BIO5105 – CELL BIOLOGY

MID TERM IMPORTANT QUESTIONS

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1. What are the consequences when topoisomerase does not work?

Topoisomerase is an enzyme that helps remove twists and tangles from DNA during replication and transcription. If this enzyme does not function properly, several problems can occur:

- ***Excessive DNA supercoiling:*** DNA becomes overly twisted because the tension generated during replication and transcription cannot be relieved.
- ***Problems in DNA replication:*** The replication machinery cannot move smoothly along the DNA strand, causing replication to slow down or stop completely.
- ***Reduced transcription:*** RNA polymerase faces difficulty reading highly twisted DNA, leading to decreased RNA and protein production.
- ***Chromosome entanglement:*** Newly replicated DNA molecules may remain linked together and fail to separate properly before cell division.
- ***DNA damage:*** Increased tension in DNA can cause strand breaks and other forms of genetic damage.
- ***Defective cell division:*** Improper chromosome separation can result in errors during mitosis or meiosis.
- ***Cell death:*** Severe DNA damage and failure of essential cellular processes may ultimately lead to cell death.

2. What is DNA? Write its structural features.

DNA (Deoxyribonucleic Acid) is the hereditary material present in almost all living organisms. It carries genetic information from one generation to the next and controls the growth, development, functioning, and reproduction of cells.

Structural Features of DNA

- ***Double Helical Structure:*** DNA consists of two long polynucleotide strands twisted around each other to form a double helix.
- ***Nucleotide Units:*** Each DNA strand is made up of repeating units called nucleotides.

- ***Components of a Nucleotide:*** Each nucleotide contains:
    - A deoxyribose sugar
    - A phosphate group
    - A nitrogenous base
- ***Nitrogenous Bases:*** DNA contains four types of bases:
    - Adenine (A)
    - Thymine (T)
    - Guanine (G)
    - Cytosine (C)
- ***Complementary Base Pairing:*** Bases pair specifically through hydrogen bonds:
    - Adenine pairs with Thymine (A–T)
    - Guanine pairs with Cytosine (G–C)
- ***Antiparallel Strands:*** The two DNA strands run in opposite directions, one from 5′→3′ and the other from 3′→5′.
- ***Sugar-Phosphate Backbone:*** The sugar and phosphate groups form the outer backbone of the DNA molecule, while the bases project inward.
- ***Hydrogen Bonds:*** The two strands are held together by hydrogen bonds between complementary bases.
- ***Genetic Information Storage:*** The sequence of nitrogenous bases stores genetic information required for protein synthesis and inheritance.

3. What are centrioles? Write their structural significance.

Centrioles are small, cylindrical cell organelles found in the centrosome of most animal cells. They play an important role in cell division by helping organize microtubules and forming the spindle fibers that separate chromosomes during mitosis and meiosis.

Structural Significance of Centrioles

- ***Cylindrical Structure:*** Each centriole is a hollow, cylindrical structure measuring about 0.2 µm in diameter and 0.5 µm in length.
- ***Arrangement of Microtubules:*** A centriole is composed of nine sets of microtubule triplets arranged in a circular pattern, known as the 9+0 arrangement**.**
- ***Paired Organization:*** Centrioles usually occur in pairs positioned at right angles to each other within the centrosome.
- ***Made of Tubulin:*** The microtubules are composed of the protein tubulin, which provides strength and stability to the centriole.
- ***Formation of Spindle Fibers:*** During cell division, centrioles help organize spindle fibers that attach to chromosomes and ensure their proper separation.
- ***Basal Body Formation:*** Centrioles can give rise to basal bodies, which serve as the foundation for the formation of cilia and flagella.
- ***Microtubule Organization Center:*** They act as centers for the organization and assembly of microtubules within the cell.

4. Write a note on nucleolus.

The nucleolus is a dense, round, and non-membrane-bound structure found within the nucleus of eukaryotic cells. It is composed mainly of DNA, RNA, and proteins and is usually visible under a microscope as a dark-stained region inside the nucleus. A cell may contain one or more nucleoli depending on its metabolic activity.

