# MB501 - CELL BIOLOGY

## FINAL TERM MOST IMPORTANT QUESTIONS

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Group link: **https://chat.whatsapp.com/BjC6W0jZx8o9yaC2ISh1Gu**

## 1. Describe: Primary cell culture, Cell line, Pure Culture.

**1. Primary Cell Culture:**

The cultivation of cells directly isolated from living tissues, maintaining their natural characteristics in an in vitro environment.

**2. Cell Line:**

A population of cells derived from a single cell and cultured to proliferate indefinitely in vitro, often through immortalization methods.

**3. Pure Culture:**

A population of identical microorganisms derived from a single strain, ensuring uniform genetic and phenotypic characteristics.

## 2. Write a short note on Polymerase Chain Reaction.

**Polymerase Chain Reaction (PCR):**

Polymerase Chain Reaction (PCR) is a widely-used molecular biology technique that amplifies DNA segments exponentially. Invented by Kary Mullis in the 1980s, PCR has become a cornerstone in various scientific fields. The process involves cyclic heating and cooling of a reaction to facilitate the synthesis of millions of copies of a specific DNA region. PCR is invaluable for tasks such as gene cloning, DNA sequencing, and diagnostics, offering a rapid and efficient means of replicating and analyzing DNA in vitro. Its impact spans from basic research to applications in forensic science, medicine, and biotechnology.

## 3. How DNA is packed inside the cell?

DNA is tightly packed inside the cell through a hierarchical organization. It begins as a double helix, wraps around histone proteins to form nucleosomes, further coils into chromatin fibers, condenses into visible chromosomes during cell division, and is organized into loop domains with the help of scaffold proteins in the interphase nucleus.

## 4. Write steps of Mitosis.

**1. Interphase:**

The cell prepares for division by undergoing normal cellular activities and replicating its DNA.

**2. Prophase:**

Chromosomes condense, the nuclear envelope breaks down, and spindle fibers form.

**3. Metaphase:**

Chromosomes align at the cell's equator (metaphase plate).

**4. Anaphase:**

Sister chromatids separate and move to opposite poles of the cell.

**5. Telophase:**

Chromatids reach the poles, the nuclear envelope reforms, and chromosomes de-condense.

**6. Cytokinesis:**

Division of the cytoplasm occurs, resulting in two genetically identical daughter cells.

## 5. Write function of Th1 and Th2 cells.

**Th1 Cells:**

Activate and stimulate immune responses against intracellular pathogens, such as viruses and certain bacteria. Promote cell-mediated immunity.

**Th2 Cells:**

Coordinate immune responses against extracellular parasites, and play a key role in allergic reactions and antibody-mediated immunity.

## 6. What are types of MHC molecule?

There are two main types of Major Histocompatibility Complex (MHC) molecules:

**1. MHC Class I:**

They are found on the surface of all nucleated cells & presents intracellular antigens to CD8+ T cells.

**2. MHC Class II:**

They are expressed on antigen-presenting cells (APCs) such as macrophages, dendritic cells, and B cells & presents extracellular antigens to CD4+ T cells.

## 7. Write functions of Endoplasmic Reticulum.

**Protein Synthesis:**

Rough endoplasmic reticulum (RER) is involved in the synthesis of proteins, especially those destined for secretion or insertion into membranes.

**Protein Folding and Modification:**

RER provides an environment for proper folding and post-translational modifications of proteins, including glycosylation.

**Lipid Synthesis:**

Smooth endoplasmic reticulum (SER) is involved in the synthesis of lipids and steroids.

**Detoxification:**

SER plays a role in detoxifying drugs and poisons, primarily in liver cells.

**Calcium Storage:**

The ER serves as a calcium reservoir, releasing calcium ions in response to cell signaling.

**Intracellular Transport:**

ER is involved in the transport of synthesized proteins and lipids to various cellular destinations, including the Golgi apparatus.

## 8. How T cells are activated?

T cells are activated through the following steps:

1. Antigen Presentation: APCs present antigens using MHC molecules.
2. TCR Recognition: TCRs on T cells bind to antigen-MHC complexes.
3. Co-stimulation: Co-stimulatory signals ensure proper T cell activation.
4. Activation Signal: TCR engagement and co-stimulation trigger intracellular signaling.
5. IL-2 Production: Activated T cells release interleukin-2 (IL-2).
6. T Cell Expansion: IL-2 induces clonal expansion of T cells.
7. Differentiation: T cells differentiate into effector subsets based on cytokine signals.
8. Deployment and Action: Activated T cells migrate to infection sites, exerting effector functions.

## 9. Write functions of immune system.

**Defense Against Pathogens:**
Recognizes and eliminates bacteria, viruses, fungi, and parasites to prevent infections.

**Surveillance for Abnormal Cells:**
Monitors and eliminates abnormal or cancerous cells to prevent tumor formation.

**Immune Memory:**
Develops memory cells to mount a faster and more effective response upon re-exposure to previously encountered pathogens.

**Tissue Repair and Homeostasis:**
Participates in tissue repair processes and helps maintain homeostasis within the body.

**Allergen and Toxin Response:**
Responds to allergens and toxins, triggering immune reactions to protect the body.

**Autoimmune Regulation:**
Distinguishes self from non-self to prevent autoimmune reactions against the body's own tissues.

**Immune Surveillance in Pregnancy:**
Monitors and regulates immune responses during pregnancy to support fetal development.

