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Commissioner,
Department of Employment and Training.

GENERAL SCIENCE
GROUP 4

Contents

CHAPTER 1: THE UNIVERSE

What is Universe

The Universe is commonly defined as the totality of existence, including planets, stars, and galaxies, the contents of intergalactic space, and all matter and energy. Definitions and usage vary and similar terms include the cosmos, the world and nature.

The most widely accepted cosmological model is that of the Big Bang. This was proven since the discovery of the cosmic microwave background radiation or CMBR. The Universe was infinitely hot at birth, cooling down as it expanded. Today's Universe is found to have an average temperature of only 2.725 Kelvin.

Observations made especially on galaxies farthest from us show that the Universe is expanding at an accelerated rate. The data that show that the Universe is cooling allows us to believe that the most probable ending for our universe is that of a Big Freeze.

The Universe is 13.7 billion years old. The information is based on measurements made on the CMBR.

The matter is spread uniformly (homogeneously) throughout the universe, when averaged over distances longer than 300 million light-years. However, on smaller length-scales, matter is observed to form clumps, i.e., to cluster hierarchically; many atoms are condensed into stars, most stars into galaxies, most galaxies into clusters, super clusters and, finally, the largest-scale structures such as the Great Wall of galaxies. The observable matter of the Universe is also spread isotropically, meaning that no direction of observation seems different from any other; each region of the sky has roughly the same content.

The Universe mainly consists of Galaxies, Stars, Solar System, Comets, Meteors and Asteroids. A galaxy is a collection of stars, dust and gas. All these materials bound together gravitationally to form a galaxy. Gas and dust found in the galaxy in between the stars. It is called interstellar gas, which is mainly hydrogen in its atomic form (H) and to some extent, in molecular form (H2).

Gas forms an important constituent of the Galaxy. Gas in the Galaxy is both in neutral and ionic form. In neutral atomic form, interstellar gas is mainly hydrogen. In ionic form, some other elements like oxygen, carbon, helium, iron, neon, sulfur and some other elements are present along with ionic hydrogen.

Another constituent of the galaxy is dust. Dust can be in small or large particle sizes. Stars are the third and final constituents of galaxies. Number of stars in a galaxy ranges from 10 million to more than a trillion.

Star

A star is a huge, shining ball that produces a large amount of energy in the form of light and other forms. Stars are very far from us, that's why they look like twinkling points of light. Our sun is also a star. A lot of stars are like our sun. Some differ in mass, size, brightness and temperature.

The nearest star to the Earth is Sun. It is nearly 150000000 kilometers away from the Earth. The next nearest star is Alpha Centauri. It is at a distance of about 40000000000000 km from the Earth.

The stars forming a group that has a recognizable shape is called a Constellation. For example, one can see Ursa Major during summer time in the early part of the night. It is also known as the Big Dipper, the Great Bear or the Saptarshi. Another well known constellation, Orion can be seen during winter in the late evenings. It is also called the Hunter. Cassiopeia is another prominent constellation in the northern sky. It is visible during winter in the early part of the night. It looks like a distorted letter W or M.

Stars come in many sizes. Some of the stars have a radius of about 1,000 times that of the sun. The smallest stars are the neutron stars, some of which have a radius of only about 6 miles (10 kilometers). About 75 percent of all stars are members of a binary system, a pair of closely spaced stars that orbit each other. The sun is not a member of a binary system. However, its nearest known stellar neighbor, Proxima Centauri, is part of a multiple-star system that also includes Alpha Centauri A and Alpha Centauri B. Proxima Centauri is 4.2 light years far from sun.

Stars are grouped in huge structures called galaxies. Telescopes have revealed galaxies throughout the universe at distances of 12 billion to 16 billion light-years. Our sun is in a galaxy called the Milky Way that contains more than 100 billion stars. There are more than 100 billion galaxies in the universe, and the average number of stars per galaxy may be 100 billion.

Stars have life cycles. They are born, pass through several phases, and finally die. The sun was born about 4.6 billion years ago and will remain much as it is for another 5 billion years.

Then it will grow to become a red giant. Late in the sun's lifetime, it will cast off its outer layers. The remaining core, called a white dwarf, will slowly fade to become a black dwarf.

Other stars will end their lives in different ways. Some will not go through a red giant stage. Instead, they will merely cool to become white dwarfs, then black dwarfs. A small percentage of stars will die in spectacular explosions called supernovae.Brightness of star seen from Earth depends on two factors:

- The amount of light energy the star emits.
- The distance from Earth to the star.

These characteristics are related to one another in a complex way. Color depends on surface temperature, and brightness depends on surface temperature and size. Mass affects the rate at which a star of a given size produces energy and so affects surface temperature.

Surface Temperature

The surface temperature of a star is determined by the rate of energy production at the core and the radius of the star and is often estimated from the star's color index. It is normally given as the effective temperature, which is the temperature of an idealized black body that radiates its energy at the same luminosity per surface area as the star. The temperature in the core region of a star is several million kelvins. The stellar temperature determines the rate of energization or ionization of different elements, resulting in characteristic absorption lines in the spectrum. The surface temperature of a star, along with its visual absolute magnitude and absorption features, is used to classify a star.

Massive main sequence stars can have surface temperatures of 50,000 K. Smaller stars such as the Sun have surface temperatures of a few thousand K. Red giants have relatively low surface temperatures of about 3,600 K, but they also have a high luminosity due to their large exterior surface area.

Why stars are of different colors

Color of a star is the color of light the star is emitting. A star can appear red, if it emits light more towards the red part of the visible band of the electromagnetic spectrum and can appear blue if it emits light more towards the blue part of the visible spectrum. Our sun emits

light equally among all wavelengths of the visible spectrum. That is why our sun appears white to us.Color of the star depends on its surface temperature.

Asteroids

Asteroids are small rocky bodies that orbit the sun in a belt (Kuiper belt) between orbits of Mars and Jupiter. Not all the asteroids orbit in the Kuiper belt. Some are between the orbits of Jupiter and some are beyond the orbit of Saturn. More than 100000 asteroids have been found with well charted orbits, out of which 2000 follow the orbits that lead them into the inner and outer solar system. Earth has been struck many times by an asteroid.

What are Meteors

A meteor is a bright streak of light that appears briefly in the sky. Meteors are often called shooting stars or falling stars because they look like stars falling from the sky. Brightest meteors are sometimes called fireballs. A meteor appears when a particle or chunk of metallic or stony matter called a meteoroid enters the earth's atmosphere from outer space. Air friction heats the meteoroid so that it glows and creates a shining trail of gases and melted meteoroid particles. The gases include vaporized meteoroid material and atmospheric gases that heat up when the meteoroid passes through the atmosphere. Most meteors glow for about a second.

Most meteoroids disintegrate before reaching the earth. But some leave a trail that lasts several minutes. Meteoroids that reach the earth are called meteorites.

Comets

Comets revolve around the Sun in highly elliptical orbits. However, their period of revolution round the Sun is usually very long. A Comet appears generally as a bright head with a long tail. The length of the tail grows in size as it approaches the Sun. The tail of a comet is always directed away from the Sun.

Many comets are known to appear periodically. One such comet is Halley’s Comet, which appears after nearly every 86 years.

The Solar System

The Sun and the celestial bodies which revolve around it form the solar system. It consists of a large number of bodies such as planets, comets, asteroids and meteors. The gravitational attraction between the Sun and these objects keeps them revolving around it. The earth is planet and a member of the solar system. There are seven other planets that revolve around the Sun. The eight planets in their order of distance from the Sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

Till 2006 there were nine planets in the solar system. Pluto was the farthest planet from the Sun. In 2006, the International Astronomical Union (IAU) adopted a new definition of a planet. Pluto does not fit this definition. It is no longer a planet of the Solar System.

A planet has a definite path in which it revolves around the Sun. This path is called an Orbit.

Mercury

The planet Mercury is nearest to the Sun. It is the smallest planet of our solar system. Mercury has no satellite of its own.

Venus

Venus is earth's nearest planetary neighbor. It is the brightest planet in the night sky. Sometimes it appears in the eastern sky before sunrise. Sometimes it appears in the western sky just after Sunset. Therefore, it is called a morning or an evening star. Venus has no moon or satellite of its own. It rotates from east to west while the Earth rotates from west to east.

Earth

The Earth is the only planet in the solar system on which life is known to exist. Some special environmental conditions are responsible for the existence and continuation of life on the Earth. From space, the Earth appears blue-green due to the reflection of light from water and landmass on its surface. The axis of rotation of the Earth is not perpendicular to the plane of its orbit. The tilt is responsible for the change of seasons on the Earth. The Earth has only one moon.

Mars

The next planet, the first outside the orbit of the Earth is Mars. It appears slightly reddish and therefore it is also called the red planet. Mars has two small natural satellites.

Jupiter

Jupiter is the largest planet of the solar system. It is so large that about 1300 earths can be placed inside this giant planet. But, the mass of Jupiter is about 318 times that of our Earth.

Saturn

Beyond Jupiter is Saturn which appears yellowish in colour. It is the least dense among all the planets. Its density is less than that of water. Its beautiful rings make it unique in the solar system.

Uranus And Neptune

These are the outermost planets of the solar system. Like Venus, Uranus also rotates from east to west. The most remarkable feature of Uranus is that it has highly tilted rotational axis.

Black Hole

Is a region of spacetime from which gravity prevents anything, including light, from escaping. The theory of general relativity predicts that a sufficiently compact mass will deform spacetime to form a black hole. Around a black hole there is a mathematically defined surface called an event horizon that marks the point of no return. It is called "black" because it absorbs all the light that hits the horizon, reflecting nothing, just like a perfect black body in thermodynamics. Quantum field theory in curved spacetime predicts that event horizons emit radiation like a black body with a finite temperature. This temperature is inversely proportional to the mass of the black hole, making it difficult to observe this radiation for black holes of stellar mass or greater.

Black holes of stellar mass are expected to form when very massive stars collapse at the end of their life cycle. After a black hole has formed it can continue to grow by absorbing mass from its surroundings. By absorbing other stars and merging with other black holes,

supermassive black holes of millions of solar masses may form. There is general consensus that supermassive black holes exist in the centers of most galaxies.

Electricity

A stream of electrons moving through a conductor constitutes an electric current. Conventionally, the direction of current is taken opposite to the direction of flow of electrons. The SI unit of electric current is ampere. Resistance is a property that resists the flow of electrons in a conductor. It controls the magnitude of the current. The SI unit of resistance is ohm.

Ohm's Law

The potential difference across the ends of a resistor is directly proportional to the current through it, provided its temperature remains the same.

The resistance of a conductor depends directly on its length, inversely on its area of cross section, and also on the material of the conductor. The equivalent resistance of several resistors in series is equal to the sum of their individual resistances.

A set of resistors connected in parallel has an equivalent resistance Rp given by $1/Rp=1/R1+1/R2+1/R3+\ldots$

The electrical energy dissipated in a resistor is given by $W= VxIxt$

The unit of power is watt (W). One watt of power is consumed when 1A of current flows at a potential difference of 1 V. The commercial unit of electrical energy is kilowatt hour(kWh).

1kWh= 3600000 J=3.6x106 J.

Magnetism

Is a class of physical phenomena that includes forces exerted by magnets on other magnets. It has its origin in electric currents and the fundamental magnetic moments of elementary particles. These give rise to a magnetic field that acts on other currents and moments. All materials are influenced to some extent by a magnetic field.

A magnetic field exists in the region surrounding a magnet, in which the force of the magnet can be detected.

A compass needle is a small magnet. Its one end, which points towards north, is called a north pole, and the other end which points towards south is called a south pole.

Field lines are used to represent a magnetic field. A field line is the path along which a hypothetical free north pole would tend to move. The direction of the magnetic field at a point is given by the direction that a north pole placed at that point would take. Field lines are shown closer together where the magnetic field is greater. A metallic wire carrying an electric current is associated with it. The field lines about the wire consist of a series of concentric circles whose direction is given by the right-hand rule.

The phenomenon of electromagnetic induction is the production of induced current in a coil placed in a region where the magnetic field changes with time.

The pattern of the magnetic field consists of a core of soft iron wrapped around with a coil of insulated copper wire.

Diamagnetism

Diamagnetism appears in all materials, and is the tendency of a material to oppose an applied magnetic field, and therefore, to be repelled by a magnetic field. However, in a material with paramagnetic properties (that is, with a tendency to enhance an external magnetic field), the paramagnetic behavior dominates. Thus, despite its universal occurrence, diamagnetic behavior is observed only in a purely diamagnetic material. In a diamagnetic material, there are no unpaired electrons, so the intrinsic electron magnetic moments cannot produce any bulk effect. In these cases, the magnetization arises from the electrons' orbital motions, which can be understood classically as follows:

When a material is put in a magnetic field, the electrons circling the nucleus will experience, in addition to their Coulomb attraction to the nucleus, a Lorentz force from the magnetic field. Depending on which direction the electron is orbiting, this force may increase the centripetal force on the electrons, pulling them in towards the nucleus, or it may decrease the force, pulling them away from the nucleus. This effect systematically increases the orbital magnetic moments that were aligned opposite the field, and decreases the ones aligned parallel to the field (in accordance with Lenz's law). This results in a small bulk magnetic moment, with an opposite direction to the applied field. The ferromagnetic substances, the diamagnetic effect is overwhelmed by the much stronger effects caused by the unpaired electrons.

Paramagnetism

In a paramagnetic material there are unpaired electrons, i.e. atomic or molecular orbitals with exactly one electron in them. While paired electrons are required by the Pauli Exclusion Principle to have their intrinsic ('spin') magnetic moments pointing in opposite directions, causing their magnetic fields to cancel out, an unpaired electron is free to align its magnetic moment in any direction. When an external magnetic field is applied, these magnetic moments will tend to align themselves in the same direction as the applied field, thus reinforcing it.

Ferromagnetism

A ferromagnet, like a paramagnetic substance, has unpaired electrons. However, in addition to the electrons' intrinsic magnetic moment's tendency to be parallel to an applied field, there is also in these materials a tendency for these magnetic moments to orient parallel to each other to maintain a lowered-energy state. Thus, even when the applied field is removed, the electrons in the material maintain a parallel orientation.

Every ferromagnetic substance has its own individual temperature, called the Curie temperature, or Curie point, above which it loses its ferromagnetic properties. This is because the thermal tendency to disorder overwhelms the energy-lowering due to ferromagnetic order.
Some well-known ferromagnetic materials that exhibit easily detectable magnetic properties (to form magnets) are nickel, iron, cobalt, gadolinium and their alloys.

Ferrimagnetic Ordering

Like ferromagnetism, ferrimagnets retain their magnetization in the absence of a field. However, like antiferromagnets, neighboring pairs of electron spins like to point in opposite directions. These two properties are not contradictory, because in the optimal geometrical arrangement, there is more magnetic moment from the sublattice of electrons that point in one direction, than from the sublattice that point in the opposite direction. Most ferrites are ferrimagnetic. The first discovered magnetic substance, magnetite, is a ferrite and was originally believed to be a ferromagnet; Louis Néel disproved this, however, after discovering ferrimagnetism.

Superparamagnetism

Subject to Brownian motion. Its response to a magnetic field is qualitatively similar to the response of a paramagnet, but much larger.

Electromagnet

An electromagnet is a type of magnet whose magnetism is produced by the flow of electric current. The magnetic field disappears when the current ceases.

Electromagnet attracts paper a clip when current is applied creating a magnetic field. The electromagnet loses them when current and magnetic field are removed.

Other Types of Magnetism

- Molecular magnet
- Metamagnetism
- Molecule-based magnet
- Spin glass

Magnetic Dipoles

A very common source of magnetic field shown in nature is a dipole, with a "South pole" and a "North pole", terms dating back to the use of magnets as compasses, interacting with the Earth's magnetic field to indicate North and South on the globe. Since opposite ends of magnets are attracted, the north pole of a magnet is attracted to the south pole of another magnet. The Earth's North Magnetic Pole (currently in the Arctic Ocean, north of Canada) is physically a south pole, as it attracts the north pole of a compass.

A magnetic field contains energy, and physical systems move toward configurations with lower energy. When diamagnetic material is placed in a magnetic field, a magnetic dipole tends to align itself in opposed polarity to that field, thereby lowering the net field strength. When ferromagnetic material is placed within a magnetic field, the magnetic dipoles align to the applied field, thus expanding the domain walls of the magnetic domains.

Magnetic Monopoles

Since a bar magnet gets its ferromagnetism from electrons distributed evenly throughout the bar, when a bar magnet is cut in half, each of the resulting pieces is a smaller bar magnet. Even though a magnet is said to have a north pole and a south pole, these two poles cannot be separated from each other. A monopole — if such a thing exists — would be a new and fundamentally different kind of magnetic object. It would act as an isolated north pole, not attached to a south pole, or vice versa. Monopoles would carry "magnetic charge" analogous to electric charge. Despite systematic searches since 1931, as of 2010, they have never been observed, and could very well not exist.

Nevertheless, some theoretical physics models predict the existence of these magnetic monopoles. Paul Dirac observed in 1931 that, because electricity and magnetism show a certain symmetry, just as quantum theory predicts that individual positive or negative electric charges can be observed without the opposing charge, isolated South or North magnetic poles should be observable. Using quantum theory Dirac showed that if magnetic monopoles exist, then one could explain the quantization of electric charge---that is, why the observed elementary particles carry charges that are multiples of the charge of the electron.

Certain grand unified theories predict the existence of monopoles which, unlike elementary particles, are solitons (localized energy packets). The initial results of using these models to estimate the number of monopoles created in the big bang contradicted cosmological observations — the monopoles would have been so plentiful and massive that they would have long since halted the expansion of the universe. However, the idea of inflation (for which this problem served as a partial motivation) was successful in solving this problem, creating models in which monopoles existed but were rare enough to be consistent with current observations.

Living Things

Some organisms can detect magnetic fields, a phenomenon known as magnetoception. Magnetobiology studies magnetic fields as a medical treatment; fields naturally produced by an organism are known as biomagnetism.

Nuclear physics is the field of physics that studies the constituents and interactions of atomic nuclei. The most commonly known applications of nuclear physics are nuclear power generation and nuclear weapons technology, but the research has provided application in many

fields, including those in nuclear medicine and magnetic resonance imaging, ion implantation in materials engineering, and radiocarbon dating in geology and archaeology.

The field of particle physics evolved out of nuclear physics and is typically taught in close association with nuclear physics.

Nuclear Physics

Nuclear Fusion

In nuclear fusion, two low mass nuclei come into very close contact with each other, so that the strong force fuses them. It requires a large amount of energy to overcome the repulsion between the nuclei for the strong or nuclear forces to produce this effect, therefore nuclear fusion can only take place at very high temperatures or high pressures. Once the process succeeds, a very large amount of energy is released and the combined nucleus assumes a lower energy level. The binding energy per nucleon increases with mass number up until nickel-62. Stars like the Sun are powered by the fusion of four protons into a helium nucleus, two positrons, and two neutrinos. The uncontrolled fusion of hydrogen into helium is known as thermonuclear runaway. A frontier in current research at various institutions, for example the Joint European Torus (JET) and ITER, is the development of an economically viable method of using energy from a controlled fusion reaction. Natural nuclear fusion is the origin of the light and energy produced by the core of all stars including our own sun.

Nuclear Fission

Nuclear fission is the reverse process of fusion. For nuclei heavier than nickel-62 the binding energy per nucleon decreases with the mass number. It is therefore possible for energy to be released if a heavy nucleus breaks apart into two lighter ones.

The process of alpha decay is in essence a special type of spontaneous nuclear fission. This process produces a highly asymmetrical fission because the four particles which make up the alpha particle are especially tightly bound to each other, making production of this nucleus in fission particularly likely.

For certain of the heaviest nuclei which produce neutrons on fission, and which also easily absorb neutrons to initiate fission, a self-igniting type of neutron-initiated fission can be obtained, in a so-called chain reaction. Chain reactions were known in chemistry before physics, and in fact many familiar processes like fires and chemical explosions are chemical chain reactions. The fission or "nuclear" chain-reaction, using fission-produced neutrons, is the source of energy for nuclear power plants and fission type nuclear bombs, such as those detonated by the United States in Hiroshima and Nagasaki, Japan, at the end of World War II. Heavy nuclei such as uranium and thorium may also undergo spontaneous fission, but they are much more likely to undergo decay by alpha decay.

For a neutron-initiated chain-reaction to occur, there must be a critical mass of the element present in a certain space under certain conditions. The conditions for the smallest critical mass require the conservation of the emitted neutrons and also their slowing or moderation so there is a greater cross-section or probabability of them initiating another fission. In two regions of Oklo, Gabon, Africa, natural nuclear fission reactors were active over 1.5 billion years ago. Measurements of natural neutrino emission have demonstrated that around half of the heat emanating from the Earth's core results from radioactive decay. However, it is not known if any of this results from fission chain-reactions.

Sound is produced by vibrating objects. In human beings, the vibration of the vocal cords produces sound. Sound travels through a medium (gas, liquid or solid). It cannot travel in vacuum.

The Doppler Effect

The Doppler effect (or Doppler shift), named after the Austrian physicist Christian Doppler, who proposed it in 1842 in Prague, is the change in frequency of a wave (or other periodic event) for an observer moving relative to its source. It is commonly heard when a vehicle sounding a siren or horn approaches, passes, and recedes from an observer. The received frequency is higher (compared to the emitted frequency) during the approach, it is identical at the instant of passing by, and it is lower during the recession.

A Sonic Boom

A sonic boom is the sound associated with the shock waves created by an object traveling through the air faster than the speed of sound. Sonic booms generate enormous amounts of sound energy, sounding much like an explosion. The crack of a supersonic bullet passing overhead is an example of a sonic boom in miniature.

Dolby NR

Dolby NR is the name given to a series of noise reduction systems developed by Dolby Laboratories for use in analog magnetic tape recording. The first was Dolby A, a professional broadband noise reduction for recording studios in 1966, but the best-known is Dolby B (introduced 1968), a sliding band system for the consumer market, which helped make high fidelity practical on cassette tapes, and is common on stereo tape players and recorders to the present day. Of the noise reduction systems, Dolby A and Dolby SR were developed for professional use.

Echo

In audio signal processing and acoustics, an echo (plural echoes) is a reflection of sound, arriving at the listener some time after the direct sound. Typical examples are the echo produced by the bottom of a well, by a building, or by the walls of an enclosed room and an empty room. A true echo is a single reflection of the sound source. The time delay is the extra distance divided by the speed of sound.

Resonance

Resonance is the tendency of a system to oscillate with greater amplitude at some frequencies than at others. Frequencies at which the response amplitude is a relative maximum are known as the system's resonant frequencies, or resonance frequencies.

Resonance phenomena occur with all types of vibrations or waves: there is mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) and resonance of quantum wave functions.

One familiar example is a playground swing, which acts as a pendulum. Pushing a person in a swing in time with the natural interval of the swing (its resonant frequency) will make the swing go higher and higher (maximum amplitude), while attempts to push the swing at a faster or slower tempo will result in smaller arcs. This is because the energy the swing absorbs is maximized when the pushes are 'in phase' with the swing's natural oscillations, while some of the swing's energy is actually extracted by the opposing force of the pushes when they are not.

Resonance occurs widely in nature, and is exploited in many man-made devices. It is the mechanism by which virtually all sinusoidal waves and vibrations are generated. Many sounds we hear, such as when hard objects of metal, glass, or wood are struck, are caused by brief resonant vibrations in the object. Light and other short wavelength electromagnetic radiation is produced by resonance on an atomic scale, such as electrons in atoms. Other examples are:

Mechanical and acoustic resonance

- the timekeeping mechanisms of modern clocks and watches, e.g. the balance wheel in a mechanical watch and the quartz crystal in a quartz watch
- the tidal resonance of the Bay of Fundy
- acoustic resonances of musical instruments and human vocal cords
- the shattering of a crystal wine glass when exposed to a musical tone of the right pitch (its resonant frequency)

Electrical Resonance

- electrical resonance of tuned circuits in radios and TVs that allow radio frequencies to be selectively received

Optical Resonance

- creation of coherent light by optical resonance in a laser cavity

A Rainbow is an optical and meteorological phenomenon that is caused by reflection of light in water droplets in the Earth's atmosphere, resulting in a spectrum of light appearing in the sky. It takes the form of a multicolored arc.

Camera Microscope

LASER-Laser is the abbreviation of Light Amplification by the Stimulated Emission of Radiation. It is a device that creates a narrow and low-divergent beam of coherent light, while most other light sources emit incoherent light, which has a phase that varies randomly with time and position. Most lasers emit nearly "monochromatic" light with a narrow wavelength spectrum.

The principle of a laser is based on three separate features: a) stimulated emission within an amplifying medium, b) population inversion of electronics and c) an optical resonator.

Spontaneous Emission and Stimulated Emission

According to quantum mechanics, an electron within an atom or lattice can have only certain values of energy, or energy levels. There are many energy levels that an electron can occupy, but here we will only consider two. If an electron is in the excited state with the energy E2 it may spontaneously decay to the ground state, with energy E1, releasing the difference in energy between the two states as a photon. This process is called spontaneous emission, producing fluorescent light. The phase and direction of the photon in spontaneous emission are completely random due to Uncertainty Principle.

Concave lens is the one whose curved surface is bent inside. It diverges the rays from the principal axis. It generally forms virtual and erect images i.e. images on the same side of the object. This image can't be taken on the screen. Convex lens is the one whose curved surface is bulged out. Simplest example is dewdrop on a leaf. It generally gives a real and inverted image and has a capacity to magnify the image.

Convex lens and Concave lens

Uses

1. Both concave and convex lenses are used in glasses
2. A microscope, like a reflecting telescope, uses a concave mirror
3. A plane mirror, and a convex lens
4. A refracting telescope uses two convex lenses to magnify images in the sky
5. Binoculars use concave lenses to improve detail.

6. Convex mirrors are often found on the passenger sides of motor vehicles. These mirrors make objects appear smaller than they really are. Due to this compression, these mirrors reflect a wider image area, or field of vision.
7. Convex mirrors are often placed near ATMs to allow bank customers to see if someone is behind them. This is a security measure that helps keep ATM users safe from robbery of any cash withdrawals and helps keep ATM users' identity more secure.
8. Two convex mirrors placed back to back are used to make a magnifying glass.
9. Concave mirrors are used in vehicle headlights to focus the light from the headlight. The light is not as diffused and the driver can see better at night.
10. Concave mirrors are used to focus light for heating purposes.

Heat

Heat is energy transferred from one body to another by thermal interactions.The transfer of energy can occur in a variety of ways, among them conduction, radiation, and convection. Heat is not a property of a system or body, but instead is always associated with a process of some kind, and is synonymous with heat flow and heat transfer. The SI unit of heat is the joule. Heat can be measured by calorimetry, or determined indirectly by calculations based on other quantities, relying for instance on the first law of thermodynamics. In calorimetry, the concepts of latent heat and of sensible heat are used. Latent heat produces changes of state without temperature change, while sensible heat produces temperature change.

The transfer of heat from a warm object to a cooler one takes place by one of three methods or a combination thereof. These methods are: conduction, convection or radiation.

