CONTENT

1. ASTRONOMY

The Universe

- The great astronomer of Roman school, Egyptian Claudius Ptolemy (140 AD) started the Systematic study of the Universe.
- According to Claudius Ptolemy the Earth is at the centre of the Universe and all the other Celestial bodies like sun and planets are revolving around it.
- Copurnicus was the first person to give theory that sun is the center of Universe.
- Age of Universe is about 13.6 Billion Years.

Origination of Universe

- Big Bang theory is the most acclaimed theory regarding the origin of the universe.
- It was proposed by a Belgian Astronomer and Clergy E. George Lamantere.
- According to him, there was a big heavenly body, which was made up of heavy matters.
- Due to sudden explosion (Big Bang) of this heavenly body galaxies , Stars and the planets were formed .
- The Universe includes all the bodies,matter and complete Solar family which Comprises the Sun, Moon, Planets, Comets, Asteroids etc.

Galaxy

- A Galaxy is an uncountable group of stars.
- Our own galaxy is known as 'Milky Way' which has spiral shape.
- There are about 10^{11} Galaxies in Universe.
- Every Galaxy has 10^{11} Stars .
- Nearest Galaxy to Milky Way is Andromada.

Units of distances

- Light year-Distance covered by light in an year.
- 1 LY=$9.46*10^{12}$ KM
- Parsec: 1 Parsec=3.26 LY.
- Astronomical Unit--Average distance between Sun and Earth.(14.98Cr KM)

The Solar System

- The Sun and bodies revolving around it including planets, satellites, comets, metiors and asteroids together constitute the solar system.
- Kepler's theory describes distance between sun and other planets.
- The Sun is the source of the solar system .
- Sun is also the source of all energy in solar system.
- The source of energy in the Sun is **Nuclear Fusion**.

The Sun

- Sun is a star.(Young Star)
- Sun revolutes round the center of Milky Way Galaxy. It's revolution period is 25 Cr. years ,which is also known as Cosmic Year.
- Sun rotates on its own axis from east to west.
- Chemical composition of Sun is : 71% Hydrogen, 26.5% Helium and 2.5% other elements.
- The temperature of the Core of Sun is around 15000000ºC.
- The illuminated part of Sun is known as photosphere. Its temperature is around 6000ºC.
- The outer Hollow of the sun at the time of total solar eclipse is known as Corona.
- Corona emits X-rays.
- Sun has 99.8% of total mass of solar system.
- Its diameter is 110 times that of earth.
- It is the nearest star to the earth.
- The nearest star to sun is proxima centuary.
- Light takes about 8 minutes and 16 seconds to reach the Earth from the Sun.

Some Important Facts related to Sun

- Minimum distance from the Earth (Perihilion)
  - 147 Million KM.
- Maximum distance from the Earth (Aphelion)
  - 152 Million KM.
- Average distance from the earth
  - 149.8 Million KM.
- Diameter of the sun
  - 13,92,00 KM.
- Volume of the sun
  - 1.3 million times that of the Earth.
- Mass of the sun
  - 3,32000 times that of the Earth.
- Temperature of the Solar-Spots
  - 4500ºC

- Energy Emission
  - 10^{26} joules/second
- Rotational time period
  - 25.38 days (relative to the equator); 33 days (relative to the poles).
- Composition of the sun
  - Hydrogen (71%), Helium (26.5%) and others (2.5%)
- Age of the sun
  - 5 billion years (approx)
- Estimated life of normal stars
  - 10 billion years.
- Time taken to rech solar light from Sun to Earth
  - 8 Min. 16 Sec.
- Velocity of the light
  - 3×10^8 m/s
- 1 light year (distance travelled by the light in one year) - 9.45×10^{13} km
- 1 parsec (largest/biggest unit of distance)
  - 3.26 light years

Bodies of Solar System

- **Bodies of solar system are divided in three parts-**

1. Traditional planets- Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune
2. Dwarf planets- Pluto, Ceres(UB 313)
3. Small planets- Comets, Satellites and other small bodies

- All planets revolves from west to east to the sun except Venus and Uranus they revolves from east to west.

Planets

Planets have been devided in two classes -

1. Terrestrial Planet (Inner Planets)-

- First four planets Mercury, Venus, Earth and Mars are called terrestrial planets
- Their structure being similar to the of earth.

2. Jovian Planets (Outer Planets)-

- Next four planets Jupiter, Saturn, Uranus and Neptune are called jovian planets
- Their structure being similar to the jupiter.

Decending order of Planets:

According to distance-

1. Mercury 2. Venus
3. Earth 4. mars
5. Jupiter 6. Saturn
7. Uranus 8. Neptune

According to size-

1. Jupitar 2. Satrun
3. Uranus 4. Neptune
5. Earth 6. Venus
7. Mars 8. Mercury

According to mass-

1. Jupitar 2. Saturn
3. Neptune 4. Uranus
5. Earth 6. Venus
7. Mars 8. Mercury

Important facts related to Planets:

Mercury

- This is the nearest planet to the Sun
- This the smallest planet of the solar-system.
- It takes 88 days to complete one revolution around the sun(shortest duration).
- It has no natural satellite.
- It has no atmosphere.
- Here range of temprature is found maximum.
- Here days are very hot and nights are chilling.

Venus–

- Venus is the second closest planet to the Sun.
- Venus is the nearest planet to the Earth.
- It completes revolution of Sun in 225 days.
- It is the brightest planet.
- It is called 'Morning star'.
- It is also called 'Evening star'.
- This planet, unlike other planets, revolutes round the Sun clockwise and rotates from East to West.
- It is the brightest object seen in the sky after the Sun and the Moon.
- Being almost similar to the Earth in size and mass it is called the sister planet of the Earth.
- Like Mercury, Venus also has no natural satellite.
- Its atmosphere contains 90-95 % Carbon dioxide.
- It is also known as 'Pressure cooker'.

Earth–

- Earth is the fifth largest planet of the solar system.
- Its equitorial diameter is 12,756 KM & polar diameter is 12,714 KM.

- It is tilted on its axis by $23^{1}/_{2}^{o}$.
- It is tilted on its orbital plane by $66^{1}/_{2}^{o}$.
- It rotates on its axis from west to east.
- It takes about $365^{1}/_{4}$ days to complete one revolution around the sun.(solar year)
- It is also called the 'Blue Planet' .
- It looks blue when seen from the outer space due to the presence of large amount of water.
- Ozone gas present in atmosphere of earth save us from harmful Ultra violet rays.
- It is the only planet with the conditions faverable for life.
- Its average distance from the sun is about 150 million km.
- It looks like planet venus.
- It has only one Natural Satellite ***"Moon"***.

Some Imoprtant Facts About Earth

• Shape	- Geoid
• Pole to pole diameter	- 12,714 KM
• Equatorial diameter	- 12, 756 KM
• Polar circumference	- 40,008 KM
• Equatorial circumference	- 40,075 KM
• Water	- 71%
• Land	- 29%
• Volume	- 10.83×10^{11} KM^3
• Total surface area	- 51.1cr KM^2
• Average Relative Density	- 5.52 (with respect ot the density of water)
• Age (estimated)	- 4.6 billion years
• Surface area	- 511 million km^2
• Rotational time	- 23 hours 56 min 4 Sec
• Revolutional time	- 365 days 5 hours 48 min 46 sec
• Minimum distance from the sun (Perihelion)	- 147.0 million km
• Maximum distance from the sun (Apehelion)	- 152.1 million km
• Average distance from the sun	- 149.8 million km
• Time taken by the light of the sun to reach earth	- 8 min 16 sec
• Distance from the moon	- 384,000 km
• Highest point	- Mt Everest (8,848 km from the sea level)
• Deepest point	- Mariana Trench (11,033 km deep from the sea level)

Moon-

- Moon is the only natural satellite of the Earth.
- The study of moon is called Celenology.
- "Sea of traquility" is the plain area of dust particles on surfaceof the Moon.
- The moon is also known as the fossil planet.
- It has a diameter of 3,475 km.
- It takes 27 days, 8 hours to rotate on its axis.
- It also take 27 days. 8 hours to revolve around the earth.
- The situation when the earth is at maximum distance from the moon is Apogee.
- Only 59% of the total surface of the moon is visible from the earth.
- Chandrayan I was launched on 22nd october 2008 by PSLVC-11.
- Chandrayan II is a joint programme of India & Russia.
- The moon dont has any Atmosphere.
- The light of the moon take 1.3 seconds to reach the earth.
- The size of the moon is $^{1}/_{4}$ the size of the earth.
- Gravitational force of the moon is $^{1}/_{6}$ that of the earth.

Some Important facts about

MOON

- Average distance from the earth - 3,84,365 km.
- Maximum distance from the earth (Apogee) - 4,06,000 km.
- Minimum distance from the earth (Perigee) - 3,64,000 km.
- Orbital time around the earth - 27 days 7 hours 43 min 11.47 sec.
- Rotational time - 27 days 7 hours 43 min 11.47 sec.
- Atmosphere - Absent.
- Diameter - 3.476 km.
- Mass (compared to the earth) - 1:81,30
- Density (relative to that of water) - 3,34.
- Density (relative to that of the earth) - 0,6058.
- Hidden part of Moon's surface - 41%. (shown part to earth -59%)
- Highest point on the Moon of - Mt Leibnitz (35,000 ft.) situated on the south pole the moon.

Mars

- It is also called 'Red Planet' because of its red appearance.
- Its red colour is due to iron-oxide present in its soil.
- It is the only planet, besides earth, where the possiblity of life exists.
- It has two natural satellites-
  - **(a) Phobos**
  - **(b) Demos - (This is the smallest satellite of solar system)**
- The highest point on this planet is Nix Olympia
- Nix Olympia is three times as high as Mt. Everest.
- The atmosphere on this planet is very thin.
- Its rotation is like as earth rotation.
- It takes 24 hr. in a single rotation on its axis.
- It's Revolution around the sun is West to East.
- It take approx. 687 days for single revolution around the sun.

Jupiter

- This is the largest planet of the solar system.
- It has maximum equitorial radius.
- It is 1300times the size of Earth.
- Ganimade is the largest satellite of this planet.
- It is the also the largest satellite of the solar system.
- This is known as mini solar system.
- It takes only around 10 hrs. to complete a rotation(fastest & least time).
- It takes 11.9 years to complete one revolution around the Sun.
- Ayo, Europa, Calisto, Almethia, etc. are other satellites of Jupiter.
- The atmosphere of this planet is composed of hydrogen, Helium, Methane and Ammonia.
- Its density is less than water.

Saturn

- It is the second largest planet of the solar family.
- Phobe revolves in opposite direction to it.
- It appears yellow in the sky.
- The atmosphere of Saturn is also composed of Hydrogen, Helium, Methane and Ammonia Like Jupiter.
- So it is also called a gasious sphere.
- It has atmosphere as well as gravitation.
- It has maximum no. of satellites.
- Titon is the largest Satellite of the saturn.
- Titon having the size comparable to Mercury.
- Other satellites of Saturn include– Mimansa, Ensiladu, Tethys, Dion, Riya, Hyperion, Ipapetus and Phobe.
- Saturn is the last planet of the solar system that can be seen through the naked eyes.
- Its most spectacular and mysterious characteristic is the presence of fully developed rings around it.

Uranus

- Uranus was discovered in 1781 AD by Sir William Harshell.
- This is the seventh planet from the sun.
- It rotates on its axis from east to west while other planets from west to east.
- Its atmosphere is very thick.
- It's atmosphere is composed of Hydrogen, helium, Methane and Ammonia like Jupiter and Saturn has.
- It has least orbital inclination.
- It is also called as tilted planet.
- Arield and Miranda are main satellites of this planet.
- It is the third largest planet of the solar system.
- It has rings around it like Saturn.
- The Sun rises in its west and sets in its east.

Neptune

- It was discovered by a German astronomer Johan Galle in 1846.
- It is green in colour.
- It's atmosphere is very dense.
- It's atmosphere consits of Hydrogen, Helium, Methane and Ammonia.
- Its main satellite is Triton.
- Its orbital time is 165 years.
- It has 8 natural satellite.
- It is the last planet of our solar system.

Dwarf planets

Pluto

- Pluto was discovered in 1930.
- It was discovered by Clyde Tombagh.
- It also known as a "Kuber".
- This planet was given status of Dwarf Planet at Prague Summit in 2006.
- Now there are only eight planets in the solar system.

UB-313

- It was discovered in 2003.
- It is also named as Arice.

Asteroids

- These are situated between Mars and Jupiter.
- Asteroids are also known as minor planets.
- These revolve round the sun.
- These are approximately 40000.
- Four vesta is the only Asteroid which we can see through naked eyes.

Comets

- These are the celestial bodies composed of dust , ice and gases.
- Comets come from the colder and darker areas, away from the sun.
- They revolve around the sun in large and irregular orbits.
- They start glowing with a bright gaseous tail always pointing **away from the Sun**.
- Many a times, comets are visible to the naked eye and present a very spetacular sight.
- Comet Halley was discovered by Edmund halley.
- Comets Halley returns after every 76 years.
- It was Last time was seen in 1986.
- Now it will be seen again in 2062 (1986+76=2062).
- Acccording to the astromers there are about 1 lakh comets wondering in the solar system.

Meteors and Meteorites

- Meteors and Meteorites are also called shooting star.

1. Meteors

- Meteors are the celestial bodies composed of dust and gases.
- Meteors are usually small and due to heat produded by air resistance, burn up before they reah the Earth's surface called meteors.

2. Meteorites

- Meteorites are large in size.
- Meteorites do not burn completely.
- Meteorites reach the surface of the earth.

2. LATITUDES & LONGITUDES

Latitudes

- It can be defined as the angular distance measured at the centre of the Earth with respect to any point on the Earth's surface.
- These are depicted in degrees, minutes and seconds.
- Equator is on the 0^o plane from center of Earth.
- There are several latitudes on both sides (north and south) of the equator up to the poles.
- These are imaginary circles, drawn on the surface of the Earth,
- At an interval of 1^o in both the hemispheres making the total number of latitudes to 181.
- These are some important latitudes-
  - (a) 0^o Latitude- It is known as Equator.
  - (b) $23^1/2^o$ N Latitude- Tropic of Cancer.
  - (c) $23^1/2^o$ S Latitude- Tropic of Capricorn.
  - (d) $66^1/2^o$ N Latitude- Arctic Circle.
  - (e) $66^1/2^o$ S Latitude- Antarctic Circle.
  - (f) 90^o N Latitude- North Pole.
  - (g) 90^o S Latitude- South Pole.
- Area between any two latitude is known as Zone.
- Distance between two consecutive latitude is 111 km.
- The duration of day and night is of 6 months on 90^0 latitude.

Longitudes

- Angular distance of any place from the Prime Meridian on its east or west is called longitude.
- These are imaginary lines drawn on the surface of Earth.
- It is measured in degrees, minutes and seconds.
- The Prime Meridian at 0^o is known as the Greenwich Line, it passes throgh Greenwich in London.
- There are 180 longitudes on both the sides (east and west) of the Prime Meridian.
- There are 360 longitudes in total.(On an interval of 1^0)
- They are actally a part of **great circle**.
- The distance between two consecutive longitudes is about 111.32 km.
- Distance decreases towards the poles.
- This Distance is maximum at the equator.
- This is because longitudes taper towards the poles.
- Part of the Earth on the eastern side of the Prime Meridian is called Eastern part and on the western side of it is called Western part.
- The earth takes 4 minutes to cover 1^o of longitude.
- Area between two longitudes is known as Gore.
- The Value of Gore at Equator is 111.32 km.

International Date Line

- It is an imaginary line drawn at the 180^o longitude, avoiding the continuous land parts.
- It is bent at 75^o N latitude towards east to avoid division of Siberia and to separate Siberia and Alaska.
- Again it is bent over the Berring Strait towards west.
- When we cross it from east to west one day is gained.
- When we are going from west to east one day is lost.
- Maximum numbers of time zones are in Russia (11) then in canada(6).
- USA has 5 time zones.

Standard Time

- This is taken from the Meridien passing almost through middle of the country.
- Standard Time of the country is followed all over the country to avoid the inconvenience casued by the difference in local times of different places in that country.
- Indian Standard Time is taken from $82^1/2^o$ East Longitude.
- $82^1/_2{}^o$ East Longitude passing through Naini, near Allahabad (Uttar Pradesh), is the Standard Meridian of India.
- The time at this longitude is the Standard time of India, called Indian Standard Time (IST).
- Russia has 11 standerd times.

3. MOTIONS OF EARTH

Rotation

- The rotation of Earth on its own axis is called rotation.
- The Earth rotates on its axis from west to east.
- Rotation of the Earth is responsible for the cycle of day and night on.
- Therefore this motion is also called 'Daily Motion'.
- The Earth completed his rotation approx in 24 hours.

Revolution

- Earth revolves around the sun in an elliptical path is called revolution.
- The elliptical path traced by the earth is called its orbit.
- Revolution of the Earth is responsible for the seasons.
- The Earth Complets one revolution around the sun approx in 365-1/4 days.
- This motion is also called annual motion of the earth.

Positions of Earth in accordance with Sun

Perihelion

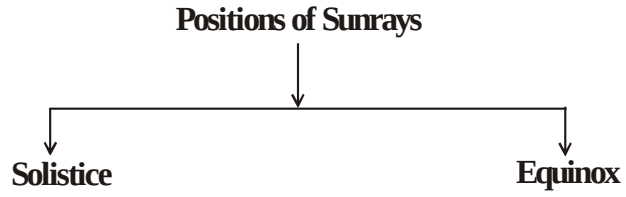
- When the earth is at the minimum distance from the sun the position is called perihelion.
- The earth attains this position on the 3rd January.
- The minimum distance between sun and earth is approx 14.70 Cr. Km.

Aphelion

- When the earth is at the maximum distance from the sun the postion is knwn as aphelion.
- The earth attains this position on 4th July.
- The maximum distance between sun and earth is approx 15.21 Cr Km.

Positions of Sunrays :

- There are two positions of sunrays on the Earth-
  - **(a) Solistice**
  - **(b) Equinox**



Solistice

- It's of two type-
  - (a) summer solistice
  - (b) Winter solistice

(a) Summer Solstice

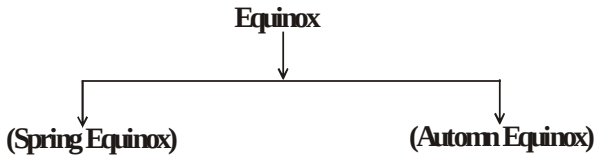
- In this position sunrays are perpendicularly over the Tropic of Cancer.
- This position is called the Summer Solstice.
- These Position Comes on 21st June.
- The day in the northern hemisphere is longest on 21st June.

(b) Winter Solstice

- In this position the Sunrays are perpendicularly over the Tropic of Capricorn.
- This position is called Winter Solstice.
- These Position Comes on 22nd December.
- During this period days are longest and nights are shortest in the southern hemisphere.

Equinox

- It is also of two types-
  - (a) Spring Equinox
  - (b) Automn Equinox



- In these two postions the Sunrays are perpendiculer over the Equator.
- Hence everywhere the duration of day and nigth is equal.
- These two positions are referred to as Equinox.

A Spring Equinox

- Spring Equinox comes on 21st March.
- Spring Equinox is also called Vernal Equinox.

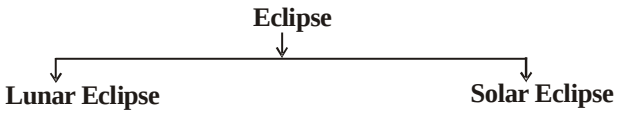
B Automn Equinox

- Automn Equinox comes on 23rd September.

4. ECLIPSE

Types of Eclipse:

- There are two types of Eclipse occuring according to the position of Sun , Earth & Moon-
  - **(a) Lunar Eclipse**
  - **(b) Solar Eclipse**



Lunar Eclipse

- When the Earth comes in between the Sun and the Moon,
- The light of the Sun is not able to reach on the Moon,
- This position is called the Lunar Eclips.
- Luner Eclipse occurs on fullmoon night. (but not on every fullmoon.)
- There would be maximum seven occasions for the Lunar eclipses in a single year.

Solar Eclipse

- When the Moon comes in between the Sun and the Earth.
- The light of the Sun is interrupted and shadow of the Moon falls on the Earth.
- This position is called the Solar eclipse.
- Solar Eclipse occurs on Newmoon.
- There would be maximum seven occasions for the lunar and Solar eclipses in one year.
- Diamond ring phenomenon is related to solar eclipse. This occurs just after total Solar eclipse.
- During total Solar eclipse Ultra-Violet rays emit out of Sun.
- The longest Solar eclipse of 21st century occured on 22nd july 2009.

5. INTERNAL STRUCTURE OF EARTH

- Various landforms on the surface of the Earth are very closely related to its internal structureE
- The study of the Earth's interior is the Subject of Geology.
- The internal part of the Earth is not visible directly.
- We have to rely totally on indirect sources so as to know Earth's internal structure.
- These indirect sources can be classified into two groups-
  (1) Artificial Sources
  (2) Natural Sources

1. Artificial Sources–

(a) Density–

- The average density of the earth is 5.52
- Whereas the density of the earth's crust is about 3.0
- This indicates that the inner parts are more denser than the crust.

(b) Pressure–

- It should be noted that density increases with increasing pressure inside Earth's interior .
- This shows that the high density in the core is the result of its heavy metallic materials of high density.

(c) Temperature–

- Temperature increases by 12^0C on first 100 KM.
- Normally, the temperature increases by 1ºC for every 32 mts. of depth.

2. Natural Sources–

(a) Volcanicity–

- The molten lava comes out of the volcano during volcanic erruption.
- This condition Indicates that there is at least a layer below the Earth's crust which is in liquid or semi-liquid state.

(b) Seismology–

- It is the scientific study of the seismic waves generated during an Earthquake.
- The intensity of seismic wave is recorded by the seismograph.
- According to **Suess** Earth's interior has been . . . . . -
  (a) Sial :- Its rich in Silica and Aluminium.
  (b) Sima:- Its rich in Silica and Magnesium.
  (c) Nife:- Its rich in Nickle and Ferrous(Iron).
- **According to recent studies Earth's interior has been devided into three main layers :**

1. The Crust–

- It is the outermost layer of Earth.
- According to the IUGG, the average thickness of this uppermost layer of the earth is about 30 km.
- Some other sources estimate its thickness around 100 Km.
- The speed of the P waves in the upper part of the crulst is 6.1 Km/sec and in the lower parts it is 6.9 km/sec.
- The average density of the upper crust 2.8 and that of the lower crust is 3.0
- This difference in density is due to the pressure.
- Silica and Alluminium are the main constituent elements of the crust.
- Therefore, it is also known as the SIAL.

2. The Mantle-

- At the lower end of the crust the speed of the seismic waves increases suddenly and reaches upto 7.9 to 8.1 km/sec.
- There is a 'Moho-discontinuity' which is in between the crust and the mantle.
- The mantle extends upto a depth of about 2900 Km from the Moho discontinuity.
- The volume of the mantle is about 83% of the total volume of the earth.
- its mass is about 68% of the total mass of the earth.
- Silica and Magnesium are the major constituting elements of this layer.
- Other name of mantle is SIMA due to presence of silica and magnesium in large amount.
- Asthenosphere is found is this part at the depth of100-200Km.

3. The Core–

- At the lower end of the lower mantle, the velocity of the P waves suddenly increases to 13.6 km/sec.

- There is a 'Weichert - Gutenberg Discontinuity' which is between mentle and core.
- The core extends upto a depth of 6371 km from the Gutenberg discontinuity.
- S waves cannot penetrate into the outer core.
- Its relatively liquid or semi-liquid due to excessive temperature.
- It is in semi-liquid or plastic state.
- The volume of the core is merely 16% of the Earth's volume.
- The mass of the core is about 32% of the Earth's mass.
- Core is mainly made-up of Nickle and Iron(Ferrous) and so this layer is also called NIFE layer.

Fact File of Earth

- Average Relative Density - 5.52 (with respect ot the density of water)
- Radius - 6371 Km
- Nick name - Blue planet
- temperature decreases by 1^0C on going 32 mtrs below Eath's surface.
- Highest point - Mount Everest(8848 m)
- Deepest point - Mariana trench(11033m)
- Lowest place - Dead sea (Jordon)[400m below sea level]

Account of different elements in earth's surface

	Elements	Amount (in%) in crust
1.	Oxygen	46.8%
2.	Silicon	27.7%
3.	Aluminium	8.1%
4.	Iron	5.0%
5.	Calcium	3.6%
6.	Sodium	2.8%
7.	Potassium	2.5%
8.	Magnessium	2.0%

6. ROCKS AND MINERALS

Types of Rocks

Minerals are naturally occurring inorganic substances, often with a crystalline structure. They are composed largely of the most abundant elements in the Earth's crust oxygen & silicon, coupled with metals or the metallic elements of iron, calcium, sodium, potassium, and magnesium.

Rocks are usually composed of two or more minerals. Often, many different minerals are present, but a few rock varieties are made almost entirely of one mineral. Most rock in the Earth's crust is extremely old, dating back many millions of years, but rock is also being formed at this very hour as active volcanoes emit lava that solidifies on contact with the atmosphere or ocean.

The Great Oxygenation Event or oxygen catastrophe which happened 2400 million years ago in the Proterozoic eon triggered an explosive growth in the diversity of minerals on Earth. The three types of Rocks are Sedimentary, Igneous and Metamorphic.

- **Igneous rocks**

These rocks have crystallized from magma which is made up of various components of pre-existing rocks and has been subjected to melting either at subduction zones or within the Earth's mantle.

- **Sedimentary rocks**

These rocks are formed through the gradual accumulation of sediment, such as sand on a beach or mud on a river bed. The sediment is buried and then it is compacted as more and more material is deposited on top. In several thousand to Lakhs of years , the sediment becomes so dense that it becomes a rock. This process is known as lithification.

- **Metamorphic rocks**

These rocks once existed as igneous or sedimentary rocks but have been subjected to varying degrees of pressure and heat within the Earth's crust. The processes involved changes the composition and fabric of the rock and their original nature is often hard to distinguish. Metamorphic rocks are typically found in areas of mountain building.

The above three classes of rocks are constantly being transformed from one to another in a continuous process through which the crustal minerals have been recycled during many millions of years of geologic time. The adjacent diagram shows these transformations.

Igneous Rocks

The upper 16 kilometers of the Earth's crust is made up of 95% Igneous rock, with a thin covering of sedimentary and metamorphic rocks. Igneous rocks are formed when molten rock cools, forming silicate mineral crystals. Felsic minerals are light colored and less dense, and mafic minerals are dark colored and more dense. The igneous rocks are generally hard and water percolates in them not so easily.

The most important characteristics of Igneous rocks are as follows:

- They usually do not occur in distinct beds or strata like sedimentary rocks.
- Igneous rocks are generally not having any fossils S They are generally granular and crystalline.
- They are less affected by chemical weathering as the water does not percolate in them easily.

Magma as source of Igneous Rocks

The mixture of the Molten Rocks which makes the Igneous rocks is called Magma. Magma in fact is a mixture of molten rocks, volatiles (gas) and other solids. It originated from the partial melting of the lower crust and the upper mantle, mainly at depths of 15-200 kilometers. Most magma is as hot as 700 °C to 1300 °C and is silicate mixtures mostly. The chambers under a volcano where Magma collects are called magma chambers. The magma chambers feed a volcano. Bulks of the igneous rocks are result of the cooling and solidifying of Magma. There are two processes by which Magma cools and solidifies. These are called "plutonic" and "Volcanic Eruption". When the Molten Magma goes down deep within the earth and gets solidified, it is called Plutonism. On the contrary, the molten Magma can also come out on the surface of earth via a volcanic eruption.

Intrusive and Extrusive Igneous Rocks

Magma that solidifies below the Earth's surface and remains surrounded by older, pre-existing rock is called intrusive igneous rock. Because intrusive rocks cool slowly, they develop large mineral crystals that are visible to the eye. They are further classified into Plutonic, Hypabyssal, Batholiths and Laccoliths as follows:

Types of Igneous Rocks

Intrusive	Plutonic	Generally very large crystal and they were formed due to cooling of magma very deep inside the Earth
	Hypabyssal	Consolidated in a zone above the base of Earth's crust and hence has distinct structural characteristics.
	Batholiths	They extend to greater depths and larger areas
	Laccoliths	A sheet intrusion that has been injected between two layers of sedimentary rock
Extrusive		Formed at the crust's surface as a result of the partial melting of rocks within the mantle and crust

If the magma reaches the surface and emerges as lava, it forms extrusive igneous rock. Extrusive igneous rocks cool very rapidly on the land surface or ocean bottom and thus show crystals of only microscopic size. Please note that Granite typically accumulates in batholiths. A single batholith sometimes extends down several kilometers and may occupy an area of several thousand square kilometers.

Felsic Rocks and Mafic Rocks

Whatever may be the process of cooling and solidifying, the magma while converting into a rock, undergoes numerous chemical and physical changes. Accordingly, there are two major types of Igneous rocks are produced viz. Felsic Rocks and Mafic Rocks. Felsic rocks are rich in silicon, oxygen, aluminium, sodium, and potassium, while the mafic rocks are rich in magnesium and iron. If the rock is highly dominated by Magnesium and Iron, it is called Ultramafic.

Examples of Igneous Rocks

- Granite: Intrusive (batholith generally), Felsic, igneous rock. Worldwide average chemical composition of Igneous Rocks has SiO_2 — 72.04% & Al_2O_3 — 14.42%
- Diorite: intermediate intrusive igneous rock
- Gabbro: Mafic igneous rocks equivalent to basalt.
- Peridotite
- Rhyolite
- Andesite
- Basalt
- Komatiite
- Diabase

Sedimentary Rocks

Sedimentary rocks are made from layers, or strata, of mineral particles found in other rocks that have been weathered and from newly formed organic matter.

