Q.2 (a) What is octet rule in chemical bonding? Explain covalent bond in detail?

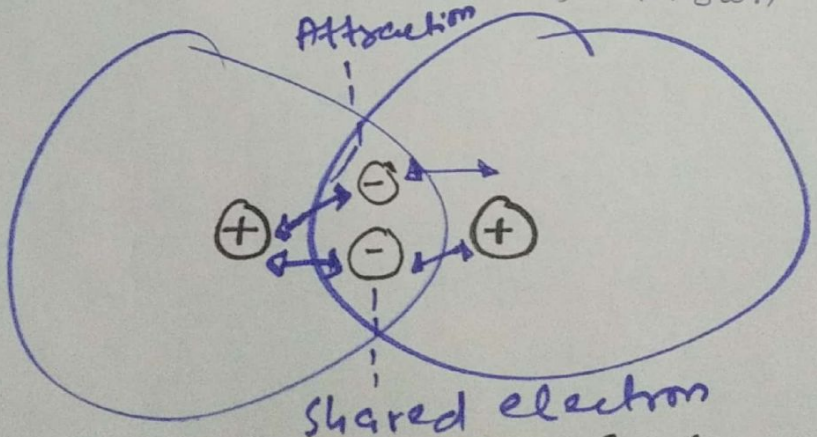
Answer:

Introduction

Covalent bonds form when atoms share electrons. Hydrogen is a first shell element with only one valence electron, so it can only form one bond creating a duet, an exception to the octet rule. With its four valence electrons, carbon can form four bonds to create an octet.

Explaining Covalent Bond:

Elements having very high ionisation energies are capable of transferring electrons, and elements having very low electron affinity can't take up electrons. The atoms of such elements tend to share their electrons with the atoms of other elements or with other atoms of the same element in a way that both the atoms obtain octet configuration in their respective valence shells, and thus achieve stability. Such association through sharing of electron pairs among different or same kinds is known as covalent bond.



Formation of Covalent Bond

Covalent bonding can be achieved in two ways:

(i) Sharing of electrons between atoms of the same kind, for ex; formation of H_2, Cl_2, O_2 etc.
(ii) Sharing of electrons between atoms of different kinds, for ex; formation of CH_4, H_2O, NH_3.

Properties of Covalent Bond

If the normal valence of an atom is not satisfied by sharing a single electron pair between atoms, the atoms may share more than one electron pair between them. Some of the properties of covalent bonds are listed below:

(a) Covalent bonding does not result in the formation of new electrons the bond only pairs them.
(b) They are powerful chemical bonds that exist between atoms.
(c) A covalent bond normally contains an energy of about -80 kilocalories per mole (Kcal/mol).
(d) Covalent bonds rarely break spontaneously after it is formed.
(e) Most compounds having covalent bonds exhibit relatively low melting points and boiling points.

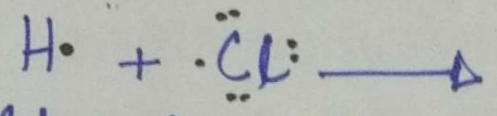
Types of Covalent Bonds

(1) Depending upon the number of shared electron pairs, the covalent bond can be classified into:
(1) Single Covalent Bond
(2) Double Covalent Bond
(3) Triple Covalent Bond

1- Single Covalent Bond:-

A Single bond is formed when only one pair of electrons is shared blw two participating atoms. It is represented by one dash (–). Although this form of Covalent bond has a smaller density and is weaker than a double and triple bond, It is the most stable.

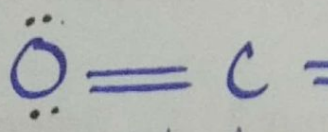
Example:-



2- Double Covalent Bonds:-

A bond is formed when two pairs of electrons are shared between the two participating atoms. It is represented by two dashes (=). Double Covalent bonds are much stronger than single bonds, but they are less stable.

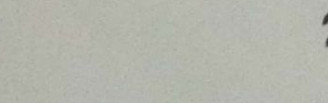
Example:-



(CO_2 Molecule with Double Covalent Bond)

3- Triple Covalent Bonds:-

A triple bond is formed when three pairs of electrons are shared blw the two participating atoms. Triple Covalent bonds are represented by three dashes (≡) and are the least stable type of Covalent bonds-



Elucidating Octet Rule :-

All atoms except noble gases have less than eight electrons in their valence shell. In other words, the valence shells of these atoms do not have stable configurations. Therefore, they combine with each other or with other atoms to attain stable electronic configurations.

Therefore,

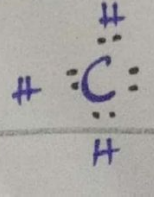
> "The tendency of atoms of various elements to attain stable configuration of eight electrons in their valence shells is the cause of chemical combination."

And,

> "The Principle of attaining the maximum of eight electrons in the valence shell of atoms is called the OCTET RULE."

LEWIS MODEL OF SYMBOLS

Lewis introduced simple symbols to denote the electrons present in the outer shell of an atom known as valence electrons. These symbols are known as **Electron Dot Symbols** and the structure of the compound is known as **Lewis Dot Structure**. which can be seen in Diagram below;



{Dot Structure of Methane}

Conditions for Writing Lewis Dot structures:

(i) Sharing of an electron pair b/w the atoms results in the formation of Covalent bonds.
(ii) During bond formation, each bond consists of two electrons which are contributed by each one the combining atoms.
(iii) By the mutual sharing of electrons, each atom attains an octet configuration in its valence shell.

