Tamil Nadu 2026 Class 12 Biology Public Question Paper with Solutions(Memory Based)

Time Allowed :3 Hour	Maximum Marks :70	Total Questions :21

General Instructions

- The total duration of the examination is 3 hours (180 minutes).
- Candidates are allotted 15 minutes for reading the question paper and verifying their particulars.
- The maximum marks for the theory paper is 70.
- Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.
- Use Blue or Black ink to write and underline, and use a pencil for drawing diagrams.
- The question paper consists of four parts (Part I, II, III, and IV).
- Part I is compulsory and contains multiple-choice questions.
- Internal choices and "answer any x out of y" options are provided in Parts II, III, and IV.
- Diagrams should be drawn wherever necessary and labeled neatly.
- Scientific calculators and other electronic gadgets are strictly not allowed.

1. Explain the process of double fertilisation and its significance in angiosperms.

Solution:
Concept: Double fertilisation is a unique feature of angiosperms in which two fertilisation events occur within the embryo sac.
Step 1: Formation of male gametes.
The pollen grain contains two male gametes (sperm cells) which are delivered into the embryo sac through the pollen tube.
Step 2: First fertilisation (Syngamy).
One male gamete fuses with the egg cell to form a diploid zygote ($2n$), which later develops into the embryo.
Step 3: Second fertilisation (Triple fusion).
The second male gamete fuses with two polar nuclei present in the central cell to form a triploid primary endosperm nucleus ($3n$).
Step 4: Development.

- Zygote develops into the embryo
- Primary endosperm nucleus develops into endosperm, which nourishes the embryo

Step 5: Significance.

- Ensures efficient use of resources as endosperm develops only after fertilisation
- Provides nourishment to the developing embryo
- Leads to simultaneous development of embryo and endosperm
- A characteristic feature distinguishing angiosperms from other plant groups

Step 6: Conclusion.
Thus, double fertilisation involves syngamy and triple fusion, resulting in the formation of both embryo and endosperm, making reproduction in angiosperms highly efficient.

Quick Tip

Remember: Double fertilisation = 2 fusions → Zygote (2n) + Endosperm (3n).

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2. Describe the structure and development of a mature 7-celled, 8-nucleated embryo sac.

Solution:
Concept: The embryo sac is the female gametophyte of angiosperms. The most common type is the *Polygonum type*, which is 7-celled and 8-nucleated.
Step 1: Development (Megasporogenesis).
A diploid megaspore mother cell (MMC) undergoes meiosis to produce four haploid megaspores, out of which three degenerate and one functional megaspore remains.
Step 2: Megagametogenesis.
The functional megaspore undergoes three successive mitotic divisions:

- First division → 2 nuclei
- Second division → 4 nuclei
- Third division → 8 nuclei

These nuclei arrange themselves within the embryo sac.
Step 3: Arrangement of nuclei.
The 8 nuclei are organized as follows:

- **Micropylar end:** 3 cells (egg apparatus)
  - 1 egg cell
  - 2 synergids
- **Central cell:** 2 polar nuclei
- **Chalazal end:** 3 antipodal cells

Step 4: Cell formation.
Cell walls form around six nuclei, while two polar nuclei remain in the central cell:

- Total cells = 7
- Total nuclei = 8

Step 5: Structure summary.

- 1 Egg cell
- 2 Synergids
- 3 Antipodal cells
- 1 Central cell (with 2 polar nuclei)

Step 6: Significance.
The embryo sac plays a crucial role in fertilisation:

- Egg cell forms zygote
- Polar nuclei participate in triple fusion
- Synergids guide pollen tube

Step 7: Conclusion.
Thus, a mature embryo sac is 7-celled and 8-nucleated, formed through orderly mitotic divisions and nuclear organization.

Quick Tip

Remember: 7 cells, 8 nuclei → Egg (1) + Synergids (2) + Antipodals (3) + Central cell (2 nuclei).

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3. Explain the basic techniques and applications of plant tissue culture.

Solution:
Concept: Plant tissue culture is the technique of growing plant cells, tissues, or organs under sterile and controlled conditions on a nutrient medium.
Step 1: Basic principle.
It is based on *totipotency*, the ability of a single plant cell to develop into a complete plant.
Step 2: Basic techniques.

- **Explant selection:** A small piece of plant tissue (leaf, stem, root, meristem) is selected.
- **Surface sterilization:** Explant is sterilized using chemicals (e.g., $HgCl_2$, alcohol) to remove contaminants.
- **Inoculation:** Explant is placed on a sterile nutrient medium (like MS medium).
- **Incubation:** Cultures are kept under controlled temperature, light, and humidity.
- **Callus formation:** Undifferentiated mass of cells develops.