Sedimentary rocks form at Earth's surface by the hydrologic system. Their origin involves the weathering of pre-existing rock, transportation of the material away from the original site, deposition of the eroded material in the sea or in some other sedimentary environment, followed by compaction and cementation. Some common features are:

- They contain strata or layers. The layers are rarely horizontal and generally tilted due to lateral compressive and tensile forces. They are formed of sediments derived from the older rocks, plants and animals remain.
- Most part (around 75 percent] of the surface area of the globe is covered by Sedimentary Rocks.
- Most of the sedimentary rocks are permeable and porous.
- Sedimentary rocks are generally characterized by different sizes of joints, generally perpendicular to the bedding plains.

When rock minerals are weathered, their chemical composition is changed, weakening the solid rock. The rock breaks up into particles of many sizes. When these particles are transported in a fluid such as air, water, or glacial ice, we call them sediment. There are three major classes of sediment: clastic sediment, chemically precipitated sediment, and organic sediment. On this basis, three main types of sedimentary rocks are recognized viz. clastic rocks, organic rocks and chemically precipitated rocks.

Types of Sedimentary Rocks

Clastic	Made up of discrete fragments or clasts of materials derived from other minerals, largely of quartz and others such as feldspar, amphiboles, clay minerals.
Organic	They contain the materials which are generated by living organisms such as corals, mollucks, and foraminifera, which cover the ocean floor with layers of calcium carbonate, which can later form limestone.
Chemical	Formed by the Chemical & Biological Processes like limestone, rock salt, gypsum and dolostone.

Clastic Sedimentary Rocks

Clastic sediment is made up of inorganic rock and mineral fragments, called clasts. These can come from igneous, sedimentary, or metamorphic rocks, and so they can include a very wide range of minerals. Quartz and feldspar usually dominate clastic sediment.

When layers of clastic sediment build up, the lower strata are pushed down by the weight of the sediments above them. This pressure compacts the sediments, squeezing out excess water. Dissolved minerals recrystallize in the spaces between mineral particles in a process called cementation, thus giving rise to the Clastic Sedimentary Rocks. Due to the mechanical process, the clastic sedimentary rocks are also sometimes called mechanically formed Sedimentary Rocks. Sandstone, a rock made of sand, and shale, a rock made of clay particles, are typical examples of Clastic Sedimentary Rocks. Shale is a clastic sedimentary rock composed of very fine grains of clay or mud.

Chemically Precipitated and Organic Sedimentary Rocks

Chemically precipitated sediment is made of solid inorganic mineral compounds that precipitate from water solutions or are formed by organisms living in water. One of the most common sedimentary rocks formed by chemical precipitation is limestone. The third class of sediment is organic sediment. This is made up of the tissues of plants and animals. Peat is an example of organic sediment. This soft, fibrous, brown or black substance accumulates in bogs and marshes where the water stops the plant or animal remains from decaying.

Limestone

Limestone is by far the most abundant chemically precipitated rock. It is composed principally of calcium carbonate (CaC03 or calcite] and originates by both inorganic chemical and biochemical processes. Limestones have a great variety of rock textures such as skeletal limestone, oolitic limestone, and microcrystalline limestone.

Marine sediments form largely by biochemical precipitation. Carbonate sediments dominate at shallow depths and in warm near-shore waters. Elsewhere, siliceous sediment, which eventually forms chert, is typical in deeper water.

Skeletal Limestone

Some marine invertebrate animals construct their shells or hard parts by extracting calcium and carbonate ions from seawater. Corals, clams, algae, snails, and many other marine organisms construct their skeletons of calcium carbonate. After the organisms die, the shells accumulate on the seafloor. Over a long period of time, they build up a deposit of limestone with a texture consisting of shells and shell fragments. These

particles may then be cemented together as more calcite precipitates between the grains. This type of limestone, composed mostly of skeletal debris, can be several hundred meters thick and can extend over thousands of square kilometers.

- Chalk is a skeletal limestone in which the skeletal fragments are remains of microscopic plants and animals. Oolitic Limestone

Other limestones are composed of small semi spherical grains of calcium carbonate known as oolites. Oolites form where small fragments of shells or other tiny grains become coated with successive thin layers of CaC03 as they are rolled along the seafloor by waves and currents.

Microcrystalline limestone

A third important type of limestone forms in quiet waters where calcium carbonate is precipitated by algae as tiny, needle like crystals that accumulate on the seafloor as limy mud. Soon after deposition, the grains commonly are modified by compaction and recrystallization.

- Some kinds of algae produce calcium carbonate particles that accumulate to form limestone.These are found near the Kuril Islands of the north Pacific.
- Diatoms are the shells of tiny single-celled algae that are made of silica. Some deepmarine sediments are dominated by diatoms. Some accumulations convert to chert.

Dolostone / Dolomite

Dolostone or dolomite rock is a sedimentary carbonate rock that contains a high percentage of the mineral dolomite. Dolomite is a carbonate mineral composed of calcium magnesium carbonate CaMg(C03]2. It is similar to limestone in general appearance, but reacts with acid only when powdered. Dolostone is commonly dull brownish yellow or light gray.

Chert

Chert is a common rock composed of microcrystalline quartz. In a hand specimen, it is hard, dense, and typically breaks like glass, but under a high-power microscope, it has a fibrous or granular texture. A distinctive type of deep-marine chert develops from deposits of siliceous shells of microscopic organisms, such as radiolaria and diatoms.

Rock salt

Rock salt is made of the mineral halite (NaCl], It crystallizes when evaporation concentrates sodium and chlorine ions to the point that salt is stable in the residual brine. Strong evaporation creates saline lakes in closed desert basins (for example, the Great Salt Lake and the Dead Sea], Enhanced evaporation also occurs in restricted bays along the shore of the ocean.

Gypsum

Gypsum, CaS04, 2H20 too originates from evaporation. It collects in layers as calcium sulphate is precipitated from water.

Hydrocarbons

Coal is an important biochemical precipitate. It forms by the decomposition of organic material buried within sedimentary rocks. Lush vegetation may form in an ancient swamp and then be converted by burial into coal. The coal beds on the left are interlayered with sandstone.

The accumulation of partially decayed vegetation is called Peat. Peat is a compound of hydrogen, carbon, and oxygen. They formed from plant remains that built up over millions of years and were compacted under thick layers of inorganic clastic sediment. Hydrocarbons can be solid (peat and coal], liquid (petroleum], or gas (natural gas). Coal is the only hydrocarbon that is a rock. We often find natural gas and petroleum in open interconnected pores in a thick sedimentary rock layer, such as in porous sandstone.

Metamorphic Rocks

The mountain-building processes of the Earth's crust involve tremendous pressures and high temperatures. These extreme conditions alter igneous or sedimentary rocks, transforming them into metamorphic rock. Thus, metamorphic rocks are formed from the pre-existing rocks within the Earth's crust by changes in temperature and pressure and by chemical action of fluid. This means that Both the Igneous and Sedimentary socks undergo profound physical and chemical changes under the increased pressure and temperature. The process is called "metamorphism". Some metamorphic Rocks are Schist, Gneiss, Slate, Quartzite, Marble and Granite. There are two basic types of metamorphic rocks:

1. Foliated metamorphic rocks such as gneiss, phyllite, schist and slate which have a layered or banded appearance that is produced by exposure to heat and directed pressure. This is called Foliation.
2. Non-foliated metamorphic rocks such as marble and quartzite which do not have a layered or banded appearance.

In the surface environment, rocks weather into sediment. In the deep environment, heat and pressure transform sediment into rock that is eventually exposed at the surface.

7. EARTHQUAKE

- An earthquake is a vibration or oscillatio of the surface of the earth caused by the elasticity or the
- An earthquake is a vibration or oscillation of the surface of the earth caused by the elasticity or the isostatic adjustment of the rocks.
- It may be caused by human as well as natural activities.
- Before the earthquake waves hit a region, the amount of 'Radon' gas increases in the atmosphere of that region.
- There are two points of earthquake-
  - **(a) Focus**
  - **(b) Epicentre**

(a) Focus–

- The point, below the surface of the earth, from where the seismic (earthquake) waves originate is called the 'Focus' of the earthquake.

Figure-Epicentre and Focus

(b) Epicentre–

- The place perpendicularly above the fouse on the surface.

Measurement of an Earthquake:

Seismograph–

- The instruments sensitive to the seismic waves which help us to measure the intensity of an earthquake is called 'Seismograph'.

Scales for measuring intensity of Earthquake–

Richter Scale–

- It is a mathematical (logarithmic) scale.
- It measures the intensity of an earthquake between 0 to 9.
- For each unit of increase in the Richter Scale, the amplitude of the earthquake wave increases by a factor of 10.

Seismic Waves

- The waves generated during an earthquake are lled Seismic Waves.
- Seismic Waves are classified into 3 types:
  - **(1) Primary Waves**
  - **(2) Secondary Waves**
  - **(3) Surface Waves**

(1) Primary Waves–

- These are simply known as P-Waves.
- These are longitudinal waves.
- Primary Waves are analogous to the sound waves.
- These waves have the maximum velocity among the three types of seismic waves.
- These waves can pass throuth the solid as well as liquid medium.
- Though their velocity gets slowed down in the liquid medium.

(2) Secondary Waves–

- These are also called as S-Waves.
- These are transversal waves.
- Secondary Waves analogous to the light waves.
- The velocity of these waves is about 40% more than the velocity of the 'P' waves.
- These waves can travel only through the solid medium.
- Secondary Waves disappear in the liquid medium.
- These waves do not pass through the core of the earth.
- They give an idea about the core being in liquid state.

(3) Surface Waves–

- These are also known as 'L' waves
- These waves Originate when 'P' wave hits the surface.
- These waves affect only the surface of the earth.
- These are the most destructive.
- These waves cover the longest distance among the

three types of waves.

- ***On the basis of the depth of the focus Earthquakes are divided into three groups –***

  (a) Moderate Earthquake. 0-50 km

  (b) Intermediate Earthquakes. 50-25 km

  (c) Deep Focus Earthquakes. 250 - 700 km.

Isoseismal lines

- The lines joining the regions of same seismic intensity are called as Isoseismal Lines.

Homoseismal Lines

- The lines joining the places which experience the earthquake tremors at the same time are called Homoseismal Lines.

World Distribution of Earthquakes

- A close view on the world map showing the distribution of earthquakes reveals that the earthquakes are associate with the weaker and isostatically disturbed areas of the earth.
- **Different earthquake belts of the world are-**

A. Circum-Pacific Belt–

- This belt accounts for about 63% of the total earthquakes of the world.
- The regions included in this belt are Chile, California, Alaska, Japan, Philippines, New Zealand etc.
- The earthquakes are directly related to faults or fractures of the rock strata and to the active volcanoes.

B. Mid-Continental Belt–

- This belt accounts for about 21% of the total earthquakes of the world. This belt is also known as mediterranean or alpine-himalayan belt.
- This belt represents the weaker zones of folded mountains where isostaic and fault-induced earthquakes occur.
- Starting from Mexico and crossing the Atlantic Ocean, this belt extends to Alps, Caucasus, Himalayas and then turn towards south and in the region of Southeastern islands.
- It culminates into the Circum-Pacific belt.
- Seismic zone of India is a part of this belt.

C. Mid-Atlantic Belt-

- This belt records moderate and shallow focus earthquakes.
- The earthquakes in this region are caused due to creation of transform faults and the fractures because this region represents the divergent plate margin.
- Most of the earthquakes in this belt occur near the equator.

Tsunami

- '**Tsunami**' is a Japanese word.
- Tsunami means oncoming oceanic waves.
- These waves are very long and with less oscillation which originate in the oceans due to earthquakes that occur on the ocean-bed.
- The movement of water with the Tsunami waves is upto complete depth which makes them more catastrophic.
- From the Tsunami point of view, **Pacific Ocean** is in the most dangerous position.
- These are the most powerful in the convergence zone of the oceanic plates.
- The tsunami that occurred on the **26th of December 2004** in the **Sumatra island of Indonesia** in the Indian Ocean was the result of subduction of Indian plate below the Burmese plate.
- The intensity of the earthquake was recorded at 8.9, which caused catastrophic tsunami waves.
- Eleven countries, including Indonesia, Malaysia, Sri Lanka and India came under the influence of these waves.
- Nagapttinam district in Tamil Nadu was the most affected area in India.
- In **October 2007**, India started the most advanced Tsunami Warning System.
- India will provide information received from it to its neighbour countries.
- The system will reveal the intensity, depth and centre of the tsunami.
- It will provide the information of every earthquake tremor of Indian Ocean in 20 minutes, after calculation, to the nearest regions.

8. VOLCANO

- The term Volcanism was first used by Versatter.
- A volcano is a prcess or an event in which lava,gases,water vapour etc. comes out on the earth's surface from the interior of earth.

TOPOGRAPH Y PRODUCED BY VOLCANO :

Vulcanicity produces varied structures, which are classified in two broad groups-

(a) Intrusive Topography

(b) Extrusive Topography

(a) Intrusive Topography

(Granite Rocks)

i) Intrusive Lava Domes
ii) Batholiths
iii) Laccoliths
iv) Phacolits
v) Lopoliths
vi) Sills
vii) Dykes
viii) Stocks

(b) Extrusive Topography

(Basaltic Rocks)

i) Volcanic cones
ii) Crater
iii) Calderas
iv) Lava platue or trapp
v) Lava plains
vi) Fumaroles
vii) Geysers

Other Part of Volcanoes-

1. Volcanic Pipe

- The narrow pipe, through which the magma comes out on the surface, is called **Volcanic Pipe.**

2. Crater

- The funnel or cup-shaped opening at the top of the volcanic cone is called as the **Crater.**

3. Crater Lake

- When crarter gets filled up with the rain-water, it forms as **Crater Lake.**

Example

- Titicaca lake in South America.
- Lonar lake in Maharashtra, lake Pushkar (Rajasthan)

4. Caldera

- Caldera is formed due to subduction of the crater or expansion of the volcanic mouth or vent due to successive eruptions.
- The largest caldera in the world is **'AEra',** which is in Japan. USA - Palis is also a example.
- Lake Towa is in Indonesia which is known as super caldera.

5. Geyser

- It is a special type of hot spring which sprouts hot water and vapour from time to time.
- The best examples of geysers are the Old Faithful and Exelsiar at the Yellow Stone National Park, in USA.
- It is not found generally is south America & Africa.
- Grand Geyser of Iceland is also very famous.

6. Fumaroles

- Fumarole means such a vent through which there is emission of gases and water vapour.
- Fumaroles impregnated with sulphur is called Solftara.

Example

- Numerous fumaroles are found in the 'Katmai' mountains of the USA.
- This region is known as 'A Valley of Ten thousnad Smokes'.
- Koh Sultan fumarole of Iran.
- The White Island fumarole in the Bay of Plenty, New Zealand, are also very famous.

9. Deccan Trapp

- The basaltic lava, which comes out of the fissure volcanoes, flows slowly and gets solidified in the form of a thick shield.
- These layers or shields are called lava plateaux or Trapp.
- The best example of Trapp is the Deccan Trapp of India.

Types of Volcanoes (According to Activism)

i) Active Volcanoes–

- These volcanoes constantly eject volcanic lavas, gases, ashes and fragmental materials.
- It is estimated that there are more than 500 active volcanoes in the world.

Exmple–

(a) Etna and Stromboli of the Mediterranean Sea are the most significant exmples of this category.

(b) **Stromboli** is known as the **Light house of the Mediterranean.**

(c) Other volcanoes of this category are - **Cotopaxi** of Equador (World's highest active volcano), Monalowa - Hawai Iland

(d) **Mt Erebus** of Antarctica (the only active volcano of the continent).

(e) The active volcano in the Barren Island of the Andaman and Nicobar Islands. India.

ii) Dormant Volcanoes–

- These volcanoes become quiet after their eruptions for some time.
- There are no indications for future eruptions but suddenly they erupt very violently and cause enormous damage to human health and wealth.
- Imporant examples of this category are-
  - (a) Vesuvius in Italy;
  - (b) Fujiyama in Japan
  - (c) Krakatao in Indonesia.
  - (d) Dormant volcanoes in the Narcondam Island (Now believed to be active after Tsunami of December 2004) of the Andaman & Nicobar.

iii) Dead or Extinct Volcanoes–

- These are those volcanoes which have not erupted since thousands of years.
- There is no indications of future eruption as well.
- Leading examples of this category are-
  - (a) Mt kenya in Eastern part of Africa.
  - (b) kilimanjaro in Eastern part of Africa.
  - (c) Chimborajo in Equador.
  - (d) Mount popa in Myanmar.
  - (e) Devband in Iran.
  - (f) Aconcagua in Andes mountains.
  - (g) Koh-sultan in Iran.

WORLD DISTRIBUTION OF VOLCANOES

- The explanation of volcanic regions of the world, based on the plate tectonic theory, is the most accepted one.
- Accourding to this theory destructive plate boundaries account for about 80% of the volcanic regions, contructive plate margins for about 15% of the volcanic regions.

Major volcanic belts are-

1. Circum-Pacific Belt–

- In this belt, volcanoes are found along the destructive plate margins. here.
- Two-third of the world's volcanoes are found in the coastal regions of the Pacific ocean, archipelagoes and oceanic islands.
- The name given to this belt is the **Fire Girdle of the Pacific.**
- This Belt also knonw as the **Fire Ring of the Pacific.**
- This belt begins form Erebus Mountain of Antarctica and runs northward through Andes and Rockies mountains of South and North Americas, respectively.

2. Mid-continental belt–

- Most of the volcanoes of this belt are found along the desturctive plate margins, due to collision of Eurasina plate with African and Indian plates.
- One branch of this belt Runs along the fault zone of east Africa and the other turns southward to meet the Circum pacific belt after running through Spain, Italy, Caucasus and Himalayas.
- This belt also includes the volcanoes of the Alpine chains and the Mediterranean Sea.
- Stromboli, Vesuvius and Etna are the important volcanoes of the Mediterranean region.
- Demband and Koh sultan volcanoes of Iran and Ararat volcano of Armenia are also included in this belt.
- Mt Camerron is the only active volcano of western Africa.

3. Mid-Atlantic Belt–

- Volcanoes of this belt are found along the constructive plate margins.
- When the plates diverge from each other, fissures are formed from which the Peridotite and Basaltic magma comes out.

- Due cooling and solidification of this magma, new crust is continuously formed along the fissure.
- Laves near the fissure or mid-oceanic ridge are the latest and get older as one moves away form the ridge.
- Hekla and Laki are the important volcanoes of Iceland in this belt. Other major volcanoes are Lesser Antilles, Southern Antilles, Azores, St. Helena etc.

MAJOR VOLCANOES OF THE WORLD

VOLCANO	COUNTRY
Ojas del Salado	Argentina-Chile
Cotopaxi	Equador
Chimborajo	Equador
Popocatapital	Mexico
Monaloa	Hawaii Island
Mt. Cameroon	Cameroon (Africa)
Mt. Erebus	Ross (Antarctica)
Mt. Peele	Mortinique Island
Hekla	Iceland
Laaki	Iceland
Vesuvius	Gulf of Naples (Italy)
Stromoboli	Lipari Island (Italy)
Katmia	Alaska (USA)
Mt. Rainier	USA
Mt. Shasta	USA
Fujiyama	Japan
Mt. Taal	Philippines
Mt. Pinatubo	Philippines
Mt. Meyon	Philippines
Demband	Iran
KohSultan	Iran
Mt. Popa	Myanmar
Elbrus	Georgia
Kilimanjaro	Tanzania
Mt. Kenya	Kenya
Acucnagua	Peru

9. PLATE TECTONICS

- Plate word was first used by Wilson.
- This theory was proposed by Herry Hess.
- Mainly six plates are there on earth-
  - American Plate
  - African Plate
  - Indo-Australian Plate
  - Pacific Plate
  - Antartica Plate
  - Eurasian Plate.
- There are two types of plates - continental plates are made of Granite where oceanic plates are Besaltic.
- The biggest plate is Pacific plate
- The plates have their boundaries there can be classified into three types of margins -
  - Constructive plate Margins
  - Destructive plate Margins
  - Conservative plate Margins
- **Constructive Margins :** When two plates are moving in opposite direction and a fault gap occures between these. Through this gap the meama material of atmosphere comes out and a new landform parth surface is made. This Margin is also known as divergent boundary. Eg - Mid Altantic ridge.
- **Destructive Margins** :- When two plates converges towards each other, during this three types of phenomenon occures:-
  - Continental & continental plate.
  - Oceanic - Oceanic plate.
  - Continental - Oceanic plate.
- **Continental - continental plate :** Oceanic plate is heavier to contirental plate. Hence this subducts under continertal plate and makes a trench also sediments are folded over the surface and make new folded mountains. eg. - Andis & Rocky
- **Oceanic - Oceanic plate :** When both plates come together then the plate which is havier subducts under the lighter one and it makes oceanic french and volcanic Ilands eg:- Japan or philipines sea has subduction of Pacific plate.
- **Continental - continental plate :** Volcanic activity doesn't occures here but folded mountain is developed eg: When Indian plate is subducted into Eurasian plate it caused - Himalaya as a result.
- **Coservative Margins :** When two plate moves parallel to each other then it may not cause any interaction, this is also known as transform fault. eg: San - Adrians Fault near california.

10. MOUNTAINS,PLATEAU,PLAINS ETC.

Acoording to origination Mountains are of four types -

1. **Block Mountain-** When due to fault rock decends and around the faults area seem to be above the normal hight,then block mountains are originated. Eg. Black forest(Germany),vindhyachal & satpura(India),salt range(Pakistan).
2. **Residual Mountain-**Formed by erosion of rocks.For example-Nilgiri,Parasnath,Aravallis,Eastern & Western ghats.
3. **Accumulated Mountain-**Mountains formed by accumulation of sand,gravels,lava etc. at a place on Earth's surface.For example-Sand dunes in deserts.
4. **Folded Mountain-**These Mountains are formed by folding of surface rocks due to internal forces of Earth.For example Himalaya,Ural,Rocky,Andes etc.

- Aravallis are the oldest mountain of India.

Plateau

Specific landform of earth which is high as compared to nearby areas and top portion is broad and almost plain. Example- Plateau of Tibbet,Ranchi plateau, Bolivian plateau, Hazaribagh palteau etc.Platues are of following types:

A. Intermountain plateau- Platues in between mountains. Ex.- Plateau of Tibbet , Bolivian plateau , Anatolia platue , Patagonia plateau.

B. Foothill plateau- Platues in between mountains and plains.

C. Continental plateau- Platueau on Earth formed by lacolith erosion. Ex.- Deccan Plateau.

D. Costal plateau- Platues on the coastal areas of oceans. Ex.- Coromandal Plateau of India.

E. Dome-Shape plateau- Plateau formed by movement. Ex.- Ramgarh Dome(India),Chota nagpur plateau.

Plains

- The plain areas of surface having hight less than 500 ft.
- **Loyas plain-** Formed by sand and soil.
- **Karst plain-** Formed by lime stone rocks.
- **Peni plain-** Formed by erosion of ricers near ocean coast.
- **Glacial plain-** Formed by glaciers.
- **Depositional plain-** Formed by river deposits.

Forest

Forests are of follwing type-

- **Tropical evergreen forests-**This type of forest is found in equitorial and tropical region, where there is rainfall more than 200 cm.Tree leaves are broader in these forests.Areas- Venezuela , Brazil.
- **Tropical decidues forests-**Forest getting rainfall less than 150cm. For example-sal,teakwood, sandlewood etc.
- **Equitorial forests-**In these forests mixture of trees and shurbs is found. Main trees- olive,cork,oak. Main areas-Amazon basin,Congo basin.
- **Taiga forests-**These are evergreen forests.Tree leaves are conical.
- **Tundra forests-**This area remains covered with snow.Main vegetations are lichane and moss.
- **Mountain forests-**These areas have coniferrous forests with broad laeves.

Tropical grass lands

Savana	-	Africa & Australia
Campose	-	Brazil
Llanos	-	Venezuela & Columbia (Guianea highlands)

Temperate grass lands

Preries	-	USA & Canada
Pamas	-	Arzentina
Welds	-	South Africa
Downs	-	Australia & Newzealand
The Steppies-eas		In Asia-Ukrane,Russia & ar- of Munchuria in china

Landforms on Earth's surface

By Ground water	-	Gysers,Karst lake
By ocean water	-	Surf,Hook,Loop,Tangrika
By Glacier	-	Drumlin,Horne,Surk
By Wind	-	Inselburg,Barkhan, zyugen,sand dunes
By Ocean waves	-	Lagoon lake,Stake,Riya Coast.

11. ATMOSPHERE:COMPOSITION & STRUCTURE

Atmosphere

- The atmoshpere is a thick gaseous envelope which surrounds the earth from all sides.
- Atmosphere is attached to the earth's surface by gravitational force.
- It filters the incoming solar radiation.
- Its prevents the ultraviolet rays to reach the earth's surface.
- It also prevents the earth from becoming too hot.
- The atmosphere allows the short wave insolation to pass through.
- It becomes opaque for the outgoing long wave terrestrial radiation.
- In this way, it acts as a huge greenhouse.
- Atmosphere maintains an average **15ºC** temperature on the earth surface.
- This optimum temperature is very essential for the development and sustenance of life on the earth.

Insolation and Temperature

- The sun is 1.3 million times bigger than the Earth.
- Sun is on an average 150 million km. away from Earth.
- The sun's rays cover this distance with a velocity of **0.3 million km. per seond**.
- The temperatre of the sun's surface is 6000ºC
- The sun is radiating its energy continuously in the space, this is called solar radiation.
- This solar radiation reaches the earth surface in the form of short wave.
- The earth receives only 0.0005% i.e. 2 billionth part of the solar radiation.
- The incoming solar radiation on the surface of the earth is called INSOLATION.
- This part of the insolation is responsible for the average 15ºC temperature found on the earth's surface.

Hotest Place

- The Al-Azizia region of Libya is the hotest place on the earth.
- It's maximum temperature is 58ºC.

Coldest place

- Vostak in Antarctica is the coldest place on the earth.
- It's minimum temperature is –87.5ºC.

Isotherm

- Isotherms are the inaginary lines joining the places of equal temperature.
- The horizontal distribution of temperature on the earth surface is represented with the help of isotherm.

Composition of the Atmosphere

- The atmosphere is composed of gases, water vapour and particulates.
- Nitrogen is in the highest amount Among the all gases.
- After the Nitrogen Oxygen , Argon, Carbon dioxide, Neon, Helium, Ozone, hydrozen etc. are in the order.
- Besides these gases, water vapour, dust particles and other particulates are also present in varying amounts.
- Water vapour, dust particles and ozone are very important for the climatic conditions of the world.

Order of gases in the Atomosphere–

Nitrogen–

- It's part in Atmosphere is aprrox 78%.
- It is in large scale within atmosphere.
- Among the atmospheric gases, it is the most important gas.
- It is fixed by the leguminous plants into nitrogenous nutrients.

Oxygen–

- It's part in the atomsphere is approx 21%.
- It's in second place in all gases.
- This is the life-giving gas to the humans and animals.
- Green plants produce it during the process of photosynthesis.

Argon–

- It's percentage is approx 0.93%.
- This is a noble gas.
- Besides it, the other noble gases present in the atmospher are- Helium, Neon, Krypton, Xenon, radon, etc.

- These gases are present in traces.

Carbon dioxide–

- It's percentage is atomospher is 0.03%.
- This is a heavy gas.
- It is permeable for the incoming solar radiation.
- It's opaque for the outgoing terrestrial radiations.
- In this way, by trapping the heat it works as a green-house gas.
- It 's increasing amount raises the overall temperature of the earth atmosphere.
- Its total amount was 150 million liters. before the onset of the Industrial Revolution.
- Presently, its amount is 250 million liters.
- It is estimated to be 350 million liters in 50 years from now.
- An International consensus is made to bring down its level by the kyoto protocol (1997).

Ozone–

- Jet planes also degrade this layer by emitting Nox.
- It is present in very less amount in the atmosphere.
- It is an important constituent of the atmosphere.
- It acts as a filer and absorbs the harmful ultraviolet rays.
- If Ultraviolet rays reach the earth's surface, they may cause skin cancer and other diseases.
- A layer of this gas is found at the lower part of the stratosphere.
- The nitrogen oxide, released by the Jet planes and chlorofluorocarbons (CFSs), hydrofluorocarbons (HFCs) used and released by the air conditioners, refrigerators, etc. are very harmful to this layer.
- Montreal Protocol (1987) Was agreed upon to save the ozone layer from depletion.

Water vapour–

- The water vapour content in the atmosphere ranges between 0-4% by volume.
- The water vapour content of the atmosphere decreases from the equator towards the poles, due to decreasing temperature.
- The amount of water vapour decreases with increasing height also.
- The half of total vapour at 2000 mts.
- In polar and desert region, max,vapour is 1%

Structure of the Atmosphere-

- Though the upper limit of the atmosphere is unknown.
- It is considered to be 10,000 km. from the sea-level.
- On the basis of the characteristics of temperature and air pressure, there are five layers from the earth's surface upwards-
  1. Tropospher
  2. Stratosphere
  3. Mesosphere
  4. Ionoshphere
  5. Exosphere

1. Troposphere–

- It is the lower most and the most important layer of the atmosphere.
- In this layer, temperature decreases with increasing height at the rate of 1ºC/165 m. or 6.5ºC/1000 m.
- The heigh speed winds of this layer is known as jet winds.
- As almost all the weather phenomena occur in this layer.
- The average height of the troposphere is about 16-18 km. over the equator and 6-8 km. over the poles.
- This rate of decreases in temperature is called Normal lapse rate.
- The transition layer between troposphere & stratosphere is tropopause.