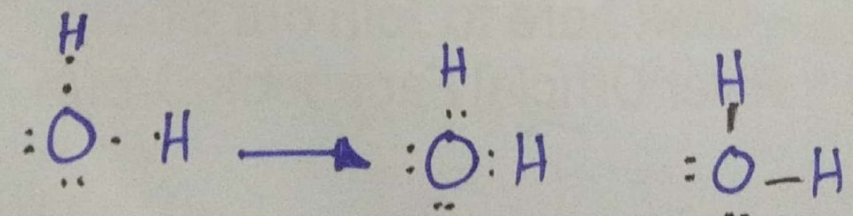
Hence, Electron dot structures of Covalent molecules are written with respect to the octet rule. According to this rule, all the atoms in the molecule will have eight electrons in their valence shell except the Hydrogen atom. Hydrogen will have only two electrons because only two electrons complete its first shell to attain helium configuration.

Thus, the elements of group 17, such as Cl, would share one electron to attain a stable octet; the elements of group 16, such as O and S, would share two electrons; the elements of group 15 would share 3 electrons and so on.

For example:

The oxygen atom, which has 6 electrons in its valence shell, completes its octet by sharing its two electrons with two hydrogen atoms to form a water molecule.

Structure:



} Lewis Structure of Water molecule }

(b) Why Water Molecule is angular in Structure?

Introduction :-

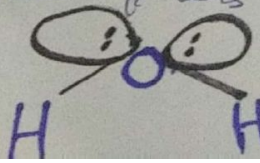
Shape of Compounds depend on various factors such as availability of different orbitals, number of electron, lone pair, bond pair etc. Valence Shell electron pair repulsion theory (VSEPR) helps to Predict the shape of different Covalent Compounds. It tells us about the repulsion of electrons in the Valence Shell. Let's Understand the angular Structure of water molecule through (VSEPR) Theory

VALENCE SHELL ELECTRON PAIR REPULSION THEORY

Valence shell electron pair repulsion theory (VSEPR) tells about lone pairs Present in the Valence Shell, the Unpaired electron forms a bond with another Unpaired electron and the paired electrons are left as lone pairs. Which causes repulsion blw bond pair - bond pair, lone pair - lone pair and they start arranging themselves to minimize the repulsion.

During this process the geometry predicted by hybridization gets distorted and different geometry of molecules are seen. The shape of the water molecule is angular due to Presence of two lone pairs on the oxygen atom.

Example:



(c) Write a note on Structure and functions of Human Brain?

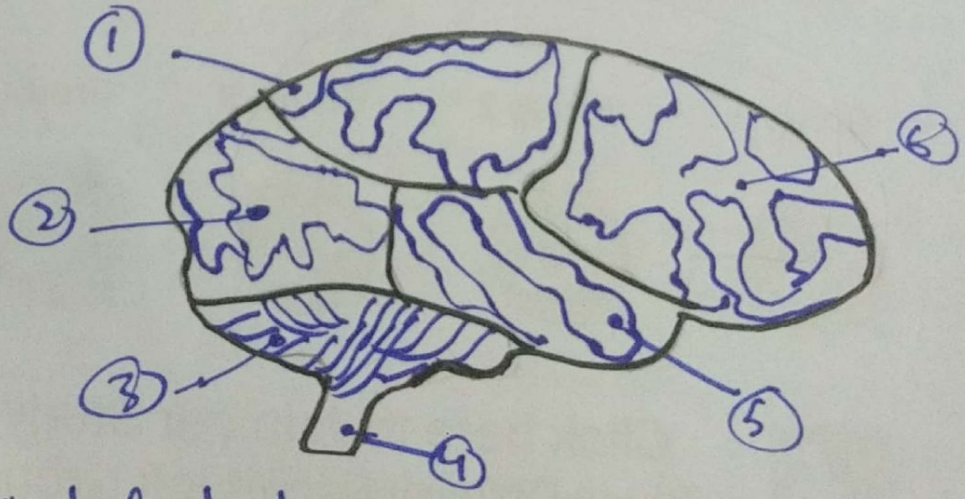
Introduction

THE HUMAN BRAIN:

The brain is the Centers of thoughts and the Central organ of the human nervous system. It is most Complex and important organ in the body, which is made up of more than 100 billion Specialized nerves and functions by Controlling all the metabolic functions of our body.

LOCATION:

The human brain is located in the head and enclosed within the skull, which provides frontal, lateral and dorsal Protection. Further, Structure of Human Brain can be studied through diagram below with its main Parts.



1. Parietal lobe
2. Occipital lobe
3. Cerebellum
4. Spinal Cord
5. Temporal lobe
6. frontal lobe

Details of Human Brain can be studied under following captions: (STRUCTURE & FUNCTIONS)

Parts of Human Brain

The human brain is divided into three main parts -

(i) Forebrain (ii) Midbrain (iii) Hindbrain

These three main parts comprises many small parts - Let's discuss them one by one -

(i) Forebrain :-

The forebrain is the anterior part of the brain, which comprises the cerebral hemispheres, the thalamus, and the hypothalamus.

It consists of two subdivisions called the telencephalon and diencephalon. Along with the optic nerves and cranial nerves, the forebrain also includes the olfactory system, or sense of smell as well as the lateral and third cerebral ventricles.