The primary function of the nucleolus is the synthesis of ribosomal RNA (rRNA) and the assembly of ribosomal subunits**.** These ribosomal subunits are then transported to the cytoplasm, where they combine to form ribosomes that carry out protein synthesis. Because of this important role, the nucleolus is often called the "ribosome factory" of the cell.

In addition to ribosome production, the nucleolus plays a role in regulating cell growth, cell division, and the organization of certain cellular proteins. Cells that are actively involved in protein synthesis, such as liver and gland cells, typically possess large and prominent nucleoli.

Thus, the nucleolus is an essential cellular structure that contributes significantly to protein production and overall cellular function.

5. How enzyme works? What is a coenzyme? Give examples of coenzymes.

Enzymes are biological catalysts that speed up chemical reactions in living organisms without being consumed in the process. They work by binding to specific molecules called substrates at a region known as the active site. The enzyme-substrate complex is formed, which lowers the activation energy required for the reaction. As a result, the substrate is converted into products more quickly, and the enzyme is released unchanged to participate in another reaction.

A coenzyme is a small organic, non-protein molecule that assists an enzyme in carrying out its catalytic activity. Coenzymes often act as carriers of electrons, atoms, or functional groups during biochemical reactions. Many coenzymes are derived from vitamins and are essential for normal metabolism.

Examples of Coenzymes

- ***NAD^+ (Nicotinamide Adenine Dinucleotide)*** – involved in oxidation-reduction reactions.
- ***FAD (Flavin Adenine Dinucleotide)*** – functions in cellular respiration and energy production.
- ***Coenzyme A (CoA)*** – involved in the transfer of acyl groups during metabolism.
- ***$NADP^+$ (Nicotinamide Adenine Dinucleotide Phosphate)*** – participates in anabolic reactions such as photosynthesis.
- ***Thiamine Pyrophosphate (TPP)*** – derived from vitamin B_1 and involved in carbohydrate metabolism.

6. What is exergonic and endergonic reactions?

Exergonic reactions are chemical reactions that release free energy to the surroundings. These reactions occur spontaneously because the products contain less energy than the reactants. The change in free energy (ΔG) is negative. ***Examples:*** Cellular respiration, breakdown of glucose, and ATP hydrolysis.

Endergonic reactions are chemical reactions that require an input of energy from the surroundings. These reactions are non-spontaneous because the products contain more energy than the reactants. The change in free energy (ΔG) is positive. ***Examples:*** Photosynthesis, protein synthesis, and ATP formation.

7. What are steroids? Give example of two naturally occurring steroids.

Steroids are a class of lipids characterized by a carbon skeleton consisting of four fused rings. They are important biological molecules that play structural and regulatory roles in living organisms. Steroids are involved in hormone production, cell membrane structure, and various metabolic processes.

Naturally occurring steroids are produced by plants and animals and are essential for normal physiological functions.

Examples of Naturally Occurring Steroids

1. ***Cholesterol*** – A major component of animal cell membranes and a precursor for the synthesis of steroid hormones, vitamin D, and bile acids.
2. ***Testosterone*** – A steroid hormone primarily produced in the testes that is responsible for the development and maintenance of male reproductive characteristics.

8. What is glycosidic linkage?

A glycosidic linkage (or glycosidic bond) is a covalent bond that joins two sugar molecules (monosaccharides) together to form a disaccharide, oligosaccharide, or polysaccharide.

- It is formed through a condensation (dehydration) reaction, in which a molecule of water is removed.
- The bond forms between the anomeric carbon of one sugar and a hydroxyl (-OH) group of another sugar.

Examples:

- In Maltose, the two glucose molecules are linked by an **α(1→4) glycosidic linkage**.
- In Lactose, glucose and galactose are joined by a **β(1→4) glycosidic linkage**.
- In Sucrose, glucose and fructose are connected by an **α(1→2) glycosidic linkage**.

9. What are okazaki fragments?

The fragments were discovered by Reiji Okazaki and Tsuneko Okazaki, after whom they are named. Okazaki fragments are short segments of newly synthesized DNA that are produced on the lagging strand during DNA replication. Because DNA polymerase can add nucleotides only in the 5′ → 3′ direction, the two strands of DNA are copied differently:

- The leading strand is synthesized continuously.
- The lagging strand is synthesized discontinuously in short pieces called Okazaki fragments.

