Government of TamilNadu

Department of Employment and Training

Course : SSC EXAM

Subject : GENERAL SCIENCE

Topic : **BIOLOGY, CHEMISTRY, PHYSICS**

It is a cost-free service provided to the job seekers who are preparing for the Competitive Exams.

Commissioner,
Department of Employment and Training.

BIOLOGY CONTENT

1. Cell – The basic unit of life
2. Nutrition
3. Respiration
4. Blood and Circulation
5. Reproduction
6. Human and Plant diseases
7. Ecosystem
8. Immunity, Antigen, Antibodies
9. RNA and DNA

CELL

- A cell is the smallest and most basic form of life. Robert Hooke, one of the first scientists to use a light microscope, discovered the cell in 1665.

- The cell is basic unit of organisation (or) structure of living matter. The cell is the smallest portion of an organism which exhibits a range of properties of living being like reproduction, mutation, metabolism and sensitivity.

- German scientist shielded and Schwann summarise the findings of many scientists and conclude that all living organisms are made of cells. This forms the basic of the cell theory of Biology.

Cell is divided into Two Types

Prokaryotes **Eukaryotes**

Prokaryotes

- The prokaryotes don't have a nucleus and rarely have membrane bound organelles (The only exception is the bacteria with vacuoles)

Eukaryotes

- The prokaryotic don't have a nucleus and rarely have membrane

Unicellular Organism

The organism with only one cell their body are called unicellular organism (e.g.) bacteria, protozoa, etc.,

Multi cellular Organism

The organisms having many cells in their body are called multi cellular organism.

(e.g) plants and animals.

Plant cell

Plant cells are eukaryotic cells having membrane-bound organelles. They are surrounded by a rigid cell wall.

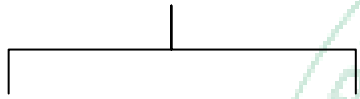
Generally, plant cells are larger than animal cells and are mostly similar in size and are rectangular or cube shaped.

Ribosomes

Ribosomes produce protein. They could be thought of as “factories” in the cell.

Endoplasmic Reticulum

The Endoplasmic Reticulum is a network of membranous canals filled with fluid. They carry materials through out the cell. The Endoplasmic Reticulum is the “transport system” of the cell.



Rough E.R Smooth E.R

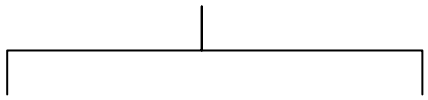
Golgi Body / Apparatus

The golgi body temporarily stores protein which can then leave the cell via vesicles pinching off from the golgi.

- The lissom is also known as a suicide sac.
- The Mitochondria is called as power house of the cell
- The mitochondria release food energy from food molecules (Sugar) to be used by cell. This process is called respiration.

NUTRITION

Nutrition is the science that interprets the interaction of nutrients and other substances in food in relation to maintenance, growth, reproduction, health and disease of an organism.



Auto trophic Nutrition Hydrotrophic Nutrition

Source of Energy

Energy is the basis of life. For example, your ability to maintain a healthy body temperature and support your breathing is called basal metabolic rate.

- Fats
- Proteins
- Carbohydrates.

(i) Fats

The word “fats” may bring up associations with the specialised tissue that stores them, called “adipose” tissue.

Chemically, Fats generally consist of a backbone of “glycerol” and three long chains made of carbon and hydrogen called “fatty acids”

Foods with high fat content include butter, cooking oils and olive oils.

(ii) Proteins

Protein are often talked about as the main thing that muscles and flesh are made of proteins are made up by stringing together smaller building blocks called " amino acids" and there are 20 standard amino acids.

(iii) Carbohydrates

Carbohydrates in the diet ultimately come from the photosynthesis of plants, which stores energy from the sun in the chemical bonds of sugars.

Through technically a carbohydrate, dietary fiber cannot be digested by humans and so is not a source of energy in food.