- **Organogenesis/Embryogenesis:** Differentiation into shoots and roots.
- **Hardening:** Gradual acclimatization of plantlets to natural conditions before field transfer.

Step 3: Types of culture.

- Callus culture
- Suspension culture
- Meristem culture
- Anther/pollen culture
- Embryo culture

Step 4: Applications.

- **Micropropagation:** Rapid multiplication of plants
- **Disease-free plants:** Production via meristem culture
- **Crop improvement:** Development of hybrids and transgenic plants
- **Germplasm conservation:** Preservation of rare and endangered species
- **Secondary metabolite production:** Alkaloids, hormones, medicines
- **Haploid production:** Useful in plant breeding

Step 5: Advantages.

- Large-scale production in short time
- Uniform and true-to-type plants
- Year-round production independent of season

Step 6: Conclusion.
Thus, plant tissue culture is a powerful biotechnological tool for plant propagation, improvement, and conservation.

Quick Tip

Remember: Tissue culture = Totipotency + Sterile conditions + Nutrient medium.

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4. Write an essay on the steps involved in recombinant DNA (rDNA) technology.

Solution:
Concept: Recombinant DNA (rDNA) technology involves the artificial combination of DNA from different sources to create new genetic combinations for useful purposes.

Step 1: Isolation of genetic material.
DNA is isolated from the donor organism using suitable methods. Since DNA is enclosed within cells, cell walls and membranes are broken using enzymes or chemicals.
Step 2: Cutting of DNA (Restriction digestion).
The isolated DNA is cut into fragments using restriction enzymes (restriction endonucleases), which recognize specific nucleotide sequences.
Step 3: Selection of vector.
A suitable vector (such as plasmid, bacteriophage, or cosmid) is selected to carry the desired DNA fragment into a host cell.
Step 4: Ligation of DNA fragments.
The desired DNA fragment is inserted into the vector using the enzyme DNA ligase, forming recombinant DNA.
Step 5: Transformation.
The recombinant DNA is introduced into a host cell (commonly bacteria like *E. coli*) through transformation.
Step 6: Selection and screening.
Transformed cells are selected using selectable markers (such as antibiotic resistance). Screening ensures that the cells contain the desired recombinant DNA.
Step 7: Cloning and expression.
The host cells multiply, producing multiple copies (clones) of the recombinant DNA. The inserted gene may also be expressed to produce a desired protein.
Step 8: Downstream processing.
The final product (such as a protein or enzyme) is extracted, purified, and processed for commercial or medical use.
Step 9: Applications.

- Production of insulin and vaccines
- Gene therapy
- Development of genetically modified crops
- Industrial enzyme production

Step 10: Conclusion.
Thus, rDNA technology is a powerful tool in biotechnology that enables genetic manipulation for medical, agricultural, and industrial advancements.

Quick Tip

Remember: rDNA steps → Isolation → Cutting → Ligation → Transformation → Selection → Expression.

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5. Explain Bentham and Hooker's system of classification.

Solution:
Concept: Bentham and Hooker proposed a natural system of classification for flowering plants

in their book *Genera Plantarum* (1862–1883). This system is based on observable morphological characters and is widely used for practical plant identification.
Step 1: Basis of classification.
The system is based on:

- Morphological features of plants
- Floral characters
- Natural affinities among plants

Step 2: Major divisions.
They divided flowering plants (Phanerogams) into three major classes:

- **Dicotyledons**
- **Gymnosperms**
- **Monocotyledons**

Step 3: Classification of Dicotyledons.
Dicots are further divided into three subclasses:

- **Polypetalae** – petals free
- **Gamopetalae** – petals fused
- **Monochlamydeae** – perianth absent or undifferentiated

Step 4: Classification of Monocotyledons.
Monocots are grouped into several series based on floral characteristics such as perianth and ovary position.
Step 5: Gymnosperms.
Placed between dicots and monocots, representing plants with naked seeds.
Step 6: Merits.

- Based on natural relationships
- Useful for identification of plants
- Widely accepted and used in herbaria

Step 7: Demerits.

- Does not consider evolutionary relationships
- Gymnosperms placed between dicots and monocots artificially
- Monochlamydeae is a heterogeneous group

Step 8: Conclusion.
Bentham and Hooker's system is a natural and practical classification system, highly valuable for plant identification despite lacking evolutionary basis.

Quick Tip

Remember: Bentham & Hooker = Natural system based on morphology.

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6. Describe the mechanism of crossing over and its significance.

