**Course Title: Basic Biochemistry**

**MLT**

**Summer Semester**

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 **Max Marks: 30**

**Note: There are FIVE questions, each carry 6 marks with grand total of 30 marks**

**ATTEMPT all questions**

**Avoid copy paste material, as it may deduct your marks**

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**Q1: Define Metabolism and also explain the types of metabolism**

**Ans**. Metabolism is a term that is used to describe all chemical reactions involved in maintaining the living state of the cells and the organism. Metabolism can be conveniently divided into two categories:

* Catabolism - the breakdown of molecules to obtain energy
* Anabolism - the synthesis of all compounds needed by the cells

Metabolism is closely linked to nutrition and the availability of nutrients. Bioenergetics is a term which describes the biochemical or metabolic pathways by which the cell ultimately obtains energy. Energy formation is one of the vital components of metabolism.

## Nutrition, metabolism and energy

Nutrition is the key to metabolism. The pathways of metabolism rely upon nutrients that they breakdown in order to produce energy. This energy in turn is required by the body to synthesize new proteins, nucleic acids (DNA, RNA) etc.

Nutrients in relation to metabolism encompass bodily requirement for various substances, individual functions in body, amount needed, level below which poor health results etc.

Essential nutrients supply energy (calories) and supply the necessary chemicals which the body itself cannot synthesize. Food provides a variety of substances that are essential for the building, upkeep, and repair of body tissues, and for the efficient functioning of the body.

The diet needs essential nutrients like carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, and around 20 other inorganic elements. The major elements are supplied in carbohydrates, lipids, and protein. In addition, vitamins, minerals and water are necessary.

## Carbohydrates in metabolism

Foods supply carbohydrates in three forms: starch, sugar, and cellulose (fiber). Starches and sugars form major and essential sources of energy for humans. Fibers contribute to bulk in diet.

Body tissues depend on glucose for all activities. Carbohydrates and sugars yield glucose by digestion or metabolism.

## Proteins in metabolism

Proteins are the main tissue builders in the body. They are part of every cell in the body. Proteins help in cell structure, functions, haemoglobin formation to carry oxygen, enzymes to carry out vital reactions and a myriad of other functions in the body. Proteins are also vital in supplying nitrogen for DNA and RNA genetic material and energy production.

Proteins are necessary for nutrition because they contain amino acids. Among the 20 or more amino acids, the human body is unable to synthesize 8 and these are called essential amino acids.

The essential amino acids include:

* lysine
* tryptophan
* methionine
* leucine
* isoleucine
* phenylalanine
* valine
* threonine

Foods with the best quality protein are eggs, milk, soybeans, meats, vegetables, and grains.

## Fat in metabolism

Fats are concentrated sources of energy. They produce twice as much energy as either carbohydrates or protein on a weight basis.

The functions of fats include:

* helping to form the cellular structure;
* forming a protective cushion and insulation around vital organs;
* helping absorb fat soluble vitamins,
* providing a reserve storage for energy

Essential fatty acids include unsaturated fatty acids like linoleic, linolinic, and arachidonic acids. These need to be taken in diet. Saturated fats, along with cholesterol, have been implicated in arteriosclerosis and heart disease.

## Minerals and vitamins in metabolism

The minerals in foods do not contribute directly to energy needs but are important as body regulators and play a role in metabolic pathways of the body. More than 50 elements are found in the human body. About 25 elements have been found to be essential, since a deficiency produces specific deficiency symptoms.

Important minerals include:

* calcium
* phosphorus
* iron
* sodium
* potassium
* chloride ions
* copper
* cobalt
* manganese
* zinc
* magnesium
* fluorine
* iodine

Vitamins are essential organic compounds that the human body cannot synthesize by itself and must therefore, be present in the diet. Vitamins particularly important in metabolism include:

* Vitamin A
* B2 (riboflavin)
* Niacin or nicotinic acid
* Pantothenic Acid etc.

## Metabolic pathways

The chemical reactions of metabolism are organized into metabolic pathways. These allow the basic chemicals from nutrition to be transformed through a series of steps into another chemical, by a sequence of enzymes.

