Biodiversity

Q.1 what is Biodiversity? What are the different levels of biodiversity?
-> Biodiversity is the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable. It is variability among living organism from terrestrial, marine and other aquatic ecosystem and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystem.

Usually there are three level of biodiversity that we are discussed:
1. Genetic diversity:
-> It is all the different genes contained in all individual plants,animals, fungi, and microorganisms. It occur within a species and between Species.s
2. Species diversity:
-> It is the difference within and between the populations of a species and between different species.
3. Ecosystem diversity:
-> It is all the different varieties of habitats, biological communities, ecological process as well as variations within individual ecosystem.

Q.2 What are the benefits of an ecosystem to humankind?
-> Nature is essential for human life. Nature provides us with water, clean air

and food, and raw materials for medicines, industry and buildings. All of these benefits, known as ecosystem services, depend on a healthy environment. Our crops rely on insect pollination and the complex biological processes that create soil. Enjoying parks, landscapes and wildlife improves our health and well-being.These services provided by ecosystems lead to benefits received by humans in the form of security, goods and materials, health and wellbeing.
Benefits:
1. It provides habitat to wild plants and animals.
2. It promotes various food chains and food webs.
3. It controls essential ecological processes and promotes lives.
4. Involved in the recycling of nutrients between biotic and abiotic components.
It helps in maintaining the usual flow of energy in an ecosystem includingCarbon Cycle, Energy Cycle, Nitrogen Cycle, Oxygen Cycle, and Water Cycle.

Q.3 Write four major threats to biodiversity?
-> Biodiversity is facing a lot of challenge and lots of biodiversity is a significant global issue. Species are becoming extinct at the fastest rate known in geological history and most of these extinctions have been in human activity.
The following are the cause for the loss of biological diversity:
1. Habitat loss and destruction is usually as a direct result of human activities and population growth, is a major force in the loss of species, populations and ecosystems.

Biodiversity

2. The over-exploitation of a species or population can lead to its downfall.
3. Human generated pollution and contamination can affect all levels of biodiversity.
4. Global climate change can alter environmental conditions. Species and populations may be lost if they are unable to adapt to new conditions or relocate.

Q1.What are microorganisms.Brief their properties.

=> Microorganisms are the tiny living organisms that can only be seen with the help of the microscope. They include bacteria, viruses, fungi, and protozoa. They are found in virtually every enviornment on earth, including soil, water and the human body. They have a diverse set of properties depending on the type, some of them are:

1.Size: Microorganisms are extremely small, with most bacteria measuring between 0.5 and 5 micrometers in diameter.

2.Shape: Microorganisms can have a variety of shapes, including spherical (coccus), rod-shaped (bacillus), spiral-shaped (spirillum), and filamentous (filament).

3.Metabolism: Some microorganisms are autotrophic, meaning they can produce their own food through photosynthesis or chemosynthesis. Others are heterotrophic, meaning they must obtain food from other sources.

4.Reproduction: Microorganisms can reproduce asexually through methods such as binary fission or budding, or sexually through methods such as conjugation or meiosis.
5.Growth: Microorganisms can grow and reproduce rapidly under the right conditions, with some bacteria doubling their population every 20 minutes.

6.daptability: Microorganisms can survive in a wide range of environments, including extreme temperatures, high radiation levels, and low oxygen levels.
Interaction with host: Microorganisms can be harmful or beneficial depending on the host they interact with, some are pathogens while others are symbionts.

7.Genetic variability: Microorganisms can evolve very quickly, allowing them to adapt to changing environmental conditions and to develop resistance to antibiotics and other treatments.

Q2. Bacteria are necessary evil. Justify this statement.

=> Bacteria can be considered a "necessary evil" in the sense that they play important roles in many ecological processes and are essential for the functioning of many ecosystems, but they can also cause harm to humans, animals, and plants. On one hand, bacteria are important decomposers and play a key role in nutrient cycling. They help to break down dead organic matter, releasing essential nutrients that can be taken up by other organisms. They also play a critical role in the food chain and are a primary food source for many organisms. They also help to form the base of the food web and are the primary decomposers in many environments. On the other hand, some bacteria can cause infections and diseases in humans, animals, and plants. They can also spoil food and other products, causing economic losses. They are also responsible for many food-borne illnesses and can be difficult to control. Additionally, some bacteria, such as those that cause antibiotic-resistant infections, can be difficult to treat and can lead to serious health complications.

Protein Synthesis

Q: explain about the different forms of RNA

A: brief about 3 types of RNA.

RNA (ribonucleic acid) is a polymer made up of nucleotides that plays a central role in the flow of genetic information within cells. There are several different forms of RNA, each with its own distinct function:

1. Messenger RNA (mRNA): This is the RNA that carries the genetic information from the DNA in the nucleus to the ribosomes in the cytoplasm, where it is translated into protein. mRNA is synthesized during transcription, in which a specific portion of the DNA is copied into RNA.

2. Transfer RNA (tRNA): This is the RNA that carries specific amino acids to the ribosomes during protein synthesis. tRNA molecules have specific binding sites for the amino acids they carry and for the codons on the mRNA that specify the sequence of the amino acids in the protein.

3. Ribosomal RNA (rRNA): This is the RNA that makes up the structural core of the ribosomes, the organelles where protein synthesis takes place. rRNA molecules form the catalytic site of the ribosomes where the peptide bond formation occurs.

Q: discuss the important steps of transcription

A: 3 major step and conclude with RNA editing.

Transcription is the process by which the genetic information in DNA is used to synthesize a complementary RNA molecule. The process of transcription has three major steps: initiation, elongation, and termination.

1. Initiation: The first step of transcription is the recognition of the specific DNA sequence that serves as the starting point for the synthesis of the RNA molecule. This starting point is called the promoter region and it is recognized by transcription factors and the RNA polymerase enzyme.

2. Elongation: Once the RNA polymerase has bound to the promoter region, it begins to move along the DNA template, adding nucleotides to the growing RNA strand. The RNA polymerase reads the DNA sequence in the 3' to 5' direction and synthesizes the RNA in the 5' to 3' direction.

3. Termination: The RNA polymerase reaches the end of the gene and releases the newly synthesized RNA molecule. The RNA polymerase then dissociates from the DNA template and the RNA molecule is released.

RNA editing is a post-transcriptional process that can occur in certain types of RNA molecules, it's an enzymatic modification of RNA nucleotides. It can involve the addition, deletion, or substitution of specific nucleotides. RNA editing can change the coding sequence of the RNA and affect the structure and function of the protein that the RNA encodes. It is a mechanism that provides an additional layer of regulation for gene expression and can also play a role in evolution.

Cell Differentiation and Stem Cells.

1. What is cell differentiation? Mention the properties of cells involved in cell differentiation.

Ans- Differentiation is the process by which cells become specialized and take on specific roles in an organism.

Properties of stem cells

1. Self renewal
2. Stem cells are unspecialized
3. Stem cells give raise to specialized cells through the process of differentiation.

2. What are the different types of stem cells based on their potential?
Ans- The different types of stem cells based on their potential are as follows:

1. **Totipotent Cell-**Stem cells that have the ability to differentiate into every type of cell in the body are called totipotent.

2. **Pluripotent**-Stem cells that can differentiate into most, but not all type ofcells are called pluripotent. Eg: Cells present within the blastocyst.

3. **multipotentStem** -cells present in an adult organism that can differentiate into a limited number of cell types are called multipotent.
3. **Unipotent-**Stem cells that can diifferentiate into only one cell type are called Unipotent. Eg: Brain cells

Q3. Discuss about any two important applications of stem cells.
Important applications of stem cells.

1. **Tissue repair** - nerve, heart, muscle, organ, skin, etc.

Regenerate spinal cord, heart tissue or any other
major tissue in the body. Tissue repair is defined as the restoration of tissue architecture and function following an injury. In toxicant-induced injury, tissue repair plays a primary role in determining whether the patient will recover from injury, or whether the injury will progress and lead to death. This article describes the process of tissue repair with particular emphasis on features unique to chemical-induced injury. The main steps in repair, along with important molecular signaling mechanisms, are reviewed. Factors determining the extent of repair following toxic injury are discussed. Features of tissue repair unique to the lung, liver, and kidney are considered. Finally, the importance of tissue repair in the development of treatment strategies following toxic exposure is discussed.

2. **Cancers**
Injections of stem cells have also reduces
leukemia and many forms of cancers
Rheumatoid Arthritis: Adult Stem Cells may be
helpful in jump starting repair of eroded cartilage.Stem cell transplants do not usually work against cancer directly. Instead, they help you recover your body's ability to produce stem cells after treatment with very high doses of radiation therapy, chemotherapy, or both.