- Carbohydrate is a organic compound, it comprises of only oxygen, carbon
- and hydrogen. The **Oxygen: Hydrogen** ration usually in 2:1
- Carbohydrates are also known as saccharides, the word saccharide comes from the
- Greek word **sakkron which means sugar.**

CARBOHYDRATES

Monosaccharides	Disaccharides	Oligosaccharides	Poly Saccharides
=> Glucose	=> Sucrose	=> Raffinose	=> Starch
=> Fructose	=> Lactose	=> Stachyose	=> Glycogen
=> Galactose	=> Maltose		=> Cellulose

A calorie is defined as the amount of energy needed to raise the temperature of 1 litre of water by 1 degree Celsius.

Fats have about twice the calories per gram as carbohydrates or proteins (9 calories per gram for fats versus 4 calories per gram for carbohydrates and proteins)

Blood and Circulation

Blood is a connection tissue which is composed of a fluid matrix (plasma) and formed elements.

Plasma

- Plasma is a straw – coloured and vicious fluid. Plasma constitutes about 55% of the blood. About 90% of plasma is water and about 6-8% is composed of proteins.
- The major plasma proteins are: fibrinogen, globulins and albumins.
- The formed elements constitute about 45% of the blood. Erythrocytes, leucocytes and platelets are collectively called formed elements.
- Erythrocytes or Red blood cells: The RBC's are the most abundant cells in bloods.
- In a healthy adult, each 100ml of blood contains 12-16ml blood. The average lifespan of RBC's is 120 days.
- Platelets are also known as thrombocyte. They are cell fragments produced from mega karyocytes.
- Leucocytes or white blood cells (WBC'S) are relatively lesser in number than RBCs. Ina healthy adult about 6000-8000 WBCs are present per cubig mm of blood.

Reproduction

Reproduction is the biological process by which new individual organisms "off spring" are produced from their "parents". Reproduction is a fundamental feature of all known life. Each individual organism exists as the result of reproduction. There are two forms of reproduction: asexual and sexual.

Type of Reproduction

asexual Sexual

Asexual Reproduction

When a single parent is involved and no gamete formation takes place the method is called asexual reproduction. No meiosis happens during asexual reproduction.

Sexual Reproduction

When two parents are involved and gamete formation takes place, the method is called sexual production.

Meiosis happens during gamete formation which is an important step of sexual reproduction.

Male Reproductive System

The entire male reproductive system is dependent on hormones. Which are chemicals that regulate the activity of many different types of cells or organs.

The primary hormones involved in the male reproductive system are follicle – stimulating hormone, testosterone.

Testosterone is responsible for the development of male characteristics, including muscle mass and strength, fat distribution, bone mass, facial hair growth voice change and sex drive.

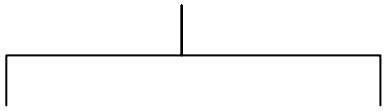
Female Reproductive System:

The female Reproductive system is designed to carry out several functions. It produces the female egg cells necessary for reproduction, called the ova (or) oocytes.

The system is designed to transport the ova to the site of fertilization.

Immune System (Antigen, Antibody)

It is ability of an organism to resist the development of a disease or the effect likely to be produced by the entry of foreign organisms.



natural immunity adaptive immunity

Antigen

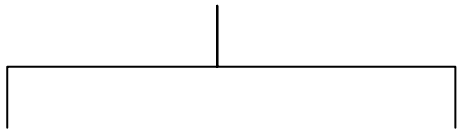
It is a substance when introduced into a vertebrate host provokes an immune response leading to acquired immunity.

Antibodies

Specific proteins synthesized by the host in response to an antigen. All antibody molecules are immune globulins.

Vitamins

Another important part of our food that is absorbed from the small intestine is the class of chemicals we call vitamins.



