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LT3D Questions

1. Signal transduction pathways are the method by which messenger molecules that cannot pass through a cell membrane transmit information to the nucleus. The first step is reception, when a signaling molecule binds to a receptor on the outside of the cell membrane. The second step is transduction, where the message goes through several changes as it travels through the cell's cytoplasm. Finally, it reaches the nucleus and activates a certain response according to the cell's genome.

2. If a signal transduction pathways is blocked, it can have extremely dangerous effects on cells. One example is anthrax, dead bacteria which can be inhaled and then start multiplying and feeding on the lungs. They release a toxin that targets adenylate cyclase, an enzyme in the cell membrane. The toxin changes the shape of the protein so that it can no longer release cAMP, the next step in the signal transduction pathway. This stops the pathway and the intended effect of the signal is never activated.

3. There are three ways cells communicate.
    a. Direct contact- A cells transfers a message to another cell directly touching it. Cells may bind together because their surface proteins are complimentary, changing the shape of the proteins and emitting a new signal. Signals may also be passed across small pathways between cells.
    b. Short distance/paracrine- This is when cells release chemical messengers to communicate and coordinate with cells over a short distance. This is used in development to stimulate a certain group of cells into becoming a certain body part (i.e., heart). Neurons also use a type of this signaling method called synaptic signaling.
    c. Long distance/endocrine- Specialized cells release messages called hormones into the bloodstream, which then travel throughout the body to reach specific cells. Organs like the thyroid, pancreas, and hypothalamus all release different hormones, many of which have a role in development.

4. Both protein signals and steroid signals are used by cells to trigger responses in a target cell. Steroid signals can pass directly through the cell membrane and into the nucleus directly, whereas proteins are too large. Instead, proteins bind to a receptor and trigger a secondary messenger, which then activates certain enzymes or triggers expression of a gene. Also, while steroids are fat-soluble, proteins are water-soluble. Finally, the proteins' signaling pathways include cAMP to activate kinases to finally trigger expression, but the steroid simply forms a hormone-receptor complex to act as a transcription factor itself.

5. There are three types of cell signalling pathways.

a. The messenger molecule links directly to a receptor protein, which activates the desired result. For example, a molecule could bind to a protein and, as a result, change its configuration to let in positively charged ions.
b. Notch signaling pathways allow large groups of cells to create larger structures. Notch proteins are embedded in the cell membrane; some of it is inside the cell, some of it is outside the cell. Notch signalling is usually triggered through direct contact. If a certain trait is turned on in one cell, the notch signalling may turn it off in neighboring cells. Notch signalling is used in several areas of development, and studies have shown it is turned off in cancerous cells.
c. The final signalling pathways involves many interactions between proteins inside the cell. When growth factors bind to kinase receptors, the kinases begin to phosphorylate. This creates a binding site for other proteins, triggering a chain of protein reactions that eventually trigger a change in gene expression.