However, in multiple myeloma and some types of leukemia, the stem cell transplant may work against cancer directly. This happens because of an effect called graft-versus-tumor that can occur after allogeneic transplants. Graft-versus-tumor occurs when white blood cells from your donor (the graft) attack any cancer cells that remain in your body (the tumor) after high-dose treatments. This effect improves the success of the treatments.

3. Autoimmune diseases

An autoimmune disease is a condition in which your immune system attacks your body.The immune system usually guards against bacteria and viruses. When it senses these foreign invaders, it sends out an army of fighter cells to attack them.
Usually, the immune system can tell the difference between foreign cells and your own cells.
In an autoimmune disease, the immune system mistakes part of your body, like your joints or skin, as foreign. It releases proteins called autoantibodies that attack healthy cells.
Eg: diabetes, rheumatoid arthritis,
Multiple sclerosis, etc.

4. Discuss about usage of stem cells in various diseases, production of cell mass and even in research.

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5. **Heart Disease**:Adult bone marrow stem cells
injected into the hearts are believed to improve
cardiac function in victims of heart failure or heart
Attack. The heart muscle relies on a steady flow of oxygen-rich blood to nourish it and keep it pumping. During a heart attack, that blood flow is interrupted by a blockage in an artery. Without blood, the area of heart fed by the affected artery begins to die and scar tissue forms in the area. Over time, this damage can lead to heart failure, especially when one heart attack comes after another. A new treatment using stem cells—which have the potential to grow into a variety of heart cell types—could potentially repair and regenerate damaged heart tissue.

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7. **Parkinsons Disease:** Stem cells could, however,
be genetically modified so as to deliver substances to the PD brain, to stop cells from dying and stimulate the function of existing cells.The current idea is to introduce stem cells directly into the affected areas of your brain where they can transform into brain cells. These new brain cells

could then help regulate dopamine levels, which should improve the symptoms of the disease.It's important to note that experts believe this would only be a treatment for Parkinson's disease and not a cure. While stem cell therapy has the potential to replace the brain cells destroyed by Parkinson's disease, the disease would still be present. Parkinson's disease would likely destroy the implanted stem cells eventually.It's unclear right now whether stem cell therapy could be used multiple times to continue to reduce symptoms of Parkinson's disease or if the effect would be the same after multiple procedures.

4. what is metabolism and what are its two components?

Ans- Metabolism is the set of life sustaining chemical reactions in organisms.
The two components of metabolism are as follows-

Anabolism: Anabolism is a biochemical process in metabolism where the simple molecules combine to generate complex molecules. **anabolism**, also called **biosynthesis**, the sequences of enzyme-catalyzed reactions by which relatively complex molecules are formed in living cells from nutrients with relatively simple structures. Anabolic processes, which include the synthesis of such cell components as carbohydrates, proteins, and lipids, require energy in the form of energy-rich compounds (e.g., adenosine triphosphate) that are produced during breakdown processes (*see* catabolism). In growing cells, anabolic processes dominate over catabolic ones. In nongrowing cells, a balance exists between the two.

Catabolism: Catabolism is the break down of complex molecules. Catabolism is the breakdown of complex substances to their constituent parts (glucose, amino acids and fatty acids) which form substrates for metabolic pathways. Catabolism is the part of the metabolism responsible for breaking complex molecules down into smaller molecules. The other part of the metabolism, anabolism, builds simple molecules into more complex ones. During the catabolism energy is released from the bonds of the large molecules being broken down. Typically, that energy is then stored in the bonds of adenosine triphosphate (ATP). The catabolism increases the concentration of ATP in the cell as it breaks down nutrients and food. The ATP, in such high concentrations, becomes much more likely to give up its energy in the release of a phosphate. The anabolism then uses this energy to combine simple precursors into complex molecules that add to the cell and store energy for cell division.

1. What is photosynthesis, why is it so important on earth?

Photosynthesis is the process by which green plants, algae, and some bacteria convert light energy into chemical energy in the form of glucose and other sugars, using carbon dioxide and water as the primary reactants. During this process, plants also release oxygen into the atmosphere as a byproduct. Photosynthesis occurs in the chloroplasts of plant cells and is essential for life on Earth as it provides the primary source of food for almost all living organisms. The chemical equation for photosynthesis can be represented as: 6 CO2 + 6 H2O + light energy = C6H12O6 + 6 O2 It shows that the light energy is used to convert Carbon Dioxide and Water into Glucose and Oxygen.

It is so important on earth because it play a critical role in maintaining the balance of life on earth, like

a) Climate change: Photosynthesis helps to remove carbon dioxide from the atmosphere, thus reducing the levels of this greenhouse gas, which is a major contributor to global warming.

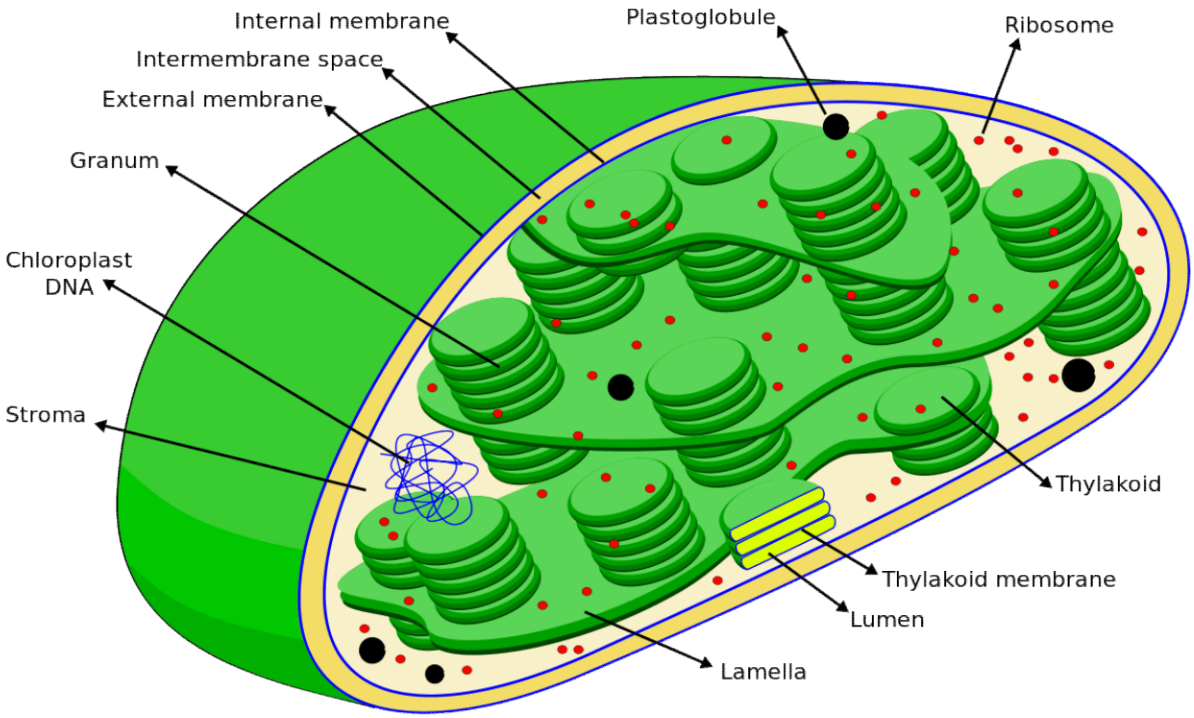
b) Biodiversity: Photosynthesis is the primary source of food for almost all living organisms, and it supports the survival and diversity of life on Earth.

c) Agriculture: Photosynthesis is the basis for the food chain, and it is essential for the growth and reproduction of plants that are used for food, fiber, and medicine.

d) Oxygen production: Photosynthesis releases oxygen into the atmosphere, which is essential for the survival of aerobic life on Earth.

e) Ecosystems: Photosynthesis supports the functioning of ecosystems and the balance of the natural environment, by providing food and oxygen to living organisms, and by helping to regulate the climate.

2. draw a well labeled diagram of a chloroplast. brief functions of any five parts.