The cerebrum consists of the cerebral cortex and other subcortical structures. It is composed of two cerebral hemispheres that are joined together by C-shaped nerve fibre called the corpus callosum.

FUNCTION

The cerebrum is the largest part, which occupies two-thirds of the brain's volume & covers most other brain structures. It is involved in controlling the major functions like learning ability and emotions.

The Cerebrum is further divided into sub-sections or lobes:

The frontal lobe:	The frontal lobe is found just below the forehead. It is mainly responsible for the Parts of Speech, Judgments, reasoning, Solving Problems, Planning and for motor functions including movements. The frontal lobe is also associated with self-regulated behaviours, facial expressions, controlling inhibition, to pay attention, to remember and to control emotions.
The Parietal lobe	The Parietal lobe is found at the upper back of our brain. This lobe functions by controlling all our complex behaviours including senses of vision, the sense of touch, spatial orientation and body awareness. It manages body Position, movements, the Perception of Stimuli, orientation, handwriting and visuospatial Processing.
The Occipital lobe	The occipital lobe is found at back. It is mainly associated with visual Processing systems such as body Postures, gestures and expressions.
The Temporal lobe	The Temporal lobe is found near to our ears and is associated with Speech, hearing, recognition and Processing of auditory stimuli.

(ii) Midbrain :-

The midbrain is the smallest region of the brain, found at Centre of the brain, between Cerebral Cortex and hindbrain. It Comprises tectum, Cerebral Peduncle, tegmentum, Cerebral aqueduct, substania nigra, Several nuclei and fasciculi-

Function : The midbrain is responsible for hearing, Vision, Sleep Cycle, temperature regulation, alterness, etc. It contains a large number of dopamine-Producing neurons in the substantia nigra, degeneration of these neurons is related to Parkinson's disease.

(iii) Hindbrain :-

The Hindbrain is also called as Rhombencephalon-

The hindbrain is located at the lower back Part of the brain. It is mainly Composed of the Cerebellum, brain Stem, Pons and the medulla-

Function: The Cerebellum Controls activities Such as balance, Coordination and muscle movements. The Cerebellum is Present at the backside of the brain at the base. The Cerebellum is responsible for Coordination and balance-

1. Describe the Cell structure? Write down the functions of at least three subcellular organelles.

Answer

CELL STRUCTURE

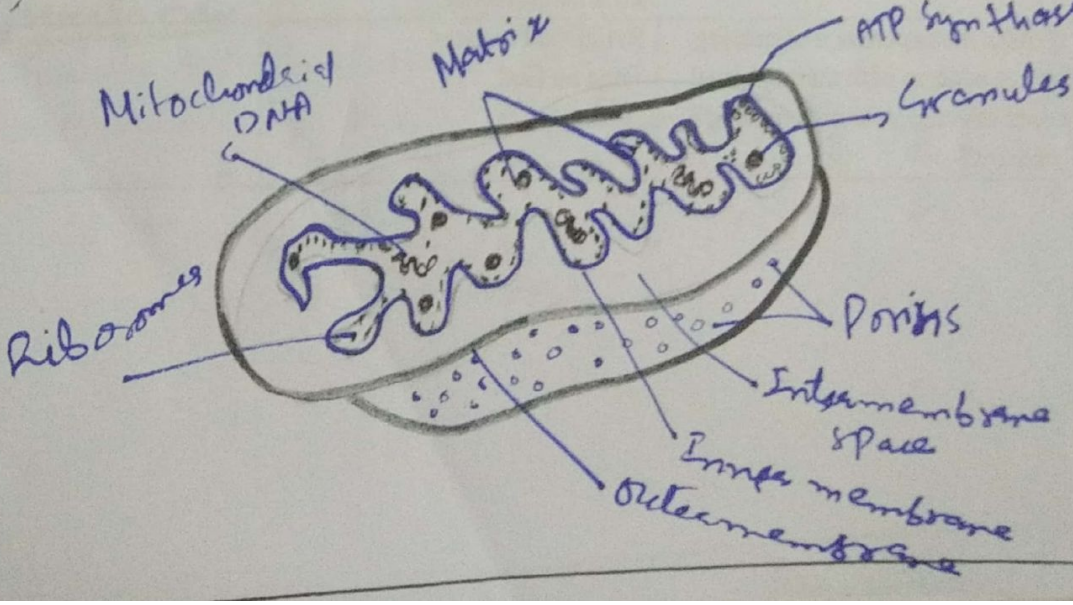
The cell structure comprises individual components with spacific functions essential to carry out life's process. The cells provide shape, structure and carry out different types of functions to keep the entire system active. The cell contains different functional structures which are collectively called organelles, and they are involved in various cellular functions.

FUNCTIONS OF SUBCELLULAR ORGANELLES:

The functions of three subcellular organelles are given below;

① Mitochondria:

Mitochondria are called the powerhouses of the cell as they produce energy-rich molecules for the cell. The mitochondrial genome is inherited maternally in several organisms. It is a double membrane-bound, sausage-shaped organelle, found in almost all eukaryotic cells.



The double membranes divide its lumen into two distinct aqueous Compartments. The inner Compartment is called a 'matrix', which is folded into Cristae whereas the outer membrane forms a Continuous boundary with the Cytoplasm.

They usually vary in their size and are found either round or oval in shape. Mitochondria are the sites of aerobic respiration in the cell, Produces energy in the form of ATP and helps in the transformation of the molecules.

