Chapter 18 Notes
Endocrine System & Review

REVIEW CHAPTERS 1-3

Physiology attempts to explain the workings of the body using established principles from physics and chemistry. Examples of these are:

- Diffusion
- Mechanical forces
- Transfers of energy
- Flow of blood and air through tubes
- Pressure gradients
- Resistance

The **levels of organization** in the human body are chemical (atoms and molecules), cellular (organelles and cells), tissue (groups of cells working together), organs (groups of tissues working together—most organs have all four tissue types), organ systems (organs working together) and the organism.

The FOUR PRIMARY FUNCTIONAL GROUPS OF CELLS are:

1. Epithelial cells. They form membranes/boundaries that vary in thickness and permeability depending on their function. They also form glands!

   Exocrine glands secrete to the outside of the body, such as mucus

   Endocrine glands secrete into the body fluid (the internal environment)

2. Nerve cells are specialized cells for transmitting and receiving information between cells in the form of electrical signals. The various targets for these cells include other nerve cells, muscle cells and glands. Nerve cells come in a variety of shapes (unipolar, bipolar, multipolar) and provide a variety of functions (afferent, efferent, interneurons)

3. Muscle cells are specialized to contract, which generates force. The three types of muscle cell are cardiac, skeletal and smooth muscle.

4. Connective tissue cells provide support or "connects" via fluid flow (blood). Other types are areolar, adipose, hyaline, dense regular and dense irregular.

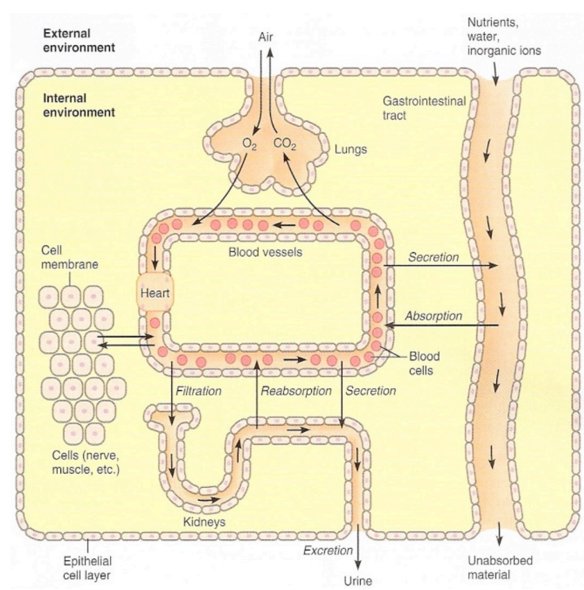
NOTE! No cell can exist on its own. They depend on one another or survival. This goes all the way up to the organ system level.

The **ORGAN SYSTEMS** of the body depend upon one another. They are:

Integumentary	Protection Synthesis of Vitamin D Cutaneous sensation Site of sweat and oil glands
Skeletal	Support Formation of blood cells Mineral storage
Muscular	Movement Maintains posture Produces heat
Nervous	Control-system Responds to internal and external changes by activating appropriate muscles and glands
Endocrine	Hormones regulate processes throughout body
Cardiovascular	Transport blood, oxygen, CO_2, nutrients, waste, etc…
Lymphatic	Returns fluid to blood Disposes of debris Houses white blood cells (immunity)
Respiratory	Supplies blood with oxygen Removes CO_2
Digestive	Breaks food down into absorbable units Excretion of indigestible foodstuffs
Urinary	Eliminates nitrogenous wastes Regulates water, electrolyte and acid-base balance of blood
Reproductive	Production of offspring

Internal vs. external environments. Note that all materials must pass through some interstitial fluid before arriving at their destination, and that epithelial cells are the boundaries, so all exchanges take place across epithelia. The forces responsible for this are:

