regions is about 5°C while in hot deserts, it is as high as 38°C.
7. Nature of the Soil
Black, yellow and clayey soils absorb more heat than sandy soils.
Heat radiates more rapidly from sandy soils than from black, yellow and clayey soils
8. Slope and Aspect
Amount of insolation varies with the Angle of the slope and its direction.
Temperature in gentle slopes is higher than steep slopes
southern slopes of the Himalayas are warmer than the northern ones

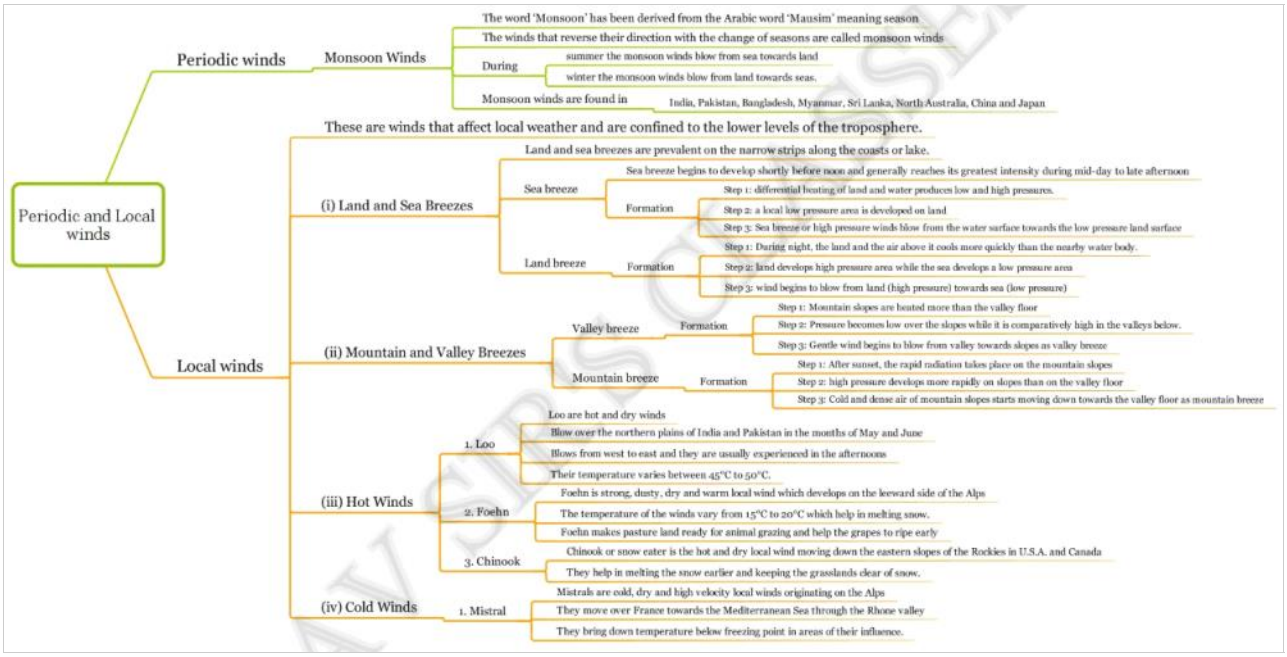

Temperature distribution
Basics
Distribution of temperature on earth's surface is uneven
Isotherms
Imaginary lines on a map joining the places of equal temperature, reduced to sea level are called Isotherms
Isotherms are regular and widely spaced in the southern hemisphere due to large expanse of water in southern hemisphere.
Isotherms are irregular and closely spaced in northern hemisphere due to large expanse of landmasses.
Annual range of temperature
Difference between the average temperatures of warmest and the coldest months is known as annual range of temperature
Annual range of temperature is higher in the interior parts of the continents in middle and high latitudes of the northern hemisphere
Verkhoyansk in Siberia records 66°C, the highest annual range of temperature in the world because it is located in the interior parts of Asia
Equatorial regions have insignificant annual range of temperature
due to constant insolation throughout the year
Warm and cold ocean currents influence the annual range of temperature significantly
Seasonal extremes are most obvious in northern and southern hemispheres during January and July.
(a) Horizontal distribution
Latitudinal distribution of temperature over the surface of the earth is called horizontal distribution
January
Sun shines vertically overhead near the Tropic of Capricorn
Summer in southern hemisphere and winter in northern hemisphere
Landmass of northern hemisphere is cooler than oceans
High temperature is found over three regions
North-west Argentina
East-Central Africa
Central Australia
Isotherms
bend towards poles when they cross the oceans in northern hemisphere and towards equator when they cross the landmasses
bend towards equator when they cross the oceans in southern hemisphere and towards poles when they cross the landmasses
July
Sun shines vertically overhead near the Tropic of Cancer
Summer in northern hemisphere and winter in southern hemisphere
High temperatures are found in the entire northern hemisphere
Isotherm of 30°C passes between 10° N and 40° N latitudes
Isotherm covers the regions of South Western USA, the Sahara, the Arabia, Iraq, Iran, Afghanistan, desert region of India and China.
Isotherms
bend towards equator while crossing oceans and towards pole while crossing landmasses in northern hemisphere
bend towards poles while crossing oceans and towards equator while crossing landmasses in southern hemisphere
(b) Vertical distribution
Temperature decreases gradually with altitude in troposphere
Rate of temperature decrease in troposphere is 6°C per km, extending to the tropopause.
This vertical gradient of temperature is called standard atmosphere or normal lapse rate
Actual lapse rate of temperature does not always show a decrease with altitude.
(C) Temperature Inversion
Anomalous increase in temperature with height in the troposphere
Process
Step 1: quick radiation of heat from the earth's surface
Step 2: quick radiation results in cooling of the air near the earth's surface
Step 3: upper layers which lose their heat not so quickly are comparatively warm
Step 4: cooler air is near the earth and the warmer air is above(Inversion)
Result: Normal condition in which temperature decreases with increasing height, is reversed
The phenomenon of inversion of temperature is observed generally in intermontane valleys.
Farmers cultivate on upper slopes and avoid the lower slopes of the mountains to escape winters frost