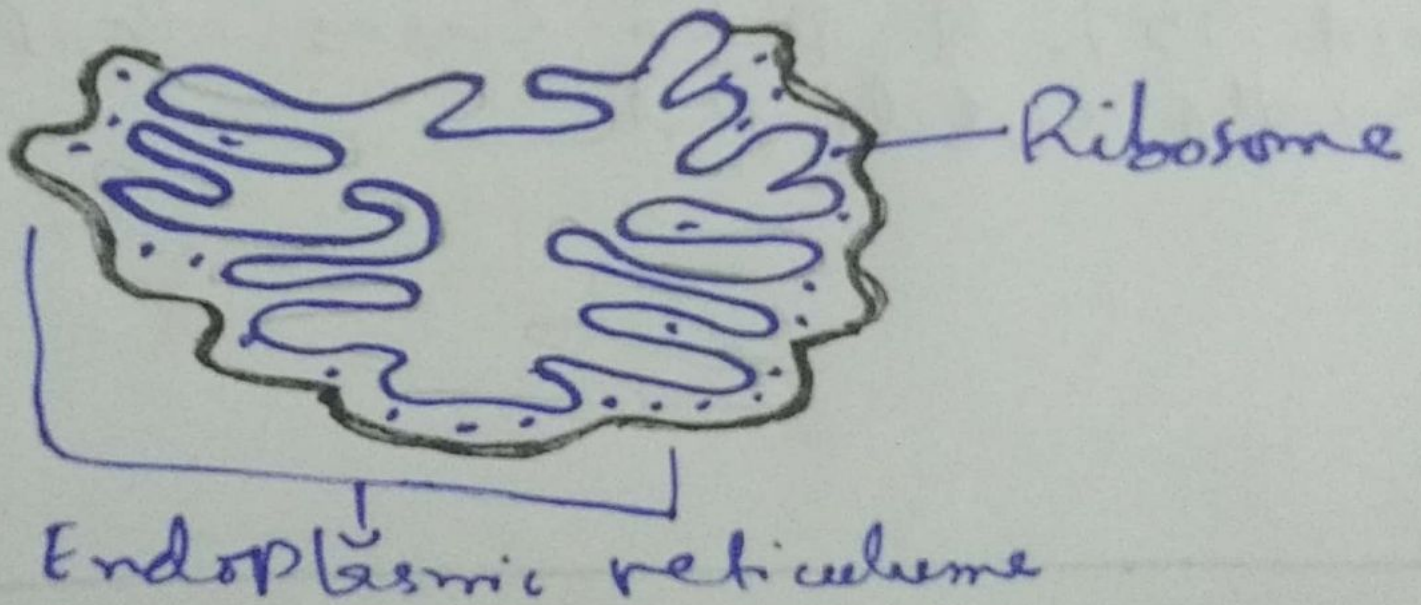
For Instance: Glucose is converted into adenosine triphosphate - ATP. Mitochondria have their own Circular DNA, RNA molecules, ribosomes (the 70s), and a few other molecules that help in Protein Synthesis.

(2) Ribosomes:

Ribosomes are non membrane-bound and important Cytoplasmic organelles found in close association with the endoplasmic reticulum. Ribosomes are found in the form of tiny Particles in a large number of Cells and are mainly Composed of 2/3rd of RNA and 1/3rd of Protein.

They are named as the 70s (found in Prokaryotes) or 80s (found in eukaryotes). The letter S refers to the density and the size, known as Svedberg's Unit. Both 70S and 80s ribosomes are Composed of two Subunits. Ribosomes are either encompassed within the endoplasmic reticulum or are freely traced in the Cell's Cytoplasm.

RIBOSOME



Q.3 (a)

What is Polio? What are the Causes and the symptoms of Polio? Differentiate b/w IPV and OPV;

Answer

Explaining Polio: Polio is also called as Poliomyelitis. It is a viral disease that destroys the nerve cells present in the spinal cord, causing paralysis or muscle weakness to some parts of the body. It is a contagious disease affecting the nervous system and is caused by Picornaviridae — a Poliovirus.

The virus is transmitted by person-to-person through the following ways-

1) **Through the faecal-oral route.**
2) **By contaminated water or food.**

This virus primarily grows and multiplies in the intestine, from where it can attack the nervous system and will cause Polio and paralysis on an advanced level.

Types of Polio:

There are 3 types of polio infections:

1) **Subclinical:**

This type of Polio do not experience any symptoms as this does not affect the central nervous system — the brain and spinal cord. 95% of Polio cases identified are usually subclinical.

2- Non - Paralytic:

This type of Polio does affect the Central nervous system, but does not result in Paralysis.