2. Stratosphere–

- It is the second layer from the Earth.
- It's height is approx 50 km from the troposphere.
- Temperature ramains stable at the beginning of this layer.
- Ozone layer presents In this layer.
- Ozone layer absorbs the ultraviolet radiations.
- This layer of the atmosphere is almost free from the weather disturbances.
- Hence it is preferred by the pilots to fly their aeroplanes.

3. Mesosphere–

- It is Third layer from the Earth
- This layer extends between 50 km and 80 km.
- In this layer temperature again decreases with inreasing height.

- In this layer temperature reaches upto - 100ºC
- It is the minimum temperature of the atmosphere.

4. Ionosphere–

- It is the fourth layer from the earth.
- It extends from 80 km to 640 km.
- Electrically charged or ionised particles are abundantly found in this layer.
- Temperatures increases with increasing height.
- This layer reflects back the radio waves.
- There are number of ionic layers in this sphere.
- The phenomenon of Aurora borialis & Aurora Australis occures in this layer.

5. Exosphere–

- It is the last layer of atmosphere
- It represents the upper most layers of the atmosphere.
- It extends beyond 640 km of height from the sea level.
- It ultimately merges with the space beyond the height of 1000 km.

12. ATMOSPHERIC PRESSURE

- Air pressure or atmospheric pressure is defined as total weight of a mass of column of air above per unit area at sea level.
- The atmosphere is held on the earth surface due to the gravitational force of the earth.
- The atmospheric pressure is measured with the help of an instrument called Barometer.
- Atmospheric Pressures unit is milibars.
- Rapid decrease in the Barometer reading indicates towards a stormy weather.
- When Barometer reading first decreases and then increases slowly, it shows that the rains are approaching.
- Continuous increase in the barometer reading indicates towards anti-cyclonic condition and a clear weather.

Isobar

- Distribution of atmospheric pressure over the globe is shown with the help of imaginary lines are called isobars.
- Isobars are the imaginary lines.
- Isobar joins the places of equal pressure at the sea level.

Distribution of atmospheric pressure-

1. Equitorial low pressure belt (5°N–5°S)–

- This is a belt of very low atmospheric pressure.
- The equatorial low pressure belt is thermally induced.
- In this zone, theer is alomst no horizontal movement of air.
- The air in this Belt rises up.
- This belt is called a **"Belt of Calm"**
- Its other name is **"Doldrum".**

2. Sub-Tropical High Pressure Belt (30-40° N&S)–

- These winds get deflected towards east due to rotation of the earth.
- This phenomenon was first discovered by the french scientist Coriolis, hence this force exerted by the rotation of the earth is called coriolis forcce.
- The quanitiy of the force keeps increasing with increasing distances from the equatorial belt.
- This zone of high pressure is called '**Horse Latitude'(40⁰ N)**.

3. Sub-Polar Low Pressure Belt (60-65° N&S)–

- Low pressure is found in this belt.
- In this belt air rise up.
- This zone is characterized by cyclonic storms.

4. Polar High Pressure Belt (90° N-S)–

- Low Temperature found in this belt
- High pressure found in this belt

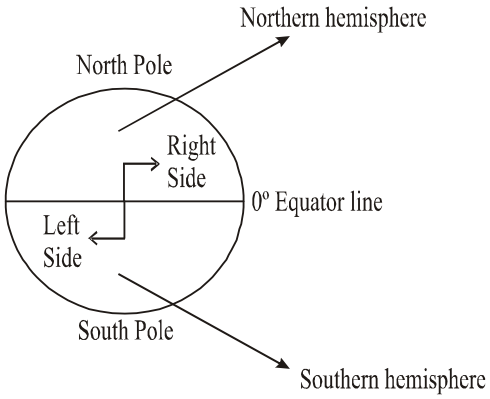
13. WIND

Defination

- Due to horizontal abnormalities, air moves from the areas of high pressure to the areas of low pressure.
- This horizontally moving air is called wind.

Movement of the wind

(a) Because of Coriolis force all winds are deflected to the right clockwise in the Northern Hemisphere.

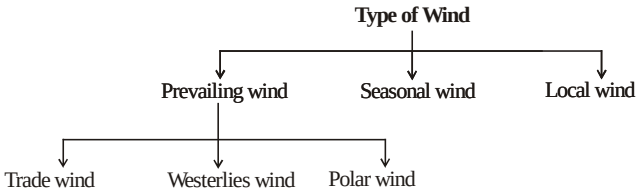


Movement of the wind

(b) While they are deflected to the left anticlock wise in the Southern Hemisphere with respect to the rotating earth.

- Coriolis force also increases with the increasing wind velocity.
- Since this phenomenon was firstly proved by a Frence scientist Ferrel, it is called Ferrel's Law

Types of winds



Prevailing wind

- It's other name is planetary wind
- It's also known as permanent wind
- The winds blowing almost in the same direction throughout the year are called pervailing winds.
- Prevailing wind are three types

(a) Trade winds

(b) Westerlines winds

(c) Polar winds

(a) Trade winds–

- These are the permanent winds blowing in both the hemispheres.
- Trade winds are the winds having fixed paths.
- Trade winds converge and rise causing convectional rainfall in the equatorial region near the equator.

(b) Westerlies winds–

- These winds are best developed in the 40º–65º latitudes.
- Westerlis wind known as veries name due to its nature.
  - **(a) On 40º SLatitudes-** These wind known as Roaring forties.
  - **(b) On 50ºS Latitudes-** These wind known as Furious Fifties.
  - **(c) On 60º SLatitudes-** These wind known as Shrieking Sixties.
- These names are given by the sailors who wer being effected by those westerlies.

(c) Polar winds–

- Polar wind blows from the polar high-perssure belts to the sub-polar low pressure belts.
- These wind have very low temperature.

2. Seasonal winds -

- Seasonal winds change their direction of blowing with the changing seasons.
- These are also calee as Periodic winds.
- Seasonal winds are of three types-
  - (a) Monsoon winds.
  - (b) Land and Sea Breezes.
  - (c) Mountain and Valley Breezes.

3. Local winds -

- This winds blow due to local variation in the tem perature and pressure.
- These wind influence a very small area.
- Hot local winds raise the temperature of the blowing area

- Cold local winds sometimes bring the temperature of the affected area below the freezing points.
- These local winds blow in the lower layers of the Troposphere.

Some important local winds are -

Chinook–

- Chinook means the 'snow-eater' (adoped from the language of Red Indians).
- This is the hot and dry wind blowing along the eastern slope of the Rockies
- Chinook covers an area from the southern part of Colorado in the south to British Columbia in Canada in the North.
- Due to its effect, the snow melts and green grass sprouts even in the winter.
- This wind is helpful for the animal rearing as it makes the grasslands snow free.

Foehn–

- This is similar to Chinook and blows along the northern slope of the Alps.
- It affects the Switzerland most.
- It melts the snow, makes the weather pleasant and helps in early ripening of the grapes.

Sirocco–

- This is a Warm, dry and dusty wind.
- It is blows in northerly direction from the Sahara Desert.
- It's crossing over the Mediterranean Sea reaches Italy, Spain etc.
- It is also known as **Blood rain** because of its redish sand brought alongwith it from Sahara desert.
- It is very much destructive to agricultural and fruit crops.
- There are different local names for Sirocco in Africa e.g.
  - (a) Khamsin in Egypt
  - (b) Gibli in Libya
  - (c) Chilli in Tunisia.
  - (d) Levanter in Spain
  - (e) Leste in Maderia island

Black Roller—

- These are the warm and dry dusty winds, blowing in the great plains of North America.

Yoma–

- This is the warm and dry wind like 'Santa Ana', blowing in Japan.

Temporal–

- This is the monsoon wind blowing in the Central America.

Simoom–

- This is the warm and dry wind blowing in the Arabian Desert.
- It causes dust storms and obstructs visibility.

Samoon–

- This is the wind blowing in the Kurdistan region of Iran and Iraq.
- It has the characteristics similar to Foehn.

Shamal–

- This is the warm, dry and sandy wind, blowing in the deserts of Iran, Iraq and UAE.

Seistan–

- This is the high velocity northerly wind blowing in the eastern parts of Iran in summer.

Haboob–

- This is the fast blowing wind full of dust and sand.
- It is blowing in the northern parts of Sudan, especially near Khartoum.
- It obstructs visibility.
- It is Causes rain with thunder storm.

Karaburan–

- These are the dust laden fast blowing winds in the Tarim Basin in the Central Asia.
- These winds blow towards the North-East.

Koimbang–

- These are winds similar to Foehn.
- It is blowing in Java (Indonesia).
- It is harmful to the tobacco crop.

Harmattan–

- This is the warm and dry wind blowing from north-east and east to the west in the Sahara desert.
- The weather becomes suddenly dry and pleasant in the western coast of Africa, at the arrival of Harmattan.
- Therefore, it is called **'Doctor'** in the Guinea coastal area.

Brick Fielder–

- This is the warm and dry wind blowing in the Victoria province of Australia.

Norwester–

- This is the warm, dry and gusty wind blowing in northern New Zealand.

Loo–

- This is a hot and dry wind blowing in the northern India from the north west and west to the east.
- It is sometimes called '**heat wave'.**

Santa Ana–

- This is the warm and dry wind blowing in California (USA).

Mistral–

- This is the cold local wind blowing in Spain and France from north-west to south-east direction.
- While blowing through the narrow valley of the Rhone River, they become stormy northerly cold winds.
- The arrival of Mistral causes sudden drop in air temperature to below freezing point.

Bora–

- It is an extremely cold and dry north-easterly Sea.
- It is similar to mistral and affects ltaly and Yugoslavia.

Blizzard–

- It is a violent stormy cold polar wind laden with dry snow.
- It is prevalent in north and south Polar Regions.
- These winds affect Canada and USA.
- On the arrival of Blizzards, the air temperature drops below the freezing point.
- In the Tundra and Siberian regions of Russia, it is known as **Purga** and **Burran,** respectively.

Pampero–

- These are the cold polar winds blowing very fast in the pampas region of South America.

Juran–

- These are the cold and dry winds.
- It is blowing from the Jura Mountains (Switzerland) to the Geneva Lake (Italy), in night.

Southern Burster –

- This is a fast blowing cold and dry wind in New South Wales (Australia).

JET STREAM

- These are the winds blowing with great velocity near the Tropopause.
- The jet streams are active in 150 km wide and 2-3 km thick transition belt.
- The general velocity of these winds is about 150-200 km/hour.
- But sometime the velocity at the core of the jet stream is found to be 325 km/hour.
- Jet streams are generally found in the North Hemisphere only.
- They are found over the South Pole In the South Hemisphere.
- They are found in the form of light **Rossby Waves** over other latitudes also.
- The reason behind the origin of these jet streams is the difference in surface temperature and pressure gradient.
- North- east Jetstream is responsible for rain is summer in India.

14. RAINFALL

The amount of moisture in air is commonly recorded as relative humidity; which is the percentage of the total water vapour air can hold at a particular air temperature. The presence of warm, moist and unstable air and sufficient amount of the hygroscopic nuclei is a prerequisite condition for rainfall. The warm and moist air after being lifted upwards becomes saturated and clouds are formed after condensation of water vapour around the hygroscopic nuclei such as dust particles.

How much water vapour a parcel of air can contain before it becomes saturated (100% relative humidity) and forms into a cloud (a group of visible and tiny water and ice particles suspended above the Earth's surface) depends on its temperature. Warmer air can contain more water vapour than cooler air before becoming saturated.

Cooling

The process of condensation begins only when the relative humidity of the ascending air becomes 100% and air is cooled through four main mechanisms to its dew point: adiabatic cooling, conductive cooling, radiational cooling, and evaporative cooling.

- Adiabatic cooling occurs when air rises and expands. The air can rise due to convection, large-scale atmospheric motions, or a physical barrier such as a mountain (orographic lift).
- Conductive cooling occurs when the air comes into contact with a colder surface, usually by being blown from one surface to another, for example from a liquid water surface to colder land.
- Radiational cooling occurs due to the emission of infrared radiation, either by the air or by the surface underneath.
- Evaporative cooling occurs when moisture is added to the air through evaporation, which forces the air temperature to cool to its wet-bulb temperature, or until it reaches saturation.

Further, we note that the very small rain drops are almost spherical in shape. As drops become larger, they become flattened on the bottom, like a hamburger bun. Very large rain drops are split into smaller ones by air resistance which makes them increasingly unstable. When water droplets fuse to create larger water droplets, it is called Coalescence. When water droplets freeze onto an ice crystal, which is known as the Bergeron process.Air resistance typically causes the water droplets in a cloud to remain stationary. When air turbulence occurs, water droplets collide, producing larger droplets. As these larger water droplets descend, coalescence continues, so that drops become heavy enough to overcome air resistance and fall as rain. Coalescence generally happens most often in clouds above freezing, and is also known as the warm rain process.

Convectional Rainfall

The convectional rainfall occurs due to the thermal convection currents caused due to the heating of ground due to insolation. The convectional rainfall is prevalent in equatorial regions. In these, the warm air rises up and expands then, reaches at a cooler layer and saturates, then condenses mainly in the form of cumulus or cumulonimbus clouds. In the equatorial regions, the precipitation due to convectional rainfall occurs in the afternoon. The rainfall is of very short duration but in the form of heavy showers.

Cyclonic / Frontal Rainfall

Frontal rainfall occurs due to the upward movement of the air caused by the convergence of different air masses with different temperatures. The warm air rises over the cold air and cyclonic rain occurs. The cold air pushes up the warm air and sky gets clear again.

Orographic Rainfall

The orographic rainfall occurs due to the ascent of air forced by the mountain barrier. The mountain barrier should be across the wind direction. So that the moist air is forced in obstruction to move upward and get cooled. In Rajasthan, the Aravalli is not an obstructing barrier to the highly moist air coming from

Arabian Sea and that is why they don't play very important role in rainfalls. Thus they produce a Rain shadow area. A rain shadow is a dry area on the lee side of a mountainous area. The mountains block the passage of rain-producing weather systems, casting a "shadow" of dryness behind them. In south India, the Mangalore is located on the western windward slope and gets 2000 mm of rainfall. But Bangalore is in rain shadow area and that is why receives less than 500 mm of rainfall.

Please note that the amount of the rainfall increases with increasing height of the barrier such as mountain, but this is up to a certain limit. After that there is a marked decrease due to lesser moisture content of the air and this phenomenon is called "Inversion of Rainfall"

Distribution of Rainfall

The regions having high temperature and abundance of water receive higher amount of rainfall, such as equatorial regions. In the subtropical regions, the western parts receive lesser rainfalls. This is due to anticyclone activities. Mean annual rainfall for earth is 970mm. The equatorial regions receive rainfall through out the year while the other regions receive rainfall seasonally. The Mediterranean region receives rainfall during the winter generally.

Air Mass & Fronts

Air mass is a volume of air defined by its temperature and water vapour content. An air mass may be of many hundreds or thousands of square miles, and adopt the characteristics of the surface below them. An air mass can be so extensive that it may cover the large portion of a continent below it and may be vertically so thick that may cover the troposphere. The vertical distribution of the temperature in an air mass and moisture content of the air are the two properties of air air mass which control the weather conditions of an area under that particular air mass. The air mass is considered to be cold air mass if its temperature is lower than the underlying surface, while an air mass is terms warm air mass when its temperature is higher than the underlying surface. The boundary between the two air masses is called the front.

Air masses are classified according to latitude and their continental or maritime source regions. Colder air masses are termed polar or arctic, while warmer air masses are deemed tropical. Continental and superior air masses are dry while maritime and monsoon air masses are moist. Weather fronts separate air masses with different density (temperature and/or moisture] characteristics. Once an air mass moves away from its source region, underlying vegetation and water bodies can quickly modify its character.

Frontogenesis and Frontolysis

The boundary between the two air masses is called the front. A temperature difference is essential in the definition of a front because it implies a density difference. The air masses of different densities don't mix readily and tend to retain their identity as far as we care for the moisture. The front represents a transition zone between two air masses of different density. Generally, an air mass from one region moves to the other region which is occupied by some other air mass. When a warmer and lighter air mass moved against a cold and denser air mass, the former rides over the other and it is called warm front. If the cold air mass forces its way under a warm air mass, it is called cold front. When new fronts are created or old fronts are regenerated, it is called Frontogenesis. Please note that fronts don't appear all of a sudden. They appear only after a process of Frontogenesis which is there in place for quite some time. When winds converge towards a point it would lead to Frontogenesis. Frontogenesis takes place only when two conditions are met. First, two air masses of different densities must exist adjacent to one another; and second, a prevailing wind field must exist to bring them together. There are three basic situations, which are conducive to Frontogenesis and satisfy the two basic requirements. The wind flow is cross isothermal and flowing from cold air to warmer air. The flow must be cross isothermal, resulting in a concentration of isotherms (increased temperature gradient]. The flow does not have to be perpendicular; however, the more perpendicular the cross isothermal flow, the greater the intensity of Frontogenesis.

On the other hand, the dying of a front is called Frontolysis. Frontolysis also does not happen all of a sudden. The process of Frontolysis must happen for quite some time to destroy the existingfront.

Types of Fronts

Cold Front

When a cold air invades the warm air, it remains at the ground and forcibly uplifts the warmer and lighter air mass. This is known as Cold front. This upward motion causes lowered pressure along the cold front and can cause the formation of a narrow line of showers and thunderstorms when enough moisture is present. Cold fronts can move up to twice as fast as warm fronts and can produce sharper changes in weather. Since cold air is denser than warm air, it rapidly replaces the warm air preceding the boundary. Cold fronts are usually associated with low-pressure areas. Cold front usually causes a shift of wind from southeast to northwest, and in the southern hemisphere a shift from northeast to southwest.

Warm front

When a warmer and lighter air mass moved against a cold and denser air mass, the former rides over the other and it is called warm front. Being lighter, the warm air mass is unable to displace the cooler air mass and instead is forced upward along the upper boundary of the colder air in a process known as overrunning. The boundary between the two air masses has a gradual slope of 130 and lifting is slow but persistent. As the air mass rises into regions oflower pressure, it expands and cools. As it cools, water vapour condenses and forms extensive cloud coverage. The first clouds to form along the sloping surface of the cold air are high cirrus, which thicken to cirrostratus and altostratus.

Occluded front

An occluded front is a front that is formed when a cold front overtakes a warm front. The cold front moves rapidly than the warm front. Ultimately, the cold front overtakes the warm front and completely displaces the warm air at the ground.

15. CYCLONE

Introduction of Cyclones

Cyclone is a system of low atmospheric pressure in which the barometric gradient is steep. Cyclones represent circular fluid motion rotating in the same direction as the Earth. This means that the inward spiralling winds in a cyclone rotate anticlockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere of the Earth. Most large-scale cyclonic circulations are centred on areas of low atmospheric pressure. The cyclones can be tropical cyclones or temperate cyclones (extra-tropical cyclones).

Basic difference between Tropical Cyclone and Extra-tropical Cyclone

The term "tropical cyclone" is used to refer to warm-core, low-pressure systems that develop over tropical or subtropical oceans. This definition differentiates tropical cyclones from extra tropical (midlatitude) cyclones that exhibit a cold-core in the upper troposphere and often form along fronts in higher latitudes. Subtropical cyclones are hybrid systems that exhibit some characteristics of tropical cyclones and some characteristics of extra-tropical cyclones.

Tropical cyclones extract much of their energy from the upper layer of the ocean, while extratropical cyclones derive much of their energy from the baroclinic temperature gradients in which they form.

Tropical Cyclones

The tropical cyclone is a system of low pressure occurring in tropical latitudes characterized by very strong winds. Here are the important notes which you must note about the Tropical Cyclones:

Distribution

- The tropical cyclones are found over the North Atlantic Ocean, Southern Atlantic Ocean, the eastern, central and western North Pacific Ocean, the central and western South Pacific Ocean and the northern and southern Indian Ocean.

Formation in Low Pressure areas

- All tropical cyclones are formed in areas of low atmospheric pressure in the Earth's atmosphere. Minimum Pressure is at centre
- The pressures recorded at the centers of tropical cyclones are among the lowest that occur on Earth's surface at sea level.

Driver is the Large Heat of Condensation

- Tropical cyclones are driven by the release of large amounts of latent heat of condensation, which occurs

when moist air is carried upwards and its water vapour condenses. This heat is distributed vertically around the center of the storm. Thus, at any given altitude, environment inside the cyclone is warmer than its outer surroundings.

Eye is the sinking air

- There is an area of sinking air at the center of circulation, which is known as Eye. Weather in the eye is normally calm and free of clouds, although the sea below it may be extremely violent. Eye is normally circular in shape, and is typically 30-65 km in diameter.

Stadium Effect

- The mature tropical cyclones sometimes exhibit an outward curving of the eye wall's top, making it resemble an arena football stadium. It is called Stadium Effect.

Greatest Wind speeds are at eye walls

- Greatest wind speeds in a tropical cyclone is found at the eye wall, which is a circle of strong thunderstorms that surrounds the eye. Here, the clouds reach the highest, and precipitation is the heaviest. The heaviest wind damage occurs where a tropical cyclones eye wall passes over land. Source of the huge Energy
- Primary energy source is the release of the heat of condensation from water vapour condensing, with solar heating being the initial source for evaporation. So a tropical cyclone can be visualized as a giant vertical heat engine supported by mechanics driven by physical forces such as the rotation (Coriolis force) and gravity of the Earth. Inflow of warmth and moisture from the underlying ocean surface is critical for tropical cyclone strengthening.

Impact of Earth's Rotation

- The rotation of the Earth causes the system to spin (Coriolis Effect) giving it a cyclonic characteristic and affecting the trajectory of the storm. In Northern Hemisphere, where the cyclone's wind flow is counterclockwise, the fastest winds relative to the surface of the Earth occur on the eastern side of a northward-moving storm and on the northern side of a westward-moving one; the opposite occurs in the Southern Hemisphere, where the wind flow is clockwise.

Movement of Clouds

- In Lower troposphere, motion of clouds is toward the center. At upper-level, there is outward flow of clouds.

Formation in Northern Atlantic Ocean

- Northern Atlantic cyclone season occurs from June 1 to November 30, sharply peaking from late August

through September. The statistical peak of the Atlantic hurricane season is 10 September.

Formation in North East Pacific

- The Northeast Pacific Ocean has a broader period of activity, but in a similar time frame to the Atlantic. Formation in North West Pacific
- The Northwest Pacific sees tropical cyclones year-round, with a minimum in February and March and a peak in early September.

Formation in North Indian basin

- Storms are most common from April to December, with peaks in May and November.

Formation in Southern Hemisphere

- Tropical cyclone year begins on July 1 and runs all year-round and encompasses the tropical cyclone seasons, which run from November 1 until the end of April, with peaks in mid-February to early March.

Requirements for formation:

- Water temperatures of at least 26.5 °C down to a depth of at least 50 m, so that it may cause the overlying atmosphere to be unstable enough to sustain convection and thunderstorms.
- Rapid cooling with height, so that it may cause release of the heat of condensation that powers a tropical cyclone.
- High humidity
- Low amounts of wind shear as high shear is disruptive to the storm's circulation.
- A distance from the Equator is necessary, which should be at least 555 km or 5° of latitude, so that it allows the Coriolis effect to deflect winds blowing towards the low pressure center and creating a circulation. Because the Coriolis effect initiates and maintains tropical cyclone rotation, tropical cyclones rarely form or move within about 5° of the equator, where the Coriolis effect is weakest.
- A pre-existing system of disturbed weather.

Movement

Coriolis Effect causes cyclonic systems to turn towards the poles in the absence of strong steering currents. The pole ward portion of a tropical cyclone contains easterly winds, and the Coriolis effect pulls them slightly more pole ward. The westerly winds on the Equatorward portion of the cyclone pull slightly towards the equator, but, because the Coriolis effect weakens toward the equator, the net drag on the cyclone is pole ward. Thus, tropical cyclones in the Northern Hemisphere usually turn north (before being blown east], and tropical cyclones in the Southern Hemisphere usually turn south (before being blown east] when no other effects counteract the Coriolis Effect.

High speed of rotation

- It is caused by Coriolis effect as well as energy released by heat of condensation.

Fujiwhara effect

When two cyclones approach one another, their centers will begin orbiting cyclonically about a point between the two systems. The two vortices will be attracted to each other, and eventually spiral into the center point and merge. When the two vortices are of unequal size, the larger vortex will tend to dominate the interaction, and the smaller vortex will orbit around it. This phenomenon is called the Fujiwhara effect.

Impact on passing over land

We should note that the deep convection is a driving force for tropical cyclones. The convection is strongest in a tropical climate; it defines the initial domain of the tropical cyclone. This is a major difference between the Tropical cyclones with other mid-latitude cyclones as the later derive their energy mostly from pre-existing horizontal temperature gradients in the atmosphere. To continue to drive its

heat engine, a tropical cyclone must remain over warm water, which provides the needed atmospheric moisture to keep the positive feedback loop running. When a tropical cyclone passes over land, it is cut off from its heat source and its strength diminishes rapidly. The moving over land deprives it of the warm water it needs to power itself, quickly losing strength. Thus, most strong storms lose their strength when the pass on to land, but if it manages to move back to ocean, it will regenerate.

Impact of passing over cold water

When a tropical storm moves over waters significantly below 26.5 °C, it will lose its strength. This is because of losing its tropical characteristic of the warm core.

Project Stormfury

The United States Government attempted in 1960s and 1970s to artificially weaken the Cyclones. During this project, Cyclones were seeded with silver iodide. It was thought that the seeding would cause supercooled water in the outer rainbands to freeze, causing the inner eye wall to collapse and thus reducing the winds. The Hurricane Debbie lost as much as 31% of its strength, when seeded with Silver Iodide in this project but Debbie regained its strength after each of two seeding forays. So, it was not a good idea. There were some more ideas applied which were as follows:

- Cooling the water under a tropical cyclone by towing icebergs into the tropical oceans and covering the ocean in a substance that inhibits evaporation
- Dropping large quantities of ice into the eye at very early stages of development (so that the latent heat is absorbed by the ice, instead of being converted to kinetic energy that would feed the positive feedback loop)
- Blasting the cyclone apart with nuclear weapons.
- A Project called Project Cirrus involved throwing dry ice on a cyclone.
- None of the idea was very much practical because the tropical storms are too large and too momentary.

Naming of Cyclones

Tropical cyclones are classified into three main groups, based on intensity: tropical depressions, tropical storms, and a third group of more intense storms, whose name depends on the region. If a tropical storm in the North- western Pacific reaches hurricane-strength winds on the Beaufort scale, it is referred to as a typhoon. If a tropical storm passes the same benchmark in the Northeast Pacific Basin, or in the Atlantic, it is called a hurricane. Neither "hurricane" nor "typhoon" is used in either the Southern Hemisphere or the Indian Ocean. In these basins, storms of tropical nature are referred to simply as "cyclones".

Types of the Tropical Cyclones

There are three kinds of Tropical cyclones:

- Tropical Depression: A tropical depression is a system with low pressure enclosed within few isobars and with the wind speed of 60 kmph. It lacks marked circulation
- Tropical Storm: It is a system with several closed isobars and a wind circulation of 115 kmph.
- Tropical Cyclone: It is a warm core vortex circulation of tropical origin with small diameter , circular shape and occurs in oceanic areas.

Anticyclones

An 'anticyclone' is opposite to a cyclone, in which winds move into a low-pressure area. In an anticyclone, winds move out from a high-pressure area with wind direction clockwise in the northern hemisphere, anti-clockwise in the southern hemisphere. Such a high pressure area is usually spread over a large area, created by descending warm air devoid of moisture. The absence of moisture makes the dry air denser than an equal quantity of air with moisture. When it displaces the heavier nitrogen and oxygen, it causes an anti-cyclone.

Tornado

Basically, hurricanes and typhoons form over water and are huge, while tornados form over land and are much smaller in size. A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. In the United States, twister is used as a colloquial term for tornado.

What is it?

Technically, a tornado is a rotating column of air that is in contact with both the surface of the earth and a cloud, which is generally cumulonimbus and occasionally cumulus. Most tornadoes have wind speeds less than 110 miles per hour and travel several kilometers before dissipating.

How it is formed?

First the rotating cloud base lowers. This lowering becomes a funnel, which continues descending while winds build near the surface, kicking up dust and other debris. Finally, the visible funnel extends to the ground, and the tornado begins causing major damage.

Where they are seen?

Tornadoes have been observed on every continent except Antarctica.

How they are detected?

Tornadoes can be detected before or as they occur through the use of Pulse-Doppler radar by recognizing patterns in velocity and reflectivity data.

What is Fujitsa Scale?

Fujita scale rates tornadoes by damage caused, and has been replaced in some countries by the updated Enhanced Fujita Scale. An F0 or EF0 is the weakest tornado, while F5 or EF5 is the strongest tornado.

What is Torro Scale?

TORRO scale ranges from a TO for extremely weak tornadoes to T11 for the most powerful known tornadoes.

Funnel Cloud as predecessor

Tornadoes often begin as funnel clouds with no associated strong winds at the surface, although not all evolve into a tornado. However, many tornadoes are preceded by a funnel cloud. Most tornadoes produce strong winds at the surface while the visible funnel is still above the ground, so it is difficult to discern the difference between a funnel cloud and a tornado from a distance.

Infrasonic signature

Tornadoes produce identifiable inaudible infrasonic signatures. Due to the long distance propagation of low- frequency sound, efforts are ongoing to develop tornado prediction and detection devices with additional value in understanding tornado morphology, dynamics, and creation.