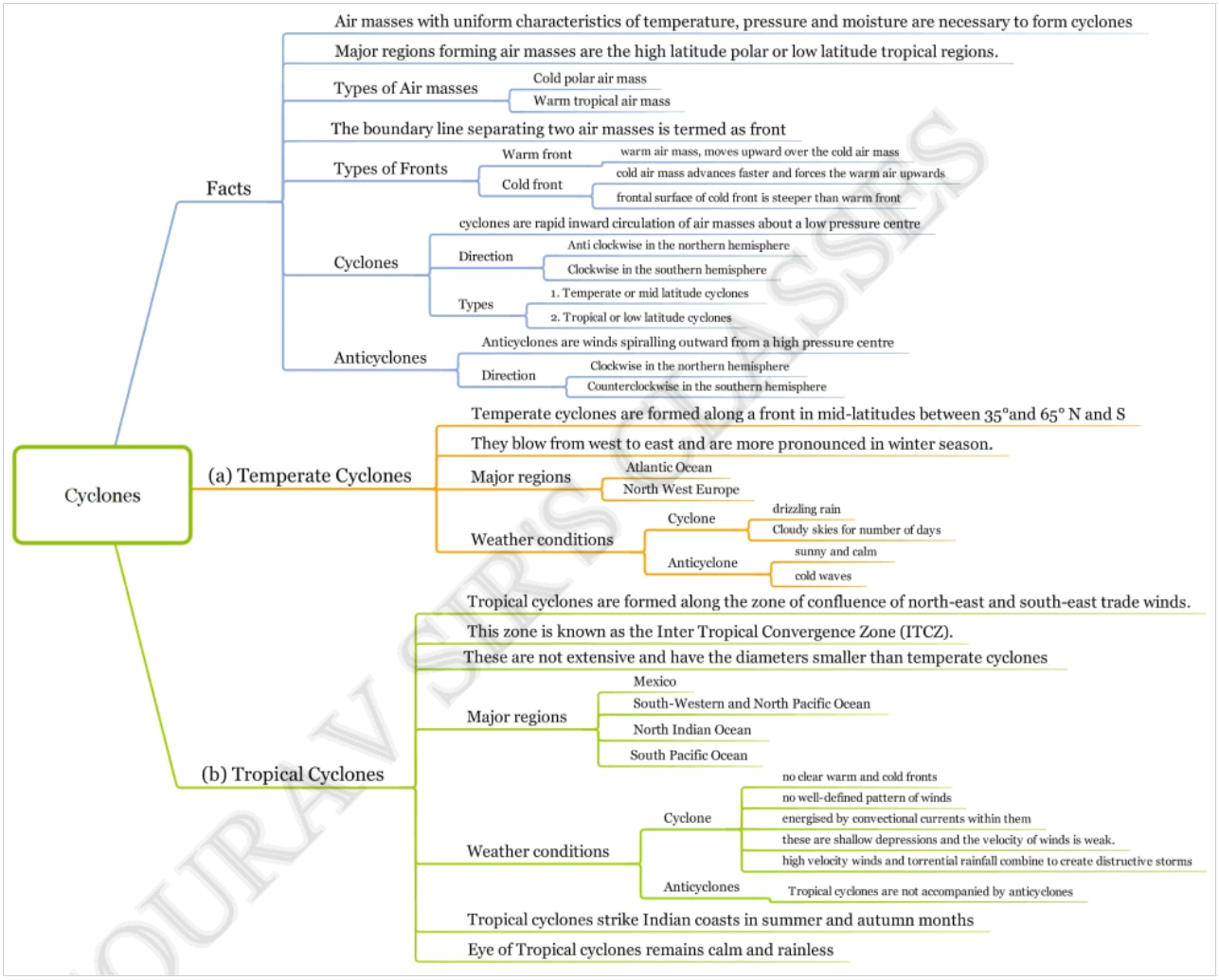

Distribution of atmospheric pressure
Facts
Atmospheric pressure on the surface of the earth is not uniform, it varies both vertically and horizontally
An isobar is a line connecting points that have equal values of pressure.
On an average air pressure decreases by 34 millibars per 300 metres increase in height.
Cooking in high mountainous areas takes long time because, low pressure reduces the boiling point of water
(a) Vertical Distribution
The columnar distribution of atmospheric pressure is known as vertical distribution of pressure.
Lower layers are more dense due to the compressive pressure exerted by the mass of air in the upper layers
Higher layers are less compressed and, hence, they have low density and low pressure
Three factors determine the air pressure of a given place and at a given time
(i) Temperature of the air
(ii) Amount of water vapour present in the air
(iii) Gravitational pull of the earth
(b) Horizontal Distribution
The distribution of atmospheric pressure over the globe is known as horizontal distribution of pressure
The spacing of isobars expresses the rate and direction of change in air pressure or pressure gradient.
Pressure gradient is the ratio between pressure difference and the actual horizontal distance between two points
Factors affecting the horizontal distribution of pressure
(i) Air temperature
(ii) The earth's rotation
(iii) Presence of water vapour
(i) Air Temperature
There is an inverse relationship between air temperature and air pressure.
The higher the air temperature, the lower is the air pressure.
Air pressure is low in equatorial regions and it is higher in polar regions
Hot air ascending in equatorial regions decreases the pressure in the region
In polar region, cold air is very dense hence it descends and pressure increases.
Pressure does not increase latitudinally in a regular fashion from equator to the poles
There are regions of high pressure in subtropics and regions of low pressure in the subpolar areas
(ii) The Earth's Rotation
The earth's rotation generates centrifugal force, which deflects the air from its original place, causing a decrease in air pressure
low pressure belts of the subpolar regions and the high pressure belts of the sub-tropical regions are created as a result of the earth's rotation.
(iii) Pressure of Water Vapour
Air with higher quantity of water vapour has lower pressure and vice versa
Important
Continents experience low pressure in summer and high pressure in winter
Oceans experience low pressure in winter and high pressure in summer

