BIO201 – CELL BIOLOGY

MID TERM MOST IMPORTANT QUESTIONS

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1. Write steps of Meiosis.

Meiosis is a cellular process that results in the formation of gametes (sperm and egg cells) with half the number of chromosomes compared to the parent cell. It involves two successive divisions: meiosis I and meiosis II. Here are the steps of meiosis:

1. Meiosis I: Reduction Division

- ***Prophase I:*** Chromosomes condense, homologous chromosomes pair up (synapsis), and genetic recombination (crossing over) occurs.
- ***Metaphase I:*** Homologous chromosome pairs align at the cell's equator (metaphase plate).
- ***Anaphase I:*** Homologous chromosomes separate and move to opposite poles, reducing the chromosome number.
- ***Telophase I:*** Chromosomes reach the poles, and the cell undergoes cytokinesis, resulting in two haploid daughter cells.

2. Meiosis II: Equational Division

- ***Prophase II:*** Chromosomes condense again in each haploid cell.
- ***Metaphase II:*** Chromosomes align at the metaphase plate in both cells.
- ***Anaphase II:*** Sister chromatids separate and move to opposite poles.
- ***Telophase II:*** Chromatids reach the poles, and cytokinesis occurs, producing four haploid daughter cells, each with unique genetic content.

2. What are the models of replication?

DNA replication models describe the mechanisms by which cells duplicate genetic material. The prominent Semiconservative Model, proposed by Watson and Crick, asserts that during replication, each parent DNA strand acts as a template for a new, complementary strand, preserving genetic information. Another theoretical model, the Conservative Model, suggests that the parent DNA remains intact, and an entirely new strand forms alongside it. Experimental evidence strongly supports the Semiconservative Model, affirming its acceptance in biology. In cellular DNA replication, the semiconservative model prevails, ensuring faithful transmission of genetic material to successive generations.

3. Differentiate between DNA and RNA.

DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are both essential nucleic acids, but they differ in structure, function, and location within cells. DNA, the genetic blueprint of life, is typically a double-stranded molecule found in the cell nucleus. Its structure includes a sugar-phosphate backbone with four nitrogenous bases: adenine (A), thymine (T), cytosine (C), and guanine (G). The pairing of these bases (A-T and C-G) forms the double helix.

On the other hand, RNA is usually a single-stranded molecule found in the nucleus and cytoplasm. It contains ribose sugar instead of deoxyribose and substitutes uracil (U) for thymine. RNA plays various roles, including carrying genetic information from DNA to the protein synthesis machinery during transcription and serving as structural and catalytic components of ribosomes.

While DNA is stable and primarily involved in storing genetic information, RNA is versatile, participating in gene expression, protein synthesis, and other cellular processes. Overall, DNA and RNA collaborate to regulate and perpetuate the genetic code within living organisms.

4. Amino acid is made up of which molecules?

Amino acids, the building blocks of proteins, are composed of three key molecules: amino groups (NH_2), carboxyl groups (COOH), and a side chain (R group). The general structure of an amino acid consists of a central carbon atom (the alpha carbon) bonded to a hydrogen atom, an amino group, a carboxyl group, and the variable side chain. The side chain differs among the 20 different amino acids, providing each with its unique properties.

The amino group (NH_2) contributes basic characteristics, while the carboxyl group (COOH) adds acidity. The side chain's composition determines the specific amino acid and influences the overall properties of the protein. During protein synthesis, amino acids link together through peptide bonds, forming polypeptide chains that fold into functional proteins. Understanding the diverse structures of amino acids is crucial for comprehending the intricate three-dimensional structures and functions of proteins in biological systems.

5. Briefly discuss three models of replication.

Three models of DNA replication are the Semiconservative Model, Conservative Model, and Dispersive Model.

1. Semiconservative Model:

Proposed by Watson and Crick, this model suggests that during DNA replication, each original DNA strand serves as a template for the synthesis of a new, complementary strand. The resulting DNA molecule consists of one original (parental) strand and one newly synthesized strand.

2. Conservative Model:

In this theoretical model, the parental DNA molecule remains intact, and an entirely new, complementary strand is synthesized to form a daughter DNA molecule. The original DNA double helix remains unchanged.

3. Dispersive Model:

Proposed by Watson and Crick as an alternative to the semiconservative model, it suggests that during replication, each daughter DNA molecule is a hybrid of old and newly synthesized DNA, with segments of both interspersed.

6. What is cholesterol and its derivatives?

Cholesterol is a type of lipid that is essential for the structure and function of cell membranes in animals. It belongs to the sterol class of lipids and is a crucial component of the lipid bilayer that forms the cell membrane. Cholesterol also serves as a precursor for the synthesis of various important molecules in the body. It is synthesized in the liver and obtained through the diet.

Cholesterol derivatives include several important compounds:

1. ***Steroid Hormones:*** Cholesterol is a precursor for the synthesis of steroid hormones, including cortisol, aldosterone, estrogen, progesterone, and testosterone. These hormones play key roles in various physiological processes, such as metabolism, stress response, and reproduction.

2. ***Bile Acids:*** Cholesterol is converted into bile acids in the liver, and these acids are then released into the digestive system. Bile acids aid in the digestion and absorption of dietary fats in the small intestine.

3. ***Vitamin D:*** Cholesterol is involved in the synthesis of vitamin D. When the skin is exposed to sunlight, a form of vitamin D is produced from a cholesterol derivative. Vitamin D is essential for calcium absorption and bone health.

7. Differentiate in Polyploidy and Aneuploidy.

Polyploidy and aneuploidy are both terms used to describe abnormalities in the number of chromosomes in a cell, but they differ in their specifics:

1. Polyploidy:

Definition: Polyploidy is a condition where a cell or organism has more than two complete sets of chromosomes. It occurs when there is a whole-genome duplication.

Types: There are two main types of polyploidy: autopolyploidy and allopolyploidy. Autopolyploidy involves multiples of the same genome within a species, while allopolyploidy involves the combination of genomes from different species.

Common Examples: Many plants, and some animals, can naturally undergo polyploidization. For example, some common crops, like wheat and cotton, are often polyploid.

2. Aneuploidy:

Definition: Aneuploidy is a condition where a cell or organism has an abnormal number of chromosomes, but not a complete set. It results from the loss or gain of one or more individual chromosomes.

Types: Aneuploidy can involve either monosomy (loss of one chromosome) or trisomy (gain of one chromosome). Down syndrome (trisomy 21) is a well-known example of aneuploidy in humans.

Causes: Aneuploidy can occur due to errors in cell division, such as nondisjunction during meiosis, leading to an unequal distribution of chromosomes in daughter cells.

8. Write importance of proteins.

Structural Foundation: Proteins are fundamental building blocks of cells, tissues, and organs, providing the structural basis for muscles, skin, hair, and nails.

Enzymatic Functions: Enzymes, specialized proteins, act as catalysts in biochemical reactions, facilitating and accelerating vital metabolic processes.

Transportation and Storage: Proteins are essential for transporting molecules within the body. For example, hemoglobin transports oxygen in the blood, and ferritin stores and releases iron as needed.

Immune System Support: Antibodies, proteins produced by the immune system, identify and neutralize harmful substances like bacteria and viruses, contributing to the body's defense mechanisms.

Cellular Communication: Signaling proteins play a crucial role in transmitting signals within and between cells, regulating various physiological processes.

Energy Source: In the absence of carbohydrates and fats, proteins can be used as an energy source, especially during periods of low carbohydrate intake or intense physical activity.

Hormonal Regulation: Certain proteins, such as hormones, help regulate various physiological processes, including growth, development, and metabolism.

Enzymatic Defense: Some proteins function as enzymes in the immune system, participating in defense mechanisms against pathogens and foreign invaders.

Maintaining pH Balance: Proteins help maintain the body's pH balance by acting as buffers, preventing rapid and harmful changes in acidity or alkalinity.

Genetic Expression: Proteins play a crucial role in genetic expression, serving as enzymes in DNA replication, transcription, and translation.

Repair and Maintenance: Proteins are essential for the repair and maintenance of tissues, ensuring the continuous renewal and health of the body's structures.

9. Explain large subunits of ribosomes.

The large subunit of ribosomes comprises of 50S subunit in prokaryotes and the 60S subunit in eukaryotes. It is integral to the translation of mRNA into polypeptide chains. This subunit accommodates ribosomal RNA (rRNA) molecules crucial for catalyzing peptide bond formation during protein synthesis. It houses the peptidyl transferase center, facilitating the elongation of the polypeptide chain. Three tRNA binding sites (A, P, and E sites) within the large subunit orchestrate the movement of tRNA and amino acids through the ribosome. Additionally, the large subunit features an exit tunnel, providing a protected pathway for the nascent protein to fold into its functional structure. Through its catalytic functions and interaction with the small subunit, the large subunit ensures the accurate and efficient translation of genetic information into functional proteins.

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10. Write functions of cell membrane.

Cellular Enclosure and Boundary: Defines the outer boundary of the cell, separating its internal environment from the external surroundings.

Selective Permeability: Regulates the passage of substances into and out of the cell, allowing some molecules to pass while restricting others.

Transport of Molecules: Facilitates the movement of ions, nutrients, and waste products across the membrane through various transport mechanisms.

Cell Signaling: Contains receptors and signaling molecules that allow cells to communicate with each other, coordinating cellular activities.

Cell Adhesion: Participates in cell adhesion, enabling cells to stick together and form tissues and organs.

Structural Support: Provides structural support to the cell, maintaining its shape and integrity.

Protection from the Environment: Acts as a barrier, protecting the cell from external factors, such as pathogens and changes in osmotic pressure.

Endocytosis and Exocytosis: Facilitates endocytosis, the process of engulfing substances into the cell via vesicles, and exocytosis, the release of substances from the cell.

Cellular Recognition: Contains glycoproteins and other molecules involved in cell recognition and immune responses.

Energy Production: Houses enzymes and proteins involved in cellular respiration and photosynthesis in the inner membranes of mitochondria and chloroplasts, respectively.

11. Write short note on transcription.

Transcription:

Transcription is the process by which the genetic information encoded in DNA is used to synthesize a complementary RNA molecule, specifically messenger RNA (mRNA).

