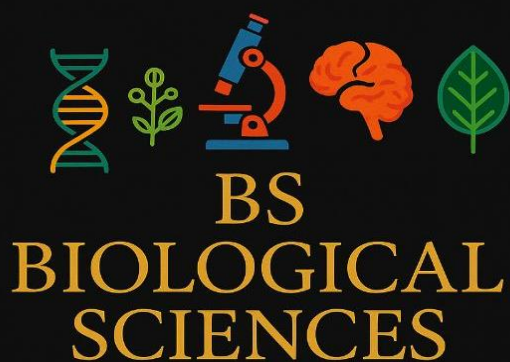




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BIO503- BIOLOGICAL PHYSICS

SHORT NOTES

By

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 **SHORT NOTES:**

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1. What is Biophysics?

Biophysics is an interdisciplinary science that applies principles of physics to biological systems. It studies life at molecular, cellular, and organism levels. It explains biological processes using physical laws and mathematical models. It connects biology with physics, chemistry, and computational sciences. It focuses on DNA, proteins, membranes, and cells. It helps understand how biological systems function. It is a bridge between life sciences and physical sciences.

2. What is the scope of Biophysics?

The scope of biophysics includes all levels of biological organization from atoms to ecosystems. It studies molecular structure, cell behavior, and biological systems. It covers areas like genetics, neuroscience, bioengineering, and systems biology. It uses experimental and computational methods. It explains biological functions using physical principles. It also includes drug design and medical imaging. It is widely used in research and healthcare.

3. Importance of Biophysics

Biophysics is important for understanding life at the molecular level. It helps in diagnosing diseases and drug development. It improves medical imaging techniques like MRI and CT scans. It helps study DNA, proteins, and enzymes. It is useful in biotechnology and genetic engineering. It identifies side effects of drugs. It plays a key role in modern medicine and research.

4. What is DNA?

DNA is deoxyribonucleic acid that carries genetic information. It has a double helix structure made of nucleotides. Each nucleotide contains sugar, phosphate, and nitrogen bases. The bases are adenine, thymine, cytosine, and guanine. DNA stores hereditary information in living organisms. It controls protein synthesis and cell function. It is found mainly in the nucleus of cells.

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5. What is RNA?

RNA is ribonucleic acid that is usually single-stranded. It contains ribose sugar instead of deoxyribose. It uses uracil instead of thymine. RNA plays a key role in protein synthesis. It carries genetic information from DNA to ribosomes. It helps in gene expression and regulation. It is less stable than DNA.

6. Difference between DNA and RNA

DNA is double-stranded, while RNA is single-stranded. DNA contains deoxyribose sugar, RNA contains ribose sugar. DNA uses thymine, RNA uses uracil. DNA stores genetic information, RNA helps in protein synthesis. DNA is stable, RNA is less stable. Both are essential for life processes.

7. What are proteins?

Proteins are large biomolecules made of amino acids. They are linked by peptide bonds forming long chains. They perform structural, enzymatic, and regulatory functions. Enzymes and hormones are proteins. Hemoglobin is a protein that carries oxygen. Proteins are essential for growth and repair. They are present in all living organisms.

8. What are amino acids?

Amino acids are the building blocks of proteins. Each amino acid contains an amino group and a carboxyl group. There are 20 standard amino acids in proteins. They join together through peptide bonds. Some amino acids are essential and must come from diet. Others are synthesized in the body. They determine protein structure and function.

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9. What is a peptide bond?

A peptide bond is a chemical bond between amino acids. It forms between the amino group of one and carboxyl group of another. Water is released during bond formation. It creates a strong linkage in proteins. It forms the backbone of protein chains. It is essential for protein structure. It is stable under normal conditions.

10. What is primary protein structure?

Primary structure is the sequence of amino acids in a protein. It is held together by peptide bonds. It is determined by genetic code in DNA. Even a small change can affect protein function. It defines the identity of a protein. It is the simplest level of protein structure. It controls all higher structures.

11. What is secondary protein structure?

Secondary structure refers to local folding of protein chains. It includes alpha helices and beta sheets. It is stabilized by hydrogen bonds. Alpha helix is a spiral structure. Beta sheets are sheet-like structures. It provides stability to proteins. It is common in most proteins.

12. What is tertiary protein structure?

Tertiary structure is the 3D shape of a protein molecule. It is formed by folding of secondary structures. It is stabilized by hydrogen bonds, ionic bonds, and disulfide bonds. Hydrophobic interactions also contribute. It determines biological function of protein. It forms a compact structure. It is biologically active form.