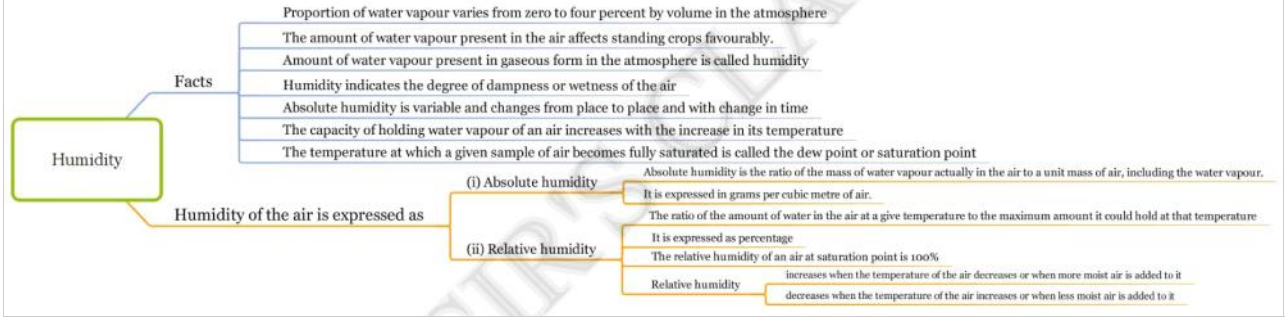

Pressure belts
Facts
ITCZ
Inter Tropical Convergence Zone (ITCZ)
is the area encircling the earth near the equator where the northeast and southeast trade winds come together
is known by sailors as the doldrums
ITCZ moves back and forth across the equator following the sun's zenith point
When the ITCZ is situated north of the equator, the southeast trade wind changes to a southwest wind as it crosses the equator.
Longer term changes in the ITCZ can result in severe droughts or flooding
Pressure belts shift northward in July and southward in January
High pressure belts are dry while low pressure belts are humid
Pressure belts
(i) Equatorial Low Pressure Belt
Formation
Step 1: Sun shines almost vertically on the equator throughout the year
Step 2: Air gets warm and rises over the equatorial region and produces equatorial low pressure
This belt is termed doldrums(the zone of calm) due to its erratic weather patterns with stagnant calms and violent thunderstorms.
Equatorial low pressure belt extends from equator to 10°N and 10°S latitudes.
Horizontal movement of air is absent in equatorial region due to excessive heating and only convectional currents occur
(ii) Sub-tropic High Pressure Belts
Sub-tropical high pressure belts extend from the tropics to about 35°latitudes in both the Hemispheres
2 Belts
North sub-tropical high pressure belt(northern hemisphere)
South sub-tropical high pressure belt(southern hemisphere)
Formation
Step 1: Sun shines almost vertically on the equator throughout the year
Step 2: Air gets warm and rises over the equatorial region
Step 3: Up rising air of the equatorial region is deflected towards poles due to the earth's rotation
Step 4: After becoming cold and heavy, it descends into sub-tropic regions with high pressure
Regions of divergence
Winds from these areas diverge towards equatorial and subpolar low pressure belts.
Calm conditions with feeble and variable winds are found here
These belts or latitudes are also called horse latitudes.
Warm and dry conditions of horse latitudes is responsible for formation of temperate deserts.
(iii) Sub-polar Low Pressure Belts
Extends between
45°N latitude and the Arctic Circle in the northern hemisphere(North sub-polar low pressure belts)
45°S latitude and the Antarctic Circle in the southern hemisphere(South sub-polar low pressure belts).
Winds from sub-tropical and the polar high belts converge here to produce cyclonic storms or low pressure conditions
The zone of convergence is also known as polar front.
Convergence of subtropical and polar winds result in the formation of cyclones in the sub-polar regions
(iv) Polar High Pressure Belts
High pressure is found in polar regions
2 Belts
North polar high pressure belt(northern hemisphere)
South polar high pressure belt(southern hemisphere)
Winds from these belts blow towards sub-polar low pressure belts.