Electromagnetic Spectrum

Tornadoes emit on the electromagnetic spectrum. There are observed correlations between tornadoes and patterns of lightning.

When they occur?

Tornadoes are most common in spring and least common in winter. Spring and fall experience peaks of activity as those are the seasons when stronger winds, wind shear, and atmospheric instability are present. Tornado occurrence is highly dependent on the time of day, because of solar heating. Worldwide, most tornadoes occur in the late afternoon, between 3 pm and 7 pm local time, with a peak near 5 pm.

Temperate Cyclones

Temperate cyclones are generally called depressions. The have low pressure at the centre and increasing pressure outwardly. They are of varying shapes such as circular, elliptical. The formation of tropical storms as we read above are confined to oceans, the temperate cyclones are formed over land and sea alike. Temperate

Cyclones are formed in 35-65° North as well as South Latitudes. While the tropical cyclones are largely formed in summer and autumn, the temperate cyclones are formed in generally winter. Rainfall in these cyclones is low and continuous not as furious as in case of tropical cyclones.

16. OCEAN CURRENTS

General Observations about Ocean Currents

Ocean current is the general movement of a mass of oceanic water in a definite direction, which is more or less similar to water streams flowing on the land surface of the earth. Ocean currents are most powerful of all the dynamics of oceanic waters because these drive oceanic waters for thousands of kilometers away. Ocean currents are divided on the basis of temperature into warm currents and cold currents.

On the basis of velocity, dimension and direction, they can be divided into drifts, currents and streams.

The forward movement of surface water of the oceans under the influence of prevailing winds is called drift whereas the ocean current involves the movement of Oceanic water in a definite direction with greater velocity.

Ocean stream involves movement of larger mass of ocean water like big rivers of the continent in a definite direction with greater velocity than the drifts and currents such as in Gulf Stream.

The currents in the oceans are originated due to combined effects of several internal as well as external factors, which control the origin and other characteristics of ocean current. They are related to different characteristics of ocean waters, rotational mechanism of the earth, external factors or atmospheric factors, topographic characteristics of the coasts and ocean basins. Besides, there are some factors which can modify the ocean currents.

- The factors relating to the earth's nature and its rotation include the gravitational force and deflective force by earth's rotation also known as Coriolis force.
- Oceanic factors include the pressure gradient, temperature variations and salinity differences. Ex- oceanic factors are atmospheric pressure and winds, evaporation and precipitation.
- Tides caused by the gravitational pull of the Moon and the Sun also play role in the forming of oceanic currents.
- The factors that can modify the currents are direction and shape of coastlines, bottom reliefs of the ocean basins, seasonal variations and rotation of the earth.
- Ocean circulation is driven by winds and by differences in water density. Along with the winds, ocean currents distribute the tropical heat worldwide, thus they play a very important role in maintaining Earth's heat balance.
- Please note that water at the poles travels in slow creeps below the surface water towards equator, which is called Ocean Creep. Ocean Creep is not a surface movement of water. It is an undercurrent flow occasioned by the sinking of cold and heavy water. The water, on becoming cold, contracts and its density increases.
- Those currents that flow from the Equator towards the poles are warmer than the surrounding water and so they are called warm currents. The ocean currents that flow from the polar areas towards the Equator are cooler compared to the surrounding water, so they are called cold currents. The actual difference in temperature of warm and cold currents is only a few degrees.
- The cold currents are usually found on the west coast of the continents in the low and middle latitudes in both the hemispheres and on the east coast in the middle latitudes in the Northern Hemisphere.
- The warm currents are usually observed on the east coast of the continents in the low and middle latitudes in both the hemispheres. In the Northern Hemisphere they are found on the west coasts of the continents in the high latitudes.
- The main effect of temperature differences on the earth occurs in a north-south direction i.e. from equator to poles. Warm equatorial waters therefore move slowly along the surface towards the poles while heavier cold waters of the polar areas creep slowly towards the Equator along the bottom of the sea. Thus, the difference in the temperature of the ocean waters causes ocean currents. They are convectional currents giving rise to a transfer of heat energy in the ocean waters from the areas of excess to the areas of deficit heat energy.
- The density of the ocean water varies from place to place, a movement in the ocean waters occurs due to this.

- A gyre is any large system of rotating surface ocean currents, particularly those involved with large wind movements. Gyres are caused by the Coriolis Effect; planetary vorticity along with horizontal and vertical friction, which determine the circulation patterns from the wind curl (torque).

Coriolis Effect and Coriolis Force

Coriolis Effect is a deflection of moving objects when they are viewed in a rotating reference frame. In a reference frame with clockwise rotation, the deflection is to the left of the motion of the object-, in one with counter- clockwise rotation, the deflection is to the right. Coriolis Effect is causes ONLY in a rotating reference frame. The deflective force causes by the Coriolis Effect is caused Coriolis force. It has its own say in many geographical phenomena, most important being the deflection of the general direction of ocean currents.

Important Observations:

- The currents flowing from equator towards the North Pole and from North Pole towards the equator are deflected to their right while the currents flowing north- south and south-north in the southern hemisphere are deflected towards their left.
- The rotational force of the earth causes movement of ocean water near the equator in opposite direction to 'the west to east rotation of the earth and thus equatorial currents are generated. These currents flow from east to west. Some ocean water moves in the direction of the rotation of the earth i.e. from west to east and thus counter equatorial currents are also formed.
- Please note that the magnitude of the deflection, or "Coriolis effect," varies significantly with latitude. The Coriolis Effect is zero at the equator and increases to a maximum at the poles. The deflection is proportional to wind speed: that is, deflection increases as wind strengthens. The resultant balance between the pressure force and the Coriolis force is such that, in the absence of surface friction, air moves parallel to isobars (lines of equal pressure). This is called the geotropic wind.
- The Coriolis force explains why winds circulate around high and low pressure systems as opposed to blowing in the direction of the pressure gradient.

Impact of Physical Properties of Ocean on Ocean Currents

Local variations in the physical properties of the ocean such as pressure gradient, temperature differences, salinity differences, density variations etc. generate ocean currents.

Temperature

The amount of insolation received at the earth's surface and consequent temperature decreases from equator towards the poles. Due to high temperature in the equatorial region the water density decreases because of greater expansion of water molecules whereas the density of sea water becomes comparatively greater in the polar areas. Consequently water moves due to expansion of volume from equatorial region (of higher temperature] to polar areas (colder areas] of relatively very low temperature.

There is movement of ocean water below the water surface in the form of subsurface current from colder polar areas to warmer equatorial areas in order to balance the loss of water in the equatorial areas. Thus, the poleward surface current and Equatorward subsurface currents form a complete circulatory system of ocean water. The Gulf Stream and Kuroshio warm currents moving from equator towards north are examples of such currents.

Salinity

Oceanic salinity affects the density of ocean water and density variation causes ocean currents. Salinity increases the density of ocean water. If two areas having equal temperature are characterized by varying salinity, the area of high salinity will have greater density than the area of low salinity. The denser water sinks and moves as subsurface current whereas less saline water moves towards greater saline water as surface current. In other words, ocean currents on the water surface are generated from the areas of less salinity to the areas of greater salinity. Such system of surface and subsurface currents caused by salinity variation is originated in open and enclosed seas. For example, the current flowing from the Atlantic Ocean to the Mediterranean Sea via Gibraltar Strait is caused because of the difference in salinity.

The salinity of the Mediterranean Sea is much higher than the adjoining Atlantic Ocean. Consequently, water sinks in the Mediterranean Sea. In order to compensate the loss of water Atlantic water flows as surface current into the Mediterranean Sea. The sinking

water in the Mediterranean Sea moves as subsurface current towards the Atlantic Ocean. Similarly, such system of surface and subsurface currents is generated between the Red Sea and the Arabian Sea via Bab-el-Mandeb Strait.

The salinity of the Baltic Sea is lowered due to the flow of fresh water by the rivers but the level of water is raised. With the result water moves northward as a surface current into the North Sea and subsurface current moves from the North Sea to the Baltic Sea.

Impact of Air Pressure and Winds on Ocean Currents

Air pressure on the oceanic water causes ocean currents through density variations. The areas of high atmospheric pressure are characterized by low volume of water and thus lowering of water level. Contrary to this the areas of low atmospheric pressure record higher volume of water and higher water level. Thus, water moves as surface current from the areas of higher water level (Low pressure areas] to low water level areas (high pressure areas).

Prevailing or planetary winds (e.g., trade winds, westerlies and polar winds) play major roles in the origin of ocean currents. The wind blowing on the water surface also moves water in its direction due to its friction with the water. Most of the ocean currents of the world follow the direction of prevailing winds. For example, equatorial currents flow westward under the influence of N.E. and S.B. trade winds. The Gulf Stream in the Atlantic and the Kuroshio in the Pacific move in northeastern direction under the influence of the westerlies. There is seasonal change in the direction of currents in the Indian Ocean twice a year (after every 6 months) due to seasonal change in the direction of monsoon winds. Friction caused by the wind sets the sea water in motion.

Types of Oecan Current

Ocean currents are of two type's viz. Surface Currents and Deep Currents. Surface currents affect surface water above the pycnocline (<10% of ocean water]. These currents are primarily driven by major wind belts. The Deep currents affect deep water below pycnocline (90% of ocean water] and are primarily driven by density differences. The deep currents are larger and slower than surface currents.

The stress of wind blowing across the sea causes a surface layer of water to move. Due to the low viscosity of water, this stress is not directly communicated to the ocean interior, but is balanced by the Coriolis force within a relatively thin surface layer, 10-200m thick. This layer is called the Ekman layer and the motion of this layer is called the Ekman transport. Because of the deflection by the Coriolis force, the Ekman transport is not in the direction of the wind, but is 90° to the right in the Northern Hemisphere and 90° toward the left in the Southern Hemisphere. The amount of water flowing in this layer depends only upon the wind and the Coriolis force and is independent of the depth of the Ekman layer and the viscosity of the water. The major surface currents are shown below:

Currents of The Atlantic Ocean

North Equatorial Current (warm)

North equatorial current is a significant Pacific and Atlantic Ocean current that flows east-to-west between about 10° north and 20° north. This current is generated because of upwelling of cold-water near the west coast of Africa. This warm current is also pushed westward by the cold Canary current. On an average, the north equatorial warm current flows from east to west but this saline current is deflected northward when it crosses the mid-Atlantic Ridge near 15°N latitude. It again turns southward after crossing over the ridge. This current, after being obstructed by the land barrier of the east coast of Brazil, is bifurcated into two branches viz. Antilles current and Caribbean current. The Antilles current is diverted northward and flows to the east of West Indies islands, and helps in the formation of Sargass Sea eddy while the second branch known as the Caribbean current enters the Gulf ofMexico and becomes Gulf Stream.

South Equatorial Current (warm)

The South Equatorial Current is a significant Pacific, Atlantic, and Indian Ocean current that flows east-to-west between the equator and about 20 degrees south. In the Pacific and Atlantic Oceans, it extends across the equator to about 5 degrees north. South equatorial current flows from the western coast of Africa to the eastern coast of South America between the equator and 20°S latitude. This current is more constant, stronger and of greater extent than the north equatorial current. In fact, this current is the continuation of the cold Benguela current. This warm current is bifurcated into two branches due to obstruction of land barrier in the form of the east coast of Brazil.

The northward branch after taking north-westerly course merges with the north equatorial current near Trinidad while the second branch turns southward and continues as Brazil warm current parallel to the east coast of South America. This current is basically originated under the stress of trade winds.

Equatorial Counter Current

Equatorial Counter Current is a significant ocean current in the Pacific and Indian oceans that flows west-to-east at approximately five degrees north. The Counter Currents result from balancing the westward flow of water in each ocean by the North and South Equatorial currents.

In El Nino years, Equatorial Counter current intensifies in the Pacific Ocean. The Equatorial Counter current flows from west to east in between the westward flowing strong north and south equatorial currents. This currents is less developed in the west due to stress of trade winds. In fact, the counter current mixes with the equatorial currents in the west but it is more developed in the east where it is known as the Guinea Stream. The Equatorial Counter current carries relatively higher temperature and lower density than the two equatorial currents. Several ideas have been put forth to explain the origin of the Equatorial Counter current. According to some scientists this current is originated because of the influence of the westerlies which blow from west to east in the calm zone of the doldrums or in the convergence zone of the north east and south east trade winds.

Gulf Stream

The Gulf Stream is a system of several currents moving in north-easterly direction. This current system originates in the Gulf of Mexico around 20°N latitude and moves in north easterly direction along the eastern coast of North America and reaches the western coasts of Europe near 70°N latitude. This system, named Gulf Stream because of its origin in the Mexican Gulf, consists of

1. Florida current from the strait of Florida to Cape Hatteras,
2. Gulf Stream from Cape Hatteras to the Grand Bank, and
3. North Atlantic Drift (current) from Grand Bank to the Western European coast.

North Equatorial Current flows westward off the coast of northern Africa. When this current interacts with the northeastern coast of South America, the current forks into two branches. One passes into the Caribbean Sea, while a second, the Antilles Current, flows north and east of the West Indies. These two branches rejoin north of the Straits of Florida. Thus, Florida current is in fact, the northward extension of the north equatorial current.

Hydrosphere and Atmosphere

This current flows through Yucatan channel into the Gulf of Mexico, thereafter the current moves forward through Florida Strait and reaches 30°N latitude. Thus, the Florida warm current contains most of the characteristics of the equatorial water mass.

The trade winds blow westward in the tropics, and the westerlies blow eastward at mid-latitudes. This wind pattern applies a stress to the subtropical ocean surface with negative curl across the North Atlantic Ocean. The resulting Sverdrup transport is Equatorward. Because of conservation of potential vorticity caused by the northward-moving winds on the subtropical ridge's western periphery and the increased relative vorticity of northward moving water, transport is balanced by a narrow, accelerating poleward current, which flows along the western boundary of the ocean basin, outweighing the effects of friction with the western boundary current known as the Labrador Current. The conservation of potential vorticity also causes bends along the Gulf Stream, which occasionally break off due to a shift in the Gulf Stream's position, forming separate warm and cold eddies. This overall process, known as western intensification, causes currents on the western boundary of an ocean basin, such as the Gulf Stream, to be stronger than those on the eastern boundary.

As a consequence, the resulting Gulf Stream is a strong ocean current. It transports water at a rate of 30 million cubic meters per second through the Florida Straits. As it passes south of Newfoundland, this rate increases to 150 million cubic meters per second.

The average temperature of water at the surface is 24°C while the salinity is 3.6%. The temperature never falls below 6.5°C . The current becomes narrow while passing through the Florida strait but thereafter its width increases and current flows close to coast.

Canary Current (Cold)

The Canary current, a cold current, flows along the western coast of north Africa between Maderia and Cape Verde. In fact, this current is the continuation of North Atlantic Drift which turns southward near the

Spanish coast and flows to the south along the coast of Canaries Island. The average velocity of this current is 8 to 30 nautical miles per day. This current brings cold water of the high latitudes to the warm water of the low latitudes and finally merges with the north equatorial current. The Canary cold current ameliorates the otherwise hot weather conditions of the western coasts ofNorth Africa.

Labrador Current (Cold)

The Labrador Current, an example of cold current, originates in the Baffin Bay and Davis Strait and after flowing through the coastal waters of Newfoundland and Grand Bank merges with the Gulf Stream around 50°W longitude. The flow discharge rate of the current is 7.5 million ml of water per second. This current brings with it a large number of big icebergs as far south as Newfoundland and Grand Bank. These icebergs present effective hindrances in the oceanic navigation. Dense fogs are also produced due to the convergence of the Labrador cold current and the Gulf Stream near New-foundland.

Brazil Current (Warm)

The Brazil current is characterized by high temperature and high salinity. This current is generated because of the bifurcation of the south equatorial current because of obstruction of the Brazilian coast near Sun Rock. The northern branch flows northward and merges with the north equatorial current while the southern branch known as the Brazil current flows southward along the east coast of South America up to 40°S latitude. Thereafter it is deflected eastward due to the deflective force of the rotation of the earth and flows in easterly direction under the influence of westerlies. The Falkland cold current coming from south merges with Brazil current at 40° S.

Falkland Current (Cold)

The cold waters of the Antarctic Sea flows in the form of Falkland cold current from south to north along the eastern coast of South America up to Argentina. This current becomes most extensive and developed near 30°S latitude. This current also brings numerous icebergs from the Antarctic area to the South American coast.

South Atlantic Drift (Cold)

The eastward continuation of the Brazil current is called South Atlantic Drift. This current is originated because of the deflection of the Brazil warm current eastward at 40°8 latitude due to the deflective force of the rotation of the earth. The South Atlantic Drift, thus, flows eastward under the influence of the westerlies. This current is also known as the Westerlies Drift or the Antarctic Drift.

Benguela Current (Cold)

The Benguela current, a cold current, flows from south to north along the western coast of south Africa. In fact, the South Atlantic Drift turns northward due to obstruction caused by the southern tip of Africa. Further northward, this current merges with the South Equatorial Current.

Currents of The Pacific Ocean

North Equatorial Current (Warm)

The north equatorial current originates off the western coast of Mexico and flows in westerly direction and reaches the Philippines coast after covering a distance of 7500 nautical miles. This current is originated because of the Californian current and north-east monsoon. The volume of water continuously increases westward because numerous minor branches join this current from the north. A few branches also come out of the main current and turn towards - north and south. One branch emerges from the north equatorial current near Taiwan and flows northward to join Kuroshio current while the southern branch turns eastward to form counter equatorial current. It is significant to note that north equatorial current flows as a continuous current i n the north Pacific Ocean but there are seasonal variations in its northern and southern marginal areas. The velocity of the current ranges between 12 and 18 nautical miles per day. With the northward (northern summer) and southward south northward and southward but it always remains to the north of equator.

South Equatorial Current (Warm)

The south equatorial current is originated due to the influence of south-east trade winds and flows from east to west. This current is stronger than the north equatorial current. The average velocity is 20 nautical miles per day while the maximum velocity becomes 100 nautical miles a day. Numerous minor currents join this current, from the left and thus, the volume of water continuously increases west-ward, The current is bifurcated into northern and southern branches near New Guinea. The northern branch turns eastward and flows as counter equatorial current w rule the southern branch -moves towards the northern and north-eastern coasts of Australia.

Counter Equatorial Current (Warm)

The current flowing west to east between the north and south equatorial currents is termed counter equatorial current. Because of trade winds immense volume of water is piled up in the western marginal parts of the ocean, with the result there is general slope gradient of water surface from west to east. This higher water level in the west and descending slope gradient of water surface from west to east make the oceanic water flow in easterly direction in the name of counter equatorial current which is the most developed counter current in the Pacific Ocean. This counter equatorial current is extended up to the Panama Bay.

Kuroshio System (Warm)

The Kuroshio System consists of several currents and drifts is similar to the Gulf Stream system of the Atlantic Ocean. This system runs from Taiwan to the Bering Strait and consists of the Kuroshio current, the Kuroshio extension, the north Pacific drift, the Tsushima current and the counter Kuroshio current.

Oyashio Current (Cold)

The Oyashio cold current is also known as Kurile cold current. This cold current flows through the Bering Strait in southerly direction and thus transports cold water of the Arctic Sea into the Pacific Ocean. Near 50°N latitude this current is bifurcated into two branches. One branch turns east-ward and merges with the Aleutian and Kuroshio currents. The second branch moves upto the Japanese coasts. This current is comparable to the cold Labrador Current of the North Atlantic Ocean. The convergence of cold Oyashio (Kurile) and warm Kuroshio Current causes dense fogs which become potential hazards for navigation.

California Current (Cold)

The California current, an example of cold current, is similar to the Canary cold current of the Atlantic Ocean in most of its characteristics. In fact, this current is the eastward extended portion of the North Pacific drift. The cold California current is generated because of the movement of oceanic water along the Californian coast from north to south in order to compensate the loss of water which is caused due to large-scale transport of water off the coast of Mexico under the influence of trade winds in the form of the north equatorial current. This current after reaching the Mexican coast turns west-ward and merges with the north equatorial current.

Peru Current (Cold)

The cold current flowing along the western coast of South America from south to north is called Peru current or Humboldt current. This current is known as Peru coastal current near the coast w bile it is called Peru oceanic current off the coast. Mean annual temperature ranges between 14°C and 17°C and the average velocity of moving water is 15 nautical miles (27km] per day. The temperature of sea water increases from the coast towards the ocean.

East Australia Current (Warm)

South equatorial current is bifurcated near the Australian coast into northern and southern branches. The southern branch flows as east Australia current from north to south along the eastern coasts of Australia. New Zealand is surrounded by this current. It is deflected eastward near 40°S latitude due to deflective force of the earth and flows in easterly direction under the influence of the westerlies. This is a warm and more consistent current. It raises the temperature of east Australian coast for considerable distance southward.

Currents of The Indian Ocean

The current systems of the Indian Ocean are largely controlled and modified by landmasses and monsoon winds. Indian Ocean being surrounded by the Indian subcontinent, Africa and Australia does not present most favourable conditions for the development of consistent system of ocean currents. The currents in the northern Indian Ocean change their flow direction twice a year due to north- east and south-west monsoon winds.

North-East Monsoon Current (Warm)

North-east monsoon winds blow from land to the ocean during winter season in the northern hemisphere and thus westward blowing north-east monsoon currents are produced in Indian Ocean. This current flows to the south of 5°N latitude. Besides, some independent currents originate in the Bay of Bengal and Arabian sea and flow in south-westerly direction.

S.W. Monsoon Current (Warm)

There is complete reversal in the direction of monsoon winds during summer season. The north-easterly direction of winter monsoon winds becomes south-westerly during summer season in the northern hemisphere. This reversal of direction of monsoon winds also reverses the direction of ocean currents of Indian Ocean during summer season. North-east monsoon ocean currents disappear and south-west monsoon ocean currents are developed. The general direction of monsoon currents is from south-west to north-east but several minor branches emerge from the main branch and move in the Bay of Bengal and Arabian Sea. The Indian counter current developed during winter season disappears due to this current.

17. WORLD REGIONAL GEOGRAPHY

Asia

- It is the worlds largest continent,which is 30% of World's area.
- More than 60% of world's population lives here.
- Except some southern islands whole continent is in Northern Hemisphere through which three main latitudenal circles pass viz. Equator, Cancer & Arctic.
- Highest peak of Asia & World is Mt. Everest (Of Himalaya range),its in Nepal.
- World's highest Platue is Pamir,whose hight 4875 mtr. Pamir is called as Roof of the world.
- World's most densly populated country is Singapore in Asia.
- World's largest natural rubber producing country Thailand is in Asia.
- Asia's hottest place is Jacobabad.
- Asia's most densly populated island Java.
- Asia's lowest point/place is Dead sea, whichis in the territory of Jordon.

Europe

- Entwarp of Belgium is the word's largest market of diamond.
- Mountain Cacasus separates Asia continent & Europe.
- Highest peak of Europe is Elbrus in Russia.
- Largest city of Europe is London, which is on the bank of Thames.
- Italy is the world's largest Grape and Olive producer country.
- Ukrane is the largest producerof wheat.It is also called as Bread basket of Bread.
- Champange wine is mainly produced in France.
- France is called the country of wine and beauty-queens.
- World's largest underground railway connects London to Paris.
- Europe is called as the Continent of Peninculas since it is surrounded by three seas.
- Italy is called as the India of Europe because it is an agro based country as India is.
- Rhine is the busiest inland waterway of Europe.
- France and Norway are known as country of Fjorde.
- Gulf stream is called as hot blanket of Europe.
- Zibralter Strait separates Europe and Africa.
- Norway,Swedon,Denmark & Iceland are 'Scandenavien' group of country.
- Rykzavik,capital of Iceland is world's northern-most capital.

Africa

- Victorial fall is on Zambazi river.
- Pemba and Zanzibar islands are famous for production of clove.
- It is second largest continent after Asia.
- It is only continent through which equator , Tropic of cancer and Tropic of capricorn passes.
- Africa is separated throgh Zibralter strait from Europe.
- Lake Victoria is the largest lake of Africa.
- World's longest river Nile originates from Victoria and its outflow is in Meditternanien sea.
- Nigeria is the country with maximum population in Africa.
- Maximum urbanised country in Africa is Libya.
- World's largest diamond mine is Kimberley(South Africa) in Africa.
- World's largest desert Sahara(84,000 Sq. Km.) is in Africa.
- Largest producer of Tea in Africa is Kenya.
- Great Rift valley in in Africa.
- Highest peak is Mt. Kilimanzaro.

North America-

- North America is wold's third largest Continent. North America was discovered by Columbus in 1492 , therefore it is known as country of newworld.
- Panama canal separates North and South America & connects Pacific ocean and Atlantic ocean.
- Highest peak of North America is Mount Mackinley in Alaska.
- Main tribes found in North America are Red Indian and Niegro.
- Temperate grassland found in North America is

know as Preries.
- World's largest Sea Port is Newyork.
- World's busiest Airprt is Canedy.
- World"s largest gold mine is in Canada.
- Largest city according to population in North America is Maxico city.
- Astrodome in USA is the largest dome of world.
- Lake Superior in North America is the world'slargest fresh water lake.
- Wood buffalo national park in Canada is the world's largest park.
- Lowest place is Death Valley which is also famous for high temperature.
- Sorrounded on east by Atlantic ocean and in west by Pacific Ocean.
- Greenland although is a part of Europe but situated in North America.
- Rocky Mt. is situated inits westurn part.

South America(Fourth largest Continent)-

- North America, Central America, Maxico & West Indies is together known as 'Latin America'.
- World's highest navigable lake Titicaca is inSoth America, On the border of Peru-Bolivia.
- Highest waterfall of World is Anzel in South America.
- Amazon river is on first position acoording to drainage and is the longest river of this continent.
- Largest city of this continent is Sao Paolo(Brazil).
- Pampas is grassland found in Arzentina.
- Brazil stands on second position in production of Coco.
- World"s largest Coffee producer is Brazil.
- Brazil is largest producer of soyabean in South America.
- Andes is the longest range of world.Its highest peak in Acuncagua(Hight 6960 mtr.).
- World's maximum meat exporter country is Arzentina.
- Maximum urbanised country in South America is Urugway.
- World famous coffee market is SAo Paolo.
- Driest place of South America is Arica(Atacama Desert).

Australia

- Ausralia, New Zealand and sorrounding islands are called 'Austrlasia'.
- Australia is world's smallest continent and world's largest island, so it is also called as island continent.
- Australia was discovered by James Cook in 1770.
- 22 countries are in this continent.
- Calgoorli and Cooligardi are famous gold mine in Australia.
- Main mountain of Australia is Great Deviding Range.
- New Zealand is called as Britain of South.
- Gibson and Victoria are the main desert of this continent.
- Australia is the main producer of world famous wool Marino.
- Zekaroos are the labours working in the rearing areas of Sheep in Australia.
- Carpentria plains are in northern part of Australia.

Important Mountain Peaks of The World

Mountain Peak	Country	Height (m)
Everest	Nepal	8848
K-2 (Godwin Austin)	India	8611
Kanchenjunga	India - Nepal	8598
Nanda Devi	India	7817
Nanga Parbat	India	8126
Makalu	Nepal - China	8481
Dhaulagiri	Nepal	8172
Annapurna	Nepal	8078

Importan Deserts of The World

Desert	Area
Sahara	North Africa (Algeria, Chad, Libya, Maliek)
Takla Makan	Si-kiang (China)
Gobi	Mangolia and China
Thar	North-West India and Pakistan
Atacama	Northern Chile (South America)
Kalahari	Botswana (Cenral America)

Important Rivers of The World

Name	Origin Place	Place of Outflow
Ganges (Ganga)	Gomukh	Bay of Bengal
Irrawadi	Confluence of Mali and Nami Rivers	Bay of Bengal
Nile	Victoria Lake and Tana Lake	Mediterranean Sea
Amazon	Laigo Wilfairo	Atlanitic Ocean
Yangtze	Tibetan Plateau	China Sea
Hwangho	Junlum Shan Mt.	Gulf of Bo Hai
Mississippi	Superior Lake and Winnipeg Lake	Gulf of Mexico
Missouri	Rocky Mountain	Mississippi River
Volga	Valdai Hills	Caspina Sea
Sao Franisco	Brazilian Highlands	Atlanitc Ocean
St. Lawrence	Ontario Lake	Gulf of St. Lawrence
Brahmaputra	Mansarovar Lake	Bay of Bengal
Indus	Rakas Lake (Near Mansarovar Lake)	Arabian Sea
Danube	Black Forest	Black Sea
Darling	Great Dividing Range	Murray River
Tigris	Touns Mt.	Pension Gulf.