13. What is quaternary structure?

Quaternary structure is formed by multiple protein subunits. These subunits combine to form a functional protein. Example is hemoglobin. It is stabilized by weak

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interactions like hydrogen bonds. It increases efficiency of protein function. Not all proteins have this structure. It is important for complex proteins.

14. What is hydrogen bonding?

Hydrogen bonding is attraction between hydrogen and electronegative atoms like oxygen or nitrogen. It is weaker than covalent bonding. It plays a key role in DNA and protein structure. It stabilizes alpha helices and beta sheets. It gives water its unique properties. It is essential for biological systems. It maintains molecular stability.

15. What are intermolecular forces?

Intermolecular forces are forces between molecules. They include hydrogen bonding, dipole-dipole, and London forces. They are weaker than chemical bonds. They affect boiling and melting points. They influence protein folding and DNA stability. They are important in biological systems. They determine physical properties of substances.

16. What are van der Waals forces?

Van der Waals forces are weak intermolecular attractions. They include dipole and dispersion forces. They occur between non-polar molecules. They are important in protein folding. They help stabilize molecular structures. They are weaker than hydrogen bonds. They play a role in biological interactions.

17. What is electrophysiology?

Electrophysiology is the study of electrical activity in biological systems. It involves movement of ions through cell membranes. It explains nerve impulses and heart signals. It measures voltage and current in tissues. It is used in medical diagnosis. It studies ion channels. It is important in neuroscience.

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18. What is spectroscopy?

Spectroscopy studies interaction of light with matter. It uses UV, IR, and X-ray radiation. It helps determine molecular structure. It is used in drug design and disease detection. It studies biomolecular properties. It is a powerful analytical tool. It is widely used in biophysics.

19. What is microscopy?

Microscopy is a technique used to observe small structures. It includes optical, electron, and confocal microscopy. It helps visualize cells and molecules. Atomic force microscopy studies surfaces. It provides high-resolution images. It is essential in biological research. It helps study living systems.

20. What is MRI?

MRI stands for Magnetic Resonance Imaging. It uses magnetic fields and radio waves. It produces detailed images of internal organs. It is non-invasive and safe. It is used for disease diagnosis. It shows soft tissues clearly. It is widely used in medicine.

21. What is hydrodynamics?

Hydrodynamics studies movement of fluids. It explains behavior of biomolecules in solution. It is important in blood flow analysis. It helps study protein size and shape. It analyzes molecular motion. It is used in biological systems. It is important in biophysics.

22. What is fluorescence?

Fluorescence is emission of light by molecules after absorbing energy. It is used in biological imaging. It helps track DNA and proteins. It is non-destructive tech-

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nique. It shows molecular interactions. It is widely used in cell biology. It helps study live cells.

23. What is protein denaturation?

Denaturation is loss of protein structure. It is caused by heat, pH, or chemicals. It destroys protein function. Primary structure remains unchanged. Protein becomes inactive. It may be reversible or irreversible. It affects biological activity.

24. What is X-ray crystallography?

X-ray crystallography is used to determine 3D structure of molecules. It uses X-ray diffraction patterns. It helps study proteins and DNA. It provided DNA double helix discovery. It gives atomic-level detail. It is highly accurate. It is widely used in research.

25. What is genome?

Genome is the complete set of genetic material in an organism. It includes all DNA sequences. It controls inheritance and traits. Human Genome Project mapped human genes. It helps in genetic research. It is essential in biophysics. It explains biological diversity.

26. What are intermolecular hydrogen bonds in DNA?

Hydrogen bonds connect DNA base pairs. Adenine pairs with thymine, cytosine with guanine. These bonds stabilize DNA structure. They allow replication and transcription. They are weak but numerous. They maintain genetic stability. They are essential for life.

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27. What is protein stability?

Protein stability is the ability to maintain structure. It depends on temperature, pH, and environment. Weak interactions stabilize proteins. Denaturation reduces stability. Aggregation affects function. Stable proteins remain biologically active. It is important in medicine.

28. What are spectroscopy applications?

Spectroscopy is used in drug development and disease detection. It helps determine molecular structure. It analyzes proteins and DNA. It studies cell interactions. It is used in pharmacology. It helps in biotechnology. It is essential in research.

29. What are forces of attraction in molecules?

There are intramolecular and intermolecular forces. Intramolecular forces hold atoms together. Intermolecular forces act between molecules. Examples include ionic, covalent, and hydrogen bonds. They determine physical properties. They are essential in biological systems. They control molecular behavior.