Conduction

Conduction of heat occurs when faster moving molecules pass on some of their energy to adjacent molecules which are slower-moving, i.e. at a lower temperature. This may occur within a solid or between a solid and an adjacent fluid such as air. In any heated building or enclosure, heat is conducted or transmitted from the warm inside air to the inside surfaces, then through the wall or roof, to the cooler outside surface and on to the outside air.

Convection

Convection transfer of heat involves the mixing of warm and cool particles of fluid. The mixing may come as a result of density differences due to temperature differences which is natural convection, or, if the mixing is produced by mechanical means, forced convection. In a heated building, convection losses occur when cold outside air enters a building, mixes with the warmer inside air, and then exits through an exhauster or through doors, cracks, etc.

Radiation

Heat transfer by radiation differs from the transfer of heat by conduction or convection in that it does not need matter to accomplish the transfer. Radiated heat is usually termed infra-red. This is just one of the several forms of radiation. Infra-red is transmitted at the speed of light, 186,000 miles per second, in a straight line with minimal loss to the air. It can be aimed, reflected or focused by materials that have a highly reflective surface, bright aluminum, for example. When infra-red strikes an absorptive object such as concrete, wood, water, paint, skin or clothing is converted into heat at the surface. Surrounding air is then warmed by conduction and convection. The best example of this transfer of heat is from the sun to the earth without loss of heat to outer space.

Radiation or infra-red energy is emitted by all matter that is above absolute zero (-460°F). The net transfer of heat is from one object to a cooler object.

Warm objects, including people inside a heated building lose or radiate heat to the cooler inside surfaces of the walls. The walls conduct heat to the outside surface and then lose heat by radiation, conduction and convection to the outside.

Latent Heat

Latent heat is the heat released or absorbed by a body or a thermodynamic system during a process that occurs without a change in temperature. A typical example is a change of state of matter, meaning a phase transition such as the melting of ice or the boiling of water.

Densities

Densities-The mass density or density of a material is its mass per unit volume. The symbol most often used for density is ρ (the lowercase Greek letter rho). Mathematically, density is defined as mass divided by volume:

Where ρ is the density, m is the mass, and V is the volume.

Different materials usually have different densities, so density is an important concept regarding buoyancy, purity and packaging.

Less dense liquids float on more dense fluids if they do not mix. This concept can be extended, with some care, to less dense solids floating on more dense fluids. If the average density (including any air below the waterline) of an object is less than water it will float in water and if it is more than water it will sink in water.

The mass density of a material varies with temperature and pressure. (The variance is typically small for solids and liquids and much greater for gasses.) Increasing the pressure on an object decreases the volume of the object and therefore increase its density. Increasing the temperature of a substance (with some exceptions) decreases its density by increasing the volume of that substance. In most materials, heating the bottom of fluid results in convection of the heat from bottom to top of the fluid due to the decrease of the density of the heated fluid. This causes it to rise relative to more dense unheated material.

Surface Tension

Surface tension is a contractive tendency of the surface of a liquid that allows it to resist an external force. It is revealed, for example, in the floating of some objects on the surface of water, even though they are denser than water, and in the ability of some insects (e.g. water striders) to run on the water surface. This property is caused by cohesion of similar molecules, and is responsible for many of the behaviors of liquids.

Surface tension has the dimension of force per unit length, or of energy per unit area. The two are equivalent—but when referring to energy per unit of area, people use the term surface energy—which is a more general term in the sense that it applies also to solids and not just liquids. In materials science, surface tension is used for either surface stress or surface free energy.

The cohesive forces among liquid molecules are responsible for the phenomenon of surface tension. In the bulk of the liquid, each molecule is pulled equally in every direction by neighboring liquid molecules, resulting in a net force of zero. The molecules at the surface do not have other molecules on all sides of them and therefore are pulled inwards. This creates some internal pressure and forces liquid surfaces to contract to the minimal area.

Surface tension is visible in other common phenomena, especially when surfactants are used to decrease it:

- Soap bubbles have very large surface areas with very little mass. Bubbles in pure water are unstable. The addition of surfactants, however, can have a stabilizing effect on the bubbles (see Marangoni effect). Notice that surfactants actually reduce the surface tension of water by a factor of three or more.
- Emulsions are a type of solution in which surface tension plays a role. Tiny fragments of oil suspended in pure water will spontaneously assemble themselves into much larger masses. But the presence of a surfactant provides a decrease in surface tension, which permits stability of minute droplets of oil in the bulk of water (or vice versa).
- Several effects of surface tension can be seen with ordinary water:
- Beading of rain water on a waxy surface, such as a leaf. Water adheres weakly to wax and strongly to itself, so water clusters into drops. Surface tension gives them their near-spherical shape, because a sphere has the smallest possible surface area to volume ratio.
- Formation of drops occurs when a mass of liquid is stretched. The animation shows water adhering to the faucet gaining mass until it is stretched to a point where the surface tension can no longer bind it to the faucet. It then separates and surface tension forms the drop into a sphere. If a stream of water were running from the faucet, the stream would break up into drops during its fall. Gravity stretches the stream, then surface tension pinches it into spheres.
- Flotation of objects denser than water occurs when the object is nonwettable and its weight is small enough to be borne by the forces arising from surface tension. For example, water striders use surface tension to walk on the surface of a pond. The surface

of the water behaves like an elastic film: the insect's feet cause indentations in the water's surface, increasing its surface area.

- Separation of oil and water (in this case, water and liquid wax) is caused by a tension in the surface between dissimilar liquids. This type of surface tension is called "interface tension", but its physics are the same.
- Tears of wine is the formation of drops and rivulets on the side of a glass containing an alcoholic beverage. Its cause is a complex interaction between the differing surface tensions of water and ethanol; it is induced by a combination of surface tension modification of water by ethanol together with ethanol evaporating faster than water.

Viscosity

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress. For liquids, it corresponds to the informal notion of "thickness". For example, honey has a higher viscosity than water.

Viscosity is due to friction between neighboring parcels of the fluid that are moving at different velocities. When fluid is forced through a tube, the fluid generally moves faster near the axis and very little near the walls, therefore some stress (such as a pressure difference between the two ends of the tube) is needed to overcome the friction between layers and keep the fluid moving. For the same velocity pattern, the stress is proportional to the fluid's viscosity.

A fluid that has no resistance to shear stress is known as an ideal fluid or inviscid fluid. In the real world, zero viscosity is observed only at very low temperatures, in superfluids. Otherwise all fluids have positive viscosity. If the viscosity is very high, such as in pitch, the fluid will seem to be solid in the short term. In common usage, a liquid whose viscosity is less than that of water is known as a mobile liquid, while a substance with a viscosity substantially greater than water is simply called a viscous liquid.

The Working Principles Behind Artificial Satellites

A satellite is an object which has been placed into orbit by human endeavor. Such objects are sometimes called artificial satellites to distinguish them from natural satellites such as the Moon.

To place a satellite at a height of 300 km, the launching velocity should at least be about 8.5 km s-1 or 30600 kmph. If this high velocity is given to the rocket at the surface of the Earth, the rocket will be burnt due to air friction. Moreover, such high velocities cannot be developed by single rocket. Hence, multistage rockets are used. To be placed in an orbit, a satellite must be raised to the desired height and given the correct speed and direction by the launching rocket At lift off, the rocket, with a manned or unmanned satellite on top, is held down by clamps on the launching pad. Now the exhaust gases built−up an upward thrust which exceeds the rocket's weight. The clamps are then removed by remote control and the rocket accelerates upwards. To penetrate the dense lower part of the atmosphere, initially the rocket rises vertically and then tilted by a guidance system. The first stage rocket, which may burn for about 2 minutes producing a speed of 3 km s-1, lifts the vehicle to a height of about 60 km and then separates and falls back to the Earth. The vehicle now goes to its orbital height, say 160 km, where it moves horizontally for a moment. Then the second stage of the rocket fires and increases the speed that is necessary for a circular orbit. By firing small rockets with a remote control system, the satellite is separated from the second stage and made to revolve in its orbit.

Newton's laws of motion are three physical laws that form the basis for classical mechanics. They describe the relationship between the forces acting on a body and its motion due to those forces. They have been expressed in several different ways over nearly three centuries, and can be summarized as follows:

1. First law: If there is no net force on an object, then its velocity is constant. The object is either at rest (if its velocity is equal to zero), or it moves with constant speed in a single direction.
2. Second law: The acceleration a of a body is parallel and directly proportional to the net force F acting on the body, is in the direction of the net force, and is inversely proportional to the mass m of the body, i.e., F = ma.
3. Third law: When a first body exerts a force F1 on a second body, the second body simultaneously exerts a force F2 = −F1 on the first body. This means that F1 and F2 are equal in magnitude and opposite in direction.

Newton's law of universal gravitation states that every point mass in the universe attracts every other point mass with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Every point mass attracts every single other point mass by a force pointing along the line intersecting both points. The force is proportional to the product of the two masses and inversely proportional to the square of the distance between them.

Everyday Applications of Newton's First Law

There are many applications of Newton's first law of motion. Consider some of your experiences in an automobile. Have you ever observed the behavior of coffee in a coffee cup filled to the rim while starting a car from rest or while bringing a car to rest from a state of motion? Coffee "keeps on doing what it is doing." When you accelerate a car from rest, the road provides an unbalanced force on the spinning wheels to push the car forward; yet the coffee (that was at rest) wants to stay at rest. While the car accelerates forward, the coffee remains in the same position; subsequently, the car accelerates out from under the coffee and the coffee spills in your lap. On the other hand, when braking from a state of motion the coffee continues forward with the same speed and in the same direction, ultimately hitting the windshield or the dash. Coffee in motion stays in motion.

Have you ever experienced inertia (resisting changes in your state of motion) in an automobile while it is braking to a stop? The force of the road on the locked wheels provides the unbalanced force to change the car's state of motion, yet there is no unbalanced force to change your own state of motion. Thus, you continue in motion, sliding along the seat in forward motion. A person in motion stays in motion with the same speed and in the same direction ... unless acted upon by the unbalanced force of a seat belt. Yes! Seat belts are used to provide safety for passengers whose motion is governed by Newton's laws. The seat belt provides the unbalanced force that brings you from a state of motion to a state of rest. Perhaps you could speculate what would occur when no seat belt is used.

There are many more applications of Newton's first law of motion. Several applications are listed below. Perhaps you could think about the law of inertia and provide explanations for each application.

- Blood rushes from your head to your feet while quickly stopping when riding on a descending elevator.
- The head of a hammer can be tightened onto the wooden handle by banging the bottom of the handle against a hard surface.
- A brick is painlessly broken over the hand of a physics teacher by slamming it with a hammer. (CAUTION: do not attempt this at home!)
- To dislodge ketchup from the bottom of a ketchup bottle, it is often turned upside down and thrusted downward at high speeds and then abruptly halted.
- Headrests are placed in cars to prevent whiplash injuries during rear-end collisions.
- While riding a skateboard (or wagon or bicycle), you fly forward off the board when hitting a curb or rock or other object that abruptly halts the motion of the skateboard.

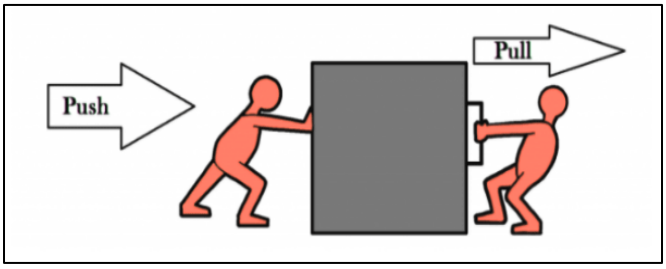
Force

Introduction

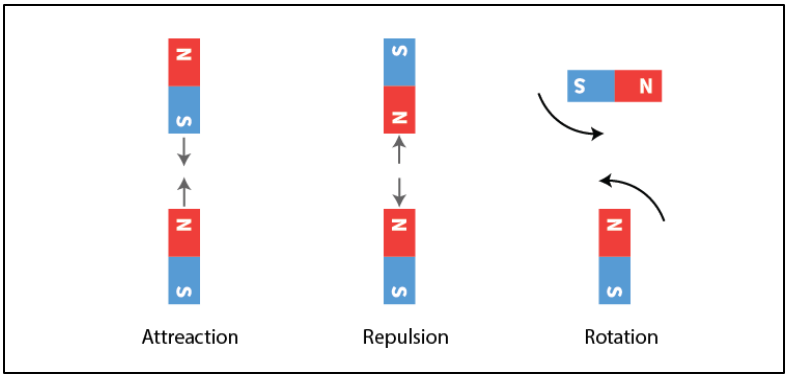
In science, a push or pull of an object is known as force. The interaction between two objects arises force. Force has both magnitude and direction. The strength of a force is expressed in magnitude. Force brings about a change in the direction or state of motion of a body.

Push

A push is a force exerted away from the body, for example, Hitting a snooker ball, or kicking a football.



The force of attraction or repulsion between two magnetic bodies due to their poles is known as a magnetic force.



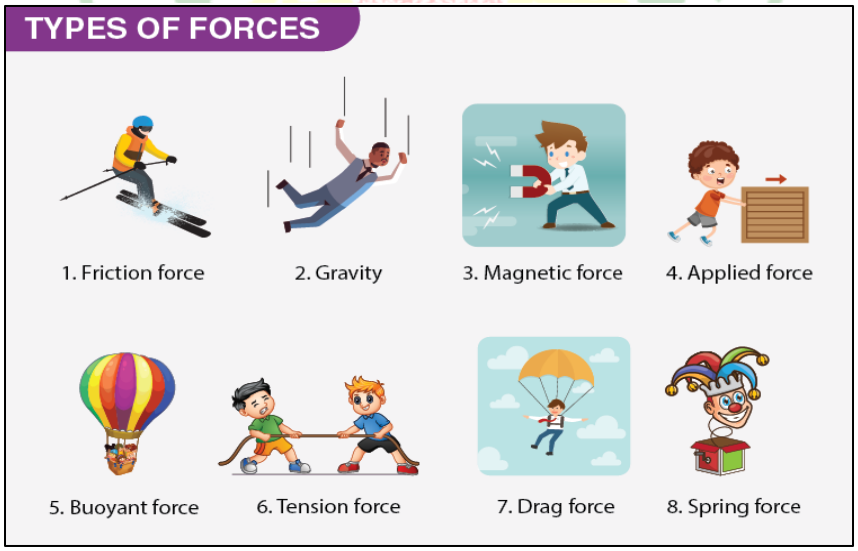
What Is It?

Pull

A pull is a force exerted towards the body, for example, drawing a bucket of water from a well or playing tug of war.

Force

- A force is a push or a pull.
- The interaction between objects can change the state of the objects.

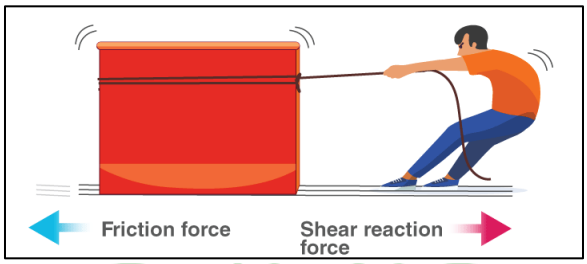


Net force

- The result of all the forces acting on a body is known as the net force.
- The acceleration of the body is along the direction of the net force.

Frictional force

- The force that opposes the relative motion between two surfaces.
- Acts between the surface of the two bodies in contact.
- Type of contact force.



What Can Force Do?

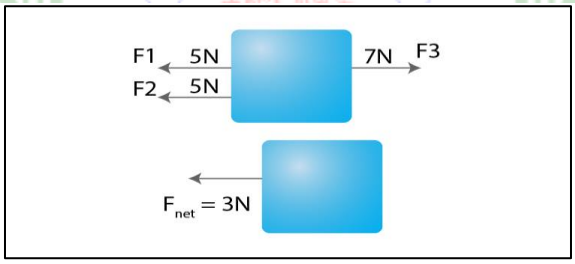
Vector

– Vector quantities are expressed in magnitude as well as the direction of the object. For example, velocity, displacement, weight, momentum, force, acceleration etc.

– Vectors are used to find the resultant component acting on a body.

– When multiple forces act on a body, they can be resolved into one component known as the net force acting on the object.

Example:



Vectors are also useful when the force acts at an angle to the horizontal.

Application of Force

– A force is an effort that changes the state of an object at rest or in motion.

– It can change an object's direction and velocity.

– Force can also change the shape of an object.

State of Motion

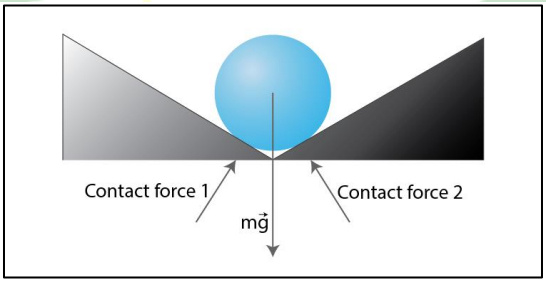
The state of motion of an object is defined by its velocity – the speed with a direction. Thus, inertia could be redefined as follows:

Inertia = tendency of an object to resist changes in its velocity. An object at rest has zero velocity – and (in the absence of an unbalanced force) will remain with a zero velocity; it will not change its state of motion (i.e., velocity). An object in motion with a velocity of 2 m/s, East; will (in the absence of an unbalanced force) remain in motion with a velocity of 2 m/s, East; it will not change its state of motion (i.e., velocity). Objects resist changes in their velocity.

Types of Forces

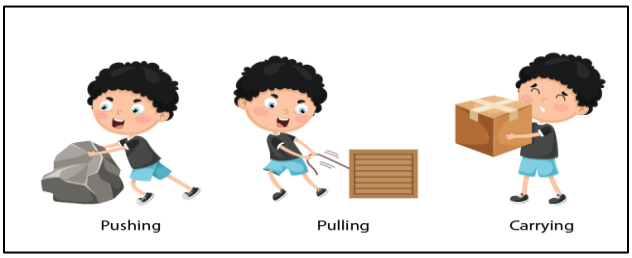
Contact

Touch or contact is required to do most of our everyday activities. For example, lifting, pulling, kicking, pushing etc.



Contact forces

Forces that require a touch or contact to be applied are known as contact forces. For example, muscular forces and frictional forces

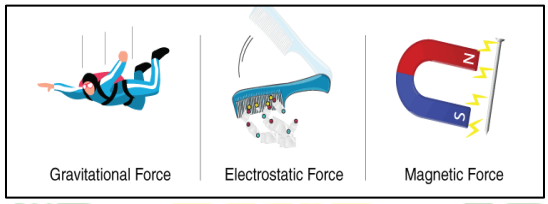


Muscular force

The force applied by the effort of our muscles, for example, lifting a heavy box, pulling a bucket of water or pedalling a cycle.

Non-contact forces

- Forces that do not need contact or that have their influence without a touch. For example, magnetic force, electrostatic force, and gravitational force.

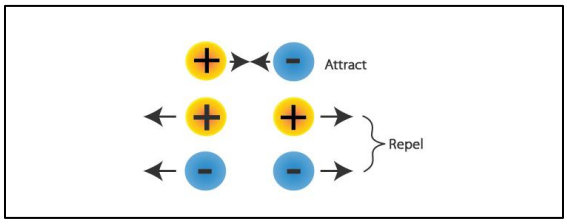


Gravitational force

- The attractive force that a body experiences towards the centre of the earth is called the force of gravity due to earth.
- Property of the universe, every object attracts or exerts a force on every other object.

Electrostatic force

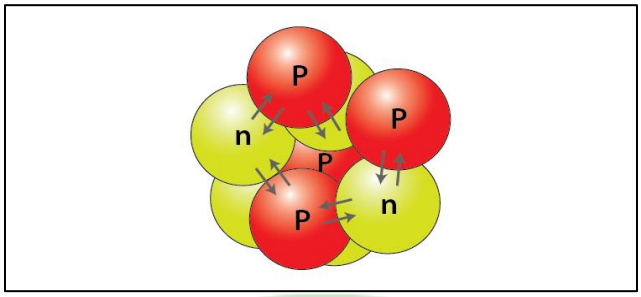
The force of attraction or repulsion experienced by a charged body from another charged body in the same vicinity is known as Electrostatic Force.



Nuclear forces

- The nuclear force acts between all the particles in the nucleus. i.e., between two neutrons, between two protons and between a neutron and a proton.

- It is an attractive force in all cases.
- It is the force that keeps the nucleus intact by overcoming the enormous repulsive force between positive protons.



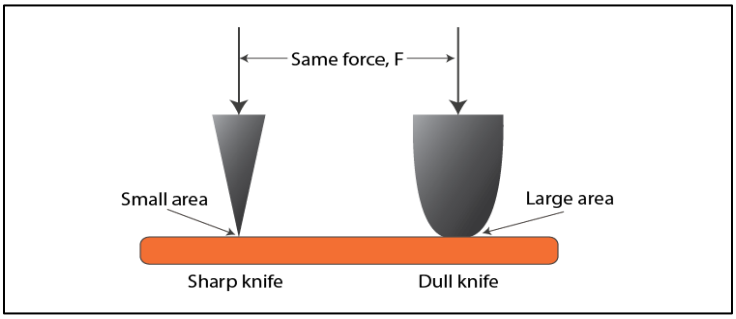
Thrust and Pressure

Pressure

- Force acting per unit area is known as pressure.
- SI unit is Pascal.

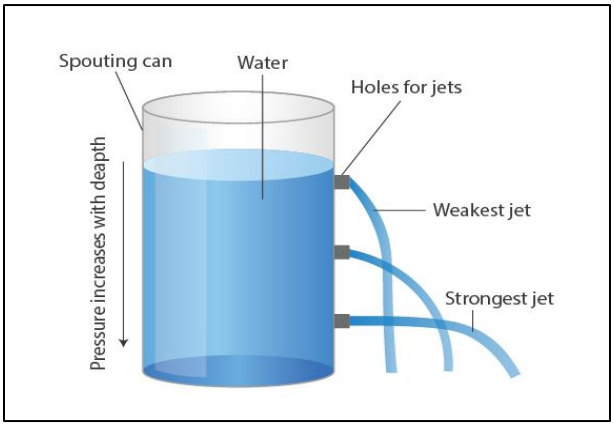
Distribution of pressure

- Force acting on a smaller area applies more pressure than the same force acting on a larger area.
- Examples: Porters place a round cloth on their heads to increase surface area and reduce pressure.
- A sharp knife cuts better as more pressure is exerted over a smaller area.



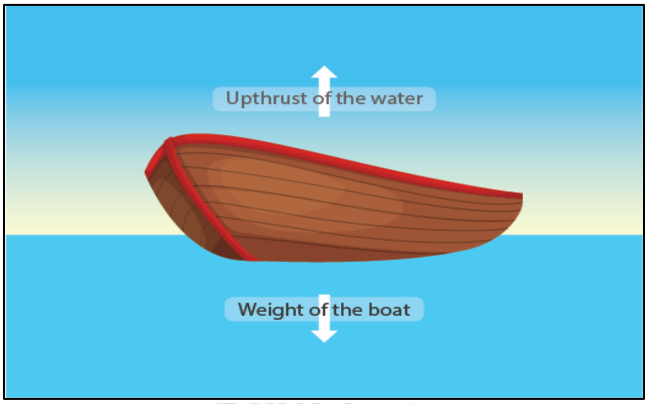
Pressure in fluids

The pressure exerted by a fluid(gases or liquids) in a container is transmitted undiminished in all direction on the walls of the container.



Upthrust

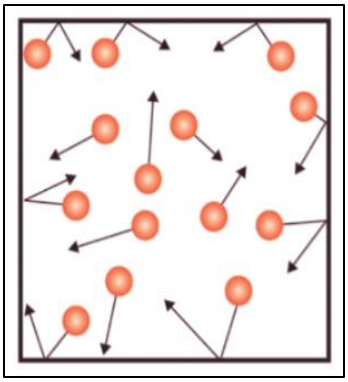
The upward force exerted by a fluid on an object is known as upthrust or buoyant force.



Atmospheric Pressure

Gaseous pressure

Gases exert the same pressure on the walls of the container in all directions.



Atmospheric pressure

- Our atmosphere extends to several kilometres above sea level. The weight of the air acts as pressure known as atmospheric pressure.
- The pressure in our body balances the atmospheric pressure and that is why we do not feel it.

What is Pressure?

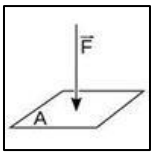
Have you ever wondered why our knives need to be so sharp or why the nails we use end with a sharp point? The answers to all these questions lie in the concept of pressure. It is the ratio of the force applied to the surface area over which the force is applied. *We can define pressure as*

The force applied perpendicular to the surface of an object per unit area over which that force is distributed.

Formula:

When a force of 'F' Newton is applied perpendicularly to a surface area 'A', then the pressure exerted on the surface by the force is equal to the ratio of F to A. The **formula for pressure** (P) is:

$$P = F / A$$



Units of Pressure

There are various units to describe Pressure some of which we will discuss further in this article.

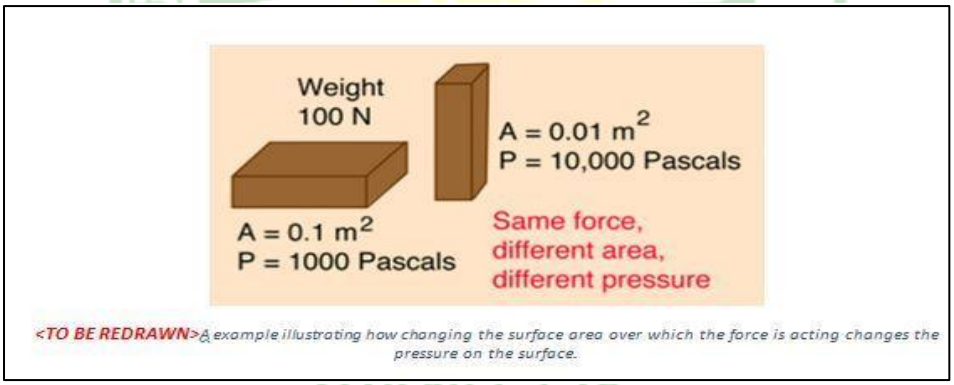
The SI unit of pressure is the **pascal (Pa)**.

A pascal can be defined as a force of one newton applied over a surface area of a one-meter square.

Factors Affecting Pressure

Since the pressure is dependent on the area over which the force is acting, the pressure can be increased and decreased without any change in the force. The force applied to be constant if the surface becomes smaller the pressure increases and vice versa.

For example, a brick sitting on a surface exerts a force equal to its weight on the object it is resting on. Now we know that a rectangular brick has a wide surface and a thin surface on the sides. By changing the orientation of the brick resting on a surface, we are effectively changing the pressure acting on the surface by the same brick. See the image below for more information.



<TO BE REDRAWN>A example illustrating how changing the surface area over which the force is acting changes the pressure on the surface.

In other words, **if the surface becomes smaller, the pressure becomes larger**. It is for this reason that our knives and nails are so sharp. A knife distributes the force over its entire cutting edge. Sharper the edge, higher the pressure, and consequently the cutting with a sharp knife is easy. In a blunt knife, the force is distributed over its blunt surface with a larger surface area. Therefore, we need to put more force in order to cut. Therefore, a knife is best when at its sharpest.