These fragments are:

1. Initiated by RNA primers.
2. Extended by DNA polymerase.
3. Later joined together by the enzyme DNA ligase to form a continuous DNA strand.

10. Differentiate between ectoplasm and endoplasm. Also tell their appearance and position.

Difference Between Ectoplasm and Endoplasm

Feature	Ectoplasm	Endoplasm
Position	Outer layer of the cytoplasm, just beneath the cell membrane	Inner region of the cytoplasm
Appearance	Clear, transparent, and non-granular	Dense, granular, and more opaque
Consistency	More viscous (gel-like)	Less viscous (sol-like)
Cell Organelles	Contains few or no organelles	Contains most cell organelles
Function	Provides support, shape, and protection to the cell	Site of most metabolic activities and intracellular transport

Appearance and Position

- ***Ectoplasm:*** Appears as a clear, transparent, non-granular layer located at the periphery (outer region) of the cytoplasm, directly beneath the plasma membrane.
- ***Endoplasm:*** Appears as a granular, dense, and opaque layer located in the central (inner region) of the cytoplasm and contains the cell organelles.

11. Explain how genetic information is transferred through central dogma.

Transfer of Genetic Information Through the Central Dogma

The Central Dogma of Molecular Biology, proposed by Francis Crick, explains the flow of genetic information within a cell: DNA → RNA → Protein

1. Replication (DNA → DNA)

- DNA makes an identical copy of itself before cell division.
- This ensures that genetic information is passed from one generation of cells to the next.

2. Transcription (DNA → RNA)

- A segment of DNA is used as a template to synthesize messenger RNA (mRNA).
- This process occurs in the nucleus of eukaryotic cells.

3. Translation (RNA → Protein)

- The mRNA moves to ribosomes, where its nucleotide sequence is decoded.
- Ribosomes use the information in mRNA to assemble amino acids into a specific protein.

12. What is a cofactor?

A cofactor is a non-protein component that binds to an enzyme and is necessary for its catalytic activity. An enzyme without its cofactor is called an apoenzyme, while the complete active enzyme (apoenzyme + cofactor) is called a holoenzyme.

Types of Cofactors

1. ***Inorganic cofactors*** – Usually metal ions such as:
    - Ca^{2+} (calcium)
    - Mg^{2+} (magnesium)
    - Zn^{2+} (zinc)
    - Fe^{2+}/Fe^{3+} (iron)
2. ***Organic cofactors (coenzymes)*** – Organic molecules, often derived from vitamins, such as:
    - NAD+
    - FAD
    - Coenzyme A

13. Differentiate between pyranose and furanose.

Difference Between Pyranose and Furanose

Feature	Pyranose	Furanose
Ring size	Six-membered ring	Five-membered ring
Composition of ring	Five carbon atoms and one oxygen atom	Four carbon atoms and one oxygen atom
Resembles	Pyran ring	Furan ring
Stability	Generally more stable	Generally less stable
Common examples	Glucose, galactose	Fructose, ribose
Shape	Usually forms a hexagonal structure	Usually forms a pentagonal structure

14. Write a note on Golgi apparatus, its structure, discovery and function.

Discovery

The Golgi apparatus was first discovered by the Italian scientist Camillo Golgi in 1898 while studying nerve cells. He used a staining technique called the *black reaction (silver nitrate method)*, which revealed a distinct internal cell structure that was later named after him as the Golgi apparatus or Golgi complex.

Structure

The Golgi apparatus is a membrane-bound organelle found in eukaryotic cells. It has a distinctive stacked structure:

- It consists of a series of flattened, disc-shaped sacs called cisternae.
- These cisternae are arranged in a stack, usually 4–8 in number.
- It has two distinct sides:
    - ***Cis face (forming face):*** Receives materials from the endoplasmic reticulum (ER).
    - ***Trans face (maturing face):*** Ships processed materials to their destinations.
- Associated with many small vesicles that transport materials in and out.

