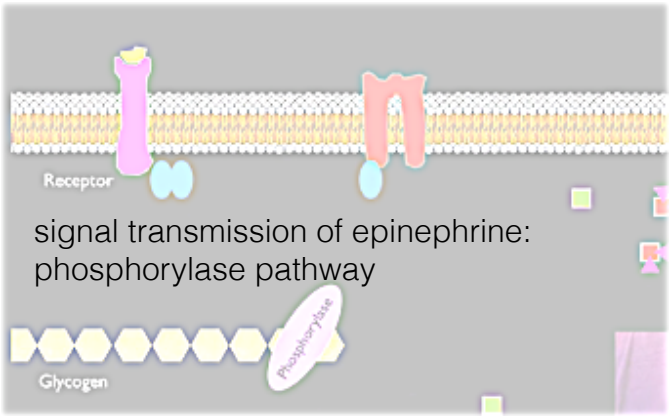
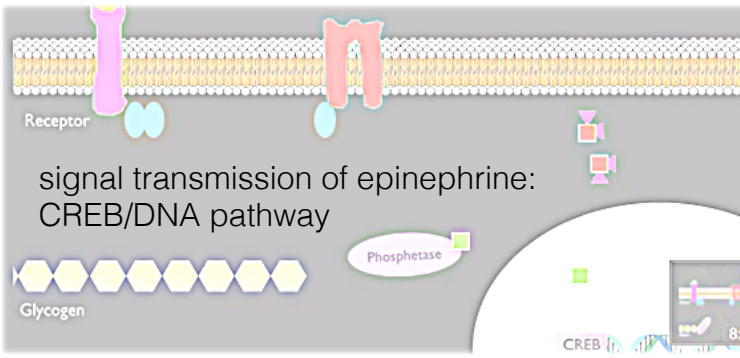
AP Exam Study Sheet: **Signal Transmission/Cell Communication**

Bozeman Video "Signal Transmission":



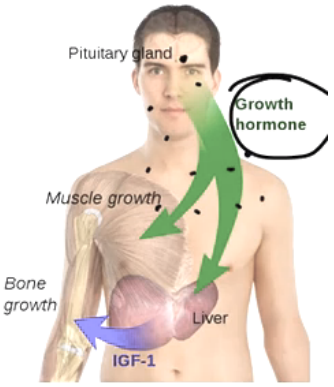


- Receive a signal, activate series of events that result in an action
- Adrenaline is made up of epinephrine (physiological effects result from this chemical, fight or flight response); liver contains glucose in form of glycogen, epinephrine can spread through liver cells and cause them to give off glucose
  - message comes from adrenal gland, diffuses throughout body
  - receptor protein picks up message; E latches on, causes shape change, phosphorylates other protein, red protein activates enzyme which makes cAMP [ATP - 2 phosphates]; cAMP goes to protein kinase, regulatory is activated, active catalytic subunit can activate phosphorylase, transfers phosphate group
  - phosphorylase can now break glycogen into glucose
  - why doesn't epinephrine just move into cell? it cannot move across the lipid layer; also, there are many G-subunits, which can AMPLIFY the signal; 1 epinephrin makes billions of glucose molecules
    - can change cell function^
    - cause gene expression, DNA expresses different proteins; remove protein that breaks down glycogen; so CREB, a transcription factor is present; protein kinase release subunits like normal, but instead of activating protein, it activates CREB; adds to DNA, allows RNA polymerase to grab on and make mRNA, new protein is phosphetase, activated by catalytic subunit, glucose is still made
- Chemicals that move through body, transmitted:
  - intercellular
  - intracellular

Bozeman Video "Cell Communication":

- 1 sticky note shopping list/message, hand specific message to someone else, can check list
- 2 GMail = specific student, no physical contact needed
- 3 FB status = goes to all friends

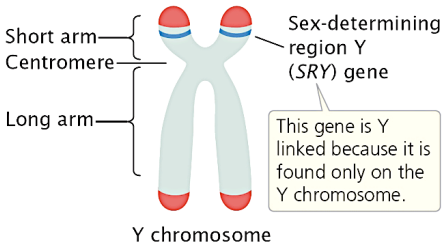
- 1 NO DISTANCE = cell to cell contact; APC cell, plant cells have plasmodesmata;
  - immune response: APC is antigen [invader = bacteria/virus] presenting cell like a macrophage senses shape to make killers, helper T cell must know specific shape; macrophage envelops antigen inside phagosome, lysosome chops up antigen, part of antigen shape is carried to surface, rest ejected, helper T cell can now recognize MHC2 protein that links to CD4 [helper T cell surface protein]; shape info is sent through connection, macrophage no longer needed, helper T cell sends message to B cell [killer and memory] and killer T cell
- 2 SHORT DISTANCE = local regulators; one other cell= neuron connected to other neuron through synapse
  - neuron sends message up spinal cord to brain; travels down pathway to other neuron; where neurons meet, they are not actually connected, local regulator/chemical signal called "neurotransmitter" is used/released, move across synapse gap; open up other channels which allow in influx of ions and message; quickly break down; *wouldn't it be smarter for actual connection?* by allowing OPENING, gives control over how much of signal can get through; endorphins block pain [after a few hours of running they will block the pain] [heroin, morphine, resemble endorphins]



- 3 LONG DISTANCE/LARGE AUDIENCE = hormone; human growth hormone = multiple cells decide; example is hormone which is chemical spread throughout the whole body; secreted by pituitary, high levels in puberty, muscles and bones grow, organs grow [not brain], stimulated immune system; choose to ignore oR act, out of control pituitary = GIANT!