Water soluble Vitamins (Vitamins B and C)

Fat soluble vitamins (Vitamins A,D,E,K)

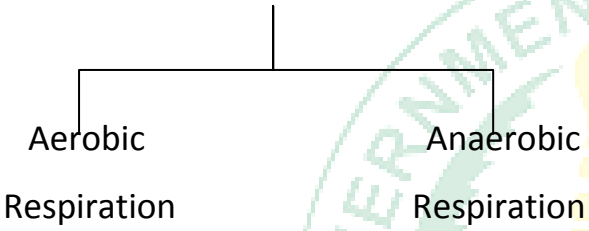
Alternate names for vitamins

- Vitamin B_1 Called as thiamine

- Vitamin B_2 – riboflavin
- Vitamin B_6 – pyridoxine
- Vitamin C – ascorbic acid

Respiration

Cellular respiration is the process by which the chemical energy of "Food" molecules is released and partially captured in the form of ATP.



Aerobic Respiration

- A process that uses oxygen and aerobic respiration happens all the time in animals and plants. Note that respiration is different to breathing (ventilation).
- Most of the reactions in aerobic respiration happen inside mitochondria in cells.

Anaerobic Respiration

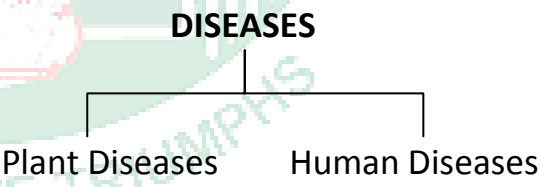
- A process that does not use oxygen, are two forms of cellular respiration. Although some cells may engage in just one type of respiration.

Divide cellular respiration into three metabolic processes.

1. glycolysis occurs in the cytosol.
2. krebs cycle.
3. oxidative phosphorylatuar via the mitochondria the electron transport chain is carried out on the inner mitochondrial membrane.

Vaccination

It is a process by which immunity is gained without suffering from disease. Vaccines are dead or weakened pathogens. The pathogens that are injected into the body are not capable of developing a disease, however they stimulate an immune response and produces antibodies.



Plant Diseases

Plant pathology is the scientific study of diseases in plants caused by pathogens and environmental conditions.

Detailed investigations of various plant diseases indicated that they were caused by

different types of pathogenic agents, (e.g) fungi, bacteria, viruses.

e.x:

Rice – bunt of rice

Wheat – Loose smut of wheat.

Human Diseases

Human diseases: Body's defence mechanisms (specific and non – specific): immune disorders (SCID and AIDS): allergies, interferon's.

- Any departure from health, presenting marked symptoms and illness disorders.
- Disease is caused by an agent. This causative agent is called as pathogen.

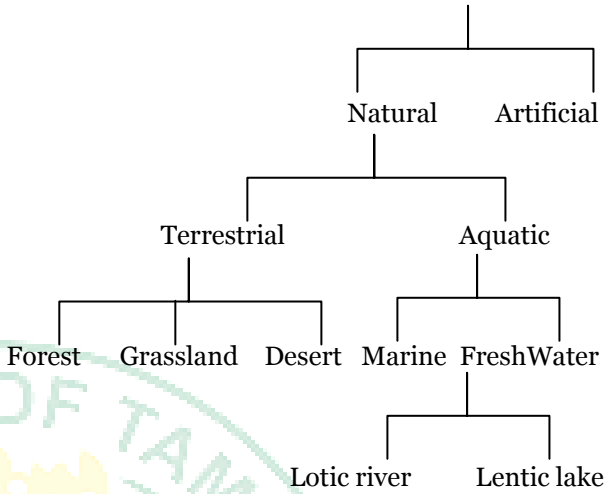
E.x:

Cancer, Virus, Fever, AIDS, SCID

- Jacob Henle formulated the germ theory of disease and outlined the procedure that demonstrating that various microbial species causes particular disease. However, this was proved experimentally later by Robert Hooke.

Eco System

Ecosystem was defined in its presently accepted form by Eugene odum as, "an unit that includes all the organisms.



Food Chains

A food chains only follows just one path as animals fine food.