Function

The Golgi apparatus plays a central role in processing and packaging cellular materials:

- Modification of proteins and lipids received from the ER (e.g., glycosylation).
- Packaging and sorting of proteins into vesicles for transport.
- Formation of lysosomes.
- Secretion of substances outside the cell (e.g., enzymes, hormones).
- In plant cells, it helps in cell wall formation by secreting polysaccharides.
- Plays a role in formation of plasma membrane components.

15. What is cell biology?

Cell biology is the branch of biology that studies the structure, function, and behavior of cells, which are the basic units of life. It focuses on how cells are built, how they work, how they interact with each other, and how they carry out essential life processes such as growth, metabolism, and reproduction.

16. What are codons?

Codons are sequences of three nucleotides present in messenger RNA (mRNA) that carry genetic information for protein synthesis. Each codon specifies either a particular amino acid or a signal to start or stop protein production during translation. For example, the codon AUG acts as a start codon and also codes for the amino acid methionine, while UAA, UAG, and UGA function as stop codons that terminate protein synthesis. Codons are read sequentially by ribosomes, and each codon pairs with a complementary tRNA anticodon to ensure that the correct amino acids are added to the growing polypeptide chain. In this way, codons form the basic language of the genetic code that directs the formation of proteins in all living organisms.

17. What are structural differences between animal cell and plant cell? How these differences contribute to their functioning?

Structural differences between plant and animal cells and their functional significance

Plant and animal cells show several important structural differences that are directly related to their functions and lifestyles.

1. Cell wall: Plant cells have a rigid cell wall made of cellulose, whereas animal cells lack a cell wall. The cell wall provides strength, protection, and a fixed shape to plant cells, while the absence of a cell wall in animal cells allows flexibility and enables movement and varied shapes.

2. Chloroplasts: Chloroplasts are present in plant cells but absent in animal cells. Chloroplasts carry out photosynthesis, allowing plants to prepare their own food, whereas animal cells depend on external sources for nutrition.

3. Vacuoles: Plant cells contain a large, central vacuole that stores water, nutrients, and waste materials and helps maintain turgor pressure, which keeps the plant upright. In animal cells, vacuoles are small and temporary and mainly involved in storage and transport.

4. Shape: Plant cells usually have a fixed, rectangular shape due to the presence of a cell wall, while animal cells are generally round or irregular in shape due to the absence of a rigid outer covering. This flexibility in animal cells supports specialized functions like movement.

5. Centrioles: Animal cells contain centrioles that play an important role in cell division by organizing spindle fibers, whereas most plant cells lack centrioles and use alternative mechanisms for spindle formation.

18. Define disaccharides.

Disaccharides are carbohydrates formed when two monosaccharide (simple sugar) units are joined together by a glycosidic bond through a condensation (dehydration) reaction, releasing one molecule of water. They are sweet in taste and can be broken down into their constituent monosaccharides during digestion. Common examples of disaccharides include sucrose (glucose + fructose), lactose (glucose + galactose), and maltose (glucose + glucose).

19. Differentiate between purines and pyrimidines.

Difference between Purines and Pyrimidines

Purines and pyrimidines are two types of nitrogenous bases found in nucleic acids (DNA and RNA).

Feature	Purines	Pyrimidines
Structure	Double-ring structure	Single-ring structure
Size	Larger molecules	Smaller molecules
Nitrogen rings	Two fused rings (6 + 5 membered)	One 6-membered ring
Examples	Adenine (A), Guanine (G)	Cytosine (C), Thymine (T in DNA), Uracil (U in RNA)
Base pairing	Pair with pyrimidines (A–T / A–U, G–C)	Pair with purines
Presence	Found in both DNA and RNA	Found in DNA (T) and RNA (U replaces T)

20. Differentiate between leading and lagging DNA strand.

Difference between Leading and Lagging DNA Strand

During DNA replication, the two new strands are synthesized in different ways due to the directionality of DNA polymerase.