The function of any five parts of chloroplast are:-

a) **Thylakoid membrane**: This is the site of the light-dependent reactions of photosynthesis, where light energy is absorbed by chlorophyll and converted into chemical energy in the form of ATP and NADPH.

b) **Grana**: These are stacks of thylakoid membranes, where the light-dependent reactions take place.

c) **Thylakoid lumen**: This is the space within the thylakoid membrane, where the light-dependent reactions take place.

d) **Stroma**: This is the fluid-filled space outside the thylakoid membrane, where the light-independent reactions of photosynthesis (Calvin cycle) take place.

e) **Chlorophyll**: This is the green pigment found in the thylakoid membrane, which absorbs light energy and is essential for the process of photosynthesis.

f) Enzymes: Chloroplasts contain various enzymes that catalyze the reactions of photosynthesis, such as Rubisco (Ribulose-1,5-bisphosphate carboxylase/oxygenase) that catalyzes the fixation of CO2 in the stroma.

g) Pigment-protein complexes: Chloroplasts contain various pigment-protein complexes, such as the photosynthetic pigments chlorophyll a and b, which absorb light energy and transfer it to the reaction centers.

h) **Granum:** This is a stack of thylakoids, where the light-dependent reactions take place.

i) Stromal thylakoids: These are thylakoids found in the stroma, where the light-independent reactions take place.

j) Stromal thylakoid ATPase: This is an enzyme that generates ATP during the light-dependent reactions.

k) Stromal thylakoid NADPH dehydrogenase: This is an enzyme that generates NADPH during the light-dependent reactions.

3. **what is chlorophyll? discuss the events of incident light on the chlorophyll.**

Chlorophyll is a green pigment found in the chloroplasts of plant cells, algae, and some bacteria. It is essential for the process of photosynthesis, as it absorbs light energy and converts it into chemical energy in the form of glucose and other sugars. It plays a key role in absorbing light energy, specifically in the blue and red regions of the electromagnetic spectrum, and transferring that energy to the reaction centers where the process of photosynthesis occurs.

When incident light strikes chlorophyll, the light energy is absorbed by the chlorophyll molecules. Chlorophyll absorbs light most efficiently in the red and blue regions of the visible spectrum, with peak absorption in the red (around 660 nm) and blue (around 430 nm) regions. This allows the chlorophyll to capture the majority of the energy from sunlight, which is used to power the process of photosynthesis.

When light strikes a chlorophyll molecule, it can be absorbed, reflected, or transmitted.

- Absorption occurs when the light energy is taken in by the chlorophyll molecule and used to power the process of photosynthesis.
- Reflection occurs when light is bounced back off the surface of the chlorophyll molecule. This is why chlorophyll appears green, as it reflects green light and absorbs other colors.
- Transmission occurs when light passes through the chlorophyll molecule without being absorbed or reflected. This can happen if the chlorophyll is in a low concentration or if the light is in a wavelength that is not absorbed by the chlorophyll.

4. **brief the events of light reactions.**

The light reaction of light dependent reaction occurs in the chloroplast of the mesophyll cells of the leaves. The chloroplasts are double-membraned cell organelles that are comprised of stacked disc-like structures known as thylakoids. The pigment, chlorophyll, which is required for the process is present on the membrane of these thylakoids and this is where the light reaction occurs.

a) Absorption of light: The first step in the light reactions is the absorption of light by pigments called chlorophylls and carotenoids. These pigments are found in the thylakoid membranes of the chloroplasts and are responsible for capturing the energy from light.

b) Harvesting of energy: The energy from light is then used to transfer electrons from water molecules to the electron carrier NADP+ (nicotinamide adenine dinucleotide phosphate), which forms NADPH. This process is called photolysis and it happens in the thylakoid membrane.

c) Hydrolysis reaction: At the same time, water molecules are split into hydrogen ions (H+) and oxygen atoms (O). The electrons from water are used to generate ATP and NADPH.

d) ATP formation: The energy from the photolysis of water is used to pump hydrogen ions across the thylakoid membrane, creating a proton gradient. This gradient is used to drive the production of

e) brief the events of light reactions. A: begin with the absorption of light. and then discuss about harvesting and brief about hydrolysis reaction followed by ATP formation and NADPH production. A net reaction is required here.

f) The light reactions of photosynthesis convert light energy into chemical energy in the form of ATP and NADPH.

g) Absorption of light: The first step in the light reactions is the absorption of light by pigments called chlorophylls and carotenoids. These pigments are found in the thylakoid membranes of the chloroplasts and are responsible for capturing the energy from light.

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j) ATP formation: The energy from the photolysis of water is used to pump hydrogen ions across the thylakoid membrane, creating a proton gradient. This gradient is used to drive the production of ATP by the enzyme ATP synthase.

k) NADPH formation: The electrons that were transferred to NADP+ during the photolysis reaction form NADPH, which is used in the next stage of photosynthesis called the Calvin cycle

l)

Net reaction.

$$2H_2O + 2NADP+ + 3ADP + 3Pi \rightarrow O_2 + 2NADPH + 3ATP$$

5. State the events of Calvin cycle.

The Calvin cycle, also known as the light-independent reactions or the dark reactions, is the second stage of photosynthesis in which plants and other organisms use the energy from ATP and NADPH to fix carbon dioxide into glucose and other sugars. The process occurs in the stroma of chloroplasts and involves several key steps:

Carbon fixation: Carbon dioxide is taken in from the atmosphere and combined with a five-carbon sugar called ribulose bisphosphate (RuBP) to form a six-carbon compound called phosphoglycerate (PGA).

Reduction: PGA is then reduced with the help of NADPH, which is produced during the light reactions, to form a three-carbon sugar called glyceraldehyde-3-phosphate (G3P).

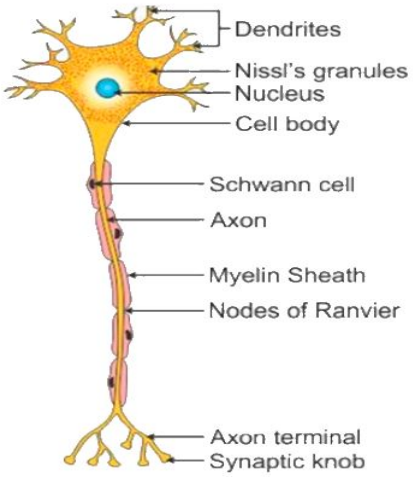
Regeneration of RuBP: Some of the G3P molecules produced in the reduction step are used to regenerate RuBP through a process called the regeneration cycle, which is also known as the C3 cycle.

The net reaction is,

$$48\ hv + 12\ H_2O + 6\ CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

1. Draw a well labeled diagram of a neuron, discuss about any five parts ?

Ans



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- Cell body (soma): contains the nucleus and other organelles that maintain the cell's metabolic functions.
- Dendrites: receive electrical impulses from other neurons and transmit them towards the cell body.
- Axon: a long, thin extension of the cell that transmits electrical impulses away from the cell body.
- Myelin sheath: a fatty coating on the axon that increases the speed of neural impulses.
- Synapse: the junction between the axon of one neuron and the dendrites or cell body of another neuron where neural impulses are transmitted.

2. what are glia? brief the functioning of any four glia ?

Ans : Glia are non-neuronal cells that support and protect neurons in the nervous system. There are several types of glia, including astrocytes, oligodendrocytes, microglia, and ependymal cells, each with specific functions. Here are four types of glia and their functions:

a) **Astrocytes**: These are the most abundant type of glia in the brain and spinal cord. They provide structural support for neurons, help to maintain the chemical environment necessary for neural signaling, and play a role in the repair and scarring process after injury.

b) **Oligodendrocytes:** These cells produce myelin, the fatty coating that insulates axons and increases the speed of neural impulses. Damage to oligodendrocytes can lead to demyelination and disorders such as multiple sclerosis.

c) **Microglia:** These are the resident immune cells of the central nervous system. They act as the first line of defense against infection and injury, and play a role in the removal of dead or dying cells.

d) **Ependymal cells:** These cells line the ventricles of the brain and the central canal of the spinal cord. They help to circulate cerebrospinal fluid, which acts as a cushion for the brain and spinal cord, and also remove metabolic waste products from the brain.

3. How does neurotransmission happen at a synapse?

Ans : Synapses refer to the points of contact between two neurons.

The two main cells involved in a synapse are the presynaptic neuron, which releases the neurotransmitters, and the postsynaptic neuron, which receives the neurotransmitters. The point of contact between these two cells is called the synaptic cleft. The presynaptic neuron has a specialized structure called the axon terminal, which contains vesicles filled with neurotransmitters.