**Inflammation Regulation:**
Initiates and resolves inflammation as part of the immune response.

**Antibody Production:**
Produces antibodies to neutralize pathogens and enhance their elimination.

**Phagocytosis:**
Engages in phagocytosis to engulf and digest foreign particles, such as bacteria and dead cells.

## 10. What takes place at synapse in neuromuscular system?

The neuromuscular junction (NMJ) is a specialized synapse where a motor neuron communicates with a muscle fiber, leading to muscle contraction. The events that take place at the synapse in the neuromuscular system can be summarized as follows:

1. The process begins with an action potential (electrical signal) traveling down the axon of a motor neuron towards the neuromuscular junction.

2. When the action potential reaches the axon terminals of the motor neuron, it triggers the opening of voltage-gated calcium channels.

3. The entry of calcium ions into the axon terminal is essential for neurotransmitter release. Calcium binds to proteins in the terminal, leading to the exposure of vesicles containing the neurotransmitter acetylcholine (ACh).

4. Acetylcholine is released into the synaptic cleft, the small gap between the motor neuron and the muscle fiber.

5. Acetylcholine diffuses across the synaptic cleft and binds to receptors on the sarcolemma (cell membrane) of the muscle fiber.

6. Acetylcholine binding to receptors opens ion channels in the sarcolemma, allowing the influx of sodium ions. This creates a localized depolarization called the end-plate potential.

7. The end-plate potential triggers an action potential that spreads along the sarcolemma and into the muscle fiber via the transverse tubules (T-tubules).

8. The muscle action potential travels deep into the muscle fiber and stimulates the release of calcium ions from the sarcoplasmic reticulum, a specialized internal membrane system in muscle cells.

9. Calcium ions bind to troponin, a regulatory protein, allowing the myosin and actin filaments to interact and initiate muscle contraction.

10. Acetylcholine in the synaptic cleft is broken down by the enzyme acetylcholinesterase, terminating the signal and preventing continuous muscle contraction.

## 11. Write functions of Mitochondria.

**Energy Production:** Mitochondria are the primary sites for cellular respiration, producing adenosine triphosphate (ATP), which is the main energy currency of the cell.

**ATP Synthesis:** Through oxidative phosphorylation, mitochondria generate ATP by utilizing the energy released during the breakdown of nutrients like glucose and fatty acids.

**Cellular Respiration:** Mitochondria play a crucial role in aerobic respiration, involving the processes of glycolysis, the citric acid cycle, and the electron transport chain.

**Metabolism Regulation:** Mitochondria are involved in regulation of cellular metabolism, helping to balance energy production and consumption based on the cell's needs.

**Calcium Homeostasis:** Mitochondria participate in regulating intracellular calcium levels, influencing various cellular processes, including muscle contraction and cell signaling.

**Apoptosis Regulation:** Mitochondria are involved in programmed cell death (apoptosis) by releasing certain proteins that trigger apoptotic pathways.

**Redox Reactions:** Mitochondria are key players in redox reactions, facilitating the transfer of electrons during oxidative phosphorylation and other metabolic processes.

**Fatty Acid Oxidation:** Mitochondria are responsible for the breakdown of fatty acids through beta-oxidation, contributing to energy production.

**Heat Production:** Brown adipose tissue mitochondria have a specific role in generating heat through a process called non-shivering thermogenesis.

**Cellular Signaling:** Mitochondria participate in cellular signaling pathways, influencing responses to stress, nutrient availability, and other environmental factors.

**Maintenance of Cellular Homeostasis:** Mitochondria contribute to the maintenance of cellular homeostasis by regulating the production of reactive oxygen species (ROS) and participating in cellular defense mechanisms.

**Inheritance:** Mitochondria have their own DNA (mitochondrial DNA or mtDNA) and are inherited maternally. This unique feature is important for understanding human genetics and evolutionary studies.

## 12. Write steps of Meiosis II.

**1. Prophase II:** Chromosomes condense, and the nuclear envelope breaks down. Spindle fibers form and attach to the centromeres of sister chromatids.

**2. Metaphase II:** Chromosomes align along the equatorial plane (metaphase plate) of the cell.

**3. Anaphase II:** Sister chromatids separate and move towards opposite poles of the cell.

**4. Telophase II:** Chromosomes reach the poles, and a nuclear envelope reforms around each set of chromosomes.

**5. Cytokinesis II:** The cytoplasm is divided, resulting in the formation of four haploid daughter cells, each with half the number of chromosomes as the original cell.

## 13. What is P13k and its function.

PI3K stands for Phosphoinositide 3-kinase. It is a family of enzymes involved in various cellular functions, primarily related to cell growth, proliferation, survival, and intracellular signaling. Here's a brief overview of PI3K and its function:

**Function:**

* PI3K is a key component of cell signaling pathways that regulate cell survival, growth, and proliferation in response to extracellular signals.

* PI3K is crucial in insulin signaling, helping to regulate glucose metabolism by facilitating the uptake of glucose into cells.

* PI3K plays a role in cell motility and migration, which is important in processes like immune response and wound healing.

* PI3K signaling can also influence apoptosis, either promoting cell survival or triggering programmed cell death depending on the context.

* PI3K is involved in controlling the cell cycle, ensuring that cells progress through each stage in a regulated manner.

* Dysregulation of the PI3K pathway is often associated with cancer. Mutations or overactivity of PI3K can lead to uncontrolled cell growth and survival, contributing to the development of tumors.

## 14. Differentiate between homotopic and heterotopic.

In cell biology, the terms "homotopic" and "heterotopic" can be used to describe different aspects of cellular structures or processes. Here's a differentiation in the context of cell biology:

**1. Homotopic:**

Homotopic in cell biology typically refers to structures or processes within cells that are identical or similar in nature. Homotopic chromosomal regions refer to portions of homologous chromosomes that align with each other during processes like mitosis or meiosis.

