# BIO504 – BIOCHEMISTRY I

## *MID TERM MOST IMPORTANT QUESTIONS*

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**GROUP LINK: https://chat.whatsapp.com/BjC6W0jZx8o9yaC2ISh1Gu**

### 1. What is domain in protein structure?

In protein structure, a domain is a distinct part of a protein that can fold independently into a stable three-dimensional shape. It often carries out a specific function, such as binding to DNA, interacting with other proteins, or catalyzing a chemical reaction. Some proteins are made up of a single domain, while others contain multiple domains that work together to perform complex tasks. Domains are considered modular units, meaning they can appear in different proteins with similar structure and function. This modularity allows for versatility and efficiency in protein design and evolution.

### 2. How amino acids are different from each other?

Amino acids are different from each other based on their side chains, also known as R-groups. Each amino acid has the same basic structure: a central carbon atom (called the alpha carbon) bonded to a hydrogen atom, an amino group ($–NH_2$), a carboxyl group (–COOH), and a unique side chain. It is this side chain that varies among the 20 standard amino acids and gives each one its distinct chemical properties. These side chains can be polar or non-polar, charged or uncharged, acidic or basic, and they influence how an amino acid behaves in water, how it interacts with other molecules, and how it contributes to the folding and function of proteins.

### 3. What are Carbohydrates and its four groups?

Carbohydrates are organic molecules made up of carbon, hydrogen, and oxygen, usually in the ratio of 1:2:1. They are a major source of energy for living organisms and also play structural and storage roles. Carbohydrates are classified into four main groups based on their size and complexity:

***Monosaccharides*** – These are the simplest carbohydrates, also known as simple sugars. Examples include glucose, fructose, and galactose.

***Disaccharides*** – These are formed by the combination of two monosaccharides. Common examples are sucrose (glucose + fructose), lactose (glucose + galactose), and maltose (glucose + glucose).

***Oligosaccharides*** – These consist of 3 to 10 monosaccharide units. They are often found attached to proteins or lipids on cell surfaces and play roles in cell recognition and signaling.

***Polysaccharides*** – These are large, complex carbohydrates made up of many monosaccharide units. Examples include starch (energy storage in plants), glycogen (energy storage in animals), and cellulose (a structural component in plant cell walls).

## 4. Write classification of Lipids?

Lipids are a diverse group of hydrophobic or amphipathic molecules that play essential roles in energy storage, cell structure, and signaling. They are classified into several main groups based on their structure and function:

1. **Simple Lipids**
   these include fats and oils, which are esters of fatty acids with glycerol.
   - **Fats** (solid at room temperature)
   - **Oils** (liquid at room temperature)

2. **Compound Lipids**
   these are lipids that contain other elements in addition to carbon, hydrogen, and oxygen.
   - **Phospholipids** (contain phosphate groups; major component of cell membranes)
   - **Glycolipids** (contain carbohydrate groups; involved in cell recognition)
   - **Lipoproteins** (lipids combined with proteins; help transport lipids in blood)

3. **Derived Lipids**
   these are substances derived from simple and compound lipids by hydrolysis.
   - Examples include fatty acids, glycerol, steroids, and fat-soluble vitamins (A, D, E, K)

4. **Steroids**
   these are lipids with a characteristic four-ring structure.
   - Examples include cholesterol, testosterone, and estrogen

## 5. Explain positive charges.

Positive charges occur when an atom or molecule loses one or more electrons, resulting in a net positive electrical charge. This happens because electrons carry a negative charge, so losing those leaves the object with more protons (positive charges) than electrons. Positively charged particles are called cations. For example, a sodium ion ($Na^+$) has a positive charge because it has lost one electron. Positive charges are important in many biological processes, such as the movement of ions across cell membranes, electrical signaling in nerves, and interactions between molecules.

