1. (a) What is the polarity of microfilament and microtubule?(2%); (b) How is the filament polarity of both types detectable? (2%); (c) Actin filaments at the leading edge of a crawling cell are believed to undergo treadmilling. What is treadmilling, and what accounts for this assembly behavior? (4%); (d) What are the three types of mitotic spindle microtublules, and what is the function of each? (6%)

2.(a) Using structural models, explain integrins mediate outside-in and inside-out signaling (4%); (b) What is homophilic interaction of cadherins between cells (2%)

3. Sophisticated molecular mechanisms have evolved to regulate the spatial and temporal organization of signal-transduction pathways. Scaffold and anchoring proteins target protein kinases and phosphatases to distinct subcellular environments where these enzymes control the phosphorylation state of neighbouring substrates. Please tell me what you know about the scaffold proteins and anchoring proteins. (6%)

4. Please describe the cellular pathway leading to increased glucose uptake in skeletal muscle after a meal. (7%)

5. The plasma membrane of eukaryotic cells, like other cell membranes, contains more lipid species than are needed to form a simple bilayer. In certain microdomains, the plasma membrane is rich in cholesterol and sphingolipid and forms a special structure called the lipid rafts. Please describe the possible function of the lipid rafts. (7%)

6. α1-antitrypsin binds to and inhibits trypsin and also the blood protease elastase. A point mutation in α1-antitrypsin is found in the hereditary form of emphysema, resulting in degradation of the fine tissues in the lung by elastase. Although the mutant α1-antitrypsin is synthesized in the rough ER (endoplasmic reticulum), it does not fold properly. Under this circumstance, what cellular response will be triggered to cope with the abnormal accumulation of mutant α1-antitrypsin? (5%)

7. Influenza virus is an enveloped virus that enters a host cell by endocytosis following binding of its envelope glycoprotein called hemagglutinin with a host's cell-surface molecule. Describe the molecular events of this viral entry and the release of viral genome into the cytosol of the host cell. (5%)

8. Describe the different phases of cell cycle. How are transitions between cell cycle phases triggered and controlled? (5%)

9. Modified cardiac muscle cells in the right atrium spontaneously depolarize their plasma membrane at regular intervals to initiate each heart beat. Depolarization of the plasma membrane triggers an action potential. How do cardiac action potentials spread from cell to cell throughout the heart? (5%)

10. What is a nucleosome? What role do nucleosomes play in gene expression? (6%)

11. The largest subunit in RNA polymerase II has a carboxy-terminal domain (CTD), which presents disordered structure in X-ray crystallography analysis. Please describe the sequence characteristics and functions of CTD in gene expression. (8%)

12. How does an activator increase the frequency of transcription? (6%)

13. Briefly describe the biochemical role of the following enzymes in DNA replication in *E. coli:* (a) DNA helicase; (b) primase; (c) the 3′ → 5′ exonuclease activity of DNA polymerase; (d) DNA ligase; (e) topoisomerases; (f) the 5′ → 3′ exonuclease activity of DNA polymerase I. (6%)

14. Explain (a) the role of DNA glycosylases in DNA repair; (b) the difference between base-excision repair and nucleotide-excision repair. (4%)

15. The process of charging tRNAs with their cognate amino acids involves multiple proofreading steps to increase the overall fidelity. Briefly describe these steps. (6%)

16. A given mRNA sequence might be translated in any of three reading frames. Describe how prokaryotes and eukaryotes determine the correct reading frame. (4%)

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