Solution:
Concept: Crossing over is the exchange of genetic material between non-sister chromatids of homologous chromosomes during meiosis (prophase I), leading to genetic recombination.
Step 1: Occurrence.
Crossing over occurs during the pachytene stage of prophase I of meiosis after homologous chromosomes have paired (synapsis).
Step 2: Synapsis and bivalent formation.
Homologous chromosomes pair closely to form a bivalent or tetrad consisting of four chromatids.
Step 3: Breakage and exchange.
Non-sister chromatids break at corresponding points and exchange segments of DNA.
Step 4: Formation of chiasmata.
The points where exchange occurs are called chiasmata, which become visible during diplotene stage.
Step 5: Separation.
After exchange, chromatids separate but remain attached at chiasmata until they move apart during later stages of meiosis.
Step 6: Result.
This leads to recombination of genes, producing new combinations of alleles in gametes.
Step 7: Significance.

- **Genetic variation:** Produces new gene combinations
- **Evolution:** Provides raw material for natural selection
- **Linkage mapping:** Helps in determining gene distances on chromosomes
- **Proper segregation:** Ensures correct separation of homologous chromosomes

Step 8: Conclusion.
Thus, crossing over is a vital process in meiosis that enhances genetic diversity and ensures proper chromosome behavior.

Quick Tip

Remember: Crossing over = Exchange of segments $\rightarrow$ Genetic variation.

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7. Describe the hormonal control of the human menstrual cycle.

Solution:
Concept: The menstrual cycle is regulated by a complex interaction of hormones secreted by the hypothalamus, pituitary gland, and ovaries.

Step 1: Role of hypothalamus.
The hypothalamus secretes Gonadotropin-Releasing Hormone (GnRH), which stimulates the anterior pituitary gland.
Step 2: Role of pituitary hormones.
The anterior pituitary releases:

- **Follicle Stimulating Hormone (FSH)** – stimulates growth of ovarian follicles
- **Luteinizing Hormone (LH)** – triggers ovulation and formation of corpus luteum

Step 3: Follicular phase (Day 1–14).

- FSH stimulates follicle development
- Growing follicles secrete estrogen
- Estrogen promotes thickening of endometrium

Step 4: Ovulation (Around Day 14).

- High estrogen levels trigger LH surge
- LH surge causes release of ovum (ovulation)

Step 5: Luteal phase (Day 15–28).

- Corpus luteum forms and secretes progesterone
- Progesterone maintains and prepares endometrium for implantation

Step 6: Menstruation.

- If fertilization does not occur, corpus luteum degenerates
- Estrogen and progesterone levels fall
- Endometrial lining sheds $\rightarrow$ menstruation

Step 7: Feedback regulation.

- Estrogen and progesterone exert feedback control on hypothalamus and pituitary
- Regulates secretion of GnRH, FSH, and LH

Step 8: Conclusion.
Thus, the menstrual cycle is hormonally regulated through coordinated actions of GnRH, FSH, LH, estrogen, and progesterone.

Quick Tip

Remember: FSH $\rightarrow$ Follicle, LH $\rightarrow$ Ovulation, Progesterone $\rightarrow$ Maintains uterus.

8. Differentiate between active and passive immunity with suitable examples.

Solution:
Concept: Immunity is the ability of the body to resist infection. It is broadly classified into active and passive immunity based on how antibodies are acquired.
Step 1: Active immunity.
Active immunity is developed when the body produces its own antibodies in response to an antigen.

- **Source:** Own immune system
- **Onset:** Slow (takes time to develop)
- **Duration:** Long-lasting (often lifelong)
- **Memory:** Immunological memory present
- **Examples:** Natural infection (e.g., measles), vaccination

Step 2: Passive immunity.
Passive immunity is acquired by receiving ready-made antibodies from another source.

- **Source:** External antibodies
- **Onset:** Immediate protection
- **Duration:** Short-lived
- **Memory:** No immunological memory
- **Examples:** Maternal antibodies (through placenta or milk), antiserum injections

Step 3: Comparison table.

Feature	**Active Immunity**	**Passive Immunity**
$Source$	$Ownbody$	$Externalsource$
$Onset$	$Slow$	$Immediate$
$Duration$	$Long-lasting$	$Short-term$
$Memory$	$Present$	$Absent$
$Example$	$Vaccination$	$Maternalantibodies$

Step 4: Conclusion.
Thus, active immunity provides long-term protection through antibody production and memory, while passive immunity offers immediate but temporary protection.

Quick Tip

Remember: Active = Own antibodies (long-term), Passive = Ready-made antibodies (short-term).