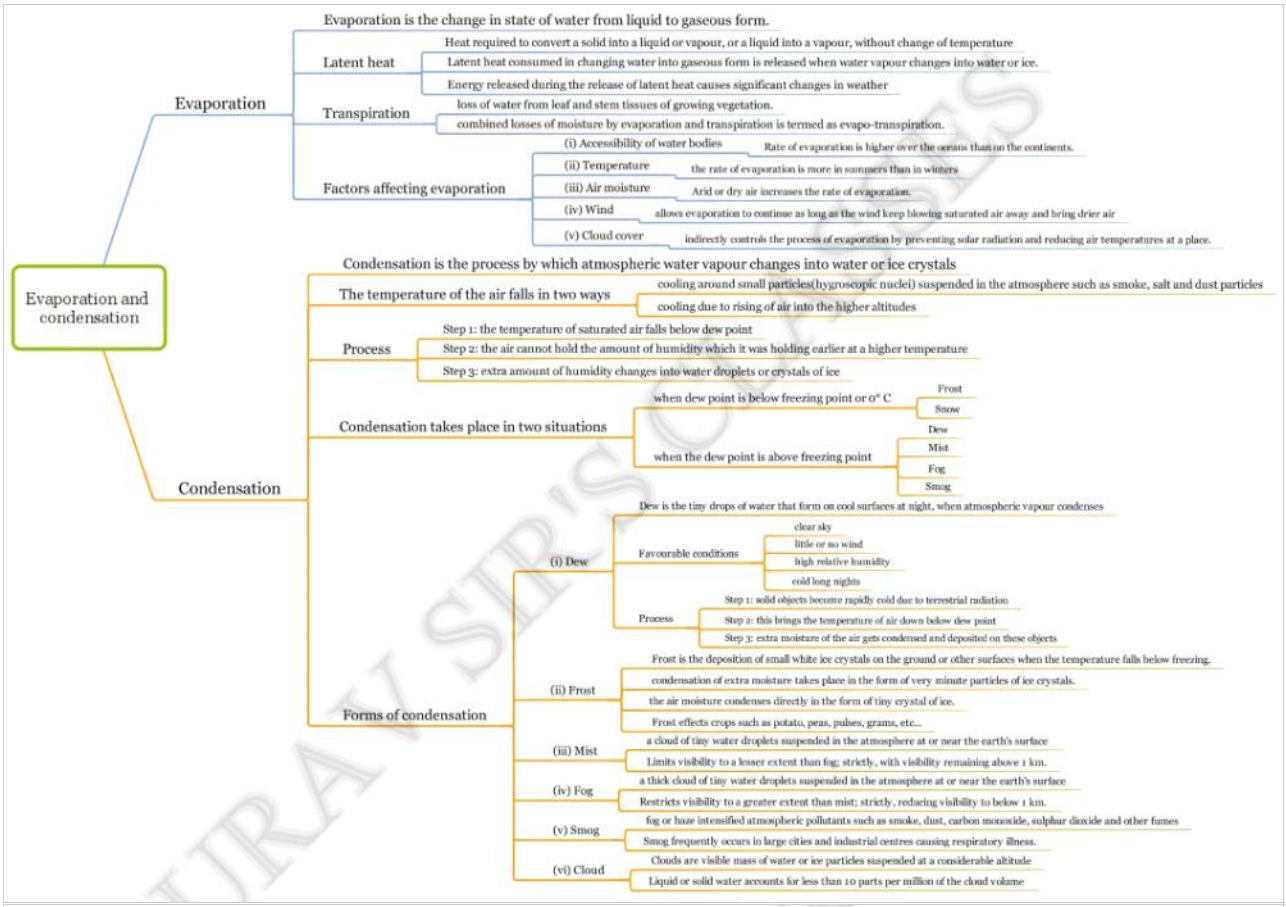

Winds
Facts
Horizontal movement of air in response to difference in pressure is termed as wind
Vertical movement of air is called air current
Factors affecting wind
(i) Pressure Gradient
Pressure gradient and speed of the wind is higher, if the difference in air pressure between the two points is High
Pressure gradient and speed of the wind is lower, if the difference in air pressure between the two points is Low.
(ii) Coriolis Effect
Winds get deflected from their original paths due to the deflection in wind direction caused by the earth's rotation on its axis.
Ferrel's' law - Coriolis force tend to deflect the winds in
northern hemisphere towards their right
southern hemisphere towards their left
Coriolis force is absent along the equator but increases gradually towards the poles.
Coriolis force is maximum at poles
Types of winds
(a) planetary winds or permanent winds
(b) periodic winds and
(c) local winds

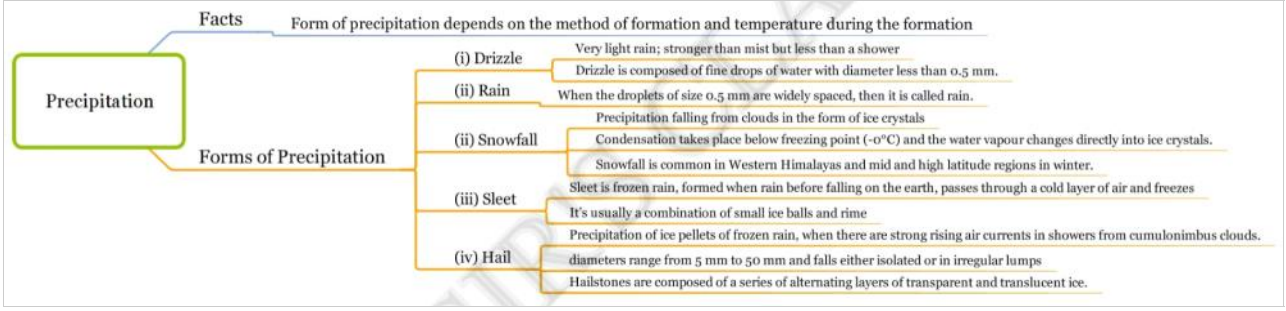

Planetary winds
Facts
Planetary or permanent winds blow from high pressure belts to low pressure belts in the same direction throughout the year
As the trade winds tend to blow mainly from the east, they are also known as the Tropical easterlies
i. Easterlies
Blows from sub-tropical high pressure areas towards equatorial low pressure areas
Also called as trade winds - 'to blow steadily and constantly in the same direction'
Trade winds
North-east trade winds
South-east trade winds
In northern hemisphere trade winds move away from the subtropical high in north-east direction
In southern hemisphere the trade winds diverge out of the sub-tropical high towards the equatorial low from the southeast direction
ii. Westerlies
Winds that move poleward from the sub-tropical high pressure belt
Also termed as antitrade winds due to their direction opposite to trade winds
Due to Coriolis force
westerlies in the southern hemisphere are deflected towards left and blow from the north-west(North-west westerlies)
westerlies in the northern hemisphere are deflected towards right in south-west direction(South-west westerlies)
Westerlies blow with higher force in southern hemisphere than in northern hemisphere due to absence of land
Velocity of westerlies increase towards south and become stormy.
Based on their velocity towards poles, westerlies are classified into
Roaring forties between 40° S latitudes
Furious fifties in 50°S latitudes
Shrieking sixties in 60° S latitudes
iii. Polar easterlies
Polar easterlies blow from polar regions towards sub-polar low pressure regions
Direction of winds is from
north-east to south-west in the northern hemisphere
south-east to north-west in the southern hemisphere.