World's Famous Towns located on the Banks of Rivers

Town	River	Contry
Baghdad	Trigris	Iraq
St. Louis	mississippi	USA
Rome	Tiber	Italy
Paris	Seine	France
Bonn	Rhine	Germany
Buenos Aives	La Plata	Argentina
Belgrade	Danube	Yugoslavia
Washington	Potomac	USA
Tokyo	Arakava	Japan
Ottawa	St. lawrence	Canada
Madrid	Majensus	Spain
Lahore	Ravi	Pakistan
Dublin	Liffy	Ireland
Chicago	Chicago	USA

Italina Grad (Volgo-grad)	Volga	Russia
Montreal	St. Lawerence	Canada
Berlin	Spree	Germany
London	Thames	Britain
Moscow	Moskwa	Russia
Cairo	Nile	Egypt
Liverpool	Mercy	England
Canton	Sikiang	China
Budapest	Danube	Hungary
Shanghais	Yangtse kiang	China
Vienna	Danube	Austria
New York	Hudson	USA
Lisbon	Tangus	Portugal
Karachi	Indus	Pakistan
Delhi	Yamuna	India
Lenningrad	Neva	Russia
Basara	Dajla-Farat	Iraq

Main Waterfalls of The World

Waterfalls	**Country**
Angel	Venezuela
Jog (Garsoppa)	India
Niagra	Canada - USA
Ribbori	California
Della	Canada
Great	Kamarana

Main Islands of The World

Name	**Location**
Greenland	Arcti Ocean
New Guinea	Western Pacific Ocean
Honshu (Japan)	North-Western Paific Ocean
Borneo	Pacific Ocean
Sumatra	Indian Ocean
Madagascar	Indian Ocean
Java Island	Indian Ocean
Victoria Island	Arctic Ocean
Tasmania	South-West Pacific Ocean
Iceland	Noth-Atlantic Ocean
Ireland	North-Atlantic Ocean

Manufactaturing Industries of the world

Industry	**Produer**
Motor Vehicle Industry	USA, Japan
Ship - Manufacturing	Japan, Sweden
Aircraft manufacturing	USA, Japan
Cotton Textile	Britain, India
Iron - Steel	USA, Ukren
Woollen Textile	Japan, USA
Silk Textile	Russia, Japan

Main Tribes of The world

Tribes	**Country/Region**
Bushman	Kalahari Desert (Sout Afria)
Pygmies	Congo Basin
Red Indian	USA, Canada
Eskimos	Greenland, Canada
Masai	East Africa (Kenya)
Maoris	New Zealand
Khirgiz	Middle Asia
Veddas	Sri Lanka
Ukaghirs	Siberia
Baddus	Arab Region
Yaku	Tundra Region

Main Vegetation Of The World

Lithophyte	Trees and plants growing on the hardrroks.
Hygrophyte	Vegetation grown in boggy and equatorial warm humid regions.
Trope-phyte	Grass and Vegetations of Tropical climate
Hydro-phyte	Vegetation of water logged regions.

Main Canals of The World

Name	Country	Loation
Suez Canal		Egypt Red Sea and Mediterranean Sea
Panama Canal	panama	Caribbean Sea and Pacific Ocean
Kiel Canal		Germany North Sea and Baltic Sea
Su-Canal	USA	Superior Lake and Huron Lake
Erie Canal		USA Erie and Ontario Lakes
K.P. Canal		India Andhra Pradesh and Tamil Nadu
Manchester Canal	Great Britain	Manchester and Liverpoool (Liverpool)

Oceans of The World

Name	Deepest Place	Depth (m)
Pacific Ocean	Mariana Trench	11033
Atlanti Ocean	Puerto Rico Trenh	9219
Indian Ocean	Sunda Trench	7725
Antarctic Ocean	-	-
Arctic Ocean	Eurasian Basin	5450

Important Water Straits of The World

Strait	Geographical Location	Connetion (Between)
Malacca	Indonesia - Malaysia	Andaman Sea and South China Sea
Palk	India - Sri Lanka	Gulf of Mannar and Bay of Bengal
Gibraltar	Spain - Moroco	Mediterranean Sea and Atlantic Ocean
Bass	Australia	Tasman Sea and Southern Ocean
Cook		New Zealand Southern Pacific Ocean
Sunda	Indonesia	Java Sea and Indian Ocean
Yucatan	Mexico - Cuba	Gulf of Mexico and Caribbean Sea
Torres	New Guinea - Australia	Arafura Sea and Gulf of Papua
Bering	Alaska - Russia	Bering Sea and Chukchi Sea
Davis	Greenland - Canada	Baffin Bay and Atlantic Ocean
Dover	England - France	North Atlantic and Arctic Ocean

World's Main Crops Producers

- In the production of wheat, China is at the first position while India is at the second position.
- In the rice prodution, China is at first place while India at the second place.
- In the production of Coarse Cereals, USA is at first place while China is at second place.

Shifting Cultivation in world

Name	Rigion
Ray	Vietnam, Laos
Chenna	Shrilanka
Ladang	Java & Maleshiya
Fag	equitorial African region
Rocca	Brazil

Konuko	Venezuela
Milpa	Yacaton, Guatemala
Tavi	Malagasi
Masolley	Congo
Lagan	Western Africa
Ichali	Guadeloup

Important Lakes of The World

Name	**Related Region**
Michingan Lake	NorthAmerica
Great Bear Lake	Canada
Rudolf Lake	Kenya
Caspian Sea	Former USSR and Iran
Superior Lake	USA and Canada
Victoria Lake	Kenya, Uganda and Tanzania
Aral Sea	Kazakhstan and Uzbekistan
Huron Lake	USSR (Russia)
Tanganika Lake	Tanzania, Burundi, Zambia and Democratic Republic of Congo
Winnipeg Lake	Canada
Malawi Lake	Malawi and Mozambique
Chad Lake	Nigetia, Niger and Chad
Titicaca Lake	Bolivia

Geographical Sobriquets of The World

Boon of the Nile River	Egypt
Empire City	New York
Queen of Adriatic	Venic (Italy)
Roof of the world	Pamir Plateau
Venice of the world	Stockholm
Land of Cakes	Scotland
Cokpit of Europe	Belgium
Dark Continent	Africa
Country of Glden Pagoda	Myammar
Town of Seven Islands	Mumbai (India)
Playground of Europe	Switzerland
Country of Rising Sun	Japan
Land of Thunder volt	Bhutan
Land of White Elephant	Thailand
Sorrow of China	Hwangho River
Land of Midnight sun	Norway
Gateway of Mediterranean Sea	Gibraltar
Garden of India	Bangalore (India)
Land of Kangaroos	Belgrade
Spice Garden of India	Kerala
Paris of Asia	Thailand
Pearl of the Indian Ocean	Sri Lanka
Garden city of India	Bangalore
Island of Pearls	Behrain
Country of Lakes	Scotland
Manchester of East	Osaka (Japan)
Forbidden City	Lhasa (Tibbet)
Town of Seven Hills	Rome (Italy)
Town of Skyscraping building	New York (USA)
City of Pope	Rome
Eternal City	Rome
	(Sweden)

18. GEOGRAPHY OF INDIA

Important Facts

- India became independance state on 15 August 1947.
- India became republic country on 26 January 1950.
- India has 28 State and 7 Union Territories.
- The geographical area of India is 32,87,263 Km^2
- The length of the india's manland from east to west is 2,933 Km.
- The length of the India's mainland from north to south is 3,214 Km.
- Delhi is the capital of india.
- Delhi become capital of india on 23 Dec 1912.
- India is situated between 8º4' to 37º6' North latitudes.
- India situated between 68º7' to 97º25' East longitudes.
- 82 $^1/_2$º East longitude passes almost through the mid of India.
- It is the Standard Meridian of India.
- This line pass through from Nani of Allahabad.
- The Standard Time of India is 5 hours 30 minutes ahead of that at the Greenwich.
- The tropic of Cancer divides India into almost two equal parts.
- The eight states through which the tropic of cancer passes are–

  1. Gujarat 2. Rajasthan 3. Madhya Pradesh 4. Chhattisgarth 5. Jharkhand 6. W.Bengal 7. Tripura 8. Mizoram
- The geographical area of India is about 2.4% of the total geographical area of the world.
- On the basis of the geographical area, India rank on 7th position. after–

  1. Russia 4. U.S.A.
  2. Canada 5. Brazil
  3. China 6. Australia
- The land frontiers of India are 15,200 km.
- The length of the coastline of the mainland is 6,100 Km.
- The total coastline, including the coastlines of the islands, is 7516.6 Km.
- In this way, the total length of the Indian frontiers is 22,716.6 Km(15,200+7516.6).
- Indira Point is the southern most point of India.
- Indira Point is located in the Great Nicobar Island.
- The coastline of Gujarat is longest due to the presence of innumerable creeks

Channels-

1. 8º Channel is in between Maldives and Minicoy.
2. 9º Channel is in between Lakshadweep and Minioy.
3. 10º Channel is in between Andaman and Nicobar islands.
4. Great Channel isin between indira point and Indonesia.

Territorial sea of india-

- The Maritime Belt or Territorial sea of India extends upto the distance of 12 Nautical Miles.
- 1 Nautical Mile = 1.8 km from the base line.
- The Exclusive Economic Zone (EEZ) of India extended further 200 nautical miles from the attached region.
- Now Exclusive Economic zone of india extended 350 Notical mile from 2011.
- In Exclusive Economic zone India has exclusive rights of carrying out scientific researches, construction of new islands and exploitation of the natural resources found in this zone.
- After that, there is extension of the High Sea where all the nations have equal rights.

India and Neighbouring Countries

- There are 28 States and 7 Union Territories in India.
- The immediate neighbours of India are-

  1. Pakistan
  2. Afghanistan
  3. Nepal
  4. Bhutan
  5. China
  6. Bangladesh
  7. Myanmar

1. Pakistan and Indian States

1. Jammu & Kashmir
2. Punjab
3. Rajasthan
4. Gujarat

2. Afghanistan and Indian States

1. Jammu and Kashmir (In Pak Occupide Kashmir)

- The only state of India touching the border with Afghanistan is Jammu and Kashmir.

3. Nepal and Indian States

1. Uttarakhand
2. Uttar pradesh
3. Bihar
4. West Bengal
5. Sikkim

4. Bhutan and Indian States

1. Sikkim
2. West Bengal
3. Assam
4. Arunachal pradesh

5. China and Indian States

1. Jammu Kashmir
2. Himachal pradesh
3. Uttarakhand
4. Sikkim
5. Arunachal pradesh

6. Bangadesh and Indian States

1. West Bengal
2. Assam
3. Tripura
4. Mizoram
5. Meghalaya

7. Myanmar and Indian States

1. Arunachal pradesh
2. Nagaland
3. Manipur
4. Mizoram

19. PHYSIOGRAPHY OF INDIA

India can be divided into six physiographic regions. They are

- The Himalayan Mountains
- Northern Plains
- The Great Indian Desert
- The Peninsular Plateau
- Coastal Plains
- Islands

The Himalayan Mountains

Himalaya Range or Himalaya Mountains also includes the Karakoram, the Hindu Kush, and other, lesser, ranges that extend out from the Pamir Knot. The Himalayan mountain system is the world's highest, and home to the world's highest peaks, the Eight-thousanders, which include Mount Everest and K2.

After Himalayan peaks, it is Aconcagua, in the Andes, at 6,962 metres, known to be the highest peak outside Asia. There are over 100 mountains in Himalaya system that exceeds 7,200 m. The main Himalayan ranges run from Indus river valley in the west to the Brahmaputra river valley in east forming an arc 2,400 km long, which varies in width from 400 km in the western Kashmir-Xinjiang region to 150 km in the eastern Tibet-Arunachal Pradesh region. In this 2400 kilometer long arc, there are three coextensive sub-ranges, with the northernmost, and highest, known as the Great or Inner Himalayas. Some other classifications divide the Himalayas into four mountain ranges viz. the Trans-Himalaya or the Tethys Himalaya, the Greater Himalaya, Lesser Himalaya and or Shivalik Himalaya.

Himalaya system gives rise to some of world's major river systems. The combined drainage basin is home to slightly less than half of world's population. The highest peak Everest is located in Nepal. Another peak K2 is on the border of Pakistan and China. Kanchenjunga is located on the border of Nepal and India. Nanda Devi is the highest peak within India.

Himalayan Orogeny

Geologically, the origin of the Himalayas is the impact of the Indian tectonic plate travelling northward at 15 cm per year to impact the Eurasian continent, about 40-50 million years ago. The formation of the Himalayan arc resulted since the lighter rock of the seabeds of that time was easily uplifted into mountains. The proof cited for this fact is that summit of Mount Everest is made of marine limestone.

Indian subcontinent was part of Gondwana and was separated from Eurasia by the Paleo-Tethys Ocean during Late Precambrian and the Paleozoic periods. Then, in the early Carboniferous, an early stage of rifting developed between the Indian continent and the Cimmerian Superterranes, which surrounded India in the Precambrian era towards north-eastern side.

During the Early Permian, this rift developed into the Neotethys Ocean. From that time on, the Cimmerian Superterranes drifted away from Gondwana towards the north. Nowadays, Iran, Afghanistan and Tibet are partly made up of these terrenes. Approximately 210 Million Years Ago, a major rifting episode split Gondwana in two parts. The Indian continent became part of East Gondwana, together with Australia and Antarctica. Later, the Indian plate broke off from Australia and Antarctica in the Early Cretaceous (130-125 Million Years Ago) with the opening of the "South Indian Ocean".

Around 85 Million Years Ago, during the Upper Cretaceous, the Indian plate began its very rapid northward drift covering a distance of about 6000 km, with the oceanic-oceanic subduction continuing until the final closure of the oceanic basin and the abduction of oceanic ophiolite onto India and the beginning of continent-continent tectonic interaction starting at about 65 Ma in the Central Himalaya.

This rapid relative speed between the Indian and Asian plates was very fast (18- 19.5 cm/yr), and it later became fast (4.5 cm/yr) at 55 Million Years Ago. Since then there has been about 2500 km of crustal shortening and rotating of India by 45° counterclockwise in North-western Himalaya to 10°-15° counterclockwise in North Central Nepal relative to Asia.

During this process, most of the oceanic crust was "simply" subducted below the Tibetan block during the northward motion of India.

But a question where the continental crust of 2500 kilometers gone, which India travelled during this period has been largely under studies. Several theories have been put forward to explain what happened, since collision, to the 2500 km of "missing continental crust".

The first mechanism says that is 2500 kilometer continental crust also got subducted below Tibet.

Second is the extrusion or escape tectonics mechanism (Molnar & Tapponnier 1975) which sees the Indian plate as an indenter that squeezed the Indochina block out of its way. The third proposed mechanism is that a large part (-1000 km (Dewey, Cande & Pitman 1989) or -800 to -1200 km] of the 2500 km of crustal shortening was accommodated by thrusting and folding of the sediments of the passive Indian margin together with the deformation of the Tibetan crust. Out of them, it is the last mechanism which explains the creation of the high topographic relief of the Himalaya.

Classification of the Himalaya System

The Indian Himalayan region (IHR) with 250-300 km across stretches over 2,500 km from Jammu & Kashmir in the west to Arunachal Pradesh in the east. This great chain of mountains in Indian territory extends all along the northern border of the country from the eastern border of Pakistan on the west to the frontiers of Myanmar in the east covering partially/fully twelve states of India, viz., Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya and hills of Assam & West Bengal. This region represents about 16.2% of total area and 3.86% of total population of India. The region is vast, rugged and versatile. It supportsremarkable cultural, ethnic and biological diversity. Multiple ethnic compositions are a striking feature of the region; more than a third of all scheduled tribes of India inhabit the region. Ethnic spectra of central and western Himalaya differ conspicuously from that of the north eastern Himalaya. The region is characterized by mountain specificities viz. inaccessibility, fragile, marginality, diversity (heterogeneity), niche (natural suitability) and adaptability. The region occupies the strategic position of entire northern boundary (North-West to North-East) of the nation and contains snow-clad peaks, glaciers of higher Himalaya and dense forest cover of mid-Himalaya.

Some scholars don't confine the extent of Himalayas between the Indus and Brahmaputra rivers and opine that Himalayas extend beyond Indus in the form ofHazara, Sulaiman, Bugati and Makaran ranges that spread up to the Arabian Sea. In the same opinion, in east, Himalayas extend till Bay of Bengal in the form of Indo-Myanmar hills, Arakan Yoma and Tenasirim ranges.

In others view, Himalayas extend from Indus in the west to beyond the Brahmaputra Gorge in the east.

The Himalaya extends like a curve of parallel ranges for nearly 2500 kilometres across southern Asia. The young fold mountains consist of a series of parallel ranges with deep valleys between them. Being young fold mountains, Himalaya has variety of rock structures, deep gorges and high pyramidal peaks. In High Himalayas the rivers have steep gradients, which result from the differential uplift of the High Himalayas. It has been suggested that a long and narrow arc of High Himalayas has been uplifted during quaternary. The classification of the Himalayan Ranges is done on three bases viz. Geographical, Regional and Geological.

Geographical Regions of Himalaya

Himalayas can be divided into several regions, which are distinct in flora and fauna also. These different regions, demarcated at various thrust and faults, make the climate of Himalayas diverse. The climate ranges from tropical at the base of the mountains to permanent ice and snow at the highest elevations. The amount of yearly rainfall increases generally from west to east along the front of the range. This diversity of climate, altitude, rainfall and soil conditions generates enormous biodiversity region making it one of the Biodiversity Hotspots of the world. Himalayas can be divided into the following ecological regions:

1. The Terai belt
2. Bhabhar belt
3. Shiwalik Hills & Inner Terai
4. Lesser Himalayas
5. Midlands
6. Greater Himalaya
7. Trans-Himalaya

Terai belt

Terai belt is the zone of sand and clay soils at the junction of northern plains and Himalayas. As the name suggests, Terai region gets higher rainfall than the plains. The speed of the Himalayan Rivers is slowed down in the Terai region and these rivers deposit fertile silt during the monsoons. The water table in this region is high and vegetation is largely savannah in a mosaic of deciduous and evergreen forests called Terai-Duar forests.

Bhabhar belt

Bhabar belt is located above the Terai belt, also sometimes known as Himalayan foothills. It is made up of porous and rocky soils that get made of the debris washed down from the higher ranges. The climate here is subtropical and vegetation is Himalayan subtropical pine forests and Himalayan subtropical broadleafforests. The Himalayan subtropical pine forests are dominated by Chir trees and Himalayan subtropical broadleafforests are dominated by the sal tree (Shorea robusta).

Shivalik Hills & Inner Terai

Shivaliks or Churia or Margalla Hills are the outermost range of foothills extending across the Himalayan region through Pakistan, India, Nepal and Bhutan. This is mainly located along a Himalayan Frontal Thrust (HFT], The vegetation here is dominated by Himalayan subtropical pine and broadleaf forests. The Inner Terai valleys are open valleys north of Shiwalik Hills or nestled between Shiwalik sub ranges. Examples include Dehra Dun in India and Chitwan in Nepal.

Lesser Himalaya

Lesser Himalaya is also known as Mahabharat Zone. The hills here range 2000 to 3000 meters and are located along the Main Boundary Thrust (MBT] fault zone. This zone is home to some of the deepest canyons in the world. The vegetation here is Himalayan subtropical forests.

Midlands

This region is located north of the Mahabharata range or Lesser Himalaya. It is located along the Main Central Thrust fault zone, where the Greater Himalaya begin. Here the vegetation is along with coniferous forests along with broadleaf forests.

Greater Himalya

The Great Himalayas which is a single range and the oldest of the three ranges with a height above 6,000 m including Mount Everest, K2 and Kanchendzonga and nine of the 14 highest peaks in the world. Greater Himalayas is located north of the Main Central Thrust Here the highest ranges rise abruptly into the realm of perpetual snow and ice. The vegetation here is Himalayan alpine shrub and meadows. The shrublands are composed of junipers as well as a wide variety of rhododendrons. They also possess a remarkable variety of wildflowers. Valley of Flowers National Park in the western Himalayan alpine shrub and meadows contains hundreds of species. The upper limit of the grasslands increases from west to east, rising from 3,500 meters to 5,500 meters.

Trans-Himalayas

The trans-Himalaya is the rain-shadow region just behind the main peaks of the towering Himalayan Mountains. Notable places of the trans-Himalayas include the Tibetan Plateau, the Ladakh area of the Northern Indian Himalayas (Indus Valley) along with the Lahaul-Kinnaur-Spiti region and in north-western Nepal the Dolpo/Dolpa, Mustang, Manang Humla and Mugu areas. The Trans-Himalayas, mainly composed of granites and volcanic rocks of Neogene and Paleogene age are bounded by the Kailas (southwest), Nganglong Kangri (north), and Nyainqentanglha (southeast) mountain ranges and by the Brahmaputra River.

Regional Divisions of Himalayas

From westto East, Himalayas have been divided into:

- The Kashmir Himalayas
- The Himachal Himalayas
- The Kumaun Himalayas
- The Central & Sikkim Himalayas
- The Arunachal Himalayas and Purvachal Himalayas

The Kashmir Himalayas

The Kashmir Himalayas has the largest number of Glaciers in India. The Ladakh region of the Kashmir Himalayas is India's Cold Desert Biosphere reserve.

A special feature of the valleys of Kashmir Himalayas is the Karewa deposits which are made up of silt, clay and sand. The Karewas are known for saffron cultivation and have orchards of fruits and dry fruits such as apple, peach, almond, and walnut. The major characters of Kashmir Himalayas are Glaciers, snow peaks, deep valleys and High Mountain passes. The important passes are Pir- Panjal, Banihal, Zoji-La, Saser-La, Chang-La, Jara-La etc.

The Himachal Himalayas

Himachal Himalayas are spread in Himachal Pradesh. The Rohtang Bara-Lacha, Shipki-La are important passes joining India and China. The valleys of Kullu, Kangra, Manali, Lahaul, Spiti are known for orchards and tourist spots.

The Kumaun Himalayas / Central Himalayas / Garhwal Himalayas

Kumaun Himalayas are located between the Sutlej and Kali rivers. They are home to India's highest peak Nanda Devi. Other peaks located in Kumaun Himalayas are Kamet, Trishul, Badrinath, Kedarnath, Dunagiri, Gangotri etc. Gangotri and Pindar are important glaciers.

Garhwal Himalaya versus Kumaon Himalaya

The western part of Kumaon Himalaya is known as Garhwal Himalayan while East as Kumaon. Geographically, Garhwal Himalaya lies between the lat. 29°31' 9" N and 31°26' 5"N and long. 77°33' 5"E and 80°6' 0"E with a total geographical area of 29,089 km.

The Sikkim (Central) Himalayas

Sikkim Himalayas are located beyond the Kali River up to the Teesta River. Most of them are located in Nepal and known as Central Himalayas. These Himalayas are home to highest peaks of Himalayas such as Everest, Kanchenjunga, Makalu, Dhaulagiri, Annapurna etc. It is characterized by very few passes. Two passes viz. Nathu La and Jelep-La are important as they connect India's Sikkim to Tibet of China.

Eastern Himalayas & Purvanchal Hills

The Eastern Himalayas occupy the Arunachal Pradesh and Bhutan. The important hills in this region are Aka Hills, Daphla Hills, Miri Hills, Mishmi Hills, Namcha Barwa etc. The Dihang and Debang passes of Arunachal Pradesh are its parts. Passing from Arunachal Pradesh, there is an eastward extension of the Himalayas in the north-eastern region of India. This is known as Purvanchal Hills. Purvanchal Hills comprises the Patkai hills, the Manipur hills, Bairal range, the Mizo hills and the Naga hills. It is a densely forested area, mainly composed of strong sandstones.

Geological Divisions of Himalayas

From a geological point of view, Himalayas can be divided into four zones. These zones are identified on the basis of age and composition of the rocks.

- Tibetan Region: This region lies north of the Greater Himalayas. Rocks in this region date back from the Palaeozoic Era to Pleistocene Epoch.
- Central or Himalayan Zone: This zone has Isoclinal folds and it includes the Greater Himalayas and some parts of Lesser Himalayas. The Isoclinal folds are essentially parallel to each other and thus approximately parallel to the axial plane. This region has abundant rocks such as granite as well as metamorphic rocks like schists and gneiss. This region also has sedimentary rocks.
- Himalayan Nappe Zone: A nappe (literally means tablecloth] is a large sheetlike body of rock that has been moved some kilometers away from its original position. Nappes form during continental plate collisions, when folds are sheared so much that they fold back over on themselves and break apart. The resulting structure is a large-scale recumbent fold. The nappes are most common in Kashmir and Kumaun Himalayas.
- Outer or Sub-Himalayan Zone: This zone includes the Siwalik range which is mainly composed of sedimentary deposits of upper tertiary period. This implies that the Shivalik hills are mainly derived from the eroded material of the main Himalayan ranges.

Important Mountain passes in Himalayas

The rugged terrain makes few routes through the mountains possible. Some of these routes include:

- Banihal is an important pass connecting the hill areas of Jammu to the Kashmir Valley. The Jawahar Tunnel (named after Pandit Jawaharlal Nehru), inaugurated in December 1956, was constructed for round-the-year surface transport
- Zoji La lies between the valley of Kashmir and the Kargil district, and is the only Western entrance to the highlands of Ladakh.
- Rohtang Pass in Himachal Pradesh, India.
- Mohan Pass is the principal pass in the Shiwalik Hills, the southernmost and geologically youngest foothills running parallel to the main Himalayas in Sikkim.
- Kora La at 4,594 meters elevation on the Nepal-Tibet border at the upper end of Mustang. The Kali Gandaki Gorge transects the main Himalaya and Transhimalayan ranges. Kora La is the lowest pass through both ranges between K2 and Everest, but some 300 metres higher than Nathula and Jelepla passes further east between Sikkim and Tibet.
- Aghill Pass: Situated to the north of K2 in the Karakoram at an elevation of5000 meters, joins Ladakh with the Xinjiang Province of China.

- Bara-Lacha: Bara-lacha la also known as Bara-lacha Pass is located in the Zanskar range connecting Lahaul district in Himachal Pradesh to Ladakh in Jammu and Kashmir, situated along the Leh-Manali highway.
- Bomdi-La: It connects Arunachal Pradesh with Lhasa, the capital of Tibet.
- Chang-La: The Changla Pass or Chang La Pass el. 5,360 m is located in Ladakh, India. It is the third highest motorable road in the world.
- Debsa Pass: Debsa Pass is a 5,360-metre (17,590 ft) high mountain pass in the Himalaya mountains between the Kullu and Spiti Districts of Himachal Pradesh.
- Dihang-Debang: Situated in the state of Arunachal Pradesh at an elevation of about 4000 feet this pass connects Arunachal Pradesh with Mandalay (Myanmar). The Dihang-Debang Biosphere reserve is located around this area.

Important Peaks of Himalayas

Eastern Himalayas versus Western Himalayas

Himalayas are also divided in terms of Eastern and Western Himalayas, the two parts which are different from each other in many ways.

The following table makes these important distinctions:

Some more observations:

- Western Himalayas are above 36°N Lat. (Mt. Godwin-Austin), and eastern Himalayas are below 28°N Lat (Kanchenjunga), Thus the 8° difference in the latitude between the two ends of the Himalayas has affected the altitude of the regional snowline so that it is lower in western Himalayas and higher in the east..
- The difference in the observed level of the snowline in western and eastern Himalayas is also due to yearly changes in the climatic conditions of the region. In the Himalayas, volume of precipitation changes from year to year, and with that the altitude at which snow falls also changes. In the years of high precipitation, often snow falls at lower altitude than the years of low precipitation.
- Himalayas are oriented east-west and their southern slopes are in direct sunshine for a larger part of the year so the snowline on the southern slopes of the ridges is higher than the northern slopes.
- Volume of precipitation decreases from the south towards the north, therefore southern ranges in eastern Himalayas have lower snowline than the northern ranges.
- Volume of precipitation increases with altitude.

The Northern Slopes and Southern Slopes of Himalayas

The Southern slopes in Himalayan region are covered with thick vegetation, while the northern slopes are generally barren. The reasons are many. The first is that Southern slopes receive more precipitation, as we all know and northern slopes in a rain shadow area. Further, the northern slopes usually receive sun rays only for a few hours during the day at a low angle. The southern slopes receive comparatively vertical rays during the middle of the day. As a result, southern slopes being warmer fall in the area of greater evapotranspiration, and that is why the vegetation is up to a higher altitude in southern slopes. Longer periods of sunshine also have an effect on the volume of snow accumulation on the southern slopes. Due to longer period of sunshine, less snow accumulates on the southern slopes than on the northern slopes. That is why; the snowline on southern slopes is lower in comparison to the northern slopes.

Great Plains

The Indo-Gangetic plains or the Great Plains are large alluvial plains dominated by three main rivers, the Indus, Ganges, and Brahmaputra. The great plains of India run parallel to the Himalayas, from Jammu and Kashmir in the west to Assam in the east, and drain most of northern and eastern India. The plains stretch 2400 kilometers from west to east and encompass an area of 700,000 km^2.

The major rivers in this region are the Ganges, Indus, and Brahmaputra along with their main tributaries- Yamuna, Chambal, Gomti, Ghaghara, Kosi, Sutlej, Ravi, Beas, Chenab, and Teesta—as well as the rivers of the Ganges Delta, such as the Meghna.The Great plain is home to nearly 1/7 of the world's population. It is bound on the north by the abruptly rising Himalayas, which feed its numerous rivers and are the source of the fertile alluvium deposited across the region by the two river systems. The southern edge of the plain is marked by the Vindhya- and Satpura Range, and the Chhota Nagpur Plateau. On the west

rises the Iranian Plateau.The Great Plains of India consists largely of alluvial deposits brought down by the rivers originating in the Himalayan and the peninsular region. The exact depth of alluvium has not yet been fully determined. As per recent estimates the average depth of alluvium in the southern side of the plain (north of Bundelkhand] varies between 1300 to 1400 meters, while towards the Shivaliks, the depth of alluvium increases. The maximum depth of alluvium has been recorded in Harvana near Ambala and Yamunanagar.

Divisions of Great Plain

Great plains are generally classified into four divisions:

The Bhabar belt

Bhabar belt is adjacent to the foothills of the Himalayas and consists of boulders and pebbles which have been carried down by the river streams. As the porosity of this belt is very high, the streams flow underground. The Bhabar is generally narrow about 7-15 km wide. Bhabar is wider in the western plains in comparison to the eastern plans of Assam. The porosity of Bhabar is so high that most of the narrow streams get disappeared in this belt only and some of them go underground. This is also one reason that it is not suitable for crops and only big trees are able to survive.

Thus, Bhabar belt is a narrow belt that is located above the Terai belt, also sometimes known as Himalayan foothills. It is made up of porous and rocky soils that get made of the debris washed down from the higher ranges. Streams disappear in this belt.