For example, a hawk eats a snake, which has eaten a frog, which has eaten a grasshopper, which has eaten grass

Hawk ⇦ Snake⇦ Frog ⇦Grass Hopper ⇦ Green Plants.

Food Web

Food web shows the many different paths plants and animals are connected. For example, a hawk might also eat a mouse, a squirrel, a frog (or) some other animal.

DNA

- Friedrich Meischer (1869): Identified DNA and named it as “Nuclein”.
- James Watson and Francis crick proposed double helix model of DNA.
- DNA is made of 2 polynucleotide chains. Its backbone is formed of sugar and phosphates. The bases project inside.
- The 2 chains have anti-parallel polarity ie. One chain has the polarity 5’→ 3’ and other has 3’→5’

RNA

- RNA was the first genetic world
- Essential life processes (motabolism, translation, etc.,) evolved around RNA.
- It acts as a genetic material and a catalyst.
- DNA evolved from RNA for stability

Types of RNA

mRNA (messenger RNA)

Provide template for translation (protein synthesis)

rRNA (ribosomal RNA)

Structural and catalytic role during translation. Eg.23 s rRNA in bacteria act as ribozyme.

tRNA (transfer RNA or Soluble RNA)

- Brings amino acids for protein synthesis and reads the genetic code.
- The adapter molecule

tRNA has an Anticodon (NaDoc) loop that has bases complementary to the code.

CHEMISTRY CONTENT

Acids, Bases and Salts

Polymer and Plastic

Nano Technology

Fertilisers

Oxidation and Reduction

Acids, Bases and Salts

Acid:

Acids are substances containing hydrogen. In aqueous solution, they produce hydrogen ions (H^+)

Some important acids are sulphuric acid, hydrochloric acid, nitric acid, acetic acid and oxalic acid.

Bases:

Bases are substances which contain hydroxyl groups and produce hydroxyl ions(OH^-) in solution.

Some important bases are sodium hydroxide, potassium hydroxide, sodium carbonate and ammonium hydroxide.

All bases are not soluble in water. Bases which are soluble in water are called alkalies.

$Hcl\ (aq) \rightleftharpoons H^+\ (aq) + cl^-\ (aq)$
acid

$NaoH(aq) \rightleftharpoons Na^+(aq) + OH^-\ (aq)$
Base

$B + H^+ \rightleftharpoons BH^+$
Base Proton

Salts

Salts are ionic compounds containing a positive ion (cation) and a negative ion (Anion). When an acid reacts with a base, a salt and water are formed. This reaction is called neutralization. Since, the acid and base neutralize each other's effect.

Ex.

Sodium chloride, Sodium Sulphate, calcium phosphate and ammonium chloride.

Acidic salt | Basic salts | Neutral salt

PH

PH is defined as the negative logarithm of hydrogen ion concentration in gram ion per liter of a solution.

$PH = - \log [H^+]$

This is just a number (from 0 to 14) without any units, any solution with PH between **0 and 6.99 is acidic**, which any solution with **pH between 7.01 and 14 is basic.**

A solution with a pH of 7 is neutral. The lower the pH of its aqueous solution, the more acidic is the compound and the higher the pH of a compound, the greater is its basicity.

Polymers and Plastics

A polymer is a large molecule (also called a macromolecule) built up from many hundreds of thousands of small units called monomeric units or monomers.

Thus, the well known polymer polythene is a polymer of ethylene (monomer)

The process of formation of polymers from monomers is called polymerization.

Addition polymers

Condensation polymers

Examples:

Polymer	Monomer
Polythene	Ethylene (CH_2=CH_2)
Polystyrene	Styrene (C_6H_5-CH=CH_2)
Polypropylene	Propylene (CH_3CH=CH_2)

Plastics

Plastics are cross – linked polymers and are very tough. Some examples of plastics are:

- Celluloid, made from nitrocellulose in camphor and alcohol
- Bakelite, obtained from phenol and formal dehyde.
- Vinyl plastics, prepared by cross – linking of PVC or PVA

Rubber

Natural and synthetic rubbers are examples of polymers, **'Raw'** rubber is obtained from the **latex** of the rubber tree (Hevea brasilienni).

