HSSC-I ANNUAL EXAMINATION – 2026	PREDICTED PAPER
SUBJECT: BIOLOGY (Pre-Medical) | NEW CURRICULUM (NCP 2022-23)	**VARIANT:** MOST REALISTIC
Time Allowed: 3 Hours 10 Minutes	**Total Marks:** 85
SECTION A: MCQs (20 marks) **SECTION B:** Short Questions (40 marks) **SECTION C:** Long Questions (25 marks)	***NOTE:*** *Attempt all MCQs. Answer as per instructions.*

SECTION A – MULTIPLE CHOICE QUESTIONS (MCQs)

*Q.1 Choose the correct answer. Each question carries **ONE (1) mark**. Total: **20 marks**. Circle the correct option on the answer bubble sheet.*

1. **[Ch.1]** The fluid mosaic model of cell membrane was proposed by:

   (A) Singer & Nicolson (B) Watson & Crick (C) Schleiden & Schwann (D) Robert Hooke

   *Expected: **92%** | Ans: **(A)***

2. **[Ch.1]** Which organelle is known as the 'powerhouse of the cell'?

   (A) Ribosome (B) Golgi apparatus (C) Mitochondria (D) Lysosome

   *Expected: **95%** | Ans: **(C)***

3. **[Ch.1]** The unit membrane model was proposed by:

   (A) Robertson (B) Davson & Danielli (C) Singer (D) Hooke

   *Expected: **75%** | Ans: **(A)***

4. **[Ch.1]** Plasmodesmata are found in:

   (A) Animal cells only (B) Plant cells only (C) Both plant and animal cells (D) Prokaryotes only

   *Expected: **80%** | Ans: **(B)***

5. **[Ch.1]** Lysosomes are called 'suicide bags' because they:

   (A) Produce energy (B) Contain hydrolytic enzymes that can digest the cell (C) Synthesize proteins (D) Store waste

   *Expected: **88%** | Ans: **(B)***

6. **[Ch.1]** Which of the following is NOT a membrane-bound organelle?

   (A) Mitochondria (B) Ribosome (C) Nucleus (D) Golgi apparatus

   *Expected: **85%** | Ans: **(B)***

7. **[Ch.1]** The endoplasmic reticulum that has ribosomes on its surface is called:

   (A) Smooth ER (B) Rough ER (C) Agranular ER (D) Sarcoplasmic reticulum

   *Expected: **82%** | Ans: **(B)***

8. **[Ch.1]** Centrioles are involved in:

   (A) Protein synthesis (B) Formation of spindle fibers (C) Photosynthesis (D) DNA replication

   *Expected: **79%** | Ans: **(B)***

9. **[Ch.2]** Which bond holds the two strands of DNA together?

   (A) Covalent bond (B) Ionic bond (C) Hydrogen bond (D) Peptide bond

   *Expected: **93%** | Ans: **(C)***

10. **[Ch.2]** The monomer of proteins is:

    (A) Glucose (B) Fatty acid (C) Amino acid (D) Nucleotide

    *Expected: **97%** | Ans: **(C)***

1 **[Ch.2]** Cellulose is a polymer of:

1. (A) Fructose (B) Glucose (β-1,4 linkage) (C) Galactose (D) Mannose
*Expected: **89%** | Ans: **(B)***

1 **[Ch.2]** Denaturation of protein means:

2. (A) Breaking of peptide bonds (B) Loss of 3D structure without breaking peptide bonds (C) Addition of amino acids (D) Formation of disulfide bonds
*Expected: **87%** | Ans: **(B)***

1 **[Ch.2]** DNA replication is:

3. (A) Conservative (B) Semi-conservative (C) Dispersive (D) Non-conservative
*Expected: **90%** | Ans: **(B)***

1 **[Ch.2]** Which vitamin is a fat-soluble vitamin?