**2. Heterotopic:**

Heterotopic in cell biology indicates structures or processes within a cell that are different or dissimilar. Heterotopic organelles may refer to organelles with distinct functions and characteristics, such as the endoplasmic reticulum and the mitochondria.

## 15. What is principle of Laminar flow?

The principle of laminar flow is a concept related to fluid dynamics, particularly the flow of fluids (liquids or gases) through a conduit or a pipe. Laminar flow is characterized by smooth, orderly layers of fluid moving parallel to each other with minimal disruption between the layers. The key principles of laminar flow include:

1. In laminar flow, the fluid moves in distinct layers or laminae, and each layer flows smoothly without significant mixing with adjacent layers.

2. Laminar flow typically occurs at low Reynolds numbers. The Reynolds number (Re) is a dimensionless parameter that characterizes the flow regime of a fluid and is defined by the ratio of inertial forces to viscous forces. Low Reynolds numbers are associated with laminar flow, where viscous forces dominate over inertial forces.

3. In laminar flow, the pathways of individual fluid particles are predictable, and there is a well-defined, orderly motion of the fluid. The fluid moves in streamlined paths without chaotic turbulence.

4. Viscous forces, which arise due to the internal friction between adjacent layers of fluid, are the dominant forces in laminar flow. These forces help maintain the ordered movement of fluid layers.

5. Laminar flow is often reversible, meaning that if the direction of the flow is reversed, the layers of fluid will follow the same ordered pattern.

## 16. Explain Lactin Pathway.

Lactate is a byproduct of anaerobic metabolism that occurs in various cells, especially during intense physical exercise. Here's a simplified explanation of lactate production in the context of cellular metabolism:

### 1. Glycolysis:

***Initial Steps:*** In the cytoplasm of cells, glucose undergoes glycolysis, a series of enzymatic reactions that break down glucose into pyruvate.

***Aerobic Conditions:*** Under normal aerobic conditions (presence of oxygen), pyruvate enters the mitochondria and undergoes further oxidation in the citric acid cycle and oxidative phosphorylation, producing a large amount of ATP.

### 2. Anaerobic Conditions:

***Limited Oxygen:*** When oxygen is limited (during intense exercise or insufficient oxygen supply), cells may shift to anaerobic metabolism.

***Lactate Production:*** Instead of entering the mitochondria, pyruvate is converted to lactate in the cytoplasm by the enzyme lactate dehydrogenase.

***NADH Recycling:*** The conversion of pyruvate to lactate helps regenerate NAD+ from NADH. This recycling is crucial for maintaining the glycolytic pathway, as glycolysis requires NAD+.

### 3. Lactate as an Energy Source:

***Cori Cycle:*** Lactate can be transported to the liver, where it is converted back to glucose through a process called the Cori cycle. This glucose can then be released into the bloodstream and used by other tissues as an energy source.

## 17. Write steps of PCR.

**1. Denaturation:** DNA is heated to separate the double strands, resulting in denaturation.

**2. Annealing:** Primers bind to the complementary sequences on each DNA strand.

**3. Extension:** DNA polymerase synthesizes new strands by adding nucleotides to the primers.

**4. Repeat:** Steps 1-3 are repeated in cycles to exponentially amplify the target DNA.

## 18. What is function of intracellular receptor?

The function of intracellular receptors is to bind to specific signaling molecules that can diffuse across the cell membrane and regulate gene expression in the nucleus.

## 19. What is phenylketonuria and its causes?

Phenylketonuria (PKU) is a genetic disorder characterized by the inability to metabolize an amino acid called phenylalanine. Phenylalanine is normally obtained through the diet, especially from protein-containing foods. In individuals with PKU, a specific enzyme called phenylalanine hydroxylase is either deficient or absent, leading to the accumulation of phenylalanine in the blood and body tissues.

### Causes:

***1. Genetic Mutation***: PKU is caused by mutations in the PAH gene, which provides instructions for making the phenylalanine hydroxylase enzyme. These mutations result in a dysfunctional enzyme or its absence.

***2. Autosomal Recessive Inheritance:*** PKU is inherited in an autosomal recessive manner, meaning that an individual must inherit two mutated copies of the PAH gene (one from each parent) to develop the disorder.

***3. Phenylalanine Hydroxylase Deficiency:*** The primary cause is a deficiency of the phenylalanine hydroxylase enzyme, which normally converts phenylalanine into another amino acid, tyrosine.

## 20. Differentiate between purines and pyramidines.

Purines and pyrimidines are two types of nitrogenous bases that are fundamental building blocks of nucleic acids, such as DNA and RNA. Here are the main differences between them:

### Purines:

Purines are larger, double-ring structures. Adenine (A) and Guanine (G) are the two purine bases found in DNA and RNA. Purines have a two-ring structure known as a double-ring or bicyclic structure. In DNA, adenine (A) pairs with thymine (T), and guanine (G) pairs with cytosine (C). Adenine and guanine are examples of purines.

### Pyrimidines:

Pyrimidines are smaller, single-ring structures. Cytosine (C), Thymine (T) in DNA, and Uracil (U) in RNA are the pyrimidine bases. Pyrimidines have a single-ring or monocyclic structure. In DNA, cytosine (C) pairs with guanine (G), and thymine (T) pairs with adenine (A). In RNA, uracil (U) replaces thymine and pairs with adenine (A). Cytosine, thymine, and uracil are examples of pyrimidines.

## 21. What are strategies of transcriptions?

Transcription is the process by which genetic information in DNA is used to synthesize RNA. The key strategies involved in transcription include:

**1. Initiation:**

- RNA polymerase binds to the promoter region on the DNA.
- DNA strands are separated, forming a transcription bubble.
- The initiation of transcription begins.