Feature	Leading Strand	Lagging Strand
Direction of synthesis	Synthesized continuously	Synthesized discontinuously
Mode of synthesis	Continuous DNA synthesis	Discontinuous synthesis in fragments
Fragments formed	No fragments formed	Okazaki fragments are formed
Enzyme activity	DNA polymerase works smoothly in 5’ → 3’ direction	DNA polymerase works in short steps repeatedly
Primer requirement	Requires only one RNA primer	Requires multiple RNA primers
Speed	Faster synthesis	Slower synthesis due to interruptions

21. Discuss multiple roles of lipids.

Lipids are a diverse group of biomolecules that are insoluble in water but soluble in organic solvents. They perform several important functions in living organisms:

1. Energy storage

Lipids serve as a long-term energy reserve. They store more energy per gram than carbohydrates and are mainly stored in adipose tissue in animals.

2. Structural component

Lipids such as phospholipids and cholesterol are major components of cell membranes, helping in maintaining membrane structure and fluidity.

3. Insulation and protection

Fat deposits act as thermal insulators, helping to maintain body temperature. They also provide cushioning and protect vital organs like kidneys and heart.

4. Hormone production

Certain lipids act as precursors for hormones such as steroid hormones (e.g., estrogen, testosterone, cortisol), which regulate various body functions.

5. Waterproofing

In plants and animals, waxy lipids provide waterproofing. For example, cutin and waxes prevent water loss from plant leaves.

6. Cell signaling

Some lipids function as signaling molecules involved in communication between cells.

22. Differentiate between prokaryotic and eukaryotic cell.

Difference between Prokaryotic and Eukaryotic Cells

Feature	Prokaryotic Cell	Eukaryotic Cell
Nucleus	True nucleus absent (no nuclear membrane)	True nucleus present (well-defined nuclear membrane)
DNA	Circular, naked DNA	Linear chromosomes with histone proteins
Cell size	Small (1–10 µm)	Larger (10–100 µm)
Membrane-bound organelles	Absent	Present (mitochondria, ER, Golgi, etc.)
Cell division	Simple division (binary fission)	Mitosis and meiosis
Ribosomes	70S type	80S type
Examples	Bacteria and Archaea	Plants, animals, fungi

23. Explain structure of cilia and flagella.

Structure of Cilia and Flagella

Cilia and flagella are hair-like, motile cell surface projections found in eukaryotic cells that help in movement of the cell or movement of substances across the cell surface. They have a similar internal structure.

1. Basic structure

- Both cilia and flagella are covered by an extension of the cell membrane.
- Inside, they contain a core structure called the axoneme.

2. Axoneme arrangement

- The axoneme has a "9 + 2" arrangement:
  - Nine pairs (doublets) of microtubules arranged in a circular pattern on the outside.
  - Two single microtubules located in the center.
- This arrangement is made of tubulin protein.

3. Basal body

- At the base, both structures are anchored by a basal body.
- The basal body has a structure similar to a centriole with a "9 triplet microtubule arrangement."
- It organizes and supports the formation of cilia and flagella.

4. Motor proteins

- Dynein arms are present on microtubules.
- They use ATP to generate sliding movements between microtubules, producing bending motion.

5. Difference in appearance

- ***Cilia:*** Short, numerous, hair-like structures.
- ***Flagella:*** Long, fewer in number, whip-like structures.

24. A person is fasting and consumes very low carbohydrates. Explain how their body will get energy from proteins?

When a person is fasting and has very low carbohydrate intake, the body switches to alternative energy sources to maintain normal functions. After using available glucose and glycogen reserves, the body begins to utilize proteins for energy through a process called gluconeogenesis.

In this process, proteins are broken down into amino acids in the liver. The amino group is removed through deamination, producing ammonia (which is converted into urea and excreted). The remaining carbon skeletons of amino acids are then converted into glucose or intermediates of the Krebs cycle. This newly formed glucose is used by cells, especially the brain and red blood cells, to produce ATP.

Thus, during prolonged fasting, proteins are converted into glucose to meet the body's energy demands, although this is not the preferred energy source because it can lead to loss of muscle mass.