4. (A) Vitamin C (B) Vitamin B12 (C) Vitamin D (D) Vitamin B1
*Expected: **83%** | Ans: **(C)***

1 **[Ch.2]** Phospholipid molecule has:

5. (A) One fatty acid tail (B) Two fatty acid tails (C) Three fatty acid tails (D) Four fatty acid tails
*Expected: **81%** | Ans: **(B)***

1 **[Ch.2]** The sugar found in RNA is:

6. (A) Deoxyribose (B) Ribose (C) Fructose (D) Galactose
*Expected: **94%** | Ans: **(B)***

1 **[Ch.3]** Enzymes are biologically active:

7. (A) Lipids (B) Carbohydrates (C) Proteins (D) Nucleic acids
*Expected: **95%** | Ans: **(C)***

1 **[Ch.3]** The region of an enzyme where the substrate binds is called:

8. (A) Allosteric site (B) Active site (C) Binding site (D) Regulatory site
*Expected: **96%** | Ans: **(B)***

1 **[Ch.3]** A competitive inhibitor:

9. (A) Binds to allosteric site (B) Permanently denatures enzyme (C) Binds to active site reversibly (D) Changes enzyme shape permanently
*Expected: **88%** | Ans: **(C)***

2 **[Ch.3]** Lock and Key model was proposed by:

0. (A) Koshland (B) Emil Fischer (C) Michaelis (D) Lineweaver
*Expected: **90%** | Ans: **(B)***

SECTION B – SHORT QUESTIONS

*Q.2 – Q.7 Each question has **TWO parts** with internal choice. Each part carries **2 marks**. Total: **40 marks**. Answer in 3–5 lines.*

Q.2 Answer EITHER (a) OR (b):

(a) **[Ch.1]** Define cell theory. Who proposed it?

■ **Expected: 85%**

Answer: *Cell theory states: (1) All living things are made of cells. (2) Cell is the basic unit of life. (3) All cells arise from pre-existing cells. Proposed by Schleiden (1838), Schwann (1839), and Virchow (1855).*

(b) **[Ch.1]** What is fluid mosaic model? Who proposed it?

■ **Expected: 90%**

Answer: *The fluid mosaic model (Singer & Nicolson, 1972) describes the cell membrane as a fluid phospholipid bilayer with proteins embedded in or on it. The phospholipids move laterally (fluid) and proteins are scattered (mosaic pattern).*

Q.3 Answer EITHER (a) OR (b):

(a) **[Ch.1]** Differentiate between smooth ER and rough ER.

■ **Expected: 88%**

Answer: *Rough ER has ribosomes on its surface and synthesizes proteins. Smooth ER lacks ribosomes and is involved in lipid synthesis, detoxification, and calcium ion storage.*

(b) **[Ch.1]** What are lysosomes? Why are they called 'suicide bags'?

■ **Expected: 87%**

Answer: *Lysosomes are membrane-bound organelles containing hydrolytic (digestive) enzymes. They are called 'suicide bags' because if their membrane ruptures, the enzymes destroy the cell itself (autolysis).*

Q.4 Answer EITHER (a) OR (b):

(a) **[Ch.1]** What is the role of Golgi apparatus?

■ **Expected: 83%**

Answer: *Golgi apparatus modifies, packages, and distributes proteins and lipids received from the ER. It produces lysosomes and secretory vesicles. It is sometimes called the 'post office of the cell'.*

(b) **[Ch.1]** Differentiate between prokaryotic and eukaryotic cells.

■ **Expected: 91%**

Answer: *Prokaryotic cells lack a membrane-bound nucleus and membrane-bound organelles (e.g., bacteria). Eukaryotic cells have a true membrane-bound nucleus and complex organelles (e.g., plant/animal cells).*

Q.5 Answer EITHER (a) OR (b):

(a) **[Ch.1]** What is the function of the cell membrane?

■ **Expected: 86%**

Answer: *Cell membrane provides selective permeability, controls entry and exit of substances, maintains cell shape, and enables cell communication through receptor proteins.*

(b) **[Ch.2]** Define denaturation of proteins. What causes it?

■ **Expected: 89%**

Answer: *Denaturation is the disruption of a protein's three-dimensional structure (secondary, tertiary, quaternary) without breaking peptide bonds, causing loss of function. It is caused by heat, extreme pH, heavy metals, or organic solvents.*

Q.6 Answer EITHER (a) OR (b):

(a) **[Ch.2]** What are essential amino acids?

■ **Expected: 82%**

Answer: *Essential amino acids are those that cannot be synthesized by the human body and must be obtained through diet. There are 8 essential amino acids in adults (e.g., leucine, valine, isoleucine, lysine).*

(b) **[Ch.2]** Differentiate between DNA and RNA.

■ **Expected: 93%**

Answer: *DNA has deoxyribose sugar, is double-stranded, contains thymine, and is found mainly in the nucleus. RNA has ribose sugar, is single-stranded, contains uracil, and is found in both nucleus and cytoplasm.*

Q.7 Answer EITHER (a) OR (b):

(a) **[Ch.2]** What is the significance of ATP?