30. What is the role of water in biophysics?

Water is essential for all biological processes. It acts as a universal solvent. It forms hydrogen bonds. It stabilizes proteins and DNA. It supports biochemical reactions. It helps in transport systems. It is vital for life.

Q31: Define Thermodynamics and its scope.

Thermodynamics is the branch of physics that studies the relationship between heat, work, temperature, and energy. It explains how energy is transferred and converted from one form to another. It deals with macroscopic systems such as gases, engines, and living organisms. The main idea is that heat is a form of energy. It helps in understanding natural processes and energy flow. It applies to both

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physical and biological systems. It does not focus on atoms but on bulk properties. It is fundamental in science and engineering.

Q32: What are the laws of thermodynamics?

The laws of thermodynamics describe energy behavior in nature. The zeroth law defines temperature and thermal equilibrium. The first law explains conservation of energy. The second law introduces entropy and states that heat flows from hot to cold. The third law states entropy becomes zero at absolute zero temperature. These laws are universal and apply to all systems. They explain energy transfer and limitations. They are the foundation of thermodynamics.

Q33: Zeroth Law of Thermodynamics.

The zeroth law states that if two systems are in thermal equilibrium with a third system, then they are also in equilibrium with each other. It defines the concept of temperature. This law allows the use of thermometers. It helps compare temperatures of different systems. If $A = B$ and $A = C$, then $B = C$. It ensures consistency in temperature measurement. It is the basis of thermal equilibrium. It is essential in thermodynamics.

Q34: First Law of Thermodynamics.

The first law states that energy cannot be created or destroyed, only converted from one form to another. The change in internal energy is equal to heat added minus work done. It is written as $\Delta U = Q - W$. It represents conservation of energy. It applies to all physical and biological systems. Heat can be converted into work. It explains energy flow in engines and cells. It is the energy accounting principle.

Q35: Second Law of Thermodynamics.

The second law states that entropy of an isolated system always increases. Heat flows naturally from hot to cold bodies. Energy conversions are never 100% effi-

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cient. Some energy is always lost as heat. It explains irreversibility of processes. It introduces the concept of entropy. It defines the direction of time. It limits useful energy in systems.

Q36: Entropy.

Entropy is a measure of disorder or randomness in a system. It increases in all natural processes. Higher entropy means less usable energy. It is defined as $\Delta S = Q/T$. In closed systems, entropy always increases. It explains why systems move toward equilibrium. Living organisms maintain low entropy using energy. It is a key thermodynamic concept.

Q37: Thermodynamic Equilibrium.

Thermodynamic equilibrium is a state where no net change occurs in a system. Temperature, pressure, and energy remain constant. There is no energy flow between system and surroundings. The system is stable and balanced. Any change requires external force. It represents maximum entropy state. All systems tend toward equilibrium. It is important in thermodynamics.

Q38: State Functions.

State functions depend only on the initial and final state of a system. They do not depend on the path taken. Examples include temperature, pressure, and internal energy. Work and heat are not state functions. They depend on the process. State functions describe equilibrium conditions. They simplify thermodynamic calculations. They are important in physics and chemistry.

Q39: Internal Energy.

Internal energy is the total energy stored in a system. It includes kinetic and potential energy of molecules. It also includes chemical bond energy. It increases when heat is added. It decreases when work is done by the system. It is a state function. It depends only on system state. It is central to thermodynamics.

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Q40: Work and Energy.

Work is done when a force moves an object through a distance. Energy is the capacity to do work. In thermodynamics, energy is transferred as heat or work. Energy can change form but is conserved. Kinetic energy is motion energy. Potential energy is stored energy. Work changes internal energy. Both are fundamental concepts.

Q41: Second Law and Entropy Relationship.

The second law explains that entropy always increases in isolated systems. Spontaneous processes increase disorder. Heat flows from hot to cold. Energy becomes less useful over time. No process is perfectly efficient. Entropy measures energy dispersal. It defines irreversibility of processes. It determines direction of natural change.

Q42: Gibbs Free Energy.

Gibbs free energy is the energy available to do useful work. It is defined as $G = H - TS$. H is enthalpy, T is temperature, S is entropy. If ΔG is negative, reaction is spontaneous. If ΔG is positive, reaction is non-spontaneous. It predicts reaction feasibility. It is important in chemistry and biology. It combines energy and entropy effects.

Q43: Endergonic and Exergonic Reactions.

Endergonic reactions absorb energy and are non-spontaneous. They have positive Gibbs free energy. Exergonic reactions release energy and are spontaneous. They have negative Gibbs free energy. Photosynthesis is endergonic. Cellular respiration is exergonic. Energy is required in endergonic reactions. Exergonic reactions release usable energy.