- ***Initiation:*** RNA polymerase binds to the DNA promoter region, initiating transcription.
- ***Elongation:*** RNA polymerase moves along the DNA template strand, synthesizing a complementary mRNA strand.
- ***Termination:*** Transcription ends as RNA polymerase reaches a terminator sequence, and the newly formed mRNA is released.
- ***Result:*** The mRNA carries genetic instructions from DNA to the ribosomes, where it serves as a template for protein synthesis during translation.

12. Write difference between coenzyme, cofactor & prosthetic group with examples.

Coenzyme:

Definition: Coenzymes are small organic molecules that assist enzymes in catalyzing reactions. They often carry chemical groups between enzymes and are essential for the enzyme's activity.

Nature: Coenzymes are usually complex organic molecules, often derived from vitamins.

Attachment: Coenzymes are loosely bound to enzymes and can be released from the enzyme's active site after a reaction.

Examples: Nicotinamide adenine dinucleotide (NAD+), flavin adenine dinucleotide (FAD), and coenzyme A (CoA) are examples of coenzymes.

Cofactor:

Definition: Cofactors are chemical entities, which can be either inorganic ions or coenzymes, that assist enzymes in performing catalytic activities.

Nature: Cofactors can be either inorganic (metal ions) or organic (coenzymes).

Attachment: Inorganic cofactors are often tightly bound to the enzyme and may participate directly in catalysis. Coenzymes, as mentioned earlier, are loosely bound.

Examples: Zinc ions, magnesium ions, and iron-sulfur clusters are examples of inorganic cofactors. NAD+, FAD, and CoA can also be considered examples when serving as cofactors.

Prosthetic Group:

Definition: A prosthetic group is a non-protein component that is tightly and permanently attached to an enzyme and is essential for its function.

Nature: Prosthetic groups can be either organic or inorganic.

Attachment: Prosthetic groups remain tightly bound to the enzyme throughout its life cycle.

Examples: Heme, which contains iron and is a part of hemoglobin, is a prosthetic group. Biotin, a vitamin-derived molecule, is another example when tightly bound to enzymes like biotin-dependent carboxylases.

13. Write the functions of Golgi apparatus.

Protein Modification: Adds carbohydrate chains to proteins (glycosylation) for proper folding and function.

Sorting and Packaging: Sorts and packages proteins into vesicles for transportation to specific cellular destinations.

Lipid Modification: Modifies and processes lipids, preparing them for various cellular functions.

Formation of Lysosomes: Plays a role in the formation of lysosomes, containing enzymes for intracellular digestion.

Secretory Vesicle Formation: Packages modified proteins into secretory vesicles for release from the cell.

Cellular Secretion: Facilitates the secretion of hormones, enzymes, and other substances from the cell.

Formation of Plant Cell Wall Components: In plant cells, synthesizes and modifies components of the cell wall.

Maintenance of Cellular Homeostasis: Involved in the transport and storage of ions, maintaining cellular balance.

Membrane Recycling: Participates in the recycling of cellular membrane components.

14. What are the requirements of PCR.

Polymerase Chain Reaction (PCR) is a widely used molecular biology technique for amplifying DNA. Several key components and conditions are necessary for a successful PCR reaction. Here are the main requirements:

1. DNA Template:

The DNA sample containing the target sequence that needs to be amplified serves as the template for PCR. This could be genomic DNA, cDNA, or DNA from another source.

2. Primers:

Short single-stranded DNA sequences (primers) that are complementary to the sequences flanking the target region. Primers serve as starting points for DNA synthesis.

3. DNA Polymerase:

A heat-stable DNA polymerase enzyme is required to catalyze the synthesis of a new DNA strand. Taq polymerase, derived from the thermophilic bacterium Thermus aquaticus, is commonly used.

4. Nucleotides (dNTPs):

Deoxynucleotide triphosphates (dATP, dTTP, dCTP, and dGTP) are the building blocks for DNA synthesis. They are added in excess to ensure efficient DNA amplification.

5. Buffer Solution:

PCR buffer provides the optimal pH and ionic conditions for the activity of the DNA polymerase. It also contains salts and stabilizers to support the reaction.

6. Magnesium ions (Mg2+):

Magnesium ions are essential cofactors for the activity of DNA polymerase. The concentration of Mg2+ in the reaction needs to be optimized for efficient amplification.

7. Thermal Cycler:

A thermal cycler or PCR machine is necessary to cyclically alter the reaction temperature. PCR typically involves denaturation, annealing, and extension steps, each occurring at specific temperatures.

8. Reaction Vessels (Tubes or Plates):
Microcentrifuge tubes or multi-well plates are used to hold the reaction mixtures during the PCR process.

9. Thermal Cycling Program:
A specific thermal cycling program is required, involving a series of temperature changes to denature the DNA, anneal primers, and extend the DNA during each cycle.

10. Template DNA Purity:
High-quality, pure DNA templates are crucial for successful PCR. Contaminants, inhibitors, or degraded DNA can compromise the reaction.

11. Primer Design:
Well-designed primers with appropriate melting temperatures and specificity for the target sequence are essential for successful amplification.

15. What are importers, symporters & antiporters? How can we differentiate them?

1. Transporters:
Transporters are proteins involved in the movement of ions, molecules, or other substances across biological membranes. They play a crucial role in maintaining the internal environment of cells and organelles. Transporters can be broadly classified into several types, including importers, symporters, and antiporters.

2. Importers:
Importers are transport proteins that facilitate the movement of molecules into a cell or organelle. They are involved in the uptake of nutrients or other essential substances. Importers typically work against a concentration gradient, requiring energy input.

3. Symporters:
Symporters are a type of transporter that moves two different molecules or ions across a membrane in the same direction. These molecules move together through the transporter, utilizing the energy generated by one moving along its concentration gradient to power the movement of the other against its gradient.

4. Antiporters:
Antiporters, on the other hand, move two different molecules or ions across a membrane in opposite directions. The energy released from one moving down its concentration gradient is used to actively transport the other molecule against its gradient.

16. Differentiate between nucleotides and nucleosides?

Nucleosides:

Definition: Nucleosides are compounds composed of a nitrogenous base and a sugar molecule, without the phosphate group.

Components:

Nitrogenous Base: Can be adenine (A), guanine (G), cytosine (C), thymine (T), or uracil (U).
Sugar: Either ribose (in RNA) or deoxyribose (in DNA).

Formation: Nucleosides form when the nitrogenous base binds to the sugar through a glycosidic bond.

Role: Nucleosides serve as the building blocks for the synthesis of nucleotides, which are essential for the formation of DNA and RNA.

Nucleotides:

Definition: Nucleotides are molecules consisting of a nucleoside (nitrogenous base + sugar) linked to one or more phosphate groups.

Components:

Nucleoside: Nitrogenous base + Sugar (ribose or deoxyribose).
Phosphate Group(s): One or more phosphate groups.

Formation: Nucleotides form when a phosphate group attaches to the 5' carbon of the sugar in a nucleoside through a phosphodiester bond.

Role: Nucleotides are the monomeric units that make up nucleic acids (DNA and RNA). They are involved in genetic information storage and transfer, energy transfer (as ATP), and various cellular processes.

17. Write examples of RNA virus.

RNA viruses are a diverse group of viruses that use RNA as their genetic material. They can be further categorized based on the type of RNA they possess (single-stranded or double-stranded) and whether the RNA is positive-sense (acts as mRNA) or negative-sense (complementary to mRNA). Here are examples of RNA viruses:

1. Positive-Sense, Single-Stranded RNA Viruses:

Picornaviruses: Includes the common cold virus (Rhinovirus) and Enteroviruses such as poliovirus and coxsackievirus.
Flaviviruses: Zika virus, Dengue virus, West Nile virus, and Yellow fever virus are examples.

2. Positive-Sense, Double-Stranded RNA Viruses:

Reoviruses: Rotavirus, which causes gastroenteritis in humans, is a well-known example.

3. Negative-Sense, Single-Stranded RNA Viruses:

Orthomyxoviruses: Influenza viruses, including seasonal influenza and avian influenza strains.
Paramyxoviruses: Measles virus, Mumps virus, and Respiratory syncytial virus (RSV).

4. Negative-Sense, Double-Stranded RNA Viruses:

Some members of the family Reoviridae also have double-stranded RNA genomes.

5. Retroviruses (Single-Stranded RNA with Reverse Transcription):

Human Immunodeficiency Virus (HIV): Causes acquired immunodeficiency syndrome (AIDS).
Human T-cell Leukemia Virus (HTLV): Associated with certain forms of leukemia.

6. Hepatitis Viruses:

Hepatitis C Virus (HCV): A bloodborne virus causing hepatitis.
Hepatitis E Virus (HEV): Causes enteric hepatitis.

18. Explain messenger hypothesis.

Messenger RNA Hypothesis:

The messenger RNA hypothesis, also known as the central dogma of molecular biology, was proposed by Francis Crick in 1957. It describes the flow of genetic information within a biological system. The central dogma consists of three main processes:

1. Replication:

The process where DNA makes an identical copy of itself, ensuring the transmission of genetic information from one generation of cells to the next.

2. Transcription:

The synthesis of mRNA from a DNA template. During transcription, a specific segment of DNA (a gene) serves as a template for the synthesis of a complementary mRNA molecule. This newly synthesized mRNA carries the genetic information from the DNA to the ribosomes.

3. Translation:

The process where the information carried by mRNA is used to synthesize a corresponding protein. Ribosomes read the mRNA in groups of three nucleotides called codons, and each codon codes for a specific amino acid. Transfer RNA (tRNA) molecules bring the corresponding amino acids to the ribosome, facilitating the assembly of a polypeptide chain.

19. Explain Kreb's cycle.

The Krebs cycle, also known as the citric acid cycle or tricarboxylic acid (TCA) cycle, is a crucial part of cellular respiration, the process by which cells generate energy in the form of ATP. This cycle occurs in the mitochondria of eukaryotic cells and involves a series of chemical reactions that oxidize acetyl-CoA, a molecule derived from the breakdown of carbohydrates, fats, and proteins.

Here is a simplified overview of the Krebs Cycle:

1. Acetyl-CoA Entry:
The cycle begins when acetyl-CoA, produced from the breakdown of glucose or fatty acids, combines with a four-carbon molecule called oxaloacetate, forming citrate (citric acid).