- Rubber obtained from this tree is a linear polymer of iso prene.
- Synthetic rubbers are made by polymerization of chloroprene, styrene and butadiene mixtures and iso butylenes.

Nano Technology

- The challenges in future of nano science are to educate and train researchers ad make them experts in the field, who can understand the science in broader way than just biology, chemistry (or) physics alone

and thus are able to combine the knowledge of different fields to common field called nanoscience.

- The Nano materials examples are metals, ceramics, polymers, semiconductors and composites.
- Composites consist of a combination of metals, ceramics or polymers. They are designed to display new, unusual properties that are not found in any single material.

Currently the field of nano chemistry includes.

- Nano particles,
- Nano crystalline materials
- Nano devices

- The most important aspect is still the development of newer strategies for the synthesis of nano materials, particularly through soft (or commercially benign) chemical routes.
- To conclude, nano science investigates materials the size of which is 10^{-9}m (ie) One nanometer.
- This size is approximately same as the diameter of ten hydrogen atoms or 1/1000 of the length of the typical bacterium.

FERTILISERS

- Plants, besides needing water and sunlight also require nitrogen, phosphorus, calcium and potassium for growth. Plants get these elements from the soil.
- But after repeated cultivation A stage is reached when the soils become poor in these elements and as a result, the growth of plants in soil stops, in other words, the soil becomes sterile. The substances added to the soil to make up the deficiency of these essential elements are known as fertilizers.

Natural Fertilisers | Chemical Fertilisers

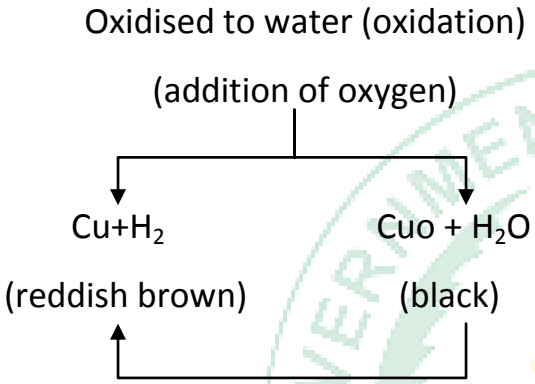
Oxidation and Reduction.

Oxidation is a process in which a substance adds on oxygen or loses hydrogen. The current definition of oxidation is the process in which a substance loses electrons.

Reduction.

Reduction on the other hand, is a process in which a substance adds on hydrogen or loses oxygen.

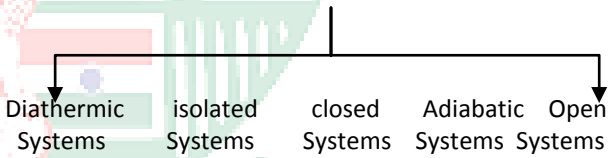
Modern terms, reduction is the process in which a substance gains electrons.



- Oxidising agents are substances which bring about the oxidation of other substances. (e.g) potassium permanganate, potassium dichromate
- Reducing agents are substances which bring about the reduction of other substances (e.g) hydrogen sulphide, hydrogen carbon, sulphur dioxide etc.,

Thermodynamics

- Thermodynamics studies the effects of change in temperature, pressure, and volume on physical systems at the macroscopic scale by analyzing the collective motion of their particles using statistics. Roughly "thermo" or heat means "energy in transit" and dynamics relates to "movement", thus, in essence thermodynamics studies the movement of energy and how energy instills movement.
- An important concept in thermo dynamics is the system. Everything in the universe concept the system is known as surrounding.



Thermodynamics process

- An isobaric process occurs at constant pressure.
- An isochoric process, or isometric, iso volumetric process, occurs at constant volume.
- An adiabatic process occurs without loss or gain of heat

- An isothermal process occurs at a constant temperature.
- A steady state process occurs without a change in the internal energy of the system.