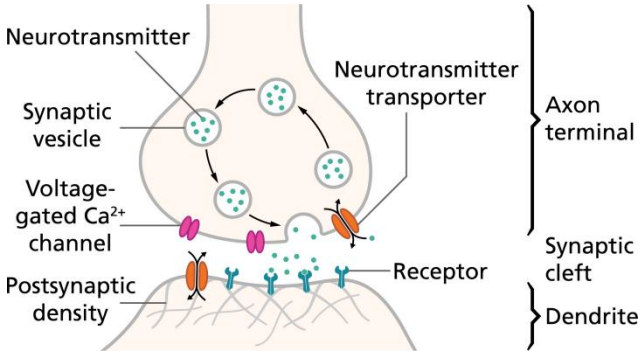
When an action potential reaches the axon terminal of the presynaptic neuron, it causes the release of the neurotransmitters from the vesicles into the synaptic cleft. This is called exocytosis. The neurotransmitters then diffuse across the synaptic cleft and bind to receptors on the postsynaptic neuron. This binding triggers a response in the postsynaptic neuron, such as an action potential or changes in membrane potential.

This process can be represented as:

[Neuron 1 - Axon terminal - Synaptic cleft - Receptors - Neuron 2]

After the neurotransmitters have been released, they are either taken back into the presynaptic neuron through a process called reuptake or broken down by enzymes in the synaptic cleft. This helps to regulate the amount of neurotransmitters present and prevent over-excitation or inhibition of the postsynaptic neuron.

Diagram :



4. discuss the events of an action potential.

ANS : An action potential is a rapid change in the electrical potential across the membrane of a neuron. It is caused by the movement of ions across the membrane, which leads to a change in the charge distribution inside and outside of the cell.

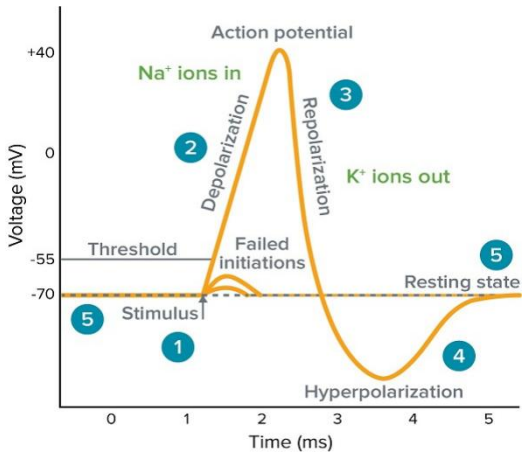


Fig : graph of action potential

The sequence of events during an action potential can be broken down into the following stages:

- **Resting state:** At rest, the membrane potential of a neuron is around -70mV, which is maintained by the balance of ions on either side of the membrane.
- **Signals of action potential :** the action potential is an electrical signal that travels along the membrane of a neuron, triggers the release of neurotransmitters at synapses, and can lead to the generation of new action potentials in other neurons.

- **Sodium and potassium pumps :** The sodium-potassium pump (also known as the Na+/K+-ATPase) plays an important role in the generation of an action potential. This pump is an enzyme that uses energy from ATP to pump positively charged sodium ions (Na+) out of the cell and positively charged potassium ions (K+) into the cell.

- **Threshold values :** the threshold value is the specific membrane potential at which an action potential is triggered. It is determined by the properties of the voltage-gated ion channels in the neuron and reached when the membrane potential changes from -70mV to around -55mV. The input received by the neuron can also affect how easily the threshold is reached.

- **Depolarization:** When an action potential is triggered, the membrane potential rapidly changes from -70mV to about +30mV due to the influx of positively charged ions, mainly Sodium (Na+) through voltage-gated ion channels. This is known as depolarization.

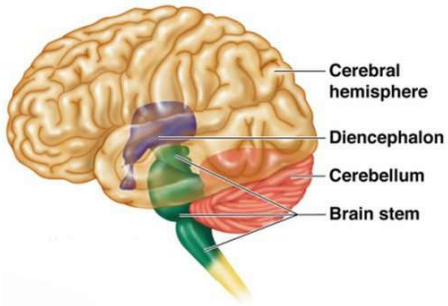
- **Repolarization:** After the depolarization stage, the membrane potential begins to repolarize, or return to the resting state. This is caused by the opening of voltage-gated potassium (K+) channels, which allow positively charged potassium ions to exit the cell.

- **Hyperpolarization:** Once the potassium channels open, the membrane potential will become more negative than the resting state, this is called hyperpolarization.

5. what are the four major parts of brain?

Ans : The brain is a complex organ that is divided into several regions, each with its own specific functions.

TRICK TO REMEMBER:- [CCBD]



The four major parts of the brain are:

- **The cerebrum:** The cerebrum is the largest part of the brain and is divided into two hemispheres, the left and the right. The cerebrum is responsible for functions such as perception, consciousness, thought, memory, and voluntary movement. The cerebral cortex, which is the outermost layer of the cerebrum, is responsible for processing information from the senses, such as vision and hearing.

- **The cerebellum:** The cerebellum is located beneath the cerebrum and is responsible for coordination of movement and balance. It also plays a role in learning and memory, as well as in cognitive functions such as attention, language and emotion.
- **The brainstem:** The brainstem is the lower part of the brain that connects the brain to the spinal cord. It is responsible for controlling basic functions such as breathing, heart rate, and blood pressure. It also contains important relay centers for the transfer of information between the brain and the rest of the body.

- **The diencephalon:** The diencephalon is a region of the brain located above the brainstem. It contains several important structures such as the thalamus, which serves as a relay center for sensory information, and the hypothalamus, which controls functions such as hunger, thirst, and body temperature.

6. how does peripheral nervous system function?

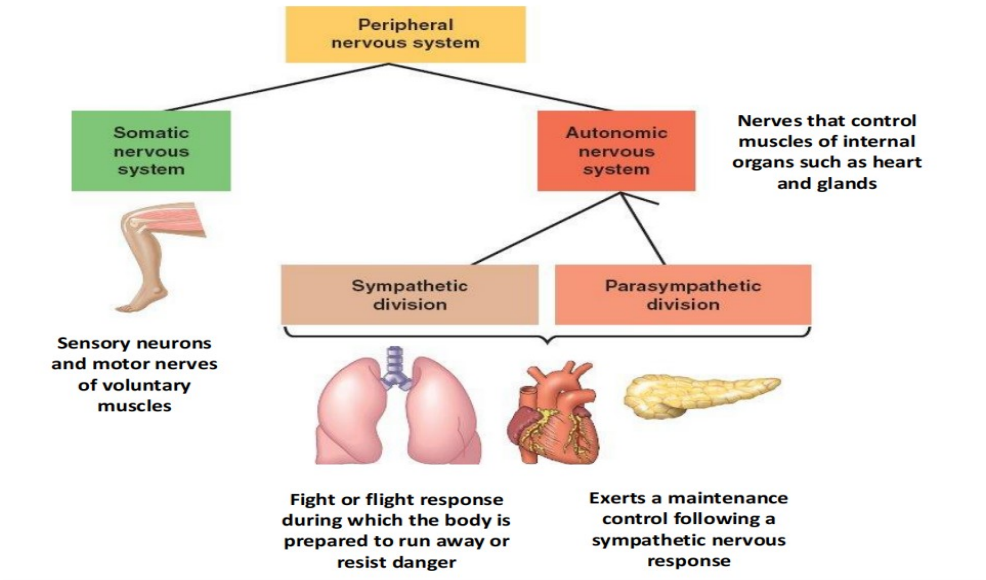
ANS : The peripheral nervous system (PNS) is the division of the nervous system that consists of all the nerves and ganglia outside of the brain and spinal cord. It is responsible for transmitting information between the central nervous system (CNS) and the rest of the body. The PNS can be further divided into the somatic and autonomic nervous system.

Peripheral nervous system consisting of:

- sensory nerves – carrying sensory information from the receptors to the CNS
- motor nerves – carrying the motor commands from the CNS to the effectors

The peripheral nervous systems (PNS) is a highly complex structure, containing the longest axons in the human body and formed by many different classes of motor, sensory, and autonomic neurons supported by both myelin-forming and nonmyelinating Schwann cells.