**2. Elongation:**

- RNA polymerase reads the template strand of DNA and synthesizes a complementary RNA strand by adding nucleotides.
- The RNA chain grows in the 5' to 3' direction.

**3. Termination:**

- Transcription continues until a termination signal is reached.
- In prokaryotes, termination often involves a specific DNA sequence that causes RNA polymerase to detach from the DNA and release the newly synthesized RNA.
- In eukaryotes, termination is more complex and involves cleavage and polyadenylation of the RNA transcript.

**4. Regulation of Transcription:**

- Transcription is tightly regulated to control gene expression.
- Transcription factors bind to specific DNA sequences, either enhancing or inhibiting transcription.
- Epigenetic modifications, such as DNA methylation and histone acetylation, can influence transcriptional activity.

**5. Proofreading and Repair:**

- RNA polymerase includes proofreading mechanisms to ensure accurate base pairing during transcription.
- DNA repair mechanisms fix errors in the DNA template.

## 22. What are types of antibodies?

Antibodies, also known as immunoglobulins (Ig), are proteins produced by the immune system in response to the presence of foreign substances (antigens). There are five main types of antibodies:

**1. IgM (Immunoglobulin M):**

***Structure:*** Pentamer (five units).
***Function:*** Early immune response, activates complement system.

**2. IgG (Immunoglobulin G):**
***Structure:*** Monomer (single unit).
***Function:*** Most abundant, provides long-term immunity, crosses placenta.

**3. IgA (Immunoglobulin A):**
***Structure:*** Monomer in serum; dimer or trimer in secretions.
***Function:*** Found in body secretions, prevents microbial attachment.

**4. IgD (Immunoglobulin D):**
***Structure:*** Monomer.
***Function:*** Found on B cell surface, involved in B cell activation.

**5. IgE (Immunoglobulin E):**
***Structure:*** Monomer.
***Function:*** Involved in allergic reactions, triggers histamine release.

## 23. Write functions of DNA.

- DNA serves as the storage of genetic information, encoding the instructions for the development, functioning, and regulation of living organisms.
- Transmission of Genetic Information: During cell division, DNA is faithfully replicated, ensuring that genetic information is passed from one generation of cells to the next.
- DNA provides the instructions for protein synthesis through a process called transcription, where RNA is produced, and translation, where proteins are synthesized based on the RNA code.
- DNA contains regulatory elements that control the timing and level of gene expression, influencing cellular processes and responses to environmental cues.
- DNA is the carrier of hereditary traits, determining the genetic characteristics passed from parents to offspring.
- Through processes like recombination and mutation, DNA contributes to genetic diversity within populations, facilitating adaptation and evolution.
- DNA repair mechanisms ensure the integrity of the genetic code by fixing errors and damage caused by various internal and external factors.
- DNA methylation and histone modifications contribute to epigenetic regulation, influencing gene expression without altering the underlying DNA sequence.

- DNA, along with proteins, forms chromatin and chromosomes, organizing and compacting genetic material within the cell nucleus.

- DNA can be transcribed into RNA, and the sequence information can be used for various purposes, including the synthesis of complementary DNA (cDNA) or studying gene expression patterns.

- DNA analysis is used in forensic science for identifying individuals based on their unique DNA profiles.

## 24. Explain signaling in olfactions.

**1. Odor Detection:**

Odorants bind to odorant receptors on olfactory receptor neurons (ORNs) in the nasal cavity.

**2. Signal Transduction:**

Odorant binding activates a signaling cascade, leading to the production of cyclic AMP.

**3. Ion Influx:**

cAMP opens ion channels, allowing an influx of ions into the ORNs.

**4. Action Potential:**

Ion influx generates an action potential in the ORNs.

**5. Transmission to Olfactory Bulb:**

Action potential travels to the olfactory bulb in the brain.

**6. Synaptic Transmission:**

ORNs synapse with mitral cells in the olfactory bulb.

**7. Perception:**

Information is transmitted to higher brain regions for the perception and recognition of specific odors.

## 25. Which phase is reverse of prophase?

The reverse phase of prophase is telophase.

## 26. What are models of replication?

**1. Semi-Conservative Replication Model:**

Each strand of the original DNA serves as a template for a new strand. This results in two daughter DNA molecules, each with one old and one newly synthesized strand.

**2. Conservative Replication Model:**

Original DNA remains intact, and a new DNA molecule is formed alongside it. Result is one daughter DNA molecule with both original strands and one with entirely new strands.

**3. Dispersive Replication Model:**

DNA replication results in a mixture of old and new DNA segments dispersed along each strand. Result is daughter DNA molecules with segments of both old and new DNA.

## 27. What is clonal selection?

Clonal selection is a fundamental concept in immunology where specific immune cells are activated upon encountering an antigen, leading to the production of a clone of cells with identical antigen specificity. This process forms the basis of adaptive immunity, generating effector cells for immediate response and memory cells for long-term immunological memory.

## 28. Write applications of PCR.

- PCR is widely used to amplify specific DNA sequences for various downstream applications.
- PCR is employed in genetic testing for the identification of genetic disorders and mutations.
- PCR is used in forensic science to analyze DNA evidence from crime scenes.
- PCR is utilized for the detection of infectious diseases and monitoring viral loads.
- PCR is used in molecular biology to generate copies of DNA fragments for cloning.
- PCR is used to detect and identify microorganisms in environmental samples.
- PCR is applied in drug development for screening and analysis of potential drug targets.
- PCR is employed for the detection of viral infections in both clinical and research settings.
- PCR is applied for the detection of pathogens and contaminants in the food industry.
- PCR is used for molecular typing and fingerprinting in various biological samples.
- PCR is employed for identifying species in biodiversity studies.
- PCR is a crucial tool in medical research for investigating various aspects of genetics and molecular biology.