25. Differentiate between reversible and irreversible enzyme inhibitors.

Difference between Reversible and Irreversible Enzyme Inhibitors

Feature	Reversible Inhibitors	Irreversible Inhibitors
Binding nature	Bind weakly and temporarily to enzyme	Bind strongly and permanently to enzyme
Effect on enzyme	Enzyme activity can be restored	Enzyme is permanently inactivated
Type of interaction	Non-covalent interactions (hydrogen bonds, ionic bonds)	Covalent bonding or very strong interaction
Duration of effect	Short-term inhibition	Long-term or permanent inhibition
Effect of substrate concentration	Can be overcome by increasing substrate concentration	Cannot be overcome by increasing substrate concentration
Examples	Competitive inhibitors like malonate (inhibits succinate dehydrogenase)	Penicillin (inhibits bacterial transpeptidase enzyme)

26. Compare free ribosomes and ER-bound ribosomes in terms of functions.

Comparison between Free Ribosomes and ER-bound Ribosomes (Functions)

Free ribosomes

- Found freely suspended in the cytoplasm.
- Mainly synthesize proteins that are used inside the cell (intracellular proteins).
- Produce proteins required for cell growth, metabolism, and organelle function (e.g., enzymes for cytosol, nucleus, and mitochondria).
- Common in cells that need large amounts of internal proteins.

ER-bound ribosomes

- Attached to the rough endoplasmic reticulum (RER).
- Synthesize proteins that are either secreted out of the cell, inserted into the cell membrane, or sent to lysosomes.
- Produce proteins like hormones, antibodies, and membrane proteins.
- Important in cells specialized for secretion (e.g., pancreatic cells).

27. Enlist major cellular processes in nucleosomes.

Major Cellular Processes Involving Nucleosomes

Nucleosomes are the basic structural units of chromatin, where DNA is wrapped around histone proteins. They play an important role in regulating many cellular processes, including:

- ***DNA packaging:*** Nucleosomes help in compacting long DNA molecules into a highly organized chromatin structure inside the nucleus.
- ***Gene regulation (gene expression):*** They control access of transcription machinery to DNA, thereby regulating which genes are turned "on" or "off."
- ***DNA replication:*** During cell division, nucleosomes are temporarily disassembled and reassembled to allow accurate DNA copying.
- ***DNA repair:*** They help in organizing DNA so that damaged regions can be accessed and repaired by repair enzymes.
- ***Transcription:*** Nucleosome positioning influences the binding of RNA polymerase and transcription factors, affecting RNA synthesis.

28. Why energy is stored as a fat and not as a carbohydrate?

Energy in the body is stored mainly as fat (lipids) rather than carbohydrates because fats are a more efficient and suitable long-term energy storage form.

1. Higher energy content:
Fats provide about 9 kcal/g**,** while carbohydrates provide only about 4 kcal/g. This means fats store more than double the energy per unit mass.

2. Compact storage:
Fats are stored in a highly reduced and anhydrous (water-free) form**,** making them lightweight and compact. In contrast, carbohydrates like glycogen store water along with them, making storage bulky.

3. Long-term energy reserve:
Carbohydrates (glycogen) are used for short-term energy needs, while fats serve as a long-term energy reserve that can sustain the body during fasting or starvation.

4. Space efficiency:
Storing large amounts of carbohydrates would require much more space due to water association, whereas fat droplets occupy less volume.

5. Metabolic stability:
Fats are chemically stable and do not interfere with cellular osmotic balance, unlike excess carbohydrates.

29. What errors may occur during replication?

During DNA replication, mistakes can sometimes occur even though the process is highly accurate. These errors include:

1. Base substitution (point mutation): A wrong nucleotide may be inserted opposite a template strand, leading to a change in one base pair.

2. Insertion errors: Extra nucleotide(s) may be added into the growing DNA strand, which can shift the reading frame.

3. Deletion errors: One or more nucleotides may be skipped or lost during replication, also causing a frameshift mutation.

4. Mismatch pairing: Incorrect base pairing (e.g., G paired with T instead of C) may occur due to DNA polymerase errors.

5. Frameshift mutations: Insertions or deletions that are not in multiples of three bases can shift the genetic reading frame, affecting protein synthesis.

6. Replication slippage: DNA polymerase may slip on repetitive sequences, leading to small insertions or deletions.

30. Define endoplasmic reticulum and exoplasmic reticulum.

Endoplasmic Reticulum (ER)

The endoplasmic reticulum (ER) is a membrane-bound network of flattened sacs, tubules, and vesicles present in the cytoplasm of eukaryotic cells. It is connected to the nuclear membrane and plays an important role in the synthesis, modification, and transport of proteins and lipids. It is of two types: rough ER (with ribosomes, involved in protein synthesis) and smooth ER (without ribosomes, involved in lipid synthesis and detoxification).