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Q44: Plasma Membrane Structure.

The plasma membrane surrounds the cell. It is made of a phospholipid bilayer. It contains proteins, lipids, and carbohydrates. It is selectively permeable. It controls movement of substances. It separates cell from environment. It follows fluid mosaic model. It is flexible and dynamic.

Q45: Fluid Mosaic Model.

The fluid mosaic model describes membrane structure. Lipids and proteins move freely in the membrane. It is not rigid but fluid. Cholesterol maintains membrane stability. Proteins float within lipid bilayer. Carbohydrates are present on outer surface. It explains membrane flexibility. It was proposed in 1972.

Q46: Phospholipids.

Phospholipids form the main structure of membranes. They have hydrophilic heads and hydrophobic tails. They form a bilayer arrangement. Heads face water environments. Tails face inward away from water. They create a barrier for molecules. They control membrane permeability. They are essential for cell structure.

Q47: Membrane Proteins.

Membrane proteins include integral and peripheral proteins. Integral proteins are embedded in the membrane. Some cross the membrane completely. Peripheral proteins are loosely attached. They help in transport and signaling. Receptor proteins detect signals. Channel proteins allow ion movement. They are essential for cell function.

Q48: Membrane Transport.

Membrane transport moves substances across the cell membrane. It includes diffusion, facilitated diffusion, and active transport. Diffusion moves molecules down concentration gradient. Facilitated diffusion uses proteins. Active transport uses

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ATP energy. It allows movement against gradient. It maintains cell balance. It is essential for survival.

Q49: Diffusion Types.

Simple diffusion occurs directly through membrane. It does not require energy. Facilitated diffusion uses protein channels. It helps ions like Na^+ and K^+ . Movement is from high to low concentration. It is passive transport. It depends on concentration difference. It is important for cells.

Q50: Active Transport.

Active transport moves substances against concentration gradient. It requires energy (ATP). It uses carrier proteins. Example is sodium-potassium pump. It maintains ion balance in cells. It is important in nerve function. It allows nutrient absorption. It is energy-dependent process.

Q51: Friction Types.

Friction opposes motion between surfaces. Types include static, sliding, rolling, and fluid friction. Static friction prevents motion. Sliding friction occurs during movement. Rolling friction is weakest. Fluid friction occurs in liquids and gases. Friction produces heat. It is useful in daily life.

Q52: Reduction of Friction.

Friction can be reduced by smoothing surfaces. Lubricants like oil reduce resistance. Streamlined shapes reduce air drag. Ball bearings reduce contact friction. Reducing force reduces friction. Wheels convert sliding into rolling friction. Water can act as lubricant. It improves efficiency.

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Q53: Types of Motion.

Motion includes translatory, rotatory, and vibratory motion. Translatory motion includes linear and circular motion. Rotatory motion is spinning around axis. Vibratory motion is back and forth movement. Random motion is irregular movement. All objects show motion. Motion is fundamental in physics. It depends on reference point.

Q54: Linear and Circular Motion.

Linear motion is movement in straight line. Example is car on road. Circular motion is movement in circular path. Example is Earth around Sun. Linear motion has constant direction. Circular motion changes direction continuously. Both are types of translatory motion. They are common in daily life.

Q55: Rotatory Motion.

Rotatory motion is spinning of a body about its axis. Every point moves in a circle. Example is wheel rotation. Earth's rotation causes day and night. Axis passes through object. It differs from circular motion. It is important in machines. It produces rotational energy.

Q56: Vibratory Motion.

Vibratory motion is back and forth movement. It occurs around mean position. Example is pendulum. It repeats periodically. It produces sound and waves. It is also called oscillatory motion. It is important in physics. It forms basis of harmonic motion.

Q57: Entropy in Biology.

Entropy measures disorder in biological systems. Living organisms maintain low entropy. They need continuous energy input. Photosynthesis reduces local entropy.

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Cellular respiration releases energy. Death increases entropy. Energy transfer is not fully efficient. Universe entropy always increases.

Q58: Gel Filtration.

Gel filtration separates molecules based on size. It is also called molecular sieve chromatography. Large molecules move faster. Small molecules enter pores and move slowly. It is used in protein purification. It separates enzymes and DNA. It determines molecular weight. It is widely used in labs.

Q59: Applications of Gel Filtration.

Gel filtration is used for protein purification. It separates enzymes, hormones, and antibodies. It helps in DNA separation. It is used in drug analysis. It determines molecular size. It is fast and efficient. It is used in biotechnology. It is important in research labs.