The Terai belt

The Terai belt lies next to the Bhabar region and is composed of newer alluvium. The underground streams reappear in this region. The region is excessively moist and thickly forested. It also receives heavy rainfall throughout the year and is populated with a variety of wildlife. The Terai tract lies south of the Bhabar belt. The tract is marshy and lots of mosquitoes thrive there. The Terai belt is wider in eastern side especially in the Brahmaputra valley. The high rainfall, newer alluvium makes it excessive damp and lots of forests are found here. This implies that Terai belt is rich in biodiversity. Over the period of time, the forests have been cleared in various states such as Uttarakhand, Uttar Pradesh, Haryana, Punjab, and Jammu Divisions for cultivation of crops. Terai belt is known for the good cultivation of sugar-cane, rice, wheat, maize, oilseeds, pulses, and fodder.

The Bhangar belt

This is the largest part of the Northern Plains made up of old alluvium and forms the alluvial terrace of the flood plains. The soil in this region consists of calcareous deposits called kankar. The Bangar or Bhangar belt consists of older alluvium. In the Gangetic plains, it has a low upland covered by Laterite deposits. The Bhangar formations were deposited during the middle Pleistocene Period. The Bhangar land lies above the flood limits of the rivers. The older alluvium soil is dark in colour, rich in humus content and productive. Bhangar is generally a well drained and the most productive land of the Great Plains of India.

The Khadar belt

The Khadar belt lies in lowland areas after the Bhangar belt. It is made up of fresh newer alluvium which is deposited by the rivers flowing down the plain. The Khadar tracts are enriched by fresh deposits of silt every year during the rainy season. The Khadar land consists of sand, silt, clay and mud. After Independence, most of the Khadar land has been brought under cultivation and devoted to sugarcane, rice, wheat, maize, oilseeds, legumes, and fodder crops.

The Delta Plains

The deltaic plain is an extension of the Khadar land. It covers about 1.9 lakh sq km of area in the lower reaches of the Ganga River. It is an area of deposition as the river flows in this tract sluggishly. The deltaic plain consists mainly of old mud, new mud and marsh. In the delta region, the uplands are called 'Char' while marshy areas are known as 'Bili. The delta of Ganga being an active one, is extending towards the Bay of Bengal.

Importance of Great Plains

The Indo-Gangetic belt is the world's most extensive expanse of uninterrupted alluvium formed by the deposition of silt by the numerous rivers. The plains are flat and mostly treeless, making it conducive for irrigation through canals. The area is also rich in ground water sources. The plains are the world's most intensely farmed areas. The main crops grown are rice and wheat, which are grown in rotation. Others include maize, sugarcane and cotton. The Indo-Gangetic plains rank among the world's most densely populated areas. The Great Plains of India are covered with one of the most productive soils of the world. Its soils have the capacity to grow any crop of the tropical and temperate regions. The plains are often termed as the 'Granary of

India'. Most of the rivers traversing the Northern Plains of India are perennial in nature. A number of canals have been carved out of these rivers which make agriculture more remunerative and sustainable. The water table is high and suitable for tube well irrigation. The gentle gradient makes it navigable over long distances.

The Thar Desert

Thar Desert or Great Indian Desert is the world's ninth largest desert. It forms a significant portion of western India and covers an area of about 200,000 km^2 to about 238,700 km^2. In Pakistan is continues as Cholistan Desert. Most of the Thar Desert is situated in Rajasthan, covering 61% of geographic area of Raiasthan. About 10 percent of this region comprises sand dunes, and the remaining 90 percent consist of craggy rock forms, compacted salt-lake bottoms, and interdunal and fixed dune areas. Annual temperatures can range from 0°C in the winter to over 50°C during the summer. Most of the rainfall received in this region is associated with the short July-September southwest monsoon thatbrings around 100-500 mm of precipitation. Water is scarce and occurs at great depths, ranging from 30 to 120 m below the ground level. Rainfall is precarious and erratic, ranging from below 120 mm in the extreme west to 375 mm eastward. The soils of the arid region are generally sandy to sandy-loam in texture. The consistency and depth vary as per the topographical features. The low-lying loams are heavier and may have a hard pan of clay, calcium carbonate or gypsum.

Origin of Thar Desert

The origin of the Thar Desert is a controversial subject. Some consider it to be 4000 to 10,000 years old, whereas others state that aridity started in this region much earlier. Another theory states that area turned to desert relatively recently: perhaps around 2000 - 1500 BC. Around this time the Ghaggar-Hakra ceased to be a major river. It now terminates in the desert but at one time was a water source for the Indus Valley Civilization centre of Mohenjodaro.

It has been observed through remote sensing techniques that Late Quaternary climatic changes and neotectonics have played a significant role in modifying the drainage courses in this part and a large number of palaeochannels exist Most studies did not share the opinion that the palaeochannels of the Sarasvati River coincide with the bed of the present-day Ghaggar and believe that the Sutlej along with the Yamuna once flowed into the present riverbed. It has been postulated that the Sutlej was the main tributary of the Ghaggar and that subsequently the tectonic movements might have forced the Sutlej westwards, the Yamuna eastwards and thus dried up the Ghaggar-Hakra. Studies on Kalibangan in the desert region by Robert Raikes indicate that it was abandoned because the river dried up. Prof. B. B. Lai (retd. Director General of Archaeological Survey of India) supports this view by asserting: "Radiocarbon dating indicates that the Mature Harappan settlement at Kalibangan had to be abandoned around 2000-1900 BCE.

And, as the hydrological evidence indicates, this abandonment took place on account of the drying up of the Ghaggar-Hakra. This latter part is duly established by the work of Raikes, an Italian hydrologist, and of his Indian collaborators", (source: wikipedia)

Peninsular India

The Peninsular India comprises the diverse topological and climatic patterns of South India. The Peninsula is in shape of a vast inverted triangle, bounded on the west by the Arabian Sea, on the east by the Bay of Bengal and on the north by the Vindhva and Satpura ranges. The line created by the Narmada River and Mahanadi river is the traditional boundary between northern and southern India. Covering an area of about 16 Lakh km^2, the peninsular upland forms the largest physiographic division of India. It is bounded by the Aravallis in the North West, Hazaribagh and Rajmahal Mis in the northeast, the Western Ghats (Sahayadri Mountains) in the west and the Eastern Ghats in the east.

- The highest peak of Peninsular India is Anamudi that is 2695 metres above sea level.

The narrow strip of verdant land between the Western Ghats and the Arabian Sea is the Konkan region; the term encompasses the area south of the Narmada as far as Goa. The Western Ghats continue south, forming the Malnad (Canara) region along the Karnataka coast, and terminate at the Nilgiri mountains, an inward (easterly) extension of the Western Ghats. The Nilgiris run in a crescent approximately along the borders of Tamil Nadu with northern Kerala and Karnataka, encompassing the Palakkad and Wayanad hills, and the Satyamangalam ranges, and extending on to the relatively low-lying hills of the Eastern Ghats,

on the western portion of the Tamil Nadu-Andhra Pradesh border. The Tirupati and Anaimalai hills form part of this range.

The Deccan plateau, covering the major portion of the states of Maharashtra, Karnataka and Tamil Nadu, is the vast elevated region bound by the C-shape defined by all these mountain ranges. No major elevations border the plateau to the east, and it slopes gently from the Western Ghats to the eastern coast.

The Peninsular India can be divided into following:

A. Central Highlands
B. Deccan Plateau
C. Western Ghats or Sahayadri
D. The Eastern Ghats

Central Highlands

The northern central highlands of peninsular India include the Aravallis, the Malwa Plateau, and some parts of Vindhyan Range.

Aravallis :

Aravallis Range literally meaning 'line of peaks' running approximately 800 km from northeast to southwest across states of Rajasthan. Harvana. and Gujarat and Pakistan's provinces of Punjab and Sindh. The northern end of the range continues as isolated hills and rocky ridges into Haryana state, ending in Delhi. The famous Delhi Ridge is the last leg of the Aravalli Range, which traverses through South Delhi and terminates into Central Delhi. The southern end is at Palanpur near Ahmadabad. Gujarat. The highest peak is Guru Shikhar in Mount Abu. Rising to 1722 meters, it lies near the southwestern extremity of the range, close to the border with the Gujarat. The city of Udaipur with its lakes lies on the south slope of the range in Rajasthan. Numerous rivers arises amidst the ranges including, Banas River, Luni River, Sakhi, Sabarmati River. The Great Boundary Fault fGBF! separates the Aravallis from the Vindhvan Mountains.

Origin of Aravallis:

The Aravallis Range is the eroded stub of a range of ancient folded mountains that rose in a Precambrian event called the Aravalli-Delhi Orogeny. The range joins two of the ancient segments that make up the Indian craton, the Marwar segment to the northwest of the range, and the Bundelkhand segment to the southeast. It has been postulated that the Aravalli peaks were extremely high once but since have worn down almost completely by millions of years of weathering. In stark contrast Himalayas are continuously rising young fold mountains of today. Aravallis is rich in mineral resources. The erosion of Aravalli has a great concern for the environment because the ranges from a natural barrier against the spread of the Thar desert northwards into the Gangetic plains in the Gangetic basin and Gujarat.

Malwa Plateau

The Malwa region occupies a plateau in western Madhya Pradesh and south-eastern Rajasthan with Gujarat in the west.

- The region includes the Madhya Pradesh districts of Dewas, Dhar, Indore, Jhabua, Mandsaur, Neemuch, Rajgarh, Ratlam, Shajapur, Ujjain, and parts of Guna and Sehore.
- Rajasthan districts of Jhalawar and parts of Banswara and Chittorgarh.
- The plateau is bound in north-east by the Hadoti region, in the north-west by the Mewar region, in the west by the Vagad region and Gujarat. To the south and east is the Vindhya Range and to the north is the Bundelkhand upland. The average elevation of the plateau is 450-500 m.

The western part of the Malwa Plateau is drained by the Mahi River, while the Chambal River drains the central part, and the Betwa River and the headwaters of the Dhasan and Ken rivers drain the east. The Shipra River is of historical importance because of the Simhasth mela, held every 12 years. Other notable rivers are Parbati, Gambhir and Choti Kali Sindh.

- The Vindhya Range marks the southern boundary of the plateau, and is the source of many rivers of the region.

Vegetation in the Malwa Plateau is tropical dry forest, with scattered teak [Tectona grandis] forests. The other main trees are Butea, Bombax, Anogeissus, Acacia, Buchanania and Boswellia. The shrubs or small trees include species of Grewia, Ziziphus mauritiana, Casearia, Prosopis, Capparis, Woodfordia, Phyllanthus, and Carissa. The Malwa plateau is considered to be an extension of the Deccan Traps and was formed at the end of Cretaceous period. Black. Brown and Bhtatori or stony soil is abundant in the Malwa Plateau. The black soil requires less irrigation because of its high capacity for moisture retention. The other two soil types are lighter and have a higher proportion of sand.

Vindhyan Range

The Vindhyan range is bounded by the Central Highlands on the south and the Aravalis on the northwest. It extends from Jobat (Gujarat] and Chittorgarh (Rajasthan] to Sasaram in Bihar for about 1050 km with general elevation between 450 to 600 metres. The western end of the Vindhyan range is in Gujarat at the eastern side of the Gujarat peninsula, near the border with Rajasthan and Madhya Pradesh. Reaching the sub-continent proper, the range runs east and north nearly to the Ganges River at Mirzapur. The area to the north and west of the range are arid and inhospitable, located in the shadow of both the Vindhya and the higher Aravalli range to the south blocking the prevailing winds.

The southern slopes of the Vindhyan Range are drained by the Narmada River, which proceeds westward to the Arabian Sea in the wide valley between the Vindhya Range and the parallel Satpura Range farther to the south. The northern slopes of the range are drained by tributaries of the Ganges, including the Kali Sindh, Parbati, Betwa, & Ken (both are tributary of the Yamuna,), Son & Tamsa or Tons both are tributary of the Ganges, drains the southern slopes of the range at its eastern end.

Vindhyachal Plateau

The Vindhyachal plateau lies to the north of the central part of the range. The cities of Bhopal, the capital of Madhya Pradesh, and Indore lie on this plateau, which rises higher than the Indo-Gangetic plain to its north.

Satpura Range

The Satpura range parallels the Vindhya Range to the north, and these two east-west ranges divide Indian Subcontinent into the Indo-Gangetic plain of northern India and the Deccan Plateau of the south. Satpura range rises in eastern Gujarat state near the Arabian Sea coast, running east through the border of Maharashtra and Madhya Pradesh to the east till Chhattisgarh.

- The Narmada River originates from north-eastern end of Satpura & runs in the depression between the Satpura and Vindhya ranges, draining the northern slope of the Satpura range and southern slopes of Vindhyan range, running west towards the Arabian Sea.
- The Tapti River originates from eastern-central part of Satpura, crosses the range in the center & further runs at the southern slopes of Satpura towards west meeting the Arabian Sea at Surat, draining central & the southern slopes of the Satpura Range.
- Please note that Mount Dhupgarh or Dhoopgarh is the highest point in the Satpura Range and in Madhya Pradesh, India. Located near Pachmarhi, it has an elevation of 1,350 metres.

The Chhotanagpur Plateau

Chhotanagpur Plateau covers much of Jharkhand state. It also covers the adjacent parts of Odisha, West Bengal, Bihar and Chhattisgarh. The Indo-Gangetic plain lies to the north and east of the plateau, and the basin of the Mahanadi River lies to the south. The total area of the Chhotanagpur Plateau is approximately 65,000 square kilometres. This Plateau consists of three steps. The highest step is in the western part of the plateau, ranging from 3,000 -3500 feet. The next part contains larger portions of the old Ranchi and Hazaribagh districts and some parts of old Palamu district, before these were broken up into smaller administrative units. The general height is 2,000 feet. The lowest step of the plateau is at an average level of around 1,000 feet, covering the old Manbhum and Singhbhum districts.

The Chhotanagpur Plateau is composed of Archaean granite and gneiss rocks with patches of Dharwar and Damuda series of the Gondwana Period, and the lava flow of the Cretaceous Period. The western higher plateau of the Chhotanagpur Plateau is called Pat region. It is believed to be composed of Deccan lava. The largest part of the Chhotanagpur Plateau is called Ranchi Plateau. Damodar River originates here and flows through a rift valley. Damodar basin forms a trough between the Ranchi and Hazaribagh plateaus resulting from enormous fractures at their present edges, which caused the land between to sink to a great depth and incidentally preserved from denudation the Karanpura, Ramgarh and Bokaro coalfields. The plateau is covered with a variety tropical and subtropical dry broadleaf forests of which Sal forest is predominant. The plateau is home to the Palamau Tiger Reserve. Chhotanagpur plateau is a store house of minerals like mica, bauxite, copper, limestone, iron ore and coal. The Damodar valley is rich in coal and it is considered as the prime centre of coking coal in the country. Massive coal deposits are found in the central basin spreading over 2,883 km2. The important

coalfields in the basin are Jharia, Raniganj, West Bokaro, EastBokaro, Ramgarh, South Karanpura and North Karanpura.

Karbi-Meghalya plateau

Karbi-Meghalya plateau is in fact an extension of the main Indian peninsular plateau and are originally two different plateaus - Karbi Anglong plateau and Meghalya plateau. It is believed that due to the force exerted by the north-eastwardly movement of the Indian plate at the time of the Himalayan origin, a huge fault was created between the Rajmahal hills and the Karbi-Meghalaya plateau. Later, this depression was filled up by the depositional activity of numerous rivers. Today the Maghalaya and Karbi Anglong plateau remains detached from the main Peninsular block. This area receives maximum rainfall from the South-West monsoon.

Deccan Plateau

The Deccan Plateau covers the majority of the southern part of the country. It is located between three mountain ranges and extends over eight Indian states. The plateau covers 4,22,000 sq. km., 43 percent of India's landmass. On the west of the plateau are the Western Ghats and in the east are the Eastern Ghats. These mountain ranges rise from their respective nearby coastal plains and nearly meet at the southern tip of India. The mountains make the southward-pointing vertex of a triangle. The northern boundary of the triangle is made up by the Satpura Range and Vindhyan Range. These northern ranges separate the plateau from the heavily populated riverine plains of northern India.

Important Observations:

- This Plateau makes up a triangle nested within the familiar downward-pointing triangle of the Indian sub-continent's coastline.
- In the south, the plateau is mostly over 1,000 metres above sea level. In the north it is mostly about 500 m above sea level. The Deccan Plateau is higher in the west and slopes gently eastwards. This would imply that most Deccan plateau rivers flow from west to east. The rivers flowing through the Deccan plateau have cut deep valleys and divided the plateau into several smaller plateus such as the Maharastra Plateau, Andhra Plateau and Karnataka Plateau, f^ The plateau is very big and there are many habitats: different Ecosystems with different sorts of vegetation, climate, geology and animals. The forests on the plateau are older than the Himalayan mountains.
- The Western Ghats mountain range is tall and blocks the moisture from the southwest monsoon from reaching the Deccan Plateau, this is the reason that the Deccan Plateau region receives very little rainfall,
- The Godavari River and its tributaries, including the Indravati River, drain most of the northern portion of the plateau, rising in the Western Ghats and flowing east towards the Bay of Bengal. The Tungabhadra River, Krishna River and its tributaries, including the Bhima River, which also run from west to east, drain the central portion of the plateau.
- The southernmost portion of the plateau is drained by the Kaveri River, which rises in the Western Ghats of Karnataka and bends south to break through the Nilgiri Hills at Hogenakal Falls into Tamil Nadu, then forming the Sivasamudram Falls at the island town of Shivanasamudra, the second-biggest waterfall in India and the sixteenth-largest in the world, before flowing into the Stanley Reservoir and the Mettur Dam that created the reservoir and finally emptying into the Bay of Bengal.
- The two main rivers which do not flow into the Bay Of Bengal are the Narmada and Tapti. They start in the Eastern Ghats and flow into the Arabian Sea.
- All Deccan plateau rivers depend on the rains and dry up in the summers.

Western Ghats

The Western Ghats or Sahyadri runs north to south along the western edge of the Deccan Plateau, and separates the plateau from a narrow coastal plain along the Arabian Sea. The range starts near the border of Gujarat and Maharashtra, south of the Tapti River, and runs approximately 1600 km through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala ending at Kanyakumari, at the southern tip of India. These hills cover 160,000 km^2 and form the catchment area for complex riverine drainage systems that drain almost 40% of India. The average elevation is around 1,200-1300 metres. Observations about Western Ghats

- In India, there are two biodiversity hotspots viz. Eastern Himalayas and Western Ghats. Western Ghats are home to over 5000 species of flowering

plants, 139 mammal species, 508 bird species and 179 amphibian species, many undiscovered species lives. At least 325 globally threatened species occur in the Western Ghats.

- The mountains of the Western Ghats are Block Mountains formed due to the down warping of a part of land into the Arabian Sea. As per other view, they are not true mountains, but are the faulted edge of the Deccan Plateau.
- All the important rivers of Peninsular India, like the Godavari, Krishna and Kaveri rise from the Western Ghats.
- Western Ghats are home to many hill stations like Matheran, Lonavala-Khandala, Mahabaleshwar, Panchgani, Amboli Ghat, Kudremukh and Kodagu.
- The range is called
  - Sahyadri in northern Maharashtra
  - Sahya Parvatam in Kerala
  - Nilagiri Malai in Tamil Nadu
- The confluence of the Eastern and the Western Ghats is at Biligirirangan Hills in Karnataka.
- Anamudi 2,695 metres in Kerala the highest peak in Western Ghats. Chembra Peak 2,100 metres, Banasura Peak 2,073 metres, Vellarimala 2,200 metres and Agasthya mala 1,868 metres are also in Kerala. Mullayanagiri is the highestpeakin Karnataka 1,950 meters.
- The smaller ranges of the Western Ghats include the Cardamom Hills and the Nilgiri Hills. Cardamom hills are located in southeast Kerala and southwest Tamil Nadu. They cover about 2,800 km^2 of mountainous terrain with deep valleys, and includes the drainages of the west flowing Periyar, Mullayar and Pamba rivers. It includes Idukki Dam and Mullaperiyar Dam. They conjoin the Anaimalai Hills to the northwest, the Palni Hills to the northeast and the Agasthyamalai Hills to the south as far as the Ariankavu pass. The crest of the hills form the boundary between Kerala and Tamil Nadu. Anamudi is also located in Cardamom Hills.
- The Nilgiri Hills are home to the hill station Ooty. In the southern part of the range in the Anaimalai Hills, in western Tamil Nadu and Kerala.
- The major gaps in the range are the Goa Gap, between the Maharashtra and Karnataka sections, and the Palghat Gap on the Tamil Nadu/Kerala border between the Nilgiri Hills and the Anaimalai Hills.
- The northern portion of the narrow coastal plain between the Western Ghats and the Arabian Sea is known as the Konkan Coast or simply Konkan, the central portion is called Kanara and the southern portion is called Malabar region or the Malabar Coast.
- The foothill region east of the Ghats in Maharashtra is known as Desh, while the eastern foothills of the central Karnataka state is known as Malenadu. The largest city within the mountains is the Pune in the Desh region on the eastern edge of the range.
- The mountains intercept the rain-bearing westerly monsoon winds, and are consequently an area of high rainfall, particularly on their western side. The dense forests also contribute to the precipitation of the area by acting as a substrate for condensation of moist rising orographic winds from the sea, and releasing much of the moisture back into the air via transpiration, allowing it to later condense and fall again as rain. The Jog Falls in Karnataka, one of the most spectacular waterfalls in India are located in Western Ghats.
- The climate is humid and tropical in the lower reaches tempered by the proximity to the sea. Elevations of 1,500 m and above in the north and 2,000 m and above in the south have a more temperate climate. Average annual temperature here is around 15 °C. In some parts frost is common, and temperatures touch the freezing point during the winter months. Mean temperature range from 20°C in the south to 24 °C in the north. It has also been observed that the coldest periods in the south western ghats coincide with the wettest.
- During the monsoon season between June and September, the unbroken Western Ghats chain acts as a barrier to the moisture laden clouds. The heavy, eastward-moving rain-bearing clouds are forced to rise and in the process deposit most of their rain on the windward side. Rainfall in this region averages 3,000- 4,000 mm. The eastern region of the Western Ghats which lie in the rain shadow, receive far less rainfall averaging about

1,000 mm bringing the average rainfall figure to 2,500 mm.

- The vegetation in Western Ghats is tropical and subtropical moist broadleaf forest ecoregions. The northern portion of the range is generally drier than the southern portion, and at lower elevations makes up the North Western Ghats moist deciduous forests ecoregions, with mostly deciduous forests made up predominantly of teak. Above 1,000 meters elevation are the cooler and wetter North Western Ghats Montane rain forests, whose evergreen forests are characterized by trees of family Lauraceae.
- The evergreen Wayanad forests of Kerala mark the transition zone between the northern and southern ecoregions of the Western Ghats. The southern ecoregions are generally wetter and more species-rich. At lower elevations are the South Western Ghats moist deciduous forests. The moist forests transition to the drier South Deccan Plateau dry deciduous forests, which lie in its rain shadow to the east.
- Above 1,000 meters are the South Western Ghats montane rain forests, also cooler and wetter than the surrounding lowland forests, and dominated by evergreen trees, although some montane grasslands and stunted forests can be found at the highest elevations.
- The South Western Ghats montane rain forests are the most species-rich ecoregion in peninsular India; eighty percent of the flowering plant species of the entire Western Ghats range are found in this ecoregion.
- The forest in the Western Ghats has been severely fragmented due to human activities, especially clear felling for tea, coffee, and teak plantations during I860 to 1950.
- Species that are rare, endemic and habitat specialists are more adversely affected and tend to be lost faster than other species. Complex and species rich habitats like the tropical rainforest are much more adversely affected than other habitats. The area is ecologically sensitive to development. Though this area covers barely five percent of India's land, 27% of all species of higher plants in India (4,000 of 15,000 species) are found here. Almost 1,800 of these are endemic to the region. The range is home to at least 84 amphibian species, 16 bird species, seven mammals, and 1,600 flowering plants which are not found elsewhere in the world.
- Western Ghats is home to India's 2 biosphere reserves. 13 National parks, several wildlife sanctuaries and many Reserve Forests.
- The Nilgiri Biosphere Reserve comprising 5500 km^2 of the evergreen forests of Nagarahole, deciduous forests of Bandipur National Park and Nugu in Karnataka and adjoining regions of Wayanad and Mudumalai National Park in the states of Kerala and Tamil Nadu forms the largest contiguous protected area in the Western Ghats.
- The Silent Valley National Park in Kerala is among the last tracts of virgin tropical evergreen forest in India.
- A critically endangered mammal of the Western Ghats is the nocturnal Malabar Large-spotted Civet. The arboreal Lion-tailed Macaque is endangered. Only 2500 of this species are remaining. The largest population of Lion Tailed Macaque is in Silent Valley National Park. Kudremukh National Park also protects a viable population.
- These hill ranges serve as important wildlife corridors, allowing seasonal migration of endangered Asian Elephants.
- The Nilgiri Bio-sphere is home to the largest population of Asian Elephants and forms an important Project Elephant and Project Tiger reserve. Brahmagiri and Pushpagiri wildlife sanctuaries are important elephant habitats. Karnataka's Ghat areas hold over six thousand elephants (as of 2004] and ten percent of India's critically endangered tiger population.

Eastern Ghats

Eastern Ghats or Purbaghata are a discontinuous range of mountains along India's eastern coast. They run from West Bengal through Orissa and Andhra Pradesh to Tamil Nadu in the south passing some parts of Karnataka. They are eroded and cut through by the four major rivers of southern India, the Godavari, Mahanadi, Krishna, and Kaveri. The mountain ranges run parallel to the Bay of Bengal. The Deccan Plateau lies to the west of the range, between the Eastern Ghats and Western Ghats.

The Eastern Ghats are not as high as the Western Ghats. The climate of the higher hill ranges is generally

cooler and wetter than the surrounding plains and the hills are home to coffee plantations and enclaves of dry forest The Bilgiri Hills, which run east from the Western Ghats to the River Kaveri, forms a forested ecological corridor that connects the Eastern and Western Ghats, and allows the second-largest wild elephant population in India to range between the South Eastern Ghats, the Biligiri and Nilgiri Hills, and the South Western Ghats. The famous temple Malai Mahadeshwara Hills Temple is situauted in Chamarajanagar District in the Karnataka state on the Eastern Ghat.

Some other Observations

- lindhagada is the highest mountain in the Eastern Ghats situated in Araku. district Vishakapatnam in Andhra Pradesh.
- The region boasts of fertile soil but hydropower generation here is not as profitable as it is in the Western Ghats.
- Eastern Ghats are older than the Western Ghats, and have a complex geologic history, related to the assembly and break-up of the ancient supercontinent of Rodinia and the assembly of the Gondwana supercontinent.
- The Eastern Ghats is the homeland for many Buddhist ruins from Orissa to south andhra.
- The Eastern Ghats harbour primarily tropical moist deciduous vegetation, which represents species of high economic, timber, medicinal potential. Eastern Ghats are highly significant in terms of its biodiversity. Of the estimated 3,200 flowering plant taxa, there are about
- 528 tree taxa under 271 genera belonging to 80 families distributed in different regions of Eastern Ghats. In total 454 species under 243 genera and 78 families are endemic to Eastern Ghats.
- Based on geological and tectonic considerations, the Eastern Ghats in Orissa starts from North of Similipal in Mayurbhanj district and runs through Malkangiri.
- Seventeen districts of Orissa come under the Eastern Ghats including 14 protected areas (13 wild life sanctuaries, one Biosphere reserve, one National Park, two tiger reserve and one Ramser Wetland],

Important Observations: Mountains, Hills and Hill Ranges of India

Mount Abu

- Highest peak in the Aravalli Range
- Located in Sirohi district, Rajasthan.
- Highest peak on the mountain is Guru Shikhar, at 1,722 metres
- Ancient name of Mount Abu is "Arbudaanchal"
- Only hill station in Rajasthan
- Mount Abu Wildlife Sanctuary was established in 1960 and covers 290 km^2 of the mountain. S Mount Abu is home to a number of Jain temples. The Dilwara Temples are a complex of temples, carved of white marble, that were built between the 11th and 13th centuries AD. The oldest of these is the Vimal Vasahi temple, built in 1021 AD by Vimal Shah and dedicated to the first of the Jain Tirthankaras.
- Home to famous Nakki Lake.
- The Achalgarh fort, built in the 14th century by Rana Kumbha of Mewar, stands nearby. It encloses several Jain temples
- Location of Madhuban which is the headquarters of the Brahma Kumaris World Spiritual University.

Cardamom Hills

- Part of the southern Western Ghats located in southeast Kerala and southwest Tamil Nadu.
- Name comes from the cardamom spice grown in much of the hill's cool elevation, which also grows pepper and coffee.
- Home to drainages of the west flowing Periyar, Mullakudy and Pamba rivers. It includes Idukki Dam and Mullaperiyar Dam.
- They conjoin the Anaimalai Hills to the northwest, the Palni Hills to the northeast and the Agasthyamalai Hills to the south as far as the Ariankavu pass. The highest peak in the range is Anamudi, with a height of 2,695 metres.
- The central part of the hills comprises the Periyar Wildlife Sanctuary covering an area of 777 km^2. The 350 km^2 core zone of the sanctuary is the Periyar National Park and Tiger Reserve. Periyar is a major ecotourism destination.

Anamudi

- Located in Kerala, Highest peak of western Ghats and also in south India. S Elevation 2695 meters.
- Anamudi literally translates to "elephants forehead," a reference to the resemblance of the mountain to an elephant's head.
- Highest point in India outside the Himalaya-Karakoram mountain range.