2. Series of Reactions:
Through a series of enzyme-catalyzed reactions, citrate undergoes transformations, releasing two molecules of carbon dioxide (CO2) and transferring high-energy electrons to carrier molecules NAD+ and FAD.

3. Generation of Reduced Coenzymes:
NADH (reduced nicotinamide adenine dinucleotide) and FADH2 (reduced flavin adenine dinucleotide) are produced during the cycle. These carry high-energy electrons to the electron transport chain for ATP synthesis.

4. Regeneration of Oxaloacetate:
After completing one cycle, oxaloacetate is regenerated, allowing the cycle to continue. The process is continuous as long as acetyl-CoA is available.

5. Energy Yield:
The Krebs Cycle is not a direct producer of ATP but generates high-energy electron carriers (NADH and FADH2), which contribute to the electron transport chain's operation. The electron transport chain produces ATP through oxidative phosphorylation.

6. Overall Outcome:
For each turn of the Krebs Cycle (per acetyl-CoA molecule), three molecules of NADH, one molecule of FADH2, one molecule of ATP (or GTP, which can later be converted to ATP), and two molecules of CO2 are produced.

20. Explain coenzymes and its examples.

A coenzyme is a non-protein organic molecule that assists enzymes in carrying out various biochemical reactions. Coenzymes often work by carrying and transferring specific chemical groups, electrons, or functional units between enzymes and substrates. They are essential for the proper functioning of many enzymes, acting as cofactors that help catalyze reactions. Coenzymes are distinct from prosthetic groups, which are tightly bound to enzymes.

Examples of Coenzymes:

- NAD+ (Nicotinamide Adenine Dinucleotide)
- FAD (Flavin Adenine Dinucleotide)
- Coenzyme A (CoA)
- ATP (Adenosine Triphosphate)
- TPP (Thiamine Pyrophosphate)
- PLP (Pyridoxal Phosphate)

- Biotin
- SAM (S-Adenosyl Methionine)

21. Write role of proteins in living organisms.

Structural Support: Proteins provide structural support to cells, tissues, and organs, contributing to their form and integrity.

Enzymatic Catalysis: Act as enzymes, catalyzing biochemical reactions by facilitating the conversion of substrates into products.

Cellular Signaling: Participate in cell signaling pathways, transmitting signals within and between cells to regulate various cellular processes.

Transportation: Serve as transport proteins, facilitating the movement of ions, molecules, and nutrients across cell membranes.

Immune Response: Form antibodies and other immune system proteins that play a crucial role in recognizing and defending against foreign invaders.

Regulation of Gene Expression: Act as transcription factors, influencing the expression of genes and controlling cellular processes.

Muscle Contraction: Muscle proteins, such as actin and myosin, are essential for muscle contraction and movement.

Hormones: Serve as hormones, acting as signaling molecules that regulate physiological processes and maintain homeostasis.

Energy Storage and Transfer: Some proteins, like ferritin, store and release iron, while others, like ATP synthase, participate in energy transfer and storage.

Structural Proteins in Extracellular Matrix: Form structural components of the extracellular matrix, providing support and organization to tissues.

Catalysts in Metabolic Pathways: Participate in metabolic pathways, serving as catalysts for reactions involved in energy production and nutrient metabolism.

Maintaining Osmotic Balance: Proteins help maintain osmotic balance by controlling the movement of water across cell membranes.

Neurotransmission: Neurotransmitter proteins facilitate communication between nerve cells by transmitting signals across synapses.

Blood Clotting: Blood clotting proteins, like fibrin, are crucial for wound healing and preventing excessive bleeding.

pH Regulation: Act as buffers to regulate pH and maintain the acid-base balance in cells and biological fluids.

Antioxidant Defense: Some proteins, such as superoxide dismutase, act as antioxidants, protecting cells from oxidative stress.

22. Explain role of technique of genetic engineering.

Genetic engineering techniques play a crucial role in manipulating the genetic material of organisms, allowing scientists to modify, insert, or delete specific genes. These techniques have broad applications across various fields, contributing to advancements in medicine, agriculture, industry, and basic research. Here are key roles and applications of genetic engineering techniques:

1. Gene Cloning:

Role: Cloning involves the production of identical copies of a gene or DNA fragment.

Applications: Gene cloning is used in the production of recombinant proteins, gene mapping, and studying gene function. It is also essential for producing large quantities of specific genes for further analysis.

2. Recombinant DNA Technology:

Role: Recombinant DNA technology involves the manipulation and combination of DNA from different sources to create novel genetic combinations.

Applications: It is widely used in the production of genetically modified organisms (GMOs), the development of therapeutic proteins (e.g., insulin), and the creation of genetically modified crops with improved traits.

3. Polymerase Chain Reaction (PCR):

Role: PCR amplifies a specific DNA sequence, producing large quantities of DNA for analysis.

Applications: PCR is used in DNA cloning, genetic testing, forensics, and diagnostic applications. It allows the rapid and precise amplification of DNA even from small samples.

4. DNA Sequencing:

Role: DNA sequencing determines the precise order of nucleotides in a DNA molecule.

Applications: DNA sequencing is fundamental for genomics, personalized medicine, and studying genetic variations. It aids in identifying genes associated with diseases and understanding the genetic basis of traits.

5. Gene Synthesis:

Role: Gene synthesis involves the artificial construction of genes or DNA sequences.

Applications: It is used for creating custom-designed genes for research, producing synthetic biology constructs, and designing genes for therapeutic purposes.

6. Transgenic Technology:

Role: Transgenic technology involves the introduction of foreign genes into an organism's genome.

Applications: It is used to create organisms with novel traits, such as disease resistance in crops, improved livestock production, and the development of animal models for studying human diseases.

23. What are prokaryotes and their characteristics?

Lack a true nucleus: Prokaryotic cells do not have a membrane-bound nucleus; instead, their genetic material is found in a nucleoid region within the cytoplasm.

No membrane-bound organelles: Prokaryotes lack membrane-bound organelles such as mitochondria, endoplasmic reticulum, and Golgi apparatus.

Small size: Prokaryotic cells are generally smaller in size compared to eukaryotic cells, typically ranging from 0.5 to 5 micrometers in diameter.

Simple structure: Prokaryotes have a relatively simple cellular structure with no internal compartmentalization.

Circular DNA: The genetic material in prokaryotes is usually a single, circular DNA molecule concentrated in the nucleoid region.

Lack histones: Unlike eukaryotes, prokaryotic DNA is not associated with histone proteins.

Ribosomes: Prokaryotic cells contain smaller ribosomes (70S) compared to eukaryotic cells (80S).

Cell wall: Many prokaryotes have a rigid cell wall outside the cell membrane, providing structural support and protection.

Flagella and pili: Prokaryotes may have flagella for movement and pili for adherence to surfaces or for transfer of genetic material.

Binary fission: Prokaryotic cells reproduce primarily through binary fission, a simple form of cell division.

24. Write process of Gel electrophoresis.

Gel electrophoresis is a widely used laboratory technique for separating and analyzing macromolecules such as DNA, RNA, and proteins based on their size and charge. Here is a general overview of the process of gel electrophoresis:

Gel Preparation:

1. Agarose Gel:

Prepare an agarose gel by melting agarose powder in a buffer solution (commonly Tris-acetate-EDTA, TAE, or Tris-borate-EDTA, TBE). Pour the molten agarose solution into a casting tray with comb-like structures to create wells for sample loading.

2. Buffer Submersion:

Submerge the gel in a buffer solution (TAE or TBE) in the electrophoresis chamber. The buffer provides ions for conductivity and maintains a stable pH during the process.

Sample Loading:

3. Preparing Samples:

Mix the DNA, RNA, or protein samples with a loading buffer that contains tracking dyes (e.g., bromophenol blue or xylene cyanol) to monitor the progress of electrophoresis and to add density for easier loading into the wells.

4. Loading Samples:

Load the prepared samples into the wells of the gel using a micropipette. Each well may contain a different sample for comparison.

Electrophoresis:

5. Applying Voltage:

Connect the gel to an electrophoresis power supply. Apply an electric field across the gel by running an electric current through it. The negatively charged macromolecules move toward the positive electrode.

6. Separation of Macromolecules:

As the electric current passes through the gel, macromolecules migrate through the gel matrix based on their size and charge. Smaller molecules move more quickly through the gel, leading to separation based on size.

Visualization:

7. Staining:

After electrophoresis, the gel is usually stained with a dye that binds to the macromolecules, making them visible. Ethidium bromide is commonly used for DNA, while Coomassie Brilliant Blue or silver staining may be used for proteins.

8. Destaining:

Remove excess dye by destaining the gel in a solution without the staining agent.

9. Documentation:

Visualize and document the separated bands using a gel documentation system or by photographing the gel under UV light (for fluorescently stained gels) or with a gel documentation apparatus.

Analysis:

10. Determination of Size:

Measure the distance migrated by the bands from the wells to determine the size of the macromolecules. Molecular weight markers are often included to estimate the sizes of the sample bands.

11. Interpretation:

Analyze the gel to interpret the results, such as identifying the presence or absence of specific DNA fragments, estimating the sizes of DNA fragments, or assessing the purity of proteins.

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25. What is phenylketonuria? How it is caused?

Phenylketonuria (PKU) is a genetic disorder characterized by the inability of the body to metabolize an amino acid called phenylalanine. Individuals with PKU are unable to properly break down phenylalanine, leading to its accumulation in the blood and body tissues. If left untreated, elevated levels of phenylalanine can cause intellectual disabilities and other health problems.

Causes:

1. Genetic Mutation:

PKU is caused by mutations in the PAH gene, which provides instructions for making an enzyme called phenylalanine hydroxylase. This enzyme is responsible for converting phenylalanine into another amino acid, tyrosine. Mutations in the PAH gene result in reduced or absent phenylalanine hydroxylase activity.

2. Inherited Disorder:

PKU is an autosomal recessive disorder, meaning that an individual must inherit two mutated copies of the PAH gene (one from each parent) to develop the condition.