A variety of intercellular and intracellular signal transmissions mediate gene expression.

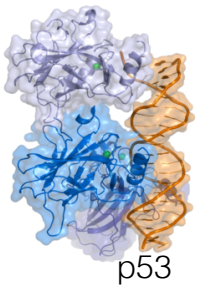
Signal transmission within and between cells mediates gene expression *see epinephrine*



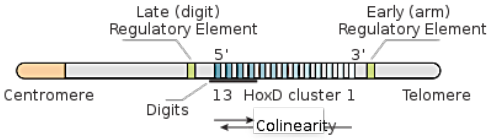
- **Cytokines** regulate gene expression to allow for cell replication and division.
- Mating pheromones in yeast trigger mating gene expression.
- *Levels of cAMP regulate metabolic gene expression in bacteria.*
- *Expression of the SRY gene triggers the male sexual development pathway in animals*
- *Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen.*
- Seed germination and gibberellin.
  Before the photosynthetic apparatus develops sufficiently in the early stages of germination, the stored energy reserves of starch nourish the seedling. Usually in germination, the breakdown of starch to glucose in the endosperm begins shortly after the seed is exposed to water. Gibberellins in the seed embryo are believed to signal starch hydrolysis through inducing the synthesis of the enzyme α-amylase *in the aleurone cells*. α-Amylase then hydrolyses starch, which is abundant in many seeds, into glucose that can be used in cellular respiration to produce energy for the seed embryo; Gibberellins cause more transcription of gene coding for α-amylase enzyme [more synthesized]

Signal transmission within and between cells mediates cell function.

- Mating **pheromones** in yeast trigger mating genes expression and sexual reproduction {secreted or excreted chemical factor that triggers a social response in members of the same species; capable of acting outside the body of the secreting individual to impact the behavior of the receiving individual; *alarm*, *food trail*, *sex pheromones*, others that affect behavior or physiology}
- **Morphogens** stimulate cell differentiation and development [substance governing pattern of tissue development+ positions of the various specialized cell types within a tissue; a signaling molecule that acts directly on cells to produce specific cellular responses depending on its local concentration. Since morphogens diffuse through the tissues of an embryo during early development, concentration gradients are set up that drive the process of differentiation of unspecialized (stem) cells into different cell types, ultimately forming all the tissues and organs of the body]



- Changes in **p53 activity** can result in cancer: regulates the cell cycle and, thus, functions as a tumor suppressor that is involved in preventing cancer; described as "the guardian of the genome" because it conserving stability by preventing genome mutation
- **HOX genes** and their role in development
  Hox proteins determine the type of segment structures (e.g. legs, antennae, and wings in fruit flies or the different vertebrate ribs in humans) that will form on a given segment. Hox proteins thus confer segmental identity, but do not form the actual segments themselves; their protein product is a transcription factor, they contain a DNA sequence known as the homeobox



Cell communication processes share common features that reflect a shared evolutionary history.

~Communication involves transduction of stimulatory/inhibitory signals from other cells, organisms, or enviro

~Correct and appropriate signal transduction processes are generally under strong selective pressure.

~In single-celled organisms, signal transduction pathways influence how the cell responds to its environment.

- Use of chemical messengers by **microbes** to communicate with other nearby cells and to regulate specific pathways in response to population density (**quorum sensing**)
- Use of **pheromones** to trigger reproduction and developmental pathways
- Response to external signals by bacteria that influences cell movement

~In multicellular organisms, signal transduction pathways coordinate the activities within individual cells that support the function of the organism as a whole.

- Epinephrine stimulation of glycogen breakdown in mammals^^^
- *Temperature determination of sex in some vertebrate organisms; DNA repair mechanisms*

Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.

~Cells communicate by cell-to-cell contact ^^

- Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells, killer T-cells
- Plasmodesmata between plant cells that allow material to be transported from cell to cell.

~Cells communicate over short distances using local regulators that target cells in vicinity of the emitting cell.

- Neurotransmitters
- Plant immune response
- Quorum sensing in bacteria
- Morphogens in embryonic development

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

- Endocrine signals are produced by endocrine cells that release signaling molecules, which are specific and can travel long distances through the blood to reach all parts of the body.
- Insulin & Thyroid hormones; Testosterone & Estrogen
- *Human growth hormone ^^^*

Signal transduction pathways link signal reception with cellular response.

~Signaling begins with the recognition of a chemical messenger, a ligand, by a receptor protein.

- Different receptors recognize different chemical messengers, which can be peptides, small chemicals or proteins, in a specific one-to-one relationship.
- A receptor protein recognizes signal molecules, causing the receptor protein's shape to change, which initiates transduction of the signal.

  G-protein linked receptors; Ligand-gated ion channels; Receptor tyrosine kinases

~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.
- Second messengers are often essential to the function of the cascade.
  - Ligand-gated ion channels
  - 2nd messengers= cyclic GMP, cyclic AMP calcium ions (Ca2+), inositol triphosphate (IP3)

- Pathways include Protein modifications (i.e. how methylation changes the signaling process) & Phosphorylation cascades = series of protein kinases add phosphate group to next protein

Changes in signal transduction pathways can alter cellular response.

Conditions where signal transduction is blocked or defective can be deleterious, preventative or prophylactic.

- *Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera*
- *Effects of neurotoxins, poisons, pesticides*
- *Drugs (Hypertensives, Anesthetics, Antihistamines and Birth Control Drugs)*