Enzymes are crucial to metabolism because they allow organisms to drive desirable reactions that require energy. These reactions also are coupled with those that release energy. As enzymes act as catalysts they allow these reactions to proceed quickly and efficiently. Enzymes also allow the regulation of metabolic pathways in response to changes in the cell's environment or signals from other cells.

**Q 2: What are the macromolecules found in Plasmalema?**

**Ans.** The plasma membrane (sometimes called the cell membrane or plasmalemma) forms the thin molecular surface of every cell.

It is made up of lipids, proteins and some carbohydrates in a flexible, dynamic and everchanging array. The plasma membrane acts as a selective barrier between the inside and the outside of the cell and controls the exchange of materials between cytoplasm and the surrounding liquid. It is almost impermeable to certain ions and molecules, and the cell uses specialized transport mechanisms to move molecules from one side to another. Phospholipids are the major structural components of most membranes. These molecules form a bi-layer (a double-layer of material) on the surface of the cell with their long, hydrophobic hydrocarbon chains pointing inward to the center of the bi-layer and their hydrophilic phosphate groups facing outwards.

Within this bi-layer of lipid float various kinds of proteins, rather like ships in a lipid sea. Some proteins remain on the surface and are called extrinsic proteins, whereas intrinsic proteins are partially submerged or extend right through the phospholipid bi-layer.

Protein and lipid constituents of membranes are not fixed in any one location, but can move and locate themselves at different points on the cell surface as required. Some, having carbohydrate or polysaccharide molecules attached to them, are complex glycoprotein and glycolipid macromolecules that play roles in recognition between cells and act as receptors for molecules such as hormones.

The physical state of membranes is dynamic, and rarely static. For example, when a cell adds extra cholesterol to a membrane, this changes the fluidity and converts the membrane from a liquid-like state to a more viscous gel-like state. Components may be added or taken away as the cell changes, grows or becomes a specialist, and the modern picture of the cell membrane is a dynamic one of constant change, movement, modification and adaptation.

**Q3: Briefly explain the formation of Urea.**

Ans.Amino acid catobolism  results in waste ammonia. All animals need a way to excrete this product. Most aquatic organisms, or ammonotelic organisms, excrete ammonia without converting it.[[1]](https://en.m.wikipedia.org/wiki/Urea_cycle#cite_note-:0-1) Organisms that cannot easily and safely remove nitrogen as ammonia convert it to a less toxic substance such as [urea](https://en.m.wikipedia.org/wiki/Urea) via the urea cycle, which occurs mainly in the liver. Urea produced by the liver is then released into the bloodstream where it travels to the kidneys and is ultimately excreted in urine. The urea cycle is essential to these organisms, because if the nitrogen or ammonia are not eliminated from the organism it can be very detrimental.[[2]](https://en.m.wikipedia.org/wiki/Urea_cycle#cite_note-:122-2) In species including birds and most insects, the ammonia is converted into uric acid or its urate salt, which is excreted in solid form.

 **Formation.** Urea was first produced industrially by the hydration of calcium cyanamide but the easy availability of ammonia led to the development of ammonia/carbon dioxide technology. This is a two step process where the ammonia and carbon dioxide react to form ammonium carbamate which is then dehydrated to urea.

**Reaction:**

 The entire process converts two amino groups, one from NH+ and one from [Aspartate](https://en.m.wikipedia.org/wiki/Aspartic_acid) and a carbonatomfrom HCO− to the relatively nontoxic excretion product [urea](https://en.m.wikipedia.org/wiki/Urea) at the cost of four "high-energy" phosphate bonds (3 ATP hydrolyzed to 2 ADP and one AMP). The conversion from ammonia to urea happens in five main steps. The first is needed for ammonia to enter the cycle and the following four are all a part of the cycle itself. To enter the cycle, ammonia is converted to carbamoyl phosphate. The urea cycle consists of four enzymatic reactions: one [mitochondrial](https://en.m.wikipedia.org/wiki/Mitochondria) and three [cytosolic](https://en.m.wikipedia.org/wiki/Cytosol)

###   **First reaction: entering the urea cycle**

Before the urea cycle begins ammonia is converted to carbamoyl phosphate. The reaction is catalyzed by [carbamoyl phosphate synthetase I](https://en.m.wikipedia.org/wiki/Carbamoyl_phosphate_synthetase_I) and requires the use of two [ATP](https://en.m.wikipedia.org/wiki/Adenosine_triphosphate) molecules. The carbamoyl phosphate then enters the urea cycle.