Anginda peak

- Anginda peak is in the Nilgiri Hills of the Western Ghats in Kerala.
- Highest peak in Silent Valley National Park.

Phawngpui

- Phawngpui or the Blue Mountain of Mizoram is a highly revered peak, considered to be the abode of the Gods.
- Phawngpui Peak is the highest mountain peak in Mizoram (2165 metres)
- Famous for orchids and rhododendrons.

Doddabetta

- Doddabetta is highest mountain in the Nilgiri Hills, at2637 metre.

Kangchenjunga

- Kangchenjunga is the third highest mountain of the world with an elevation of 8,586 m.
- Located along the India-Nepal border in the Himalayas.
- Kangchenjunga is also the name of the section of the Himalayas and means "The Five Treasures of Snows", as it contains five peaks, four of them over 8,450 m
- The treasures represent the five repositories of God, which are gold, silver, gems, grain, and holy books.
- Until 1852, Kangchenjunga was assumed to be the highest mountain in the world, but calculations made by the Great Trigonometric Survey of India in 1849 came to the conclusion that Mount Everest (known as Peak XV at the time) was the highest and Kangchenjunga the third-highest

Nanda Devi

- Second highest mountain in India and highest entirely within the country.
- Part of the Garhwal Himalayas, and is located in the state of Uttarakhand, between the Rishiganga valley on the west and the Goriganga valley on the east.
- Peak is regarded as the patron-goddess of the Uttarakhand Himalaya.

Garo Hills

- Part of the Garo-Khasi range in Meghalaya, India.It is one of the wettest places in the world. The range is part of the Meghalaya subtropical forests ecoregion.
- Two mountain ranges - the Arabella range and the Tura range, pass through the Garo Hills, forming the great Balpakram valley in between.
- Largest town Tura.
- Shillong also located in Garo Hills. Khasi Hills
- Khasi Hills are part of the Garo-Khasi range in the Indian state of Meghalaya, and is part of the Patkai range and of the Meghalaya subtropical forests ecoregion.

Jaintia Hills

- Tribal region located in HImalaya.
- Home to Monolith in Nartiang which is touted as one of the tallest monolith in the world.

Mizo Hills

- Lushai Hills (or Mizo Hills) are part of the Patkai range in Mizoram and partially in Tripura, India.

Naga Hills

- Located on India Myanmar border,
- Naga hills, reaching a height of around 3825 metres, lie on the border of India and Burma (Myanmar). These hills are part of a complex mountain system, and the parts of the mountain ranges inside the Indian state of Nagaland and the Burmese region of Sagaing are called the Naga Hills.
- In British India, the major part of the hills came under the Naga Hills district.
- The hills, due to their complexity and position form a barrier between the two countries. The Naga Hills are part of the Arakan Range (Rahkine Range) which to the north rise to 12,552feet.

Palni Hills

- Palni Hills or Palani Hills are in Tamil Nadu.
- They are eastward extension of the Western Ghats ranges, which run parallel to the west coast of India.

- Home to one of the shrines of Lord Karthikeyan or Murugan.

Patkai Hills

- Located on India's North Eastern border with Burma.
- Mawsynram and Cherrapunji, on the windward side of these hills are the world's wettest places, having the highest annual rainfall.
- Climate ranges from temperate to alpine due to altitude.

Shivalik Hills

- Was known as Manak Parbat in ancient times.
- Also known as Churia andMargalla hills.
- Southernmost and geologically youngest east-west mountain chain of the Himalayas ranging from Indus to Brahamputra.
- Chiefly composed of sandstone and conglomerate rock formations, which are the solidified detritus of the great range in their rear, but often poorly consolidated.
- Bounded on the south by a fault system called the Main Frontal Thrust, with steeper slopes on that side.
- Sivapithecus or Ramapithecus is among many fossil finds in the Siwalik region.
- The Siwalik Hills are also among the richest fossil sites for large animals anywhere in Asia.

Zanskar Range

- Located in Jammu & Kashmir of India, seperates Zanskar from Ladakh.
- Geologically, the Zanskar Range is part of the Tethys Himalaya, an approximately 100-km-wide synclinorium formed by strongly folded and imbricated, weakly metamorphosed sedimentary series.
- The average height of the Zanskar Range is about 6,000 m (19,700ft). S Its eastern part is known as Rupshu.

20. RIVERS OF INDIA & MULTI-PURPOSE PROJECTS

- On the basis of origin, Indian rivers are divided into (A) Himalayan Rivers and (B) Peninsular Rivers.

A. HIMALAYAN RIVERS

- Himalayan Rivers are examples of antecedent rivers, they have carried out the erosional activity throughout the evolution of Himalayas and have formed gorges. These rivers are still young and engaged in erosional activities.
- Himalayan Rivers can be divided into three main river-systems-Indus system, Ganga-system and Brahmaputra systers.

Indus River System

- Indus along with its tributaries forms one of the largest drainage systems of the world.
- Indus river enters India at damchok (Changla Pass) elevation of 4206m and continues to flow in the north-west direction between the Ladakh and the Zaskar Ranges.
- Just above Mithankot, it receives accumulated waters of Panjnad–Jhelum, Chenab, Ravi, Beas and Satluj.
- Finally, it empties itself in the Arabian Sea, making a big delta.

The Jhelum

- It rises in a spring at Verinag.
- At Muzaffarabad, the river takes a sharp hairpin swing southward and the Kishanganga joins it on its rightbanks.
- Thereafter, it forms the Indian-Pakistan boundary for 170 km.
- It joins the Chenab at Jhang.

The Chenab

- It originates from near the Bara Lacha Pass in the Lahul-Spiti part of the Zaskar Range. The united stream-Chandra and Bhaga-called the Chandrabhaga flows in the north-west direction through Himachal Pradesh and enters Jammu & Kashmir as Chenab.
- It receives waters of Jhelum and Ravi rivers.

The Ravi

- It originates from Kullu hills near the Rohtang Pass in Himachal Pradesh.
- It cuts a deep gorge in the Dhaola Dhar range after crossing Chamba.
- It enters Punjab Plains near Madhopur and later enters Pakistan 26 km below Amritsar.
- It debouches into the Chenab a little above Rangpur.

The Beas

- It also originates near Rohtang Pass, close to the source of the Ravi.
- It debouches on the plain near Pong and meets the Satluj river at Harike.
- It lies entirely within the Indian territory.

The Satluj

- It rises from the Manasarovar – Rakas Lake near Darma Pass.
- It enters the plain at Rupnagar (Ropar).
- It is joined by the Beas at Harike.
- From Ferozepur to Fazilka, it forms the boundary between India and Pakistan for nearly 120 km.

The Ganga River System

- It originates as Bhagirathi from the Gangotri glacier.
- Alaknanda from Satopant glaciar joins it at Devaprayag. Pindar river joins it at Karan Prayag and Mandakini or Kali Ganga at Rudra Prayag.
- The combined water of the Bhagirathi and the Alaknanda flows in the name of the Ganga, below Devprayag.
- It debouches on plain from hills in Haridwar.
- It is joined by Yamuna in Allahabad.
- Beyond Farakka, it is known as Padma in Bangladesh.
- It bifurcates itseif into Bhagirathi-Hooghly in West Bengal and Padma-Meghna in Bangladesh.
- The Brahmaputra as the Jamuna joins it at Goalundo.

The Yamuna

- It is the largest and the most important tributary of the Ganga.
- It originates from the Yamunotri glacier on the Bandarpunch Peak in Garhwal in Uttaranchal.

The Chambal

- It rises near Mhow in (M.P).
- It joins Yamuna in Etawah district of Uttar Pradesh.
- Banas joins it near Sawai Madhopur.
- Betwa, rising in Bhopal, joins the Yamuna near Hamipur. Dhasan is also a tributary.

The Son

- The Son river springs from the Amarkantak Plateau.
- It joins the Ganga near Danapur at Patna district in Bihar.

The Damodar

- It rises in the hills of the Chotanagpur plateau and flows through a rift valley.
- It is also called 'Sorrow of Bengal'.
- It joins the Hugli 48 km below Kolkata.

The Ramganga

- It rises in the Garhwal district of Uttaranchal.
- It joins the Ganga at Kannauj

The Ghaghra

- It originates near the Gurla Mandhota peak, south of Manasarovar in Tibet.
- It joins Ganga a few kilometres downstream of Chapra in Bihar.

The Kali

- It originates from Milan Glacier as Gori Ganga in Nepal.
- It forms the boundary between Nepal and Kumaon.
- It is known as the Sarda or Chauka after it reaches the plains near Tanakpur.
- In Barabanki (UP) it joined Ghaghra.

The Gandak

- It originates near the Tibet-Nepal border.
- it joint Ganga at Sonpur (Patna)

The Kosi

- The Kosi river consists of seven streams.
- Seven rivers mingle with each other to form three streams named the Tumar, Arun and Sun Kosi.
- Then all three streams unite at Triveni to the north of the Mahabharat Range to form the Kosi.

The Brahmaputra River System

- The Brahmaputra rises in the great chemayungdung glacier in the Kailas range.
- It is known as Tsangpo in Tibet.
- It turns suddenly south and south-west near Namcha Barwa.
- It emerges from the foothills under the name of Siang and the the Dihang in Arunchal Pradesh.
- Near Dhubari it enters Bangladesh as Jamuna and meets Padma at Goalundo.
- Majuli is the river island of the river Brahmaputra (area – 1250 sq km).
- National waterways – 2 is on the Brahmaputra river from sadiya to Dhubri.

The Peninsular River System

- Three main directions of flow:
- Mahanadi, Godavari, Krishna, Cauvery and several smaller rivers draining south-east into the Bay of bengal.
- The Narmada and the Tapi flowing west as well as several small rivers originating from the Western Ghats flow westwards into the Arabian Sea.
- Tributaries of Ganga and Yamuna such as Chambal, Betwa, Ken, Son and Damodar flow in the north-easterly direction.

The East Flowing River

The Mahanadi

- It has it's source in Dandakaranya near Sihawa in Raipur district of Chhattisgarh.
- Hirakud dam is built on this river.

The Godavari

- It is the largest river system of the peninsular India.
- It is known as 'Vridha Ganga' or 'Dakshina Ganga'
- The source of the river is in the Trimbak Plateau of North Sahyadri near Nashik in Maharashtra.
- Manjra is the only important right bank tributary which joins the Godavari near Kondalwadi.

The Krishna

- It rises in Western Ghats near Mahabaleshwar.
- Koyna Dam is made on the Koyana river, a tributary of the Krishna river.

The Cauvery

- It is designated as "the Ganga of the South".
- Its source lies at Taal Cauvery on the Brahmagiri range of hills in the Western Ghat.
- Sivasamudram waterfalls is on this river.

The Subarnarekha

- It originates from the Ranchi plateau.
- It forms the boundary between West Bengal and Orissa in its lower course.

The Brahmani

- It comes into existence by the confluence of the Koel and the Sankh rivers near Rourkela in Orissa.

The Penneru

- It springs from the Nandi Durg peak in Karnataka.

The Palar

- Important River of T.N.
- Rises from Karnataka near Kolar Godl Field.

Vaigai

- Most Important River of Southern T.N.
- Rises from Cardamom hills.
- Drained into Pak Bay.

The West Flowing Rivers of the Peninsula

The Narmada

- It is the largest of all the west flowing rivers of the Peninsula.
- It risea from the Amarkantak plateau in Shahdol district of Madhya Pradesh.
- The Duan Dhar falls is formed by the Narmada River in Jabalpur.
- It makes an estuary studded with several islands. Aliabet is the largest island.

The Tapi

- It is also known as 'the twin' or 'the handmaind' of the Narmada.
- It originates from Multai in Betul district of Madhya Pradesh.

The Sabarmati

- This, 320 km long river is the name given to the combined streams–the Sabar and the Hathmati.
- It rises from the hills of Mewar from lake jaisamudra in the Aravali Range.

The Mahi

- It rises in the Vindhyan range and debouches into the Gulf of Khambhat.

The Luni

- Its source lies to the west of Ajmer in the Aravalli.
- Finally, it is lost in the Rann of Kuchchh.

Periyar

- Longest River of Kerala
- Known as 'the life line of Kerala'.

Major Lakes of India

- **Wular :** It is an ox-bow lake on the Jhelum River in Jammu & Kashmir. Tulbul project is situated on it. This is the largest fresh water lake in India.
- **Dal :** It is a beautiful and an important lake of Jammu and Kashmir.
- **Sambar,** Lunakarsar, Panchabhadra and **Didwana** are salt lakes of Rajasthan. Salt is produced from these lakes.
- Udaysagar, Pichhaula, **Jaisamand** and **Rajsamand** are other important lakes of Rajasthan.
- **Rana Pratapsagar** and **Jawahar Sagar** (Rajasthan) and **Gandhi Sagar** (MP) are man-made lakes on the Chambal River.
- **Ukai** (Gujarat) is a man-made lake on the Tapi. river.,
- **Govind Sagar** is the lake formed behind the Bhakhra Nangal Dam, in Himachal Pradesh.
- **Nagarjuna Sagar** (Andhra Pradesh) on Krishna River, Nizam Sagar (Andhra Pradesh) on Manjara and Tungabhadra (Karnataka) on Tunga Bhadra River are other important manmade lakes.
- **Govind Vallabha Pant** (Chhatisgarh & UP) is a lake formed on river Rihand a tributary of Son.
- **Stanley reservoir** is the lake formed behind the Mettur Dam on river Kaveri
- **Loktak Lake :** It is the largest fresh water lake in North East India. There is a floating National park on it, called Keubullamjao.
- **Chilka lake** (Orissa) is the large salt water lagoon lake of India.
- **Kolleru** is a large lagoon lake formed in the deltaic region of Andhra Pradesh.
- **Pulicat Lake :** It is a lagoon lake. Sriharikota island is situated here, where we find the Satish Dhawan Satellite launch centre.
- **Vembanad Lake** is located in Kerala. On this lake is located the Wellington island where boat races are organised.
- **Ashtamudi** is another important lake in Kerala.
- **Lonar Lake** in the Buldhana district of Maharashtra, is a crater lake, which has been formed due to falling of a meteorite.

21. SOILS OF INDIA

SOILS OF INDIA

- The regional variations in soil composition and texture in vast country like India are an obvious outcome of variety of landforms and climatic conditions found here.
- The Indian Council of Agricultural Research has classified the Indian soils into 8 categories:

Alluvial Soil

- This type of soil is spread over about 13 lakhs Km^2 area of the country, which constitutes about 40% of the total land area.
- It contains sand, loam, and clay in different proportions.
- It is found mainly in coastal plain areas and deltaic regions.
- These are also found in foothills regions in plenty.
- It can be further divided into khadar and Bhangar.
- Old alluvial is called Bhangar and contains pebbles and calcium carbonate. Its colour is black or dark brown.
- It is found at a height of about 30 m. from the khadar.
- New alluvial called Khadar is the soil deposited by the rivers every year.
- It is more fertile than the Bhangar.
- Alluvial soils are rich in Potash, Phosphoric acids, lime and Carbon compounds.
- It is poor in Nitrogen and humus.

Black Soil

- It is also known as 'Regur' Soil.
- Black Soil also knwon as 'Cotton Soil'.
- It is of black colour.
- It is best suited for the cultivation of cotton.
- It spreads over about 5.46 lakhs km^2 area.
- It is formed by the weathering and erosion of volcanic lavas.
- The climatic factor along with the nature and composition of rocks is very much important in the formation of black soil.
- Its black colour is due to the presence of magnetite, iron, compounds of aluminium, humus, aluminium silicate, etc.
- It becomes sticky when wet, whereas when it is dry, cracks develop in it.
- It has very high moisture retaining capacity.
- Black soil is the most suiable soil for dry farming. Cotton, coarse grains, Sunflower, Oil seeds, Vegetables and citrus fruits are grown in it.
- It is rich in aluminium, calcium and magnesium, iron, lime and potash.
- It is poor in nitrogenm phosphorus and carbon compounds.

Red Soils

- It speads over an area of about 5.18 lakhs km^2.
- It is formed from the crystalline rocks in the areas of heavy rainfall.
- In the low lying areas, it is found as clay and in the higher land.
- It is found as unconsolidated soil.
- It is relatively less fertile soil and needs irrigation.
- In the higher parts, it is suitable for growing bajra, groundnut and potato whereas in low lying areas, rice, ragi, tobacco and vegetables are grown in it.
- Red soils have ample amount of soluble salts,
- It is devoid of phosphoric acid, Carbon compounds, organic matter, lime and nitrogen.

Laterite Soils

- It spreads over an area of about 1.26 lakhs km^2.
- It is formed in the areas of heavy rainfall (200 cm or more) due to washing away of lime and silica.
- It is suitable for bushes and pastures only, but can be made suitable for the cultivation of rice, ragi, cashew, etc. by the use of fertilizers.
- In this Soil Iron oxides and aluminium oxides are found in sufficient quantities.
- It lacks in nitrogen, phosphoric acid, potash, lime and carbon compounds.

Forest and Mountainous Soils

- These soils are spead over an area of about 2.85 lakhs km^2.
- Variations are found in these soils due to various climatic and ecological conditions in which they are found.

- These soils are, yet, under formation process.
- These are acidic in nature due to excessive presence of less decomposed humus.
- These soils require fertilizers for agricultural purposes.
- In the regions of heavy rainfall, it contains more humus.
- Therefore, in these regions it is suitable for the cultivation of tea, Coffee, spices and tropical fruits. these soils are found in the mountainous and hilly tracts of Karnataka, Kerala, Manipur, Jammu & Kashmir and Himachal Pradesh.
- It is also suitable for the cultivation of various fruits, wheat, maize, barley, etc.
- Froest soils are devoid of potash, Phosphorus, and Lime.

Dry and Desert Soils-

- Thers soils are found over 1.42 lakhs km^2 area of arid and semiarid regions of the country.
- It contains sand in large quantities and is suitable for the cultivation of crops like Jowar and bajra.
- Wherever irrigation facilities are available, like Sri Ganganagar of Rajasthan, wheat and cotton are also grown in it.
- These soils contain soluble salts and phosphorus in large quantities.
- It lacks in carbon compounds and nitrogen.

Pete and Organic Soil-

- These soils are found in about 1.70 lakhs km^2 area of arid and semi arid parts of Rajasthan, Punjab, Haryana, Uttar Pradesh, Bihar, Maharashtra and Tamil Nadu.
- Howerver, excessive amounts of sodium and magnesium cause salinity in the soil, while higher amount of calcuim cause alcanity.
- So these are unsuitable for agricultural purposes.
- They formed in the area of canal irrigation due to capillary transference and are harmfully infertile for agriculture.
- These are locally known as- Reh, Kallar, Rankas, Oosar, Karl, Choppen, etc.
- These soils can be treated by irrigation with mixing lime and gypsum and by growing anti- salinity crops like rice and sugarcane.
- It can be made suitable for growing rice, sugarcane, cotton, wheat, tobacco, etc.

Deltaic Soil-

- These soils are formed due to excessive water and deposition of carbon compounds.
- These are found, chiefly, in the coastal areas and areas where water stagnates for long periods.
- These are rich in soluble salts but lack in phosphourus and potash.
- Wet soils are generally good for the cultivation of rice.
- Marshy soil is formed in the areas of excessive water and in anairobic condition due to the excessive presence of iron and vegetative remains.
- This soil is useless for agriculture.

22. NATURAL VEGETATION OF INDIA & FORESTS

- India is a country of a variety of climates and soils.
- Here different types of natural vegetations, ranging from tropical forests to tundra vegetation, are found.
- Natual vegetations of India can be classified into following six types:

Tropical Evergreen Forests

- These forests are found in the areas receiving more than 200 cm of rainfall.
- Major regions having this vegetation are Sahyadri (Western Ghats), Plateau of Shillong, Andaman and Nicobar Islands and Lakshadweep.
- Like the equatorial forests, the trees of these forests are also wood type and various species of trees are found.
- The average heightof the trees is more than 60 m.
- Major trees found here are Mahogany, Bamboo, Cane, Cinchona, Rubber, etc.
- These forests are important for spices.
- 95% of the land area in Andaman & Nicobar Islands is covered with these forests.

Tropical wet Deciduous Forests

- These are found in the area with 100-200 cm. of rainfall.
- Major areas are-eastern slopes of Sahyadri, north-eastern parts of peninsular plateau, bhabar and Terai region along the foothills of Shiwalik.
- These are characterised as Monsoon forests.
- Major trees of these forests are – Teak, Sal, Mango, Mahua, Bamboo, Shisham, Khari and Sandal. All these trees are ecnomically very important.
- Teak, Sal and Shisham are used for making furniture.
- Sal wood is used for making railway sleeper berths.

Tropical Dry Deciduous Forests:

- These forests are found in the regions with 70-100 cm. of rainfall.
- Trees of these forests are not very high.
- At the dry margins, these forests are replaced by thorny bushes.
- Excessive grazing is the most important problem of these forests.

Thorny Forests and Bushes(Desert Forests)-

- These vegetations are found in those parts of Gujarat, Rajasthan, Punjab & Haryana where the rainfall is less than. 60 cm.
- These forests are also found in a crescent belt extending from Indore district of Madhya Pradesh to Plateau regions of Kurnool district of Andhra Pradesh.
- Important trees are Babool, Khair, Date, Cactii, etc.

Mountain Vegetation

- Since climatic conditions change with increasing height, the change in vegetation cover at different heights in mountains is also observed.
- Here the vegetation ranges from tropical to alpine type.
- At a height of 1500 m., deciduous forests are found.
- At a height of 1500- 3500 m. coniferous forests are found which have trees with soft wood.
- Her, important fress are Deodar, Spruce, Silver fir, chir, etc., whose leaves are pointed at the ends.
- Broad leaf evergreen trees like oak, magnalia and Lawrell are found in the heavy rainfall regions of the eastern Himalays.
- Alpine vegetaion is found at a height of about 2800-4800 m.
- Initially only chinar and apricot trees and pastures are found and at a higher altitude, no vegetation is found.

Tidal Forests

- These forests are found in those marshy areas where the fresh water of rivers continuously mixes with the saline water of sea.
- The deltaic tracts of Ganga, Godavari, Krishna, etc. are ideally suited for this type of forests.
- Major trees of these forests prevent the erosion of coastal areas by the sea waves.
- The wood of these trees does not get spoiled in water.
- These are also evergreen forests.

Grasses-

- In India 60 species of grasses are found.
- Bamboo is the longest grass.Its main use is in Handicraft industry.
- Indian survey of forest report-2011 (ISFR - 2011) was issued on 7th Feb. 2012 .
- First National Forest Policy came in 1952.
- Present National Forest Policy is of 1988.
- Acoording to this policy there should be atleast 330% forests.If the area is hilly or tribal then it becomes 66%.

Land use in India -

(a)	Very Dense Forests (More than 70%)	2.54%
(b)	Medium Dense Forests (40%-70%)	9.76%
(c)	Open Forests(10%-40%)	8.75%
(d)	Tree Cover	2.75%
(e)	Shurbs	1.28%
(f)	Non Forests	77.67%

Data

A. Maximum Forest Cover Area (Statewise):-
   1. Madhya Pradesh
   2. Arunachal Pradesh
   3. Chattisgarh

B. Maximum Forest Cover Area (Union Territories):-
   1. Andaman Nicobar
   2. Dadar Nagar Hveli
   3. Puduchhery

C. Maximum Forest Cover Percentage:-
   1. Mizoram (90.68%)
   2. Lakshdweep (84.56%)
   3. Andaman & Nicobar Islands (81.51%)
   4. Arunachal Pradesh (80.50%)
   5. Nagaland (80.33%)

D. Minimum Forest Cover Area (Statewise):-
   1. Sikkim
   2. Tripura
   3. Mizoram

E. Minimum Forest Cover Area (Union Territories):-
   1. Daman & Diu
   2. Puduchhery
   3. Delhi

F. Minimum Forest Cover Percentage:-
   1. Punjab (3.50%)
   2. Haryana (3.64%)
   3. Rajasthan (4.70%)
   4. Daman & Diu (5.40%)
   5. Puduchhery (10.40%)

23. AGRICULTURE OF INDIA

- 52 % of India's area is under agriculture.
- 52 % of tatal manpower in India is directly engaged in agriculture activities.Share of agriculture sector in total GDP in 2011-2012 was 13.9 %.

Crop	Producer
Rice	West Bengal,Andhra Pradesh,UP,Bihar,Punjab
Wheat	UP,Punjab,Haryana,Bihar,MP,Rajasthan
Jowar	Maharashtra,Karnatka,MP,Andhra Pradesh
Bazra	Gujrat,Rajasthan,UP
Pulses	MP,UP,Punjab,Haryana,Rajasthan
Oilseeds	Gujrat,MP,Bihar,UP,Rajasthan
Barley	UP,Rajasthan,Bihar,Punjab
Sugercane	UP,Maharashtra,Tamilnadu,Karnatka
Groundnut	Gujrat,Andhra,TamilnaduKarnatka
Tea	Assam,West bengal,Tamilnadu
Coffee	Karnatka,Tamilnadu,Kerala
Cotton	Gujrat,Maharashtra,MP,Punjab
Rubber	Kerala,Tamilnadu,Karnatka,Assam
Jute	West baengal,Bihar,Assam
Tobacco	Andhra Pradesh,Gujrat,Bihar
Black Peeper	Kerala,Karnataka,Tamilnadu
Turmeric	Andhra Pradesh,Odisha,Tamilnadu
Cashew	Kerala, Maharashtra, Karnatka, Andhra Pradesh

Differnt Crop Seasons in India

- There are three crop seasons in India :
  (i) Rabi
  (ii) Karif
  (iii) Zayad

Rabi :

- This season starts after the rainy season.
- Sowing begins in September-October and harvesting takes place in February-March.
- Rabi season is cooler and drier than the Kharif season.
- Wheat, bearley, pulses and some oil seeds are grown in the Rabi season.

Kharif :

- The Kharif season begins with the onset of the monsoons in June-July.
- The crop grows in the rainy season and harvesting takes place after the retreat of monsoon in September-October. Rice, maize, millets, groundnuts, cotton and jute are grown in the Kharif season.

Zayad :

- This is the summer season for growing crops which remain till April, May and June.
- Products are mainly vegetables and fruits.

Green Revolution

- The increase in agriculture productivity of cereals that has taken place since the 1960s mainly as a result of introduction of high yielding varieties of wheat and rice and use of fertillzers, machines and irrigation etc., is known as green revolution.
- Green revolution has made us self-sufficinent in food production.
- This had not only saved our much precious foreign exchange but has also made us self-reliant.
- But green revolution has proved more beneficial to rich farmers only, because it involves a lot of investment.

Types of Agriculture in India

Subsistence Farming:

- In this type of agriculture, farmers work hard to grow enough food to survive only.
- In this type of farming the produce is cosumed mainly by farmer and his family.
- There remains no surplus to sell in the market.

Mixed Farming:

- The combination of agriculature and pastoral farming is called mixed farming.
- In this type of farming, cultivation of crops and rearing of animals are done together on the same farm.

Shifting Cultivation:

- This is a primitive form of agriculture, in which a plot of land is cultivated for a few uears and then

is deserted.

- This slash and burn method of farming is carried on in jungles of north eastern part of India.
- A plot of land is clared for cultivation. As the yield decreases after two or three years, the plot is abandoned and a fresh clearing is made.

Extensive Farming:

- This is a system of farming in which the cultivator uses a limited amount of labour and capital on relatively large area.
- This type of agriculture is practised countries where population size is small and land is enough.
- Here, per acre yield is low but overall production is in surplus due to less population.
- Agriculture is done with the help of machines.

Intensive Farming:

- This is a system of farming in which the cultivator use large amount of labour and capital on a relatively small area.
- In countries where the size of population is big but land is less, this type of farming is done.
- Annually two or three crops are grown due to the demand of food for the large size of population.
- Agriculture is done with the help of manual labour.

Plantation Agriculature:

- In this type of agriculture, trees or bushes are planted on huge estates.
- A single crop like rubber, sugarcane, coffee, tea or banana is grown.
- These crops are major items of export.

Problems of India Agriculture

- The low productivity of our agriculture is mainly due to the difficulties faced by our peasants.
- Indian agriculture is chiefly of subsistence type where a large manual labour is employed to work on farms to grow just enough food for the needs of the family and very little is left for marketing.
- A major part of the India soil has been impoverished because it has been under plough for the last 4000 or 5000 years.
- Deforestation, overgrazing and heavy rainfall have led to soil erosion.
- Divisions of land have led to fragmentation.
- The size of land holding is very small and uneconomic.
- They use primitive tools and out-dated method.
- They lack financial credit and investment.
- Good seeds, fertilizers and improved technology are not available to them.
- They lack irrigation faciities and are still on the mercy of nature.
- Most of the farmers have no security aganist crop failure or loss casued by nature.
- Generally farmers are uneducated and have no scientific approaches.

USES OF LAND

Uses of land	% put to use of land
Cultivated land	52.00
Forested area	19.03
Wasteland (acid, rocky and sandy areas)	13.01
Cultivable waste	6.04
Fallow land	5.00
Pastures and meadows	4.00

Water Resources and Their Urilization in India

- Water resources of India can be divided into two parts :
  (i) Surface water Resources
  (ii) Underground Water Resources.

Surface Water Resources :

- According to the estimate, India receives and average of 109 cm of rainfall annually.
- This rainfall amounts to 37,000 million cubic metre. Out of this, 12,500 million cubic metres evaporates and another 7,900 million cubic metres is absorbed by land. Only 16,600 million cubic metres water is available in our rivers.
- Out of this, only 6,600 million cubic metres of water can be used for irrigation.