3. Phenylalanine Accumulation:

In individuals with PKU, the absence or deficiency of functional phenylalanine hydroxylase leads to the accumulation of phenylalanine in the blood and tissues. High levels of phenylalanine are toxic to the developing brain, particularly during infancy and childhood.

26. What are components of cellular membrane?

1. Phospholipid Bilayer
2. Proteins
3. Cholesterol
4. Glycolipids
5. Glycoproteins
6. Carbohydrates
7. Integral Proteins
8. Peripheral Proteins

27. What is principle of RFLP?

RFLP, or Restriction Fragment Length Polymorphism, is a molecular biology technique used to detect variations in DNA sequences. The principle of RFLP relies on the fact that individuals within a population can have variations in the DNA sequences that are recognized and cleaved by restriction enzymes. Here's a simplified explanation of the RFLP principle:

1. DNA Digestion:

DNA from different individuals is extracted and digested using specific restriction enzymes. These enzymes recognize specific DNA sequences and cut the DNA at or near those sequences.

2. Fragment Separation:
The resulting DNA fragments, which vary in size due to polymorphisms or variations in the DNA sequence, are separated using gel electrophoresis. Gel electrophoresis separates DNA fragments based on their size, with smaller fragments traveling farther through the gel.

3. Southern Blotting:
After electrophoresis, the DNA fragments are transferred from the gel to a membrane in a process known as Southern blotting. This transfers the DNA fragments in their separated positions on the gel to a solid support.

4. Probe Hybridization:
The membrane is then exposed to a labeled DNA probe. The probe is a single-stranded DNA molecule that is complementary to a specific sequence of interest. It will hybridize or bind to the complementary sequences on the membrane.

5. Detection of Variations:
Autoradiography or other detection methods are used to visualize the location of the labeled DNA probe on the membrane. Variations in DNA sequence, represented by differences in the pattern of hybridized fragments, can be observed.

6. Analysis:
The resulting pattern of bands or fragments on the membrane reflects the presence or absence of specific DNA sequences. By comparing the patterns among individuals, researchers can identify polymorphisms or variations in the DNA sequence.

7. Genetic Variation Identification:
RFLP analysis is often used for genetic mapping, forensic analysis, and paternity testing. Variations in the DNA sequence can be indicative of genetic diversity, relationships among individuals, or the presence of specific genes or alleles.

28. Write features of nucleus.

Membrane-bound structure: The nucleus is enclosed by a double membrane known as the nuclear envelope, which separates its contents from the cytoplasm.

Nuclear pores: The nuclear envelope contains small channels called nuclear pores that regulate the passage of molecules between the nucleus and the cytoplasm.

Nucleoplasm: The interior of the nucleus, called nucleoplasm, is a semi-fluid substance that houses various structures and the chromatin.

Chromatin: Chromatin, composed of DNA and proteins (histones), is the material that makes up the chromosomes within the nucleus.

Nucleolus: The nucleolus is a distinct region within the nucleus where ribosomal RNA (rRNA) is synthesized and ribosomal subunits are assembled.

Genetic information: The nucleus contains the genetic material (DNA) that carries instructions for the synthesis of proteins and the regulation of cellular activities.

Nucleoplasmic reticulum: This is a network of membranes within the nucleus that may be involved in the transport of molecules.

Nuclear matrix: The nuclear matrix provides structural support to the nucleus and is involved in organizing and maintaining the shape of the nucleus.

Nucleotide pool: The nucleus houses a pool of nucleotides that are essential for DNA and RNA synthesis.

Control center: The nucleus serves as the control center of the cell, directing cellular activities through the regulation of gene expression.

29. Explain prosthetic group with examples.

A prosthetic group is a non-protein molecule that is tightly and permanently attached to a protein, playing a crucial role in the protein's structure and function. Prosthetic groups are distinct from cofactors and coenzymes, which are temporarily associated with proteins and can be loosely bound or released during enzyme catalysis. Prosthetic groups are integral to the protein's structure and are essential for its biological activity. Here are some examples of prosthetic groups:

1. Heme:

Heme is a prosthetic group found in hemoglobin and myoglobin, two proteins involved in oxygen transport and storage in red blood cells and muscle cells, respectively.

2. Biotin:

Biotin serves as a prosthetic group in enzymes known as carboxylases, which are involved in various metabolic pathways, including fatty acid synthesis and gluconeogenesis.

3. Heme Cofactor in Cytochromes:

Cytochromes are proteins involved in electron transport in cellular respiration. They contain heme as a prosthetic group, facilitating electron transfer during the respiratory chain.

4. Flavin Mononucleotide (FMN):

FMN is a prosthetic group in flavoproteins, including flavin adenine dinucleotide (FAD). These proteins participate in redox reactions in various metabolic pathways.

5. Iron-Sulfur Clusters:

Iron-sulfur clusters serve as prosthetic groups in various enzymes involved in electron transfer reactions, such as those in the electron transport chain.

30. Define the terms: phagocytosis, pinocytosis, endocytosis and exocytosis.

1. Phagocytosis:

Phagocytosis is a process by which cells engulf large particles or microorganisms, such as bacteria, cell debris, or foreign particles. It is a type of endocytosis where the cell membrane surrounds and engulfs the particle, forming a phagosome. The phagosome then fuses with lysosomes, and the contents are digested by enzymes.

2. Pinocytosis:

Pinocytosis is a type of endocytosis where cells take in small droplets of extracellular fluid or dissolved substances. It involves the invagination of the cell membrane to form small vesicles containing the fluid or solutes. Pinocytosis is a non-selective process and occurs continuously in most cells for the uptake of nutrients and fluids.

3. Endocytosis:

Endocytosis is a general term for the process by which cells internalize substances from the external environment. It includes both phagocytosis and pinocytosis. In endocytosis, the cell membrane surrounds the material to be internalized, forming a vesicle or vacuole. The vesicle is then transported into the cell's interior.

4. Exocytosis:

Exocytosis is the process by which cells release substances from the intracellular environment to the extracellular space. It involves the fusion of membrane-bound vesicles containing cellular products with the cell membrane, leading to the expulsion of the vesicle contents outside the cell. Exocytosis is crucial for the secretion of various substances, such as hormones, neurotransmitters, and digestive enzymes.

31. Differentiate between SER and RER.

Smooth Endoplasmic Reticulum (SER):

The smooth endoplasmic reticulum is a network of membrane-enclosed tubules and sacs lacking ribosomes on its surface. It is often found in close association with the rough endoplasmic reticulum and other cellular structures. SER is involved in the synthesis of lipids, including phospholipids and steroids. It plays a role in detoxifying drugs and poisons, especially in liver cells. Some cells, like muscle cells, store calcium ions in the smooth endoplasmic reticulum. SER is also involved in various metabolic processes, such as the metabolism of carbohydrates.

Rough Endoplasmic Reticulum (RER):

The rough endoplasmic reticulum is studded with ribosomes on its cytoplasmic surface, giving it a "rough" appearance under a microscope. It is commonly found near the nucleus and is extensive in cells actively involved in protein synthesis. RER is primarily involved in the synthesis of proteins. Ribosomes on its surface translate the genetic code into proteins. Proteins synthesized in the RER undergo modifications, including folding and addition of sugars (glycosylation). RER plays a crucial role in the transport of proteins within the cell, and it is often associated with the Golgi apparatus in this function. Proteins destined for secretion or incorporation into the cell membrane are often synthesized in the rough endoplasmic reticulum.

32. Differentiate between active and passive transport.

Active Transport:

Active transport is a cellular process that requires the expenditure of energy to move substances across a cell membrane against their concentration gradient, from an area of lower concentration to an area of higher concentration. This energy input is typically provided by adenosine triphosphate (ATP) or other energy carriers. Integral membrane proteins often referred to as pumps, actively transport ions or molecules across the membrane, creating concentration gradients that are crucial for various cellular

functions. One of the most well-known examples of active transport is the sodium-potassium pump, which actively transports sodium ions out of the cell and potassium ions into the cell, maintaining the appropriate ion balance. Active transport is essential for processes such as nutrient uptake, ion homeostasis, and the maintenance of electrochemical gradients critical for cellular function.

Passive Transport:

Passive transport, in contrast, is a cellular mechanism that relies on the inherent kinetic energy of molecules to move them across the cell membrane. This process occurs spontaneously, driven by the concentration gradient of the substances involved. Unlike active transport, passive transport does not require an external energy source. Simple diffusion, facilitated diffusion, and osmosis are common types of passive transport. In simple diffusion, small, nonpolar molecules move directly through the lipid bilayer, while facilitated diffusion involves the movement of larger or polar molecules through channel or carrier proteins. Osmosis is the passive movement of water across a selectively permeable membrane. Passive transport is crucial for the movement of gases, nutrients, and waste products into and out of cells, contributing to the maintenance of cellular homeostasis without the need for energy expenditure.

33. Define plasmid, genetic engineering and mutation.

1. Plasmid:

A plasmid is a small, circular, extrachromosomal DNA molecule found in bacteria and some other microorganisms. Plasmids are separate from the chromosomal DNA and can replicate independently. They often carry genes that provide advantages to the host organism, such as antibiotic resistance or the ability to metabolize certain substances. In genetic engineering, plasmids are commonly used as vectors to introduce foreign genes into host cells.

2. Genetic Engineering:

Genetic engineering, also known as genetic modification or biotechnology, is the direct manipulation of an organism's genes using various techniques. It involves the insertion, deletion, or modification of specific DNA sequences to achieve desired traits or functions. Genetic engineering has applications in agriculture, medicine, industry, and research. Common techniques include gene cloning, recombinant DNA technology, and genome editing using tools like CRISPR-Cas9. Genetic engineering has led to the development of genetically modified organisms (GMOs) with improved characteristics or novel functionalities.

3. Mutation:

A mutation is a heritable change in the nucleotide sequence of an organism's DNA. Mutations can occur spontaneously due to errors during DNA replication or as a result of environmental factors such as radiation or certain chemicals. Mutations can be classified into various types, including point mutations (single nucleotide changes), insertions, deletions, and chromosomal rearrangements. While some mutations have no noticeable effect, others can lead to genetic disorders, diseases, or provide the raw material for evolution by introducing genetic diversity. Mutations are essential for the evolutionary process and can be studied to understand the genetic basis of various traits and diseases.