### Steps of the urea cycle

1. Carbamoyl phosphate is converted to [citrulline](https://en.m.wikipedia.org/wiki/Citrulline%22%20%5Co%20%22Citrulline). With catalysis by [ornithine transcarbamoylase](https://en.m.wikipedia.org/wiki/Ornithine_transcarbamylase), the carbamoyl phosphate group is donated to ornithine and releases a phosphate group.[[1]](https://en.m.wikipedia.org/wiki/Urea_cycle#cite_note-:0-1)
2. A [condensation reaction](https://en.m.wikipedia.org/wiki/Condensation_reaction) occurs between the amino group of aspartate and the carbonyl group of citrulline to form [argininosuccinate](https://en.m.wikipedia.org/wiki/Argininosuccinic_acid%22%20%5Co%20%22Argininosuccinic%20acid). This reaction is ATP dependent and is catalyzed by [argininosuccinate synthetase](https://en.m.wikipedia.org/wiki/Argininosuccinate_synthase%22%20%5Co%20%22Argininosuccinate%20synthase).[[1]](https://en.m.wikipedia.org/wiki/Urea_cycle#cite_note-:0-1)
3. Argininosuccinate undergoes cleavage by [argininosuccinase](https://en.m.wikipedia.org/wiki/Argininosuccinate_lyase%22%20%5Co%20%22Argininosuccinate%20lyase) to form [arginine](https://en.m.wikipedia.org/wiki/Arginine) and [fumarate](https://en.m.wikipedia.org/wiki/Fumarate).[[1]](https://en.m.wikipedia.org/wiki/Urea_cycle#cite_note-:0-1)
4. Arginine is cleaved by [arginase](https://en.m.wikipedia.org/wiki/Arginase) to form urea and ornithine. The ornithine is then transported back to the mitochondria to begin the urea cycle again.

**Q4. Discuss the function of saccharides.**

**Ans.** A carbohydrate  is a [biomolecule](https://en.m.wikipedia.org/wiki/Biomolecule) consisting of [carbon](https://en.m.wikipedia.org/wiki/Carbon) (C), [hydrogen](https://en.m.wikipedia.org/wiki/Hydrogen) (H) and [oxygen](https://en.m.wikipedia.org/wiki/Oxygen) (O) atoms, usually with a hydrogen–oxygen [atom](https://en.m.wikipedia.org/wiki/Atom) ratio of 2:1 (as in water) and thus with the [empirical formula](https://en.m.wikipedia.org/wiki/Empirical_formula) C*m*(H2O)*n* (where *m* may be different from *n*). This [formula](https://en.m.wikipedia.org/wiki/Chemical_formula) holds true for [monosaccharides](https://en.m.wikipedia.org/wiki/Monosaccharide). Some exceptions exist; for example, [deoxyribose](https://en.m.wikipedia.org/wiki/Deoxyribose), a sugar component of [DNA](https://en.m.wikipedia.org/wiki/DNA), has the empirical formula C5H10O4. The carbohydrates are technically [hydrates](https://en.m.wikipedia.org/wiki/Hydrate) of carbon; structurally it is more accurate to view them as [aldoses](https://en.m.wikipedia.org/wiki/Aldose) and [ketoses](https://en.m.wikipedia.org/wiki/Ketose).