For the same reason—that is, that reduction of surface area increases net pressure—an expertly delivered karate chop is much more damaging and deadly than an open-handed slap. When you slap someone, the force you apply in slapping the surface is distributed all over the

palm of your hand. In contrast, a karate chop concentrates all the force on the sides of your hand which have significantly lesser surface area than your palms. This leads to a greater application of pressure on the surface thereby rendering a karate chop is deadlier than a slap.

Sometimes though, a greater surface area is also preferred. A typical drawing pin comes with one flat round end with which you push the other sharp end into the drawing board. Can you imagine how hard it would be to push a drawing pin into a board if both its sides were sharp? Since one end is flat, you can apply the necessary force easily. Similar tactics are used in skiing and surfing. By using surfboards and skis, we increase the area over which our weight acts thereby allowing us to float or glide over the surface of water or ice.

What Is Energy?

There are different forms of energy on earth. The sun is considered the elemental form of energy on earth. In physics, energy is considered a quantitative property that can be transferred from an object to perform work. Hence, we can define energy as the strength to do any kind of physical activity.

Thus, in simple words, we can define energy as, Energy is the ability to do work

According to the laws of conservation of energy, " energy can neither be created nor destroyed but can only be converted from one form to another". The SI unit of energy is Joule.

Units of Energy

The International System of Units of measurement of energy is **joule**. The unit of energy is named after James Prescott Joule. Joule is a derived unit equal to the energy expended in applying a force of **one newton through a distance of one meter**. However, energy is also expressed in many other units not part of the SI, such as ergs, calories, British Thermal Units, kilowatt-hours, and kilocalories, which require a conversion factor when expressed in SI units.

Different Types of Energy

Although there are many forms of energy, it is broadly categorized into:

- Kinetic Energy
- Potential Energy

Kinetic Energy

Kinetic energy is the energy associated with the object's motion. Objects in motion are capable of causing a change or are capable of doing work. To better understand, let us think of a wrecking ball. A wrecking ball in motion is used to do work such as the demolition of buildings, stones, etc. Even a slow-moving wrecking ball is capable of causing a lot of damage to another object, such as an empty house. However, a wrecking ball that is not in motion does not do any work.

Another example of kinetic energy is the energy associated with the constant, random bouncing of atoms or molecules. This is also known as thermal energy. The average thermal energy of a group of molecules is what we call temperature, and when thermal energy is transferred between two objects, it's known as heat.

$$\text{Kinetic energy} = \tfrac{1}{2}\, mv^2$$

Different Types of Kinetic Energy:

Radiant energy

- Radiant energy is the type of energy that travels by waves or particles. This energy is created through electromagnetic waves and is most commonly experienced by humans in the form of heat. Following are a few examples of radiant energy:
- When you turn on an incandescent light bulb, it gives off two forms of energy. There is visible light and heat that is generated. Both these generated energies are a form of radiant energy.
- Sunlight is an example of radiant energy.

Thermal Energy

Thermal energy is similar to radiant energy and is experienced in the form of heat or warmth. While radiant energy refers to waves or particles, thermal energy describes the activity level among the atoms and molecules in an object. This is the only difference between radiant energy and thermal energy. Some examples of thermal energy include:

- The geothermal energy that comes from the decay of natural minerals and the volcanic action of the earth is an example of thermal energy.
- When you heat up the pizza in the oven, you raise the pizza's temperature. The molecules that make up the pizza move more quickly when the pizza is piping hot.
- The warmth you feel emanating from the engine is an example of thermal energy.

Sound Energy

Humans experience the vibrations that reach the human ear as sound. The disturbance moves in the form of waves through a medium like air and reaches our eardrum. On reaching the eardrum, these vibrations are converted into electrical signals and sent to the brain, which we interpret as the sensation of sound.

Electrical Energy

The flow of negatively charged electrons around a circuit results in electricity which we more commonly refer to as electrical energy.

Mechanical Energy

Mechanical energy is the energy associated with the mechanical movement of objects. This type of energy can also be referred to as motion energy.

Potential Energy

Potential energy is the energy stored in an object or system of objects. Potential energy can transform into a more obvious form of kinetic energy.

Potential energy $= m \times g \times h$

Both potential energy and kinetic energy form mechanical energy.

Mechanical energy $= \frac{1}{2} mv^2 + mgh$

Different Types of Potential Energy

Gravitational Potential Energy

Gravitational potential energy is the energy stored in an object due to its vertical position or height. A book on a high bookshelf has a higher gravitational potential energy than a book on the bottom bookshelf.

Gravitational Potential Energy Examples

- River water at the top of a waterfall
- A book on a table before it falls
- A car that is parked at the top of a hill

Elastic Potential Energy

Elastic potential energy is stored as a result of applying a force to deform an elastic object. The energy is stored until the force is removed and the object springs back to its original shape, doing work in the process. The deformation could involve compressing, stretching or twisting the object.

Elastic Potential Energy Examples

- A spring that is coiled
- The string of an archer's bow is pulled back
- Rubber band that has been stretched

Chemical Potential Energy

Chemical potential energy is the energy stored in the chemical bonds of the substance. The energy can be absorbed and released due to a change in the particle number of the given species.

Chemical Potential Energy Examples

- Before the sun shines on the green leaves (potential photosynthesis)

- Gasoline before it is ignited
- Fireworks before they are launched

Electric Potential Energy

Electric potential energy is the energy that is needed to move a charge against an electric field.

Electric Potential Energy Examples

- An incandescent light bulb that is turned off
- A radio tower that is not working
- A black-light turned off
- A television before it is turned on

Energy Conversion: Transfer and Transform

We know energy can be transferred from one form to another. The movement of energy from one location to another is known as energy transfer. We notice various energy transformations happening around us.

Following are the four ways through which energy can be transferred:

- Mechanically – By the action of force
- Electrically – Electrically
- By Radiation – By Light waves or Sound waves
- By Heating – By conduction, convection, or radiation

The process which results in the energy changing from one form to another is known as energy transformation. While energy can be transformed or transferred, the total amount of energy does not change -– this is called energy conservation.

Law of Conservation of Energy

The law of energy conservation is one of physics's basic laws. It governs the microscopic motion of individual atoms in a chemical reaction. The law of conservation of energy states that "*In a closed system, i.e., a system that is isolated from its surroundings, the total energy of the*

system is conserved." According to the law, the total energy in a system is conserved even though energy transformation occurs. Energy can neither be created nor destroyed, it can only be converted from one form to another.

UNIT – 3 CHEMISTRY

The first law of thermodynamics, also called conservation of energy, states that the total amount of energy in the universe is constant. This means that all of the energy has to end up somewhere, either in the original form or in a different form. We can use this knowledge to determine the amount of energy in a system, the amount lost as waste heat, and the efficiency of the system.

The second law of thermodynamics states that the disorder in the universe always increases. After cleaning your room, it always has a tendency to become messy again. This is a result of the second law. As the disorder in the universe increases, the energy is transformed into less usable forms. Thus, the efficiency of any process will always be less than 100%.

The third law of thermodynamics tells us that all molecular movement stops at a temperature we call absolute zero, or 0 Kelvin (-273oC). Since temperature is a measure of molecular movement, there can be no temperature lower than absolute zero. At this temperature, a perfect crystal has no disorder.

CHAPTER 2: POLYSACCHARIDES-USE AND SOURCES

Polysaccharides are long carbohydrate molecules of repeated monomer units joined together by glycosidic bonds. They range in structure from linear to highly branched. Polysaccharides are often quite heterogeneous, containing slight modifications of the repeating unit. Depending on the structure, these macromolecules can have distinct properties from their monosaccharide building blocks. They may be amorphous or even insoluble in water.

When all the monosaccharides in a polysaccharide are the same type, the polysaccharide is called a homopolysaccharide or homoglycan, but when more than one type of monosaccharide is present they are called heteropolysaccharides or heteroglycans.

Examples include storage polysaccharides such as starch and glycogen, and structural polysaccharides such as cellulose and chitin.

Polysaccharides have a general formula of Cx(H2O)y where x is usually a large number between 200 and 2500. Considering that the repeating units in the polymer backbone are often six- carbon monosaccharide, the general formula can also be represented as (C6H10O5)n

Sources of Polysaccharides-Glycogen (cereals, tubers, roots, banana, sweet potatoes, yams, beans) Starch (bread, fruit, grain, rice, pasta),Cellulose (crisp fruits and vegetables)

Basic energy sources for living organisms

GLYCOGEN- an energy reserve, (stored in liver), can break down into glucose when it is needed -Precursors for other biologically important molecules---i.e. mono saccharides are used to make other molecules like glycerol and fatty acids and some amino acids. -Cellulose-structural material in plants (not in syllabus)

Biotechnology is the use of living systems and organisms to develop or make useful products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use" (UN Convention on Biological Diversity).

For thousands of years, humankind has used biotechnology in agriculture, food production and medicine.

Biotechnology has applications in four major industrial areas, including health care (medical), crop production and agriculture, non-food (industrial) uses of crops and other products (e.g. biodegradable plastics, vegetable oil, biofuels), and environmental uses.

For example, one application of biotechnology is the directed use of organisms for the manufacture of organic products (examples include beer and milk products). Another example is using naturally present bacteria by the mining industry in bioleaching. Biotechnology is also used to recycle, treat waste, clean up sites contaminated by industrial activities (bioremediation), and also to produce biological weapons.

A series of derived terms have been coined to identify several branches of biotechnology; for example:

- Bioinformatics is an interdisciplinary field which addresses biological problems using computational techniques, and makes the rapid organization and analysis of biological data possible. The field may also be referred to as computational biology, and can be defined as, "conceptualizing biology in terms of molecules and then applying informatics techniques to understand and organize the information associated with these molecules, on a large scale." Bioinformatics plays a key role in various areas, such as functional genomics, structural genomics, and proteomics, and forms a key component in the biotechnology and pharmaceutical sector.
- Blue biotechnology is a term that has been used to describe the marine and aquatic applications of biotechnology, but its use is relatively rare.
- Green biotechnology is biotechnology applied to agricultural processes. An example would be the selection and domestication of plants by micropropagation. Another example is the designing of transgenic plants to grow under specific environments in the presence (or absence) of chemicals. One hope is that green biotechnology might produce more environmentally friendly solutions than traditional industrial agriculture. An example of this is the engineering of a plant to express a pesticide, thereby ending the need for external application of pesticides. An example of this would be Bt corn. Whether or not green biotechnology products such as this are ultimately more environmentally friendly is a topic of considerable debate.
- Red biotechnology is applied to medical processes. Some examples are the designing of organisms to produce antibiotics, and the engineering of genetic cures through genetic manipulation.
- White biotechnology, also known as industrial biotechnology, is biotechnology applied to industrial processes. An example is the designing of an organism to produce a useful chemical. Another example is the use of enzymes as industrial catalysts to either produce valuable chemicals or destroy hazardous/polluting chemicals. White biotechnology tends to consume less in resources than traditional processes used to produce industrial goods.

Medicine

In medicine, modern biotechnology finds promising applications in such areas as

- Drug production
- Pharmacogenomics
- Gene therapy
- Genetic testing (or genetic screening): techniques in molecular biology detect genetic diseases. To test the developing fetus for Down syndrome, Amniocentesis and chorionic villus sampling can be used.

DNA microarray chip – some can do as many as a million blood tests at once

Pharmacogenomics

Pharmacogenomics is the study of how the genetic inheritance of an individual affects his/her body's response to drugs. It is a compound derived from the root of the word "pharmacology" plus the word "genomics". It is hence the study of the relationship between pharmaceuticals and genetics. The vision of pharmacogenomics is to be able to design and produce drugs that are adapted to each person's genetic makeup.

Pharmacogenomics results in the following benefits:

1. Development of tailor-made medicines. Using pharmacogenomics, pharmaceutical companies can create drugs based on the proteins, enzymes and RNA molecules that are associated with specific genes and diseases. These tailor-made drugs promise not only to maximize therapeutic effects but also to decrease damage to nearby healthy cells.

2. More accurate methods of determining appropriate drug dosages. Knowing a patient's genetics will enable doctors to determine how well his/ her body can process and metabolize a medicine. This will maximize the value of the medicine and decrease the likelihood of overdose.

3. Improvements in the drug discovery and approval process. The discovery of potential therapies will be made easier using genome targets. Genes have been associated with numerous diseases and disorders. With modern biotechnology, these genes can be used as targets for the development of effective new therapies, which could significantly shorten the drug discovery process.

4. Better vaccines. Safer vaccines can be designed and produced by organisms transformed by means of genetic engineering. These vaccines will elicit the immune

response without the attendant risks of infection. They will be inexpensive, stable, easy to store, and capable of being engineered to carry several strains of pathogen at once.

Modern biotechnology is often associated with the use of genetically altered microorganisms such as E. coli or yeast for the production of substances like synthetic insulin or antibiotics. It can also refer to transgenic animals or transgenic plants, such as Bt corn. Genetically altered mammalian cells, such as Chinese Hamster Ovary cells (CHO), are also used to manufacture certain pharmaceuticals. Another promising new biotechnology application is the development of plant-made pharmaceuticals.

Biotechnology is also commonly associated with landmark breakthroughs in new medical therapies to treat hepatitis B, hepatitis C, cancers, arthritis, hemophilia, bone fractures, multiple sclerosis, and cardiovascular disorders. The biotechnology industry has also been instrumental in developing molecular diagnostic devices that can be used to define the target patient population for a given biopharmaceutical. Herceptin, for example, was the first drug approved for use with a matching diagnostic test and is used to treat breast cancer in women whose cancer cells express the protein HER2.

Nanotechnology

Nanotechnology (sometimes shortened to "nanotech") is the manipulation of matter on an atomic and molecular scale. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also now referred to as molecular nanotechnology.

The Applications of Nanotechnology

Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in medicine, electronics, biomaterials and energy production. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Nanotechnology can be helpful in

1) Reduction of energy consumption
2) Increasing the efficiency of energy production
3) Nuclear accident cleanup and waste storage
4) In creating Nano-foods The most prominent application of nanotechnology in the household is self-cleaning or "easy-to-clean" surfaces on ceramics or glasses
5) It is also used in manufacturing stain-repellent and wrinkle free textiles.
6) In making sunscreens.
7) In manufacturing sports goods.
8) In aircraft manufacturing
9) Nanotechnology is also used in fire protection and detection

CHAPTER 4: EMULSION AND GELS

An emulsion is a mixture of two or more liquids that are normally immiscible (non mixable or unblendable). Emulsions are part of a more general class of two-phase systems of matter called colloids. Although the terms colloid and emulsion are sometimes used interchangeably, emulsion should be used when both the dispersed and the continuous phase are liquids. In an emulsion, one liquid (the dispersed phase) is dispersed in the other (the continuous phase).

Examples of emulsions include vinaigrettes, milk, mayonnaise, and some cutting fluids for metal working. The photo-sensitive side of photographic film is an example of a colloid.

Emulsion stability refers to the ability of an emulsion to resist change in its properties over time. There are four types of instability in emulsions: flocculation, creaming, coalescence and Ostwald ripening. Flocculation occurs when there is an attractive force between the droplets, so they form flocs, like bunches of grapes. Coalescence occurs when droplets bump into each other and combine to form a larger droplet, so the average droplet size increases over time. Emulsions can also undergo creaming, where the droplets rise to the top of the emulsion under the influence of buoyancy, or under the influence of the centripetal force induced when a centrifuge is used.

Oil-in-Water Emulsions

- Crema (foam) in espresso – coffee oil in water (brewed coffee), unstable emulsion

- Mayonnaise and Hollandaise sauce – these are oil-in-water emulsions that are stabilized with egg yolk lecithin, or with other types of food additives, such as sodium stearoyl lactylate
- Homogenized milk – an emulsion of milk fat in water and milk proteins
- Water-in-oil emulsions
- Butter – an emulsion of water in butterfat
- Vinaigrette – an emulsion of vegetable oil in vinegar. If this is prepared using only oil and vinegar (i.e. without an emulsifier), an unstable emulsion results

In pharmaceutics, hairstyling, personal hygiene, and cosmetics, emulsions are frequently used. These are usually oil and water emulsions, but which are dispersed and which continuously depends in many cases on the pharmaceutical formulation. These emulsions may be called creams, ointments, liniments (balms), pastes, films, or liquids, depending mostly on their oil-to-water ratios, other additives, and their intended route of administration.

Emulsion is also used in Firefighting

Emulsifier

An emulsifier (also known as an emulgent) is a substance that stabilizes an emulsion by increasing its kinetic stability. One class of emulsifiers is known as surface active substances, or surfactants.

Examples of food emulsifiers are:

- Egg yolk – in which the main emulsifying agent is lecithin. In fact, lekithos is the Greek word for egg yolk.
- Mustard – where a variety of chemicals in the mucilage surrounding the seed hull act as emulsifiers
- Proteins
- Low molecular weight emulsifiers
- Soy lecithin is another emulsifier and thickener

- Pickering stabilization – uses particles under certain circumstances
- sodium stearoyl lactylate
- DATEM (Diacetyl Tartaric (Acid) Ester of Monoglyceride) – an emulsifier primarily used in baking

Detergents are another class of surfactants, and will physically interact with both oil and water, thus stabilizing the interface between the oil and water droplets in suspension. This principle is exploited in soap, to remove grease for the purpose of cleaning. Many different emulsifiers are used in pharmacies to prepare emulsions such as creams and lotions. Common examples include emulsifying wax, cetearyl alcohol, polysorbate, and ceteareth. Sometimes the inner phase itself can act as an emulsifier, and the result is a nanoemulsion, where the inner state disperses into "nano-size" droplets within the outer phase. A well-known example of this phenomenon, the Ouzo effect, happens when water is poured into a strong alcoholic anise-based beverage, such as ouzo, pastis, arak, or raki. The anisolic compounds, which are soluble in ethanol, then form nano-size droplets and emulsify within the water. The resulting color of the drink is opaque and milky white.

Gel

A gel is a solid, jelly-like material that can have properties ranging from soft and weak to hard and tough. Gels are defined as a substantially dilute cross-linked system, which exhibits no flow when in the steady-state. By weight, gels are mostly liquid, yet they behave like solids due to a three-dimensional cross-linked network within the liquid. It is the crosslinking within the fluid that gives a gel its structure (hardness) and contributes to the adhesive stick. In this way gels are a dispersion of molecules of a liquid within a solid in which the solid is the continuous phase and the liquid is the discontinuous phase.

Gels consist of a solid three-dimensional network that spans the volume of a liquid medium and ensnares it through surface tension effects. This internal network structure may result from physical bonds (physical gels) or chemical bonds (chemical gels), as well as crystallites or other junctions that remain intact within the extending fluid. Virtually any fluid can be used as an extender including water (hydrogels), oil, and air (aerogel). Both by weight and volume, gels are mostly fluid in composition and thus exhibit densities similar to those of

their constituent liquids. Edible jelly is a common example of a hydrogel and has approximately the density of water.

A colloid is a Suspension microscopically dispersed throughout another substance.

A colloidal system consists of two separate phases: a dispersed phase (or internal phase) and a continuous phase (or dispersion medium) in which the colloid is dispersed. A colloidal system may be solid, liquid, or gas.

Classification Based on Physical State of Dispersed Phase and Dispersion Medium.

Depending upon the physical state of the dispersed phase and dispersion medium, eight types of colloidal systems are possible. These are described in the table given below:

Depending upon the affinity of the dispersed phase for the dispersion medium, colloidal systems can be classified into following two categories.

(i) Lyophilic sols (ii) Lyophobic sols

Classification of Colloids Based on Type of Particles of the Dispersed PHASE: Multimolecular, Macromolecular and Associated Colloids

We have already seen that the colloidal particles present in a colloidal system have size lying in the range 1nm-100nm. Depending upon how different substances forming colloidal solutions acquire the size of particles in this range, colloidal solutions may be classified into the following three categories.

(i) Multimolecular colloids

(ii) Macromolecular colloids

(iii) Associated colloids

Metal Extraction

It can be defined as the separation of metals in a pure or relatively pure state from the minerals in which they naturally occur.

The earth's crust is the biggest source of metals. Some soluble salts of the metals are also found in sea-water. Metals occur in nature sometimes free but mostly in combined state. The natural mode of occurrence of a metals is largely dependent on its nature. Those metals which are least reactive and have little or no affinity for oxygen, moisture and other chemical reagents

occur in free or metallic or native state i.e., in uncombined state. Most of the metals are reactive and hence are found in combined state i.e., as compounds.

The natural substances in which the metals or their compounds occur in the earth are called minerals. The mineral has a definite composition. It may be a single compound or a complex mixture. The minerals from which the metals can be conveniently and economically extracted are known as ores. All the ores are minerals but all minerals cannot be ores. For example, both bauxite ($Al_2O_3. 2H_2O$) and clay ($Al_2O_3.2SiO_2.2H_2O$) are minerals of aluminium. It is bauxite which is used for extraction of aluminium and not clay. Thus, bauxite is an ore of aluminium.

Petroleum

Petroleum is a naturally occurring flammable liquid consisting of a complex mixture of hydrocarbons of various molecular weights and other liquid organic compounds, that are found in geologic formations beneath the Earth's surface. The name Petroleum covers both naturally occurring unprocessed crude oils and petroleum products that are made up of refined crude oil. A fossil fuel, it is formed when large quantities of dead organisms, usually zooplankton and algae, are buried underneath sedimentary rock and undergo intense heat and pressure.

Petroleum is a mixture of a very large number of different hydrocarbons; the most commonly found molecules are alkanes (linear or branched), cycloalkanes, aromatic hydrocarbons, or more complicated chemicals like asphaltenes. Each petroleum variety has a unique mix of molecules, which define its physical and chemical properties, like color and viscosity. Petroleum is recovered mostly through oil drilling

Compounds

Steel

Steel is an alloy of iron and other elements, principally carbon. When carbon is the primary alloying element, its content in the steel is between 0.002% and 2.1% by weight. The following elements are always present in steel: carbon, manganese, phosphorus, sulfur, silicon, and traces of oxygen, nitrogen and aluminum. Alloying elements intentionally added to modify the characteristics of steel are: manganese, nickel, chromium, molybdenum, boron, titanium, vanadium and niobium.

Rusting

The rusting of iron is an electrochemical process that begins with the transfer of electrons from iron to oxygen. The rate of corrosion is affected by water and accelerated by electrolytes, as illustrated by the effects of road salt on the corrosion of automobiles. Rust is composed of iron oxides. In colloquial usage, the term is applied to red oxides, formed by the reaction of iron and oxygen in the presence of water or air moisture. Other forms of rust exist, like the result of reactions between iron and chloride in an environment deprived of oxygen – rebar used in underwater concrete pillars is an example – which generates green rust. Several forms of rust are distinguishable visually and by spectroscopy, and form under different circumstances. Rust consists of hydrated iron (III) oxides $Fe_2O_3•nH_2O$ and iron (III) oxide-hydroxide $FeO(OH)•Fe(OH)_3$.

Given sufficient time, oxygen, and water, any iron mass will eventually convert entirely to rust and disintegrate. Surface rust is flaky and friable, and provides no protection to the underlying iron, unlike the formation of patina on copper surfaces. Rusting is the common term for corrosion of iron and its alloys, such as steel.

Cement Glass:

A binding mixture used to affix glass to glass or to some other material (as metal)

Carbon is the chemical element with symbol C and atomic number 6. As a member of group 14 on the periodic table, it is nonmetallic and tetravalent—making four electrons available to form covalent chemical bonds. There are three naturally occurring isotopes, with 12C and 13C being stable, while 14C is radioactive, decaying with a half-life of about 5,730 years. Carbon is one of the few elements known since antiquity.

Carbon is the 15th most abundant element in the Earth's crust, and the fourth most abundant element in the universe by mass after hydrogen, helium, and oxygen. It is present in all known life forms, and in the human body carbon is the second most abundant element by mass (about 18.5%) after oxygen. This abundance, together with the unique diversity of organic compounds and their unusual polymer-forming ability at the temperatures commonly encountered on Earth, make this element the chemical basis of all known life.

Carbon is the fourth most abundant chemical element in the universe by mass after hydrogen, helium, and oxygen. Carbon is abundant in the Sun, stars, comets, and in the atmospheres of most planets. Some meteorites contain microscopic diamonds that were formed when the solar system was still a protoplanetary disk. Microscopic diamonds may also be formed by the intense pressure and high temperature at the sites of meteorite impacts.

Oxidation is usually used to describe a process in which electrons are removed from a molecule or atom. Oxidation means the addition of oxygen to a molecule or the removal of hydrogen from a molecule.

Reduction is used to describe a process in which electrons are added to a molecule or atom. Reduction means the addition of hydrogen to a molecule or the removal of oxygen from a molecule.

Let's look at some examples:

What about a reaction in which both oxygen and hydrogen are added or subtracted. If the ratio is one oxygen to two hydrogens (in other words, water), neither oxidation or reduction is happening. Addition or removal of water does not involve, by itself, an oxidation or a reduction reaction. The addition of water to an aldehyde to form a hydrate does not involve oxidation or reduction. You may wish to look at the formation of an acetal or hemiacetal in this way. If the net change in the number of hydrogens and oxygens comes out to be a ratio of two hydrogens to one oxygen, neither oxidation nor reduction is involved.

CHAPTER 9: CONCEPT OF SOLUBILITY

Solubility is the property of a solid, liquid, or gaseous chemical substance called solute to dissolve in a solid, liquid, or gaseous solvent to form a homogeneous solution of the solute in the solvent. The solubility of a substance fundamentally depends on the physical and chemical properties of the used solute and solvent as well as on temperature, pressure and the pH of the solution. The extent of the solubility of a substance in a specific solvent is measured as the saturation concentration, where adding more solute does not increase the concentration of the solution and begin to precipitate the excess amount of solute.

Most often, the solvent is a liquid, which can be a pure substance or a mixture. One may also speak of solid solution, but rarely of solution in a gas (see vapor-liquid equilibrium instead).

The extent of solubility ranges widely, from infinitely soluble (without limit) (fully miscible) such as ethanol in water, to poorly soluble, such as silver chloride in water. The term insoluble is often applied to poorly or very poorly soluble compounds.

Under certain conditions, the equilibrium solubility can be exceeded to give a so-called supersaturated solution, which is metastable.

Solubility is not to be confused with the ability to dissolve or liquefy a substance, because the solution might occur not only because of dissolution but also because of a chemical reaction. For example zinc, which is insoluble in hydrochloric acid, does dissolve in hydrochloric acid but by chemical reaction into hydrogen gas and zinc chloride, which in turn is soluble in the acid. Solubility does not also depend on particle size or other kinetic factors; given enough time, even large particles will eventually dissolve.

Solubility is defined for specific phases. For example, the solubility of aragonite and calcite in water are expected to differ, even though they are both polymorphs of calcium carbonate and have the same chemical formula.

The solubility of one substance in another is determined by the balance of intermolecular forces between the solvent and solute, and the entropy change that accompanies the solvation. Factors such as temperature and pressure will alter this balance, thus changing the solubility.