34. Differentiate between heterochromatin and euchromatin.

Heterochromatin:

Heterochromatin and euchromatin are two distinct forms of chromatin, the complex of DNA and proteins that makes up chromosomes within the cell nucleus. Heterochromatin is a densely packed and transcriptionally inactive form of chromatin. It appears as dark, condensed regions under a microscope during interphase. Heterochromatin is characterized by a high concentration of repetitive DNA sequences, such as satellite DNA, and contains genes that are typically not expressed. It plays a role in maintaining chromosome structure, preventing DNA damage, and ensuring proper chromosome segregation during cell division. Heterochromatin is further classified into constitutive heterochromatin, which is permanently condensed and typically found near centromeres and telomeres, and facultative heterochromatin, which can switch between condensed and decondensed states and is associated with genes that are developmentally regulated.

Euchromatin:

Euchromatin, on the other hand, is a more loosely packed and transcriptionally active form of chromatin. It appears as a lighter, less condensed region under a microscope during interphase. Euchromatin contains actively transcribed genes and is involved in the regulation of gene expression. It is characterized by a higher gene density, a lower concentration of repetitive DNA sequences, and a greater accessibility to transcriptional machinery. Euchromatin undergoes dynamic changes in response to cellular needs, transitioning between more open and closed states. This plasticity allows for the activation or repression of specific genes, contributing to the cell's ability to respond to environmental cues and developmental signals. Euchromatin is associated with regions of the genome involved in active transcription, and it is crucial for the diverse functions of different cell types within an organism.

35. Differentiate between purines and pyrimidines.

Purines and pyrimidines are two types of nitrogenous bases that constitute the building blocks of nucleic acids, such as DNA and RNA. These bases play a crucial role in the genetic code by forming the rungs of the DNA double helix. Here are the key differences between purines and pyrimidines:

1. Chemical Structure:

Purines: Purines are larger, double-ring structures. The two common purines found in nucleic acids are adenine (A) and guanine (G).

Pyrimidines: Pyrimidines are smaller, single-ring structures. The three common pyrimidines found in nucleic acids are cytosine (C), thymine (T) in DNA, and uracil (U) in RNA.

2. Number of Rings:

Purines: Purines have two fused rings in their structure, known as a double-ring structure.

Pyrimidines: Pyrimidines have a single ring in their structure.

3. Nucleotide Pairing in DNA:

Purines and Pyrimidines: In DNA, purines always pair with pyrimidines. Adenine (purine) pairs with thymine (pyrimidine), forming two hydrogen bonds, while guanine (purine) pairs with cytosine (pyrimidine), forming three hydrogen bonds.

4. Presence in DNA and RNA:

Purines: Adenine and guanine are present in both DNA and RNA.

Pyrimidines: Cytosine and thymine are found in DNA, while cytosine and uracil are found in RNA.

5. Base Pairing in RNA:

Purines and Pyrimidines: In RNA, adenine (purine) pairs with uracil (pyrimidine), forming two hydrogen bonds, while guanine (purine) still pairs with cytosine (pyrimidine), forming three hydrogen bonds.

6. Size:

Purines: Purines are larger and more complex molecules.

Pyrimidines: Pyrimidines are smaller and simpler in structure.

36. Write five functions of DNA.

Genetic Information Storage:

DNA carries the hereditary information that determines the traits and characteristics of living organisms.

Transmission of Genetic Information:

DNA is replicated during cell division, ensuring that each daughter cell receives an accurate copy of the genetic code.

Protein Synthesis:

DNA serves as a template for the synthesis of RNA, which, in turn, directs the synthesis of proteins through transcription and translation processes.

Regulation of Gene Expression:

DNA contains regulatory elements that control when and to what extent genes are expressed, allowing cells to respond to environmental cues and signals.

Maintenance of Genetic Stability:

DNA has repair mechanisms that correct errors or damage, contributing to the stability and integrity of the genetic code over time.

37. What is physical barrier of enzyme regulation?

Physical barriers in enzyme regulation refer to factors like cellular compartmentalization, membrane structures, substrate accessibility, cytoskeletal elements, and environmental conditions (pH and temperature) that physically influence or impede enzyme activity by affecting their structure, accessibility, or mobility within cells.

38. Explain messenger and adapter hypothesis.

1. Messenger RNA (mRNA) Hypothesis:

The central dogma of molecular biology outlines the flow of genetic information in cells. According to this dogma, DNA is transcribed into mRNA, which is then translated into proteins. The mRNA hypothesis essentially refers to the role of mRNA as a messenger molecule that carries the genetic information from DNA to the ribosomes, where protein synthesis occurs. mRNA serves as an intermediary, conveying the genetic code in a form that can be deciphered by ribosomes to synthesize specific proteins.

2. Adapter Hypothesis (Aminoacyl-tRNA Synthetase Hypothesis):

The adapter hypothesis is related to the process of translation during protein synthesis. Aminoacyl-tRNA synthetases are enzymes responsible for attaching specific amino acids to their corresponding tRNA molecules. In the adapter hypothesis, these enzymes act as adapters or connectors between the nucleotide sequence of tRNA and the amino acid sequence of proteins. Each aminoacyl-tRNA synthetase recognizes a specific tRNA molecule and ensures the accurate pairing of amino acids with the appropriate tRNA during translation, facilitating the correct incorporation of amino acids into the growing polypeptide chain.

39. Explain RNA types and their functions.

RNA, or ribonucleic acid, is a versatile molecule with various types, each serving distinct functions within cells. The main types of RNA include messenger RNA (mRNA), transfer RNA (tRNA), ribosomal RNA (rRNA), microRNA (miRNA), and small nuclear RNA (snRNA). Here's an overview of each RNA type and its functions:

1. Messenger RNA (mRNA):

mRNA carries genetic information from the DNA in the cell nucleus to the ribosomes in the cytoplasm. It serves as a template for protein synthesis during translation. The sequence of nucleotides in mRNA encodes the amino acid sequence of a protein.

2. Transfer RNA (tRNA):

tRNA is involved in the translation process by bringing specific amino acids to the ribosome based on the mRNA code. Each tRNA molecule has an anticodon region that recognizes a complementary codon on the mRNA and carries the corresponding amino acid, facilitating the assembly of proteins.

3. Ribosomal RNA (rRNA):

rRNA is a structural component of ribosomes, the cellular machinery responsible for protein synthesis. It provides a scaffold for the assembly of proteins and catalyzes the formation of peptide bonds between amino acids during translation.

4. MicroRNA (miRNA):

miRNAs are short RNA molecules that play a role in post-transcriptional gene regulation. They can bind to specific mRNA molecules, leading to their degradation or inhibiting their translation. miRNAs are involved in controlling the expression of genes and are crucial for various cellular processes.

5. Small Nuclear RNA (snRNA):

snRNAs are components of the spliceosome, a complex involved in RNA splicing, a process where non-coding introns are removed from pre-mRNA, and exons are joined to form the mature mRNA. snRNAs contribute to the precision of gene expression by ensuring accurate splicing.

6. Small Interfering RNA (siRNA):

siRNAs are similar to miRNAs and play a role in RNA interference (RNAi). They can bind to specific mRNA molecules, leading to their degradation or inhibition of translation. siRNAs are often used in research and therapeutic applications to silence specific genes.

7. Long Non-Coding RNA (lncRNA):

lncRNAs are a diverse group of RNA molecules that do not code for proteins but play regulatory roles in gene expression. They can influence chromatin structure, modulate transcription, and participate in various cellular processes.

40. What is epistasis?

Epistasis is a genetic phenomenon where the expression of one gene masks or modifies the phenotypic effects of another gene at a different locus. It involves the interaction between genes, impacting the overall phenotype of an organism.

41. Explain Benzer Conclusion.

The "Benzer Conclusion" refers to the groundbreaking work of the American geneticist Seymour Benzer in the mid-20th century. Benzer conducted extensive research using the bacteriophage T4, a virus that infects bacteria, to investigate the fine structure of genes and the nature of mutations. His experiments provided important insights into the molecular mechanisms of gene function.

Benzer's key conclusion was derived from his study of the rII region of the T4 bacteriophage. The rII region is involved in the ability of the bacteriophage to cause lysis (destruction) of bacterial cells. Benzer conducted a series of fine-structure genetic experiments, isolating and characterizing numerous mutations within the rII region.

His main findings included:

1. Identification of Mutational Sites:

Benzer identified specific sites within the rII region where mutations occurred. By analyzing the phenotypic effects of these mutations, he inferred the locations of individual nucleotide changes.

2. Definition of Cistrons:

Benzer introduced the concept of the cistron, which he defined as the smallest functional unit of genetic information. A cistron corresponds to a specific nucleotide sequence that codes for a discrete biological function.

3. Demonstration of the Molecular Nature of Genes:

Benzer's work provided evidence for the molecular nature of genes. He showed that mutations could be mapped to specific nucleotide changes within the DNA sequence, supporting the idea that genes are composed of DNA and have a linear structure.

4. Introduction of the Concept of the "Nucleotide":

Benzer's work contributed to the recognition of the role of nucleotides as the building blocks of genes. He demonstrated that changes at the nucleotide level could lead to observable phenotypic changes.

42. Write vital role of lipid bilayer.

Structural Foundation: Forms the basic structural framework of cell membranes, defining cell boundaries and organelle compartments.

Selective Permeability: Regulates the passage of substances into and out of cells, allowing selective transport of ions, nutrients, and signaling molecules.

Cell Signaling: Hosts receptors and proteins involved in cell signaling, enabling the detection of external signals and initiation of intracellular responses.

Cell Adhesion: Facilitates cell adhesion and recognition through surface molecules that interact with counterparts on adjacent cells or extracellular matrix.

Energy Storage: Stores energy in the form of lipids, which can be mobilized to provide a source of energy for cellular processes.

Metabolism: Hosts integral membrane proteins involved in energy metabolism, such as those in the electron transport chain.

Transport Facilitation: Provides a platform for transport proteins that regulate the movement of ions, water, and other molecules across the membrane.

Cellular Recognition: Presents antigens on the cell surface for cellular recognition, influencing immune responses.

Structural Support: Contributes to the overall shape and stability of cells, helping maintain the integrity of cellular compartments and resist changes in shape due to osmotic pressure.