Brief about each tyes of PNS :



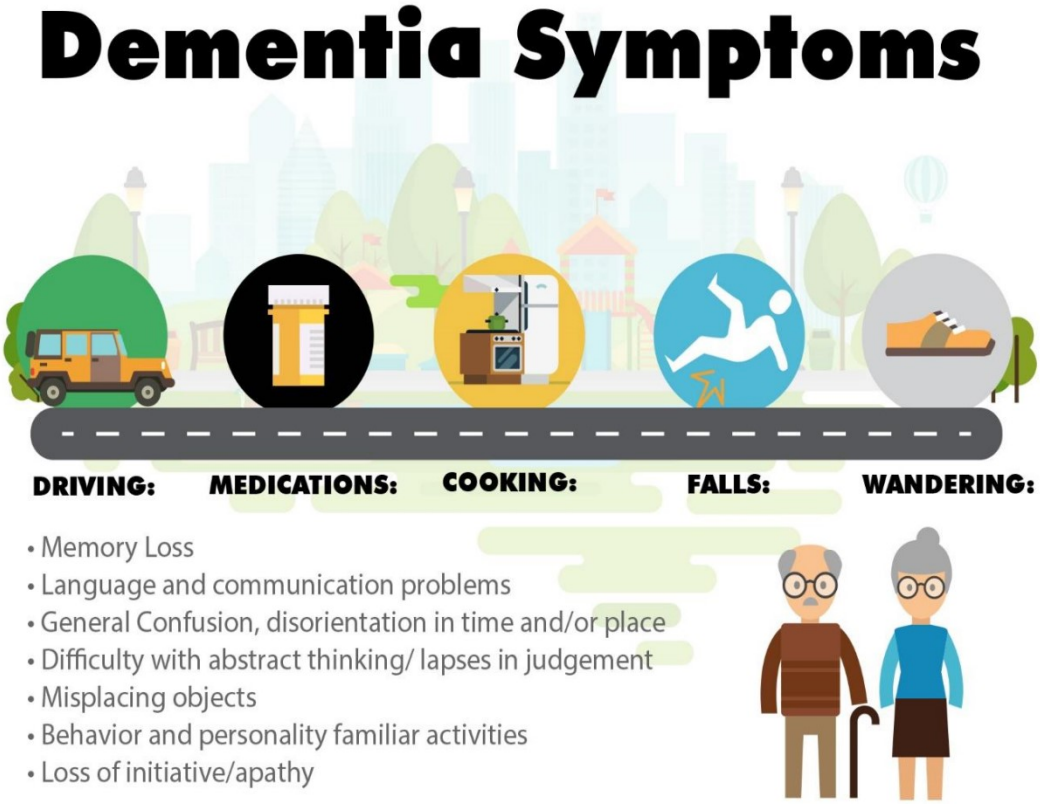
7. what is a neurotransmitter? brief any four types of neurotransmitters.

Ans : Neurotransmitters are chemical messengers that your body can't function without. Their job is to carry chemical signals ("messages") from one neuron (nerve cell) to the next target cell. The next target cell can be another nerve cell, a muscle cell or a gland.

Types of neurotransmitters.

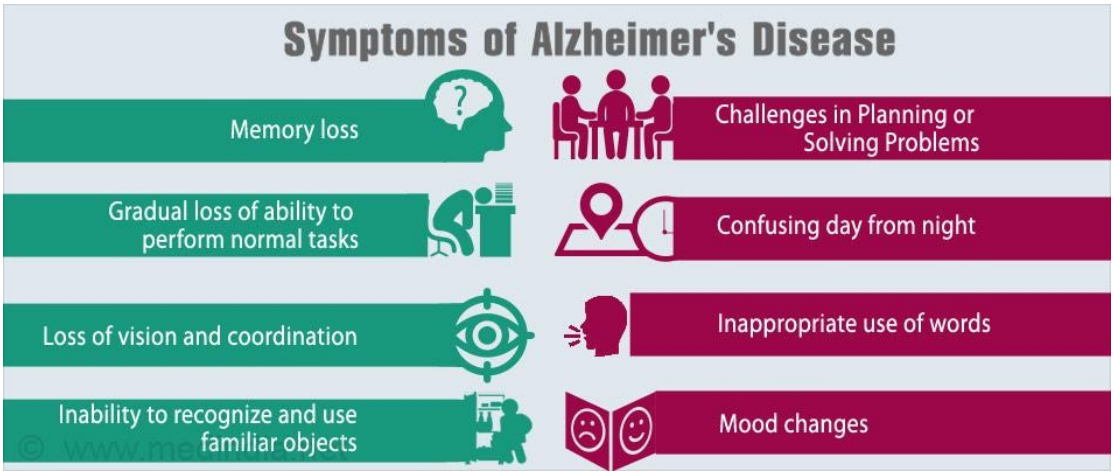
8. what is dementia? what are its symptoms?

ANS : Dementia is another disorder associated with aging seen in patients over 60.



9. How does Alzheimer's disease occur? what are its symptoms?

ANS : Alzheimer's disease is **thought to be caused by the abnormal build-up of proteins in and around brain cells.** One of the proteins involved is called amyloid, deposits of which form plaques around brain cells. The other protein is called tau, deposits of which form tangles within brain cells.

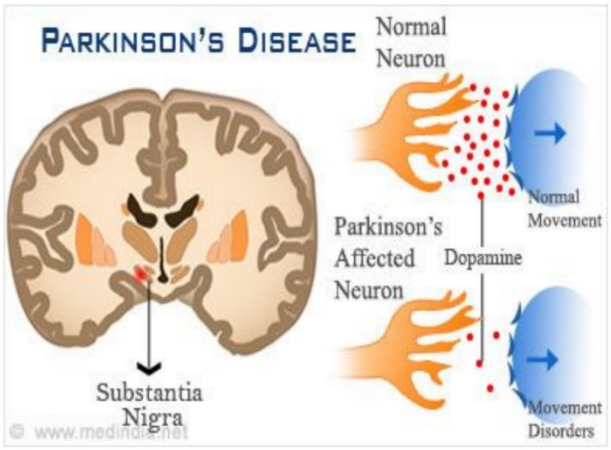


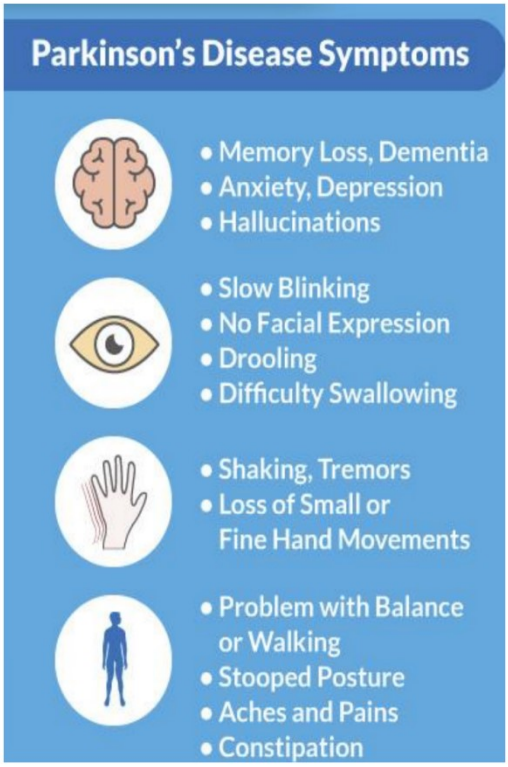
10.Why does Parkinson's disease happen? what are its symptoms?

ANS : The substantia nigra is **a brain structure that is part of your basal ganglia**. While it's very small, this structure is essential in how your brain controls your body's movements.

2. Parkinson disease

- **Parkinson is usually observed between the ages of 50-60.**
- **Environmental toxins may be responsible for onset of the disease.**
- **Destruction of cell bodies and neurons that produce dopamine.**





11. what are computer based neural networks? brief any four applications of computer based neural networks.

ANS : Computer-based neural networks are a type of artificial intelligence that are modeled after the structure and function of the human brain. They are composed of interconnected processing nodes, or "neurons," that are able to learn and adapt to new information.

Some common applications of computer-based neural networks include:

a) Image recognition: Neural networks can be trained to recognize and classify objects within images, which is useful in applications such as self-driving cars, security systems, and medical imaging.

b) Natural language processing: Neural networks can be used to understand and generate human language, which is useful in applications such as speech recognition, machine translation, and text-to-speech systems.

c) Predictive modeling: Neural networks can be trained to make predictions based on historical data, which is useful in applications such as stock market analysis, weather forecasting, and healthcare diagnosis.

d) Robotics: Neural networks can be used to control robots, allowing them to learn and adapt to their environment, which is useful in applications such as manufacturing, agriculture, and search and rescue operations.

1) What are molecular machines?