## 29. Name organelles of cell.

1. Nucleus
2. Mitochondria
3. Endoplasmic Reticulum
4. Golgi Apparatus
5. Ribosomes
6. Lysosomes
7. Vacuoles (in plant cells)
8. Chloroplasts (in plant cells)
9. Peroxisomes
10. Cytoskeleton

## 30. Differentiate between T and B cells.

**T Cells:**

- Developed in the thymus.
- Responsible for cell-mediated immunity.
- Have T cell receptors (TCRs) to recognize antigens.
- Differentiate into helper T cells, cytotoxic T cells, and regulatory T cells.

**B Cells:**

- Developed in the bone marrow.
- Responsible for humoral immunity.
- Have B cell receptors (BCRs) to recognize antigens.
- Differentiate into plasma cells that produce antibodies and memory B cells.

## 31. Briefly explain the large subunits of ribosomes.

The large subunit of ribosomes is a structural component essential for protein synthesis. In eukaryotes, such as human cells, the large subunit is composed of various ribosomal RNA (rRNA) molecules and numerous proteins. The primary rRNA molecules involved in the large subunit are 28S, 5.8S, and 5S rRNA.

**1. 28S rRNA:** This ribosomal RNA molecule, along with other associated proteins, forms the major catalytic center of the large subunit. It plays a central role in peptide bond formation during protein synthesis.

**2. 5.8S rRNA:** This rRNA molecule is also involved in the catalytic activity of the large subunit, contributing to the overall structure and function of the ribosome.

**3. 5S rRNA:** This smaller rRNA molecule is part of the large subunit and contributes to the stability and proper folding of the ribosomal RNA.

## 32. How beta blocker effect the function of adrenaline?

Beta blockers block the beta-adrenergic receptors, preventing adrenaline from binding. This reduces heart rate, force of contraction, and blood pressure, counteracting the physiological effects of adrenaline and managing conditions like hypertension and angina.

## 33. Define smooth endoplasmic reticulum.

**Smooth Endoplasmic Reticulum (SER):**

**Structure:** Tubular network without ribosomes on its surface.
**Function:** Lipid synthesis, detoxification of drugs and poisons, storage of calcium ions.
**Location:** Abundant in cells with high lipid metabolism, such as liver cells.

## 34. Write short note on genetic engineering.

Genetic engineering is a revolutionary field in biotechnology that encompasses the deliberate manipulation of an organism's genetic material. At the core of this technology is recombinant DNA, enabling the introduction of specific genes or DNA segments into the genetic makeup of an organism. This powerful capability has found applications across diverse fields. In agriculture, genetically modified crops are engineered to exhibit traits like resistance to pests, diseases, or herbicides, contributing to improved crop yields and sustainability. In medicine, genetic engineering facilitates the production of therapeutic proteins, the correction of genetic disorders through gene therapy, and advancements in personalized medicine. Despite its transformative potential, genetic engineering raises ethical concerns regarding the responsible use of genetic information, potential environmental impacts of genetically modified organisms (GMOs), and the need for thoughtful regulatory frameworks. The completion of the Human Genome Project has further deepened our understanding of genetics, opening new avenues for research and application in this dynamic and rapidly evolving field.

## 35. Name five major growth promoting oncogens.

1. Ras (H-Ras, K-Ras, N-Ras)
2. c-Myc
3. HER2 (ErbB2)
4. Bcl-2
5. EGFR (Epidermal Growth Factor Receptor)

## 36. Define genotype, phenotype, homozygous and heterozygous.

**1. Genotype:**

The genetic makeup of an individual, represented by the combination of alleles present in its genes.

**2. Phenotype:**

The observable traits or characteristics of an organism, determined by its genotype and influenced by environmental factors.

**3. Homozygous:**

Having identical alleles for a particular gene locus on homologous chromosomes.

**4. Heterozygous:**

Having different alleles for a particular gene locus on homologous chromosomes.

## 37. Explain double pass transmembrane and multiple pass transmembrane.

**Double Pass Transmembrane:**

In a double pass transmembrane protein, the polypeptide chain crosses the lipid bilayer of the cell membrane twice. This means that the protein has two transmembrane segments or regions. Each transmembrane segment typically consists of hydrophobic amino acid residues that facilitate the insertion and anchoring of the protein within the lipid bilayer. Examples of double pass transmembrane proteins include certain receptors and transporters, where the protein traverses the membrane, with portions exposed on both the extracellular and intracellular sides.

**Multiple Pass Transmembrane:**

In contrast, a multiple pass transmembrane protein crosses the lipid bilayer more than twice. This class of membrane proteins can have three or more transmembrane segments. The specific arrangement and number of transmembrane segments contribute to the overall structure and function of the protein. Examples of multiple pass transmembrane proteins include G protein-coupled receptors (GPCRs), ion channels, and some transporters. The multiple pass architecture allows these proteins to span the membrane multiple times, interacting with different regions of the lipid bilayer and facilitating diverse cellular functions.

## 38. Define endocytosis, pinocytosis, phagocytosis and exocytosis.

**1. Endocytosis:**

A cellular process by which cells engulf substances from the external environment by invaginating the cell membrane to form vesicles that bring the engulfed material into the cell.

**2. Pinocytosis:**

A type of endocytosis in which cells engulf fluids or dissolved substances by forming small vesicles at the cell membrane.

**3. Phagocytosis:**

A form of endocytosis where cells engulf large solid particles, such as bacteria or debris, by extending pseudopodia around the particle and enclosing it within a phagocytic vesicle.