## 6. Define 2,3 biphosphoglycerate.

2,3-Bisphosphoglycerate (2,3-BPG) is a small organic molecule found in red blood cells that plays a crucial role in regulating oxygen delivery to tissues. It binds to hemoglobin and decreases hemoglobin's affinity for oxygen, making it easier for oxygen to be released from hemoglobin into body tissues. This helps improve oxygen supply, especially under conditions like high altitude or low oxygen levels. Chemically, 2,3-BPG is a phosphorylated sugar intermediate formed during glycolysis.

## 7. Write properties of fructose.

- Fructose is a monosaccharide and a simple sugar.
- It has the chemical formula $C_6H_{12}O_6$.

- It is a ketose sugar, meaning it contains a ketone group.
- Fructose is very sweet, even sweeter than glucose and sucrose.
- It is soluble in water and forms a sweet, crystalline solid.
- Fructose is found naturally in many fruits, honey, and some vegetables.
- It can exist in both linear and cyclic forms, but in solution, the cyclic form predominates.
- It is easily absorbed and metabolized by the body to produce energy.

## 8. What are disaccharides?

Disaccharides are carbohydrates made up of two monosaccharide (simple sugar) molecules linked together by a glycosidic bond. They are formed when two monosaccharides undergo a dehydration reaction, which removes a water molecule. Disaccharides serve as a source of energy and can be broken down into their monosaccharide components during digestion. Common examples of disaccharides include:

- ***Sucrose*** *(table sugar)* — made of glucose + fructose
- ***Lactose*** *(milk sugar)* — made of glucose + galactose
- ***Maltose*** *(malt sugar)* — made of two glucose molecules

## 9. Explain side chain of serine.

The side chain of serine is a $–CH_2–OH$ group, which means it has a hydroxyl group (–OH) attached to a methylene ($–CH_2–$) group. This hydroxyl group makes serine a polar and uncharged amino acid. Because of this polar –OH group, serine can form hydrogen bonds with water and other molecules, making it hydrophilic (water-loving). The side chain's polarity also allows serine to participate in enzyme active sites and be involved in various biochemical reactions, such as phosphorylation.

## 10. Explain steps involved in protein folding.

Protein folding is the process by which a linear chain of amino acids acquires its functional three-dimensional structure. The steps involved in protein folding generally include:

1. ***Primary Structure Formation:*** The protein's amino acid sequence (primary structure) is synthesized by ribosomes.
2. ***Secondary Structure Formation:*** Local folding occurs, forming structures like alpha-helices and beta-sheets stabilized by hydrogen bonds between the backbones atoms.
3. ***Tertiary Structure Formation:*** The overall 3D shape is formed by the folding of secondary structures into a compact structure. This is driven by interactions among the side chains (R-groups), including hydrophobic interactions, hydrogen bonds, ionic bonds, and disulfide bridges.
4. ***Quaternary Structure Formation (if applicable):*** Some proteins consist of multiple polypeptide chains (subunits) that assemble into a functional complex.
5. ***Assisted Folding:*** Molecular chaperones often help proteins fold correctly and prevent misfolding or aggregation.

## 11. How misfolding of proteins occur?

Protein misfolding occurs when a protein fails to fold into its correct three-dimensional shape. This can happen due to several reasons:

- ***Genetic mutations*** that change the amino acid sequence, affecting folding patterns.
- ***Environmental stress*** such as changes in temperature, pH, or the presence of chemicals that disrupt normal folding.
- ***Errors during protein synthesis*** or folding machinery failure, including malfunction of molecular chaperones.
- ***Post-translational modifications*** gone wrong, altering the protein's structure.

## 12. What is role of proton binding in heme groups in tissues and lungs?

The role of proton binding in heme groups is closely related to how hemoglobin picks up and releases oxygen in the lungs and tissues. This process is part of the Bohr Effect, which helps regulate oxygen delivery based on the environment's pH and carbon dioxide levels.

In the lungs, where the pH is higher (less acidic) and $CO_2$ levels are low, hemoglobin binds oxygen strongly. Proton ($H^+$) concentration is low, so fewer protons bind to hemoglobin, allowing it to hold onto oxygen.