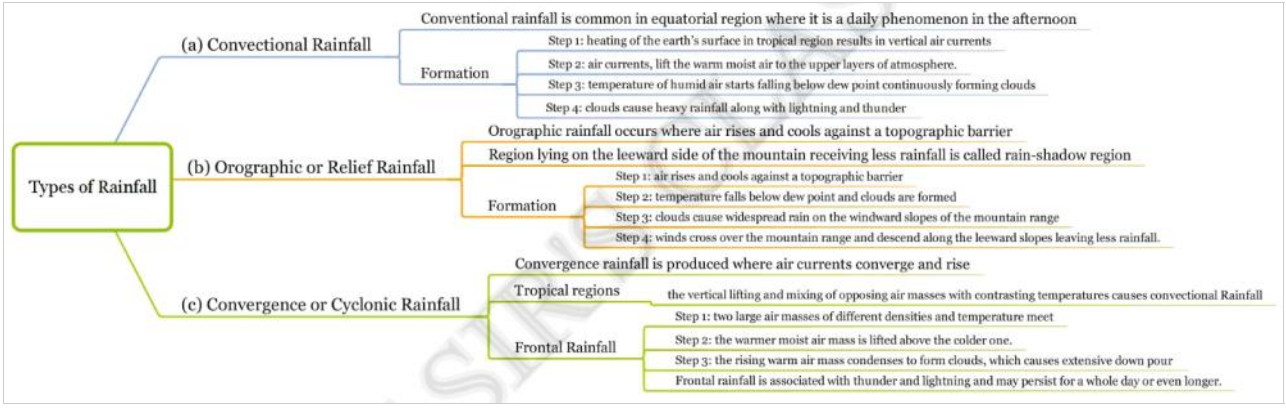

Periodic and Local winds
Periodic winds
Monsoon Winds
The word 'Monsoon' has been derived from the Arabic word 'Mausim' meaning season
The winds that reverse their direction with the change of seasons are called monsoon winds
During
summer the monsoon winds blow from sea towards land
winter the monsoon winds blow from land towards seas.
Monsoon winds are found in
India, Pakistan, Bangladesh, Myanmar, Sri Lanka, North Australia, China and Japan
Local winds
These are winds that affect local weather and are confined to the lower levels of the troposphere.
(i) Land and Sea Breezes
Land and sea breezes are prevalent on the narrow strips along the coasts or lake.
Sea breeze
Sea breeze begins to develop shortly before noon and generally reaches its greatest intensity during mid-day to late afternoon
Formation
Step 1: differential heating of land and water produces low and high pressures.
Step 2: a local low pressure area is developed on land
Step 3: Sea breeze or high pressure winds blow from the water surface towards the low pressure land surface
Land breeze
Formation
Step 1: During night, the land and the air above it cools more quickly than the nearby water body.
Step 2: land develops high pressure area while the sea develops a low pressure area
Step 3: wind begins to blow from land (high pressure) towards sea (low pressure)
(ii) Mountain and Valley Breezes
Valley breeze
Formation
Step 1: Mountain slopes are heated more than the valley floor
Step 2: Pressure becomes low over the slopes while it is comparatively high in the valleys below.
Step 3: Gentle wind begins to blow from valley towards slopes as valley breeze
Mountain breeze
Formation
Step 1: After sunset, the rapid radiation takes place on the mountain slopes
Step 2: high pressure develops more rapidly on slopes than on the valley floor
Step 3: Cold and dense air of mountain slopes starts moving down towards the valley floor as mountain breeze
(iii) Hot Winds
1. Loo
Loo are hot and dry winds
Blow over the northern plains of India and Pakistan in the months of May and June
Blows from west to east and they are usually experienced in the afternoons
Their temperature varies between 45°C to 50°C.
2. Foehn
Foehn is strong, dusty, dry and warm local wind which develops on the leeward side of the Alps
The temperature of the winds vary from 15°C to 20°C which help in melting snow.
Foehn makes pasture land ready for animal grazing and help the grapes to ripe early
3. Chinook
Chinook or snow eater is the hot and dry local wind moving down the eastern slopes of the Rockies in U.S.A. and Canada
They help in melting the snow earlier and keeping the grasslands clear of snow.
(iv) Cold Winds
1. Mistral
Mistrals are cold, dry and high velocity local winds originating on the Alps
They move over France towards the Mediterranean Sea through the Rhone valley
They bring down temperature below freezing point in areas of their influence.