Q60: Energy in Thermodynamics.

Energy is the ability to do work. It exists in different forms. It is conserved in all processes. It can be kinetic or potential. Heat is a form of energy. Energy transfers between systems. It cannot be destroyed. It follows the first law of thermodynamics.

61. What is the importance of studying protein–ligand interactions?

Protein–ligand interactions are fundamental to understanding biological processes at molecular level. They explain how enzymes, inhibitors, and receptors function. These interactions control metabolism, signaling, and regulation in cells. Identifying binding partners helps in drug discovery and disease treatment. It is a key concept in proteomics and genomics. These studies reveal how biological specificity is

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achieved. They also help design therapeutic molecules. Thus, they are essential in modern biochemistry and medicine.

62. What techniques are used to study protein interactions?

Several methods are used to analyze protein interactions. These include affinity chromatography and gel filtration. Cross-linking helps stabilize protein complexes. Spectroscopic methods provide structural information. ELISA and immunoblotting detect protein binding. X-ray crystallography gives 3D structure details. Surface plasmon resonance measures real-time binding. These techniques help understand molecular mechanisms in biology.

63. What is Radioimmunoassay (RIA)?

RIA is a sensitive technique used to measure small quantities of biological molecules. It uses a radioactively labeled antigen. This competes with an unlabeled antigen for antibody binding. The more antigen present, the less radioactive binding occurs. The bound and free fractions are separated. Radioactivity is then measured. It is highly accurate and sensitive. It is widely used in hormone and drug detection.

64. What are limitations of RIA?

RIA requires radioactive materials, which are hazardous. It needs strict safety precautions during handling. Disposal of radioactive waste is difficult. It is expensive to perform. Specialized equipment is required. It has largely been replaced by ELISA. Despite this, it remains highly sensitive. It is still used in some research applications.

65. What is ELISA?

ELISA is an enzyme-based immunoassay technique. It detects antigens or antibodies in a sample. The antigen is fixed on a solid surface. A specific antibody binds to it. An enzyme-linked secondary antibody is added. A substrate produces a color

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change. The intensity of color shows concentration. It is widely used in diagnostics and research.

66. What is sandwich ELISA?

Sandwich ELISA is a highly sensitive detection method. A capture antibody is attached to a surface. The antigen binds to this antibody. A second enzyme-linked antibody binds the antigen. This forms a sandwich structure. A substrate produces a measurable color signal. The color intensity indicates antigen level. It is used in medical testing like pregnancy tests.

67. What are molecular motors?

Molecular motors are protein machines inside cells. They convert ATP energy into mechanical work. They move along cytoskeletal filaments. Examples include kinesin, dynein, and myosin. They transport organelles and vesicles. They are essential for cell movement and division. They work in a cyclic ATP-driven process. They are vital for cellular life.

68. How do molecular motors function?

Molecular motors work by ATP hydrolysis. ATP binding changes their shape. This creates mechanical movement along filaments. Myosin interacts with actin for muscle contraction. Kinesin and dynein move along microtubules. Each step is powered by ATP breakdown. The cycle repeats continuously. This enables intracellular transport and motion.

69. What is sedimentation?

Sedimentation is the settling of particles in a fluid. It occurs due to gravity or centrifugal force. Heavier particles move downward. It is used to separate biological materials. It depends on size and density of particles. It is important in laboratory techniques. It helps isolate proteins and cells. It is widely used in biophysics.

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70. What forces act in sedimentation?

Three forces act in sedimentation. Gravity pulls particles downward. Buoyant force pushes them upward. Drag force resists motion through fluid. The balance of these forces determines settling rate. Density difference is very important. Larger particles settle faster. It is essential in centrifugation studies. It explains particle movement in fluids.

71. What is Reynolds number?

Reynolds number is a dimensionless quantity in fluid dynamics. It compares inertial and viscous forces. It predicts flow behavior in fluids. Low values indicate laminar flow. High values indicate turbulent flow. It is used in biological and engineering systems. It helps study blood flow and air movement. It is very important in physics and biology.

72. What is laminar flow?

Laminar flow is smooth and regular fluid motion. Fluid particles move in parallel layers. There is no mixing between layers. It occurs at low Reynolds number. It is stable and predictable. Blood flow in small vessels is often laminar. It reduces energy loss. It is important in biological systems.