In the tissues, where metabolism produces $CO_2$, the environment becomes more acidic (lower pH), increasing proton concentration. Protons bind to specific sites on the hemoglobin (including the heme group's surroundings), causing a change in hemoglobin's shape that reduces its affinity for oxygen. This promotes oxygen release where it is needed.

## 13. What is cooperative binding?

Cooperative binding is a process where the binding of one molecule to a protein affects the binding affinity of additional molecules at other sites on the same protein. In simple terms, when one molecule binds, it makes it easier (or sometimes harder) for others to bind. Cooperative binding allows proteins to respond efficiently to changes in molecule concentration, making processes like oxygen transport more effective.

## 14. What is free energy equation at constant pressure?

The free energy equation at constant pressure is given by the Gibbs free energy formula:

$$\Delta G = \Delta H - T\Delta S$$

Where:

- $\Delta G$ = change in Gibbs free energy
- $\Delta H$ = change in enthalpy (heat content)
- $T$ = absolute temperature (in Kelvin)
- $\Delta S$ = change in entropy (disorder)

## 15. How Gluconic, Glucuronic and Glucaric acid are produced from glucose?

Gluconic acid, glucuronic acid, and glucaric acid are all derived from glucose by oxidation reactions, but at different positions on the glucose molecule:

1. ***Gluconic acid:*** It is produced by the oxidation of the aldehyde group (at carbon 1) of glucose to a carboxylic acid group. This converts the aldehyde (-CHO) into a carboxyl (-COOH) group, forming gluconic acid.
2. ***Glucuronic acid:*** It is formed when the primary alcohol group at carbon 6 (–CH2OH) of glucose is oxidized to a carboxylic acid group, while the aldehyde at carbon 1 remains unchanged. So, carbon 6 is converted from –CH2OH to –COOH, producing glucuronic acid.
3. ***Glucaric acid:*** This acid is produced by the oxidation of both the aldehyde group at carbon 1 and the primary alcohol at carbon 6 of glucose to carboxylic acid groups. Both ends of the glucose molecule become –COOH groups, resulting in glucaric acid (also known as saccharic acid).

## 16. Explain secondary structure of proteins.

The secondary structure of proteins refers to the local folding of the polypeptide chain into regular shapes stabilized mainly by hydrogen bonds between the backbone atoms. It does not involve the side chains (R-groups) but focuses on interactions within the protein's main chain. The two most common types of secondary structures are:

1. **Alpha-helix (α-helix):**
   A right-handed coiled structure where the backbone forms a spiral, and hydrogen bonds form between the carbonyl oxygen of one amino acid and the amide hydrogen of another amino acid four residues earlier. This gives the helix stability and a compact shape.
2. **Beta-sheet (β-sheet):**
   Consists of beta strands connected laterally by hydrogen bonds, forming a sheet-like arrangement. Strands can be parallel or antiparallel depending on their orientation. The hydrogen bonds stabilize the sheet structure.

## 17. Write a short note on lipids.

Lipids are a diverse group of organic molecules that are mostly insoluble in water but soluble in nonpolar solvents. They play important roles in living organisms, including energy storage, cell membrane structure, and signaling. Common types of lipids include fats and oils (used for long-term energy storage), phospholipids (key components of cell membranes), and steroids (such as cholesterol, which is important for membrane fluidity and hormone production). Lipids are made up mainly of carbon, hydrogen, and oxygen atoms, and their hydrophobic nature helps form barriers that separate the inside of cells from the outside environment.

## 18. What are types of neurotransmitters?

Neurotransmitters are chemical messengers that transmit signals across a synapse from one neuron to another. They can be classified into several types based on their chemical structure and function:

- ***Amino acid neurotransmitters:*** Glutamate (excitatory), GABA (gamma-aminobutyric acid, inhibitory), Glycine (inhibitory)
- ***Monoamine neurotransmitters:*** Dopamine, Norepinephrine (noradrenaline), Epinephrine (adrenaline), Serotonin
- ***Peptide neurotransmitters (neuropeptides):*** Substance P, Endorphins, Enkephalins

- ***Purines:*** Adenosine, ATP
- ***Others:*** Acetylcholine, Nitric oxide (a gaseous neurotransmitter)

## 19. List the hydrolysis products of maltose, sucrose and lactose.

Here are the hydrolysis products of the given disaccharides:

- Maltose hydrolyzes into two glucose molecules.
- Sucrose hydrolyzes into glucose and fructose.
- Lactose hydrolyzes into glucose and galactose.