Solubility may also strongly depend on the presence of other species dissolved in the solvent, for example, complex-forming anions (ligands) in liquids. Solubility will also depend on the excess or deficiency of a common ion in the solution, a phenomenon known as the common-ion effect. To a lesser extent, solubility will depend on the ionic strength of solutions. The last two effects can be quantified using the equation for solubility equilibrium.

CHAPTER 10: USE OF CHEMICAL COMPOUND

A chemical compound is a pure chemical substance consisting of two or more different chemical elements that can be separated into simpler substances by chemical reactions. Chemical compounds have a unique and defined chemical structure; they consist of a fixed ratio of atoms that are held together in a defined spatial arrangement by chemical bonds. Chemical compounds can be molecular compounds held together by covalent bonds, salts held together by ionic bonds, intermetallic compounds held together by metallic bonds, or complexes held together by coordinate covalent bonds. Pure chemical elements are not considered chemical compounds, even if they consist of molecules which contain only multiple atoms of a single element (such as H2, S8, etc.), which are called diatomic molecules or polyatomic molecules.

- Sodium fluoride (NaF) in toothpaste
- Sodium lauryl sulfate (C12H25SO4Na) in soap
- Sucrose (C12H22O11) in foods
- Titanium dioxide (TiO2) as white pigment in paint Vinegar (CH3COOH, acetic acid; ethanoic acid) in foods Sodium hypochlorite (NaOCl) in bleach
- Sodium nitrate (NaNO3) in fertilizer Phosphoric acid (H3PO4) in cola Ethanol (CH3CH2OH) in alcoholic drinks
- Methane (CH4) to burn for fuel in gas boilers and hobs
- Butane (C4H10) as lighter fuel Octane (C8H18) as automobile fuel Phenol (C6H5OH) in antiseptics

ACID, ALKALI AND SALTS – II

Alkalis

- The word alkuli means plant ash. It is derived from the Arabic word alquili.
- All alkalis are bases, but not all bases are alkalis.

Definition:

- Metal oxide and hydroxide compounds that do not give hydroxide ions in aqueous
- solutions are called bases.

- Acid rain - Sulfuric acid, Nitric acid
- To dissolve glass - Hydrofluoric acid (HF)
- To clean glass - Boric acid

Physical Properties:

- Alkalis are colourless, odorless but iron and copper hydroxides have specific colour,
- Alkalis have a bitter taste,
- Alkalis are corrosive
- Smooth to the touch like soap and oil.
- Excellent conductors.
- Contains hydroxyl (OH) group.
- The only non-metal hydroxide is ammonium hydroxide (NH 4 OH).

Chemical properties

1. Alkalis react with acids to form salts and water.

This is called a neutralization reaction.

Alkali + acid -> salt + water

(eg): KOH + HCl -> KCl + H 2 O

2. Alkalis react with metals to release hydrogen gas.

(eg): Zn + 2NaOH -> Na 2 znO 2 + H2↑

Acidity:

- The number of displaceable hydroxide ions per molecular base.

Benefits of Alkaline:

- Used to make soap, cloth and plastic.
- Paper, used to make medicine.
- Used to remove stains, oil stains from clothes.

Colorants:

- Chemicals that show the acidity and alkalinity of solutions by a certain precise color change.

  (eg): Phenaphthalene

UNIT - 4 AGRICULTURE

Plants are the fundamental building blocks of life on earth. Plants are life forms belonging to the kingdom Plantae. The scientific study has revealed at least 500,000 species of plants. The types of plants vary in size from microscopic algae, to huge sequoia trees more than 8m (26 ft) tall.

Plant Kingdom is mainly classified into two. This type of plant classification is done according to how they reproduce.

- Spore bearing plants (Algae, mosses, ferns and their relatives)
- Seed bearing plants (Conifers and flowering plants)

The plant kingdom can also be classified on the basis of the presence or absence of conductive (vascular) tissue.

Ferns (pteridophytes), gymnosperms and angiosperms have vascular tissue which transports the nutrients and water through the plant. They are collectively known as tracheophytes.
Mosses, liverworts, hornworts (bryophytes) are non-vascular i.e. they do not have conductive tissue to transport sugar, water and nutrients.

Spore Bearing Plants

Algae, mosses, ferns and their genus all reproduce by means of spores. These are minute and are formed inside the sporangia that look like fine powder. Each spore contains a small quantity of vital genetic matter in a compact sheathe.

Algae

The simplest plant of this type is algae. They do not have leaves, stems or roots. Algae thrive in a moist or wet environment. Many are tiny single celled plants, but some seaweeds are huge.

Mosses

Mosses and most liverworts have simple stems and tiny, slender leaves. They can be found growing on the plain land, on rocks, and on other plants. They habitually live in mild, damp regions, but some can live in very cold places.

Ferns

Ferns are the most superior spore bearing type of plants. Many ferns grow in cool, dry places but the largest ones are found in the hot, damp tropic regions. Around 15,000 species of ferns are there in existence now according to scientific research.

Plants that reproduce by means of seeds belong to this type of plant. Conifers or gymnosperms and flowering plants or gymnosperms reproduce by seeds. Each seed contains an embryo and a food supply. This is enclosed by a seed covering. A germinating seed is nourished by the food treasury until it can start to make its own.

Conifers or Gymnosperms

Gymnosperms or conifers are plants that have cones instead of flowers. Their seeds grow within female cones. The seeds develop on scales inside cones. The majority of gymnosperms are trees or shrubs. The cones are not as diverse as flowers but they can be brilliantly coloured and attractive.

Fowering plants or Angiosperms

Angiosperms or flowering plants are the most varied set of land vegetation. There are at least 250,000 kinds of flowering plants identified till now. The distinguishing trait of flowering plants or angiosperms is the flower. The chief role of the flower is to make certain that fertilization of the ovule occurs and that results in the growth of fruit containing seeds.

Monocotyledons And Dicotyledons

Flowering plants or angiosperms have either one or two cotyledons. Monocotyledons (one seed leaf) have floral parts in multiple of three. Dicotyledons (two seed leaves) have floral

parts usually in multiples of four or five. In the figure, the left side plant is monocotyledon and right is a dicotyledon.

Different Types Of Plants

Annuals:

Annuals are one type of plant based on the Latin word. They live for one year hence they have a very short period of life. These plants are grown for their colored look. These annuals flower for only less than four months which grow through the seeds.

Examples for this type of plant are Asters, Phlox, Balsam, Dianthus, and Cosmos.

Biennials:

This is one type of plant which grows from the seeds and it takes two years for grow. This name is derived from the Latin word bennis. This type of plant is also a seasonal flowering plants which flowers only in the second year after planting. These plants are considered as the short lived perennials.

Examples for this type of plant are Foxglove, wild pretii and some others.

Perennials:

This type of plant lives for many years. This type of plant keeps on flowering for long years. This type does not need any replanting and they can change the layout of the garden. In this type we should provide deep watering which improves the deep rooting and also helps in the reduction of diseases.

Examples of this type are Water lily, Gerberas, Geraniums and Anthuriums.

Shrubs:

Shrubs are the plants which are smaller than the trees and they are considered as the woody plants. These shrubs have the short stem which occurs near the ground.

Flowering shrubs:

This type of shrubs produces flowers continuously throughout the year. These shrubs are long lived shrubs and are grown for designing the garden. Examples are Mosanda, Pentas, Ixora.

Ornamental shrubs:

These shrubs do not produce flowers but these are used for creating the ornamental look. These shrubs can be modified into various shapes and sizes. Examples are Juniperus, Tuja, Aralia,Crotons.

Creepers and climbers:

This is another type of plant which is grown at the wall of a compound. It is also grown as the cover for the walls.

Climbers:

Climbers are the plants which grow with a support. This type of plant contains the soft stem hence they need support. Both the creepers and also the climbers are grown in a mixture of earth as well as manure.

Bulbs:

This type is planted under the soil which is in a specific stem structure and stays underground. These bulbs have a resting period whenever there is no growth. Here these plants grow the flower which remains for some time. These plants are easy to grow and they can bloom. Examples: Daffodils, Tulips, Bluebells.

Medicinal Plants: Examples And Uses

Those plants that have healing properties are termed as medicinal plants or herbs. Pharmacognosy is the study of medicines derived from natural sources, including plants. Medical herbalism is the practice of healing with medicinal plants. Some examples of Aloe vera gel are used to treat burns.

- Aloe Vera - Aloe is a common plant. Aloe vera gel is used to treat burns.

- Basil - A common garden herb. It is used to treat stomach cramps, constipation and flatulence.
- Calendula (AKA pot marigold) is antiseptic and is used to treat wounds as well as added to a lotion to treat chapped skin.
- Dill - found in most herb gardens. A decoction of dill is used to treat stomach upsets, insomnia, and flatulence.
- Echinacea - (AKA purple coneflower) Used as an immune system support.
- Feverfew - a small daisy like plant that is used in the treatment of migraines.
- Ginger - used to treat motion sickness Hops - used to treat anxiety and insomnia Irish moss - a form of seaweed - is used in treatment of coughs and ulcers. It is currently being studied as a treatment for influenza B and mumps because it is antiviral. Joe Pye Weed - (AKA gravel root) used to treat kidney stones.

Bio-insecticides are organic formulations recommended for the management of insects that feed on crops. They are different from chemical pesticides in several ways. They contain live bacteria that produce toxins which cause stomach poison in the insects and kill them.

The resistance power of plant pathogens increased several folds due to indiscriminate and over use of chemical pesticides. Several generic chemical pesticides became obsolete due to this reason.

Bio-insecticides are the best remedies where the growers were not able to control the insects in spite of using heavy doses of chemical pesticides. They cure the plant and soil from disease causing pathogens. Unlike chemical pesticides, bio-insecticides give everlasting protection to the crop and soil. We recommend VBT, Toxin, Shock and Biostorm based on your crop and the type of insects plaguing the crops.

UNIT - 5 ANIMAL HUSBANDRY

The branch of agriculture is concerned with the care and breeding of domestic animals such as cattle, hogs, sheep, and horses. The contribution of animal husbandry and dairying to total gross domestic product (GDP) was 5.9 per cent in 2000-2001 at current prices. The value of output of livestock and fisheries sectors was estimated to be Rs 1,70,205 crore during 2000-

2001, which is 30.3 per cent of the total value of output of Rs 5,61,717 crore from the agricultural and allied sectors.

The Department of Animal Husbandry and Dairying (AH&D) - now renamed as Department of Animal Husbandry Dairying & Fisheries (DADF) is one of the Departments in the Ministry of Agriculture and came into existence on 1st February, 1991, by converting two divisions of the Department of Agriculture and Cooperation namely Animal Husbandry and Dairy Development into a separate Department.

Animal husbandry includes domestication of animals to obtain animal products like milk, meat, wool, skin and Hyde etc. and to use them for draught and transportation. These animals are cow, buffalo, goat, sheep, pig, camel, horse, mule, donkey and yak etc. India has about 500 species of animals of which only few are domesticated for different uses.

Cattle

India has about 20 percent of the world's cattle population. These animals are the backbone of the country's agriculture and have significant contributions in the rural economy. Bullocks have a major role in agricultural operations and rural goods movement and transportation while cows provide nutritious milk to enrich the Indian diet.

These are also good sources of hides and skins for the leather industry which earns substantial foreign exchange. Also cow dung is a good source of manure and domestic fuel.

According to the 1997 livestock census there were 198.9 million cattle in the country of which 42 per cent were bullocks, 32 percent cows and 26 percent young livestock. There has been a 28.1 per cent increase in the number of cattle between 1951 and 1997.

Cattle population in India belongs to different breeds. These include: (i) milch breed, (ii) draw' breed, and (iii) mixed or general breed.

Milch Breeds

Here cows yield higher quantities of milk but the bullocks are not of good quality. Some important milch breeds include Gir, Sindhi, Sahiwal, Tharparkar and Deoni. The Gir breed is a native of Saurashtra ' which yields about 3175 kg of milk per lactation period. Sahiwal breed belongs to Montgomery district of Pakistan yielding 2725-4535 kg of milk per lactation period.

The Sindhi and Red Sindhi breeds hail from the Sindh area of Pakistan producing about 5440 kg of milk per lactation period. The Deoni breed belongs to the western and north-western parts of Andhra Pradesh where cows yield 1580 kg of milk; per lactation period. The Tharparkar breed is also a native of Sindh area of Pakistan whose cow yields 1815 to 2720 kg of milk per lactation period.

Draught Breeds

Here the cows are poor milkers but the bullocks are excellent draught animals. This group consists of (a) short-horned, white or light grey colour with coffin-shaped skull and face slightly convex in profile, e.g. Nagori and Bachaur; (b) the lyre horned grey coloured with wide forehead, prominent orbital arches, flat or dished profile, deep body and powerful draught capacity, e.g., Kathiawar, Malvi and Kherigarh; (c) the Mysore type characterized by prominent forehead with long and pointed horns which rise close together, e.g. Mallikar, Amritmahal, Kangyam and Killari; and (d) small black, red or dun coloured with large patches of white markings, found in the foothill region of the Himalayas, e.g., Ponwar and Siri.

Dual Purpose Breeds

Here cows are fairly good yielders of milk and the bullocks are good for draught purposes. The group includes:

(a) short-horned, white or light grey cattle with long coffin-shaped skull and face slightly convex in profile, e.g., Mariana, Ongale, Gaolo, Rath, Dangi, Krishna Valley and Nimari etc; and

(b) lyre-horned, grey cattle, deep bodied with wide forehead, prominent arches, flat or dished in profile and good draught capacity, e.g., Tharparkar and Kankrej.

The Mariana breed is very popular in Haryana, Delhi and western Uttar Pradesh. Bullocks are strong and useful for draught purposes and cows yield up to 5 kg. of milk per day. The Ongale belongs to Guntur and Nellore districts of Andhra Pradesh whose bullocks are heavy ploughing and carting.

The Gaolo breed is indigenous to Nagpur and Wardha districts of Maharashtra and Chhindwara district of Madhya Pradesh whose cows yield about 7.5 kg of milk every day. The Rath breed is an admixture of the Mariana, Nagori and Mewati breeds. Its cows give up to 5 kg

of milk per day and the bullock is fit for draught work. The Dangi breed comes from Nashik, Thane, Ahmadnagar and Kolaba districts of Maharashtra.

The Krishna Valley is very popular breed of north Karnataka and southern Maharashtra. Its cows provide about 916 kg of milk per lactation period while bullocks are good for agricultural work. The Nimari breed is very common in East and West Nimar districts of Madhya Pradesh whose cows yield about 915 kg of milk per lactation period.

The Kankrej breed is indigenous to the Gujarat plains whose cows provide 4.5 to 6.5 kg of milk per day and the bullocks are sturdy for draught work.

In order to improve the breed of the Indian cattle 7 central cattle breeding farms have been established. Some of the exotic breeds yielding higher quantities of milk like Jersey, Holstein- Friesian, Swiss-Brown, Gurnsey, German Fleckvich and Ayreshire have been introduced in the country which is becoming popular amongst dairy farmers.

Breeds	Breeding Centres	Remarks
Hallikar	Tumkur, Hassan and Mysore (Karnataka)	Draught Breed
Kangayam	Erode (Tamil Nadu)	Draught Breed
Red Sindhi	Gujrat	Dairy Breed
Tharparkar	Umarkot, Naukot, Dhoro naro Chor	Dairy Breed
Vechur	Kerala	Dairy Breed
Jersy	Island of Jersy, crossbreds available in all Indian states	Dairy Breed
Holstein	Swiss Province of North Holland and West Friesland	Daily Breed

Artificial Insemination

Artificial insemination (AI) is the deliberate introduction of semen into a female's vagina or oviduct for the purpose of fertilisation by means other than ejaculation. It is the medical alternative to sexual intercourse, or natural insemination.

Artificial insemination is a fertility treatment for humans and is a common practice in the breeding of dairy cattle and pigs. Artificial insemination may employ assisted reproductive technology, donated sperm, and/or animal husbandry techniques.

FOOD ADULTERATION

Introduction to Food Adulteration

Food is a basic necessity of life. The food we eat is absorbed by our body and is used to run metabolic processes and sustain life. Food is essential for growth, and various life processes. An array of food in our daily diet includes vegetables, fruits, legumes, pulses, grains, etc. All of these are either consumed raw or made into delicacies and savoured. But, nowadays, you might have seen very thin milk due to mixing with water, white, yellow, or black pebbles in raw pulses, white tiny stones mixed with rice, and so on. This mixing of elements with food items is adulteration.

As we deal with the overgrowing population, environmental hazards, and depleting natural resources, one of the man-made hazards is the adulteration of food. When food is contaminated with external sources or when its natural composition or quality is changed, it is adulterated. Food adulteration has serious effects on our health. Despite various measures taken by the government, spreading awareness about the hazards of food adulteration is a prevalent practice in many countries. Various methods of food adulteration are deployed by the food industries using various chemical and synthetic substances. The article encompasses the discussion of food adulteration, types, and methods below.

What is Food Adulteration?

Adulteration is a legal offence and when the food fails to meet the legal standards set by the government, it is said to have been adulterated. Food adulteration takes place when intentionally or unintentionally substances that degrade the quality of food are added to it. Thus, food adulteration can be defined as the contamination or adulteration of food or food materials by adding harmful substances to it.

What is Adulterant?

The substances that lower the quality of food, when added to it, are called adulterants. It is a substance found within other food substances that hamper the natural quality of the food. The adulterant may be present in any form and in any quantity. Adulterants are mostly harmful

and pose the ability to lower the potency of the product. Even if the adulterant is not harmful, it reduces the nutritional value of the food to a greater extent. Some adulterants are also identified as carcinogenic or lethal when exposed to them for a longer period. Different types of adulterants are used to adulterate different types of food.

When is Food Considered Adulterated?

There are some conditions that are required to conclude whether a food is adulterated or not. These points are summarised below.

- A substance that degrades the quality of food or turns it hazardous is added to it.
- Cheaper or low-quality substances are used as a substitute for whole or a few ingredients.
- A constituent of food is partly or wholly taken out, reducing the quality of food.
- It's made presentable with harmful substances. or its colour is changed to make it look better.
- Anything that depreciates the quality of food is added to or abstracted from it.

Examples of Food Adulteration

Some of the examples of food adulteration are listed below.

- Mixing of pulses with sand particles, pebbles.
- Mixing of milk with water.
- Mixing oil with chemical derivatives or cheaper oils.
- Packing low-quality food products with fresh and high-quality ones.
- These are a few examples of food adulteration.

Why is Food Adulteration Done?

For many years, you might have noticed the practice of adding water to milk to increase its quantity and gain more profit from less volume of milk. Similarly, food adulteration is done by food manufacturers and industries for various reasons.

1. Food adulteration is practised as a part of a business strategy to gain more profit by cheaper means.

2. It is also done to make the food presentable and as an imitation of some other food which is more in demand.
3. Food adulteration is many times done by those who do not have a proper understanding of its hazards. Due to a lack of awareness and proper knowledge, it is still widely practised.
4. Adulteration increases the weight of the food, helps gain more profit, and increases sales in cheaper ways.
5. The increasing rate of the population also plays a major role in food adulteration.
6. The inefficiency of government initiatives to control it.

Types of Food Adulteration

There are four different types of food adulteration.

- **Intentional Adulteration:-** When substances that look similar to the constituents of the food are added to it, to increase its weight and gain more profit. Example- mixing of pebbles, stones, marbles, sand, mud, filth, chalk powder, contaminated water, etc.
- **Incidental Adulteration:-** Incidental adulteration occurs due to negligence while handling food. Like residues of pesticides in grains, larvae growth, presence of droppings of rodents, etc.
- **Metallic Adulteration**:- The addition of metallic materials into food like lead or mercury is metallic adulteration. It may happen accidentally or even intentionally.
- **Packaging Hazard**:- The packing materials in which the food is packed may also interfere and mix with the constituents of the food, leading to packaging hazards.

Methods of Food Adulteration

Various food adulteration methods are as follows:-

- **Mixing**:- Mixing of sand, dust, clay, mud, and pebbles with food particles.

- **Substituting:**- Some healthy constituents are replaced by cheaper and low-quality ones, which alter the nutritional values of the food and may even impose a health hazard.
- **Using Decomposed Food**:- This method indicates mixing decomposed food with healthy ones. Food that even conceals damage or inferiority of any manner is also considered to be adulterated. Also, the deliberate mixing of healthy food with questionable quality food leads to the final product being adulterated.
- **Additions of Toxic Substances**:- Food adulteration also involves the mixing of food with toxic substances to gain higher profit and increase sales. For example, addition of colour, dyes, or harmful unpermitted preservatives.
- **Misbranding**:- Altering the manufacturing dates, expiry dates, list of ingredients or misleading ingredient derivatives, and so on.
- **Artificial Ripening**:- Adding chemicals to the fruits and vegetables which speed up the process of ripening in them, is also considered food adulteration. For example, mango is ripened with carbide for meeting the commercial demand against supply.

Effects of Food Adulteration

Food adulteration has a great impact on our health. Be it any kind of adulteration, prolonged consumption of this type of food is very harmful to the body. Consuming such food increases toxicity in the body. As the nutritional value of the adulterated food goes down, such food is no longer nutritive for the body. The addition of chemical adulterants and colours many times proves to be fatal as they pose an onset of health risks and also carcinogens. Some adulterated food may also affect our internal organs directly leading to heart, kidney, liver, and many more organ disorders and failure.

How to Detect Food Adulteration

Food adulteration has many ill effects on our health. Prolonged consumption of adulterated food may even prove to be lethal. The use of organic food is more trending these days, as organic foods give us the complete nutrition that a particular food is supposed to give. It is not laden with harmful chemicals or polished with toxins like wax. But, due to low

productivity, organic food is not always available and is more expensive than the common produce. Therefore, it is important to detect if your food is adulterated. Various home methods can be used to do this.

For example, to determine if milk is adulterated with detergents, take some milk in a bottle along with some water and shake it well. If it settles into a frothy layer, it is pure. If the milk is adulterated, it forms a thick layer.

Similarly, if you want to know if milk, sugar, or jaggery is adulterated with chalk powder, take your sample and mix it in a glass of water. Any precipitate at the bottom of the glass indicates the presence of chalk.

To determine if the vegetables are polished with colour, soak them in water for some time and you will be able to see the colour getting dissolved in water.

How to Prevent Food Adulteration

Some of the methods of prevention of food adulteration are mentioned below.

- On the industry level, food adulteration can only be checked with strict and stringent laws and government interventions and checks.
- To avoid consuming adulterated food, always make sure that you don’t buy deep or dark-coloured groceries.
- Stop consuming processed food.
- Wash or soak your fruits and vegetables well in water before consuming.
- Canned or tinned foods must be checked for any leakages or puffing before buying.
- In Indian markets, FSSAI is the government license number that stands for food safety. Thus, always make sure to look for FSSAI, a list of ingredients, manufacturing, and expiry dates on the food packs.

FERTILISERS

What are Fertilisers?

Fertilisers are additional substances supplied to the crops to increase their productivity. These are used by the farmers daily to increase the crop yield. These fertilisers contain essential nutrients required by the plants, including nitrogen, potassium, and phosphorus. They also enhance the water retention capacity of the soil and increase its fertility.

Types of Fertilisers

Fertilisers are mainly classified into two main types, organic and inorganic fertilisers.

Organic Fertilizers

Natural fertilisers derived from plants and animals are known as organic fertilisers. By adding carbonic molecules necessary for plant growth, it enriches the soil. Organic fertilisers boost the amount of organic matter in the soil, encourage microbial reproduction, and alter the physical and chemical composition of the soil. It is regarded as one of the essential elements for foods that are green.

Organic fertilizers can be obtained from the following products:

- Agricultural Waste
- Livestock Manure
- Industrial Waste
- Municipal Sludge

Inorganic Fertilisers

Chemical fertilisers generated by chemical techniques that contain nutrients for crop growth are known as inorganic fertilisers. The inorganic fertilisers are of the following types:

Nitrogen Fertilisers

Nitrogen fertilisers contain nitrogen necessary for the development of crops. Nitrogen, a key constituent of chlorophyll, helps main balance in the process of photosynthesis. It is also a part of amino acids in plants and contains protein. Nitrogen fertilisers improve the production and quality of agricultural products.

Phosphorus Fertiliser

In a phosphorus fertiliser, phosphorus is the principal nutrient. The effective phosphorus concentration, fertilisation techniques, soil characteristics, and crop strains all affect how successful a fertiliser is. The protoplasm of the cell contains phosphorus, which is crucial for cell growth and proliferation. The growth of the plants' roots is aided by the phosphorus fertiliser.

Advantages Of Fertilisers

The advantages of fertilisers are mentioned below:

- Easy to transport, store, and apply
- For supplying a specific nutrient we can select a specific fertiliser due to its nutrient specific nature
- Water-soluble and can easily dissolve in the soil. Hence, they are easily absorbed by the plants
- They have a rapid effect on the crops
- Increase the crop yield and provide enough food to feed the large population
- Predictable and reliable

Disadvantages Of Fertilisers

Fertilisers have the following disadvantages:

- Expensive
- The ingredients in the fertilizers are toxic to the skin and respiratory system
- Excessive use of fertilisers damages the plants and reduces soil fertility
- Leaching occurs and the fertilisers reach the rivers causing eutrophication
- Long term use reduces the microbial activity and disturbs the pH of the soil

Uses Of Fertilisers

Fertilisers are used for various purposes. The uses of fertilisers are mentioned below:

- Used to provide additional nutrients to the plants
- They are added to improve the yield of the crops
- Nitrogen-rich fertilisers are used for the greening of lawns
- Organic fertilisers improve the texture and fertility of the soil
- Gardeners use fertilisers to address certain needs of the plants such as nutritional needs
- Fertilisers are added to potted plants to replace the lost nutrients

Importance Of Fertilisers

With such limited resources, it is quite challenging to meet the demands of the expanding population. Agriculture output has declined due to pests, a shortage of fertilisers, and declining soil fertility. The significance of fertilisers in agriculture has expanded as a result.

Fertilisers can be essential to plants in the following ways:

- Fertilisers make plants more resistant to pests. As a result, they are using fewer insecticides and herbicides, which results in healthier crops. Hence, fewer illnesses are present, giving the crops an aesthetic value.
- Fertilisers improve the water holding capacity of the plants and increase root depth.
- The potassium content present in the fertilisers strengthens the straws and stalks of the plants.
- The phosphorus present in the fertilisers helps in faster development of roots and formation of seeds in plants.
- Nitrogen in the fertilisers promotes plant growth, which is seen in the green colour of the plants

Since chemical fertilisers adversely affect soil fertility, biofertilizers were brought into use. These are substances that contain living or latent cells, and even micro-organisms. They provide the soil with the necessary nutrients and microbes for the growth of the plants. They help the soil to retain its fertility. They are environment-friendly and also destroy pathogenic

components responsible for causing disease in plants. **Acetobacter** and **Rhizobium** are two such widely used biofertilisers.