Underground Water Resources :

- Out of total rainfall, only 7900 million cubic metres of water percolates inside / beneath the earth.
- Out of this, only 4300 million cubic metres of water is able to rreach the upper layer of the soil.
- This water is more important for agricultural production.
- Rest 3600 million cubic metres reaches the impervious rocks which can be used by digging wells or Tube wells. Out of this only 2250 million cubic

metres of water is economically vrable

Sources of Irrigation in india

There are varius sources of irrigation which are :

(a) Wells & Tubewells : 46% of total irrigation
(b) Canals : 39% of total irrigation
(c) Tanks : 8% of total irrigation
(d) Other Sources : (Dongs, Kuhls, Springs etc.)

Power Resources of India

India uses a large amount of fossil fuels as a source of energy alongwith a number of renewalbe sources of energy, viz., hydroelectric power, thermal power, petroleum, nuclear or atomic power, solar energy, wind energy, tidal energy, bio-gas etc.

Multipurpose Projects of India

Multipurpose river valley projects, once referred by Jawaharlal Nehru as 'Temples of Modern India', persent an integrating system of controlling floods, generation of hydroelectricity, irrigationm development of fishery and tourists spots, boating, navigation, and draining away extra water. These projects aim at all round development of river valleys.

Shifting cultivation in different regions of India

- Jhoom — North east
- Deepa — Bastar (Chattisgarh)
- Podu — Andhra Pradesh
- Kumari — Western coast hill area of Kerala
- Batra — South- east Rajasthan
- Kamn, Vinga, Dhavi — Orissa

24. INDUSTRIES OF INDIA

Iron-Steel Industry-

- First Iron-Steel industry in India was established in 1874 in Kulti(West Bengal) by the name of Barakar Iron Company.
- First industry on larger scale was established in 1907 in Bihar(Now Jharkhand) in Sakchi by Jamshedji Tata. Name was TISCO.
- **Industries established before independence-**

1. Indian Iron-Steel Company- It was established in 1908 in West Bengal,Damodar river valley at Hirapur.

2. Mysore Iron & Steel Works- In 1923 Mysore (Bhadravati). At present its name is Vishwesarya Iron & Steel Company Ltd.(VISCL).

3. Steel Corporation of Bengal- It was established in 1937 in Burnpur(W. Bengal).It was furthur murged in Indian Iron-Steel Company.

- **Industries established after independence-**

1. Industries established during second Five Year Plan-

(i) Bhilai Steel Plant-1955 in Chattisgarh with the help of USSR.

(ii) Hindustan Steel Ltd.,Raurkela-Estd. in 1953 with the help of Germany in Odisha.

(iii) Hindustan Steel Ltd.,Durgapur-Estd. in 1956 with the help of Germany in Britain.

2. Industries established during third Five Year Plan-

(i) Bokaro Steel Plant-1968 in Jharkhand with the help of USSR.

3. Industries established during fourth Five Year Plan-

(i) SalemSteel Plant-Salem (Tamilnadu).

(ii) Vishakhapattnam Steel Plant-Vishakhapattanam(Andhra Pradesh).

(iii) Vizaynagar Steel Plant Haspet,Bellari(Karnatka).

- **Steel Authority of India Ltd.(SAIL)-**Thies is a public sector company established by govt. of india on **24th january 1973**.From 1989 almost all steel companies are under management of this authority.

Aluminium Industry-

- First Aluminum factory in India was established in W.Bengal near Asansole, J.K.Nagar in year 1937.
- Hindustan Aluminum Corporation (HINDALCO) was establshed in Chattisgarh (Korba).
- Madras Aluminium Company (MALCO) in Mettur(Tamilnadu).

Cotton-Textile Industry-

- First industry of modern type was established in 1818 at Fort Gloster,Kolkata, but it was unsuccessful.
- first successful and modern cotton industry was establishe inBombay by Kawasji Daburji in1854.Here production started in 1856.
- Mumbai is known as Cottonopolis.
- Kanpur is known as Manchester of North India.
- Coimbtur is known as Manchester of South India.
- Ahmadabad is known as Manchester & Boston India.

Jute Industry-

- Jute is Famous as Golden Fibre.India stands on first position in manufacturing Jute products.
- Its first factory was established in Rishra near Kolkata in year 1859.
- Indian Jute Corporation was established in1971 for taking care of import ,export and internal market.
- India produces 35% of Jute products of whole world.

Sugar Industry-

- This industry is mainly in UP, Maharashtra, Bihar, Tamilnadu, MP, Andhra Pradesh, Punjab, Harayana, W. Bengal & Raajasthan states. Following cities are related with sugar industry.

UP

Devaria,Bhatni,Padrauna,Gorakhpur,Gauri Bazar,Siswa Bazar,Basti,Gonda,
Balrampur, Barabanki, Sitapur, Hardoi, Bijnore, Meerut, Saharanpur, Moradabad, Bulandshhar,Kanpur, Faizabad, Muzaffarnagar etc.

Bihar

Motihari, Sugauli, Majholia, Chanpatia, Narkatiaganj, Madhura, Gopalganj, Motipur, Dalmiyanagar, Saran, Samastipur, Darbhanga, Champaran, Hasanpur, Muzaffarpur etc.

Maharashtra	Mansad, Nasik, Ahmadnagar, Pune, Sholapur, Kolhapur.
Punjab	Hamira,Phagwara,Amritsar.
Haryana	Jagadhari,Rohtak.

Cement Industry-

- World's first cement factory was estd. in 1824 in Portland(Britain).
- First modern cement industry in India was estd. in Madras in 1904 ,but it failed.
- After this event Indian Cement Company Ltd. established a factory in 1912-1913 at Parbandar (Gujrat),here production started in 1914.
- Associate Cement Company Ltd. (ACC) was established in 1934.
- Rajasthan is the largest proucing state of Cement.
- Main cement producing states are-

Rajasthan	Jaipur, Lakheri.
MP	Satna, Katni, Jabalpur, Banmore, Ratlam.
UP	Mirzapur,Churk.
Jharkhand	Dalmiyanagar, Japla, Khelari, Kalyanpur, Sindari, Cheenkpani.
Andhra Pradesh	Krishna,Vizaywara, Mancheriyal, Macheriya, panyam.
Gujrat	Porbandar, Dwarka, Sika (Jamnagar), Bhavnagar, Sevaliyam & Ranayay.

Paper Industry-

- First modern paper industry was established in Trancuwar(Madras) in 1716, but it failed.
- First successful industry was in Lucknow in year 1879.
- W. Bengal is the largest producer of paper.
- Main paper producing states are-

West Bengal	Titagarh, Raniganj, Naihati, Triveni, Kolkata, Kinada, Hugli, Baranagar, Shiraphooli, etc.
Andhra Pradesh	Rajmahendri, Sirpur, Kagajnagar, Tirupati etc.
UP	Sikandrabad, Meerut, Saharanpur, Pipraich, Muzaffarpur, Pilkhua,Lucknow, Naini (Allahabad) etc.
Bihar	Patna, Barauni, Samastipur etc.
MP	Nepanagar (for Newspaper's paper), Hoshangabad.

Chemical Fertilizer Industry-

- First super phosphate fertilizer factory was established in 1906 in Ranipet(Tamilnadu).
- Ammonia firtilizer industry was estd. in 1944 in Karnatka(Bailegula) by name Mysore Chemicals & Fertilizers.
- Indian Fertilizer Corporation was founded in 1951, under which Asia's largest fertilizer industry was estd. in Sindari.
- India is world's third largest producer and consumer of Fertilizer.
- Main fretilizer producers are-

Jharkhand - Sindari
Bihar - Barauni
UP -
Kanpur,Gorakhpur,Allahabad(Phoolpur).

Ship-building Industry-

- First Ship-building industry was estd. in 1941 by Sindhia Steam Navigation Company in Vishakhapattnam.
- Govt. of India undertaken this company in1952 andnamed as Hindustan Shipyard, Vishakhapattnam.
- Other public sector companies are-
  (i) Gardenreich Workshop Ltd.-Kolkata(W.Bengal)
  (ii) Goa Shipyard Ltd.-Goa
  (iii) Majhgaon Docs Ltd.-Maharashtra

Aeroplane-building Industry-

- First industry was established in 1940 in Begaluru as Hindustan Aircrafts Co.Its present name is Hidustan Aeronautics Ltd.At present five units are itself in Bangaluru & one unit each in Koraput,Nasik,Bairakpur,Lucknow, Hydrabad and Kanpur.

Automobile Industry-

- This industry is basicly known as development industry.
- The main units are-Hindustan Motors(Kolkata),Premier company Ltd.(Jamshedpur), Mahindra Mahindra & Ltd.(Pune), Maruti Udyaog Ltd.,Gurgaon(Haryana)Sunrise Industries(Banaluru).

Glass Industry-

- This industry is basicly developed in areas of railway centralisation.This industry is developed mainly in W.Bengal,UP,Maharashtra&Tamilnadu.

- Main centres in India are Firozabad & Shikohabad.
- Main centres of Glass industry are-

West Bengal: Belgachiya, Serampur,Resra ,Wardmaan, Raniganj & Asansole.

UP: Naini (Allahabad), Ramnagar (Varanasi), Bahzoi (Moradabad), Balabali & Firazabad.

Jharkhand: Kandra (Jamshedpur), Bhurkunda (Hazaribagh), Dhanbad.

Bihar: Patna & Kahalgaon.

Maharashtra: Mumbai, Pune,Dadar , Satara, Sholapur, Nagpur.

Gujrat: Baroda, Morvi.

Rajasthan: Jaipur.

Other: Ambala, Amritser, Hydrabad, Jabalpur, Bangaluru Guwahati.

13. Medicines-Manfacturing Industry-

- Main place- Mumbai,Delhi,Kanpur, Haridwar, Rishikesh, Ahmadabad, Pune, Pimpari (Peniciline), Mathura, Hydrabad etc.

14. Engineering Industry

- Main place- Hatiya(Ranchi), Durgapur, Vishakhapattanam ,Naini(Allahabad),Bangaluru , Ajmer,Jadaupur(Kolkata) etc.

15. Rail Instrument Industry-

- India is totally self dependent in mafacturing of rail engines,passenger compartments & wagons.
- Chittranjan(West Bengal)is the oldest factory of rail engines.It was estd. on 26th Jan. 1950 by the name of Chittranjan Locomotive Works.Presesntly here electric engines are manfactured.
- Deisel engines are manfacuted in Varanasi.
- Rail engines are also manfacured in Jamshedpur(Jharkhand).
- Rail compartment are manfacuring in Paramboor(Chennai), which was estd. on 1925. Other centres are Bangaluru , Kolkata , Karoorthala (Punjab-name Integral Coach Factory).

16. Electric Intrument Industry-Bhopal, Haridwara(Ranipur), Ramchandrapur near Hydrabad, Tirucharapalli & Kolkata.

17. Telephone Industry- Bangaluru, Roopnarayan (Kolkata)

18. Woolen Industry-

- First Woolen mill in India was established in 1870 at Kanpur, but this industry raelly developed after.
- At present this industry is mainly in Punjab ,Haryana, UP, Maharashtra & Gujart states.
- Main centers are :

UP

Mirzapur,Agra, Muzaffarpur, Shajahanpur.

Punjab

Amritser, Dhariwal.

- Britain ,USA,Canada , Germany are main importer.

19. Silk Industry-

- India is a country in which all four varities of silk viz. Malburry, Erie,Tasar & Munga are found.
- Two third of India's silk is produced in Karnatka.
- Non-Malburry silk is mainly found in Assam , Bihar & MP.
- Main centers are-

J & K Shrinagar, Jammu, Udhampur, Anatnag, Baramula.

Punjab Amritser, Gurudas, Hoshiarpur, Ludhiyana.

UP Mirzapur, Varanasi, Shahjahanpur.

W.Bengal Murshidabad, Bakura, Howra, Chaubis-Pargana.

20. Atomic Power

- Atomic Energy Research Institute was established in India with great efforts of Dr. Homi Jahangir Bhabha in 1948.
- A seperate Department of Atomic energy was created in 1954.
- The first Atomic research reactor was APSARA in Trombey (Mumbai).
- The first Atomic poser plant of India was - Tarapur (Maharashtra) started in 1969.

25. MINIRAL RESOURCES OF INDIA

- **Geological survey of India**,whoses head quarter's is in **Kolkata** & **Indian Mines Bureou** is responsible for survey and development of minirals in India.

Miniral - **Iron Ore**

Main Place

Odisha (Sonai , Kyonjhar ,Mayurbhanj) Jharkhand (Singhbhoom, Hazaribagh, Palamu , Dhanbad)

,Chattisgarh (Bastar, Durg Raipur ,Raigarh ,MP (Jabalpur),Karnatka (Belari, Chikmangalore, Chitaldurg) ,Maharashtra (Ratnagiri & Chanda) , Tamilnadu (Salem & Tirucharapalli) , Goa.

Special Point

75% of the total ore of India is found in Jharkhand & Odisha.India exports its ore to Japan ,Czecoslovakia, Italy, & Srilanka.India stands on first position according to re- serves in whole world.

Miniral - Manganese

Main Place

Jharkahand (Singhbhoom) , Maharashtra (Nagpur, Bhandara) ,Odisha(Kyonjhar, Sundergarh) ,Andhra Pradesh(Kakulmani) , Karnataka (Shimoga, Belari) ,Gujrat (Panchmahal), Rajasthan. Special Point-India stands third rank in production in world. Odisha is the largest producer of Mangaese in world.

Miniral - Coal

Main Place

Jharkahand (Dhanbad , Singhbhoom, Giridih) ,W. Bengal (Raniganj , Asansole), Chattisgarh (Raigarh) ,Odisha(Deshgarh& Talchar) , Assam(Makam , Lakhimpur) , Maharashtra(Chanda), Andhra Pradesh(Singreni), Meghalaya, J&K,Nagaland etc.

Special Point

India is on First position in production of coal inworld.Three main coal producing states are Jharkhand,Chattisgarh ,Odisha. Anthracite is best coal varity.

Miniral - Copper

Main Place

Jharkhand (Singhbhoom, Hazaribagh) , Rajasthan(Khetri, Jhunjhnu, Bhilwara, Alwar & Sirohi) , Maharashtra (Kolhapur) , Karnatka (Chitaldurg, Hasan ,Raichur) , MP (Balaghat) , Andhra Pradesh(Agnigundal).

Special Point-Three main copper producing states are-MP, Rajasthan , Jharkhand. Copper is extracted from Jowar mine also.

Miniral - Bauxite

Main Place -Jharkhand (Singhbhoom, Hazaribagh), Bihar(Gaya , Munger),Maharashtra(Nagpur , Bhandara , Ratnagiri) , Rajasthan(Ajmer , Shahpura).

Special Point-Largest producer of Bauxite in India is Odisha (50% of total production).

Miniral - Mica

Main Place -Jharkhand (Palamu) , Gujrat(Khera) , MP(Katni, Balaghat, Jabalpur), Chattisgarh.

Special Point-India is on first production in Mica production.51% of India's production is in Rajasthan.

Miniral - Gold

Main Place -Karnatka(Kolar & Hatti mine) ,Andhra Pradesh(Ananthpur & Warangal).

Special Point-98% of total production of India is from Karnatka.

Miniral - Zinc

Main Place -Rajasthan(Udaipur),Odisha, J&K(Second place in production).

Special Point-Rajasthan(First in production)-Jawar mine is famous for zinc production.

26. TRANSPOTATION IN INDIA

- The Present transport system of the country comprises several modes of transport inluding rail, road, coastal shipping, air transport etc.

Road Transport

- The total length of the roads in the country is **42.36 Lakh Km.**(Upto **March 2011**)
- India is one of the largest road transport systems in the world.
- India's road network consists of Expressways, National Highways, State Highways, Major District Roads, Other District Roads and Village Roads.

National Highways

- They are constructed and maintained by the central governement.
- The National Highways has **70,934 Km**.(upto **March 2009**) length Comprising only 1.94 % of the total length of roads, carries abouth 40% of the total traffic of India.
- The central government has taken up a programme of 4/6 lanning of about 13,000 kms. of National Highways (NH) under the National Highways Development Programme (NHDP).
- This programme includes the **'Golden Quadrilateral' (GQ)** comprising the National Highways connecting the four metropolitan cities of Delhi, Mumbai, Chennai and Kolkata.
- The programme of development of National Highways also includes the creation of the North-South Corridor conecting Sinagan to Kanyakumari and East-West Corridor connetion Silchar to Porbander. This component of the NHDP has a total length of about 7,300 kms. and is to be completed by December, 2007.
- Total length of **'Golden Quadrilateral' (GQ)** is 5846 Km.

Some Important National highways

- There are around 225 National Highways in the country. Some of them are:

  N.H. 1. : Delhi-Ambala-Indo-Pak Border(Amritser) (546 Km)

  N.H. 2. : Delhi-Agra - Kanpur - Varanasi - Kolkata (1490 Km)

  N.H. 3 : Agra- Gwaliar - Indore - Nasik - Mumbai (1161 Km)

  N.H. 4 : Junction with N. H. 3 near Thane - Belgaum - Bangalore - Ranipet - Chennai (1235 Km)

  N.H. 5 : Kolkata-Chennai (1610 Km)

  N.H. 6: Kolkata-Mumbai(1945Km)

  N.H. 7 : Varanasi - Jabalpur - Nagpur - Hyderabad - Bangalor - Madurai - Kanyakumari (2369 Km).

  N.H. 8 : Delhi-Jaipur - Ahmedabad - Vadodara - Mumbai (1428 Km)

- The longest National highway in India is NH-7; which has a length of 128 kms in Uttar Pradesh, 504 kms in Madhya Pradesh, 232 kms in Maharashtra, 753 kms in Andhra Pradesh, 125 kms in Karnataka, 627 Kms in Tamil Nadu i.e. total 2369 kms.
- Smallest National Highway in India is NH-47A

State Highways

- They are constructed and maintained by the state government.
- Maharashtra has the maximum length of roads.
- Maharashtra also has the maximum length of metalled roads.
- Orissa has the maximum length of unpaved roads.
- West Bengal has the maximum road density.
- Roads on the borders are constructed and maintained by the Border Roads Organisation (BRO).
- BRO was established in May 1960.
- Today, the BRO is a premier construction agency not only of roads but also airfields, bridges, buildings, hospitals and Schools.
- Since inception and upto March 2005, it has completed over 40,450 km of roads and constructed permanent bridges totaling a length of about 21,314 runining meters.
- The BRO, through 'Project Dantak' is constructing and maintaining a large road infrastructure and executing other prestingious projects in Bhutan.
- The BRO is doing highly Commendable jobs of construction and maitenance in Myanmar and Af-

ghanistan too.

Rail Transport

- The Indian Railways have been a great integrating force for more than 150 years.
- From a very modest beginning in 1853 Indian Railways have grown into a vast network of 7,031 stations spread over a route-length of **64,400 Km.(March 2011)** with a fleet of 7,817 locomotives, 5,321 passenger service vehicles 4,904 other coaching vehicles and 2,28,170 wagons as on 31 March, 2004.
- Indian Railway network is the largest in Asia and second largest in the World.
- The first rail in India started in 1853 between Mumbai and Thane (34 kms.)
- Indian Railway Board was established in March 1905.
- Indian Railway was nationalised in 1950.
- There are three types of rail lines in India : (i) Broad Gauge (ii) Meter Gauge and (iii) Narrow Gauge.
- The management and governance of the Indian railways is in the hands of the Railway Board.
- Railways have been divided into 17 zones.

Zone	Headquarters	Divisions
West Central Railway	Jabalpur	Jabalpur and Bhopal divisions of CR, reorganized Kota division of WR
North Central Railway	Allahabad	Reorganized divisions : Allahabad of NR, Jhansi of CR, and new Agra division
South East Central Railway	Bilaspur	Nagpur division and reorganized Bilaspur division of SER, new Raipur division
New Zones that were created on 10th October, 2002		
North Western Railway	Jaipur	Jodhpur division and reorganized Bikaner division of NR, reorganized Jaipur and Ajmer division of WR
East Central Railway	Hajipur	Sonepur and Smastipur divisions of NER, Danapur, Mughalsarai and Dhanbad divisions of ER, (was earlier constituted to have katihar division of NFR as well.)
Old Zones as they are after April, 2003		
Western Railway	Mumbai	Bhavnagar and Mumbai divisions, reorganized Ratlam, Rajkot and Vadodara divisions, new Ahmedabad divi sion.
Central Railway	Mumbai	Bhusawal and Nagpur divisions, reorganized Mumbai CST and Solapur divisions, new Pune divisions (including Pune-Kolapur)
Eastern Railway	Kolkata	Howrah, Malda, Sealdah and
Southern Railway	Chennai	Asansol divisions Chennai, Palghat, Tiruchirapalli,m Thiruvananthapuram and Madurai divisions
Northern Railway	New Delhi	Ferozpur, Ambala, Lucknow and Moradabad divisions, reorganized Delhi division.
South Central Railway	Secunderabad	Reorganized Secunderabad, Hyderabad, Guntakal (including Bellary-Guntakal (MG) and Bellary-Rayadurg), and Vijayawada divi sions, new Guntur and Nanded divisions.

Other zones are

South East Railway	Kolkata
North-Eastern Railway	Gorakhpur
North-East Frontier Railway	Maligaon
Eastern Railway	Bhubneswar
South-Western Railway	Hubli

Air Transport

- Airways in India started in 1911.
- Indian National Airways Company was started in 1933.
- All the airway companies were nationalised in 1953 and were put under two corporations namely – Indian Airlines and Air India.
- Indian Airlines provides its services to the internal parts of India along with neighbouring countries of nepal, Bangladesh, Pakistan, Afghanistan, Sri Lanka, Myanmar and Maldives.
- Air India provides its services to the foreign locations.
- Vayudoot was established in 1981 for domestic services, but was later merged in Indian Airlines.

Major International Airports of India

- Chhatrapati Shivaji International Airport (Santa Cruz Airport)
  Mumbai
- Subhash Chandra Bose Airport (DumDum Airport) Kolkata
- Indira Gandhi International Airport
  Delhi
- Meenambkam International Airport
  Chennai
- Thiruanathpuram Airport
  Thiruvananthpuram
- Rajasansi Airport
  Chandigarh

Water Transport

- The Central Water Tribunal was established in 1887.
- Its headquarter is in Kolkata.
- The waterways of the country have been divided into - Internal water - ways and Oceanic waterways.
- About 44 million tonnes of Cargo is being moved annually by Inland Water Transport (IWT).
- The waterway from Haldia to Allahabad was made a national highway in 1986.
- The Inland Waterways Authority of India (IWAI) came into existence on 27 October, 1986 for development and regulation of inland waterways in the country.

Oceanic Waterway

- The peninsular bank is very important for this purpose.
- There are 13 large and 200 small ports on the major bank of 6,100 kms.
- Large ports are maintained by the central government whereas small ports are included in the concurrent list and are managed by the state government.

Major Ports of India

	Name	State	River/Strait/Ocean
1.	Kolkata/Haldia	West Bengal	Hoogly River
2.	Mumbai	Maharashtra	Arabian Sea
3.	Chennai	Tamil Nadu	Bay of Bengal
4.	Kochhi	Kerala	Arabian Sea
5.	Vishakhapatnam	Andhra Pradesh	Bay of Bengal
6.	Paradip	Orissa	Bay of Bengal
7.	Tuticorin	Tamil Nadu	Bay of Bengal
8.	Marmagao	Goa	Arabian Sea
9.	Kandla	Gujarat	Arabian Sea
10.	New Mangalore	Karnataka	Arabian Sea
11.	Nhavasheva (Jawahar Lal Nehru Port)	Maharasthra	Arabian Sea
12.	Ennore	Tamil Nadu	Bay of Bengal
13.	Port Blair	A&N	In Bay of Bengal

- Largest port of India is Jawaharlal Nehru Port in Mumbai.
- The largest natural port is in Vishakhapatnam.
- Kandla & Haldia are tidal port.

27. CENSUS OF INDIA : 2011

- Art. 246 of Indian Constitution gives all rights to Union Govt. for census of India.
- Census is on **serial no. 69 in Union List of Seventh Schedule**.
- Census started in India in **1872 AD** at the time of **Lord Mayo**.
- Reguler Census started in **1881 AD** at the time of **Lord Rippon**.
- According to 2011 census India's population in world's population is around 17.5 %.
- Total population of India is 121.02 Cr.
- Decade growth of India is 18.14 Cr.
- Decade growth rate of India is 17.64 % and annual growth rate is 1.64 %.
- No. of females on per thousand male in India is 943
- Literacy rate of India is 74.04 %
  Male Literacy - 82.14%
  Female Literacy - 65.46%
- Population Density of India is 382 persons per square kilometers.
- State with maximum population **- UP**
- State with minimum population **- Sikkim**
- Union Territory with maximum population **- Delhi**
- Union Territory with minimum population **- UP**
- States with maximum population-(Decending)
  (i) UP (ii) Maharashtra
  (iii) Bihar (iv) W.Bengal
  (v) Andhra Pradesh
- States with minimum population-(Ascending)
  (i) Sikkim (ii) Mizoram
  (iii) Arunachal Pr. (iv) Goa
  (v) Nagaland
- States with maximum population Density-(Decending)
  (i) Bihar (ii) W.Bengal
  (iii) Kearla (iv) UP
  (v) Haryana
- States with minimum population Density-(Ascending)
  (i) Arunachal Pr. (ii) Mizoram
  (iii) Sikkim (iv) Nagaland
  (v) Manipur
- States with maximum Sex Ratio-(Decending)
  (i) Kerala (ii) Tamilnadu
  (iii) Andhra Pr. (iv) Chattisgarh
  (v) Manipur
- States with minimum Sex Ratio-(Ascending)
  (i) Haryana (ii) J&K
  (iii) Sikkim (iv) Punjab
  (v) UP
- States with maximum Literacy Rate-(Decending)
  (i) Kerala (ii) Mizoram
  (iii) Tripura (iv) Goa
  (v) Himachal Pradesh
- States with minimum Literacy Rate-(Ascending)
  (i) Bihar (ii) Arunachal Pr.
  (iii) Rajasthan (iv) Jharkhand
  (v) Andhra Pradesh
- Union Territory with maximum Population Den- **Delhi**
- Union Territory with minimum Population Density -**Andaman & Nicobar**
- Union Territory with maximum Literacy Rate - **Lakshdweep**
- Union Territory with minimum Literacy Rate - **Dadar and Nagar Haveli**
- Maximum Male Literacy Rate - Kerala
- Minimum Male Literacy Rate - Bihar
- Maximum Female Literacy Rate - Kerala
- Minimum Female Literacy Rate - Rajasthan
- Union Territory with maximum Sex Ratio - **Puduchhery**
- Union Territory with minimum Sex Ratio -**Daman and Deu**

28. CAPITALS OF STATES & UNION TERRITORIES

- The capital from admission into the Indian Union.
- An absence of a legislative capital means that it is administered by the Central government.

STATES AND THEIR CAPITALS

State/UT	Administrative Capital	Legislative Capital	Judicial Capital	Since
Andaman and Nicobar Islands	Port Blair	—	Kolkata	1956
Arunachal Pradesh	Itanagar	Itanagar	Guwahati	1972
Andhra Pradesh	Hyderabad	Hyderabad	Hyderabad	1956
Assam	Dispur	Dispur	Guwahati	1972
Former Capital : Shillong (1874-1972)...				
BiharPatna	Patna	Patna	1936	
Chhatisgarh	Raipur	Raipur	Bilaspur	2000
Chandigarh	Chandigarh	—	Chandigarh	1966
Dadra and Nagar Haveli	Silvasa	—	Mumbai	1961
Daman and Diu	Daman	—	Mumbai	1987
NCT-Delhi	Delhi	Delhi	Delhi	1956
Goa	Panaji	Porvorim	Mumbai	1961
Gujarat	Gandhinagar	Gandhinagar	Ahmedabad	1970
Former Capital : Ahmedabad (1960-1970)				
Haryana	Chandigarh	Chandigarh	Chandigarh	1966
Himachal Pradesh	Shimla	Shimla	Shimla	1948
Jammu and Kashmir	* Srinagar (S) * Jammu (W)	* Srinagar (S) * Jammu (W)	Srinagar	1948
Jharkhand	Ranchi	Ranchi	Ranchi	2000
Karnataka	Bangalore	Bangalore	Bangalore	1956
Kerala	Thiruvanantha puram	T' puram	Erankulam	1956
Former Capital : Kochhi (1949 - 1956)				
Lakshadweep	Kavaratti	—	Ernakulam	1956
Madhya Pradesh	Bhopal	Bhopal	Jabalpur	1956
Maharashtra	Mumbai	* Mumbai (S+B) * Nagpur (W)	Mumbai	1818
Manipur	Imphal	Imphal	Guwahati	1947
Meghalaya	Shillong	Shillong	Guwahati	1970
Mizoram	Aizawl	Aizawl	Guwahati	1972
Nagaland	Kohima	Kohima	Guwahati	1963
Orissa	Bhubaneshwar.	Bhubaneshwar	Cuttack	1948
Former Capital : Cuttack (1936-1948)				
Puducherry	Ponducherry	Pondicherry	Chennai	1954
Punjab	Chandigarh	Chandigarh	Chandigarh	1966
Former Capital : Lahor (1936-1947) & Shimla (1947-1966)				
Rajasthan	Jaipur	Jaipur	Jodhpur	1948
Sikkim	Gangtok	Gangtok	Gangtok	1975
Tamil Nadu	Chennai	Chennai	Chennai	1956
Tripura	Agartala	Agartala	Guwahati	1956
Uttarakhand	Dehradun	Dehradun	Nainital	2000
Uttar Pradesh	Lucknow	Lucknow	Allahabad	1937
West Bengal	Kolkata	Kolkata	Kolkata	1905