

Subjective Questions (Attempt one question between Q1 and Q2; and one question from Q3 and Q4). Each question = 10 marks

1. The partnership between a G-protein-coupled receptor (GPCR) and its G-protein is fundamental to signaling. Critically analyze the statement: "The physical separation of the ligand-binding function (in the GPCR) from the signal-transducing function (in the G-protein) is a masterstroke of evolutionary design." Discuss the advantages this modular, two-part system provides in terms of signal amplification, diversification, and integration.
2. Cells use small, non-protein second messengers like cAMP and Ca²⁺ to relay signals internally. Evaluate the strategic purpose of using these molecules instead of relying solely on a direct protein-to-protein cascade. Compare and contrast the generation, properties, and downstream effects of the cAMP and the IP₃/Ca²⁺ second messenger systems.
3. Cells possess two major pathways for repairing DNA double-strand breaks (DSBs): Non-Homologous End Joining (NHEJ) and Homologous Recombination (HR). Critically evaluate the pros and cons of each pathway. Explain why NHEJ is considered "error-prone" yet is active throughout the cell cycle, while the high-fidelity HR pathway is predominantly restricted to the S and G2 phases.
4. Xeroderma Pigmentosum (XP) is a genetic disorder caused by defects in the Nucleotide Excision Repair (NER) pathway, leading to extreme UV sensitivity. Analyze the molecular link between the failure of NER and the development of skin cancer in XP patients. Explain why the Base Excision Repair (BER) pathway cannot effectively compensate for the loss of NER function, despite both being excision repair mechanisms.

Objective Questions (Attempt all questions. Each question = 8 marks, more than one Answer is applicable, each wrong option = -2

1. A ligand binds to its receptor, initiating a signaling cascade that involves a G-protein. Which of the following events occurs *after* the G α subunit binds GTP

Max Marks = 36 (20 + 16)

but *before* adenylyl cyclase produces cAMP? a) GTP is hydrolyzed to GDP. b) The ligand unbinds from the receptor. c) The $G\alpha$ subunit dissociates from the $G\beta\gamma$ dimer. d) The G-protein physically phosphorylates the receptor.

2. All of the following molecules are widely considered intracellular second messengers EXCEPT: a) Inositol trisphosphate (IP3), b) Phosphatidylinositol 4,5-bisphosphate (PIP2), c) Calcium ions (Ca^{2+}), d) Cyclic adenosine monophosphate (cAMP).
3. The Base Excision Repair (BER) pathway corrects common, non-helix-distorting DNA lesions. The process involves several enzymes acting in a specific order. Which of the following enzymes is NOT directly involved in the canonical repair of a deaminated cytosine (uracil) in human DNA? a) DNA Glycosylase b) AP Endonuclease c) DNA Photolyase d) DNA Polymerase
4. Which of the following types of DNA damage would most likely be repaired by Nucleotide Excision Repair (NER) rather than any other pathway? a) An A-G mismatch created during replication. b) A uracil base present in the DNA sequence due to cytosine deamination. c) A double-strand break caused by an X-ray. d) A bulky DNA adduct caused by the carcinogen benzo[a]pyrene.