■ **Expected: 90%**

Answer: *ATP (Adenosine Triphosphate) is the universal energy currency of cells. It stores and releases energy for cellular processes including muscle contraction, active transport, biosynthesis, and nerve transmission.*

(b) **[Ch.2]** Define peptide bond. How is it formed?

■ **Expected: 85%**

Answer: *A peptide bond is a covalent bond formed between the carboxyl group (-COOH) of one amino acid and the amino group (-NH2) of another, with the release of a water molecule (condensation reaction).*

Q.8 Answer EITHER (a) OR (b):

(a) **[Ch.3]** What is meant by enzyme specificity?

■ **Expected: 91%**

Answer: *Enzyme specificity means each enzyme acts on a specific substrate. This is due to the complementary shape of the enzyme's active site and the substrate. Types include absolute specificity, group specificity, and stereochemical specificity.*

(b) **[Ch.3]** Differentiate between competitive and non-competitive inhibition.

■ **Expected: 93%**

Answer: *Competitive inhibitor has structural similarity to substrate and binds reversibly to the active site; its effect can be overcome by increasing substrate concentration. Non-competitive inhibitor binds to the allosteric site, changing enzyme shape and cannot be overcome by increasing substrate.*

Q.9 Answer EITHER (a) OR (b):

(a) **[Ch.3]** What are cofactors? Give examples.

■ **Expected: 85%**

Answer: *Cofactors are non-protein helpers required by some enzymes for activity. They may be inorganic ions (e.g., Mg^{2}■, Zn^{2}■, Fe^{2}■) or organic molecules (coenzymes, e.g., NAD, FAD). Tightly bound cofactors are prosthetic groups.*

(b) **[Ch.3]** How does temperature affect enzyme activity?

■ **Expected: 92%**

Answer: *As temperature increases, enzyme activity increases up to the optimum (about 37°C for human enzymes). Beyond this, high temperature denatures the enzyme by disrupting its 3D structure, reducing activity to zero.*

SECTION C – LONG QUESTIONS (DETAILED ANSWER)

*Q.8 – Q.12 Each question has internal choice. Each carries **5 marks**. Total: **25 marks**. Answer in detail with diagrams where required.*

Q.8 [Ch.1] Describe the structure of a eukaryotic cell with reference to its organelles and their functions.

■ **Expected: 92%**

Answer:

- Plasma membrane: phospholipid bilayer with embedded proteins; selective permeability; fluid mosaic model (Singer & Nicolson, 1972).
- Nucleus: double membrane; contains DNA (chromosomes); nucleolus synthesizes rRNA; controls cell activities.
- Mitochondria: double membrane; site of aerobic respiration; cristae (inner folds) increase surface area; produce ATP.
- Ribosomes: 80S in eukaryotes (60S + 40S); site of protein synthesis; free or attached to rough ER.
- Endoplasmic Reticulum: Rough ER (has ribosomes; protein synthesis/transport) and Smooth ER (lipid synthesis, detoxification).
- Golgi apparatus: modifies, packages, sorts proteins/lipids into vesicles; forms lysosomes.
- Lysosomes: contain hydrolytic enzymes; intracellular digestion; 'suicide bags' (autolysis).
- Vacuoles: store water, food, or waste; central vacuole in plant cells provides turgor pressure.
- Cell wall (plants only): cellulose; structural support and protection.
- Chloroplasts (plants): double membrane; thylakoids (grana) for light reactions; stroma for Calvin cycle.
- Centrioles (animals): form spindle fibers during cell division.

Q.9 [Ch.3] Describe the mechanism of enzyme action. Explain the factors that affect enzyme activity.

■ **Expected: 93%**

Answer:

- Enzymes: biological catalysts (mostly proteins) that speed up reactions without being consumed.