The term is most common in [biochemistry](https://en.m.wikipedia.org/wiki/Biochemistry), where it is a synonym of saccharide, a group that includes [sugars](https://en.m.wikipedia.org/wiki/Sugar), [starch](https://en.m.wikipedia.org/wiki/Starch), and [cellulose](https://en.m.wikipedia.org/wiki/Cellulose). The saccharides are divided into four chemical groups: monosaccharides, [disaccharides](https://en.m.wikipedia.org/wiki/Disaccharide), [oligosaccharides](https://en.m.wikipedia.org/wiki/Oligosaccharide), and [polysaccharides](https://en.m.wikipedia.org/wiki/Polysaccharide). Monosaccharides and disaccharides, the smallest (lower [molecular weight](https://en.m.wikipedia.org/wiki/Molecular_weight)) carbohydrates, are commonly referred to as sugars. The word *saccharide* comes from the [Greek](https://en.m.wikipedia.org/wiki/Greek_language) word *σάκχαρον* (*sákkharon*), meaning "sugar".[[4]](https://en.m.wikipedia.org/wiki/Carbohydrate#cite_note-avenas-4) While the scientific nomenclature of carbohydrates is complex, the names of the monosaccharides and disaccharides very often end in the suffix [-ose](https://en.m.wikipedia.org/wiki/-ose), as in the monosaccharides [fructose](https://en.m.wikipedia.org/wiki/Fructose) (fruit sugar) and [glucose](https://en.m.wikipedia.org/wiki/Glucose) (starch sugar) and the disaccharides [sucrose](https://en.m.wikipedia.org/wiki/Sucrose) ([cane](https://en.m.wikipedia.org/wiki/Sugar_cane) or [beet](https://en.m.wikipedia.org/wiki/Sugar_beet) sugar) and [lactose](https://en.m.wikipedia.org/wiki/Lactose) (milk sugar).

Carbohydrates perform numerous roles in living organisms. Polysaccharides serve for the storage of [energy](https://en.m.wikipedia.org/wiki/Energy) (e.g. [starch](https://en.m.wikipedia.org/wiki/Starch) and [glycogen](https://en.m.wikipedia.org/wiki/Glycogen)) and as structural components (e.g. [cellulose](https://en.m.wikipedia.org/wiki/Cellulose) in plants and [chitin](https://en.m.wikipedia.org/wiki/Chitin) in arthropods). The 5-carbon monosaccharide [ribose](https://en.m.wikipedia.org/wiki/Ribose) is an important component of [coenzymes](https://en.m.wikipedia.org/wiki/Coenzyme) (e.g. [ATP](https://en.m.wikipedia.org/wiki/Adenosine_triphosphate), [FAD](https://en.m.wikipedia.org/wiki/Flavin_adenine_dinucleotide) and [NAD](https://en.m.wikipedia.org/wiki/Nicotinamide_adenine_dinucleotide)) and the backbone of the genetic molecule known as [RNA](https://en.m.wikipedia.org/wiki/RNA). The related [deoxyribose](https://en.m.wikipedia.org/wiki/Deoxyribose) is a component of DNA. Saccharides and their derivatives include many other important [biomolecules](https://en.m.wikipedia.org/wiki/Biomolecules) that play key roles in the [immune system](https://en.m.wikipedia.org/wiki/Immune_system), [fertilization](https://en.m.wikipedia.org/wiki/Fertilization), preventing [pathogenesis](https://en.m.wikipedia.org/wiki/Pathogenesis), [blood clotting](https://en.m.wikipedia.org/wiki/Blood_clotting), and [development](https://en.m.wikipedia.org/wiki/Developmental_biology).

Carbohydrates are central to [nutrition](https://en.m.wikipedia.org/wiki/Nutrition) and are found in a wide variety of natural and processed foods. Starch is a polysaccharide. It is abundant in cereals (wheat, maize, rice), potatoes, and processed food based on cereal [flour](https://en.m.wikipedia.org/wiki/Flour), such as bread, pizza or pasta. Sugars appear in human diet mainly as table sugar (sucrose, extracted from [sugarcane](https://en.m.wikipedia.org/wiki/Sugarcane) or [sugar beets](https://en.m.wikipedia.org/wiki/Sugar_beet)), lactose (abundant in milk), glucose and fructose, both of which occur naturally in [honey](https://en.m.wikipedia.org/wiki/Honey), many fruits, and some vegetables. Table sugar, milk, or honey are often added to drinks and many prepared foods such as jam, biscuits and cakes.