PHYSICS

HEAT

- The temperature of a body is the quantity that tells how hot (or) cold it is with respect to some standard body. Heat is the internal energy transferred from one body to another due to temperature difference.

- Thus, heat is the name given to energy only in the process of transfer. After heat has been transferred to a body, it becomes the internal energy of the body.

- Heat always flows from a substance at a higher temperature into a substance at a lower temperature, but not necessarily from a substance with more internal energy into a substance with less internal energy.

MEASUREMENT OF TEMPARATURE

- Temperature is measured by a thermometer. There are several types of thermometers but the most common is the mercury in glass type which measures temperature by means of the expansion and contraction of mercury.

- To fix a scale for a thermometer, the number is assigned to the temperature of pure melting ice and the number 100 to the temperature of steam from water boiling under the standard atmospheric pressure of 760 mm of mercury. This is called Celsius scale and the temperature on this scale is called degree Celsius (°C)
- On the Fahrenheit scale of temperature 32°F corresponds to 0°C and 212°F to 100°C . To convert temperatures from the Fahrenheit to the Celsius scale, the following relation is used.

Tc=5/Y (Tf-32)

ABSOLUTE ZERO AND KELVIN SCALE

- In principle, there is no upper limit to temperature, but there is a definite lower limit, the “absolute zero”.
- The limiting temperature is 273.16° below Zero on the Celsius scale of temperature.
- On the Kelvin scale absolute zero is 0K on Kelvin scale.

Types of Thermometer

- Clinical Thermometer
- Mercury in Thermometer
- Electronic Thermometer
- Maximum and Minimum Thermometer

Types of Thermometer

- Conduction
- Convection
- Radiation

LIGHT

Light is the form of energy which causes the sensation of vision. Self – Luminous objects, such as the Sun and the Stars, are sources of light. Some living creatures, such as glow worms (or) hatchet fish, are also self luminous.

Interaction of light

1. Reflection
2. Refraction
3. Diffraction
4. Scattering
5. Interference
6. Polarisation

Reflection

When light is incident upon a surface, part of it is reflected but certain surfaces like mirrors and polished metals reflect almost all the light incident upon them.

Refraction

Light bends when it passes obliquely from one medium to another. This is called refraction of light. When a ray passes from a rarer medium to denser medium.

(e.g) Air to water

Dispersion

White light consist of seven colours – Violet, Indigo, Blue, Green, Yellow, Orange and Red. These colours are called spectrum of the white light.

Violet has the minimum wavelength (or maximum frequency) and red the maximum wavelength (or Minimum frequency)

Rainbow

- The most spectacular illustration of dispersion is the rainbow

- When the sun shines soon after a shower of rain, a rainbow is seen in the sky.

Sound

Sound plays an important role in our day to day life. We cannot imagine life without sound because sound is the predominant medium of communication between not only human but also animals.

Sound is produced by the vibration of material objects. The voice results from the vibration of vocal chord.

Source of Sound	Noise
Whisper	20
Ordinary Conversation	65
Traffic on a busy road	70
Amplified rock music	120
Jet aeroplane	140

Speed of sound

The pitch and loudness of sounds have no effect on their speed. In dry air at $0^{o}C$, the speed of sound is about 330 metres per second or 750 miles per hour.

Opposite the sun.

The beautiful colours of the rainbow are due to the dispersion of sunlight by water droplets suspended in the air after rain.

Scattering of light

When light falls on atoms and molecules it is scattered in all directing.

There are two types:

i) Ray high scattering

ii) Raman Scattering

Diffraction of Light

When a beam of light, passes through a narrow slit or an aperture, it spreads out to a certain extent into the region of geometrical shadow. This is an example of diffraction.

Speed of certain air crafts are expressed in mach. Mach is the speed of sound in air, ie 330m/s velocity greater than 330 m/s or 1 mach is

called supersonic. Velocity greater than 5 mach is said to be hypersonic.