**4. Exocytosis:**

The process by which cells expel substances from the cell interior to the external environment. This involves the fusion of vesicles containing the material with the cell membrane, releasing the contents outside the cell.

## 39. Write functions of N-terminal signaling.

- Guides proteins to the endoplasmic reticulum (ER) during translation.
- Initiates co-translational translocation into the ER.
- Undergoes cleavage during or after translocation.
- Facilitates proper protein folding within the ER.
- Prevents premature folding in the cytoplasm.
- Aids in sorting and targeting proteins to specific organelles.
- Regulates protein secretion by determining whether a protein is secreted or retained.

## 40. What are adult stem cells and their benefits?

Adult stem cells, also known as somatic or tissue-specific stem cells, are undifferentiated cells found in various tissues of the adult body. These cells have the capacity to differentiate into specialized cell types within the tissue where they reside. Here are some key aspects and potential benefits associated with adult stem cells:

- Adult stem cells play a crucial role in tissue repair and regeneration by differentiating into specialized cells needed to replace damaged or lost cells in specific tissues.

- Adult stem cells contribute to the maintenance of tissue homeostasis by continually replenishing cells that are constantly being turned over in various tissues, such as the skin, blood, and intestinal lining.

- Adult stem cells are multipotent or unipotent, meaning they have a limited differentiation potential and can give rise to specific cell types within their tissue of origin.

- Adult stem cells generally have a lower risk of forming tumors compared to pluripotent stem cells like embryonic stem cells. This lower risk makes them potentially safer for therapeutic applications.

- The use of adult stem cells raises fewer ethical concerns compared to embryonic stem cells, as their extraction does not involve the destruction of embryos.

- Adult stem cells can often be harvested from a patient's own body (autologous transplantation), reducing the risk of immune rejection and ethical concerns associated with using cells from other donors.

## 41. What are antibiotics?

Antibiotics are a class of drugs that are used to treat bacterial infections. They work by either killing bacteria or inhibiting their growth, thereby helping the body's immune system to overcome the infection. Antibiotics can be effective against a wide range of bacterial infections, from mild to severe.

There are different classes of antibiotics, and each class targets specific types of bacteria. Some common classes of antibiotics include penicillins, cephalosporins, tetracyclines, macrolides, fluoroquinolones, and others. Each class has its own mechanism of action and spectrum of activity.

## 42. What roles do lipids play?

**Energy Storage:**

- Lipids, particularly triglycerides, serve as a highly concentrated form of energy storage in the body.
- Adipose tissue stores excess energy in the form of triglycerides.

**Structural Component:**

- Phospholipids are essential components of cell membranes, contributing to their structure and fluidity.
- Sphingolipids also play a structural role in cell membranes.

**Insulation and Protection:**

- Lipids, especially adipose tissue, provide insulation and help protect organs from mechanical damage.
- They contribute to the formation of myelin, which insulates nerve cells and facilitates nerve signal transmission.

**Hormone Production:**

Steroid hormones, derived from cholesterol, play crucial roles in various physiological processes, including metabolism and reproduction.

**Cell Signaling:**

Lipids such as prostaglandins and leukotrienes act as signaling molecules, regulating inflammation, blood clotting, and other physiological responses.

**Absorption of Fat-Soluble Vitamins:**

Lipids aid in the absorption and transportation of fat-soluble vitamins (A, D, E, K) in the body.

**Buoyancy and Floatation:**

Lipids in some marine organisms contribute to buoyancy, helping them float in water.

**Thermal Regulation:**

Lipids contribute to thermal regulation by helping to insulate the body, particularly in cold environments.

**Metabolic Function:**

Lipids are involved in various metabolic processes, including beta-oxidation for energy production and ketogenesis during periods of low carbohydrate availability.

## 43. Write names of five subclasses of human IgG.

There are five subclasses of human IgG.

1. IgG1
2. IgG2
3. IgG3
4. IgG4

## 44. How proteins transport in mitochondria?

Proteins are transported into mitochondria through a process called mitochondrial protein import. This involves recognition of targeting sequences, translocation through the outer membrane, targeting to specific compartments (such as the matrix or intermembrane space), and subsequent cleavage of targeting sequences. Specialized translocases and chaperone proteins facilitate these processes.

## 45. Explain why cell is important?

Cells are the basic units of life and are essential for various reasons:

- They carry out vital functions, such as metabolism, growth, and reproduction.
- Cells form tissues, organs, and organisms, contributing to the overall structure and function of living organisms.
- Cellular processes maintain homeostasis, ensuring internal stability.
- Cells enable the transmission of genetic information through DNA, allowing for inheritance and evolution.

## 46. Describe structure of Antibody.

An antibody has a Y-shaped structure consisting of two heavy chains and two light chains. Each chain contains constant and variable regions. The variable regions form the antigen-binding site, providing specificity for antigen recognition. The constant regions determine the antibody's class and functional properties.

## 47. How turbutalene and B blocker effect the function of epinephrine adrenaline?

Terbutaline and beta-blockers (B blockers) have opposing effects on the function of epinephrine (adrenaline).

**Terbutaline:**

- Terbutaline is a beta-2 adrenergic receptor agonist.
- It mimics the action of epinephrine on beta-2 receptors.
- This leads to bronchodilation, relaxation of smooth muscle, and increased airflow in the respiratory system.

**Beta-blockers:**

- Beta-blockers, on the other hand, block the action of epinephrine on beta receptors.
- Beta-blockers are antagonists to beta receptors, inhibiting the effects of sympathetic stimulation.
- In the cardiovascular system, beta-blockers can reduce heart rate, blood pressure, and the force of heart contractions.