BIOLOGY

CHAPTER 1 NUTRITION AND DIGESTION SYSTEM

What Is Nutrition

Nutrition is the process of acquiring energy and food materials. Nutrition is the provision, to cells and organisms, of the materials necessary (in the form of food) to support life. The human body contains chemical compounds, such as water, carbohydrates (sugar, starch, and fiber), amino acids (in proteins), fatty acids (in lipids), and nucleic acids (DNA and RNA). These compounds in turn consist of elements such as carbon, hydrogen, oxygen, nitrogen, phosphorus, calcium, iron, zinc, magnesium, manganese, and so on. All of these chemical compounds and elements occur in various forms and combinations (e.g. hormones, vitamins, phospholipids, hydroxyapatite), both in the human body and in the plant and animal organisms that humans eat.

What is Nutrient-A nutrient is a chemical that an organism needs to live and grow or a substance used in an organism's metabolism which must be taken in from its environment. They are used to build and repair tissues, regulate body processes and are converted to and used as energy.

Classification of Nutrient-: There are six major classes of nutrients- Carbohydrates, protein, vitamins, minerals, fats and water.

CARBOHYDRATE

Nature- A Carbohydrate is an organic compound that consists only of Carbon, Hydrogen and Oxygen. It is divided into four chemical groupings: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. For example, blood sugar is the monosaccharide glucose, table sugar is the disaccharide sucrose, and milk sugar is the disaccharide lactose.

Function- Carbohydrates perform numerous roles in living organisms. Polysaccharides serve for the storage of energy (e.g., starch and glycogen), and as structural components (e.g., cellulose in plants and chitin in arthropods). The 5-carbon monosaccharide ribose is an important component of coenzymes (e.g., ATP, FAD, and NAD) and the backbone of the genetic molecule known as RNA. The related deoxyribose is a component of DNA. Saccharides and their derivatives include many other important biomolecules that play key roles in the immune system, fertilization, preventing pathogenesis, blood clotting, and development.

Source-Starch (such as cereals, bread, and pasta) or simple carbohydrates, such as sugar (found in candy, jams, and desserts).

Fats

Fats consist of a wide group of compounds that are generally soluble in organic solvents and generally insoluble in water. Fats can be categorized into saturated fats and unsaturated fats.

Function-Fat provides needed energy. It is difficult to eat large amounts of food in a very low fat diet to get all the energy you need.

- Fat is needed to prevent essential fatty acid deficiency.
- Fat is needed so your body can absorb the fat soluble vitamins A, S, E, K, and prevent deficiencies of these vitamins.
- Fat provides flavor and texture to help prevent food from being bland and dry.
- Fat may help your body produce endorphins (natural substances in the brain that produce pleasurable feelings).

Source- Mutton, Milk, Egg Etc. are rich in fat.

Minerals

Just like vitamins, minerals help your body grow, develop, and stay healthy. The body uses minerals to perform many different functions — from building strong bones to transmitting nerve impulses. Some minerals are even used to make hormones or maintain a normal heartbeat.

Function-Minerals such as calcium, zinc and potassium are needed by the body for a number of processes such as breaking down, digesting and releasing energy from food, strengthening bones, nails and teeth and regulating fluid and cholesterol in the body. There are 16 essential minerals

required by the body, which are divided into macrominerals, or minerals that are needed in fairly large quantities, microminerals, which are needed in smaller quantities and trace elements, which are needed in minute quantities but which are still vital for the body's well-being.

The benefits of some minerals cannot be seen without the presence of certain minerals and vice versa, for example, vitamin D is required in order to absorb calcium and when foods containing vitamin C are consumed, iron is absorbed more efficiently. A short description of some important minerals has been given:-

Calcium

Calcium is the top macromineral when it comes to your bones. This mineral helps build strong bones, so you can do everything from standing up straight to scoring that winning goal. It also helps build strong, healthy teeth, for chomping on tasty food.

Dairy products, such as milk, cheese, and yogurt, canned salmon and sardines with bones, leafy green vegetables, such as broccoli, calcium-fortified foods — from orange juice to cereals and crackers are rich source of Calcium.

Iron

The body needs iron to transport oxygen from your lungs to the rest of your body. Your entire body needs oxygen to stay healthy and alive. Iron helps because it's important in the formation of hemoglobin (say: HEE-muh-glo-bun), which is the part of your red blood cells that carries oxygen throughout the body. Meat, especially red meat, such as beef, tuna and salmon, eggs, beans, baked potato with skins, dried fruits, like raisins, leafy green vegetables, such as broccoli, whole and enriched grains, like wheat or oats are examples of food which are rich in Iron.

Potassium

Potassium keeps your muscles and nervous system working properly. Potassium helps make sure the amount of water is just right between cells and body fluids.

Bananas, tomatoes, potatoes and sweet potatoes, with skins, green vegetables, such as spinach and broccoli, citrus fruits, like oranges, low-fat milk and yogurt, legumes, such as beans, split peas, and lentils are good sources of Potassium.

Zinc

Zinc helps your immune system, which is your body's system for fighting off illnesses and infections. It also helps with cell growth and helps heal wounds, such as cuts. Beef, pork, and dark meat chicken, nuts, such as cashews, almonds, and peanuts, legumes, such as beans, split peas, and lentils are rich sources of Zinc.

When people don't get enough of these important minerals, they can have health problems. For instance, too little calcium — especially when you're a kid — can lead to weaker bones. Some kids may take mineral supplements, but most kids don't need them if they eat a nutritious diet. So eat those minerals and stay healthy!

Protein

Protein-Proteins are large biological molecules consisting of one or more chains of amino acids.

Function- Proteins perform a vast array of functions within living organisms, including catalyzing metabolic reactions, replicating DNA, responding to stimuli, and transporting molecules from one location to another.

Source-Meat, milk, fish and eggs, as well as in plant sources such as whole grains, pulses, legumes, soy, fruits, nuts and seeds are good sources of protein.

Vitamins

A Vitamin is an organic compound required by an organism as a vital nutrient in limited amounts. An organic chemical compound (or related set of compounds) is called a vitamin when it cannot be synthesized in sufficient quantities by an organism, and must be obtained from the diet.

Function: Vitamins have diverse biochemical functions. Some have hormone-like functions as regulators of mineral metabolism (such as vitamin D), or regulators of cell and tissue growth and differentiation (such as some forms of vitamin A). Others function as antioxidants (e.g., vitamin E and sometimes vitamin C). The largest number of vitamins such as

B complex vitamins function as precursors for enzyme cofactors that help enzymes in their work as catalysts in metabolism.

Water

Function- Water is a carrier, distributing essential nutrients to cells, such as minerals, vitamins and glucose. Its five top functions are as following:-

1) Cell life,
2) Chemical and metabolic reactions,
3) Transport of nutrients
4) Body temperature regulation,
5) Elimination of waste,

The human digestive system is a complex series of organs and glands that processes food. In order to consume the food we eat, our body has to break the food down into smaller molecules that it can process; it also has to excrete waste.

The digestive system is essentially a long, twisting tube that runs from the mouth to the anus, plus a few other organs (like the liver and pancreas) that produce or store digestive chemicals.

The Digestive Process

The Mouth

The digestive process begins in the mouth. Food is partly broken down by the process of chewing and by the chemical action of salivary enzymes (these enzymes are produced by the salivary glands and break down starches into smaller molecules).

The Esophagus

After being chewed and swallowed, the food enters the esophagus. The esophagus is a long tube that runs from the mouth to the stomach. It uses rhythmic, wave-like muscle movements (called peristalsis) to force food from the throat into the stomach.

The Stomach

The stomach is a large, sack-like organ that releases the gastric acid to digest the food. Food in the stomach that is digested in the stomach and mixed with stomach acids is called chyme.

The Small Intestine

After being in the stomach, food enters the duodenum, the first part of the small intestine. It then enters the jejunum and then the ileum (the final part of the small intestine). In the small intestine, bile (produced in the liver and stored in the gall bladder), pancreatic enzymes, and other digestive enzymes produced by the inner wall of the small intestine help in the breakdown of food.

The Large Intestine

After passing through the small intestine, food passes into the large intestine. In the large intestine, some of the water and electrolytes (chemicals like sodium) are removed from the food. Many microbes (bacteria like Bacteroides, Lactobacillus acidophilus, Escherichia coli, and Klebsiella) in the large intestine help in the digestion process. The first part of the large intestine is called the cecum (the appendix is connected to the cecum). Food then travels upward in the ascending colon. The food travels across the abdomen in the transverse colon, goes back down the other side of the body in the descending colon, and then through the sigmoid colon. Solid waste is then stored in the rectum until it is excreted via the anus.

Enzymes

In general, enzymes are large protein-based molecules that help chemical reactions take place faster than they otherwise would, explain Reginald Garrett and Charles Grisham in their book "Biochemistry." Your body cells run a wide array of chemical reactions, nearly all of which are enzyme-dependent. Specifically, digestive enzymes help you break down large nutrient molecules in your food into smaller nutrient molecules that you can absorb.

Pepsin

Pepsin is secreted by the gastric glands and is responsible for breaking down proteins into smaller pieces, called polypeptides. Pepsin is secreted in its inactive form, known as pepsinogen, and is converted into its active form in the acidic environment of the stomach. The acidic environment of the stomach also alters the shape of proteins, allowing pepsin access to break the peptide bonds holding them together. Pepsin's role in breaking protein down into polypeptides allows enzymes in the small intestines to further break down these polypeptides into amino acids for use by the body, according to the University of Cincinnati Clermont College.

Proteases

Protein digestion is initiated by pepsin in the stomach but is finished by proteases in the small intestines. Proteases are secreted by the pancreas and function to break down polypeptides, or broken down proteins, into amino acids -- the building blocks critical to life. Trypsin and chymotrypsin are the two primary proteases secreted by the pancreas, according to Colorado State University.

Bile

Bile is a digestive fluid primarily involved in the digestion of fats. Secreted by the liver and stored in the gallbladder, bile is a complex mixture of bile acids, potassium and sodium, cholesterol and bilirubin -- a byproduct from the breakdown of red blood cells. In the small intestine, the bile acids break down dietary fat and fat-soluble vitamins into fatty acid components, which can then be absorbed by the body. Bile acids are synthesized from cholesterol and thus play a large role in the breakdown and elimination of cholesterol from the body.

Glossary Related to Digestive System

- Abdomen - the part of the body that contains the digestive organs. In human beings, this is between the diaphragm
- Pelvis alimentary canal - the passage through which food passes, including the mouth, esophagus, stomach, intestines, and anus.

- Anus - the opening at the end of the digestive system from which feces (waste) exits the body.
- Appendix - a small sac located on the cecum.
- Ascending colon - the part of the large intestine that run upwards; it is located after the cecum.
- Bile - a digestive chemical that is produced in the liver, stored in the gall bladder, and secreted into the small intestine.
- Cecum - the first part of the large intestine; the appendix is connected to the cecum.
- Chyme - food in the stomach that is partly digested and mixed with stomach acids. Chyme goes on to the small intestine for further digestion.
- Descending colon - the part of the large intestine that run downwards after the transverse colon and before the sigmoid colon.
- Digestive system - (also called the gastrointestinal tract or gi tract) the system of the body that processes food and gets rid of waste.
- Duodenum - the first part of the small intestine; it is c-shaped and runs from the stomach to the jejunum.
- Epiglottis - the flap at the back of the tongue that keeps chewed food from going down the windpipe to the lungs. When you swallow, the epiglottis automatically closes. When you breathe, the epiglottis opens so that air can go in and out of the windpipe.
- Esophagus - the long tube between the mouth and the stomach. It uses rhythmic
- Gall bladder - a small, sac-like organ located by the duodenum. It stores and releases bile (a digestive chemical which is produced in the liver) into the small intestine.
- Gastrointestinal tract - (also called the gi tract or digestive system) the system of the body that processes food and gets rid of waste.
- Ileum - the last part of the small intestine before the large intestine begins.
- Intestines - the part of the alimentary canal located between the stomach and the anus.
- Jejunum - the long, coiled mid-section of the small intestine; it is between the duodenum and the ileum.

- Liver - a large organ located above and in front of the stomach. It filters toxins from the blood, and makes bile (which breaks down fats) and some blood proteins.
- Mouth - the first part of the digestive system, where food enters the body. Chewing and salivary enzymes in the mouth are the beginning of the digestive process (breaking down the food).
- Pancreas - an enzyme-producing gland located below the stomach and above the intestines. Enzymes from the pancreas help in the digestion of carbohydrates, fats and proteins in the small intestine.
- Peristalsis - rhythmic muscle movements that force food in the esophagus from the throat into the stomach. Peristalsis is involuntary - you cannot control it. It is also what allows you to eat and drink while upside-down.
- Rectum - the lower part of the large intestine, where feces are stored before they are excreted.
- Salivary glands - glands located in the mouth that produce saliva. Saliva contains enzymes that break down carbohydrates (starch) into smaller molecules.
- Sigmoid colon - the part of the large intestine between the descending colon and the rectum.
- Stomach - a sack-like, muscular organ that is attached to the esophagus. Both chemical and mechanical digestion takes place in the stomach. When food enters the stomach, it is churned in a bath of acids and enzymes.
- Transverse colon - the part of the large intestine that runs horizontally across the abdomen.

CHAPTER 3: FUNCTIONS OF HEART AND KIDNEY

Kidney: The kidneys perform the essential function of removing waste products from the blood and regulating the water fluid levels. The kidneys receive blood through the renal artery. The blood is passed through the structure of the kidneys called nephrons, where waste products and excess water pass out of the blood stream, as shown in the diagram below.

When the kidneys are not functional, dialysis becomes necessary to save the victim. In dialysis, the blood passes through an external membrane which allows waste products from the blood to pass out of the blood and into the dialysis fluid. Because of the rate of buildup of the waste

Kidney Functions

Kidneys are essential in the urinary system and also serve homeostatic functions such as the regulation of electrolytes, maintenance of acid–base balance, and regulation of blood pressure (via maintaining salt and water balance). They serve the body as a natural filter of the blood and remove wastes which are diverted to the urinary bladder. In producing urine, the kidneys excrete wastes such as urea and ammonium, and they are also responsible for the reabsorption of water, glucose, and amino acids. The kidneys also produce hormones including calcitriol, erythropoietin, and the enzyme renin.

Located at the rear of the abdominal cavity in the retroperitoneum, the kidneys receive blood from the paired renal arteries, and drain into the paired renal veins. Each kidney excretes urine into a ureter, itself a paired structure that empties into the urinary bladder.

Renal physiology is the study of kidney function, while nephrology is the medical specialty concerned with kidney diseases. Diseases of the kidney are diverse, but individuals with kidney disease frequently display characteristic clinical features. Common clinical conditions involving the kidney include the nephritic and nephrotic syndromes, renal cysts, acute kidney injury, chronic kidney disease, urinary tract infection, nephrolithiasis, and urinary tract obstruction. Various cancers of the kidney exist; the most common adult renal cancer is renal cell carcinoma. Cancers, cysts, and some other renal conditions can be managed with removal of the kidney, or nephrectomy. When renal function, measured by glomerular filtration rate, is

persistently poor, dialysis and kidney transplantation may be treatment options. Although they are not severely harmful, kidney stones can be painful and a nuisance. The removal of kidney stones involves ultrasound treatment to break up the stones into smaller pieces, which are then passed through the urinary tract. One common symptom of kidney stones is a sharp pain in the medial/lateral segments of the lower back.

The kidneys secrete a variety of hormones, including erythropoietin, and the enzyme renin. Erythropoietin is released in response to hypoxia (low levels of oxygen at tissue level) in the renal circulation. It stimulates erythropoiesis (production of red blood cells) in the bone marrow. Calcitriol, the activated form of vitamin D, promotes intestinal absorption of calcium and the renal reabsorption of phosphate. Part of the renin-angiotensin-aldosterone system, renin is an enzyme involved in the regulation of aldosterone levels.

The kidneys perform a wide range of vital functions in the healthy body, such as:

- Removing wastes and water from the blood
- Balancing chemicals in your body
- Releasing hormones
- Helping control blood pressure
- Helping to produce red blood cells
- Producing vitamin D, which keeps the bones strong and healthy

Heart: The heart is one of the most important organs in the entire human body. It is really nothing more than a pump, composed of muscle which pumps blood throughout the body, beating approximately 72 times per minute of our lives.

The human circulatory system functions to transport blood and oxygen from the lungs to the various tissues of the body. The heart pumps blood throughout the body. The lymphatic system is an extension of the human circulatory system that includes cell-mediated and antibody-mediated immune systems. The components of the human circulatory system include the heart, blood, red and white blood cells, platelets, and the lymphatic system.

The human heart is about the size of a clenched fist. It contains four chambers: two atria and two ventricles. Oxygen-poor blood enters the right atrium through a major vein called the vena cava. The blood passes through the tricuspid valve into the right ventricle. Next, the blood is pumped through the pulmonary artery to the lungs for gas exchange. Oxygen-rich blood returns to the left atrium via the pulmonary vein. The oxygen-rich blood flows through the

bicuspid (mitral) valve into the left ventricle, from which it is pumped through a major artery, the aorta. Two valves called semilunar valves are found in the pulmonary artery and aorta.

The ventricles contract about 70 times per minute, which represents a person's pulse rate. Blood pressure, in contrast, is the pressure exerted against the walls of the arteries. Blood pressure is measured by noting the height to which a column of mercury can be pushed by the blood pressing against the arterial walls. A normal blood pressure is a height of 120 millimeters of mercury during heart contraction (SYSTOLE), and a height of 80 millimeters of mercury during heart relaxation (DIASTOLE). Normal blood pressure is usually expressed as “120 over 80.”

Coronary arteries supply the heart muscle with blood. The heart is controlled by nerves that originate on the right side in the upper region of the atrium at the sinoatrial node. This node is called the PACEMAKER. It generates nerve impulses that spread to the atrioventricular node where the impulses are amplified and spread to other regions of the heart by nerves called Purkinje fibers.

CHAPTER 4: SKELETAL SYSTEM

Appendicular Skeleton

The appendicular skeleton (126 bones) is formed by the pectoral girdles (4), the upper limbs (60), the pelvic girdle (2), and the lower limbs (60). Their functions are to make locomotion possible and to protect the major organs of locomotion, digestion, excretion, and reproduction.

Function

Support

The skeleton provides the framework which supports the body and maintains its shape. The pelvis, associated ligaments and muscles provide a floor for the pelvic structures. Without the rib cages, costal cartilages, and intercostal muscles, the heart would collapse.

Movement

The joints between bones permit movement, some allowing a wider range of movement than others, e.g. the ball and socket joint allows a greater range of movement than the pivot joint at the neck. Movement is powered by skeletal muscles, which are attached to the skeleton at various sites on bones. Muscles, bones, and joints provide the principal mechanics for movement, all coordinated by the nervous system.

Protection

The skeleton protects many vital organs:

- The skull protects the brain, the eyes, and the middle and inner ears. The vertebrae protect the spinal cord.
- The rib cage, spine, and sternum protect the human lungs, human heart and major blood vessels.
- The clavicle and scapula protect the shoulder.
- The ilium and spine protect the digestive and urogenital systems and the hip. The patella and the ulna protect the knee and the elbow respectively.
- The carpals and tarsals protect the wrist and ankle respectively. Blood cell production
- The skeleton is the site of haematopoiesis, the development of blood cells that takes place in the bone marrow.

Storage

Bone matrix can store calcium and is involved in calcium metabolism, and bone marrow can store iron in ferritin and is involved in iron metabolism. However, bones are not entirely made of calcium, but a mixture of chondroitin sulfate and hydroxyapatite, the latter making up 70% of a bone.

Endocrine Regulation

Bone cells release a hormone called osteocalcin, which contributes to the regulation of blood sugar (glucose) and fat deposition. Osteocalcin increases both the insulin secretion and sensitivity, in addition to boosting the number of insulin-producing cells and reducing stores of fat.

Sexual Dimorphism

There are many differences between the male and female human skeletons. Most prominent is the difference in the pelvis, owing to characteristics required for the processes of childbirth. The shape of a female pelvis is flatter, more rounded and proportionally larger to allow the head of a fetus to pass. A male's pelvis is about 90 degrees or less of angle, whereas a female's is 100 degrees or more. Also, the coccyx of a female's pelvis is oriented more inferiorly whereas a male's coccyx is usually oriented more anteriorly. This difference allows more room for childbirth. Males tend to have slightly thicker and longer limbs and digit bones (phalanges), while females tend to have narrower rib cages, smaller teeth, less angular mandibles, less pronounced cranial features such as the brow ridges and external occipital protuberance (the small bump at the back of the skull), and the carrying angle of the forearm is more pronounced in females. Females also tend to have more rounded shoulder blades.

Osteoporosis

Osteoporosis is a disease of bone, which leads to an increased risk of fracture. In osteoporosis, the bone mineral density (BMD) is reduced, bone microarchitecture is disrupted, and the amount and variety of non-collagenous proteins in bone is altered. Osteoporosis is defined by the World Health Organization (WHO) in women as a bone mineral density 2.5 standard deviations below peak bone mass (20-year-old sex-matched healthy person average) as measured by DXA; the term "established osteoporosis" includes the presence of a fragility fracture.[6] Osteoporosis is most common in women after the menopause, when it is called postmenopausal osteoporosis, but may develop in men and premenopausal women in the presence of particular hormonal disorders and other chronic diseases or as a result of smoking

and medications, specifically glucocorticoids, when the disease is craned steroid- or glucocorticoid-induced osteoporosis (SIOP or GIOP).

Osteoporosis can be prevented with lifestyle advice and medication, and preventing falls in people with known or suspected osteoporosis is an established way to prevent fractures. Osteoporosis can also be prevented with having a good source of calcium and vitamin D. Osteoporosis can be treated with bisphosphonates and various other medical treatments.

Disease/ Infection	This disease is spread by	Time between exposure and sickness	Symptoms
Campylobacter	Undercooked food (eg, chicken and meat); food/water contaminated with faeces from an infected person or animal. Direct spread from an infected person or animal.	1–10 days, usually 2–5 days	Stomach pain, fever and diarrhoea.
Chickenpox	Coughing and sneezing. Also direct contact with weeping blisters.	10–21 days, usually 14–16 days	Fever and spots with a blister on top of each spot.
Conjunctivitis (viral or bacterial)	Direct contact with discharge from the eyes or with items contaminated by the discharge.	12 hours–12 days	Irritation and redness of eye. Sometimes there is a discharge.
Cryptosporidium Giardia	Food or water contaminated with faeces from an infected person or animal. Direct spread from an infected person or animal.	Cryptosporidium m1–12 days, average about 7 days Giardia 3–25 days, usually about 7–10 days	Stomach pain and diarrhea.
Gastroenteritis (viral)	Food or water contaminated with faeces from an infected person or animal. Direct spread from an infected person.	1–3 days	Vomiting, diarrhoea and fever.
Glandular fever	Transfer of saliva.	4–6 weeks	Sore throat, swollen glands in the neck, fever. Vague ill health for some time.
Hand, foot and mouth disease	Coughing or poor hand washing. Direct spread from an infected person.	3–5 days	Fever, rash on soles and palms and in mouth. Flu-like symptoms.

Hepatitis A Food or water contaminated with faeces from an infected person.
Direct spread from an infected person. 15–50 days,
usually 28–30 days Nausea, stomach pains, general sickness. Jaundice a few days later.
Hepatitis B Close physical contact with the blood or body fluids of an infected person. 6 weeks–6 months, usually 2–3 months Similar to Hepatitis A.
Impetigo (School sores) Direct contact with discharge from infected skin. Usually a few days, variable Scabby sores on exposed parts of the body.
Influenza Coughing and sneezing and direct contact with respiratory droplets. 1–4 days Sudden onset of fever with cough, sore throat, muscular aches and headache.
Measles Coughing and sneezing. Also direct contact with the nose/throat secretions of an infected person. 7–18 days,
usually 10 days to onset and 14 days to rash Running nose and eyes, cough, fever and a rash.
Meningitis (Meningococcal) Close physical contact such as kissing. Sleeping in the same room. 2–10 days,
usually 3–4 days Generally unwell, fever, headache, vomiting, sometimes a rash. Urgent treatment is required!
Mumps Contact with infected saliva, eg, coughing, sneezing, kissing and sharing food and drink. 12–25 days,
usually 16–18 days Pain in my jaw, then swelling in front of my ear and fever.
Ringworm Contact with infected person's skin, clothes or personal items. Also through contaminated floors and shower stalls. 10–14 days Flat spreading ring-shaped lesions.
Rubella Coughing and sneezing. Also direct contact with 14–23 days,
usually 16–18 Fever, swollen neck glands and a rash on the face, scalp and
the nose/throat secretions of an infected person. days body. Rubella during early pregnancy can cause abnormalities in the baby.
Salmonella Undercooked food (eg, chicken and meat); food/water contaminated with feces from infected person or animal; direct spread from infected person or animal. 6–72 hours,
usually 12–36 hours Stomach pain, nausea, fever and diarrhea.
Scabies Direct skin contact with the infected person, and sharing sheets and clothes. Days–weeks Itchy rash in places such as the forearm, around waist, between fingers and buttocks and under armpits.

Slapped cheek (Human parvovirus infection)Coughing and sneezing. The virus may be passed from mother to child during pregnancy. 4–20 days Red cheeks and lace-like rash on body.

Streptococcal sore throat Usually contact with the secretions of a strep sore throat. Sometimes through contaminated food. 1–3 days Headache, vomiting, sore throat.

Whooping cough (Pertussis) Coughing. Adults and older children may pass on the infection to babies. 5–21 days,

usually 7–10 days Running nose, persistent cough followed by “whoop”, vomiting or breathlessness.

CHAPTER 6: REPRODUCTION

It is defined as a biological process in which an organism gives rise to young ones similar to itself. There are two types of reproduction; 1) Sexual Reproduction 2) Asexual Reproduction

Asexual Reproduction

When offspring is produced by a single parent with or without the involvement of gamete formation, the reproduction is asexual. It is common among single-celled organisms and in plants and animals with relatively simple organizations. In Protists and Monerans, the organism or the parent cell divides into two to give rise to new individuals.

Sexual Reproduction

When two parents (opposite sex) participate in the reproductive process and also involve fusion of male and female gametes, it is called sexual reproduction. All organisms have to reach a certain stage of growth and maturity in their life, before they can reproduce sexually. The period of growth is called the juvenile phase. It is known as vegetative phase in plants.

The females of placental mammals exhibit cyclical changes in the activities of ovaries and accessory ducts as well as hormones during the reproductive phase. In non-primate mammals like cows, sheep, dogs such cyclical changes during reproduction are called oestrus cycle whereas in primates (Monkeys, apes and humans) it is called menstrual cycle.

Many mammals exhibit such cycles only during favourable seasons in their reproductive phase and are therefore called seasonal breeders. Many other mammals are reproductively active throughout their reproductive phase and therefore termed as continuous breeders.

Sexual Reproduction in other words is the fusion of gamets. This process is called syngamy or fertilization which results in the formation of a diploid zygote. It is universal in all sexually reproducing organisms. Fertilisation is either external or internal.

External Fertilization

External fertilization: In most aquatic organisms, such as a majority of fishes and algae as well as amphibians, fertilization occurs in the water, outside the body of the organism.

Internal Fertilization

Internal fertilization: Fertilisation occurs inside the body of the organism, hence the process is called internal fertilization.