=) Molecular machines are biological structures that perform specific functions through the movement of molecules. They are made up of protein molecules that can move in relation to one another and can be thought of as tiny machines or robots at the molecular level. Examples include enzymes, which catalyse chemical reactions in cells, and motor proteins, which move along microtubules to transport molecules within cells.

2) Types of tiny motors available inside a cell. brief about all of them. Explain how they are important for cellular functioning?

=) There are several types of molecular motors found within cells, each of which perform specific functions that are important for cellular functioning. Some examples include:

1. Myosin: Myosin is a motor protein that generates the force necessary for muscle contraction. It binds to actin filaments and generates force by undergoing a cycle of conformational changes.
2. Kinesin: Kinesin is a motor protein that moves along microtubules in the cell, transporting various molecules and organelles to different parts of the cell.
3. Dynein: Dynein is a motor protein that also moves along microtubules, but in the opposite direction of kinesin. It is involved in the movement of cilia and flagella, as well as the transport of molecules within cells.
4. RNA polymerase: RNA polymerase is a molecular motor that is responsible for transcribing DNA into RNA.
5. ATP synthase: ATP synthase is a molecular motor that generates ATP, the primary energy currency of the cell, through the process of chemiosmosis.

All these molecular machines are vital for the proper functioning of cells. They are responsible for generating force, transporting molecules and organelles, and facilitating chemical reactions that are necessary for cell survival. Without them, the cell would not be able to perform the various processes that are necessary for life.

3) What are the various types of protein based molecular motors? state any four differences between Rotary and non-Rotary motors?

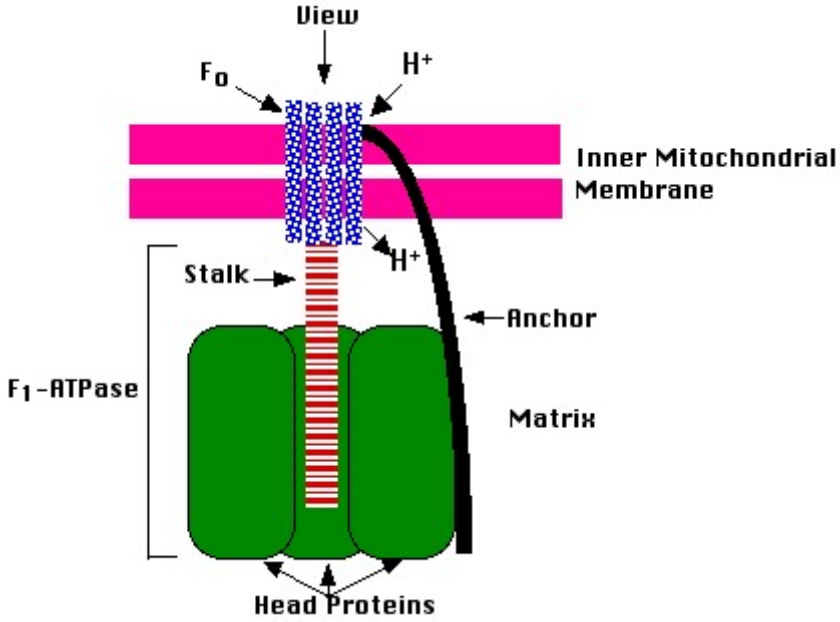
=) There are several types of protein-based molecular motors, including myosins, kinesins, and dyneins. Four differences between Rotary and non-Rotary motors are written below.

1. Rotary vs non-rotary: Rotary motors, such as ATP synthase and F1-ATPase, convert chemical energy into mechanical energy through rotation, while non-

rotary motors, such as myosins and kinesins, convert chemical energy into mechanical energy through linear movement.

2. ATP hydrolysis: Rotary motors typically use ATP hydrolysis as the source of energy, while non-rotary motors can use either ATP hydrolysis or other chemical reactions.
3. Directionality: Rotary motors typically have a fixed direction of rotation, while non-rotary motors can move in either direction.
4. Force generation: Rotary motors typically generate less force than non-rotary motors, but over a longer distance.

4) Explain the functioning of ATP synthase/ bacterial flagellum.



ATP synthase is an enzyme complex that catalyses the synthesis of ATP. It is a type of ligase as it catalyses the formation of phosphodiester bonds.

The reaction is as follows:

ADP + Pi + 2H+(out) ⍰ ATP + H2O + 2H+(in)

The formation of ATP is energetically unfavourable, therefore it is coupled to an electrochemical gradient created during cellular respiration in the electron transport chain. The electrochemical gradient is formed by the difference in proton concentration across the inner mitochondrial membrane.

The facilitated diffusion of protons through the transmembrane channel of ATP synthase releases energy that causes conformational changes in the enzyme and leads to the formation of ATP molecules.

The ATP synthase is also sometimes referred to as complex V of the electron transport system.

It consists of two components:

1. A transmembrane protein complex known as F0
2. A peripheral protein complex known as F1

The F1 headpiece present peripherally contains the site of ATP synthesis. F0 is a channel protein and allows the diffusion of protons through it, down the electrochemical gradient.

ATP synthesis by chemiosmosis requires a membrane, proton pump, a proton gradient and the ATP Synthase. The transmembrane channel of ATP synthase facilitates the diffusion of protons back to the

mitochondrial matrix. The energy released in the process activates ATP synthase and it catalyses ATP synthesis.
Two protons pass through the F0 channel from intermembrane space to the matrix of mitochondria for each ATP molecule synthesised.
On complete oxidation of one glucose molecule, theoretically, there is a net gain of 38 ATP molecules. There are various factors that influence this, such as many pathways occurring simultaneously, withdrawal of substrates from the pathway, alternative substrates entering the pathway at intermediary stages, ATP utilisation whenever required, etc. Hence, this calculation is based on assumptions and is not very valid for living systems.

5) discuss the functions of myosin and kinesin.

=) Perceptual and Motor Domain includes fine and gross motor skills, coordination, integrating motor skills and vision (e.g., eye-hand coordination), sensory integration, visual memory (e.g., recalling visual details), and tactile defensiveness (e.g., exploring materials of different textures).

The cytoskeleton of a cell is made up of **microtubules, actin filaments, and intermediate filaments**. These structures give the cell its shape and help organize the cell's parts. In addition, they provide a basis for movement and cell division.

ATP (Adenosine triphosphate) hydrolysis is the process by which the energy-rich molecule ATP is broken down into ADP (Adenosine diphosphate) and inorganic phosphate (Pi) through the addition of a water molecule. This reaction releases energy in the form of heat and light, which can be used to drive various cellular processes. The overall chemical reaction for ATP hydrolysis is:

ATP + H2O --> ADP + Pi + energy

ATP hydrolysis is exothermic, meaning that it releases energy. The energy released during ATP hydrolysis is used by cells to perform various functions, such as muscle contraction, protein synthesis, and transport of molecules across cell membranes. The energy released during ATP hydrolysis is stored in the chemical bond between the adenine and the phosphate group of ADP, making it a high energy molecule.

ATP hydrolysis is catalyzed by enzymes called ATPases. These enzymes are found in all living organisms, and they play a critical role in the metabolism of cells. The energy released during ATP hydrolysis is harnessed by cells to perform various functions, such as active transport, muscle contraction, and protein synthesis.

In summary, ATP hydrolysis is a process by which cells release energy from the high-energy molecule ATP. This energy is used to power various cellular processes and is an essential for the survival of living organisms.

Myosin and kinesin are both motor proteins that play important roles in cell movement. The functions are of them: -

Myosin is a muscle protein that works with actin to produce muscle contractions. It attaches to the actin filament and pulls it along, causing the muscle to shorten. Myosin also plays a role in non-muscle cells, where it is involved in cell movement and the formation of cell junctions.