73. What is turbulent flow?

Turbulent flow is irregular and chaotic motion. It contains eddies and vortices. It occurs at high Reynolds number. Fluid particles move randomly. It increases mixing and energy loss. It is seen in fast-moving rivers. It is common in large blood vessels. It is important in fluid dynamics.

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74. What is molecular self-assembly?

Molecular self-assembly is spontaneous organization of molecules. No external guidance is required. It is driven by weak interactions. These include hydrogen bonding and van der Waals forces. It forms structured biological systems. It is important in nanotechnology. It is reversible under certain conditions. It is essential for life processes.

75. What are types of self-assembly?

There are two main types of self-assembly. Intramolecular self-assembly occurs within one molecule. Intermolecular self-assembly occurs between different molecules. Intermolecular is more common in biology. It forms large molecular structures. Intramolecular relates to folding processes. Both depend on non-covalent forces. They are essential in biological organization.

76. Give examples of self-assembly.

DNA double helix formation is an example. Lipid bilayers form cell membranes. Protein complexes assemble naturally. Viral particles are self-assembled structures. Ribosomes are also formed by self-assembly. These structures form without external control. They rely on hydrogen bonding. They are essential for cellular life.

77. What are ion channels?

Ion channels are membrane proteins in cells. They allow ions to pass through membranes. They are selective for specific ions. Examples include sodium and potassium channels. They regulate electrical signals in cells. They are found in all living organisms. They control nerve and muscle activity. They are essential for life.

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78. Why are ion channels important?

Ion channels control electrical signaling in cells. They help transmit nerve impulses. They regulate heartbeat and muscle contraction. They maintain ion balance in cells. They are involved in secretion processes. They respond to voltage or ligands. They are crucial for brain function. Their malfunction causes diseases.

79. What is radiation?

Radiation is energy emitted as waves or particles. It includes electromagnetic and particle radiation. It travels through space or matter. It can be natural or artificial. It interacts with atoms and molecules. It may cause ionization. It includes light, X-rays, and gamma rays. It is widely used in medicine.

80. What is ionizing radiation?

Ionizing radiation removes electrons from atoms. It produces charged ions in matter. It includes alpha, beta, and gamma radiation. It can damage DNA and cells. It is harmful at high exposure levels. It is used in cancer therapy. It requires safety precautions. It is measured in Gray and Sievert.

81. What is non-ionizing radiation?

Non-ionizing radiation cannot ionize atoms. It includes radio waves and microwaves. It mainly produces heat effects. It is generally less harmful. UV radiation can still cause damage. It is used in communication systems. It includes visible light. It has many technological applications.

82. What is Geiger counter?

A Geiger counter is a radiation detection device. It measures ionizing radiation levels. It produces audible clicking sounds. It detects alpha, beta, and gamma rays. It contains a gas-filled tube. Radiation causes ionization inside. It is widely used in safety monitoring. It is portable and easy to use.

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83. What is absorbed dose?

Absorbed dose is radiation energy per unit mass. It is measured in Gray (Gy). It shows energy deposited in tissue. It is important in medical physics. It does not measure biological effect. It is used in radiation therapy. It is a physical quantity. It helps in exposure calculations.

84. What is equivalent dose?

Equivalent dose measures biological damage from radiation. It is measured in Sievert (Sv). It depends on radiation type. Different radiations have different effects. Weighting factors are used. Alpha radiation is more harmful. It ensures safety standards. It is important in radiation protection.

85. What is bioelectromagnetics?

Bioelectromagnetics studies electrical activity in living systems. It examines interaction with electromagnetic fields. It includes nerve and muscle signals. It studies action potentials in cells. It is used in medical imaging like MRI. It helps understand brain and heart signals. It links physics and biology. It has medical applications.

86. What are action potentials?

Action potentials are electrical signals in cells. They occur in neurons and muscles. They involve ion movement across membranes. Voltage-gated channels control them. They transmit information rapidly. They are temporary and fast. They enable communication in nervous system. They are essential for body function.

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87. What is molecular motor role in muscles?

Myosin is the main motor protein in muscles. It interacts with actin filaments. ATP provides energy for movement. Myosin pulls actin to cause contraction. Calcium controls activation. The process is cyclic. It results in muscle shortening. It enables body movement.

88. What is ion channel selectivity?

Ion channel selectivity allows specific ions to pass. Each channel is designed for certain ions. For example, potassium channels allow K^+ only. It depends on pore structure. It maintains electrical balance. It prevents unwanted ion movement. It ensures proper cell function. It is essential for signaling.

89. What is ELISA used for?

ELISA is used in medical diagnostics. It detects diseases and infections. It is used in pregnancy tests. It identifies hormones and antibodies. It provides color-based results. It is highly sensitive and safe. It is widely used in labs. It replaces radioactive methods.

