Medical Biochemistry Exam 1

Section A (Multiple Choice Questions – each 1 mark)

1. Which one of the following is stored in the liver?
A. Vitamin A
B. Vitamin D
C. Amino acid
D. A and B

2. Which one of the following is not a component of a nucleoside?
A. Ribose
B. Guanine
C. Deoxyribose
D. Fucose

3. Which one of the following best explains the difference between ribose and deoxyribose?
A. Ribose has –OH groups at carbon atom number 1,2&3
B. Deoxyribose does not contain oxygen at the second carbon atom
C.Ribose is found in RNA while deoxyribose is found in DNA
D.Ribose has a single ring while Deoxyribose has two rings.

4.Which one of the following is a purine?
A. Cytosine
B. Guanine
C. Thymine
D. Uracil

5.The following are true about glucose except?
A. It is the chief physiological sugar present in normal blood
B. It occurs as a constituent of disaccharides and polysaccharides
C. It is stored as glycogen in the muscles
D. It is stored as such in the liver cells

6.Starch is a polymer of?
A. Glucose
B. Glucose and fructose
C. Mannose and fucose
D. Triose and ribose

7.The following are true about vitamins except?
A. They do not enter tissue structures
B. They may serve as coenzymes
C. They are mostly provided in the diet
D. They provide energy

8.The following are involved in the normal regulation of blood calcium level except?
A. Vitamin
B. Adrenaline
C. Parathyroid hormone
D. Calcitonin

9.The following are true about marasmus except?
A. It is a deficiency of total calories
B. It usually presents before the end of one year
C. It is frequently attributed to early, abrupt weaning and inadequate diet.
D. It is characterized by low plasma albumin level.

10.The following are pituitary hormones except?
A. TSH
B. ADH
C. Prolactin
D. Epinephrine

11.The following are true about the enzyme tyalin except?
A. It is an ? – amylase
B. It hydrolyses ? – 1 – 4 glycosidic linkages
C. It is active at pH 6.6 – 6.8
D. It digests carbohydrates in the stomach

12.The following are monosaccharides except?
A. Trioses
B. Ribose
C. Deoxyribose
D. Maltose

13.Essential fatty acids serve the following functions except?
A. They form structural elements of gonads
B. They increase fibrinolytic activity
C. They increase fat in the liver
D. They improve vision

14.The liver serves the following functions except?
A. Storage of glycogen
B. Storage of lipids
C. Secretion of bile
D. Detoxification of drugs

15.Steroid hormones can be characterized by the following except?
A. They bind to cytosolic receptors
B. They are metabolized in the kidney
C. They are synthesized in the adrenal cortex
D. They are synthesized in the gonads

16.The following are true about cholesterol except?

A. It is a precursor of androgens and estrogens
B. It is found in egg and milk.
C. It cannot be synthesized in the body
D. It is a major component of the plasma membrane

17.Which one of the following bonds is found in a nucleotide?
A. Phosphodiester bond
B. N- glycosidic bond
C. Covalent bond
D. Hydrogen bond

18.Which one of the following best describes an ampholyte?
A. It is an ionized molecule
B. It has both negative and positive charges
C. It has either a positive or a negative charge
D. It has equal numbers of cations and anions

19.Which one of the following best describes glycogen?
A. It is stored in the liver
B. It is used for energy provision
C. It is used for maintaining blood glucose level
D. It is the major form of carbohydrate

20.Which one of the following is not a dietary fibre?
A. Cellulose
B. Glycogen
C. Lignin
D. Pectin

Section B (Short Answer Questions)

1.Outline the fate of glucose and its utilization in the body.(6 marks)

The fate of glucose in the body involves several processes. Upon consumption, glucose is absorbed into the bloodstream through the small intestine. It is then transported to various tissues and organs, where it undergoes different metabolic pathways. In most cells, glucose is broken down through a series of reactions called glycolysis, which converts glucose into pyruvate. This process occurs in the cytoplasm and yields a small amount of energy in the form of ATP. The fate of pyruvate depends on the availability of oxygen. Under aerobic conditions, pyruvate enters the mitochondria and undergoes further oxidation, forming acetyl-CoA through a process called the citric acid cycle or Krebs cycle. This cycle generates more ATP and other energy-rich molecules. In the absence of oxygen, pyruvate can be converted into lactate through a process called fermentation, which occurs in the cytoplasm. Lactate can be further metabolized or converted back into glucose in the liver through gluconeogenesis.

2.Explain the relationship between cholesterol with atherosclerosis. (6 marks)

Cholesterol plays a complex role in the development of atherosclerosis. Atherosclerosis is a condition characterized by the accumulation of plaque in the arterial walls, leading to narrowing and hardening of the arteries. Cholesterol, particularly low-density lipoprotein (LDL) cholesterol, is a major contributor to the formation of atherosclerotic plaque. When LDL cholesterol levels are elevated, it can infiltrate the inner lining of the arteries and become oxidized. This triggers an inflammatory response and the recruitment of immune cells, such as macrophages, to the site. Over time, the accumulation of oxidized LDL cholesterol and immune cells leads to the formation of foam cells, which contribute to the development of fatty streaks in the arterial walls. These fatty streaks can progress into plaques, causing narrowing of the arteries and impairing blood flow. Furthermore, the presence of plaques makes the arterial walls more susceptible to the formation of blood clots, which can completely block the blood flow to vital organs and lead to serious complications such as heart attack or stroke.