• Mechanism: enzyme-substrate complex forms at active site → transition state stabilized → products released.
• Lock & Key model (Fischer, 1894): rigid complementary fit.
• Induced Fit model (Koshland, 1958): active site flexible, adjusts shape on substrate binding.
• Factors affecting enzyme activity:
• 1. Temperature: activity increases with temp up to optimum (~37°C for humans); beyond → denaturation (irreversible loss of shape).
• 2. pH: each enzyme has optimum pH (pepsin: 2, trypsin: 8, salivary amylase: 7); extreme pH denatures enzyme.
• 3. Substrate concentration: activity increases with [S] until all active sites saturated (Vmax).
• 4. Enzyme concentration: more enzyme = more active sites = faster reaction.
• 5. Inhibitors: Competitive (bind active site; overcome by ↑[S]); Non-competitive (bind allosteric site; change shape; not overcome by ↑[S]).
• 6. Cofactors: inorganic ions or coenzymes needed by some enzymes.

Q.10 [Ch.4] Explain the process of photosynthesis including light reactions and the Calvin cycle.

■ **Expected: 91%**

Answer:

• Photosynthesis: 6CO2 + 6H2O + light → C6H12O6 + 6O2 (in chloroplasts).
• Chloroplast structure: double membrane; grana (thylakoid stacks) for light reactions; stroma for dark reactions.
• LIGHT REACTIONS (thylakoid membrane):
• - Photosystems I and II absorb light energy.
• - Photolysis of water: H2O → 2H+ + 2e- + ½O2 (O2 released as byproduct).
• - Electrons move through electron transport chain → ATP synthesis (photophosphorylation).
• - NADP+ reduced to NADPH.
• - Products: ATP, NADPH, O2.
• DARK REACTIONS / CALVIN CYCLE (stroma):
• - CO2 fixation by RuBisCO enzyme: CO2 + RuBP (5C) → 2× 3-PGA (3C).
• - 3-PGA reduced using ATP and NADPH to form G3P.
• - G3P used to: synthesize glucose; regenerate RuBP.
• - 3 turns of cycle → 1 G3P net gain; 6 turns → 1 glucose.

Q.11 [Ch.4] Explain cellular respiration. Compare aerobic and anaerobic respiration.

■ **Expected: 89%**

Answer:

• Cellular respiration: breakdown of glucose to release energy (ATP).
• Overall (aerobic): C6H12O6 + 6O2 → 6CO2 + 6H2O + 36-38 ATP.
• GLYCOLYSIS (cytoplasm, anaerobic):
• - Glucose (6C) → 2 Pyruvate (3C); net gain: 2 ATP, 2 NADH.
• LINK REACTION (mitochondrial matrix): Pyruvate → Acetyl-CoA + CO2; produces NADH.
• KREBS CYCLE (mitochondrial matrix):
• - Acetyl-CoA (2C) + oxaloacetate → citrate cycle; per glucose: 6 NADH, 2 FADH2, 2 GTP, 4 CO2.
• OXIDATIVE PHOSPHORYLATION (inner mitochondrial membrane):
• - NADH and FADH2 donate electrons to ETC.
• - O2 is final electron acceptor → H2O.
• - ATP synthase produces ATP via chemiosmosis.
• - ~32-34 ATP from ETC; total ~36-38 ATP per glucose.
• ANAEROBIC RESPIRATION (without O2):
• - Glucose → Pyruvate (glycolysis, 2 ATP only).
• - Lactic acid fermentation (animals): Pyruvate → Lactate (regenerates NAD+).
• - Alcoholic fermentation (yeast): Pyruvate → Ethanol + CO2.

Q.12 [Ch.13] Describe the immune system. Differentiate between innate and adaptive immunity. Explain the role of B and T cells.

■ **Expected: 92%**

Answer:

- Immune system protects against pathogens, cancer cells, and foreign substances.
- INNATE (NON-SPECIFIC) IMMUNITY: first line of defense; immediate; not antigen-specific.
- - Physical barriers: skin, mucus, cilia.
- - Chemical barriers: lysozyme (tears, saliva), stomach acid.
- - Cellular: phagocytes (neutrophils, macrophages), NK cells, inflammation, fever.
- ADAPTIVE (SPECIFIC) IMMUNITY: slower; antigen-specific; has memory.
- - Humoral immunity (B cells): B cells → plasma cells → antibodies; target extracellular pathogens.
- - Cell-mediated immunity (T cells): cytotoxic T cells kill infected/cancerous cells directly.
- - T helper cells (CD4+): activate both B cells and cytotoxic T cells; secrete cytokines.
- - Memory cells (B and T): long-lived; responsible for rapid secondary immune response (basis of vaccination).
- - Antigen presentation: macrophages/dendritic cells present antigens to T cells via MHC proteins.
- Primary response: slow (days); Secondary response: rapid and stronger (memory cells).