## 20. Discuss the biomedical importance of carbohydrates.

Carbohydrates have significant biomedical importance due to their diverse roles in the body:

1. ***Energy Source:*** Carbohydrates are the primary source of energy for cells. Glucose, a simple carbohydrate, is crucial for cellular respiration and ATP production, fueling various biological processes.
2. ***Structural Role:*** Some carbohydrates, like cellulose in plants and glycosaminoglycans in humans, provide structural support. In humans, carbohydrates form part of connective tissues and the extracellular matrix.
3. ***Cell Recognition and Signaling:*** Carbohydrates attached to proteins and lipids on cell surfaces (glycoproteins and glycolipids) play key roles in cell-cell recognition, immune responses, and signaling pathways.
4. ***Blood Group Determination:*** Specific carbohydrate structures on red blood cell surfaces determine blood groups (A, B, AB, O), which is crucial for safe blood transfusions.
5. ***Disease Markers:*** Abnormal carbohydrate metabolism or glycosylation patterns are linked to diseases like diabetes, cancer, and congenital disorders of glycosylation.
6. ***Medical Applications:*** Carbohydrates are used in drug formulations, vaccines (as antigens), and as biomarkers for diagnosis and monitoring of diseases.

## 21. What is the role of alpha, beta and gamma in the protein structure?

In the context of protein structure, alpha (α), beta (β), and gamma (γ) often refer to different levels or components related to the folding and organization of proteins, but they can mean slightly different things depending on the specific context. Here's a common explanation related to protein structure:

1. ***Alpha (α) — Alpha Helix:*** The alpha helix is a common type of secondary structure in proteins. It is a right-handed coil stabilized by hydrogen bonds between the backbone atoms. The alpha helix gives proteins stability and elasticity.

2. ***Beta (β) — Beta Sheet:*** The beta sheet is another major form of secondary structure. It consists of beta strands linked laterally by hydrogen bonds, forming a sheet-like arrangement. Beta sheets can be parallel or antiparallel and contribute to protein rigidity and strength.

3. ***Gamma (γ) — Less Common Term in Protein Structure:*** The term gamma is less commonly used in general protein structure descriptions. However, sometimes gamma turns or gamma loops refer to specific

tight turns or loops in the protein chain that connect secondary structures. These help in compact folding and influence protein shape.

## 22. What is equilibrium constant in reversible reaction?

The equilibrium constant (K) for a reversible reaction is a numerical value that expresses the ratio of the concentrations of products to reactants when the reaction has reached chemical equilibrium—meaning the forward and reverse reaction rates are equal. For a general reversible reaction:

$$aA+bB \rightleftharpoons cC+dD$$

## 23. Explain primary structure of proteins.

The primary structure of a protein is the linear sequence of amino acids linked together by peptide bonds in a specific order. This sequence is determined by the gene encoding the protein and dictates all higher levels of protein structure. Each amino acid in the chain is connected to the next through a covalent bond between the carboxyl group of one amino acid and the amino group of the next, forming a backbone with side chains (R-groups) that vary for each amino acid.

## 24. Define cooperative binding of oxygen.

Cooperative binding of oxygen refers to the process by which the binding of one oxygen molecule to a protein (such as hemoglobin) increases the affinity of the remaining binding sites for oxygen. In simpler terms, when one oxygen binds, it makes it easier for additional oxygen molecules to bind.

In hemoglobin, which has four oxygen-binding sites, the first oxygen binding causes a change in the protein's shape that enhances the ability of the other sites to bind oxygen. This results in a sigmoidal (S-shaped) oxygen saturation curve, allowing efficient oxygen uptake in the lungs and release in the tissues.