Embryogenesis

Embryogenesis is the process which traces the development of the embryo from the zygote. During this process, Zygote undergoes cell division (mitosis) and cell differentiation. Cell differentiation helps groups of cells to undergo certain modifications to form specialized tissues and organs to form an organism.

Animals are further categorized into oviparous and viviparous. In oviparous animals like reptiles and birds the development of zygote takes place outside the body of the female parent; where they lay unfertilsed/fertilised eggs.

In viviparous animals (majority of mammals including humans) female parents give birth to young ones.

The term clone is used to describe such morphologically and genetically similar individuals.

Sexual Reproduction in Flowering Plants

The pollen grains represent the male gametophytes while the gynoecium represents the female reproductive part of the flower. It may have one single pistil or may have more than one pistil. Each pistil has three parts;- The Stigma, style and ovary. The stigma serves as a landing platform for pollen grains. The style is the elongated slender part beneath the stigma. The basal bulged part of the pistil is the ovary.

Inside the ovary is the ovarian cavity. The placenta is located inside the ovarian cavity. Arising from the placenta are the megasporangia, commonly called ovules. Each ovule has one or two protective envelopes called integuments. Enclosed within the integuments is a mass of cells called the nucellus. Located in the nucellus is the embryo sac or female gametophyte.

The process of formation of megaspores from the megaspore mother cell is called megasporogenesis.

In a majority of flowering plants, one of the megaspores is functional while the other three degenerate. Only the functional megaspore develops into the female gametophyte (embryo sac).

Pollination

Pollination is the mechanism under which pollen grains are transferred to the stigma of a pistil.

Types of Pollination

Depending upon the source of pollen, pollination can be divided into three types.

Autogamy- And Autogamy, pollination is achieved within the same flower. Transfer of pollen grains from the anther to the stigma of the same flower.

Geitonogamy-Transfer of pollen grains from the anther to the stigma of another flower of the same plant.

Xenogamy- Transfer of pollen grains from anther to the stigma of a different plant. This is the only type of pollination which brings genetically different types of pollen grains to the stigma during pollination.

Agents of Pollination: plants use two abiotic (wind and water) and one biotic (animals) agents to achieve pollination. Majority of plants use biotic agents for pollination. Only a small proportion of plants use abiotic agents.

Majority of flowering plants use a range of animals as pollinating agents. Bees, butterflies, ants, wasps and birds are the common pollinating agents.

Human Reproduction

The male reproductive system is composed of a pair of testes, the male reproductive system is composed of a pair of testes, the male sex accessory ducts and the accessory glands and external genitalia. Each testis has about 250 compartments called testicular lobules, and each lobule contains one to three highly coiled seminiferous tubules. Each seminiferous tubule is lined inside by spermatogonia and sertoli cells.

The female reproductive system consists of a pair of ovaries, a pair of oviducts, a uterus, a vagina, external genitalia and a pair of mammary glands. The ovaries produce the female gamete (ovum) and some steroid hormones (ovarian hormones). Ovarian follicles in different stages of development are embedded in the stroma. The oviducts, uterus and vagina are female accessory ducts. The uterus has three layers namely perimetrium, myometrium and endometrium. The female external genitalia include mons pubis, labia majora, labia minora, hymen and clitoris.

Spermatogenesis results in the formation of sperms that are transported by the male sex accessory ducts. A normal human sperm is composed of a head, neck, a middle piece and tail. The process of formation of mature female gametes is called oogenesis.

During copulation (coitus) semen is released by the penis into the vagina (insemination). The motile sperms swim rapidly, pass through the cervix, enter into the uterus and finally reach the junction of the isthmus and ampulla (ampullary-isthmic) of the fallopian tube. The ovum released by the ovary is also transported to the ampullary-isthmic junction where fertilization takes place. Fertilization can only occur if the ovum and sperms are transported simultaneously to the ampullary-isthmic junction.

The process of fusion of a sperm with an ovum is called fertlisation. During fertlisation, a sperm comes in contact with the zona pellucida layer of the ovum and induces changes in the membrane that block the entry of additional sperms. Thus, it ensures that only one sperm can

fertilise an ovum. The secretions of the acrosome help the sperm enter into the cytoplasm of the ovum through the zona pellucid and the plasma membrane.

The reproductive cycle of female primates is called menstrual cycle which starts only after attaining sexual maturation termed as puberty. During ovulation only one ovum is released per menstrual cycle. After coitus, sperm fertilizes the ovum leading to formation of a diploid zygote. The presence of X or Y chromosomes in the sperm determines the sex of the embryo. The zygote undergoes repeated mitotic division to form a blastocyst, which is implanted in the uterus resulting in pregnancy. The average duration of human pregnancy is about 9 months which is called the gestation period.

The structural and functional unit between the developing embryo (foetus) and maternal body is called placenta. The placenta facilitates the supply of oxygen and nutrients to the embryo and also removal of carbon dioxide and excretory/ waste materials produced by the embryo. Placenta also acts as an endocrine tissue and produces several hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, progestogens, etc. In the later phase of pregnancy, a hormone called relaxin is also secreted by the ovary. It should be noted that hCG, hPL and relaxin are produced in women during pregnancy. In addition, during pregnancy the levels of other hormones like estrogens, progestogens, cortisol, prolactin, and thyroxine are increased many-folds in the maternal blood. Increased production of these hormones is essential for supporting fetal growth, metabolic changes in the mother and maintenance of pregnancy.

The process of childbirth is called parturition which is induced by a complex neuroendocrine mechanism involving cortisol, estrogens and oxytocin.

The major female and male hormones can be classified as estrogens or androgens. Both classes of male and female hormones are present in both males and females alike, but in vastly different amounts. Most men produce 6-8 mg of the male hormone testosterone (an androgen) per day, compared to most women who produce 0.5 mg daily. Female hormones, estrogens, are also present in both sexes, but in larger amounts for women.

Estrogens are the sex hormones produced primarily by a female's ovaries that stimulate the growth of a girl's sex organs, as well as her breasts and pubic hair, known as secondary sex characteristics. Estrogens also regulate the functioning of the menstrual cycle.

Testosterone is a steroid hormone from the androgen group and is found in mammals, reptiles, birds, and other vertebrates. In mammals, testosterone is primarily secreted in the testicles of males and the ovaries of females, although small amounts are also secreted by the adrenal glands. It is the principal male sex hormone and an anabolic steroid.

In men, testosterone plays a key role in the development of male reproductive tissues such as the testis and prostate as well as promoting secondary sexual characteristics such as increased muscle, bone mass, and the growth of body hair. In addition, testosterone is essential for health and well-being as well as the prevention of osteoporosis.

On average, in adult human males, the plasma concentration of testosterone is about 7–8 times as great as the concentration in adult human females' plasma, but as the metabolic consumption of testosterone in males is greater, the daily production is about 20 times greater in men.

Artificial Methods of Vegetative Reproduction

Besides natural methods of vegetative propagation, artificial modes of propagation are also being used. Farmers, gardeners and horticulturists have adopted several such methods like grafting, layering, cutting and tissue culture for propagating plants in gardens and nurseries.

Grafting

In horticultural practices this method is commonly used. In this method the cutting of a plant (scion) is attached to the stem of another rooted plant (stock). After some time the attached cutting becomes an integrated part of the rooted plant. The scion and stock are placed in such a way that no gap remains between them. Finally they become joined in such a way that their vascular systems are united. Usually the scion is of a plant having desirable characteristics like large sized fruits and the stock has good absorbing capacity. Because of the arrangement of their vascular bundles, grafting experiments are successful only in divots and not in monocots. This method is commonly applied to improve the variety of fruits like mango. Wax is used to cover the place where grafting is being done. This is to avoid infection.

Bud Grafting

A bud is taken along with a portion of bark from a plant and is used as scion in this process. A T- shaped cut is made and the bud is fixed tightly on the stock with a tape. The bud gets attached to the stock after some time and new branches are formed. Pears, peaches, plum, citrus, roses, etc., are propagated by this method. This method is usually employed during spring.

Cutting

In rose, sugar-cane, Coleus, Bougainvillea, etc., this method is used to produce new plants. In this process stem cuttings with some nodes and internodes are placed in moist soil which gives rise to adventitious roots and a new plant subsequently. It is a very common method of vegetative propagation. Farmers divide up the rhizomes, tubers or roots stocks at the end of flowering or growing season. Each part grows into a separate plant in the following year. Some plants like dahlia are propagated by root cuttings.

Layering

In some plants one or more branches are bent close to the ground and covered with moist soil. After some time, the underground portion of those branches produce new roots and develop into a separate plant as in jasmine, Rhododendron, Magnolia, etc. The stem or branch that develops adventitious roots while still attached to the parent plant is called a layer. In many plants, layering can also be induced artificially.

In mound layering the stem is pruned and the base of the plant is covered with soil. From the base, new shoots develop, which are separated from the parent plant, and grown into a new plant. Many types of apples and gooseberries are grown using this method.

Air layering is another type of layering in which branches of the plants cannot be bent to the ground. A piece of the branch is scraped (girdled) in this method and polythene or plastic sheet is used as cover to preserve moisture. Roots arise from the scraped part after a few weeks. This branch is then detached from the parent plant which grows into a new plant after plantation.

Layering differs from cutting in that the developments of adventitious buds are induced before the stem is cut to form the new plant.

Tissue Culture

In this technique a small piece of tissue of a desired plant is cut. This is placed with a suitable nutrient medium under proper conditions. The tissue grows into an unorganized mass, known as callus. Small part of this tissue is put in another medium, which induces the formation of plantlets. The plantlets can be transplanted in soil or pots foe developing to maturity. This technique is also called micro propagation. This method is used in propagating plants like Asparagus, orchids, and Chrysanthemum. This method allows us to grow whole plant from cells taken from various parts of the plant body.

- Air enters the nostrils
- passes through the nasopharynx,
- the oropharynx
- through the glottis
- into the trachea
- into the right and left bronchi, which branches and branches into
- bronchioles, each of which terminates in a cluster of
- alveoli

Only in the alveoli does actual gas exchange takes place. There are some 300 million alveoli in two adult lungs. These provide a surface area of some 160 m2 (almost equal to the singles area of a tennis court and 80 times the area of our skin!).

Breathing

In mammals, the diaphragm divides the body cavity into the

- Abdominal cavity, which contains the viscera (e.g., stomach and intestines) and the
- Thoracic cavity, which contains the heart and lungs.

The inner surface of the thoracic cavity and the outer surface of the lungs are lined with pleural membranes which adhere to each other. If air is introduced between them, the adhesion is broken and the natural elasticity of the lung causes it to collapse. This can occur from trauma. And it is sometimes induced deliberately to allow the lung to rest. In either case, reinflation occurs as the air is gradually absorbed by the tissues.

Because of this adhesion, any action that increases the volume of the thoracic cavity causes the lungs to expand, drawing air into them.

During inspiration (inhaling),

- The external intercostal muscles contract, lifting the ribs up and out.
- The diaphragm contracts, drawing it down .

During expiration (exhaling), these processes are reversed and the natural elasticity of the lungs returns them to their normal volume. At rest, we breath 15–18 times a minute exchanging about 500 ml of air.

In more vigorous expiration,

- The internal intercostal muscles draw the ribs down and inward
- The wall of the abdomen contracts pushing the stomach and liver upward.

Under these conditions, an average adult male can flush his lungs with about 4 liters of air at each breath. This is called the vital capacity. Even with maximum expiration, about 1200 ml of residual air remain.

The table shows what happens to the composition of air when it reaches the alveoli. Some of the oxygen dissolves in the film of moisture covering the epithelium of the alveoli. From here it diffuses into the blood in a nearby capillary. It enters a red blood cell and combines with the hemoglobin therein.

At the same time, some of the carbon dioxide in the blood diffuses into the alveoli from which it can be exhaled.

The ease with which oxygen and carbon dioxide can pass between air and blood is clear from this electron micrograph of two alveoli (Air) and an adjacent capillary from the lung of a laboratory mouse. Note the thinness of the epithelial cells (EP) that line the alveoli and capillary (except where the nucleus is located). At the closest point, the surface of the red blood cell is only 0.7 µm away from the air in the alveolus.

Central Control of Breathing

The rate of cellular respiration (and hence oxygen consumption and carbon dioxide production) varies with level of activity. Vigorous exercise can increase by 20–25 times the demand of the tissues for oxygen. This is met by increasing the rate and depth of breathing.

It is a rising concentration of carbon dioxide — not a declining concentration of oxygen — that plays the major role in regulating the ventilation of the lungs. Certain cells in the medulla oblongata are very sensitive to a drop in pH. As the CO_2 content of the blood rises above normal

levels, the pH drops and the medulla oblongata responds by increasing the number and rate of nerve impulses that control the action of the intercostal muscles and diaphragm. This produces an increase in the rate of lung ventilation, which quickly brings the CO2 concentration of the alveolar air, and then of the blood, back to normal levels.

However, the carotid body in the carotid arteries does have receptors that respond to a drop in oxygen. Their activation is important in situations (e.g., at high altitude in the unpressurized cabin of an aircraft) where oxygen supply is inadequate but there has been no increase in the production of CO2.

The smooth muscle in the walls of the bronchioles is very sensitive to the concentration of carbon dioxide. A rising level of CO2 causes the bronchioles to dilate. This lowers the resistance in the airways and thus increases the flow of air in and out.

Vital Capacity of Lung

Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inhalation. It is equal to the sum of inspiratory reserve volume, tidal volume, and expiratory reserve volume.

A person's vital capacity can be measured by a wet or regular spirometer. In combination with other physiological measurements, the vital capacity can help make a diagnosis of underlying lung disease.

A normal adult has a vital capacity between 3 and 5 litres. A human's vital capacity depends on age, sex, height, weight, and ethnicity.

Lung Volumes

Lung volumes and lung capacities refer to the volume of air associated with different phases of the respiratory cycle. Lung volumes are directly measured, whereas lung capacities are inferred from volumes.

Lung Diseases

- Asthma: The airways are persistently inflamed, and may occasionally spasm, causing wheezing and shortness of breath. Allergies, infections, or pollution can trigger asthma's symptoms.

- Chronic obstructive pulmonary disease (COPD): Lung conditions defined by an inability to exhale normally, which causes difficulty breathing.
- Chronic bronchitis: A form of COPD characterized by a chronic productive cough.
- Emphysema: Lung damage allows air to be trapped in the lungs in this form of COPD. Difficulty blowing air out is its hallmark.
- Acute bronchitis: A sudden infection of the airways, usually by a virus.
- Cystic fibrosis: A genetic condition causing poor clearance of mucus from the bronchi. The accumulated mucus results in repeated lung infections.
- Pneumonia: An infection of the alveoli, usually by bacteria.
- Tuberculosis: A slowly progressive pneumonia caused by the bacteria Mycobacterium tuberculosis.
- Emphysema results from damage to the fragile connections between alveoli. Smoking is the usual cause. (Emphysema also limits airflow, affecting the airways as well.)
- Pulmonary edema: Fluid leaks out of the small blood vessels of the lung into the air sacs and the surrounding area. One form is caused by heart failure and back pressure in the lungs' blood vessels; in another form, direct injury to the lung causes the leak of fluid.
- Lung cancer has many forms, and may develop in any part of the lungs. Most often this is in the main part of the lung, in or near the air sacs. The type, location, and spread of lung cancer determines the treatment options.
- Acute respiratory distress syndrome (ARDS): Severe, sudden injury to the lungs caused by a serious illness. Life support with mechanical ventilation is usually needed to survive until the lungs recover.
- Pneumoconiosis: A category of conditions caused by the inhalation of a substance that injures the lungs. Examples include black lung disease from inhaled coal dust and asbestosis from inhaled asbestos dust.
- Interstitial lung disease (ILD): A broad collection of lung conditions affecting the interstitium. Sarcoidosis, idiopathic pulmonary fibrosis, and autoimmune disease are among the many types of ILD.
- Pneumonias and pulmonary edemas can also affect the interstitium.

- Pulmonary embolism (PE): A blood clot (usually in a deep leg vein, deep vein thrombosis) breaks off, travels to the heart, and is pumped into the lungs. The clot lodges in a pulmonary artery, often causing shortness of breath and low blood oxygen levels.
- Pulmonary hypertension: Various conditions can lead to high blood pressure in the pulmonary arteries. This can cause shortness of breath and chest pain. When no cause is identified, the condition is called idiopathic pulmonary arterial hypertension.
- Pleural effusion: Fluid collects in the normally tiny pleura space between the lung and the chest wall. Pneumonia or heart failure is usually responsible. If large, pleural effusions can impair breathing, and should be drained.
- Pneumothorax: Air may enter the space between the chest wall and the lung, collapsing the lung. To remove the air, a tube is typically inserted through the chest wall.
- Mesothelioma: A rare form of cancer that forms on the pleura. Mesothelioma tends to emerge several decades after asbestos exposure.
- Obesity hypoventilation syndrome: Extra weight on the chest and abdomen makes it difficult for the chest to expand. Serious breathing problems can result.
- Neuromuscular disorders: Poor function in the nerves controlling the respiratory muscles causes difficulty breathing. Amyotrophic lateral sclerosis and myasthenia gravis are examples of neuromuscular lung disease.

Photosynthesis

Photosynthesis is the process of converting light energy to chemical energy and storing it in the bonds of sugar. This process occurs in plants and some algae (Kingdom Protista). Plants need only light energy, CO2, and H2O to make sugar. The process of photosynthesis takes place in the chloroplasts, specifically using chlorophyll, the green pigment involved in photosynthesis. Photosynthesis takes place primarily in plant leaves, and little to none occurs in stems, etc. The parts of a typical leaf include the upper and lower epidermis, the mesophyll, the vascular bundle(s) (veins), and the stomates. The upper and lower epidermal cells do not have chloroplasts, thus photosynthesis does not occur there. They serve primarily as protection for the rest of the leaf. The stomata are holes which occur primarily in the lower epidermis and are for

air exchange: they let CO_2 in and O_2 out. The vascular bundles or veins in a leaf are part of the plant's transportation system, moving water and nutrients around the plant as needed. The mesophyll cells have chloroplasts and this is where photosynthesis occurs.

As you hopefully recall, the parts of a chloroplast include the outer and inner membranes, intermembrane space, stroma, and thylakoids stacked in grana. The chlorophyll is built into the membranes of the thylakoids.

Chlorophyll looks green because it absorbs red and blue light, making these colors unavailable to be seen by our eyes. It is the green light which is NOT absorbed that finally reaches our eyes, making chlorophyll appear green. However, it is the energy from the red and blue light that are absorbed that is, thereby, able to be used to do photosynthesis. The green light we can see is not/cannot be absorbed by the plant, and thus cannot be used to do photosynthesis.

The overall chemical reaction involved in photosynthesis is: $6CO_2 + 6H_2O$ (+ light energy) $C_6H_{12}O_6 + 6O_2$. This is the source of the O_2 we breathe, and thus, a significant factor in the concerns about deforestation.

CHAPTER 8: PARTS OF CELL AND THEIR FUNCTIONS

Cell can be best defined as the basic structural unit of an organ. The organisms made up of a single cell are called unicellular. Examples-a) Amoeba b) Paramecium.

A single-celled organism performs all the necessary functions that multicellular organisms perform. Organisms made up of more than one cell are called multicellular organisms.

The parts of cell are as following:-

a. Membrane
b. Cytoplasm and
c. Nucleus

The cytoplasm and nucleus are enclosed within the cell membrane, also called the plasma membrane. The membrane separates cells from one another and also the cell from the

surrounding medium. The plasma membrane is porous and allows the movement of substances or materials both inward and outward.

Cytoplasm is the jelly-like substance present between the cell membrane and the nucleus. Various other components or organelles of cells are present in the cytoplasm. These are mitochondria, ribosomes etc.

Nucleus is an important component of the living cell. It is separated from the cytoplasm by a membrane called the nuclear membrane. This membrane is also porous and allows the movement of materials between the cytoplasm and the inside of the nucleus.

Nucleus in addition to its role in inheritance acts as the control centre of the activities of the cell. Using a sophisticated microscope, we can see a smaller spherical body in the nucleus. It is called the nucleolus. In addition, the nucleus contains thread-like structures called chromosomes. These carry genes and help in inheritance or transfer of characters from the parents to the offspring.

Mitosis is a process of cell duplication, or reproduction, during which one cell gives rise to two genetically identical daughter cells.

Meiosis, on the other hand, is a division of a germ cell involving two fissions of the nucleus and giving rise to four gametes, or sex cells, each possessing half the number of chromosomes of the original cell.

Mitosis is used by single celled organisms to reproduce; it is also used for the organic growth of tissues, fibers, and membranes. Meiosis is useful for sexual reproduction of organisms; The male and female sex cells, e.g. the spermatozoa and egg, fuse to create a new, singular biological organism.

Meiosis

Mitosis

Definition: A type of cellular reproduction in which the number of chromosomes are reduced by half through the separation of homologous chromosomes in a diploid cell. A process of asexual reproduction in which the cell divides in two producing a replica, with an equal number of chromosomes in haploid cell

Function: sexual reproduction Cellular Reproduction & general growth and repair of the body

Type of Reproduction: Sexual Asexual

Occurs in: Humans, animals, plants, fungi all organisms

Genetically: different identical

Crossing Over: Yes, mixing of chromosomes can occur. No, crossing over cannot occur.

Pairing of Homologues: Yes No

Number of Divisions: 2 1

Number of 4 2

Chromosome Number: Reduced by half Remains the same

Steps: The steps of meiosis are Interphase, Prophase I, Metaphase I, Anaphase I, Telophase I, Prophase II, Metaphase II, Anaphase II and Telophase II. The steps of mitosis are Interphase, Prophase, Metaphase, Anaphase, Telophase and Cytokinesis

Karyokenesis: Occurs in Interphase I Occurs in Interphase

Cytokenesis: Occurs in Telophase I & Telohpase II Occurs in Telophase

Centromeres Split: The centromeres do not separate during anaphase I, but during anaphase II The centromeres split during Anaphase

Creates: Sex cells only: Female egg cells or Male sperm cells Makes everything other than sex cells

Discovered by: Oscar Hertwig Walther Flemming

CHAPTER 10: TISSUE SYSTEM

Tissue can be categorized as a group of cells similar in structure and function. It can be categorized under animal and plant tissues. Plant tissues are of two main types-meristematic and permanent. Meristematic tissue is the dividing tissue present in the growing regions of the plant. Meristematic tissues are classified as apical, lateral and intercalary depending on the region where they are present. Apical meristem is present at the growing tips of stems and roots and increases the length of the stem and the root. The girth of the stem or root increases due to lateral meristem (cambium). Intercalary meristem is the meristem at the base of the leaves or internodes on twigs.

Permanent tissues are derived from meristematic tissue once they lose the ability to divide. They are classified as simple and complex tissues. Parenchyma, collenchyma and sclerenchyma are three types of simple tissues. Xylem and Phloem are types of complex tissues. Animal tissues can be epithelial, connective, muscular and nervous tissue. Depending on shape and function, epithelial tissue is classified as squamous, cuboidal, columnar, ciliated and glandular. The different types of connective tissues in our body include areolar tissue, adipose tissue, bone, tendon, ligament, cartilage and blood. Striated, striated and cardiac are three types of muscle tissues. Nervous tissue is made of neurons that receive and conduct impulses.

Sometimes a portion of the epithelial tissue folds inward and a multicellular gland is formed. This is glandular epithelium. Two bones can be connected to each other by another type of connective tissue called the ligament. This tissue is very elastic.

Muscular tissue consisting of elongated cells are also called muscle fibres. This tissue is responsible for movement in our body. Muscles contain special proteins called contractile proteins, which contract and relax to cause movement.

Sex Determination in Humans

The sex determining mechanism in case of humans is XY type. Out of 23 pairs of chromosomes present, 22 pairs are exactly the same in both females and males; these are the autosomes.

A pair of X chromosomes is present in the female, whereas the presence of an X and Y chromosome are determinants of the male characteristic. During spermatogenesis among males, two types of gametes are produced. Fifty percent of the total sperm produced carry the X chromosome and the rest 50 percent have Y chromosomes besides the autosomes.

Females however produce only one type of ovum with an X chromosome. There is an equal probability of fertilization of the ovum with the sperm carrying either X or Y chromosome. In case the ovum fertilized with a sperm carrying X chromosome the zygote develops into a female and the fertilization of ovum with Y chromosome carrying sperm results into a male offspring.

Sex Determination in Birds

In birds, a different mechanism of sex determination is observed. In this case, the total number of chromosomes is the same in both males and females. But two different types of gametes in terms of the sex chromosomes are produced by females. In order to have a distinction with the mechanism of sex determination described earlier, the two different sex chromosomes of a female bird has been designated to be the Z and W chromosomes. In these organisms the

Females have one Z and one W chromosome, whereas males have a pair of Z-chromosomes besides the autosomes.

CHAPTER 12: MONOCLONAL ANTIBODIES

Monoclonal antibodies (mAb or moAb) are monospecific antibodies that are the same because they are made by identical immune cells that are all clones of a unique parent cell, in contrast to polyclonal antibodies which are made from several different immune cells. Monoclonal antibodies have monovalent affinity, in that they bind to the same epitope.

Given almost any substance, it is possible to produce monoclonal antibodies that specifically bind to that substance; they can then serve to detect or purify that substance. This has become an important tool in biochemistry, molecular biology and medicine.

CHAPTER 13: BASICS OF ANTIGEN-ANTIBODY

Antigen

Antigen- A toxin or other foreign substance that induces an immune response in the body, especially the production of antibodies. In immunology, an antigen is a substance that evokes the production of one or more antibodies.

An antibody (Ab), also known as an immunoglobulin (Ig), is a large Y-shaped protein produced by B-cells that is used by the immune system to identify and neutralize foreign objects such as bacteria and viruses. The antibody recognizes a unique part of the foreign target, called

an antigen. Antibodies are secreted by a type of white blood cell called a plasma cell. Antibodies can occur in two physical forms, a soluble form that is secreted from the cell, and a membrane-bound form that is attached to the surface of a B cell and is referred to as the B cell receptor (BCR). The BCR is only found on the surface of B cells and facilitates the activation of these cells and their subsequent differentiation into either antibody factories called plasma cells, or memory B cells that will survive in the body and remember that same antigen so the B cells can respond faster upon future exposure. In most cases, interaction of the B cell with a T helper cell is necessary to produce full activation of the B cell and, therefore, antibody generation following antigen binding. Soluble antibodies are released into the blood and tissue fluids, as well as many secretions to continue to survey for invading microorganisms.

Antibodies are glycoproteins belonging to the immunoglobulin superfamily; the terms antibody and immunoglobulin are often used interchangeably.

An antigen is a substance that evokes the production of one or more antibodies. Each antibody binds to a specific antigen by way of an interaction similar to the fit between a lock and a key. The substance may be from the external environment or formed within the body. The immune system will try to destroy or neutralize any antigen that is recognized as a foreign and potentially harmful invader. The term originally came from antibody generator and was a molecule that binds specifically to an antibody, but the term now also refers to any molecule or molecular fragment that can be bound by a major histocompatibility complex (MHC) and presented to a T-cell receptor. "Self" antigens are usually tolerated by the immune system, whereas "non-self" antigens can be identified as invaders and can be attacked by the immune system.