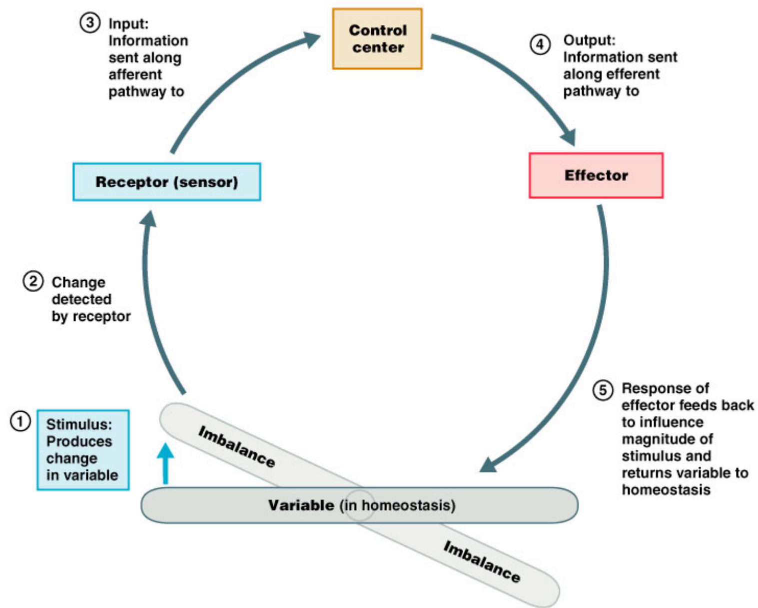
- Active transport (Na-K pump)
- Partial pressure gradient
- Diffusion
- Hydrostatic pressure gradient (fluid)
- Gas pressure gradient



Body fluids are compartmentalized, and water (solution) is usually free to diffuse between compartments. Total body fluids are:

- Total body water 42 L
- Intracellular fluid 28 L (2/3 of our water is intracellular)
- Extracellular fluid 14 L
- Plasma 3 L (average volume of blood is 5-6 L)
- Interstitial fluid 11 L

HOMEOSTASIS is the maintenance of relatively stable internal environments, despite changes in the external environment.



Example: Temperature change. The body keeps the core temperature stable by sweating, vasodilation, vasoconstriction, shivering and even behavioral change (put on a sweater, or take it off!)

Some homeostatically-controlled variables are: temperature, pH, ions, glucose/nutrients, H20, CO2, O2, blood pressure.

All of these have normal ranges or a "set-point". A lot of the variables have to do with blood (pressure, pH, volume, gasses, ions, etc…). The consequence of not maintaining one or more of these variables within normal limits is a **disease state**.

The mechanism for keeping the body at homeostasis is the Negative Feedback Loop. It consists of a variable, a stimulus, a receptor, a control center and an effector. The purpose of this loop is to **negate** the original stimulus. Some negative feedback loops are controlled by the nervous system, others by the endocrine system and the rest are controlled by both systems.

The endocrine and nervous systems are the control systems of the body. They communicate via chemical messengers.

Positive feedback loops are not for regulation of homeostasis. Instead they move the body further from equilibrium temporarily. Examples are blood clotting, generation of action potentials and labor contractions.

So, how does the control center signal the effector? Through **INTERCELLULLAR COMMUNICATION**!

Direct cell communication involves the diffusion of material across a gap junction. This is further divided into two categories…electrical communication and metabolic coupling.

Electrical communication includes the electrical synapsing between neurons, which is rare, and the more common event which is the coordination of excitable cells to operate as a functioning unit. These would be cardiac muscle cells and ciliated epithelial cells. With **metabolic coupling** nutrients move from cell to cell. For example, ostecytes on the periphery of bone are closer to the blood vessel than the deeper osteocytes. While the nutrients do get into these osteocytes via the canaliculi, they also get there via metabolic coupling…they use gap junctions to go from cell to cell to cell.

Indirect cell communication involves a ligand, which binds reversibly to the receptor protein. It binds and detaches continually until it binds to a degradation enzyme. The point is, it can't linger on its one binding site forever.

A LIGAND is an ion or molecule that binds to another chemical entity to form a larger complex.