90. What is importance of self-assembly in biology?

Self-assembly is essential for biological structure formation. It forms DNA, proteins, and membranes. It is driven by weak interactions. It is spontaneous and reversible. It supports cell organization. It is important in nanotechnology. It allows complex structure formation. It is fundamental to life.

Q91. What is Ion-Exchange Chromatography?

Ion-exchange chromatography is a technique used to separate proteins based on their net electrical charge. Proteins interact with oppositely charged functional groups on a resin. Binding occurs due to electrostatic attraction. The column is equilibrated with buffer before sample loading. Proteins are separated depending

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on pH and their isoelectric point (pI). Elution is achieved using salt gradient or pH change. It is widely used in protein purification and biochemical analysis.

Q92. What is the principle of Ion-Exchange Chromatography?

The principle is based on attraction between charged molecules and oppositely charged stationary phase. Proteins carry positive or negative charge depending on pH. Below pI proteins are positively charged, above pI negatively charged. Oppositely charged proteins bind to resin while others pass through. Increasing ionic strength weakens binding. This allows controlled separation. It is a high-resolution purification method.

Q93. Write formula for pH and explain.

pH is used to measure acidity of a solution. It determines protein charge behavior in chromatography. Lower pH means more acidic environment. Higher pH means basic environment. It is essential in buffer preparation.

Formula:

$$pH = -\log[H^+]$$

It is widely used in biochemical and analytical chemistry.

Q94. Write formula for pOH and explain.

pOH measures hydroxide ion concentration in a solution. It is related to pH in aqueous systems. It helps in determining basicity. Used in buffer and equilibrium calculations. Important in protein chemistry.

Formula:

$$pOH = -\log[OH^-]$$

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Q95. Relationship between pH and pOH

pH and pOH are interconnected in aqueous solutions. Their sum is always constant at room temperature. This is important in biological systems. Used for buffer design. Helps in ionization control of proteins.

Formula:

$$pH + pOH = 14$$

Q96. What is isoelectric point (pI)?

Isoelectric point is the pH at which a protein has no net charge. At this point, protein does not move in electric field. Below pI it becomes positively charged. Above pI it becomes negatively charged. It is important in ion-exchange selection. It determines binding behavior in chromatography. It is calculated from pKa values.

Q97. Formula of pI for amino acids

pI is calculated using pKa values of acidic and basic groups. It is used to predict protein behavior in separation. Important in protein purification. Helps select buffer pH.

Formula:

$$pI = \frac{pKa_1 + pKa_2}{2}$$

Q98. What is affinity chromatography?

Affinity chromatography separates biomolecules based on specific biological binding. It uses ligand attached to solid matrix. Only target molecules bind specifically. Other molecules are washed away. Elution is done by changing pH or adding competitor. It provides very high specificity. It is widely used in antibody purification.

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Q99. Steps of affinity chromatography

First, ligand is attached to resin forming stationary phase. Sample is passed through column. Target molecules bind specifically to ligand. Unbound molecules are washed away. Elution is done using salt, pH, or competitive ligand. Bound molecules are collected. Final step is dialysis for purification.

Q100. What is HPLC?

HPLC is a high-pressure analytical technique used for separation of compounds. It uses liquid mobile phase and solid stationary phase. Sample is injected into column. Components separate based on interaction strength. Detector records signals as chromatogram. It is used in pharmaceuticals and biochemistry. It provides accurate quantitative analysis.

Q101. Formula used in HPLC (Beer-Lambert Law)

HPLC detection is based on absorbance. Concentration is proportional to absorbance. Used in UV detectors. Important in quantitative analysis.

Formula:

$$A = \epsilon cl$$

Q102. What is retention time in HPLC?

Retention time is the time taken for a compound to pass through the column. Different compounds have different retention times. Strong interaction means longer retention. Weak interaction means faster elution. It is used for identification. It is shown in chromatogram peaks. It is important in qualitative analysis.

Q103. What is mass spectrometry?

Mass spectrometry is an analytical technique used to measure mass-to-charge ratio of ions. Sample is ionized to produce charged particles. Ions are separated in

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electric or magnetic fields. Detector records ion signals. It produces a mass spectrum. It is used for molecular identification. It is highly sensitive technique.

Q104. Formula of mass-to-charge ratio

m/z ratio is fundamental in mass spectrometry. It determines ion separation. Used for identifying molecular weight. Important in proteomics.