Exoplasmic Reticulum

The term **"**exoplasmic reticulum**"** is not commonly used in standard cell biology. In many cases, it is either a misused or outdated term. If it is used in some contexts, it may refer to membrane systems or regions of the ER oriented toward the outside (extracellular or luminal side)**,** but it is not a recognized distinct organelle like the endoplasmic reticulum.

31. Explain Hershey's law.

Hershey's Experiment (Hershey–Chase Experiment) / "Hershey's Law"

Hershey's experiment, conducted in 1952 by Alfred Hershey and Martha Chase, provided strong evidence that DNA is the genetic material. They used bacteriophages (viruses that infect bacteria) and labeled their two components differently:

- DNA was labeled with radioactive phosphorus (^{32}P) because DNA contains phosphorus but no sulfur.
- Protein coat was labeled with radioactive sulfur (^{35}S) because proteins contain sulfur but no phosphorus.

Procedure:

- The labeled bacteriophages were allowed to infect E. coli bacteria**.**
- After infection, the mixture was shaken to separate viral coats from bacteria.
- It was then centrifuged to distinguish bacterial cells from viral particles.

Observations:

- Radioactive ^{32}P (DNA) was found inside the bacterial cells.
- Radioactive ^{35}S (protein) remained outside in the viral coats.

32. What were differences between Robert Hooke's and Leuwenhoek's theory?

Differences between Robert Hooke's and Antonie van Leeuwenhoek's contributions

Feature	Robert Hooke	Antonie van Leeuwenhoek
Discovery	First observed and named "cells"	First observed living microorganisms
Year	1665	1674–1683
Observation material	Dead cork cells (plant tissue)	Living organisms in pond water, saliva, etc.
Type of cells seen	Only non-living, empty cell walls	Living single-celled organisms (bacteria, protozoa)
Microscope used	Simple compound microscope	Powerful single-lens microscope
Contribution	Coined the term "cell"	Father of microbiology due to discovery of microbes

33. Why DNA is used in transmission of genetic information?

DNA is used as the genetic material because it has several unique properties that make it ideal for storing and transmitting hereditary information.

1. Stability: DNA is chemically more stable than RNA due to its double-stranded structure and the presence of deoxyribose sugar, which makes it less reactive and suitable for long-term information storage.

2. Accurate replication: DNA can replicate itself precisely through complementary base pairing (A–T and G–C), ensuring that genetic information is faithfully passed to daughter cells.

3. Capacity to store information: The sequence of nucleotide bases in DNA acts as a genetic code that can store a vast amount of information required for building and maintaining an organism.

4. Ability to mutate: DNA can undergo slow, controlled mutations, which provide variation necessary for evolution and adaptation.

5. Protection of genetic material: In eukaryotes, DNA is protected inside the nucleus and associated with histone proteins, reducing damage.

34. Explain molecular structure of steroids.

Molecular Structure of Steroids

Steroids are a class of lipids characterized by a distinct four-ring carbon structure. They are derived from cholesterol and have a common structural framework.

1. Basic carbon skeleton

- Steroids contain a core structure of four fused rings:
  - Three six-membered rings (A, B, and C rings)
  - One five-membered ring (D ring)
- This structure is called the cyclopentanoperhydrophenanthrene nucleus.

2. Arrangement of rings

- The four rings are fused together in a specific, rigid configuration.
- This rigidity gives steroids their characteristic shape and stability.

3. Functional groups

- Different steroids vary based on the functional groups attached (e.g., hydroxyl, keto groups).
- These modifications determine their specific biological functions (e.g., hormones, bile acids).

4. Side chain variation

- Many steroids have a hydrocarbon side chain attached at carbon-17.
- This side chain influences solubility and biological activity.

5. Examples

- Cholesterol (membrane structure)
- Testosterone and estrogen (sex hormones)
- Cortisol (stress hormone)

LMS Handling

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