## 48. Write condition in which cell have specific binding?

The condition in which a cell exhibits specific binding is typically related to the presence of specific receptors on the cell membrane that can interact with ligands or molecules in a highly selective manner. This binding specificity occurs under certain conditions, including:

- Cells have specific receptors on their surfaces that recognize and bind to particular ligands or signaling molecules.

- The binding is often described by a "lock-and-key" mechanism, where the receptor (lock) has a specific binding site for a particular ligand (key).

- This specificity is crucial for various cellular processes, such as signal transduction, hormone response, and immune system recognition.

- Specific binding is involved in cellular recognition events, including the binding of antigens to antibodies on immune cells or the binding of neurotransmitters to receptors on nerve cells.

- Specific binding is essential for regulating biological functions and maintaining homeostasis within the organism.

## 49. What is inclusion cell diseases?

Inclusion cell diseases (also known as storage diseases) are a group of genetic disorders characterized by the accumulation of abnormal substances (inclusions) within cells. These substances are often metabolic byproducts that the cell cannot properly break down or eliminate.

One well-known example of an inclusion cell disease is Niemann-Pick disease, a lysosomal storage disorder where there is an abnormal buildup of lipids, specifically sphingomyelin, within cells.

## 50. Write function of cAm kinease.

cAMP-dependent protein kinase (also known as protein kinase A or PKA), here is its function:

- PKA is a serine/threonine kinase that plays a key role in cellular signaling.
- It is activated when cellular levels of cyclic AMP (cAMP) increase.
- PKA regulates various cellular processes by phosphorylating target proteins, which can lead to changes in their activity.
- Examples of PKA-regulated processes include glycogen metabolism, gene transcription, ion channel activity, and cell growth.
- PKA is involved in the response to extracellular signals, such as hormones like adrenaline, which trigger cAMP production and subsequent PKA activation.

## 51. Write mechanism of growth promoting factor.

**1. Reception of Growth Factor:**

External growth factors, such as certain proteins or hormones, bind to specific receptors on the cell surface.

**2. Activation of Receptors:**

Binding triggers a conformational change in the receptor, activating its intracellular domain.

**3. Intracellular Signaling Cascades:**

Activated receptors initiate intracellular signaling cascades. This often involves the activation of protein kinases.

**4. Phosphorylation Events:**

Protein kinases phosphorylate downstream signaling proteins. Phosphorylation serves as a signaling mechanism, transmitting the growth signal within the cell.

**5. Activation of Transcription Factors:**

Signaling pathways may converge on transcription factors, which translocate to the nucleus.

**6. Gene Expression Regulation:**

In the nucleus, transcription factors regulate the expression of genes involved in cell cycle progression, DNA replication, and cell growth.

**7. Cell Cycle Progression:**

Activation of specific genes promotes progression through the cell cycle, leading to DNA synthesis and cell division.

**8. Cell Growth and Division:**

As a result of the growth-promoting factor's action, the cell undergoes increased growth, division, or both.

## 52. Write functions of proteins.

- Proteins act as enzymes, catalyzing biochemical reactions and facilitating various metabolic processes.
- Proteins provide structural support to cells and tissues. Examples include collagen in connective tissues and keratin in hair and nails.
- Some proteins, like hemoglobin, transport molecules (e.g., oxygen) within the bloodstream.
- Signaling proteins relay messages within and between cells, regulating processes such as growth, differentiation, and response to external stimuli.
- Antibodies are proteins that play a crucial role in the immune system by recognizing and neutralizing foreign substances.
- Proteins like actin and myosin are essential for muscle contraction and movement.
- Some proteins, like insulin, act as hormones, regulating physiological processes such as glucose metabolism.
- Proteins contribute to cell adhesion, maintaining the integrity of tissues and facilitating interactions between cells.

- Proteins can store ions and molecules for later use, acting as reservoirs for essential substances.
- Certain proteins help maintain the pH balance within cells and biological fluids.
- Transcription factors and RNA polymerases are proteins involved in the regulation of gene expression.
- Proteins on cell membranes serve as receptors, allowing cells to respond to external signals and stimuli.
- Some proteins, like lysozyme, participate in the defense against pathogens by breaking down their cell walls.
- Proteins are involved in DNA replication, repair, and maintenance of genomic integrity.
- Enzymes involved in metabolic pathways, such as those in glycolysis or the citric acid cycle, are proteins.

## 53. What reagents are used in sterilizing?

1. Ethylene oxide
2. Hydrogen peroxide
3. Chlorine dioxide
4. Formaldehyde
5. Glutaraldehyde
6. Isopropyl alcohol
7. Peracetic acid
8. Gamma radiation
9. UV radiation
10. Autoclave (steam)

## 54. Write a short note on Gel Electrophoresis.

### Gel Electrophoresis:

Gel electrophoresis is a widely used laboratory technique that separates macromolecules, such as DNA, RNA, or proteins, based on their size and charge. It is a crucial tool in molecular biology, biochemistry, and genetics for analyzing and characterizing biomolecules.

**Principle:**

The principle of gel electrophoresis relies on the migration of charged particles through a gel matrix when an electric field is applied. The gel, typically made of agarose or polyacrylamide, provides a sieving effect, allowing smaller molecules to move through the matrix more easily than larger ones. The direction of migration is determined by the charge of the molecules: negatively charged molecules move towards the positive electrode, and positively charged molecules move towards the negative electrode.

## 55. How UV radiation causes sterilization?

UV radiation causes sterilization by damaging the genetic material (DNA or RNA) of microorganisms, disrupting their ability to replicate and preventing their reproduction. This is achieved through the formation of thymine dimers, which interfere with the normal structure of DNA and RNA, inhibiting cell division and rendering the microorganisms unable to reproduce.