Cellulose, a polysaccharide found in the cell walls of all plants, is one of the main components of insoluble [dietary fiber](https://en.m.wikipedia.org/wiki/Dietary_fiber). Although it is not digestible, insoluble dietary fiber helps to maintain a healthy digestive system[[6]](https://en.m.wikipedia.org/wiki/Carbohydrate#cite_note-6) by easing [defecation](https://en.m.wikipedia.org/wiki/Defecation). Other polysaccharides contained in dietary fiber include [resistant starch](https://en.m.wikipedia.org/wiki/Resistant_starch) and [inulin](https://en.m.wikipedia.org/wiki/Inulin), which feed some bacteria in the [microbiota](https://en.m.wikipedia.org/wiki/Microbiota) of the [large intestine](https://en.m.wikipedia.org/wiki/Large_intestine), and are [metabolized](https://en.m.wikipedia.org/wiki/Metabolism) by these bacteria to yield [short-chain fatty acids](https://en.m.wikipedia.org/wiki/Short-chain_fatty_acids).

**Q5: Enlist the Acidic, Aliphatic and Basic amino acids**.

**Ans. Acidic:** Having the properties of an acid, or containing acid; having a pH below cocktail of acidic pollutants' Often contrasted with alkaline and basic. More example sentences. 'When this compound is dissolved in water, an acidic solution of hydrogen cyanide, also known as prussic acid, is produced.

**Example.** Acids are corrosive to metals while releasing Hydrogen gas, have a pH between 0 and 6.9 and are sour to the taste. There are many common substances that are acids: lemon juice (citric acid), (acetic acid), stomach acid, and soda pop (carbonic acid)

.**Types.** Usually acids can be divided into three major types. First one is binary acid, second one is oxyacid, and the last one is carboxylic acid. Binary acids are all written in “H-A” form, which means bond to a nonmetal atom.

**Aliphatic acid.** These include aliphatic acids such as acetic, citric, isocitric, fumaric, tartaric, oxalic, formic, lactic, malic, malonic, butyric, succinic, trans-aconitic, propionic, adipic and glycolic acids, and cyclic and aromatic acids such as benzoic, phenylacetic, shikimic, phthalic, ferulic, syringic, p-coumaric, vanillic,

 In organic chemistry, hydrocarbons (compounds composed solely of carbon and hydrogen) are divided into two classes: aromatic compounds and aliphatic compounds Open-chain compounds (whether straight or branched) contain no rings of any type, and are thus aliphatic.

**Amino acid.** Amino acids are organic compounds that combine to form [proteins](https://medlineplus.gov/ency/article/002467.htm). Amino acids and proteins are the building blocks of life.

When proteins are digested or broken down, amino acids are left. The human body uses amino acids to make proteins to help the body:

* Break down food
* Grow
* Repair body tissue
* Perform many other body functions

Amino acids can also be used as a source of energy by the body.

Amino acids are classified into three groups:

* Essential amino acids
* Nonessential amino acids
* Conditional amino acids

ESSENTIAL AMINO ACIDS

* Essential amino acids cannot be made by the body. As a result, they must come from food.
* The 9 essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, [tryptophan](https://medlineplus.gov/ency/article/002332.htm), and valine.

NONESSENTIAL AMINO ACIDS

Nonessential means that our bodies produce an amino acid, even if we do not get it from the food we eat. Nonessential amino acids include: alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine.

CONDITIONAL AMINO ACIDS

* Conditional amino acids are usually not essential, except in times of illness and stress.
* Conditional amino acids include: arginine, cysteine, glutamine, tyrosine, glycine, ornithine, proline, and serine.

You do not need to eat essential and nonessential amino acids at every meal, but getting a balance of them over the whole day is important. A diet based on a single plant item will not be adequate, but we no longer worry about pairing proteins (such as beans with rice) at a single meal. Instead we look at the adequacy of the diet overall throughout the day

 **The end.**