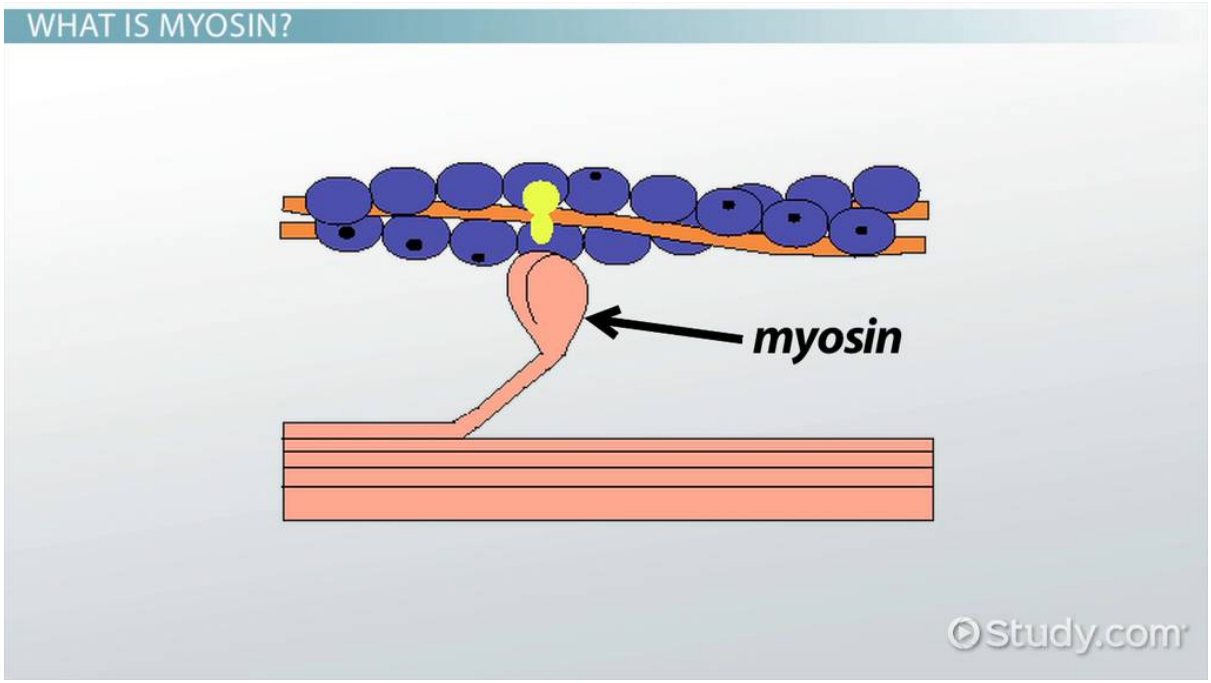
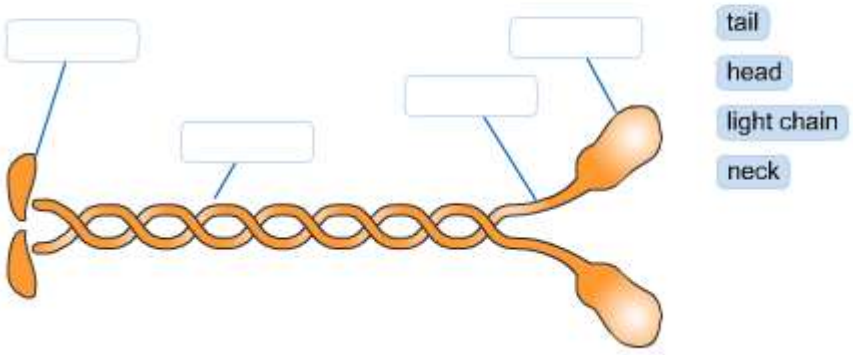


Fig: - myosin motors

Kinesin is a motor protein that works with microtubules to transport materials within cells. It walks along the microtubules, using energy from ATP to move cargo (such as vesicles containing neurotransmitters) from one end of the cell to the other. Kinesin also plays a role in cell division, where it helps to separate the chromosomes during mitosis.

Kinesin, a motor protein, is shown below. Label the structure of kinesin and then determine which statements about kinesin are true.

a)



6) Differentiate between myosin and dynein?

=) Differences between myosin and dynein are: -

1)Myosin's are the motor proteins with a long central stalk, but dynein has a short central stalk.

2) Myosin's work independently but dynein work in groups.

3) Myosin connects to actin, but dynein connects to tubulin.

4) Myosin moves towards the positive end of a cytoskeleton, but dynein move to the negative end.

5) Dynein moves from periphery to centre but myosin's work at the centre.

Biosensors

Q1. what is a biosensor? brief about working principle of biosensors.

A: begin with sensors. then talk about biological reactions. then define biosensors.

A sensor is a device that detects and measures a specific physical or chemical property, such as temperature, light, or pressure. Sensors can be classified based on the type of physical or chemical property they detect, and the type of transducer used to convert the detected property into an electrical signal.

Biosensors are a special type of sensor that use biological reactions to detect and measure specific molecules or compounds. These devices combine a biological component, such as an enzyme or antibody, with a physical transducer, such as a semiconductor or electrochemical device, to detect and measure specific molecules or compounds in a sample. The biological component specifically binds to the target molecule, while the physical transducer converts the binding event into a measurable signal, such as an electrical current or a change in optical properties.
The working principle of a biosensor is based on the specific binding between the biological component and the target molecule, which results in a change in the physical or chemical properties of the biosensor that can be detected by the transducer.

Q2. state the components of biosensors?

A: discuss about each and every component of the biosensor. draw the flow charts available on textbook or on the slides.

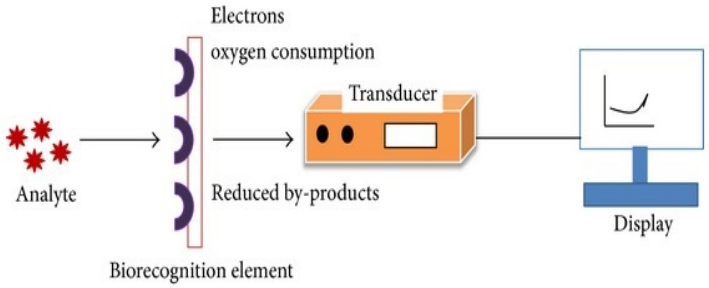
The components of a biosensor typically include:

1. **Bioreceptor:** This is the biological component of the biosensor, also known as the recognition element, which is responsible for recognizing and binding to a specific target analyte. This component can be made of enzymes, antibodies, nucleic acids, or other biomolecules that specifically interact with the target analyte. The bioreceptor is usually immobilized on a solid support.

2. **Transducer:** The transducer is the component that converts the biological response of the bioreceptor into a measurable signal. This can be an electrical, optical, or other form of signal. For example, in an enzyme-based biosensor, the transducer can be an electrode that measures changes in the electrical current resulting from the enzymatic reaction. In an optical biosensor, the transducer can be a light-emitting diode or a laser diode that generates light in response to changes in the optical properties of the bioreceptor.
3. **Detector:** The detector is the component that measures the signal generated by the transducer and converts it into a quantitative result. This can be an ammeter, a voltmeter, a photodetector, or other type of detector, depending on the type of signal generated by the transducer.
4. **Signal Processor:** This component analyzes the data received from the detector and processes it to provide a meaningful result. This can include amplification, filtering, and/or other types of signal processing as required.
5. **Display/Output device:** This component presents the analyzed data in a readable format, such as a numerical value or a graph. This can be a display screen or an output port to connect to external devices.

All these components are integrated together to form a biosensor. A biosensor works by selectively binding a target analyte to the bioreceptor and generating a measurable signal proportional to the amount of the target analyte present in the sample. The signal is then processed and displayed in a meaningful way, allowing for the quantification of the target analyte.

Flow chart of Biosensors :



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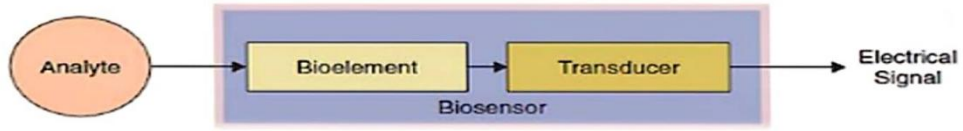


Q3: brief about any two types of biosensors?

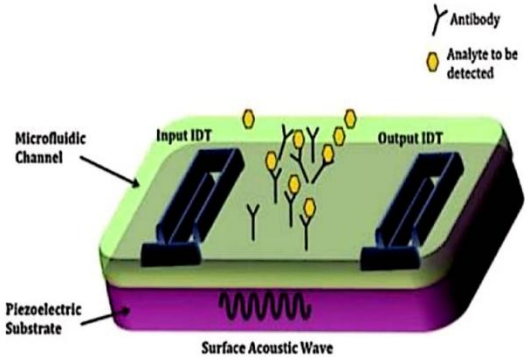
Resonant biosensors

In this type of biosensor, an acoustic wave transducer is coupled with an antibody (bio-element). When the analyte molecule (or antigen) gets attached to the membrane, there is alteration in the mass of the membrane leading to changes in the resonant frequency of the transducer. This frequency change is then measured.

Resonant Biosensors.

- An Acoustic Wave Transducer is coupled with Bioelement.
- Measures the change in Resonant Frequency.