## 25. Explain starch and its structure.

Starch is a polysaccharide that serves as the primary energy storage molecule in plants. It is made up of many glucose units linked together. Starch consists of two main components:

1. **Amylose:**
   - A mostly linear chain of glucose molecules connected by α-1,4 glycosidic bonds**.**
   - It tends to form a helical structure due to the way glucose units are linked.

2. **Amylopectin:**
   - A branched polymer with glucose units connected mainly by α-1,4 glycosidic bonds, but branches occur via α-1,6 glycosidic bonds approximately every 24-30 glucose units.
   - The branching creates a compact, tree-like structure.

## 26. Explain contractile and transport protein.

### Contractile Proteins

Contractile proteins are responsible for movement in cells and tissues. They enable muscles to contract and generate force. The main examples are actin and myosin, which work together in muscle fibers to produce muscle contraction. These proteins also play roles in cell division and intracellular movement.

### Transport Proteins

Transport proteins help move molecules or ions across cell membranes or throughout the body. They can carry substances like oxygen, nutrients, or waste products to where they are needed. Examples include:

- **Hemoglobin**, which transports oxygen in the blood.
- **Membrane transporters**, which move ions or molecules across cell membranes (like glucose transporters).

## 27. What are epimers? Explain with examples.

Epimers are a type of stereoisomer — specifically, they are sugars that differ in the configuration around only one specific carbon atom (except the anomeric carbon). In other words, two sugars are epimers if they have the same molecular formula and differ in the spatial arrangement of the groups attached to just one chiral center.

### Example:

- Glucose and Galactose are epimers differing at carbon 4. Both have the same formula ($C_6H_{12}O_6$) and overall structure, but the –OH group on carbon 4 is oriented differently.
- Glucose and Mannose are epimers differing at carbon 2.

## 28. Define PKA.

PKA stands for Protein Kinase A, which is an important enzyme in cells that regulates many processes by adding phosphate groups to other proteins—a process called phosphorylation. PKA is activated by a molecule called cyclic AMP (cAMP). When cAMP levels rise in the cell, it binds to PKA, causing PKA to become active. Once active, PKA can modify target proteins, changing their activity, location, or interactions, and thereby controlling processes like metabolism, gene expression, and cell signaling. In short, PKA is a key player in how cells respond to signals and regulate their functions.

## 29. Explain titration curve of glycine.

The titration curve of glycine shows how the pH changes when acid or base is added to a solution of glycine. Glycine has two important groups that can lose or gain hydrogen ions: the carboxyl group and the amino group.

1. At very low pH (acidic conditions), glycine mostly exists in a form where both the amino group and carboxyl group are fully protonated (have hydrogen ions attached).
2. As you add base, the first group to lose a hydrogen ion is the carboxyl group. This causes the pH to rise slowly near its specific pH value (called pKa1), creating the first buffering region where the solution resists changes in pH.
3. Around a neutral pH, glycine mainly exists in a form called a zwitterion, where the molecule has both positive and negative charges but overall is neutral.

4. When you add more base, the amino group starts losing its hydrogen ion. This happens near a second specific pH value (pKa2), creating a second buffering region.
5. At very high pH (basic conditions), glycine mostly exists in a fully deprotonated form, meaning both groups have lost their hydrogen ions.

## 30. What are homo and hetero polysaccharides?

Homopolysaccharides are polysaccharides made up of only one type of monosaccharide (simple sugar) repeated many times. For example, starch and cellulose are made entirely of glucose units.

Heteropolysaccharides, on the other hand, are composed of two or more different types of monosaccharides. An example is hyaluronic acid, which contains repeating units of different sugars.