Reflection of sound, echo.

- Waves have the property of being reflected when they meet an obstacle. When a sound wave is reflected by a distant obstacle, such as a wall or a cliff, an echo is heard.
- For an echo to be heard separately from the original sound, it must arrive 0.1.s after the original sound is made.
- This can happen if the minimum distance of the reflecting surface from the source of sound is 17m.
- Echoes of ultrasonic waves are used for measuring the depth of sea beds (or) location submerged objects. An apparatus called sonar is used for this purpose.

Doppler Effect:

The Doppler Effect is the apparent change in pitch (or) frequency of a wave (sound or light) due to the relative motion of the source or observer.

The Doppler effect is very useful in astronomy.

Astronomy and space science

The science which deals with the study of heavenly bodies in respect of their motions, positions and compositions is known as astronomy.

Universe

The sun around which the planets revolve is a star. It is one of the hundred billion stars that comprise our galaxy called the milky way. A vast collections of stars held together by mutual gravitation is called a galaxy. The billions of such galaxies form the universe.

Galaxy

A large band of stars, gas and dust particles held together by gravitational forces is called a galaxy.

In the addition to stars, galaxies contain gases and dust. Our solar

system is a part of the galaxy, called the “Milky way”.

Nebulae, which appear in the sky as bright spots, are actually clusters of stars and gaseous cloud. There are many nebulae such as the Orion Nebula within the milky way.

Stars:

Galaxies contain clouds of gases, and stars are formed within such clouds. The total mass of gas in a cloud like Orion Nebula is enough to form nearly 100,000 stars.

Solar System.

- Sun
- Planets
- Atmosphere

The sun is extremely hot and self luminous body. It is made of hydrogeneous matter. It is the star nearest to the earth.

It is a hot sphere of gas – 74% hydrogen, 25% helium and 1& other elements.

Atmosphere

The sun that we see directly consists of outer layers, together known as the atmosphere.

- ✓ Photosphere
- ✓ Chromospheres’
- ✓ Corona

Planets

Compared to the sun, the planets are quite small and relatively cool. They are not self luminous (i.e) they do not have their own light, but shine only by reflecting the sun light.

Terrestrial Planets (Mercury, Venus, Earth and Mars)

Jovian Planets (Jupiter, Saturn, Uranus and Neptune)

- The average distance of the earth from the sun is 1.495 x 10^{11}m. This distance is called one astronomical unit (AV)
- Venus is like a twin of the earth
- Jupiter is the most massive planet in our solar systems.

- **Asteroids** are small heavenly bodies which lies between the orbits of mars and Jupiter.

Meteors or shooting stars:

- A meteor is a bright streak of light in the sky (a shooting star (or) a falling star) produced by the entry of a small meteoroid into the earth's atmosphere.

Atomic Physics

- Atomic physics deals with the study of the atom. An atom consists of proton, electron and neutron.

Moseley's law

- Moseley investigated systematically the characteristic radiations emitted by different targets. Based on his experiments, he has concluded that the frequency of the spectrum line in the characteristic X-ray spectrum is directly proportional to the square of the atomic number (z) of the element considered. This is known as moseley's law.

Nuclear Physics

- Nuclear physics deals with the study of the atomic nucleus. Nucleus was discovered by Earnest Rutherford in 1911.
- The nucleus of an atom consists of protons and neutrons. The number of protons in a nucleus is referred to as the atomic number and denoted by Z. Classification of Nuclei.

Isotopes

Isotopes are atoms of the same element having the same atomic number Z but different mass number

E.x. ${}_1H^1$. ${}_1H^2$, ${}_1H^3$

Isobars

Isobars are atoms of different elements having the same mass number but different.

Ex. ${}_8O^{16}$. ${}_7N^{16}$

Isotones

Isotones are atoms of different elements having the same number of neutrons

Ex. ${}_6C^{14}$. ${}_8O^{16}$