3.Briefly describe the functions of plasma proteins. (6 marks)

Plasma proteins have diverse functions in the body. Here are some of their key roles: - Transport: Plasma proteins, such as albumin and globulins, help transport various substances throughout the body. For instance, albumin transports hormones, fatty acids, and drugs, while globulins carry antibodies and other immune molecules. - Blood clotting: Specific proteins, including fibrinogen and various clotting factors, play a crucial role in the formation and regulation of blood clots. They help prevent excessive bleeding and promote wound healing. - Immune response: Plasma proteins, including immunoglobulins, function as antibodies and play a vital role in immune responses. They recognize and neutralize pathogens, toxins, and foreign substances, contributing to the body's defense against infections. - Regulation of fluid balance: Albumin helps maintain the osmotic pressure and fluid balance between blood vessels and tissues. It prevents excessive fluid leakage from the blood vessels into the surrounding tissues. - Buffering and pH regulation: Certain plasma proteins, such as buffers and enzymes, help maintain the pH balance in the blood and body fluids, ensuring optimal physiological functioning.

4.Explain the clinical significance of blood sugar level. (6 marks)

Blood sugar levels, also known as blood glucose levels, are clinically significant due to their impact on overall health and well-being. Here are some key aspects of their clinical significance: - Diabetes diagnosis and management: Blood sugar levels are used to diagnose and monitor diabetes. Elevated fasting glucose levels or abnormal glucose tolerance tests can indicate diabetes or pre-diabetes. Regular monitoring of blood sugar levels is crucial in managing diabetes and adjusting medication or lifestyle interventions accordingly. - Hypoglycemia: Low blood sugar levels (hypoglycemia) can occur in individuals with diabetes who take certain medications, such as insulin or certain oral hypoglycemic drugs. Hypoglycemia can cause symptoms like dizziness, confusion, weakness, and even loss of consciousness. Prompt recognition and treatment are essential to prevent complications. - Long-term complications: Consistently high blood sugar levels over time can lead to various complications, including cardiovascular disease, kidney disease, nerve damage (neuropathy), eye problems (retinopathy), and impaired wound healing. Monitoring and maintaining optimal blood sugar levels can help prevent or delay the onset of these complications. - Pregnancy management: Blood sugar levels are closely monitored during pregnancy, especially in women with gestational diabetes. Proper management of blood sugar levels during pregnancy is essential to ensure the health of the mother and the developing baby.

5.Briefly describe the mechanism of hormone action. (6 marks)

The mechanism of hormone action involves several steps: 1. Hormone synthesis and release: Hormones are produced by specialized cells or organs and are released into the bloodstream or extracellular fluid. 2. Hormone transport: Once released, hormones travel through the bloodstream to their target tissues or organs. Some hormones bind to carrier proteins for transport, while others circulate freely. 3. Hormone-receptor interaction: Hormones exert their effects by binding to specific receptors on target cells or within target tissues. Receptors are proteins located on the cell membrane, within the cell, or within the nucleus. 4. Signal transduction: Upon hormone-receptor binding, a series of intracellular events is initiated, collectively known as signal transduction. This process converts the hormone signal into a cellular response. 5. Cellular response: The signal transduction pathway triggered by hormone-receptor interaction can lead to various cellular responses. This could include changes in gene expression, enzyme activation or inhibition, alterations in membrane permeability, or other physiological changes specific to the particular hormone and target cell. 6. Feedback regulation: Hormone action is often regulated through feedback mechanisms. Feedback can be positive, amplifying the hormone's effect, or negative, reducing or inhibiting hormone production or release.

6.Explain the significance of urea cycle. (6 marks)

The urea cycle is a crucial metabolic pathway that occurs primarily in the liver. Its significance lies in the elimination of toxic ammonia, which is produced during the breakdown of proteins. The urea cycle: 1. Protein breakdown: When dietary proteins are digested, or when body tissues are broken down, nitrogen-containing compounds called amino acids are released. 2. Amino acid deamination: Amino acids undergo deamination, where the amino group (-NH2) is removed, resulting in the formation of ammonia (NH3) and organic acid or keto acid. 3. Ammonia detoxification in the liver: Ammonia is highly toxic to the body, especially to the central nervous system. In the liver, ammonia is converted into urea through a series of reactions known as the urea cycle. 4. Urea formation: The urea cycle involves several enzymatic reactions that occur in the liver mitochondria and cytosol. Ammonia combines with carbon dioxide (CO2) and other components to form urea. Urea is then transported to the kidneys and excreted in urine, effectively eliminating the toxic ammonia. The urea cycle prevents ammonia buildup in the body and ensures the safe elimination of nitrogen waste products. Disorders of the urea cycle can lead to elevated ammonia levels, causing severe neurological symptoms and complications.