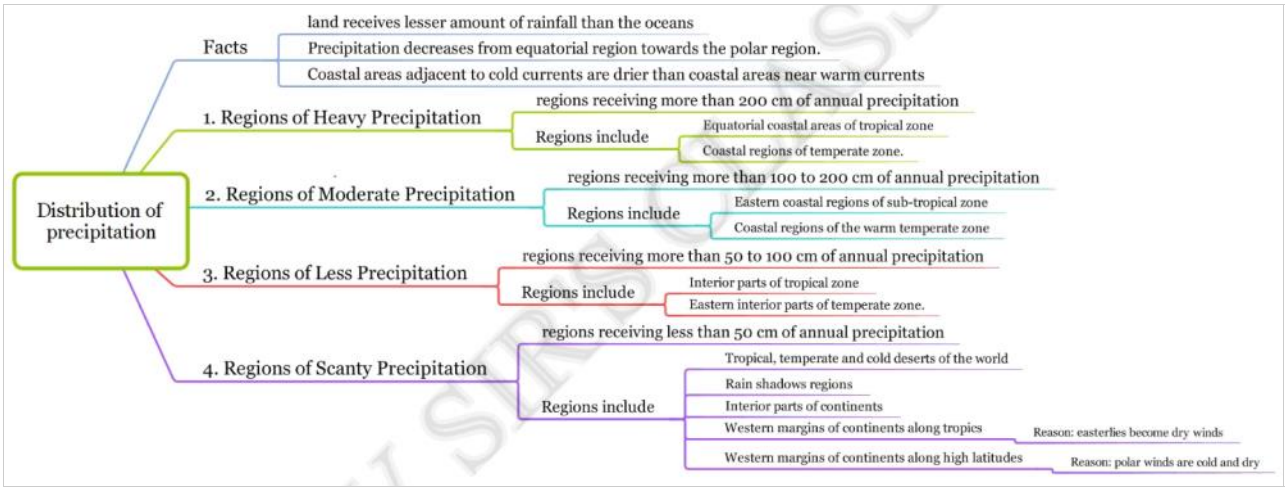

Cyclones
Facts
Air masses with uniform characteristics of temperature, pressure and moisture are necessary to form cyclones
Major regions forming air masses are the high latitude polar or low latitude tropical regions.
Types of Air masses
Cold polar air mass
Warm tropical air mass
The boundary line separating two air masses is termed as front
Types of Fronts
Warm front
warm air mass, moves upward over the cold air mass
Cold front
cold air mass advances faster and forces the warm air upwards
frontal surface of cold front is steeper than warm front
Cyclones
cyclones are rapid inward circulation of air masses about a low pressure centre
Direction
Anti clockwise in the northern hemisphere
Clockwise in the southern hemisphere
Types
1. Temperate or mid latitude cyclones
2. Tropical or low latitude cyclones
Anticyclones
Anticyclones are winds spiralling outward from a high pressure centre
Direction
Clockwise in the northern hemisphere
Counterclockwise in the southern hemisphere
(a) Temperate Cyclones
Temperate cyclones are formed along a front in mid-latitudes between 35°and 65° N and S
They blow from west to east and are more pronounced in winter season.
Major regions
Atlantic Ocean
North West Europe
Weather conditions
Cyclone
drizzling rain
Cloudy skies for number of days
Anticyclone
sunny and calm
cold waves
(b) Tropical Cyclones
Tropical cyclones are formed along the zone of confluence of north-east and south-east trade winds.
This zone is known as the Inter Tropical Convergence Zone (ITCZ).
These are not extensive and have the diameters smaller than temperate cyclones
Major regions
Mexico
South-Western and North Pacific Ocean
North Indian Ocean
South Pacific Ocean
Weather conditions
Cyclone
no clear warm and cold fronts
no well-defined pattern of winds
energised by convectional currents within them
these are shallow depressions and the velocity of winds is weak.
high velocity winds and torrential rainfall combine to create distructive storms
Anticyclones
Tropical cyclones are not accompanied by anticyclones
Tropical cyclones strike Indian coasts in summer and autumn months
Eye of Tropical cyclones remains calm and rainless

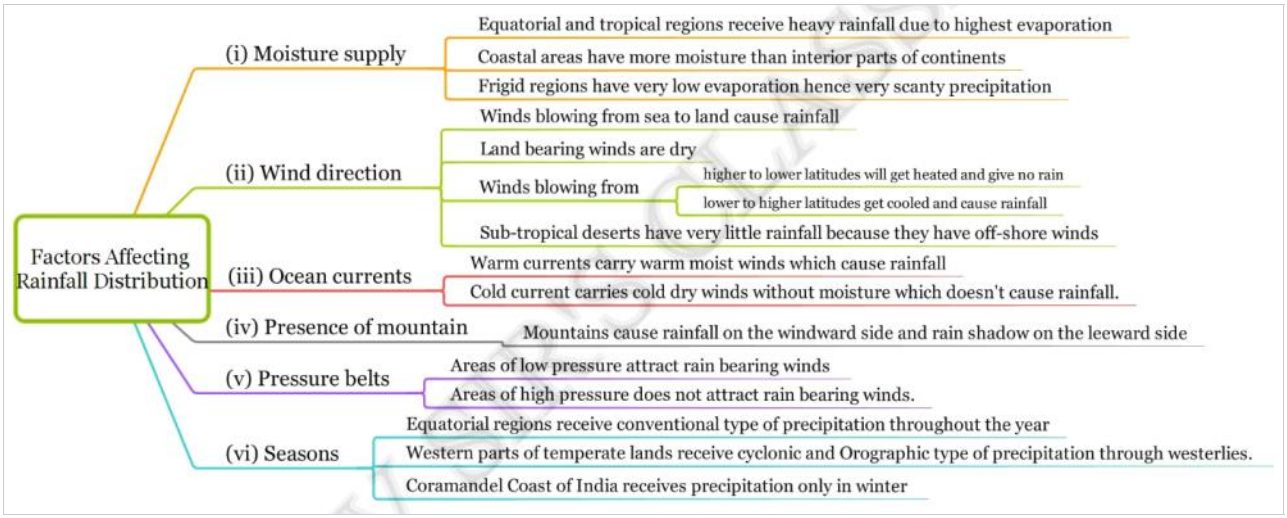

Humidity
Facts
Proportion of water vapour varies from zero to four percent by volume in the atmosphere
The amount of water vapour present in the air affects standing crops favourably.
Amount of water vapour present in gaseous form in the atmosphere is called humidity
Humidity indicates the degree of dampness or wetness of the air
Absolute humidity is variable and changes from place to place and with change in time
The capacity of holding water vapour of an air increases with the increase in its temperature
The temperature at which a given sample of air becomes fully saturated is called the dew point or saturation point
Humidity of the air is expressed as
(i) Absolute humidity
Absolute humidity is the ratio of the mass of water vapour actually in the air to a unit mass of air, including the water vapour.
It is expressed in grams per cubic metre of air.
(ii) Relative humidity
The ratio of the amount of water in the air at a give temperature to the maximum amount it could hold at that temperature
It is expressed as percentage
The relative humidity of an air at saturation point is 100%
Relative humidity
increases when the temperature of the air decreases or when more moist air is added to it
decreases when the temperature of the air increases or when less moist air is added to it