## 31. Write properties of glutamate and aspartine?

- ***Both are acidic amino acids:*** They have carboxyl groups in their side chains, which can release hydrogen ions, making them negatively charged at physiological pH.
- ***Polar and charged side chains:*** Their side chains are hydrophilic (water-loving) due to the extra carboxyl group, which helps them interact with water and other charged molecules.
- ***Involved in protein structure and function:*** Because of their negative charge, glutamate and aspartate often participate in forming salt bridges and hydrogen bonds that stabilize protein structures.
- ***Role in metabolism and signaling:*** Glutamate acts as a key neurotransmitter in the brain, involved in excitatory signaling. Aspartate is important in the urea cycle and helps in synthesizing other amino acids and nucleotides.
- ***pKa values:*** The side chains of glutamate and aspartate have pKa values around 4, meaning they lose their proton and carry a negative charge at physiological pH (~7.4).

## 32. Write properties of furfural compounds.

1. ***Chemical nature:*** Furfural is an organic compound derived from agricultural byproducts like corn cobs, oat hulls, and sawdust. It has a five-membered ring with an aldehyde group.
2. ***Physical properties:*** Furfural is a colorless to yellow liquid with a characteristic almond-like odor. It is soluble in water and many organic solvents.
3. ***Reactivity:*** The aldehyde group in furfural makes it reactive, allowing it to undergo addition and condensation reactions. It can be easily oxidized or reduced.
4. ***Industrial importance:*** Furfural is used as a precursor in the production of resins, solvents, and synthetic fuels. It also serves as a starting material for making other chemicals like furfuryl alcohol.
5. ***Biodegradability:*** Furfural is biodegradable and can be broken down by microorganisms, making it relatively environmentally friendly compared to some synthetic chemicals.
6. ***Toxicity:*** While useful industrially, furfural can be toxic if inhaled or ingested in large amounts, so handling requires proper safety measures.

## 33. Write classification of isomers.

1. **Structural (or Constitutional) Isomers:**
   These isomers have the same molecular formula but different connectivity of atoms. Examples include:
   - ***Chain isomers:*** Different arrangements of the carbon chain
   - ***Position isomers:*** Different positions of a functional group on the same carbon chain
   - ***Functional group isomers:*** Different functional groups altogether

2. **Stereoisomers:**
   These have the same molecular formula and connectivity but differ in the spatial arrangement of atoms. Types include:
   - ***Geometric (cis-trans) isomers:*** Different arrangement around a double bond or ring structure
   - ***Optical isomers (enantiomers):*** Non-superimposable mirror images due to chiral centers
   - ***Diastereomers:*** Stereoisomers that are not mirror images

## 34. Define auxiliary proteins.

Auxiliary proteins are helper proteins that assist other proteins in performing their functions. They do not carry out the main activity themselves but support processes such as protein folding, assembly, transport, or regulation. For example, chaperone proteins are a type of auxiliary protein that help other proteins fold correctly and prevent them from aggregating. In muscle contraction, auxiliary proteins like tropomyosin regulate the interaction between actin and myosin.

## 35. What is allosteric effect of hemoglobin?

The allosteric effect of hemoglobin refers to the way the binding of oxygen or other molecules at one site on the hemoglobin protein influences the binding properties at other sites. Hemoglobin has four oxygen-binding sites, and it exhibits cooperative binding — meaning when one oxygen molecule binds, it changes the shape of hemoglobin, making it easier for the next oxygen molecules to bind.

Similarly, molecules like carbon dioxide, hydrogen ions (protons), and 2,3-bisphosphoglycerate (2,3-BPG) can bind to hemoglobin at different sites (not the oxygen-binding sites) and alter hemoglobin's affinity for oxygen. This is an example of allosteric regulation, where binding at one site affects function at another.

## 36. Differentiate between tyrosine, soloneystin and tryptophan.

**Tyrosine** is a non-essential amino acid that contains an aromatic ring with a hydroxyl group, making it polar. It is important in the body because it serves as a precursor for several vital molecules, including neurotransmitters like dopamine and hormones such as thyroid hormones. Tyrosine also plays a role in protein structure and can be modified through phosphorylation, which helps regulate protein activity.