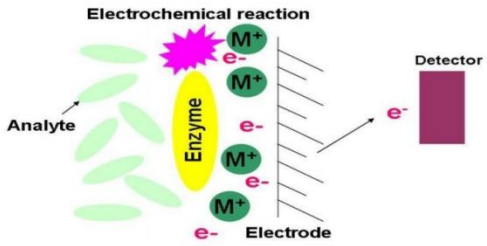
- Analyte - Antigen
- Bioelement – Antibody
- Transducer – Acoustic wave transducer
- Signal – Change in frequency/mass measured



2.Electrochemical Biosensors

Electrochemical Biosensor

Many chemical reactions produce or consume ions or electrons which in turn cause some change in the electrical properties of the solution which can be sensed out and used as measuring parameter.



Electrochemical Biosensor types:

- Potentiometric
  : measure E
- Amperometric
  : apply E, measure I
- Conductimetric
  : measure the change in conductance

Q4: how does a glucose biosensor work?

A: explain the interactions that happens but when glucose oxidase reacts with the glucose, then discuss about the electron densities or the oxygen measurement or the hydrogen peroxide measurement. A schematic diagram is must.

A glucose biosensor typically consists of a glucose oxidase enzyme immobilized on a transducer. The transducer can be an electrode (such as a carbon electrode or a gold electrode) or a optical device. When glucose comes into contact with the enzyme, the enzyme catalyzes the oxidation of glucose to gluconic acid and hydrogen peroxide (H2O2). The H2O2 produced in this reaction can then be measured by the transducer.

In an electrochemical biosensor, the H2O2 is oxidized at the electrode surface, generating a current that is proportional to the concentration of glucose. This current can be measured using a potentiometer or an ammeter, and the resulting signal can be used to determine the glucose concentration.

A schematic diagram of a glucose biosensor using an electrode transducer is shown below:

Glucose + Glucose Oxidase --> Gluconic acid + H_2O_2

H_2O_2 + Electrode --> $O_2 + 2H^+ + 2e^-$

Where the electrode is measuring the amount of electrons being produced from the H_2O_2 reaction.

Q5: state the importance of DNA biosensors

A: Read the points available on the textbook. diagram is not required.

DNA biosensors are important for a variety of applications, including medical diagnostics, environmental monitoring, and food safety testing.

1. Medical diagnostics: DNA biosensors are used to detect specific genetic sequences associated with diseases such as cancer, genetic disorders, and infectious diseases. This allows for early detection and diagnosis of diseases, which can improve patient outcomes.

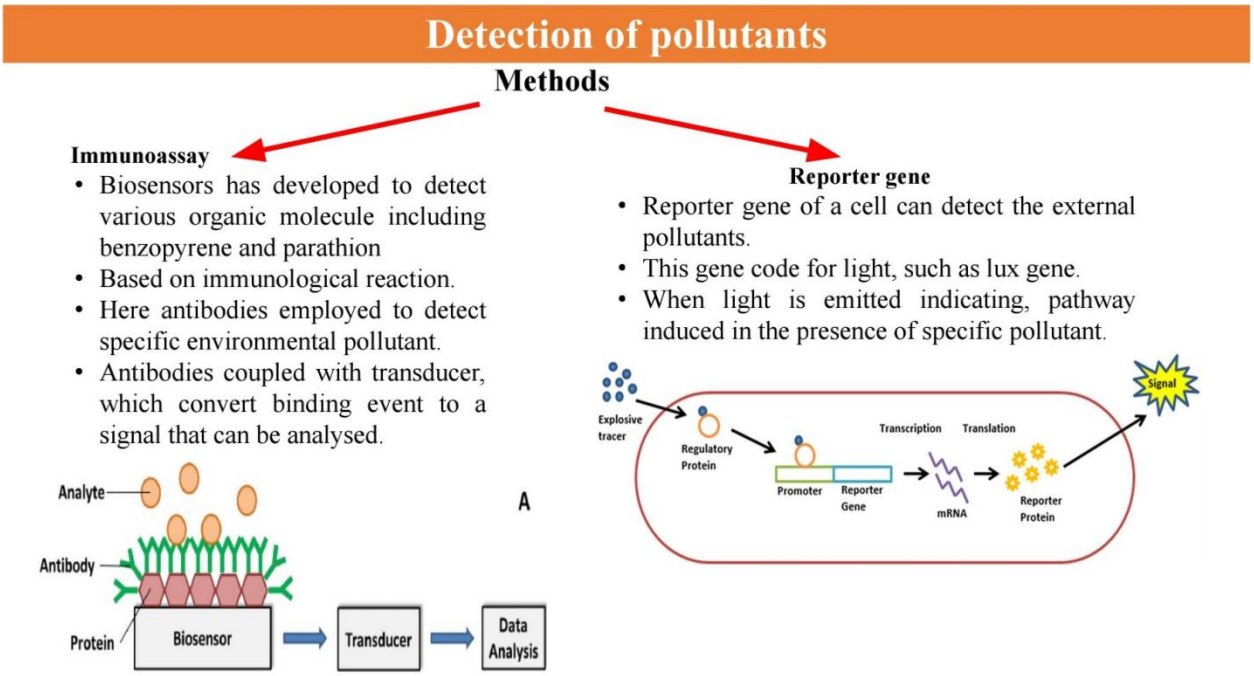
2. Environmental monitoring: DNA biosensors can be used to detect and quantify specific microorganisms in the environment, such as bacteria and viruses. This can help to monitor the spread of harmful pathogens and to identify sources of pollution.

3. Food safety testing: DNA biosensors can be used to detect food-borne pathogens such as E. coli, Salmonella, and Listeria. This can help to ensure that food products are safe for consumption and to identify sources of contamination.

4. Genetic engineering: DNA biosensors can also be used in genetic engineering, to detect the specific sequence of DNA, to monitor the expression of specific genes, and to detect genetic mutations.

Q6: how are biosensors useful in pollution detection

A: the theory has to be read from the textbook. diagram should be practiced from slides.



There are two types of Biosensors which are use in pollution detection.

1.Immunoassay biosensors are useful in pollution detection because they can quickly and sensitively detect specific pollutants in a sample. The biosensor typically consists of a biological recognition element, such as an antibody or receptor, that binds to a specific pollutant, and a transducer that converts the binding event into a measurable signal. This allows for rapid, on-site detection of pollutants without the need for time-consuming and expensive laboratory analysis. Additionally, immunoassay biosensors can be used to detect a wide range of pollutants, including heavy metals, pesticides, and toxic organic compounds**.**

2.Reporter gene biosensors are a powerful tool for the detection of specific pollutants in a wide range of sample types. These biosensors rely on the insertion of a reporter gene, such as a fluorescent protein or a protein that can be converted into a colorimetric signal, into a host cell. The reporter gene is linked to a genetic construct that allows the pollutant of interest to activate or repress the expression of the reporter gene.

When the pollutant is present in the sample, it binds to the genetic construct and modifies the expression of the reporter gene, leading to the production of a measurable output. This output, whether it be fluorescence, color change or other measurable signal, can then be easily quantified, allowing for the rapid and sensitive detection of the pollutant at very low concentrations. This approach can be multiplexed to detect multiple pollutants simultaneously, and can be adapted for use in a variety of sample **types,** including water, air, and soil. Furthermore, reporter gene biosensors offer the advantage of being able to detect a wide range of pollutants, including heavy metals, pesticides, and toxic organic compounds.

Q7: discuss the importance of biosensors in food industry.

A: you can provide with the examples I have given in the classroom. About the detection pattern, look at the methods from the textbook.

- Uses
  - Measurement of carbohydrates, alcohols
  - Sterility, food safety in meats, beverages (Beer, soft drinks) etc.
- Objective – Used in quality assurance
- Methods
  - 1. Flow injection system

The importance of biosensors in food in food industry are discussed below:

1. Biosensors are important in the food industry for detecting foodborne pathogens such as E. coli, Salmonella, and Listeria. This helps prevent foodborne illnesses and protect consumers.

2. Biosensors can detect food allergens such as peanuts and gluten at low levels which can help ensure that food products are safe for individuals with allergies to consume.

3. Biosensors can monitor the quality and freshness of food products, such as detecting spoilage organisms in meat and dairy products or measuring pH and temperature of food products.

4. Biosensors can detect food additives such as preservatives and sweeteners which may have negative health effects or be harmful for some people.

5. Biosensors can help improve food safety and quality, protect consumers, and ensure that food products are safe and nutritious to eat.