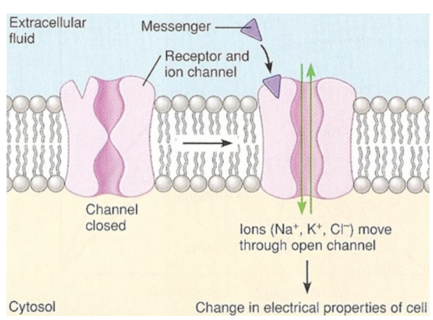
When a chemical messenger is used, the messenger is secreted and then diffuses either across the synapse (as is the case with neurotransmitters), or into the extracellular fluid (as is the case with paracrine communication, autocrine communication and endocrine communication/hormones).

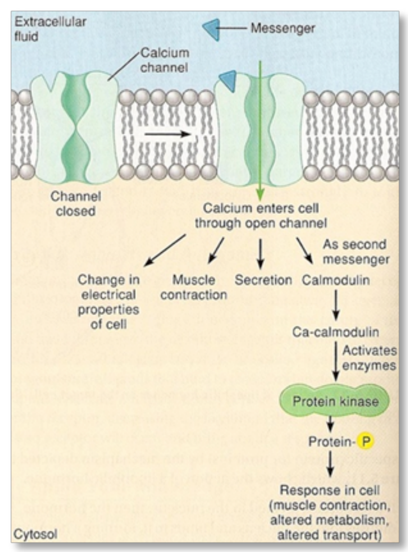
Paracrine: Signals target only cells in the vicinity. Blood stream is not needed.
Autocrine: Secretory cell has receptors for its own product.
Endocrine: Signals travel throughout the blood, "long distance." HORMONES!!!

Once the hormone reaches its target destination, it binds to the target cell receptor as a **LIGAND.** The receptor is either an intracellular receptor or a membrane receptor. The hormone will affect the target cell by changing its protein activity, affecting its biochemical activity or by affecting its physical structure. Any and all of these will ultimately affect tissue/organ function.

3 GENERAL WAYS PROTEIN ACTIVITY IS CHANGED

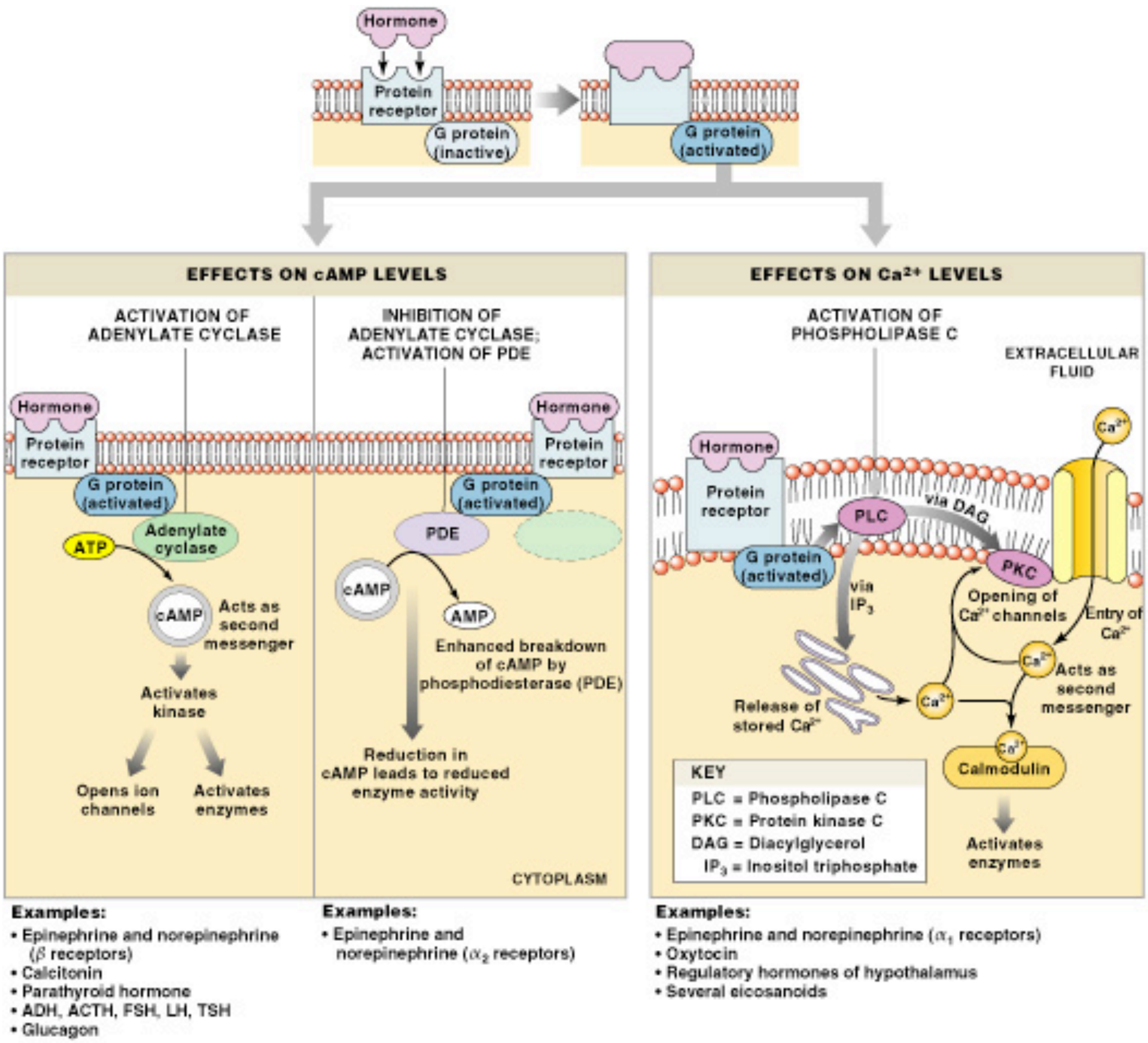
1. Some ligands **open a channel** (ligand-gated channel), causing changes in the **membrane's permeability**, and ultimately the electrical properties of the cell.



