

**Indraprastha Institute of Information Technology Delhi (IIITD)**

**Department of Computational Biotechnology**

**BIO211 – Cell Biology and Biochemistry**

**Quiz-3 (December 05, 2022)**

**Duration: 40 mins**

**Total marks: 30**

1. Which of the following statements are correct? Give explanation for the incorrect statement. (9 marks)
- A. The extracellular signal molecule acetylcholine has different effects on different cell types in an animal and often binds to different cell-surface receptor molecules on different cell types.  
Correct (0.5 mark)
- B. Nitric oxide acts a broadcasting signal by diffusing in the whole body *via* blood stream.  
Incorrect. Nitric oxide acts locally because it is quickly converted to nitrates and nitrites (with a half-life of about 5-10 seconds) by reacting with oxygen and water outside cells. (0.5+1 marks)
- C. Tyrosine phosphorylation serves to build binding sites for other proteins to bind to RTKs.  
Correct (0.5 mark)
- D. Channels have specific binding pockets for the solute molecules they allow to pass.  
Incorrect. Channels do not have binding pockets for the solute that passes through them. Selectivity of a channel is achieved by the size of the internal pore and by charged regions at the entrance of the pore that attract or repel ions of the appropriate charge. (0.5+1 marks)
- E. The plasma membrane is highly impermeable to all charged molecules.  
Incorrect. The plasma membrane contains transport proteins that confer selective permeability to many but not all charged molecules. In contrast, a pure lipid bilayer lacking proteins is highly impermeable to all charged molecules. (0.5+1 marks)
- F. Both the GTP-bound  $\alpha$  subunits and nucleotide-free  $\beta\gamma$  complexes—but not GDP-bound, fully assembled G proteins—can activate other molecules downstream of GPCRs.  
Correct (0.5 mark)
- G. Transporters allow solutes to cross a membrane at much faster rates than do channels.  
Incorrect. Transporters are slower. They have enzymelike properties, i.e., they bind solutes and need to undergo conformational changes during their functional cycle. This limits the maximal rate of transport to about 1000 solute molecules per second, whereas channels can pass up to 1,000,000 solute molecules per second. (0.5+1 marks)
- H. Interpolar microtubules attach end-to-end and are therefore continuous from one spindle pole to the other.  
Incorrect. The ends of interpolar microtubules overlap and attach to one another via proteins (including motor proteins) that bridge between the microtubules. (0.5+1 marks)
2. Match the following substances with their respective natural signaling agent: (2.5 marks)
- |                |                            |     |
|----------------|----------------------------|-----|
| A. Curare      | i. Gamma-aminobutyric acid | (D) |
| B. Capsaicin   | ii. Acetylcholine          | (A) |
| C. Strychnine  | iii. Serotonin             | (E) |
| D. Barbiturate | iv. Glycine                | (C) |
| E. Nicotine    | v. Heat                    | (B) |
- (0.5 marks for each correct answer)

3. Describe two ways in which the enzymatic activity of Cdk-cyclin complexes is regulated during the cell division cycle. (3 marks)
- The cyclin-Cdk complex contains inhibitory phosphates, and to become active, the Cdk must be dephosphorylated by a specific protein phosphatase. Thus protein kinases and phosphatases regulate the activity of specific cyclin-Cdk complexes and help control progression through the cell cycle.
  - In addition to phosphorylation and dephosphorylation, the activity of Cdks can also be modulated by the binding of Cdk inhibitor protein, p27. (1.5 marks for each point)
4. Answer the following: (6 marks)
- Insulin enzyme produced in pancreas regulates the glucose uptake by cells in the body.
  - Two steroidal hormones that rely on intracellular receptor proteins for cell signaling: cortisol, estradiol, testosterone (any two).
  - Cell to cell communication in a developing embryo is mediated through Delta-Notch proteins expressed on the surface of different cells.
  - Retinoblastoma protein acts as a negative transcriptional regulator of genes involved in cell proliferation during G1 phase of cell cycle.
  - Cdc6 protein ensures that the DNA is replicated exactly once during each cell division cycle. (1 mark for each blank)
5. Rarely, both sister chromatids of a replicated chromosome end up in one daughter cell. How might this happen? What could be the consequences of such a mitotic error? (4 marks)
- Both sister chromatids could end up in the same daughter cell for any of a number of reasons. (Give 2 marks if any of these reasons is mentioned)
- If the microtubules or their connections with a kinetochore break during anaphase, both sister chromatids could be drawn to the same pole, and hence into the same daughter cell.
  - If microtubules from the same spindle pole attached to both kinetochores, the chromosome would be pulled to the same pole.
  - If the cohesins that link sister chromatids were not degraded, the pair of chromatids might be pulled to the same pole.
  - If a duplicated chromosome never engaged microtubules and was left out of the spindle, it would also end up in one daughter cell.
- In humans, such mis-segregation can lead to abnormal numbers of chromosomes, as in individuals with Down Syndrome, who have three copies of chromosome 21. (2 marks – similar alternate explanations should also be awarded marks)
6. Match the following: (2.5 marks)
- |                            |                                   |     |
|----------------------------|-----------------------------------|-----|
| A. Auditory hair cell      | i. Excitatory neurotransmitter    | (B) |
| B. Glutamate               | ii. Lateral inhibition            | (D) |
| C. Gamma-aminobutyric acid | iii. Relaxation of smooth muscles | (E) |
| D. Delta-Notch             | iv. Mechanically-gated channels   | (A) |
| E. Nitroglycerine          | v. Inhibitory neurotransmitter    | (C) |
- (0.5 marks for each correct answer)

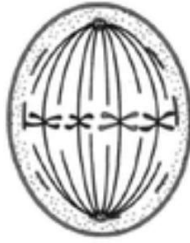
7. Identify the mitosis stage in each of the following figures:

(3 marks)



A.

Anaphase



B.

Metaphase



C.

Telophase

(1 mark for each correct answer)