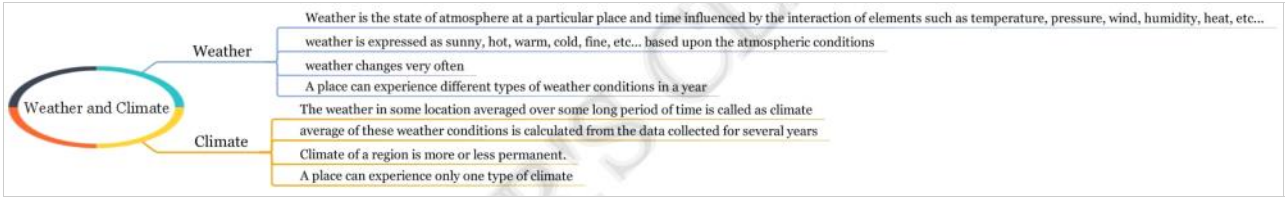

Evaporation and condensation
Evaporation
Evaporation is the change in state of water from liquid to gaseous form.
Latent heat
Heat required to convert a solid into a liquid or vapour, or a liquid into a vapour, without change of temperature
Latent heat consumed in changing water into gaseous form is released when water vapour changes into water or ice.
Energy released during the release of latent heat causes significant changes in weather
Transpiration
loss of water from leaf and stem tissues of growing vegetation.
combined losses of moisture by evaporation and transpiration is termed as evapo-transpiration.
Factors affecting evaporation
(i) Accessibility of water bodies
Rate of evaporation is higher over the oceans than on the continents.
(ii) Temperature
the rate of evaporation is more in summers than in winters
(iii) Air moisture
Arid or dry air increases the rate of evaporation.
(iv) Wind
allows evaporation to continue as long as the wind keep blowing saturated air away and bring drier air
(v) Cloud cover
indirectly controls the process of evaporation by preventing solar radiation and reducing air temperatures at a place.
Condensation
Condensation is the process by which atmospheric water vapour changes into water or ice crystals
The temperature of the air falls in two ways
cooling around small particles(hygroscopic nuclei) suspended in the atmosphere such as smoke, salt and dust particles
cooling due to rising of air into the higher altitudes
Process
Step 1: the temperature of saturated air falls below dew point
Step 2: the air cannot hold the amount of humidity which it was holding earlier at a higher temperature
Step 3: extra amount of humidity changes into water droplets or crystals of ice
Condensation takes place in two situations
when dew point is below freezing point or 0° C
Frost
Snow
when the dew point is above freezing point
Dew
Mist
Fog
Smog
Forms of condensation
(i) Dew
Dew is the tiny drops of water that form on cool surfaces at night, when atmospheric vapour condenses
Favourable conditions
clear sky
little or no wind
high relative humidity
cold long nights
Process
Step 1: solid objects become rapidly cold due to terrestrial radiation
Step 2: this brings the temperature of air down below dew point
Step 3: extra moisture of the air gets condensed and deposited on these objects
(ii) Frost
Frost is the deposition of small white ice crystals on the ground or other surfaces when the temperature falls below freezing.
condensation of extra moisture takes place in the form of very minute particles of ice crystals.
the air moisture condenses directly in the form of tiny crystal of ice.
Frost effects crops such as potato, peas, pulses, grams, etc..
(iii) Mist
a cloud of tiny water droplets suspended in the atmosphere at or near the earth's surface
Limits visibility to a lesser extent than fog; strictly, with visibility remaining above 1 km.
(iv) Fog
a thick cloud of tiny water droplets suspended in the atmosphere at or near the earth's surface
Restricts visibility to a greater extent than mist; strictly, reducing visibility to below 1 km.
(v) Smog
fog or haze intensified atmospheric pollutants such as smoke, dust, carbon monoxide, sulphur dioxide and other fumes
Smog frequently occurs in large cities and industrial centres causing respiratory illness.
(vi) Cloud
Clouds are visible mass of water or ice particles suspended at a considerable altitude
Liquid or solid water accounts for less than 10 parts per million of the cloud volume

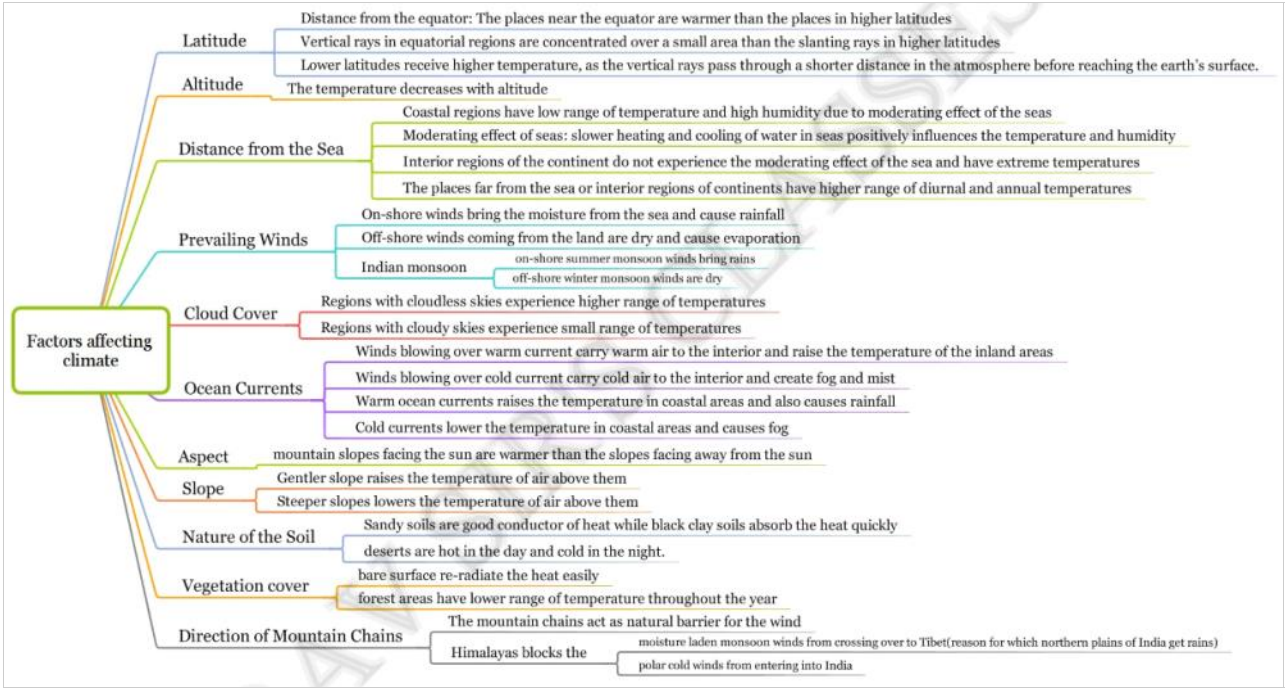

Precipitation
Facts
Form of precipitation depends on the method of formation and temperature during the formation
Forms of Precipitation
(i) Drizzle
Very light rain; stronger than mist but less than a shower
Drizzle is composed of fine drops of water with diameter less than 0.5 mm.
(ii) Rain
When the droplets of size 0.5 mm are widely spaced, then it is called rain.
(ii) Snowfall
Precipitation falling from clouds in the form of ice crystals
Condensation takes place below freezing point (-0°C) and the water vapour changes directly into ice crystals.
Snowfall is common in Western Himalayas and mid and high latitude regions in winter.
(iii) Sleet
Sleet is frozen rain, formed when rain before falling on the earth, passes through a cold layer of air and freezes
It's usually a combination of small ice balls and rime
(iv) Hail
Precipitation of ice pellets of frozen rain, when there are strong rising air currents in showers from cumulonimbus clouds.
diameters range from 5 mm to 50 mm and falls either isolated or in irregular lumps
Hailstones are composed of a series of alternating layers of transparent and translucent ice.