Formula:

$$m/z = \frac{\text{mass}}{\text{charge}}$$

Q105. Steps of mass spectrometry

Mass spectrometry involves four main steps. Ionization converts molecules into ions. Acceleration moves ions using electric field. Deflection separates ions in magnetic field. Detection records ion signal. Output is mass spectrum. It is used for structural analysis.

Q106. What is ionization in MS?

Ionization is the process of forming charged ions from neutral molecules. High-energy electrons remove electrons from sample. Positive ions are formed. These ions can be analyzed. It is first step in mass spectrometry. Without ionization, separation is not possible. It determines fragmentation pattern.

Q107. What is Bragg's Law?

Bragg's Law explains X-ray diffraction in crystals. It determines spacing between atomic planes. Used in XRD analysis. Important in material science. Helps identify crystal structure.

Formula:

$$2d\sin\theta = n\lambda$$

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Q108. What is X-ray diffraction (XRD)?

XRD is a technique used to study crystal structure. X-rays are scattered by atomic planes. Constructive interference produces diffraction pattern. Used to identify compounds. Powder samples are commonly used. It provides structural information. It is widely used in chemistry and physics.

Q109. What is specific activity in protein purification?

Specific activity measures enzyme purity. It increases as purification improves. It is ratio of activity to protein amount. Used to monitor purification steps. Higher value means higher purity.

Formula:

$$\text{Specific Activity} = \frac{\text{Enzyme Activity}}{\text{Total Protein}}$$

Q110. What is purification fold?

Purification fold shows improvement in protein purity. It compares final and initial specific activity. It is important in biochemical experiments. Higher fold means better purification. Used in lab reporting.

Formula:

$$\text{Purification Fold} = \frac{\text{Specific Activity}_{\text{final}}}{\text{Specific Activity}_{\text{initial}}}$$

Q111. What is yield in protein purification?

Yield shows how much protein activity is retained after purification. It is expressed in percentage. It decreases with each purification step. Important for process efficiency.

Formula:

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$$\text{Yield} = \frac{\text{Final Activity}}{\text{Initial Activity}} \times 100$$

Q112. What is atomic absorption spectroscopy (AAS)?

AAS measures absorption of light by gas-phase atoms. Sample is atomized in flame or furnace. Atoms absorb specific wavelength. Absorbance is proportional to concentration. Used for metal analysis. It is highly accurate technique. Based on Beer-Lambert law.

Q113. What is atomic emission spectroscopy?

AES measures light emitted by excited atoms. Atoms absorb energy and emit radiation when returning to ground state. Each element emits unique wavelength. Used for elemental identification. Flame or plasma is used. It provides qualitative and quantitative results. It is widely used in labs.

Q114. Formula of energy in spectroscopy

Energy of emitted light is related to wavelength. Used in AES, fluorescence, ICP. Important in quantum theory.

Formula:

$$E = \frac{hc}{\lambda}$$

Q115. What is ICP-MS?

ICP-MS is a technique combining plasma ionization and mass spectrometry. It detects trace elements at very low concentration. Sample is ionized in argon plasma. Ions are separated by mass analyzer. It provides isotopic information. It is highly sensitive technique. Used in environmental and biological analysis.

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Q116. What is fluorescence spectroscopy?

Fluorescence spectroscopy measures emitted light from excited molecules. Molecules absorb UV light and emit visible light. It has high sensitivity. Used in biochemical detection. It has very low background noise. Used in HPLC detection. It is important in medical research.

Q117. What is quantum yield?

Quantum yield measures efficiency of fluorescence emission. It compares emitted photons to absorbed photons. Higher value means stronger fluorescence. Used in biochemical assays. Important in imaging systems.

Formula:

$$\Phi = \frac{\text{Emitted photons}}{\text{Absorbed photons}}$$

Q118. What is centrifugation principle?

Centrifugation separates particles based on density. Heavier particles settle faster. Used in protein fractionation. Different speeds separate different organelles. Used in cell biology. Important in sample purification. Based on centrifugal force.

Q119. What is RCF formula in centrifugation?

RCF measures relative centrifugal force. It depends on rotor radius and speed. Used to calculate separation efficiency. Important in lab centrifuges.

Formula:

$$RCF = 1.118 \times 10^{-5} \times r \times RPM^2$$

Q120. What is protein purification process?

Protein purification involves multiple steps. Cell disruption releases proteins. Fractionation separates organelles. Crude purification uses salting out and dialy-

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sis. Chromatography gives final purification. HPLC and affinity methods improve purity. Final product is analyzed for activity and purity.

Good Luck ☺

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