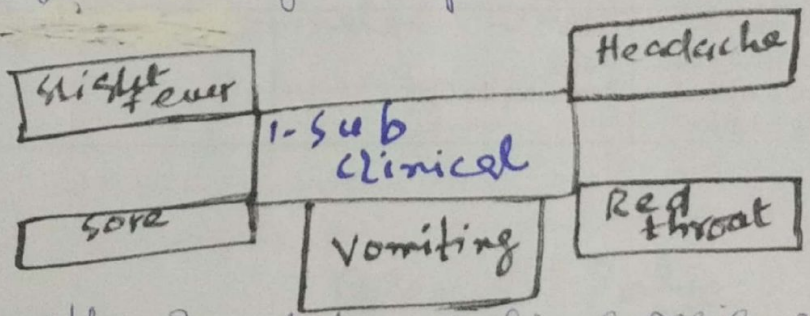
3- Paralytic:

This is the most serious and rarest form of Polio as it results in full or Partial Paralysis in the Patient. Three types of Paralytic Polio are -

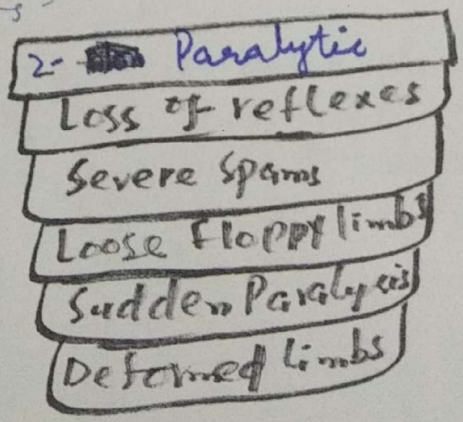
1) Spinal Polio - As the name suggests, it affects the Spine.
2) Bulbar Polio - It affects the brainstem.
3) Bulbospinal Polio - It affects the spine and brainstem.

Symptoms of Polio

As we discussed types of Polio, so the symptoms also vary according to type mentioned above.



People with Paralytic Polio experience the symptoms of Non - Paralytic Polio followed by these symptoms.



The following are the symptoms of Non-Paralytic Polio-

3. Non Paralytic

Stiffness & Pain in arm and leg

Problems with swallowing and breathing

Back Pain, Particularly neck stiffness

Muscle tenderness and Spams

Abnormal reflexes

Fever, Vomiting, Headache

Differentiate b/w IPV and OPV

IPV stands for Inactivated Polio Vaccine, while OPV stands for oral Polio Vaccine. They are two different types of Vaccines used to protect against Polio-

IPV: It is an injectable vaccine made from inactivated (killed) Poliovirus. It is typically administered as a series of shots and is effective in providing immunity against all three types of Poliovirus - Since the virus in IPV is killed, there is no risk of causing the disease it is designed to prevent.

OPV: On the other hand, OPV is is an oral vaccine made from weakened live Poliovirus. It is administered as drops in the mouth and is effective in producing an immune response. One advantage of OPV is its ability to provide not only individual protection but also to provide immunity in the community through fecal-oral transmission.

However, in rare cases the weakened virus in OPV can mutate and cause Vaccine-derived Poliovirus cases, which can be common in areas with low vaccination coverage.

b- Name the two parts of the Nervous System? Briefly describe the CNS. Describe Alzheimer Disease.

Introduction:- (Two Parts of Nervous System)

The nervous system transmit signals. The two parts of the nervous system are the Central Nervous System (CNS) and the Peripheral Nervous System (PNS).

(i) The Central nervous system is made up of the brain and Spinal Cord.

(ii) The Peripheral nervous system is made up of nerves that branch off from the Spinal Cord and extend to all parts of the body.

Central Nervous System

The Central Nervous System (CNS) is the most important unit in an organism as it is the 'Centre' or the hub which instigates information, commands and coordination and also influences all other activities within a body. Thus it is often called the Central processing unit of the body. It comprises of two parts: the brain and Spinal Cord.

Alzheimer's Disease:

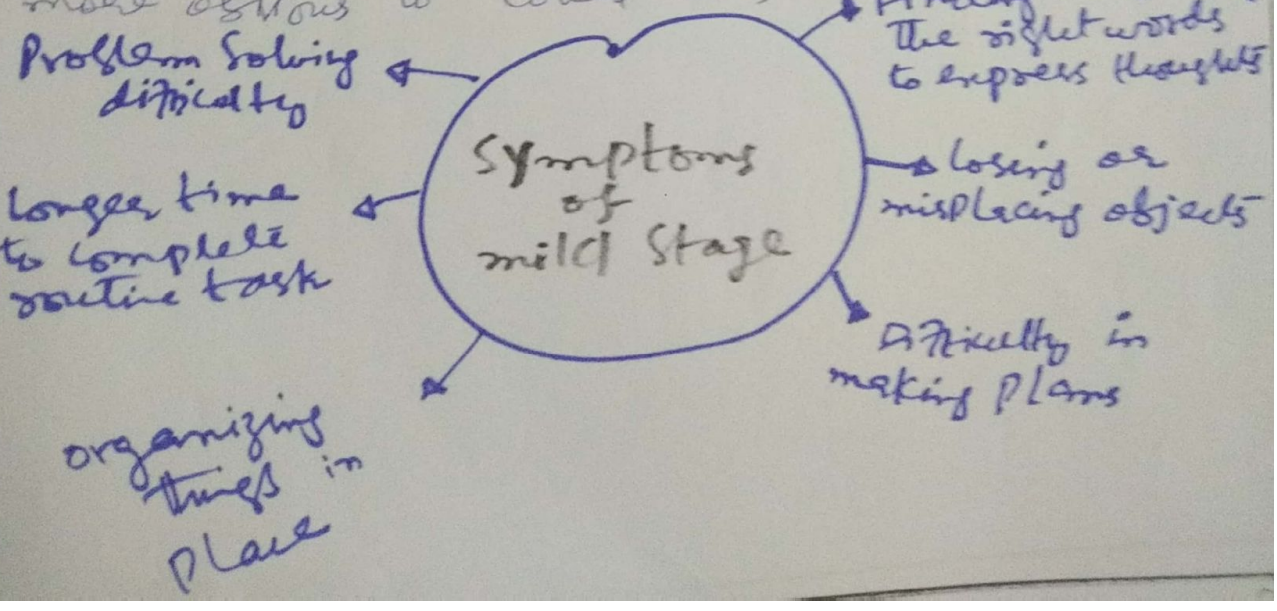
Defining Alzheimer's Disease: It is a brain condition that causes a progressive decline in memory, thinking, learning and organizing skills. It eventually affects a person's ability to carry out basic daily activities - Alzheimer's disease (AD) is the most common cause of dementia - It mostly affects people over the age of 65.