**Selenocysteine** is a rare amino acid often called the 21st amino acid. Its side chain is unique because it contains a selenium atom instead of sulfur, which gives it special chemical properties. Selenocysteine is incorporated into certain enzymes known as selenoproteins, where it helps carry out redox reactions essential for antioxidant defense and other cellular functions.

**Tryptophan** is an essential amino acid characterized by a large aromatic indole ring. Although it is less polar than tyrosine, the nitrogen atom in the indole ring gives it some polarity. Tryptophan is important as a precursor for molecules like serotonin and melatonin, which regulate mood, sleep, and other physiological processes. Its bulky side chain also influences protein folding and interactions.

## 37. What happens when oxygen binds with heme group at sea level and high altitude?

When oxygen binds to the heme group at sea level, the oxygen concentration and pressure are relatively high. This means hemoglobin binds oxygen more easily and becomes highly saturated. The heme groups in hemoglobin pick up oxygen efficiently in the lungs, allowing maximum oxygen transport to tissues.

At high altitude, the oxygen pressure is much lower, so less oxygen is available to bind with the heme groups. To adapt, the body produces more 2,3-bisphosphoglycerate (2,3-BPG), a molecule that binds to hemoglobin and reduces its affinity for oxygen. This change helps hemoglobin release oxygen more readily to the tissues even when oxygen levels in the environment are low, improving oxygen delivery under these conditions.

## 38. Define Chaperon and its role.

Chaperones are special proteins that help other proteins fold correctly inside the cell. When proteins are made, they start as simple chains of amino acids and need to fold into specific three-dimensional shapes to function properly. Sometimes, proteins can fold incorrectly or get stuck in the wrong shape, which can cause problems for the cell.

Chaperones assist by preventing misfolding and helping proteins reach their proper structure. They can also help refold proteins that have become unfolded due to stress or help transport proteins to the right location inside the cell. In short, chaperones act like helpers or guides to ensure proteins fold correctly and maintain their proper function.

## 39. What is dissociation of carboxylic group of alanine?

The dissociation of the carboxylic group of alanine refers to the process where the carboxyl group (–COOH) in alanine loses a hydrogen ion (proton) and becomes negatively charged ($–COO^-$). This happens when alanine is in a solution with a pH above the carboxyl group's pKa, which is around 2.3. At this pH or higher, the carboxyl group releases its proton, resulting in the alanine molecule carrying a negative charge on that group. This dissociation is important because it affects the overall charge of alanine and influences how it behaves in biological systems, including its solubility and interaction with other molecules.

## 40. Define cis isomerism.

Cis isomerism is a type of geometrical isomerism where two similar or identical groups are located on the same side of a double bond or a ring structure in a molecule. This occurs because double bonds and ring structures restrict the rotation of atoms, leading to fixed spatial arrangements.

In a cis isomer, the functional groups or atoms of interest are positioned on the same side, resulting in different physical and chemical properties compared to the trans isomer, where the groups are on opposite sides.

**Example:**

In cis-butene, both hydrogen atoms are on the same side of the carbon–carbon double bond, while in trans-butene, they are on opposite sides.

## 41. What is glycine?

Glycine is the simplest and smallest amino acid found in proteins. It has a single hydrogen atom as its side chain, which makes it unique among amino acids. Its basic structure includes an amino group, a carboxyl group, and a hydrogen atom, all attached to a central carbon atom.

Because of its small size, glycine is non-polar and non-essential, meaning the human body can produce it on its own. It plays important roles in the structure and flexibility of proteins, especially in tight or compact areas like collagen. Glycine also acts as a neurotransmitter in the central nervous system, where it helps regulate nerve signals.

## 42. How abnormal amino acid sequence effects the protein function?

An abnormal amino acid sequence can significantly affect a protein's function because the sequence determines how a protein folds, and folding determines its shape and activity. Proteins rely on their specific three-dimensional structure to bind to other molecules and carry out their roles. If even one amino acid is changed, added, or missing, it can lead to:

1. ***Improper folding*** – the protein may not fold into its correct shape, making it nonfunctional or unstable.
2. ***Loss of function*** – the protein might not bind to its target or perform its biological role.
3. ***Gain of harmful function*** – the altered protein might interact inappropriately with other molecules, causing damage.
4. ***Diseases*** – many genetic disorders are caused by abnormal amino acid sequences, such as sickle cell anemia, where a single amino acid change in hemoglobin causes serious health problems.