Types of Rainfall
(a) Convectional Rainfall
Conventional rainfall is common in equatorial region where it is a daily phenomenon in the afternoon
Formation
Step 1: heating of the earth's surface in tropical region results in vertical air currents
Step 2: air currents, lift the warm moist air to the upper layers of atmosphere.
Step 3: temperature of humid air starts falling below dew point continuously forming clouds
Step 4: clouds cause heavy rainfall along with lightning and thunder
(b) Orographic or Relief Rainfall
Orographic rainfall occurs where air rises and cools against a topographic barrier
Region lying on the leeward side of the mountain receiving less rainfall is called rain-shadow region
Formation
Step 1: air rises and cools against a topographic barrier
Step 2: temperature falls below dew point and clouds are formed
Step 3: clouds cause widespread rain on the windward slopes of the mountain range
Step 4: winds cross over the mountain range and descend along the leeward slopes leaving less rainfall.
(c) Convergence or Cyclonic Rainfall
Convergence rainfall is produced where air currents converge and rise
Tropical regions
the vertical lifting and mixing of opposing air masses with contrasting temperatures causes convectional Rainfall
Frontal Rainfall
Step 1: two large air masses of different densities and temperature meet
Step 2: the warmer moist air mass is lifted above the colder one.
Step 3: the rising warm air mass condenses to form clouds, which causes extensive down pour
Frontal rainfall is associated with thunder and lightning and may persist for a whole day or even longer.


Distribution of precipitation
Facts
land receives lesser amount of rainfall than the oceans
Precipitation decreases from equatorial region towards the polar region.
Coastal areas adjacent to cold currents are drier than coastal areas near warm currents
1. Regions of Heavy Precipitation
regions receiving more than 200 cm of annual precipitation
Regions include
Equatorial coastal areas of tropical zone
Coastal regions of temperate zone.
2. Regions of Moderate Precipitation
regions receiving more than 100 to 200 cm of annual precipitation
Regions include
Eastern coastal regions of sub-tropical zone
Coastal regions of the warm temperate zone
3. Regions of Less Precipitation
regions receiving more than 50 to 100 cm of annual precipitation
Regions include
Interior parts of tropical zone
Eastern interior parts of temperate zone.
4. Regions of Scanty Precipitation
regions receiving less than 50 cm of annual precipitation
Regions include
Tropical, temperate and cold deserts of the world
Rain shadows regions
Interior parts of continents
Western margins of continents along tropics
Reason: easterlies become dry winds
Western margins of continents along high latitudes
Reason: polar winds are cold and dry


Factors Affecting Rainfall Distribution
(i) Moisture supply
Equatorial and tropical regions receive heavy rainfall due to highest evaporation
Coastal areas have more moisture than interior parts of continents
Frigid regions have very low evaporation hence very scanty precipitation
(ii) Wind direction
Winds blowing from sea to land cause rainfall
Land bearing winds are dry
Winds blowing from
higher to lower latitudes will get heated and give no rain
lower to higher latitudes get cooled and cause rainfall
Sub-tropical deserts have very little rainfall because they have off-shore winds
(iii) Ocean currents
Warm currents carry warm moist winds which cause rainfall
Cold current carries cold dry winds without moisture which doesn't cause rainfall.
(iv) Presence of mountain
Mountains cause rainfall on the windward side and rain shadow on the leeward side
(v) Pressure belts
Areas of low pressure attract rain bearing winds
Areas of high pressure does not attract rain bearing winds.
(vi) Seasons
Equatorial regions receive conventional type of precipitation throughout the year
Western parts of temperate lands receive cyclonic and Orographic type of precipitation through westerlies.
Coramandel Coast of India receives precipitation only in winter


Weather and Climate
Weather
Weather is the state of atmosphere at a particular place and time influenced by the interaction of elements such as temperature, pressure, wind, humidity, heat, etc...
weather is expressed as sunny, hot, warm, cold, fine, etc... based upon the atmospheric conditions
weather changes very often
A place can experience different types of weather conditions in a year
Climate
The weather in some location averaged over some long period of time is called as climate
average of these weather conditions is calculated from the data collected for several years
Climate of a region is more or less permanent.
A place can experience only one type of climate


Factors affecting climate
Latitude
Distance from the equator: The places near the equator are warmer than the places in higher latitudes
Vertical rays in equatorial regions are concentrated over a small area than the slanting rays in higher latitudes
Lower latitudes receive higher temperature, as the vertical rays pass through a shorter distance in the atmosphere before reaching the earth's surface.
Altitude
The temperature decreases with altitude
Distance from the Sea
Coastal regions have low range of temperature and high humidity due to moderating effect of the seas
Moderating effect of seas: slower heating and cooling of water in seas positively influences the temperature and humidity
Interior regions of the continent do not experience the moderating effect of the sea and have extreme temperatures
The places far from the sea or interior regions of continents have higher range of diurnal and annual temperatures
Prevailing Winds
On-shore winds bring the moisture from the sea and cause rainfall
Off-shore winds coming from the land are dry and cause evaporation
Indian monsoon
on-shore summer monsoon winds bring rains
off-shore winter monsoon winds are dry
Cloud Cover
Regions with cloudless skies experience higher range of temperatures
Regions with cloudy skies experience small range of temperatures
Ocean Currents
Winds blowing over warm current carry warm air to the interior and raise the temperature of the inland areas
Winds blowing over cold current carry cold air to the interior and create fog and mist
Warm ocean currents raises the temperature in coastal areas and also causes rainfall
Cold currents lower the temperature in coastal areas and causes fog
Aspect
mountain slopes facing the sun are warmer than the slopes facing away from the sun
Slope
Gentler slope raises the temperature of air above them
Steeper slopes lowers the temperature of air above them
Nature of the Soil
Sandy soils are good conductor of heat while black clay soils absorb the heat quickly
deserts are hot in the day and cold in the night.
Vegetation cover
bare surface re-radiate the heat easily
forest areas have lower range of temperature throughout the year
Direction of Mountain Chains
The mountain chains act as natural barrier for the wind
Himalayas blocks the
moisture laden monsoon winds from crossing over to Tibet(reason for which northern plains of India get rains)
polar cold winds from entering into India