**Focus Topics Unit 4: Cell Communication:**

Cell Communication Methods

G Protein Transduction Pathway

Cascade Transduction Pathway

3 Phases of Signal Transduction

Cell Cycle Phases (Chromosome numbers)

Positive and Negative Feedback Mechanisms

Control of Cell Cycle Checkpoints

**Cell Communication Methods:**

**Juxtacrine-**Direct contact where cells are touching. Once cell can recognize the molecules on the adjacent cell. Examples include plasmodesmata in plants, gap junctions, tight junctions, and desmosomes. Similar to two people have a personal conversation.

**Autocrine-**when a cell signals itself. he production and secretion of an extracellular mediator by a cell followed by the binding of that mediator to receptors on the same cell to initiate signal transduction. Examples include: cancer cells making their own growth hormone rather than relying on its release from the pituitary gland, macrophages which attack infected cells. Development of embryos so cells can take on and reinforce their correct identities.

**Paracrine-** Uses ligands produced by cells that can travel through extracellular fluid (diffusion) and can be read by other local cells. They use short-lived molecules. Similar to a teacher teaching a class. Examples include: Quorum sensing, morphogens, pheromones, neurotransmitters, ions.

**Endocrine-** Ligand released by a cell and makes it way to the (blood) circulatory system. Can be spread to the entire body. They use long-lived molecules known as hormones. Similar to someone making an announcement over the PA system. Examples include adrenaline, cortisol, thyroid stimulating hormone, insulin, glucagon.

**G Protein Transduction Pathways:**

See handwritten notes

**Cascade Pathways:**

See Signal Transduction Pathway Pogil Model 2:

**3 Phases of Signal Transduction:**

Reception- The target cell’s detection of a signal molecule (ligand) coming from the outside.

Reception occurs when a signal molecule (ligand) binds to a receptor protein.

Found in two places:

-plasma membrane receptor proteins

-Binds to water-soluble ligands

-intracellular receptor proteins

-Found inside the plasma membrane in the cytoplasm or nucleus.

Examples include ligands such as hormones, neurotransmitters etc.

Transduction- The conversion of the signal to a form that can bring about a specific cellular response.

-Commonly a shape change in a protein

-Shape change is brought about by phosphorylation (addition of a phosphate group)

-Signal transduction often involve a phosphorylation cascade.

When receptors are membrane proteins, the transduction stage is usually a multistep pathway

-Multistep pathways can amplify a signal

-Enzymes called protein kinases phosphorylate and thereby activate many proteins at the next level. This cascade of phosphorylation greatly enhances the signal, allowing for a large cellular response.

-Many signaling pathways involve small, nonprotein water-soluble molecules or ions called second messengers.

-Located inside the cell membrane or in the cytoplasm of the cell, or nuclear membrane.

Calcium ions and cyclic AMP are two common second messengers. The second messengers, once activated, can initiate a phosphorylation cascade resulting in a cellular response.

Response- The specific cellular response to the signal molecule. Leads to regulation of cytoplasmic activities or transcription. Many signaling pathways ultimately regulate protein synthesis, usually by turning on or off in the nucleus. Often, the final activated molecule in a signaling pathway functions as a transcription factor.

In the cytoplasm, signaling pathways often regulate the activity of proteins rather than their synthesis. For example, the final step in the signaling pathway may affect the activity of enzymes or cause cytoskeleton rearrangement.

-Can activate some proteins by dephosphorylation

-Can deactivate some proteins by phosphorylation

Location can vary to activities in cytoplasm or in the nucleus.

**Phases of the Cell Cycle (# of Chromosomes in each phase)**

Interphase: (no chromosomes yet)

-G1: cell doing its “everyday job”, cell grows, Protein production, ATP Production

-S: DNA replicates

-G2: cell growth, produces organelles, proteins, membranes, prepares for mitosis

-G0 stage: -Cell grows and matures to never divide again. Example: Brain/Nerve/Muscle cells

Prophase: (46 chromosomes)

-Chromatin condenses into visible chromosomes. Chromatids pair. Centrioles move to

-opposite poles of cell (animal cell)

-Protein fibers cross cell to form mitotic spindle: microtubules coordinates movement of chromosomes

-Nucleolus disappears

-Nuclear membrane breaks down

-spindle fibers attach to centromeres. creating kinetochores

-microtubules attach at kinetochores

-connect centromeres to centrioles, chromosomes begin moving

Metaphase: (46 chromosomes)

-Chromosomes align along middle of cell

-metaphase plate

-spindle fibers coordinate movement

-helps to ensure chromosomes separate properly

-each new nucleus receives only 1 copy of each chromosome

Anaphase: (92 chromosomes)

-Sister chromatids separate at kinetochores

-move to opposite poles

-pulled at centromeres

-pulled by motor proteins “walking” along microtubules

-increased production of ATP by mitochondria

-Poles move farther apart

-polar microtubules lengthen

Telophase: (92 chromosomes until cytokinesis)

-Chromosomes arrive at opposite poles

-daughter nuclei form

-nucleoli form

-chromosomes disperse

-no longer visible under light microscope

-Spindle fibers disperse

-Cytokinesis begins

**Positive and Negative Feedback Mechanisms:**

A negative feedback loop inhibits a response by reducing the initial stimulus, thus preventing excessive pathway activity. Brings it back to Normal. Examples include: Blood Sugar regulation, sweating, breathing rate control.

Positive feedback reinforces a stimulus to produce an even greater response. Examples include uterine contraction in childbirth, blood clotting, production of enzymes for digestion.

**Control of Cell Cycle (checkpoints)**

3 major checkpoints:

-G1/S: can DNA synthesis begin?

-G1/S checkpoint is most critical. It is the primary decision point. If cell receives “GO” signal, it divides

The Interaction of Cdk’s & different cyclins triggers the stages of the cell cycle

-G2/M: has DNA synthesis been completed correctly? commitment to mitosis

-spindle checkpoint. Are all chromosomes attached to spindle? can sister chromatids separate correctly?

What signals trigger division?

-internal signals: cell growth (size), cell nutrition, promoting factors

-external signals: “growth factors”

- Growth factors: coordination between cells

They are protein signals released by body cells that stimulate other cells to divide

-Includes density-dependent inhibition crowded cells stop dividing

each cell binds a bit of growth factor. not enough activator left to trigger division in any one cell

-anchorage dependence: to divide cells must be attached to a substrate. Example: -“touch sensor” receptors

- Example: Platelet Derived Growth Factor (PDGF)

if cell does not receive signal, it exits cycle & switches to G0 phase the non-dividing, working state

Primary mechanism of control is phosphorylation using kinase enzymes. These either activates or inactivates cell signals

Cell cycle controls include:

-cyclins (regulatory proteins). The concentration levels cycle in the cell

-Cdk’s (cyclin-dependent kinases). They phosphorylates cellular proteins which activates or inactivates proteins

-Cdk-cyclin complex triggers passage through different stages of cell cycle