43. Write role of plasma membrane.

Cellular Boundary: Forms the outer boundary of cells, separating the internal environment from the external surroundings.

Selective Permeability: Regulates the entry and exit of substances, controlling the passage of ions, nutrients, and signaling molecules.

Cell Signaling: Hosts receptors that participate in cell signaling, enabling cells to detect and respond to external signals.

Cell Adhesion: Contains proteins involved in cell adhesion, allowing cells to adhere to neighboring cells or extracellular matrix.

Structural Support: Provides structural support to cells, maintaining cell shape and integrity.

Transport Proteins: Embeds various transport proteins that facilitate the movement of specific molecules across the membrane.

Energy Production: Houses components of the electron transport chain for energy production in cellular respiration.

Endocytosis and Exocytosis: Facilitates processes such as endocytosis (internalization of substances) and exocytosis (release of substances).

Cellular Recognition: Displays antigens on the cell surface, influencing immune responses and cellular recognition.

Communication and Interaction: Enables communication and interaction between cells and their environment through receptors and signaling molecules.

44. What is three stop codon?

Stop codons, also known as termination codons or nonsense codons, are specific nucleotide triplets in messenger RNA (mRNA) that signal the termination of protein synthesis during translation. When a ribosome encounters a stop codon, the translation process comes to a halt, and the newly synthesized polypeptide chain is released from the ribosome. There are three stop codons in the genetic code:

1. UAA (UAG in DNA):
   - Known as the ochre codon.

2. UAG (UAA in DNA):
   - Known as the amber codon.

3. UGA (TGA in DNA):
   - Known as the opal codon.

45. Enlist features of cell organelles.

Cell organelles are specialized structures within a cell that perform specific functions, contributing to the overall organization and functionality of the cell. Here are some features of prominent cell organelles:

1. Nucleus:

- Double-membrane structure with nuclear pores.
- Contains genetic material (DNA) organized into chromosomes.
- Controls cell activities and houses the nucleolus for ribosome synthesis.

2. Mitochondria:

- Double-membrane structure with an inner mitochondrial matrix.
- Site of cellular respiration, producing ATP (energy currency of the cell).
- Contains its own DNA and can replicate independently.

3. Endoplasmic Reticulum (ER):

- Rough ER has ribosomes on its surface, involved in protein synthesis.
- Smooth ER lacks ribosomes and is involved in lipid synthesis, detoxification, and calcium storage.

4. Golgi Apparatus:

- Stack of flattened membranous sacs (cisternae).
- Modifies, sorts, and packages proteins and lipids for secretion or delivery to other organelles.

5. Lysosomes:

- Membrane-bound vesicles containing digestive enzymes.
- Involved in intracellular digestion, recycling of cellular components, and programmed cell death (apoptosis).

6. Ribosomes:

- Non-membranous organelles composed of RNA and proteins.
- Site of protein synthesis in the cytoplasm (free ribosomes) or attached to the endoplasmic reticulum (bound ribosomes).

7. Cytoskeleton:

- Network of protein filaments (microtubules, microfilaments, and intermediate filaments).
- Provides structural support, maintains cell shape, and facilitates intracellular transport.

8. **Vacuoles:**

- Membrane-bound sacs for storage of substances, such as nutrients, ions, or waste products.
- More prominent in plant cells, where they contribute to turgor pressure.

9. Chloroplasts:

- Double-membrane organelles containing chlorophyll.
- Site of photosynthesis in plant cells, converting light energy into chemical energy.

10. Centrioles:

- Pair of cylindrical structures composed of microtubules.
- Involved in organizing the microtubule network during cell division (animal cells).

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11. Peroxisomes:

- Membrane-bound organelles containing enzymes involved in lipid metabolism and detoxification reactions.

12. Nucleolus:

- Non-membranous structure within the nucleus.
- Site of ribosomal RNA (rRNA) synthesis and assembly of ribosomal subunits.

46. What are applications of PCR?

Polymerase Chain Reaction (PCR) is a powerful molecular biology technique that amplifies DNA, allowing the production of many copies of a specific DNA sequence. PCR has a wide range of applications in various scientific fields. Here are some key applications of PCR:

1. DNA Amplification:

PCR is extensively used to amplify specific DNA regions for further analysis, such as sequencing, genotyping, and mutation detection. PCR is used to generate sufficient quantities of DNA for cloning purposes.

2. DNA Sequencing:

Amplified DNA fragments generated by PCR can be used in Sanger sequencing to determine the exact sequence of nucleotides.

3. Molecular Diagnostics:

PCR is widely employed for the detection of infectious agents, genetic diseases, and cancer markers in clinical samples. PCR is used in forensic analysis for DNA profiling and identification of individuals.

4. Genetic Testing:

PCR is used to identify genetic variations, including single nucleotide polymorphisms (SNPs) and other mutations, which are associated with diseases or specific traits.

5. Gene Expression Analysis:

PCR can be used to quantify the amount of a specific RNA molecule, providing insights into gene expression levels.

6. DNA Fingerprinting:

PCR-based DNA fingerprinting techniques, such as short tandem repeat (STR) analysis, are employed for forensic purposes and paternity testing.

7. Infectious Disease Detection:

PCR is used to detect the presence of infectious agents, such as bacteria, viruses, and parasites, in clinical samples.

8. Environmental Studies:
PCR is utilized to study microbial diversity and dynamics in environmental samples, such as soil and water.

9. Ancient DNA Studies:
PCR enables the amplification of ancient DNA, allowing researchers to study the genetics of extinct species or ancient human populations.

10. Mutagenesis Studies:
PCR is employed to introduce specific mutations into DNA sequences for functional studies of genes and proteins.

11. Viral Load Measurement:
PCR is used to quantify the viral load in individuals infected with HIV, aiding in the management of antiretroviral therapy.

12. Food Safety Testing:
PCR is used to detect the presence of foodborne pathogens, ensuring the safety of food products.

47. Differentiate between hypertonic, isotonic and hypotonic solution.

1. Hypotonic Solution:
A hypotonic solution has a lower concentration of solutes compared to another solution. When a cell is placed in a hypotonic solution, water will move into the cell from the surrounding solution. This can cause the cell to swell or even burst (lyse) if the osmotic pressure becomes too great. Example: If a red blood cell is placed in a hypotonic solution (e.g., pure water), water will enter the cell, causing it to swell and potentially burst.

2. Isotonic Solution:
An isotonic solution has the same concentration of solutes as another solution. When a cell is placed in an isotonic solution, there is no net movement of water into or out of the cell. The cell maintains its shape and size. Example: If a red blood cell is placed in an isotonic solution (e.g., normal saline), the concentration of solutes inside and outside the cell is equal, and the cell remains unchanged.

3. Hypertonic Solution:
A hypertonic solution has a higher concentration of solutes compared to another solution. When a cell is placed in a hypertonic solution, water will move out of the cell into the surrounding solution. This can cause the cell to shrink or undergo crenation. Example: If a red blood cell is placed in a hypertonic solution (e.g., a concentrated salt solution), water will leave the cell, causing it to shrink and deform.

48. Write a note on uniporters.

Uniporters:

Uniporters are integral membrane proteins facilitating the passive transport of a specific molecule across biological membranes. They operate through facilitated diffusion, moving molecules down their concentration gradient without energy input. Uniporters exhibit high substrate specificity, recognizing and transporting a single type of molecule. These proteins play crucial roles in nutrient uptake, ion transport, and cellular homeostasis. Uniporters consist of one or multiple protein subunits with defined three-dimensional structures. The direction of substrate movement is determined by the concentration gradient, either into or out of the cell. Dysregulation of uniporters can impact cellular functions and is implicated in various diseases.

Key Characteristics:

- Substrate specificity
- Passive transport (facilitated diffusion)
- Integral membrane proteins
- Protein structure with defined three-dimensional conformation
- Single-type molecule transport
- Cellular roles in nutrient uptake and ion transport
- Directionality based on concentration gradient
- Regulation of activity
- Implications in health and disease

49. What is anticodon and where it is present?

An anticodon is a sequence of three nucleotides in a transfer RNA (tRNA) molecule that is complementary to a specific codon in messenger RNA (mRNA) during protein synthesis. tRNA molecules play a key role in the translation of the genetic code from mRNA into proteins. The anticodon region of a tRNA molecule base-pairs with the corresponding mRNA codon, ensuring the correct amino acid is incorporated into the growing polypeptide chain.

The anticodon is located on the tRNA molecule, and it is this region that pairs with the complementary codon on messenger RNA (mRNA) during the process of translation.

50. Define factors which inhibit the enzyme activity?

Enzyme activity can be influenced by various factors, and inhibition refers to the decrease or cessation of enzymatic activity. There are several factors that can inhibit enzyme function. Here are some common types of enzyme inhibitors and factors that can affect enzyme activity:

1. Competitive Inhibition:

Competitive inhibitors are molecules that resemble the substrate and compete for binding to the active site of the enzyme. They reduce the rate of substrate binding to the enzyme's active site, leading to a decrease in enzymatic activity. Example: Many drugs and therapeutic agents act as competitive inhibitors.

2. Non-Competitive Inhibition:

Non-competitive inhibitors bind to the enzyme at a location other than the active site, altering the enzyme's shape and reducing its catalytic activity. This type of inhibition does not compete directly with the substrate for the active site. Example: Allosteric inhibitors are a common type of non-competitive inhibitors.

3. Uncompetitive Inhibition:

Uncompetitive inhibitors bind only to the enzyme-substrate complex, preventing the release of the product. This type of inhibition is dependent on the presence of both the substrate and the enzyme. Example: Certain drugs and toxins can act as uncompetitive inhibitors.

4. Feedback Inhibition:

Feedback inhibition occurs when the end product of a metabolic pathway inhibits an enzyme earlier in the pathway. It helps regulate the synthesis of products and prevent the overproduction of certain metabolites. Example: Control of enzyme activity in metabolic pathways.

5. pH:

Extreme pH levels (either too acidic or too basic) can denature the enzyme, altering its three-dimensional structure and inhibiting its activity.

6. Temperature:

Extreme temperatures can denature enzymes. High temperatures can increase molecular motion beyond optimal levels, while low temperatures can slow down enzymatic reactions.

