BiS200 Quiz#2 (2024-04-01) (Answer in English, Closed book, 15 minutes)

Fill-in-the-blank questions:

1. pK_A is equal to the pH at which half of the weak acid molecules are ionized. At physiological pH (values near 7.4), most acidic groups (pK_A<7.4) are (deprotonated).
2. Cytoskeleton is a cell's internal skeleton for cell shape and coordination of movement and it is composed mainly of three biopolymers: (actin), (microtubule), (intermediate filament).
3. Transmembrane movement of small molecules mediated by (transporters) can be either active or passive, whereas that mediated by (channels) is always passive.
4. Stem cells are undifferentiated precursors capable of (self-renewal) and (differentiation) into specialized cell types.

Short-answer questions:

1. Describe the general mechanism by which insulin regulates blood glucose level, without mentioning specific molecular names.
    1. Insulin signals cells to increase the uptake of glucose from the bloodstream. It does this by triggering a cascade of events inside the cell that results in the movement of glucose transporter proteins to the cell membrane.
2. How does the speed of signal transmission compare between ligand-gated ion channels and G-protein-coupled receptors (GPCRs) in neuronal signaling, and what accounts for this difference?
    1. Ligand-gated ion channels are known for their fast response in neuronal signaling. When a neurotransmitter binds to these channels, they open almost instantaneously, allowing ions to flow through the membrane, which can quickly change the neuron's membrane potential. G-protein-coupled receptors (GPCRs) operate on a slower timescale. Upon ligand binding, GPCRs activate a G-protein, which then initiates a series of downstream signaling events. This process can involve the activation of second messengers, enzymes, and other cellular pathways that eventually lead to changes in cell function.
3. In the process of action potential generation within a neuron, which specific phase represents positive feedback, and which phase represents negative feedback? Explain briefly.
    1. The positive feedback phase of an action potential occurs during the depolarization phase. When a neuron is sufficiently stimulated, voltage-gated sodium channels open, allowing sodium ions to enter the cell.
    2. The negative feedback phase begins during the repolarization phase. After the peak of the action potential, the sodium channels close and voltage-gated potassium channels open. Potassium ions flow out of the neuron, which removes the positive charges from inside the cell, returning the membrane potential towards the resting state.
4. Among the four modes of cell signaling—contact-dependent, paracrine, synaptic, and endocrine—which are utilized by cytotoxic T-cells and helper T-cells in their immune functions?
    1. Cytotoxic T-cells primarily use contact-dependent signaling when they recognize and destroy infected or malignant cells.
    2. Helper T-cells engage in both contact-dependent and paracrine signaling modes. Contact-dependent signaling occurs when they interact directly with antigen-presenting cells, like dendritic cells, through their T-cell receptor. Paracrine signaling is employed when helper T-cells release cytokines, which are signaling molecules that affect nearby cells, modulating immune responses such as stimulating cytotoxic T-cell activity or B-cell antibody production.