An immunogen is a specific type of antigen. An immunogen is a substance that is able to provoke an adaptive immune response if injected on its own. An immunogen is able to induce an immune response, whereas an antigen is able to combine with the products of an immune response once they are made. Hapten is a small molecule that cannot induce an immune response by itself. It needs to be attached to a large carrier molecule such as protein. The overlapping concepts of immunogenicity and antigenicity are, therefore, subtly different.

According to a current textbook:

Immunogenicity is the ability to induce a humoral and/or cell-mediated immune response
Antigenicity is the ability to combine specifically with the final products of the immune response

(i.e. secreted antibodies and/or surface receptors on T-cells). Although all molecules that have the property of immunogenicity also have the property of antigenicity, the reverse is not true.

Red blood cell compatibility chart

In addition to donating to the same blood group; type O blood donors can give to A, B and AB; blood donors of types A and B can give to AB

Red Blood cell Compatibility Table

DAD DAD

In addition to the blood group (A, B, O, AB), the Rh factor is written as either positive (Rh+ present) or negative (Rh-, absent). Most people (about 85%) are Rh positive (Rh+), meaning that they have the factor. About 15% of the population does not have the Rh factor, they are Rh-. This factor does not affect your health except during pregnancy.

Appendix

Questions (200 Multiple Choice Questions)

1. The space telescope of NASA discovered astonishing magnetic braids of super-hot matter in the outer atmosphere of the Sun. Which of the following statements is true in context with this statement?

a) The scientists claimed that this discovery could help in explaining the mysterious hot centre of the Sun.

b) NASA's telescope captured 1000 photographs depicting astonishing details.

c) It was found out that the Sun’s surface was almost up to 6125 degrees Celsius.

d) The scientists also discovered the powerful magnetic waves which rippled from within the surface of the Sun.

2. Iran on 28 January 2013 announced that it had successfully sent into space a primate. Which primate did it send into space?

a) Worms

b) Monkey

c) Turtle

d) Mouse

3. NASA on 1 February 2013 marked the 10th anniversary of the Space Shuttle?

a) Columbia

b) Challenger

c) Both of these

d) None of these

4. Scientists from NASA in the last week of January 2013 discovered an old star called TW Hydrae which they believe could create new planets even now. How old is this star?

a) 100 million years old

b) 50 million years old

c) 20 million years old

d) 10 million years old

5. The Japanese scientists from the Saitama University in the first week of February 2013 filmed for the first time, the thoughts of which animal while it was tracking its prey?

a) A fish

b) A zebra

c) An elephant

d) A snail

6. UK scientists in the third week of January 2013 discovered a set of hydrothermal vents, the deepest anywhere in the world while exploring the ocean floor in the….. Fill in the blank with an appropriate option.

a) Caribbean Islands
b) Cayman Trough
c) Atlantic
d) None of these

7. Where did the researchers in the third week of February 2013 detected water traces inside the crystalline structure?

a) Mars
b) Sun
c) Earth
d) Moon

8. The astronomers in the second week of February 2013 discovered the proof that cosmic rays originate as the results of explosions of stars or supernovae, these are termed as the most energetic event in the galaxy. Who discovered the cosmic rays first in 1912?

a) Eratosthenes
b) Victor Hess
c) Claudius Ptolemy
d) Abd al-Rahman al-Sufi

9. Scientists discovered in their study that Bumblebees (Bombus terrestris) can detect the electric fields of….. Fill in the blank with an appropriate option.

a) Plants
b) Vegetables
c) Flowers
d) Fruits

10. Where will the first wildlife skywalk of India come up?

a) Shillong

b) Manali

c) Manipur

d) Sikkim

11. NASA on 9 February 2013 announced that its Mars rover Curiosity drilled into the surface of the planet for first time. Which of the following statements is not true in context to this statement?

a) As an outcome of the drilling, the pictures were sent by Curiosity which depicted a hole of around 0.63 inches wide and 2.5 inches deep in the fine-grained sedimentary bedrock.

b) Engineers are absolutely clear whether the powder was produced in what quantity but it is enough for laboratory analysis.

c) NASA announced that using drill was the biggest achievement for the team of Curiosity ever since the rover landed on Mars in August 2012.

d) The final target of Curiosity is a 3-mile- (5-km) high mound of layered sediment which rises from the floor of Gale Crater landing site.

12. A new study using data from a pair of gravity-measuring NASA satellites found on 12 February 2013 that large parts of the arid The region lost freshwater reserves rapidly during the past decade. Fill in the blank with an appropriate option.

a) Middle East

b) South Eastern

c) Saudi Arabia

d) North Western

13. Astronomers in the third week of February 2013 discovered six speeding stars which were racing through space at a speed of 3.2 million kilometres per hour. The mass of these stars is equivalent to what?

a) Moon

b) Earth

c) Milky Way

d) Sun

14. NASA scientists discovered the youngest black hole in our galaxy, the Milky Way, in February 2013. How far is this black hole from Earth?

a) 26000 light years away

b) 12000 light years away

c) 10000 light years away

d) 25000 light years away

15. The core of the Milky Way is actually cloaked in dust which makes all stars unclear from the telescopes of the astronomers, except the brightest stars. But these hypervelocity stars were useful in providing a peep into….. Fill in the blank with an appropriate option.

a) Deaths of stars in Milky Way

b) Birth of the stars in the universe

c) Deaths of the stars around the Sun

d) Formation of stars in Milky Way

16. Name the Mars rover of NASA.

a) Era

b) Curiosity

c) Discovery

d) Challenger

17. Where was the first bionic man of the world called Rex unveiled on 7 February 2013?

a) London's Science Museum

b) American Science Museum

c) Paris Science Museum

d) Europe Science Museum

18. Which of the following statements is not true?

a) NASA on 9 February 2013 announced that its Mars rover Curiosity drilled into the surface of the planet for the first time.

b) The drilling into Martian surface took place for the first time on 8 February 2013.

c) As an outcome of the drilling, the pictures were sent by Challenger which depicted a hole of around 0.63 inches wide and 2.5 inches deep in the fine-grained sedimentary bedrock.

d) The first drill target of Curiosity was a Martian rock which was laced with the veins which appeared like water-deposited minerals.

19. In the first bionic man of the world, Rex, where did the synthetic blood come from?

a) MIT

b) Swansea

c) University College London

d) Sheffield University

20. Curiosity is on a mission on Mars for finding out the chemical and geologic conditions on Mars which are required for supporting as well as preserving the microbial life. Fill in the blank with an appropriate option:

a) 3-year

b) 5-year

c) 2-year

d) 10-year

21. Scientists at the Johns Hopkins University School of Medicine, US and Karolinska Institutet in Sweden got a genetic get through into the main cause of arthritis. What, according to the scientists, could be used for predicting the person who could potentially be at a risk of this disease?

a) Simple X-Ray

b) Simple Blood test

c) Simple Diagnosis

d) None of these

22. A team at Intel, the computer hardware firm created a device, which is said to allow renowned physicists of the world to communicate faster than before.

a) Nikola Tesla

b) Antoine Henri Becquerel

c) Max Planck

d) Stephen Hawking

23. The researchers from EMBL- European Bioinformatics Institute (EMBL-EBI) in January 2013 developed a new method that allows storage of 100 million hours of high-definition video in a cup of DNA. Which of the following statements is true in context to this?

a) The scientists in Cambridge downloaded all the 154 sonnets of Wordsworth on the strands of the synthetic DNA, a genetic storage device that has been used.

b) Scientists were successful in encoding the information and reproduction of Brad's words with complete accuracy.

c) One sonnet from Shakespeare weighs 0.3 millionths of a millionth of a gram when written on the DNA and thus a gram of the DNA can easily store information that more than one million of compact disks (CDs) can store.

d) Scientists claimed that the genes can be used as the robust way to store information as the information once stored in it can be extracted from the mammoth bones, even after tens of thousands of years.

24. In which Indian zoo were the thirty one Black Bucks killed by the stray dogs on 19 January 2013?

a) Kanpur Zoo

b) Lucknow Zoo

c) Delhi Zoo

d) Patna Zoo

25. Where was the Vulture Population Estimation-2013 conducted by the State Government?

a) Manas Tiger Reserve

b) Panna Tiger Reserve

c) Palamau Tiger Reserve

d) Pench Tiger Reserve

26. Researchers at the University of California, San Diego, in the third week of January 2013 developed a fresh technique that enables surgeons to find out about the reach of tumours and helps them to decide which tissues should be removed for saving the healthy cells in cancer patients. What is the name of this new technique?

a) Laser Imaging
b) Molecular-Laser Imaging
c) Molecular-Targeted imaging
d) Target Imaging

27. Kaspersky Lab, the Russian cyber security firm on 14 January 2013 revealed that India is one among various nations which are hit by the cyber spying which has been targeting governmental, diplomatic and scientific research organisations for around 5 years. What is the name of this cyber spying campaign?

a) Blue October
b) Red December
c) Blue December
d) Red October

28. Which space agency released surprising pictures of the remains of a huge river which ran across the Red Planet, Mars at some point of time, on 17 January 2013?

a) NASA
b) European Space Agency
c) Australian Space Agency
d) None of these

29. The meteorological authority of China issued yellow alerts in various cities. Which of the following statements is not correct in this context?

a) Yellow alert indicated the presence of fog that shows dangerous smog levels in the northern as well as western regions of China.

b) The Beijing Municipal Environmental Monitoring Center website declared that the density of the PM2.5 particulates crossed the 700 micrograms per cubic meter level in various parts of Beijing.

c) Initially, it was found that the PM2.5 that is an indicator of the air quality had reached 500 points in certain monitoring stations.

d) PM2.5 is an indicator of the extent of pollution in the air.

30. Astronomers had already discovered that the supermassive black holes which sit in the centres of various galaxies were growing faster. Professor Graham explained that every time there is a ten times increase in the stellar mass of the galaxy, it leads to around 100 times increase in the . Fill in the blank with an appropriate option:

a) Mass of black hole

b) Density of black hole

c) Both of these

d) None of these

31. NASA in the first week of January 2013 unveiled that Mars Curiosity Rover has captured an image of a flower-like object embedded on the rocks of Mars. It has also photographed a snake-like rock formation on the Martian Rocks. What was the name of the microscope that captured the image?

a) Light Microscopy Module

b) Mars Hand Lens Imager

c) Fluorescence light microscope

d) None of these

32. Scientists at the University of Edinburgh's School of Biological Sciences in the second week of January 2013 discovered that the oldest known super predator of the world was the marine crocodile. What is the name of this oldest known super predator of the world?

a) Tyrant Swimmer

b) Tylosaurus

c) Predator X

d) Basilosaurus

33. Scientists at the Stanford University in the second week of January 2013, California developed an experimental drug called LM11A-31 which is claimed to help paralysed people reclaim their movements. Which of the following statements is true in context to this sentence?

a) The new drug enabled the dogs which had no movements in lower limbs, to walk again with the coordinated steps.

b) In the tests, it was also observed that the medication did not cause any pain in dogs.

c) Blood brain barrier, which is responsible for protecting the central nervous system (CNS) from harmful chemicals carried in the bloodstream, was also crossed efficiently.

d) None of these

34. Which kind of wine can distort the results of testosterone levels in the body?

a) White Wine

b) Rose Wine

c) Purple Wine

d) Red Wine

35. Which is the largest cosmic structure in the universe that is powered by super massive black holes clumped together? This structure was discovered by astronomers in the first week of January 2013.

a) Large Quasar Group

b) Galaxy Filaments

c) Inflationary universe

d) None of these

36. Astronomers studying about the newborn star called HD 142527, observed glimpses of the planets which were forming around it, depicting the stage of planetary evolution which was never seen before. Which telescope helped to observe these planets?

a) Large Binocular Telescope

b) Gemini South

c) Hale Telescope (200 inch)

d) Atacama Large Millimetre /submillimetre Array

37. A team of researchers including that of an Indian-origin, at Oregon State University discovered in the first week of January 2013, one malfunctioning protein which leads to itchy, dry as well as inflamed skin wounds in a kind of eczema. What is the name of this protein?

a) Tropomyosin
b) Fibronectin
c) Ctip2
d) Coronin

38. Scientists claimed that the 2-billion year old dark black rock, called Northwest Africa (NWA) 7034 or Black Beauty is actually a new kind of Martian meteorite which contains 10 times excess water than the normal. Where did this rock land in 2011?

a) Mexico
b) Sahara
c) Antarctica
d) None of these

39. Astronomers studying about the newborn star observed glimpses of the planets which were forming around it. Astronomers were studying the HD 142527 which is away from the Earth. Fill in the blank with an appropriate option:

a) 450 light years
b) 350 light years
c) 250 light years
d) 150 light years

40. Which largest mountain glacier of the world was claimed to have been reduced to 5.9 km in its longitudinal extent from the time period of 1989 to 2009 because of increasing temperatures and presence of humans?

a) Gangotri
b) Janapa
c) Miyar
d) Siachen

41. The Mayan Doomsday predictions about the world ending on 21 December 2012 had failed and additionally NASA ruled out the asteroid collision with Earth in 2040. What is the name of this asteroid which was feared to be collided?

a) 2011 AG5

b) 5224 Abbe

c) 2646 Abetti

d) 6805 Abstracta

42. The space plane constructed by Richard Branson's space flight company called Virgin Galactic successfully completed the important flight test which would be able to carry the people to space. What is the name of this spaceplane?

a) Boeing X-37

b) Soviet Buran

c) SpaceShipTwo

d) BOR-4

43. Astronomers claimed that a rare super comet called was moving towards the Sun from the outer solar system. Fill in the blank with an appropriate option:

a) C/1980 E1 (Bowell)

b) Comet Hale–Bopp (C/1995 O1)

c) Comet Lulin (C/2007 N3)

d) C/2012 S1 (ISON)

44. Australian researchers of Sydney's Garvan Institute claimed that they discovered a primary factor which made breast cancer aggressive as well as resistant to the treatments. Which of the following statements is false in this context?

a) Protein called ELF5 is responsible for making the tumours of breast cancer more aggressive as well as resistant to treatments, revealed the key researcher Chris Ormandy.

b) The study would be helpful in targeting ELF5 in such a way that it would help in treating the breast cancers which are not numb to anti-oestrogens.

c) Around half of the women will eventually not be able to tackle anti-oestrogen treatment which they would have been undergoing, which would in turn further progress their tumour.

d) In the tissue-culture models of this type of cancer which were made numb to anti-oestrogen treatment, levels of ELF5 increase dramatically.

45. Researchers from the Penn State University in the last week of December declared that the cause of encouragement of human evolution might have been the swift environmental changes in areas like East Africa around . Fill in the blank with appropriate option:

a) 3 million years ago

b) 200 million years ago

c) 2 million years ago

d) 300 million years ago

46. The Central Zoo Authority of India approved exchanging white tigress from the Delhi Zoo against an animal from the Krasnoyarsk Park of flora and fauna, Royev Ruchey in Russia. Which animal was traded in exchange of white tigress?

a) South American Jaguars

b) Kangaroos

c) Puma

d) Leopard

47. NASA developed a new next-gen spacesuit called Z-1 Prototype Spacesuit and Portable Life Support System (PLSS) 2.0 for the sophisticated and complex space ventures, which also include Mars mission. Which of the following statement is not true in this context:

a) The spacesuit is crafted out of various hard elements on the fabric. It also becomes flexible after being inflated.

b) There is no need of an airlock for seeking entry or getting exit in and out of this suit.

c) It makes use of the recent technique that includes sublimator which works only in hard vacuum.

d) The spacesuit packs in itself a water membrane evaporation cooler which cools the suit through the same method like sweating.

48. The gravity mapping satellites of NASA ended the successful mission to the Moon by crashing on the rim of the crater. What is the name of these gravity mapping satellites of NASA?

a) Voyager 1 and Voyager 2

b) Ebb and Flow

c) Orion and Kepler

d) Dawn and Orion

49. Scientists in the month of December revealed a planet that could support life, orbits a Sun-like star near the Earth. What is the name of the star around which this planet was found orbiting?

a) Tau Ceti

b) Sirius

c) 36 Ophiuchi

d) Gliese 33

50. A microbe led to the extinction of more than 90 species on Earth's surface around 251 million years ago, researchers found in the second week of December 2012. Which of the following statements is true in this context:

a) According to the current theory, mass extinction by the end of the Permian period was started because of volcanic eruptions in a large area, now called Siberia.

b) When the group of researchers analysed the genome of Methanosarcina - a methanogen which is accountable for most of the biogenic methane on Earth today, it was discovered that microbes acquired this ability some 231 million years ago.

c) Methanosarcina needs a huge amount of nickel for producing methane fast.

d) All the statements are true

51. French scientists claimed that they developed a new system which enables humans to get 360 degree vision. The headset in the system is said to capture the images from different directions and thereafter transform these into the matter which is possible for the human vision system to comprehend. What is the name of this new system?

a) Eidograph

b) FlyVIZ

c) Scoliometer

d) Xylometer

52. Scientists from NASA spotted the longest extra-terrestrial river system ever on Saturn's moon Titan which appears to be a miniature version of one of the Earth's rivers. Titan which appears to be a miniature version of which river of Earth?

a) Amazon River

b) Thames River

c) Nile River

d) Rhine River

53. Researchers of the University of Michigan Health System and Harvard Medical School in the second week of December 2012 showed that anti-ageing genes might be helpful in curtailing the multiplication of cancer. Which of the following statements is not true in context of this?

a) The researchers had shown that the decrease in SIRT6 protein in rats increased the size, aggressiveness as well as number of tumors.

b) In the new research the role of SIRT6 in diminishing the growth of cancer by repressing aerobic glycolysis was highlighted.

c) SIRT6 is also responsible for inhibiting the activity of a major cancer gene called Myc.

d) SIRT6 does not play any role in stopping cancer or controlling cellular metabolism.

54. Scientists in northern Mexico discovered a new dinosaur with a large prominent nose which lived about 73 million years ago. What is the name of this new dinosaur?

a) Latirhinus Uitstlani

b) Gigantoraptor

c) Khaan

d) Raptorex

55. British scientists claimed that they developed in the first week of December 2012, the first toothbrush of the world called Emmident toothbrush which makes use of the for-cleaning teeth. Fill in the blank with appropriate word:

a) X-Ray
b) Ultrasound waves
c) 3D Imaging
d) None of these

56. Scientists in the last week of November 2012 developed a new drug for stopping the cancerous cells from multiplying. The new drug compels the cancerous cells to sleep which in turn stops them in multiplying. The drug is said to trick the tumours for becoming inactive by swapping the molecular switches in cancer structure so that there is no multiplication of the cancerous cells. What is the name of this drug?

a) Letrozole
b) Mitomycin
c) Cyclophosphamide
d) Aflibercept

57. Astronomers claimed that they have discovered the biggest ever black hole in the small galaxy which is situated around 250 million light years away from our planet. This galaxy constitutes the mass equal to 17 billion suns. The biggest ever black hole sits in the Perseus constellation. What is the name of this galaxy in which the black hole sits?

a) Milky Way
b) Cartwheel Galaxy
c) NGC 1277 galaxy
d) Mayall's Object Galaxy

58. The temperature variations at the shallow levels under the surface of Earth are influenced by the….. Fill in the blank with an appropriate option.

a) Topography
b) Geography

c) Both of these

d) None of these

59. Software engineers as well as neuroscientists at University of Waterloo, Canada claimed that they have developed a closest model of the functioning human brain. What is this artificial human brain called?

a) AbioCor

b) Bioartificial

c) i-Limb

d) Spaun

60. Boeing, the US aircraft manufacturer, claimed that a new missile was tested which can permanently blackout the electronics of the country without causing any harm to people. What is the name of this missile?

a) CHAMP

b) Mathago

c) Ikara

d) ERYX

61. Which of the following statements are true?

a) The Solar Eclipse occurs when the moon crosses between the Sun and the Earth blocking the sun completely or partially.

b) The Solar Eclipse can occur only on the day of a new moon when the sun and the moon lie in conjunction with each other when seen from the earth.

c) Statements a and b are true.

d) None of the statements is true.

62. Researchers at the University of Edinburgh discovered a new gene known as miR-941, which explains the evolution of humans from chimpanzees. Which of the following statements is true in this context?

a) The gene is found only in human beings.

b) The gene is found in humans and apes.

c) The gene could be used for knowing how humans learnt the usage of languages as well as tools.

d) Statements (a) and (c) are true.

63. Which of the following statements/statements is/are true?

a) Rheumatoid arthritis affects various organs.

b) Rheumatoid arthritis affects tissues, various organs as well as joints.

c) Both (a) and (b) are true.

d) Only (b) is true.

64. A study led by Scientist and Evolutionary Anthropologist, Dean Falk of Florida State University revealed in the Month of October that a Physicist's brain had an "extraordinary" prefrontal cortex - unlike those of most people which may have contributed to his remarkable genius. What is the name of this physicist?

a) Stephen Hawking

b) Charles Darwin

c) Sir Issac Newton

d) Albert Einstein

65. Researchers from Stanford who were led by the scientists of Indian origin, in the third week of November 2012 claimed the development of fastest as well as most reliable mathematical algorithm which can help the disabled trick the computer cursors. The computer cursors could be controlled with the help of which mechanism?

a) Thoughts

b) Sight

c) Smell

d) Touch

66. Gases that come out from the volcano provide a potential threat to the people, animals and agriculture as well as property of the people residing in the nearby area of the volcano. The gases released from the volcano contain gases like sulfur dioxide, hydrogen fluoride and carbon dioxide in huge amounts, which pollutes the air in the atmosphere. Which of the following gasses causes acid rain?

a) Hydrogen Fluoride
b) Carbon Dioxide
c) Helium
d) Sulfur Dioxide

67. Researchers fabricated an all-new paper thin bullet-proof super material, which has the capability to self-assemble into alternating rubbery as well as glassy layers. The nano-material has the ability to translate into safety beyond the vests. These technological advancements could be used for protective coating for the jet engine turbine blades as well as the satellites. Name the institute from which the researchers and scientists belong?

a) University of Edinburgh and Rice University
b) Massachusetts Institute of Technology (MIT) and Rice University
c) Massachusetts Institute of Technology (MIT) and University of Edinburgh
d) Rice University and University of Sterling

68. Australia on 22 November 2012 approved the plan to save an ailing river system. What is the name of this ailing river system?

a) Murray-Darling Basin River System
b) Cooper Creek- Darling Basin River System
c) Murrumbidgee - Murray Basin River System
d) Flinders- Cooper Creek Basin River System

69. Which is the third brightest object in the sky after the sun and moon?

a) Venus
b) International Space Station (ISS)
c) Saturn
d) None of these

70. Scientists on 8 November 2012 revealed about the discovery of a special type of bacteria in the Ocean with abilities of combining together for the formation of the long conducting nano wire cable for transportation of electrons and capturing the oxygen available at the surface for carrying out the metabolic activities. What is the live wire made up of?

a) Living neurons
b) Living bacteria cells
c) Living biological cells
d) None of these

71. Scientists tracked 55 large robber crabs on the Christmas Island in South of Indonesia in the third week of November, 2012. It was found that the land crabs having the leg span of around 3.3 feet or 1 metre usually stay in the small home range. Which technology was used to track these crabs?

a) Infrared Technology
b) GPS Technology
c) Google Maps Technology
d) None of these

72. Major changes on the earth's surface by checking the increase or decrease in gravity level are detected by which organisation/organisations?

a) World Meteorological Organization (WMO)
b) Gravity Recovery and Climate Experiment (GRACE)
c) Both of these
d) None of these

73. Which of these is not a greenhouse gas?

a) Carbon Dioxide
b) Methane
c) Hydrogen
d) Nitrous Oxide

74. The Tongariro Volcano in Mount Tongariro at Tongariro National Park, New Zealand erupted on 21 November 2012. This was which kind of a volcano?

a) Shield Volcano

b) Cinder Cones

c) Compound Volcano

d) Composite Volcano

75. The Mantle comprises thick molten rock. What is this thick molten rock called?

a) Crust

b) Lava

c) Core

d) Magma

76. The Supreme Court of India in November 2012 expressed its concerns on the growing smog cover over the National Capital, which is caused due to the pollution created by the increase in the number of vehicles in the Capital. Which of the following statements is true in this context?

a) One can see the smog cover in the sky even during the hot summer days when the wind density is low and weak.

b) Smog cover in the sky can only be seen in the cold winter months.

c) Smog in itself is the mixture of smoke and fog, which is the combination of pollutants created from industries and vehicles.

d) Smog is a mixture of fog and pollutants.

i. Statements a and c are correct

ii. All the above statements are correct

iii. Statements a and d are correct

iv. None of the above statements is correct

77. When was the term Photochemical Smog first used and described?

a) In 1970s

b) In 1980s

c) In 1950s

d) In 1940s

78. The world's rarest whale species was spotted for the first time by scientists of New Zealand in the Pacific Ocean. What is the name of this rarest whale species?

a) Spade-toothed beaked whales
b) Bowhead Whales
c) North Pacific Right Whales
d) Southern Right Whales

79. The research paper published by the scientists presents a positive report about the change in the number of vultures, which resulted in a catastrophic decline in its number by more than 99 percent in the past two decades. The study reveals that there has been a marginal rise in the population of Vultures between 2011 and 2012. Who published the research paper?

a) Delhi Development Authority (DDA)
b) Bombay Natural History Society (BNHS)
c) Delhi University's Centre for Environmental Management of Degraded Systems
d) None of these

80. Australia on 16 November 2012 created the world's largest network of marine reserves, protecting more than 2.3 million square kilometres of ocean environment. However, the Marine reserve creation is going to ruin coastal communities and it will also affect thousands of jobs with a serious impact on the US $ 2 billion aquaculture Industry. This was criticised by which organisation/organisations?

a) Commonwealth Fisheries Association
b) Australian Marine Alliance
c) Both of these
d) None of these

81. Scientists at NASA on 27 September 2012 announced that the Mars Curiosity Rover has discovered stream bed gravel, which hints towards the presence of waist-deep water on the surface of Mars in the past. What is this Mars Curiosity Rover?

a) Satellite
b) Team of Astronauts
c) Robotic explorer
d) Meteors

82. The Indian Institute of Toxicology Research reported that the water in and around the deserted Union Carbide plant is contaminated and not fit for consumption. Where is this Union Carbide Plant Located?

a) Bhopal
b) Jaipur
c) Shimla
d) Bhubaneswar

83. The endangered species, Great Indian Bustard and Lesser Florican have got a dedicated land for breeding in the Shonkaliya Region of Ajmer District, Rajasthan. What are they?

a) Birds
b) Animals
c) Insects
d) Amphibian

84. The simultaneous earthquakes seen in the past few years in which region is found to be a cause of the Tectonic Plate Disintegration?

a) Arabian Sea
b) Indian Ocean
c) Arabian Peninsula
d) Himalayan Region

85. On which date the most outstanding demonstrations of its own kind in Khandwa district of Madhya Pradesh named Jal Satyagraha which had continued for 17 days at Omkareshwar Dam Project came to an end?

a) 10 September 2012
b) 15 September 2012
c) 17 September 2012
d) 12 September 2012

86. Name the astronaut of Indian American origin who took over the command of the International Space Station on 15 September 2012.

