Unit 7 Content

1. Feedback

a. Negative feedback mechanisms maintain dynamic homeostasis for a particular condition (variable) by regulating physiological processes, returning the changing condition back to its target set point.

b. Positive feedback mechanisms amplify responses and processes in biological organisms. The condition initiating the response is moved farther away from the initial set-point. Amplification occurs when the stimulus is further activated which, in turn, initiates an additional response that produces system change.

2. Cell-to-cell communication

a. Cells receive or send inhibitory or stimulatory signals from other cells, organisms or the environment.

b. In single-celled organisms it is response to its environment.

c. In multicellular organisms, signal transduction pathways coordinate the activities within individual cells. Ex. Epinephrine stimulation of glycogen breakdown in mammals

d. Cells communicate by cell-to-cell contact. Ex Immune cells interact by cell-cell contact, antigen- presenting cells (APCs), helper T-cells and killer T cells or plasmodesmata between plant cells that allow material to be transported from cell to cell.

e. Cells communicate over short distances by using local regulators that target cells in the vicinity of the emitting cell. Ex. Neurotransmitters, plant immune response

f. Signals released by one cell type can travel long distances to target cells of another cell type. Ex. Hormones

g. A receptor protein recognizes signal molecules, causing the receptor protein’s shape to change, which initiates transduction of the signal. Ex. G-protein linked receptors, ligand-gated ion channels, tyrosine kinase receptors.

h. Signal transduction is the process by which a signal is converted to a cellular response. Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, with the result of appropriate responses by the cell.

i. Second messengers inside of cells are often essential to the function of the cascade.

j. Many signal transduction pathways include: Protein modifications or phosphorylation cascades in which a series of protein kinases add a phosphate group to the next protein in the cascade sequence.

3. Gene Regulation

a. Prokaryotes

(1) Inducers (turn genes on) and repressors (turn genes off) are small molecules that interact with regulatory proteins and/or regulatory sequences.

(2) Regulatory proteins inhibit gene expression by binding to DNA and blocking transcription (negative control).

(3) Regulatory proteins stimulate gene expression by binding to DNA and stimulating transcription (positive control) or binding to repressors to inactivate repressor function.

b. Eukaryotes

(1) Transcription factors bind to DNA sequences and other regulatory proteins

(2) Some of these transcription factors are activators (increase expression), while others are repressors (decrease expression).

(3) The combination of transcription factors binding to the regulatory regions at any one time determines how much, if any, of the gene product will be produced.

4. Viruses

a. Replication

(1) Viruses inject DNA or RNA into host cell

(2) Viruses have highly efficient replicative capabilities that allow for rapid evolution

(3) Viruses replicate via the lytic cycle, allowing one virus to produce many progeny simultaneously

(4) Virus replication allows for mutations to occur through usual host pathways.

(5) RNA viruses lack replication error-checking mechanisms, and thus have higher rates of mutation.

(6) Related viruses can combine/recombine information if they infect the same host cell.

 (7) Some viruses are able to integrate into the host DNA and establish a latent (lysogenic) infection

(8) HIV is a well-studied system where the rapid evolution of a virus within the host contributes to the pathogenicity of viral infection.

(9) Genetic information in retroviruses is a special case and has an alternate flow of information: from RNA to DNA, made possible by reverse transcriptase, an enzyme that copies the viral RNA genome into DNA. This DNA integrates into the host genome and becomes transcribed and translated for the assembly of new viral progeny.