9. Explain the semi-conservative mode of DNA replication.

Solution:
Concept: The semi-conservative mode of DNA replication means that after replication, each newly formed DNA molecule contains one parental (old) strand and one newly synthesized strand.
Step 1: Meaning of semi-conservative replication.
During DNA replication, the two strands of the parent DNA separate and each strand acts as a template for the synthesis of a new complementary strand. As a result, each daughter DNA molecule conserves one original strand and contains one new strand.
Step 2: Unwinding of DNA.
The double helix unwinds with the help of enzymes such as helicase. Hydrogen bonds between the nitrogenous bases are broken, and the two strands separate.
Step 3: Template function of parental strands.
Each separated parental strand serves as a template. Free nucleotides from the nucleoplasm pair with the exposed bases according to the base-pairing rule:

$$A \leftrightarrow T, \qquad G \leftrightarrow C$$

Step 4: Formation of new strands.
DNA polymerase joins the incoming nucleotides and synthesizes new complementary strands along each parental strand.
Step 5: Result of replication.
At the end of replication, two identical DNA molecules are produced. Each consists of:

- one old (parental) strand
- one new (daughter) strand

Step 6: Experimental proof.
The semi-conservative nature of DNA replication was demonstrated by Meselson and Stahl using *E. coli*. They grew bacteria in heavy nitrogen (^{15}N) and then shifted them to light nitrogen (^{14}N). The results proved that each new DNA molecule had one old and one new strand.
Step 7: Significance.

- Ensures accurate transmission of genetic information
- Maintains continuity of genetic material from one generation to the next
- Reduces errors during DNA duplication

Step 8: Conclusion.
Thus, in semi-conservative replication, each daughter DNA molecule contains one parental strand and one newly synthesized strand, ensuring faithful copying of genetic material.

Quick Tip

Remember: Semi-conservative = Half old + Half new in each daughter DNA molecule.

10. Describe the mechanism of urine formation, including filtration, reabsorption, and secretion.

Solution:
Concept: Urine formation is a vital process carried out in the nephrons of the kidneys. It involves three main steps: glomerular filtration, tubular reabsorption, and tubular secretion.
Step 1: Glomerular filtration.

- Occurs in the glomerulus and Bowman's capsule
- Blood is filtered under high pressure
- Water, glucose, salts, amino acids, and urea pass into the filtrate
- Large molecules like proteins and blood cells are retained in blood

Step 2: Tubular reabsorption.

- Takes place mainly in the proximal convoluted tubule (PCT), loop of Henle, and distal convoluted tubule (DCT)
- Useful substances such as glucose, amino acids, ions, and most water are reabsorbed back into the blood
- Reabsorption may be active (requiring energy) or passive

Step 3: Tubular secretion.

- Occurs mainly in DCT and collecting duct
- Waste substances like hydrogen ions, potassium ions, ammonia, and drugs are secreted from blood into the filtrate
- Helps in maintaining pH and ionic balance

Step 4: Concentration of urine.

- Loop of Henle and collecting duct regulate water reabsorption
- Antidiuretic hormone (ADH) controls water permeability
- Produces concentrated or dilute urine depending on body needs

Step 5: Final urine formation.
The remaining filtrate, containing urea, excess salts, and water, is excreted as urine through ureters to the urinary bladder.
Step 6: Conclusion.
Thus, urine formation involves filtration of blood, selective reabsorption of useful substances, and secretion of wastes, ensuring proper excretion and homeostasis.

Quick Tip

Remember: Urine formation = Filtration → Reabsorption → Secretion.

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11. Explain the production of recombinant insulin and its advantages over conventional insulin.

Solution:
Concept: Recombinant insulin is produced using recombinant DNA (rDNA) technology by inserting the human insulin gene into microorganisms such as *E. coli*.
Step 1: Isolation of insulin gene.
The gene responsible for insulin production is identified and isolated from human DNA.
Step 2: Insertion into vector.
The insulin gene is inserted into a plasmid vector using restriction enzymes and DNA ligase to form recombinant DNA.
Step 3: Transformation.
The recombinant plasmid is introduced into bacterial cells (commonly *E. coli*).
Step 4: Expression of insulin.
The bacteria multiply and express the insulin gene, producing insulin protein (initially as separate A and B chains or proinsulin).
Step 5: Processing and purification.
The insulin chains are purified and combined to form functional insulin, which is then processed for medical use.
Step 6: Advantages over conventional insulin.

- **High purity:** Free from animal impurities
- **Reduced allergic reactions:** More compatible with human body
- **Large-scale production:** Easily produced in bulk
- **Ethical advantage:** No need to extract from animal pancreas
- **Consistent quality:** Uniform and reliable product

Step 7: Conclusion.
Thus, recombinant insulin is produced through genetic engineering and offers safer, more efficient, and ethical treatment for diabetes compared to conventional insulin.

Quick Tip

Remember: Recombinant insulin = Human gene + Bacteria → Safe insulin.