a) Sunita Williams
b) Kalpana Chawla
c) Ravish Malhotra
d) None of these

87. Scientists at Goddard Institute for Space Studies (GISS) warned that most of Earth's land areas might face an extreme summer heat wave than they did in between 1951 to 1980. Goddard Institute of Space Studies is a division of which space research centre?

a) ISRO
b) NASA
c) Centre of astrophysics
d) European Space Agency

88. On which date from 1995 onwards the International Day for the Preservation of the Ozone Layer is celebrated worldwide?

a) 15 September
b) 18 September
c) 16 September
d) 12 September

89. Where the ozone layer is mainly found in the Earth’s atmosphere?

a) Stratosphere
b) Hemisphere
c) Ozonosphere
d) Troposphere

90. The environment ministry on 12 September 2012 suspended the clearance of environmental guidelines issued to 93 Mines across which state?

a) Himachal Pradesh
b) Rajasthan
c) Goa
d) Madhya Pradesh

91. Scientists of the University of Michigan developed a gene therapy which they claimed could restore the sense of olfactory function. What is this olfactory function related to?

a) Sense of hearing
b) Sense of smell
c) Sense of sight
d) Sense of touch

92. Australian scientists along with US experts claimed that they have discovered treatment for Alzheimer patients following a study finding a link to abnormalities in Alzheimer Patients. Alzheimer's disease related to?

a) Brain
b) Heart
c) Eye sightedness
d) Liver

93. Researchers from the Walter and Eliza Hall Institute in Australia discovered that two proteins that work together to kill self-reactive immune cells can protect against diseases such as type1 diabetes and rheumatoid arthritis. Rheumatoid arthritis principally attacks which part of the body?

a) Joints
b) Skin
c) Lungs
d) Kidney

94. India entered into its first multilateral Social Science research collaboration with four European Nations by the approval of projects for networking and social science research cooperation between the researchers of these nations. The collaboration came into existence on which date?

a) 2 September 2012
b) 7 September 2012
c) 5 September 2012
d) 4 September 2012

95. The Zoological Society of London and International Union for Conservation of Nature (IUCN) released a list of 100 different species to be first in line for extinction from 48 different countries during the World Conservation Congress held in the Republic of Korea on 11 September 2012. The Indian species that was categorized under first line of extinction was

a) Great Indian Bustard
b) One horned Rhino
c) Indian giant Squirrel
d) Asiatic Lion

96. A new strain of rice developed by the scientists, which can enhance the productivity in the soil that lacks a nutrient content. Name the nutrient, lack of which affects crop yield.

a) Sulphur
b) Oxygen
c) Phosphorous
d) Carbon

97. Name the two planets that came together in the Western sky on 15 August 2012 after sunset.

a) Mars and Saturn
b) Earth and Mars
c) Jupiter and Saturn
d) Venus and Earth

98. The identified singing mice that use songs to communicate are found in which region?

a) The Himalayan terrain

b) The tropical cloud forests in the mountains of Costa Rica

c) On the volcanic plates of Pacific

d) Greenland

99. Name the NASA's Robert that has recently touched the surface of Mars

a) Rover Curiosity

b) Gale Crater

c) Martian home

d) Calif

100. Name the process that will be applied for transferring the gene of the newly developed Stained Rice to the modern variety of rice

a) Cross-Breeding

b) Genetic Engineering

c) Hybridization

d) None of these

101. Which Indian University signed an agreement for establishing a centre for earthquake and hydrological studies with Hyderabad based NGRI (National Geophysical Research Institute) on August 15, 2012?

a) University of Kerala

b) University of West Bengal

c) University of Kashmir

d) University of Assam

102. On 25 August 2012, the ballistic missile "Prithvi II" was successfully launched from the test range off Odisha Coast. Which type of missile is Prithvi II?

a) Air-to-air missile

b) Surface-to-air missile

c) Air-to-surface missile

d) Surface-to-surface missile

103. On 23 August 2012, won environmental approval for its A$10 billion Alpha coal and rail project in Australia's Queensland.

a) Jaypee Enterprises

b) GMR Infrastructure

c) GVK Power and Infrastructure

d) Adani Enterprises

104. Which university scientists developed a mechanical device that measures the mass of individual molecules?

a) University of Oxford

b) University of Delhi

c) University of China

d) California University of Technology

105. On which date NASA's Mars rover Curiosity has fired its laser for the first time on Mars, using the beam to study a fist-size rock called "Coronation."

a) Aug. 10, 2012

b) Aug. 20, 2012

c) Aug. 15, 2012

d) Aug 22, 2012

106. The Prime Minister said India will send a mission to "Mars" to collect scientific information. What is the name of this mission?

a) Mars Orbitor Mission

b) Mars Yojana

c) Mangal Yaan

d) India Mars Plan

107. The House Sparrow was on declared as the state bird of Delhi by the state government. The new status of the bird is likely to help in its conservation.

a) 14 August 2012
b) 13 Feb 2012
c) 12 March 2012
d) 16 July 2012

108. Which Indian institute developed a web-based system for advising farmers the right quantity of fertilizers that they should use in their soils for a particular type of crop?

a) Indian Institute of Management
b) Indian Institute of Soil Sciences
c) Indian Institute of Foreign Trade
d) Indian Institute of Finance

109. On which date in August 2012, the Ring-planet Saturn and Red planet Mars came together in Western Sky after sunset?

a) August 12
b) August 05
c) August 15
d) August 11

110. Scientists in the second week of August 2012 found a stem cell therapy to prevent which disease? Scientists used MSCs (mesenchymal) stem cells in mice with fractures that typically result in developing arthritis.

a) Osteoarthritis after a joint injury
b) Cataract
c) Cancer
d) Skin Infection

111. The Australian Climate Commission warned that the world's sea levels could increase by _ the end of the 21st Century.

a) 1.5 Metre.
b) 2 Metres.
c) 3 Metres.
d) 1 Metres.

112. Isle of Wight rock yielded three fossil footprints of Dinosaurs. In which one of the following countries Isle of Wight is located?

a) USA
b) UK
c) India
d) Germany

113. In the studies conducted by American, Belgian, British and Dutch researchers it was found that tumors contain their own pool of stem cells that can multiply and keep fueling the cancer, seeding regrowth. Which one of the following techniques researchers used to trace the ancestry of cells within mouse tumors?

a) labeling technique
b) Striking technique
c) Bubble technique
d) None of the above

114. US researchers are using a new tool called for detecting illegal nuclear explosions.

a) The Earth's Global Positioning System (GPS)
b) Water alarm device
c) Seismometer
d) Geiger counter

115. A Rare bird Jerdan's Baza was found for the first time in Dandepally tank area in Pocharam reserve forest on 16 June 2012. Consider the given facts regarding Jerdan's Baza.

i) Jerdan's Baza mainly eats frogs, lizards and large insects.

ii) The bird is recognized by broad round wings, a long squarish tail, jaunty crest and forest dwelling habits.

Choose the right option:

a) Only i is correct.

b) Only ii is correct.

c) Both i and ii are correct.

d) Neither i nor ii is correct.

116. Which one of the following cities has been slated to host the United Nations Conference on Sustainable Development 2012?

a) Rio de Janeiro

b) Buenos Aires

c) Hawana

d) Toronto

117. NASA on 13 May 2012 launched the Nuclear Spectroscopic Telescope Array (NuSTAR) on a Pegasus rocket from Kwajalein Atoll in the Marshall Islands. Consider the following given facts related to NuSTAR and choose the right option?

i) NuSTAR will help scientists find the most subtle and energetic black holes.

ii) NuSTAR will work in coordination with other telescopes in space, including NASA's Chandra X-ray Observatory, which observes lower-energy X-rays

Choose the right option:

a) Both i and ii are wrong.

b) Only i is wrong.

c) Only ii is correct.

d) Both i and ii are correct

118. China on 16 June 2012 launched its spacecraft Shenzhou-9 from the Jiuquan satellite launch centre in north-western Gansu province. Which of the following facts related to Shenzhou-9 is not true?

i) Shenzhou-9 is China's fourth human spaceflight

ii) Shenzhou -9 spacecraft will conduct the first manned docking mission

iii) Shenzhou-9 space mission comprise three astronauts including China's first woman astronaut Liu Yang

iv) Shenzhou-9 is China's first manned space programme Choose the right option:

a) Both i and ii are wrong

b) Only i is wrong

c) Only iv is wrong

d) Neither i nor ii is wrong

119. According to the World Health Organization's cancer agency's report declared on 12 June 2012, is the most probable cause of cancer among the people.

a) Diesel Fumes

b) Dust

c) Petrol exhaust

d) None of the above

120. According to a new government report India's greenhouse gas (GHG) emissions rose by 58 per cent between 1994 and 2007. Greenhouse gases are those gases that can absorb and emit infrared radiation. Which one of the following is not a greenhouse gas?

a) nitrogen (N)

b) methane (CH_4)

c) nitrous oxide (N_2O)

d) ozone (O_3)

121.World Environment Day was observed across the globe on 5 June 2012. Theme for the World Environment Day 2012 was

a) Green Economy: Does it include you?

b) Forests-Nature At Your Service

c) Water- all we need

d) None of the above

122. The UN General Assembly started observing the World Environment Day in 1972 to

i) raise public awareness about the need of better environment.

ii) to mark the opening of the Stockholm Conference on the Human Environment Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

123. World IPv6 (Internet Protocol version 6) Launch Day held globally on 6 June 2012. Which of the following facts related to World IPv6 (Internet Protocol version 6) Launch Day is not true?

i) The day, organized by Internet Society, represents a major milestone in the global deployment of IPv6.

ii) Previous year the World IPv6 Day was observed on 8 June

iii) World IPv6 Day 2012 was an event sponsored and organized by the Internet Society and several large content providers to test public IPv6 deployment

iv) The day was announced by Google Choose the right option:

a) Both i and ii are wrong

b) Only i is wrong

c) Only iv is wrong

d) Neither i nor ii is wrong

124. Scientists discovered eight genes which could pave the way for the development of effective treatments for ankylosing spondylitis which is painful form of_

a) Joint pain
b) Headache
c) Arthritis
d) Cancer

125. Scientists at the Tomato Genome Consortium (TGC) successfully sequenced the genomes of which of the following vegetables?

a) Tomato
b) Onion
c) Brinjal
d) Potato

126. Scientists found a diarrhea bug called Dientamoeba Fragilis in_.

a) Pigs
b) Rabbits
c) Rats
d) Cows

127. Scientists identified common childhood obesity genes called and .

a) OLFM4 and HOXB5
b) OLFM and HOX
c) OFM4 and HOXC5
d) OFFM and HOXCC

128. Assam registered a_ percent increase in the last three years.

a) 14
b) 15
c) 16
d) 17

129. The Union Cabinet of India on 12 April 2012 approved India`s Second National Communication to the Secretariat of the United Nations Framework Convention on Climate Change. Consider the following statements:

i) India is a member of the United Nations Framework Convention on Climate Change (UNFCC).

ii) The Convention, in accordance with its Article 4.1 and 12.1, enjoins all Parties, both developed and developing country Parties, to furnish information, in the form of a National Communication (a national report).

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

130.The Union ministry of environment and forests (MoEF) banned the use of live animals in dissection and other experiments in educational and research institutions. The ban is based on

a) The prevention of cruelty to Animals Act 1960.

b) The prevention of cruelty to animals act 1970

c) The prevention of cruelty to animals act 1980

d) The Prevention of cruelty to animals act 1990

131. Scientists recently found the treatment for Glaucoma in rats. Glaucoma is an disease.

a) Eye

b) Ear

c) Lung

d) Skin

132. Scientists identified two genes, which are linked to Parkinson's. The genes are called .

a) NACP and MAPT

b) NCAP and MPAT

c) NPAC and MTPA

d) NNCP and MMPA

133. Erosion and diversion of Rushikulya river mouth in Odisha's Ganjam district seem to be posing a serious threat to the annual mass nesting of the endangered Olive Ridley sea turtles. Consider the following statements:

i) The olive ridley sea turtle is also known as the Pacific ridley.

ii) It is a species of sea turtle. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

134. Which one of the following state governments imposed restrictions on the visit of foreign tourists to the areas inhabited by Tribals?

a) Odisha

b) Bihar

c) Madhya Pradesh

d) Uttar Pradesh

135. Indian black eagle was spotted in the Aravalli Biodiversity park after a gap of years.

a) 90

b) 80

c) 70

d) 60

136. Scientists identified a new gene in maize plants called .

a) Meg1

b) Meg2

c) Meg3

d) Meg4

137.Researchers discovered new earthworm species in Port Blair. What is the name of the new species?

a) Moniligaster ivanios
b) Annelida
c) Nematoda
d) Onychophora

138.Scientists recently developed a new wireless device to detect the presence of termites. Consider the following statements: i) when the new device detects the presence of termites, it sends an SMS or email to a pest control firm. ii) The device is made of a tiny sensor, even smaller than a fingernail.

Choose the right option:

a) Both i and ii are correct.
b) Only i is correct.
c) Only ii is correct.
d) Neither i nor ii is correct.

139.The scientists claimed that the Meteorite, which fell in Morocco in July 2011, was from Mars. The event happened for the first time in years.

a) 50
b) 100
c) 200
d) 150

140.Scientists found the Extinct Monkey, the Miller's Grizzled Langur in the forests of .

a) Indonesia
b) Malaysia
c) India
d) Africa

141.Scientists for the first time produced mixed embryo monkeys. Consider the following statements:

i) Scientists produced monkeys composed of cells taken from separate embryos.

ii) The cells stay together and work together to form tissues and organs.

Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

142.Scientists discovered unknown species off the coast of Antarctica. Consider the following statements:

i) The temperature in this region rises to 380 degree Celsius.

ii) There is plenty of light in this region.

Which of the above statements is/ are correct?

a) Only i

b) Only ii

c) Both i and ii

d) Neither i nor ii

143.The world's first hybrid sharks was discovered by the researchers in Australian waters. The hybrid shark is the result of cross-breeding between which one of the following set of shark species?

a) Common black tip Shark and Australian black-tip shark

b) Indian black-tip Shark and Australian black-tip Shark

c) Blue Whale and Common black-tip Shark

d) Blue Whale and Australian black-tip Shark

144.Scientists produced artificial human semen to help infertile men. Consider the following statements:

i) The scientists grew the sperm by enveloping the germ cells in a special compound called agar jelly.

ii) The artificial human semen could help infertile men father their own children.

Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

145.Health Authorities in Australia recently detected Deadly Disease, Murray Valley Encephalitis. The disease is caused by the .

a) Flies

b) Mosquitoes

c) Birds

d) Dogs

146.Name the Cyclone, which hit the coast of Chennai and south-eastern coastal areas.

a) Thane

b) Nargis

c) Rita

d) Katrina

147.Name the gene, which controls memory in the human brain.

a) Npas4

b) Npas3

c) Mpas4

d) Npas2

148. WGEEP designated the entire Western Ghats as an ecologically sensitive area. What is the full form of WGEEP?

a) Western Ghats expert panel
b) Western Ghats environmental panel
c) Western Ghats environmental expert panel
d) Western Ghats ecology expert panel

149. China launched a High-Speed Bullet Train in Qingdao, Shandong. Consider the following statements:

i) Its speed can reach up to 500 kilometers per hour.
ii) The train was launched by China's largest rail vehicle maker, CSR Corp. Ltd.

Choose the right option:

a) Both i and ii are correct.
b) Only i is correct.
c) Only ii is correct.
d) Neither i nor ii is correct.

150. Scientists discovered a Way to Transform Ordinary Tissue into Heart Muscle Cells. Consider the following statements:

i) It could pave the way for new therapeutic approaches for repairing a damaged heart to repair itself.
ii) Scientists used a zebrafish system to develop a small and robust molecule, which can transform stem cells into beating heart muscle cells.

Choose the right option:

a) Both i and ii are correct.
b) Only i is correct.
c) Only ii is correct.
d) Neither i nor ii is correct.

151.NASA's Kepler mission discovered the first Earth-size planets orbiting a sun-like star outside our solar system. These planets are called and .

a) Kepler-20e; Kepler-20f
b) Kepler-20a; Kepler-20b
c) Kepler-20c; Kepler-20d
d) Kepler-20m; Kepler-20n

152.Scientists at the Salk Institute for Biological Studies report discovered a missing link between the body's biological clock and sugar metabolism system. Consider the following statements i) Sugar Metabolism is a process by which the body uses sugar for energy. ii) If the human body produces too little insulin, the amount of sugar in the blood increases abnormally, a condition known as hyperglycemia. Choose the right option:

a) Both i and ii are correct.
b) Neither i nor ii is correct.
c) Only i is correct.
d) Only ii is correct.

153.China on 23 December 2011 launched a High-Speed Bullet Train in Qingdao, Shandong. Its speed can reach upto —---- kilometers.

a) 500
b) 300
c) 400
d) 200

154.The WGEEP (Western Ghats expert Panel) designated as an Ecologically Sensitive Area.

a) Western Ghats
b) E astern Ghats
c) Malabar Coast
d) Coromandel Coast

155. Name the gene found by neuroscientists, which could help in creating and altering memory.

a) Mpas4
b) Npas4
c) Npas3
d) Mpas2

156. Scientists discovered that the protein is responsible for regulating fatty acid oxidation in the liver and is critical for metabolism.

a) CPT1
b) CTP1
c) CTT1
d) CPT2

157. NASA (National Aeronautics and Space Administration) developed Space Harpoon to take Samples from Comets. Where are the headquarters of NASA located?

a) Washington DC
b) New York
c) Florida
d) Paris

158. British Scientists recently developed a technology to produce pocket TV. Consider the following statements:

i) Scientists developed a new form of light-emitting crystals, known as quantum dots.

ii) These tiny crystals are 100000 times smaller than the width of human hair. Choose the right option:

a) Both i and ii are correct.
b) Only i is correct.
c) Only ii is correct.
d) Neither i nor ii is correct.

159.Scientists developed a hydrogel that regenerates healthy and scar-free tissue on skin damaged by severe burns. Consider the following statements:

i) The hydrogel helps in formatting of new blood vessels and skin including hair follicles.

ii) The injured soldiers, fire victims and people with third degree burns can avail of the gel. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

160.A cargo ship called MV Rak sank off Mumbai coast on 5 August 2011. Consider the following statements:

i) The oil spill from the ship enters into the food chain.

ii) The algae imbibe the oil and this affects the entire marine ecology. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

161.NASA's Kepler mission recently discovered a Habitable Earth-like planet .

a) Kepler 22-b b)Kepler-22 b

c) Kepler 22-c

c) kepler 22-a

162.Which one of the following countries recently approved the bill that reformed the rules on the amount of land farmers must preserve as forest?

a) Brazil

b) India

c) USA

d) China

163.The Labour Party conference in Australia approved Uranium Exports to India. What is the atomic number of Uranium?

a) 92

b) 82

c) 88

d) 86

164.Scientists produced the most detailed map of Antarctica called BEDMAP. Consider the following statements on BEDMAP:

i) This is the second generation of the digital BEDMAP.

ii) It incorporates 27 million measurement points. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Both i and ii are incorrect.

165.Cargo Ship MV Rak sank 20 nautical miles off Mumbai coast in August 2011. Consider the following statements:

i) The oil spill from a ship accident can be harmful for fishing activity.

ii) The oil spill can damage the mangrove belt in and around the city. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

166.Scientists identified genes that can increase a person's risk of developing multiple myeloma by 30 percent. Consider the following statements on multiple myeloma:

i) Multiple myeloma is also known as plasma cell myeloma or Kahler's disease.

ii) It is a cancer of plasma cells.

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

167. As per the report compiled by British-based firm Maplecroft, which one of the following countries is top greenhouse gas emitter?

a) India
b) USA
c) China
d) Japan

168. NASA launched a rover, nicknamed Curiosity, to explore the planet Mars. The rover was launched from which one of the following provinces of the USA?

a) Florida
b) Texas
c) Washington
d) California

169. The Cabinet Committee on Economic Affairs (CCEA) on 1 December 2011 approved 1656 crore rupees scheme for the Yamuna Action plan.

a) phase-3
b) phase-2
c) phase-1
d) phase-4

170. The first Eld's deer was born via in vitro fertilization in Thailand.

i) Eld's Deer is also known as the Thamin or Brow-antlered Deer.
ii) It is an endangered species of deer indigenous to southeastern Asia.

Consider the following statements:

a) Both i and ii are correct.
b) Only i is correct.
c) Only ii is correct.
d) Neither i nor ii is correct.

171. Scientists discovered a gene which makes people alcoholic.

a) HTR7

b) HHR7

c) HHH7

d) THR7

172. The Delhi Jal Board (DJB) signed a Memorandum of Understanding (MoU) with which one of the following countries for upgrading its sewage treatment plant at Keshopur?

a) Sweden

b) UK

c) China

d) Russia

173. What is the name of the gene that can reduce the length of time people sleep?

a) ABCC9

b) ACCB9

c) ABCC 6

d) ABBB9

174. Scientists discovered a planet, which has an environment much similar to that of Earth. Consider the following statements:

i) The Planet is called Gliese 581g.

ii) The planet is located around 123 trillion miles away from Earth. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

175. NASA launched a rover from Florida on an Atlas 5 rocket. What is the name of the rover?

a) Discovery
b) Rover-d5
c) Curiosity
d) Experiment

176. In Japan, rice with radiation levels exceeding the country's safety levels was discovered for the first time since the nuclear disaster at Fukushima in early 2011. The acronym LASER stands for

a) Light Amplification by Stimulated Emission of Radiation
b) Light Amplification by Stimulated Emission of Rays
c) Light Amplified by Stimulated Emission of Radiation
d) Light and Sound emitted by Radiation

177. Anti erosion project to protect Moisa and Belguri villages in Assam was approved by the Planning commission of India. Consider the following statements on the project.

i) The project aims to protect villages from the River Gangadhar.
ii) The project will cost 14.97 crore rupees. Choose the right option:

a) Both i and ii are correct.
b) Only i is correct.
c) Only ii is correct.
d) Neither i nor ii is correct.

178. The Assam government launched a pilot project to vaccinate girls against human papillomavirus (HPV) causing cervical cancer. HPV is a member of the family of viruses.

a) Papillomavirus
b) Human T-cell lymphotropic virus
c) Bluetongue virus
d) Reoviridae

179.Scientists recently discovered Sunken Islands that linked India to Australia. These islands were once part of the supercontinent Gondwana. The islands were formed during Cretacious period .

a) When dinosaurs roamed the Earth
b) When Himalayas were formed
c) When the very first man came on earth
d) When there was no life on earth

180.The latest technique in Medical Science, dracula therapy is now available in India. Dracula therapy is used to fight against which one of the following?

a) Aging
b) Cancer
c) Aids
d) Dengue

181.Crops in India face threat from Ug99 stem rust. Ug99 was first discovered in Uganda in .

a) 1999
b) 2000
c) 2001
d) 2002

182.A 400-metre-wide giant asteroid, called 2005 YU55, came within 201700 miles of earth on 8 November 2011. 2005 YU55 makes one complete lap around the Sun every month.

a) 15
b) 14
c) 17
d) 25

183.The Union Environment Ministry approved the Lavasa township project in Pune. Consider the following statements:

i) Lavasa is a private, planned city being built near Pune.

ii) The project is being developed by HCC (Hindustan Construction Company). Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

184.Russia successfully launched a manned spacecraft Soyuz TMA-22 spaceship from Baikonur Cosmodrome in Kazakhstan. Consider the following statements:

i) When a spacecraft is manned, it can be piloted directly, as opposed to robotic space probes and satellites.

ii) The only countries to have independent human spaceflight capability are Russia and China. Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor ii is correct.

185.Arctic ozone hole was detected at record level. The journal nature reported. The ozone layer blocks from the Sun.

a) Infra-Red rays

b) Ultraviolet-B rays

c) Ultraviolet-C rays

d) X-rays

186. Scientists found a new species of Trap-door spider, the albino spider, in Australia. Consider the following statements. i) The albino spider is white headed and the colour of its legs is black and brown.

ii) It is about the size of a 50-cent piece. Choose the right option:

a) Only i is correct.

b) Only ii is correct.

c) Neither i nor ii is correct.

d) Both i and ii are correct.

187. The government gave its approval to revive 60 Mines in the Netravali Wildlife Sanctuary. The sanctuary is located in .

a) Goa

b) Jharkhand

c) Tamil Nadu

d) Madhya Pradesh

188. India scientists succeeded in decoding the genome of the arhar dal, which is also known as

a) Pigeon Pea

b) Black-eyed Pea

c) Sweet Pea

d) Split Pea

189. Scientists are set to begin a six-week mission to explore the Indian Ocean's underwater mountains. Name the ship, which will carry out the mission.

a) RRS James Cook

b) RRS Ernest Shackleton

c) RRS James Clark Ross

d) Royal Research Ship

190. A report recently stated that bluefin tuna was fished illegally during Libya conflict. Consider the following statements:

i) Bluefin Tuna are dark blue-black on the back, and white on the lower sides and belly.

ii) The scientific name of bluefin tuna is Thunnus thynnus. Choose the right option:

a) Both i and ii are correct.

b) Neither i nor ii is correct.

c) Only i is correct.

d) Only ii is correct.

191. Scientists identified the bug, which caused the Bubonic plague (Black Death) in Europe between 1347 and 1351. Consider the following statements on Bubonic plague:

i) Bubonic plague still strikes somewhere between 1000 and 3000 people.

ii) Bubonic plague is caused by Yersinia pestis.

Choose the right option:

a) Both i and ii are correct.

b) Only i is correct.

c) Only ii is correct.

d) Neither i nor iii is correct.

192. Scientists identified the genes, which increase a Person's risk of getting Dengue. Dengue is the most common mosquito-borne infection after .

a) Malaria

b) Yellow Fever

c) Japanese encephalitis

d) West Nile Virus

193. Scientists found the Ozone hole above Antarctica, which is the fifth largest on record. The size of this Ozone hole is square kilometres.

a) 27

b) 25

c) 23

d) 29

194. Union government of India decided to ban the use of infertility drug Letrozole. Letrozole is mainly recommended for treating .

a) Cancer
b) AIDS
c) Dengue
d) Malaria

195. Australian Scientists created the world's first drug, which can prevent blindness from cataracts. Cataracts are formed when a protein, known as calpain, clouds the eye lens and impairs vision.

a) Hemoglobin
b) Keratin
c) Calpain
d) Myosin

196. European Scientists reported particles apparently travelling faster than light called .

a) Neutrinos
b) Endothelial
c) Polyglactin
d) Pollen

197. Planetary scientists provided new insights into the process behind the evolution of Earth. Earth's core is mainly made of _

a) Iron
b) Silicon
c) Oxygen
d) Nitrogen

198.China Successfully launched its first unmanned space laboratory. What is the name of this space laboratory?

a) Tiangong-1
b) MEASAT-1
c) ZY-2
d) CH 726

199.Scientists recently discovered genetic factors in frogs that make it immune to the fungal disease

a) Pathogenic
b) Chytridiomycosis
c) Sporothrix schenckii
d) endophyte

200.What is the name of the powerful Typhoon which hit Japan on 21 September 2011?

a) Roke
b) Nargis
c) Nesat
d) Nalgae