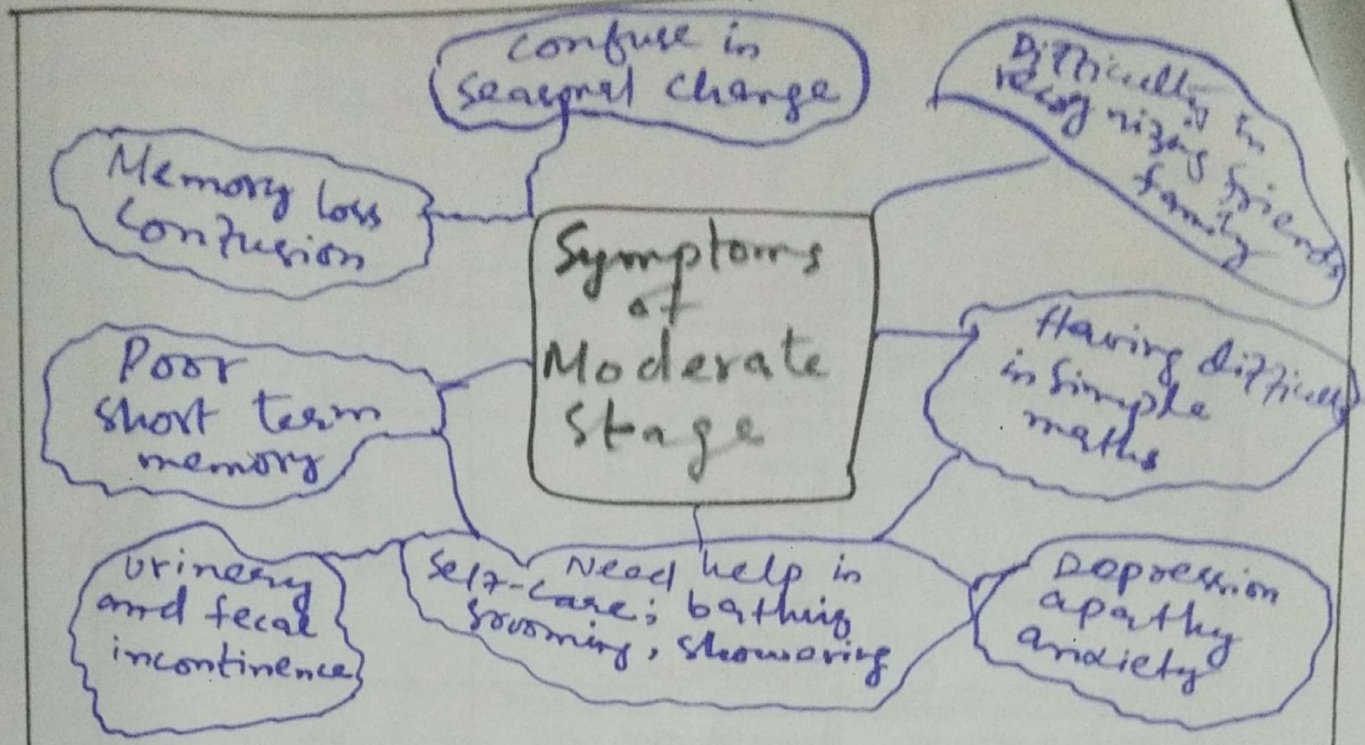
Symptoms of Alzheimer's Disease:

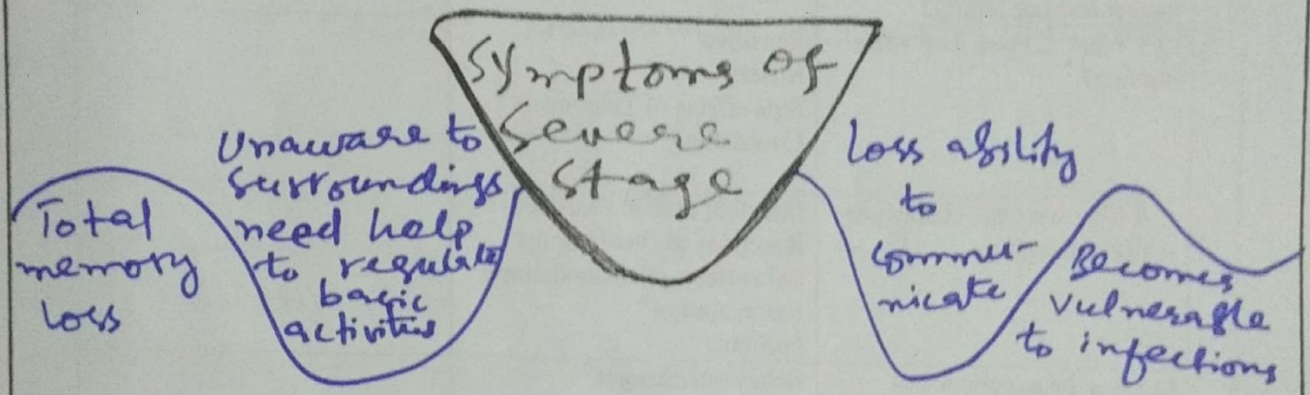
The signs and symptoms of Alzheimer's disease vary based on the stage of the condition. In general, the symptoms of (AD) involve a gradual decline in some, most or all of the following:

i) Memory and language
ii) Reasoning and handling of complex tasks
iii) Understanding visual form of and space relationship
iv) Behavior and personality

People with memory loss or other signs of Alzheimer's may have difficulty recognizing their mental decline. These signs may be more obvious to loved ones.