7. Substrate Concentration:

At high substrate concentrations, enzymes may become saturated, leading to a plateau in reaction rates. This is not inhibition but a saturation effect.

51. What is excision repair mechanism?

The excision repair mechanism is a DNA repair process that corrects damage to the DNA molecule caused by various environmental factors, such as ultraviolet (UV) radiation, chemical mutagens, and other forms of DNA damage. The primary goal of excision repair is to remove and replace the damaged DNA segment with an undamaged sequence.

There are two main types of excision repair mechanisms:

1. Nucleotide Excision Repair (NER):

Process: NER is a versatile and widely conserved repair mechanism. It operates by recognizing and removing a wide range of DNA lesions, such as bulky adducts, thymine dimers caused by UV radiation, and other distortions in the DNA helix.

Steps:

1. ***Recognition:*** A complex of proteins scans the DNA for distortions and abnormalities.
2. ***Incision:*** The damaged segment is excised or cut out by endonucleases, leaving a gap.
3. ***DNA Synthesis and Ligation:*** DNA polymerase fills in the gap with the correct sequence, and ligase seals the nick, completing the repair.

2. Base Excision Repair (BER):

Process: BER primarily deals with the repair of damaged or altered bases in the DNA molecule. It addresses small, non-distorting lesions, such as damaged bases resulting from oxidation or deamination.

Steps:

1. ***Recognition and Excision:*** Specific glycosylases recognize and remove the damaged base, creating an apurinic or apyrimidinic (AP) site.
2. ***Endonuclease Cleavage:*** An endonuclease cleaves the DNA strand at the AP site, generating a gap.
3. ***DNA Synthesis and Ligation:*** DNA polymerase fills in the gap with the correct nucleotides, and ligase seals the nick, completing the repair.

52. What are reversible inhibitor and its types?

A reversible inhibitor is a type of enzyme inhibitor that forms a relatively weak and temporary interaction with the enzyme, allowing the inhibition to be reversed under certain conditions. There are two main types of reversible inhibitors: competitive inhibitors and non-competitive inhibitors.

1. Competitive Inhibitors:

Mechanism: Competitive inhibitors compete with the substrate for binding to the active site of the enzyme. They resemble the structure of the substrate and can bind to the enzyme, but they do not undergo a chemical reaction.

Effect on Enzyme Activity: The presence of a competitive inhibitor increases the apparent Km (Michaelis-Menten constant) of the enzyme because more substrate is required to reach half of the maximum reaction rate (Vmax). However, the maximum velocity of the reaction (Vmax) remains unchanged.

Reversibility: Competitive inhibition can be overcome by increasing the concentration of the substrate. As the substrate concentration increases, it outcompetes the inhibitor for binding to the active site, restoring enzyme activity.

2. Non-Competitive Inhibitors:

Mechanism: Non-competitive inhibitors bind to the enzyme at a site other than the active site, causing a conformational change in the enzyme's structure. This change makes the active site less accessible or alters the enzyme's catalytic properties.

Effect on Enzyme Activity: Non-competitive inhibitors do not compete with the substrate for binding to the active site. Instead, they decrease the maximum velocity of the reaction (Vmax) by reducing the catalytic efficiency of the enzyme.

Reversibility: Non-competitive inhibition cannot be overcome by increasing the concentration of the substrate because the inhibitor does not bind to the active site. The inhibition is generally reversible but not by simply adding more substrate. Removing the inhibitor or altering conditions may restore enzyme activity.

53. What are exergonic reactions?

Exergonic reactions are chemical reactions that release energy, usually in the form of heat or the production of high-energy molecules like adenosine triphosphate (ATP). These reactions occur when the products of the reaction have less energy than the reactants. The term "exergonic" comes from the Greek words "exer" (meaning "out") and "gonia" (meaning "work"), indicating that energy is released and can be used to perform work.

Key characteristics of exergonic reactions include:

1. ***Energy Release:*** Exergonic reactions release energy, and this energy is often utilized by the cell to perform various cellular functions, such as mechanical work, active transport, and the synthesis of biomolecules.

2. ***Spontaneity:*** Exergonic reactions tend to occur spontaneously. This means that, under the given conditions, the reaction will proceed without the need for an external source of energy.

3. ***Entropy Increase:*** Exergonic reactions often contribute to an increase in entropy (disorder) in the system. The products of the reaction typically have a higher degree of randomness than the reactants.

54. What are multifactorial disorders?

Multifactorial disorders, also known as complex or polygenic disorders, are conditions that result from a combination of genetic, environmental, and lifestyle factors. Unlike single-gene disorders, where a mutation in a single gene is responsible for the condition, multifactorial disorders involve the interplay of multiple genetic and environmental factors.

Key features of multifactorial disorders include:

1. Genetic Factors: Multiple genes contribute to the risk of developing the disorder. These genes may interact with each other in complex ways, and variations in these genes can increase susceptibility.

2. Environmental Factors: External factors, such as exposure to certain substances, diet, lifestyle choices, and environmental conditions, play a role in the development of multifactorial disorders. These factors can influence the expression of genes and contribute to the overall risk.

3. Complex Inheritance Patterns: The inheritance pattern of multifactorial disorders is not straightforward. There is often no clear pattern of Mendelian inheritance, as seen in single-gene disorders. Instead, the risk is influenced by the combination of genetic and environmental factors.

Common examples of multifactorial disorders include:

Heart disease: Genetic factors, lifestyle choices (such as diet and exercise), and environmental factors (like exposure to tobacco smoke) contribute to the risk of developing cardiovascular diseases.

Type 2 diabetes: Both genetic predisposition and lifestyle factors, such as diet and physical activity, contribute to the development of type 2 diabetes.

Certain types of cancer: Many cancers result from a combination of genetic mutations and exposure to environmental factors, such as UV radiation for skin cancer or smoking for lung cancer.

Neural tube defects: Conditions like spina bifida result from a combination of genetic susceptibility and environmental factors, particularly folic acid deficiency during pregnancy.

55. What are steps of PCR?

Polymerase Chain Reaction (PCR) is a molecular biology technique used to amplify and replicate a specific DNA sequence. PCR involves a series of temperature-dependent steps, and the process typically consists of three main stages: denaturation, annealing, and extension. The following is an overview of the steps involved in a basic PCR reaction:

1. Denaturation:

Temperature: Approximately 94-98°C.
Duration: 20-30 seconds.
Purpose: The double-stranded DNA template is heated to a high temperature to denature or separate the DNA strands. This is typically done by subjecting the reaction mixture to a high-temperature environment (e.g., 94°C), causing the hydrogen bonds between complementary bases to break, resulting in two single-stranded DNA molecules.

2. Annealing:

Temperature: Typically between 50-65°C.
Duration: 20-40 seconds.
Purpose: The reaction temperature is lowered to allow primers (short DNA sequences that are complementary to the target DNA region) to bind to their complementary sequences on the single-stranded DNA. This step enables the primers to serve as starting points for DNA synthesis by the DNA polymerase enzyme.

3. Extension (Elongation):

Temperature: Usually around 72°C.
Duration: Time depends on the DNA polymerase used and the length of the target sequence.
Purpose: The temperature is increased to the optimum for DNA polymerase activity. The enzyme synthesizes a new DNA strand complementary to the template strand by adding nucleotides in the 5' to 3' direction. This process extends the DNA from the primers and results in the replication of the target DNA sequence.

56. What are functions of cellular membrane?

Selective Permeability: Regulates the entry and exit of substances, allowing some molecules to pass while restricting others.
Cellular Barrier: Separates the internal environment of the cell from the external environment, maintaining distinct conditions.
Reception of Signals: Contains receptors for various signaling molecules, facilitating communication between cells.

Cell Adhesion: Plays a role in cell adhesion, allowing cells to attach to each other and form tissues.
Protection: Provides a physical barrier that protects the cell from mechanical damage and external threats.
Transport: Facilitates the transport of specific molecules through various transport proteins.
Recognition: Participates in cell recognition and identification, crucial for immune responses and self-recognition.
Fluidity: Maintains a dynamic structure, allowing the cell to change shape and facilitating membrane fusion/fission during cellular processes.
Energy Storage: Some membranes store energy in the form of electrochemical gradients used in cellular processes.
Cellular Compartmentalization: Creates distinct membrane-bound organelles within the cell, enabling specialized functions in different cellular regions.

57. Write short note on Klinfelter syndrome.

Klinefelter Syndrome:

Klinefelter syndrome (KS) is a chromosomal disorder characterized by the presence of one or more extra X chromosomes in males. The most common karyotype associated with Klinefelter syndrome is XXY, although variants such as XXYY and XXXY can also occur. It typically arises due to a random error during the formation of reproductive cells, leading to the combination of an extra X chromosome with the normal XY configuration.

Clinical Features:
Infertility: Individuals with Klinefelter syndrome are often infertile due to underdeveloped testes and reduced testosterone production.
Physical Characteristics: May exhibit tall stature, gynecomastia (enlarged breast tissue), reduced facial and body hair, and a slender build.
Learning Disabilities: Some individuals may experience language and learning disabilities, although intelligence can vary widely.
Hormonal Imbalances: Reduced testosterone levels can lead to hormonal imbalances affecting physical and sexual development.
Diagnosis: Typically diagnosed through karyotype analysis, revealing the presence of the extra X chromosome.
Treatment: While there is no cure for Klinefelter syndrome, treatment may involve hormone replacement therapy (testosterone) to address developmental and hormonal imbalances. Fertility treatments may be considered for those seeking to have children.
Psychosocial Support: Individuals with Klinefelter syndrome may benefit from psychosocial support and educational interventions to address potential challenges and improve overall quality of life.

58. Write Harshey and Chase experiment.

The Hershey-Chase experiment, conducted in 1952 by Martha Chase and Alfred Hershey, provided crucial evidence supporting the idea that DNA, rather than protein, is the genetic material responsible for transmitting hereditary information in living organisms. This experiment was instrumental in the establishment of DNA as the molecule that carries genetic instructions.

Here is a summary of the Hershey-Chase experiment:

Objective:

To determine whether DNA or protein is the genetic material transferred during viral infection.