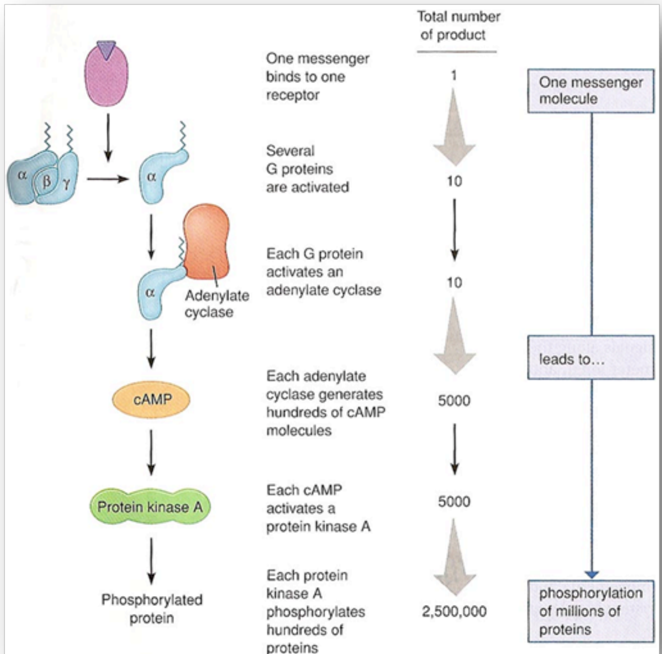


2. A ligand can also use a second messenger to **increase or decrease enzyme activity**. Second messengers also amplify the original signal. Note that Cyclic AMP (a second messenger) activates kinase, which phosphorylates ATP.

In many hormone sensitive systems the systemic hormone does not enter the target cell but binds to a receptor and indirectly affects the production of another molecule within the cell. This diffuses intracellularly to the target enzymes or intracellular receptor to produce the response. The intracellular mediator is called the second messenger.



Signal amplification



3. Ligands can also
bind to target cell receptors inside the cell, and these ligands **affect protein synthesis**. Because the steroid is lipid soluble, it can get inside the membrane and even enter the nucleus. Once in the nucleus (via simple diffusion) it can then affect protein synthesis, with the goal of making new proteins that provide a new affect.