## 43. Explain geometric isomerism.

Geometric isomerism is a type of stereoisomerism where molecules have the **sa**me molecular formula and the same sequence of bonded atoms, but differ in the spatial arrangement of groups around a rigid structure, such as a double bond or a ring. This rigidity prevents the free rotation of atoms, leading to distinct forms. Geometric isomerism affects the physical and chemical properties of compounds, such as boiling points, solubility, and reactivity. It is especially important in organic molecules and biological systems, where shape influences function. The two main types of geometric isomers are:

1. ***Cis isomers –*** where similar or identical groups are on the same side of the double bond or ring.
2. ***Trans isomers –*** where the groups are on opposite sides.

## 44. Enlist the non polar aliphatic amino acids.

Here is a list of non-polar aliphatic amino acids:

1. **Glycine, Alanine, Valine, Leucine, Isoleucine, Proline**

## 45. Write importance of sorbitol.

Sorbitol is a sugar alcohol that has several important uses and roles in both health and industry:

1. ***Low-calorie sweetener:*** Sorbitol is used as a sugar substitute in sugar-free gums, candies, and diabetic-friendly foods. It provides sweetness with fewer calories than regular sugar.
2. ***Diabetic use:*** Since sorbitol is slowly absorbed and metabolized, it causes a smaller rise in blood sugar, making it useful for people with diabetes.
3. ***Humectant:*** Sorbitol retains moisture, so it is commonly used in cosmetics, toothpaste, and skin care products to keep them from drying out.
4. ***Pharmaceutical applications:*** It is used in the formulation of syrups, chewable tablets, and as a stabilizer in vitamins and medicines.
5. ***Laxative effect:*** In larger amounts, sorbitol draws water into the intestine and can act as a mild laxative.

## 46. What is renaturation and its process?

Renaturation is the process by which a denatured protein regains its native (original) structure and function after the removal of the denaturing agent. When proteins are exposed to heat, chemicals, or extreme pH, they can lose their natural shape — a process called denaturation. If the conditions return to normal, some proteins can refold correctly; this reversal is called renaturation.

### Process of Renaturation:

1. ***Removal of Denaturing Agent:*** The first step is to eliminate the factor that caused denaturation (e.g., reducing temperature, removing urea or detergents, or neutralizing pH).
2. ***Protein Refolding:*** Once the stress is removed, the amino acid chain begins to refold into its correct three-dimensional shape, driven by interactions like hydrogen bonds, hydrophobic interactions, and ionic bonds.
3. ***Assistance by Chaperones (optional):*** In cells, chaperone proteins may help guide the folding process to prevent incorrect folding or aggregation.

## 47. Name aromatic amino acids with examples.

Aromatic amino acids are amino acids that contain an aromatic ring in their side chain. These rings are stable and allow the amino acids to absorb ultraviolet (UV) light. The main aromatic amino acids are:

1. ***Phenylalanine*** – has a benzene ring as part of its side chain.
2. ***Tyrosine*** – similar to phenylalanine but with a hydroxyl group (–OH) on the aromatic ring.
3. ***Tryptophan*** – contains a larger, more complex indole ring, which includes nitrogen.

## 48. Write a short note on tautomerization.

Tautomerization is a chemical process in which a molecule shifts between two structural forms, called tautomers that differ mainly in the position of a hydrogen atom and a double bond. This is a type of isomerism known as tautomerism.

One common example is the shift between keto and enol forms in organic compounds. In the keto form, the molecule has a carbonyl group (C=O), while in the enol form, the hydrogen moves to the oxygen, and a double bond appears between two carbon atoms (C=C–OH).

***Disclaimer:***

*For best results, it is advised NOT to rely on this file only. Go through video lectures, handouts and other sources as well.*

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