Experimental Setup:

1. The researchers used the T2 bacteriophage, a type of virus that infects the bacterium Escherichia coli (E. coli).
2. The T2 bacteriophage consists of a protein coat (capsid) and genetic material (either DNA or RNA).

Procedure:

1. Radioactive Labeling:

Hershey and Chase labeled the viral DNA with radioactive phosphorus-32 (^32P). Phosphorus is a component of DNA but not of proteins. They labeled the protein coat with radioactive sulfur-35 (^35S). Sulfur is a component of proteins but not of DNA.

2. Infection:

They labeled T2 bacteriophages were allowed to infect E. coli bacteria. The viral proteins (labeled with ^35S) stayed outside the bacterial cells, while the viral DNA (labeled with ^32P) entered the bacterial cells during infection.

3. Blending and Separation:

After allowing time for infection, the researchers used a blender to separate the viral protein coats from the bacterial cells. This process was known as "blending" or "blender experiment." The purpose of blending was to detach the protein coats (containing ^35S) from the bacterial cells.

4. Centrifugation:

The blended mixture was then subjected to centrifugation, a process that separates cellular components based on their density. Centrifugation resulted in the formation of a pellet containing the heavier bacterial cells and a supernatant containing the lighter viral protein coats.

5. Results:

The researchers observed that the radioactively labeled phosphorus (^32P) from the viral DNA was found inside the bacterial cells (pellet). The radioactively labeled sulfur (^35S) from the viral protein coats remained outside the bacterial cells (supernatant).

59. How confrontational changes effect enzyme activity?

Conformational changes in enzymes play a crucial role in regulating their activity. The three-dimensional structure of an enzyme is essential for its function, and alterations in this structure, known as conformational changes, can significantly impact enzyme activity. Here's how conformational changes affect enzyme activity:

1. Substrate Binding:
Enzymes typically undergo conformational changes upon binding to their substrate. This is often referred to as the "induced fit" model. The enzyme's active site may undergo structural adjustments to accommodate and bind the substrate more effectively. This conformational change is essential for the formation of the enzyme-substrate complex and catalysis.

2. Active Site Accessibility:
Conformational changes can modulate the accessibility of the enzyme's active site. In some cases, the active site may be exposed or concealed based on the conformational state of the enzyme. This influences the enzyme's ability to bind substrates and carry out catalysis.

3. Allosteric Regulation:
Enzymes can have allosteric sites, which are distinct from the active site. Binding of molecules to these allosteric sites induces conformational changes that affect the enzyme's activity. Allosteric regulation can either enhance (positive allosteric regulation) or inhibit (negative allosteric regulation) enzyme activity.

4. Cofactor Binding:
Many enzymes require cofactors, such as metal ions or coenzymes, for proper function. Conformational changes may occur upon cofactor binding, altering the enzyme's structure and enhancing its catalytic activity.

5. pH and Temperature Sensitivity:
Changes in pH and temperature can induce conformational changes in enzymes. Each enzyme has an optimal pH and temperature for activity. Deviations from these optimal conditions can lead to alterations in the enzyme's structure, affecting its catalytic efficiency.

6. Covalent Modifications:
Enzymes can undergo covalent modifications, such as phosphorylation or dephosphorylation, which induce conformational changes. These modifications can act as regulatory switches, turning enzyme activity on or off in response to cellular signals.

7. Denaturation:
Extreme conditions, such as high temperatures or extreme pH values, can cause denaturation of enzymes. Denaturation involves a loss of the enzyme's three-dimensional structure, leading to a loss of activity. In this case, conformational changes are detrimental to enzyme function.

60. What is basic structure of nucleic acid?

The basic structure of nucleic acids consists of nucleotides, each comprising a phosphate group, a five-carbon sugar (deoxyribose or ribose), and a nitrogenous base (adenine, thymine/uracil, cytosine, or guanine). Nucleotides form a linear chain through covalent bonds, creating a sugar-phosphate backbone. In DNA, two such chains coil into a double helix through complementary base pairing (A-T and C-G). RNA is typically single-stranded.

61. Write functions of carbohydrates.

- ***Energy Source:*** Carbohydrates serve as a primary source of energy for the body, particularly glucose, which is readily used in cellular processes.
- ***Energy Storage:*** Excess glucose is stored in the form of glycogen in the liver and muscles, providing a short-term energy reserve.
- ***Structural Support:*** Carbohydrates contribute to the structural integrity of cells and tissues, forming components such as cellulose in plant cell walls and chitin in the exoskeletons of arthropods.
- ***Cellular Recognition:*** Carbohydrates on the cell surface, often in the form of glycoproteins and glycolipids, play a crucial role in cell recognition and communication.
- ***Blood Clotting:*** Carbohydrates are involved in blood clotting processes, influencing the interactions of blood clotting factors.
- ***Immune Response:*** Carbohydrates on the surface of pathogens and cells play a role in immune system recognition and response.
- ***Dietary Fiber:*** Certain carbohydrates, such as dietary fiber, aid in digestion, promote bowel regularity, and contribute to overall gastrointestinal health.
- ***Protein Modification:*** Carbohydrates can be added to proteins, forming glycoproteins, which are involved in various cellular functions, including protein folding and stability.
- ***DNA and RNA Structure:*** Deoxyribose and ribose, both carbohydrates, are essential components of the backbone structure of DNA and RNA, respectively.
- ***Metabolic Regulation:*** Carbohydrates influence metabolic processes, such as insulin's role in glucose uptake by cells and the regulation of blood sugar levels.

62. What is agarose and where is it extracted from?

Agarose is a polysaccharide extracted from certain types of red seaweed, primarily belonging to the genera Gelidium and Gracilaria. It is commonly used in molecular biology and biochemistry for various applications, especially in the preparation of agarose gel for electrophoresis.

The extraction process involves harvesting the seaweed and subjecting it to treatment to remove impurities and obtain the agarose. Once extracted, agarose is processed into a fine powder or sold in the form of precast gel products. It has several properties that make it suitable for various laboratory applications:

1. ***Gel Formation:*** Agarose forms a gel when dissolved in water and then cooled. The concentration of agarose in the solution determines the strength of the resulting gel. Agarose gels are widely used in techniques like agarose gel electrophoresis for separating and analyzing nucleic acids (DNA and RNA) based on their size.

2. ***Biocompatibility:*** Agarose is biocompatible, meaning it is generally non-toxic and does not interfere with biological processes. This property makes it suitable for use in various applications involving biological samples.

3. ***Porous Structure:*** Agarose gels have a porous structure, allowing molecules to move through the gel matrix during electrophoresis based on their size. This separation is useful for analyzing DNA fragments or other biomolecules.

4. ***High Melting and Gelling Temperatures:*** Agarose has a relatively high melting temperature and gelling temperature, allowing the formation of stable gels at a wide range of temperatures commonly used in laboratory settings.

63. Explain role of allele in genetic inheritance.

An allele is one of the alternative forms of a gene that occupies a specific position, or locus, on a chromosome. Genes code for specific traits, and the presence of different alleles at a particular gene locus can result in variations in those traits. Alleles play a crucial role in genetic inheritance by determining the characteristics or phenotypes of an organism.

Here are key aspects of the role of alleles in genetic inheritance:

1. Inheritance of Traits:

Each individual inherits one allele for a specific gene from each parent. The combination of alleles an individual receives determines their genotype, which in turn influences their phenotype—the observable traits or characteristics.

2. Dominance and Recessiveness:

Alleles can be dominant, recessive, or co-dominant. A dominant allele masks the effect of a recessive allele when present in a heterozygous individual (having two different alleles). Co-dominance occurs when both alleles contribute to the phenotype.

3. Homozygous and Heterozygous Genotypes:

If an individual has two identical alleles for a particular gene, they are said to be homozygous for that gene (e.g., homozygous dominant or homozygous recessive). If they have two different alleles, they are heterozygous.

4. Mendelian Inheritance:

The principles of Mendelian inheritance describe how alleles segregate and assort during the formation of gametes (sperm and egg cells) and are passed on to offspring. The law of segregation states that each individual has two alleles for each gene, and these alleles segregate during gamete formation, resulting in each gamete carrying only one allele.

5. Genetic Variation:

The existence of multiple alleles for a gene within a population contributes to genetic variation. This variation is essential for the evolution of populations over time.

6. Recombination and Crossing Over:

Recombination and crossing over during meiosis lead to the exchange of genetic material between homologous chromosomes. This can result in the formation of new combinations of alleles, further increasing genetic diversity.

7. Expression of Traits:

The combination of alleles an individual inherits influences the expression of specific traits. Some traits are controlled by a single gene with two alleles, while others may involve multiple genes and alleles.

8. Genetic Disorders:

Certain genetic disorders are associated with specific alleles. Inherited disorders, such as sickle cell anemia or cystic fibrosis, are caused by variations in alleles that affect the function of a particular gene.

64. What are autosomal recessive disorders?

Autosomal recessive disorders are genetic conditions where an individual needs to inherit two copies of a mutated gene (one from each parent) to express the disorder. Carriers, with one normal and one mutated allele, are typically asymptomatic. Examples include cystic fibrosis, sickle cell anemia, and phenylketonuria (PKU).

65. Differentiate between hydrolysis and condensation.

Hydrolysis and condensation are two opposing chemical processes that involve the breaking and forming of chemical bonds, respectively. Here's a brief differentiation between hydrolysis and condensation:

1. Hydrolysis:

Hydrolysis is a chemical process in which a molecule is broken down into smaller components through the addition of water molecules. Water molecules are added to the molecular structure, leading to the cleavage of chemical bonds. The components of water (hydrogen and hydroxyl ions) are incorporated into the resulting molecules. Example: The digestion of complex molecules such as carbohydrates, proteins, and fats into their monomeric units (sugars, amino acids, and fatty acids) involves hydrolysis.

2. Condensation (Dehydration Synthesis):

Condensation is a chemical process in which two molecules combine to form a larger molecule, releasing a molecule of water in the process. Two molecules react, and a water molecule is eliminated as a byproduct. This results in the formation of a covalent bond between the two molecules.
Example: The synthesis of macromolecules such as proteins, nucleic acids, and polysaccharides involves condensation reactions. For instance, amino acids combine to form a protein, releasing water in the process.

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