CAUSES OF ALZHEMER'S DISEASE

i) Abnormal build-up Of Proteins

An abnormal build-up of proteins in brain causes (AD). The build-up of these proteins include
a) amyloid protein and tau-
b) Tangles that result in loss of neurons-
It is believed that amyloid protein builds up in brain cells, forming larger masses called plaques. Twisted fibres of another protein called tau form into tangles- These plaques and tangles block the communication b/w nerve cells-

Treatment option for Alzheimer's Disease:

There's no cure for Alzheimer's disease but certain medications temporarily slow the worsening of (AD) symptoms. Medications and other interventions can also help with behavioral symptoms.

Begining treatment as early as possible could help maintain daily functioning for a while. However, current medications won't stop or reverse (AD).

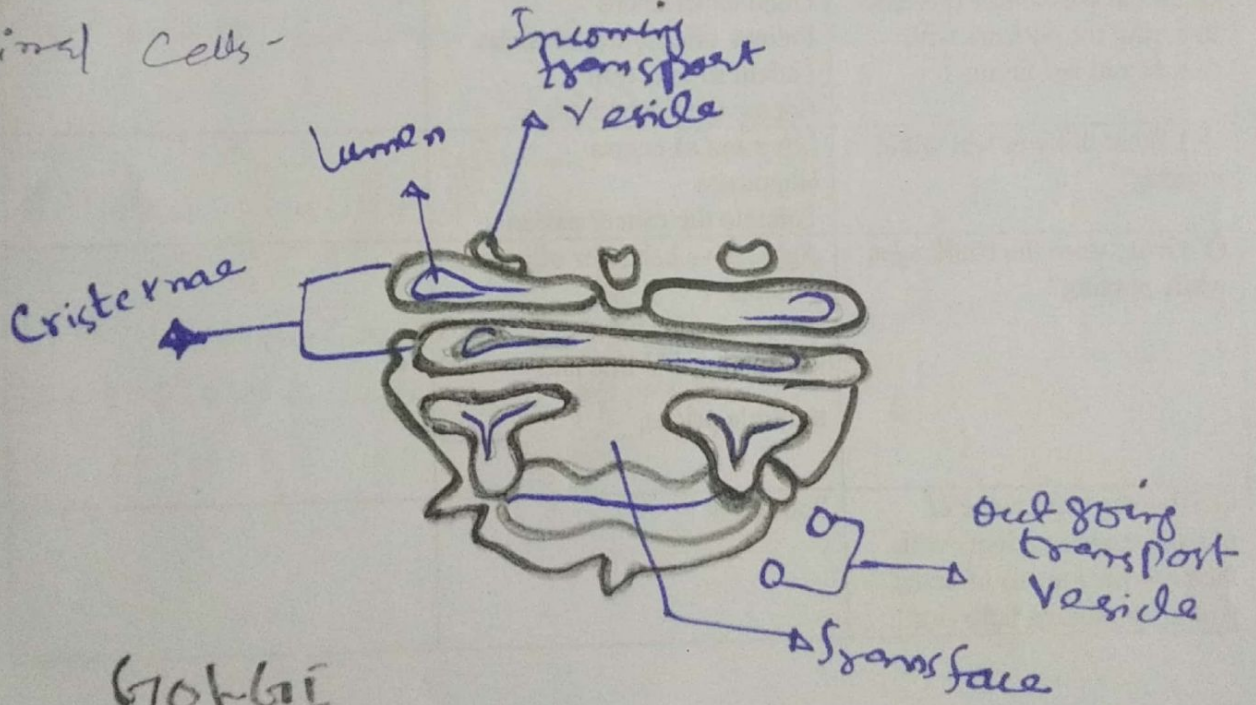
However, The U.S. Food and Drug Administration (FDA) has approved two types of drugs to treat the symptoms of Alzheimer's disease mentioned below; (i) Cholinesterase inhibitors
(ii) NMDA antagonists

The FDA has given accelerated approval for aducanumab (Aduhelm), the first disease modifying therapy for Alzheimer's disease. The medication helps to reduce amyloid deposits in brain resultantly.

Ribosomal RNA and Ribosomal Proteins are the two components that together constitute ribosomes. The primary function of the ribosomes includes protein synthesis in all living cells that ensure the survival of the cell.

(3) Golgi Apparatus:

Golgi Apparatus is also termed as Golgi complex. It is a membrane-bound organelle, which is mainly composed of a series of flattened, stacked pouches called cisternae. This cell organelle is primarily responsible for transporting, modifying, and packaging Proteins and Lipids to targeted destinations. Golgi Apparatus is found within the cytoplasm of a cell and is present in both plants and animal cells.