## 56. Define prosthetic group with examples.

A prosthetic group is a non-protein molecule that is tightly and permanently attached to a protein, contributing to the structure and function of the protein. Unlike cofactors, which can be loosely bound and may associate with a protein reversibly, prosthetic groups are covalently bonded to the protein.

Examples of prosthetic groups include:

**1. Heme:** Found in hemoglobin and myoglobin, heme is a prosthetic group containing iron. It plays a crucial role in binding and transporting oxygen in red blood cells.

**2. Biotin:** Biotin is a prosthetic group that attaches covalently to certain enzymes, especially those involved in carboxylation reactions. It participates in various metabolic processes, including fatty acid synthesis.

**3. Flavin Mononucleotide (FMN) and Flavin Adenine Dinucleotide (FAD):** These are prosthetic groups containing the vitamin riboflavin (vitamin B2). They are involved in electron transfer reactions, often serving as cofactors for enzymes in cellular respiration.

**4. NAD (Nicotinamide Adenine Dinucleotide) and NADP (Nicotinamide Adenine Dinucleotide Phosphate):** These coenzymes serve as prosthetic groups and play essential roles in carrying and transferring electrons during various metabolic reactions.

**5. Ubiquinone (Coenzyme Q):** Ubiquinone is a lipid-soluble prosthetic group that participates in the electron transport chain of cellular respiration, shuttling electrons between protein complexes.

## 57. Define with example: incomplete dominance, codominance, epistasis.

**1. Incomplete Dominance:**

In incomplete dominance, neither of two alleles is completely dominant over the other. The heterozygous phenotype is an intermediate blend of the homozygous phenotypes. For example, in snapdragons, the gene for flower color exhibits incomplete dominance. Red (RR) and white (rr) homozygotes produce red and white flowers, respectively, while heterozygotes (Rr) exhibit pink flowers.

**2. Codominance:**

In codominance, both alleles of a gene are expressed fully in the heterozygous phenotype. Instead of blending, both traits are visibly present. For example, ABO blood group system. Alleles for blood type (A and B) are codominant. Individuals with AB blood type express both A and B antigens on their red blood cells.

**3. Epistasis:**

Epistasis occurs when the expression of one gene masks or modifies the expression of another gene at a different locus. For example, in coat color in dogs, the gene responsible for pigment production (B/b) is epistatic to the gene controlling whether pigment is deposited in the hair (C/c). If a dog has the recessive genotype (bb) for pigment production, the coat color will be determined solely by the presence or absence of the pigment (C/c) gene, making it an epistatic interaction.

## 58. Differentiate between confluent monolayer & past confluency stages.

A confluent monolayer refers to a cell culture where cells have grown to cover the entire surface of the culture vessel, forming a continuous and uniform layer. Past confluency, on the other hand, occurs when cells continue to proliferate beyond the confluent monolayer stage, leading to overcrowding, reduced cell-to-cell contact, and potential alterations in cell behavior. In the past confluency stage, cells may stack on top of each other, and nutrient and oxygen availability may become limited, affecting cellular responses and functions.

## 59. Differentiate between T1 and cytotoxin.

T1 is a bacteriophage, a virus that infects bacteria, particularly Escherichia coli (E. coli). Its primary role is to infect and replicate within bacterial cells.

Cytotoxins are toxic substances that can cause damage or death to cells. In the context of bacteria, cytotoxins are typically produced by certain strains and can harm host cells or contribute to the bacteria's pathogenicity. Cytotoxins may have various mechanisms of action and can affect cells of different organisms, including bacteria.

## 60. What are regulatory sequence and its two elements?

A regulatory sequence is a segment of DNA that controls the expression of genes. It plays a crucial role in determining when and to what extent a particular gene is transcribed into mRNA and translated into a protein. Regulatory sequences can be located upstream or downstream of a gene and serve as binding sites for regulatory proteins.

Two common elements within regulatory sequences are:

**1. Promoter:**

A promoter is a specific region of DNA that serves as the initiation site for transcription. It is located upstream of the coding sequence of a gene. The promoter contains binding sites for RNA polymerase and transcription factors. RNA polymerase binds to the promoter, initiating the process of transcription.

**2. Enhancer:**

An enhancer is a DNA sequence that can be located upstream, downstream, or within the introns of a gene. It acts to enhance the activity of the promoter and increase gene transcription. Enhancers contain binding sites for specific transcription factors. When these transcription factors bind to the enhancer, they facilitate the recruitment of RNA polymerase to the promoter, promoting transcription.

## 61. Write role of rod cells in vision process.

Rod cells play a crucial role in the vision process, particularly in low-light or dim-light conditions. Here are their key functions:

1. Rod cells are highly sensitive to low levels of light. They allow us to see in conditions of low illumination, such as during nighttime.

2. Rod cells are predominantly located in the peripheral regions of the retina. This distribution makes them essential for peripheral vision, helping us detect motion and objects in our side vision.

3. Rod cells are responsible for monochromatic (black and white) vision. They are not as effective in distinguishing different colors compared to cone cells, which are responsible for color vision.

4. Rod cells contain a light-sensitive pigment called rhodopsin. When exposed to light, rhodopsin undergoes a chemical reaction, leading to the generation of electrical signals that initiate the visual signal transduction cascade.

5. When light strikes the rhodopsin molecules in rod cells, it triggers a series of events that result in the generation of electrical signals. These signals are then transmitted to the brain via the optic nerve, allowing us to perceive the visual information even in low-light conditions.

62.