7.Enumerate the biological significance of polyunsaturated fatty acids. (4 marks)

Polyunsaturated fatty acids (PUFAs) are essential fatty acids that have significant biological significance. Here are some key points regarding their importance: - Heart health: PUFAs, particularly omega-3 fatty acids, have been associated with numerous cardiovascular benefits. They can help lower blood pressure, reduce inflammation, improve blood vessel function, and decrease the risk of heart disease. - Brain function: PUFAs, especially omega-3 fatty acids like docosahexaenoic acid (DHA), are crucial for brain development and function. They play a vital role in maintaining cell membranes, promoting neuronal growth, and supporting cognitive processes. - Anti-inflammatory effects: PUFAs possess anti-inflammatory properties and can help modulate the

body's inflammatory response. They are precursors to certain anti-inflammatory molecules, such as prostaglandins and resolvins, which help regulate immune and inflammatory processes. - Eye health: PUFAs, particularly DHA, are essential for the development and maintenance of the retina, the light-sensitive part of the eye. Adequate intake of PUFAs is associated with a reduced risk of age-related macular degeneration and other eye disorders. - Hormone regulation: PUFAs are involved in the production of hormone-like substances called eicosanoids, which play significant roles in regulating various physiological processes, including immune responses, blood clotting, and inflammatory pathways. - Skin health: PUFAs can help maintain healthy skin by promoting proper moisture retention, supporting skin barrier function, and reducing inflammation. They are often used in skincare products for their potential benefits.

Section C (Essay Questions – each 20 marks)

1. Citing suitable examples, compare the energetics of carbohydrate and lipid metabolism.

Carbohydrates and lipids are two primary macronutrients that the body uses for energy. Carbohydrates include sugars, starches, and fibers, whereas lipids include fats, oils, and cholesterol. The energetics of carbohydrate metabolism is primarily characterized by the metabolism of glucose through glycolysis, the citric acid cycle, and oxidative phosphorylation. During glycolysis, glucose is converted into pyruvate, which then enters the mitochondria and converts into acetyl-coenzyme A (acetyl-CoA), which enters the citric acid cycle. Through a series of redox reactions, the citric acid cycle produces reducing agents, such as NADH and FADH2, which are then used in oxidative phosphorylation to generate ATP. Generally, carbohydrate metabolism yields 4 calories of energy per gram of glucose. In contrast, lipid metabolism is more efficient in terms of energy production, yielding 9 calories per gram of fat. Lipid metabolism primarily involves the oxidation of fatty acids into acetyl-CoA, which enters the citric acid cycle. Fatty acids are broken down into two-carbon units in a series of reactions called beta-oxidation. The acetyl-CoA generated through beta-oxidation yields more reducing agents than carbohydrate metabolism, leading to more ATP production in oxidative phosphorylation. Moreover, lipids, unlike carbohydrates, can be stored in adipose tissues, providing the body with a long-term energy source. During periods of fasting or exercise, the body can mobilize stored fats and convert them into usable energy, sparing carbohydrates for essential organ functions.

2. Describe the structural and functional classification of proteins.

Proteins are organic macromolecules composed of one or more long chains of amino acids. The structural and functional classification of proteins is based on the shape and sequence of their amino acids and their specific biological roles.

Structural Classification:

Proteins can be broadly classified into four main categories based on their three-dimensional structure:

1. Primary structure: It refers to the linear sequence of amino acids in a protein chain, determined by the genetic code. This structure serves as the foundation for all higher-order structures of a

protein.

2. Secondary structure: It describes the local spatial arrangement of the polypeptide chain arising due to hydrogen bonding between the backbone atoms. This structure includes alpha-helices , beta-pleated sheets , and random coil segments.

3. Tertiary structure: It describes the overall three-dimensional arrangement of a single polypeptide chain, which is determined primarily by the interactions between the R-groups of amino acids. These interactions include ionic bonds, hydrogen bonds, hydrophobic interactions, and disulfide bonds.

4. Quaternary structure: It refers to the interactions between two or more individual polypeptide chains to form a functional protein complex. This structure arises through the same types of interactions seen in tertiary structures.

Functional Classification:

Proteins can also be classified based on their biological function. Proteins play vital roles in many biological processes, such as enzymatic catalysis, transport, signaling, and structural maintenance. Here are some of the functional classes of proteins:

1. Enzymes: Proteins that catalyze chemical reactions in the body by lowering the activation energy required for the reaction to occur.

2. Structural proteins: Proteins that provide mechanical support and maintain the structural integrity of cells and tissues. For example, collagen is a fibrous protein in connective tissues that provides strength and elasticity to the tissues.

3. Transport proteins: Proteins that transport molecules and ions across cellular membranes. Hemoglobin, for instance, is a protein that transports oxygen in the blood.

4. Hormones: Proteins that act as signaling molecules and help regulate various physiological processes. Examples include insulin, which regulates blood sugar levels, and growth hormone, which plays a role in cell growth and division.

5. Antibodies: Proteins that play a crucial role in the immune system by recognizing and neutralizing foreign substances such as pathogens, toxins, and cancer cells.