Golgi APPARATUS.

(c) Carbohydrates are the major source of energy for cells. Describe structure, function and classification.

Structure of carbohydrates:

(i) Carbohydrates consist of carbon, hydrogen and oxygen.

(ii) The general empirical structure for carbohydrates is $(CH_2O)_n$.

(iii) They are organic compounds organized in the form of aldehydes or ketones with multiple hydroxyl groups coming off the carbon chain.

(iv) The building blocks of all carbohydrates are simple sugars called monosaccharides.

(v) A monosaccharide can be a polyhydroxy aldehyde (aldose) or a polyhydroxy ketone (ketose).

The carbohydrates can be structurally represented in any of the three forms:

Open chain structure — It is the long straight-chain form of carbohydrates.

Hemi-acetal structure — Here the 1st carbon of the glucose condenses with the OH group of the 5th carbon to form a ring structure.

Haworth structure — It is the presence of the pyranose ring structure.

Functions of Carbohydrates:

Carbohydrates are widely distributed molecules in plant and animal tissues. In plants and arthropods, carbohydrates form the skeletal structures, they also serve as food reserves in plants and animals. They are important energy sources required for various metabolic activities, the energy is derived by oxidation.

Some of their functions include

(i) Living organisms use carbohydrates as accessible energy to fuel cellular reactions. They are the most abundant dietary source of energy (4kcal/gm) for all living beings.

ii) Carbohydrates along with being the chief energy source, in many animals, are instant sources of energy. Glucose is broken down by glycolysis/Kerb's cycle to yield ATP.

iii) Serve as energy stores, fuels, and metabolic intermediates. It is stored as glycogen in animals and starch in plants.

iv) Stored carbohydrates act as an energy source instead of proteins.

v) They form structural and protective components, like in the cell wall of plants and microorganisms. Structural elements in the cell walls of bacteria (Peptidoglycan or murein), plants (cellulose), and animals (chitin).

vi) Carbohydrates are intermediates in the biosynthesis of fats and proteins.

d) Discuss the importance of Preservatives and antioxidants in food.

Introduction

Preservatives and antioxidants play vital roles in food preservation and safety. Preservatives extend the shelf life of products by inhibiting the growth of bacteria, yeast, and molds, preventing spoilage and maintaining freshness. This is crucial for reducing food waste and ensuring products remain safe to consume for longer periods.

Role of Preservatives in food Protection

Food preservatives are made of natural chemicals such as salt or alcohol. They can also be man made, or synthetic chemicals. Natural or organic chemicals are not certainly healthier than synthetic or man-made chemicals. In reality artificial preservatives have long been used in food preparation because they are effective in small amounts. They include-

(i) Sodium nitrate (ii) Sodium benzoate, and (iii) Propionate.

Nowadays, Preservatives, including food and colour additives, are more precisely monitored than at any other time of history.

Food and Drug Administration (FDA) has main legal responsibility for determining the safe use of Preservatives.

Antioxidants: This helps prevent oxidation and rancidity in foods, maintaining their color, flavor, and nutritional values. They neutralize harmful free radicals, reducing the risk of chronic diseases. In this case these additives contribute to the overall quality and safety of the food supply chain, allowing consumers to enjoy a wide variety of foods while minimizing health risks.

Defi:

"Substances that inhibit the oxidation of other molecules are called antioxidants."

Use of Antioxidants:

Antioxidants are widely used in dietary supplements and these are very important for the prevention of many diseases that include cardiac disorders and cancer.

The other use uses of antioxidants include application in industry for controlling reactions- food preservatives and cosmetics.

Presence of Antioxidants in food:

Sufficient intake of antioxidants is vital, and our life is dependent on the consumption of some antioxidants, like Vitamin C and Vit E. Nonetheless, other non-important antioxidants too are present in our food. Though they happen to be unnecessary for our bodies, yet they do play a huge role in health. We get massive benefits from a die

that is rich in plants due to various antioxidants. For eg; green tea, berries, dark chocolate and coffee are quite popular for being excellent sources of antioxidants. Vitamin C is also used to processed foods for working as preservatives.
A table below, showing examples of some antioxidants to preserve food.

E-Number	Substance	Some food stuffs in which antioxidants are used
E 300	Ascorbic acid	Soft drinks, jams
E 301	Sodium ascorbate	Sausage, Condensed milk
E 302	Calcium ascorbate	
E 304	Ascorbyl Palmitate	Sausage Chicken broth
E 306 - 309	Tocopherols	Vegetable oils

Conclusion:

Hence, Food Processing and Preservation are important to prevent food loss, improve storage stability and retain most nutrients during storage.

Importance of Food Preservatives at Chemical and Physical Levels :-

Chemical Preservatives

(a) Interfere with the cell membranes of microorganisms and their enzyme activity or their genetic mechanisms.

(b) Chemicals that function to preserve the food are generally added after the food has been processed and before it is Packaged.

(c) The Purpose of using a chemical agent as a Preservative is to retard food spoilage caused by microorganism.

(d) Chemical food Preservatives are seem best and most effective for a longer shelf life Examples of Chemical food preservatives includes (i) Benzoates (such as sodium benzoate, benzoic acid)
(ii) Nitrates (iii) Suphites (iv) Sorbates.

Physical Preservatives

Physical food Preservation techniques involve such as Salt Curing, refrigeration, smoking, drying & Chilling, Pasteurization, Pickling. and other many techniques can also be used.