Chapter 8

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October 14, 2020

- Cells communicate through Signal Transduction, started by the attachment of a ligand to a receptor, which has three steps:
    1. Reception
    2. Transduction
    3. Response
- There are two types of signals:
    1. Local signaling
        (a) Paracrine Signaling
        (b) Synaptic Signaling (specific to nervous system)
        (c) Cell Junctions (Gap junctions in animals, and Plasmodesmata in plant cells)
        (d) Cell-cell Recognition
    2. Long-distance signaling
    3. Signaling Pathway
        (a) G-Protein Linked Reception
            i. First step in protein relay, activated by GTP (Guanine Triphosphate)
        (b) Kinase: a protein that phosphorylates (adds a phosphate) to another molecule
        (c) Ligand-gated Ion Channels
            i. Attachment of ligand will open up a gate, through which some kind of particles move
- Second Messengers − Internal signaling molecules released due to external ("first") signals. Trigger sub-response pathways.
    1. Cyclic AMP − A typical second messenger that affects metabolism
    2. Calcium ions are another common second messenger

- Epinephrine (Adrenaline) − A common hormone in vertebrates, and involved in short term stress ("fight or flight")

    1. Acts as a first messenger, which activates G-protein, which activates an enzyme, which releases cAMP. Overall, this inhibits glycogen synthesis and promotes breakdown

- Signaling process through epinephrine:

    1. Epinephrine binds to G-protein, which becomes an active G-protein, which activates adenylyl cyclase, which turns ATP into cAMP, which activates the protein kinase, which activates the phosphorylation kinase, which activates glycogen phosphorylase, which turns glycogen into glucose, ultimately releasing 10^8 molecules

- Complication − A branching network

    1. Quorum Sensing − Communication among microbes trigger group response once a certain population density is reached
    2. Yeast Mating − Mating type in (haploid) yeast is genetically determined. Two mating types (a and α). Each makes signaling molecules that the other receives. The reception of a mating factor leads to the production of a mating "shmoo." Fusion of shmoos = diploid yeast cell, and meiosis ensues.
    3. Apoptosis − Programmed cell death is programmed because of the signaling pathway that it is programmed to. Death proteins are always present, but inactive.

- Hormones: Chemical signals that cause a response in *target cells* (receptor proteins for specific hormones)

    1. Affects 1 tissue, a few, or most tissues in body
    2. Regulation of homeostasis by positive and negative feedback
    3. Homeostasis: maintaining a constant internal balance

- Negative Feedback Loop Example: Insulin and Glucagon control blood glucose levels

- Control of blood glucose in steps:

    1. High blood glucose
    2. Insulin released from pancreas
    3. Body cells take up glucose, Liver stores glucose as glycogen
    4. Blood glucose drops
    5. Glucagon released from pancreas
    6. Liver breaks down glycogen and released glucose into blood

- Positive Feedback Loop: Reinforces a signal, leading to an even greater response (amplification)