Brief Review of Physiology

Compartmental Organization of Animals/Humans (91 & 943):

- We are surrounded by hostile external environment. This intrudes into body via respiratory, digestive & urogenital tracts.
- Our bodies contain mostly fluid (young adult men contain 55-60% H₂O - women slightly less)
- There are 2 major fluid compartments inside us – separated by cell/plasma membranes
  1) Intracellular compartment (within cell) contains intracellular fluid (65%).
  2) Extracellular compartment (outside cell) contains extracellular fluid (35%), which normally provides appropriate environment for cells to grow, live & function. (O₂, CO₂, pH, electrolytes, water, nutrients).

- Extracellular fluid (ECF) is subdivided:
  1) Interstitial fluid (25%) present in all tissues except blood
  2) Blood plasma and lymph (8%)
  3) Transcellular fluid (2%) in cavities (pleural fluid, synovial fluid, cerebral spinal fluid)

Homeostasis (16)
- Means stable internal environment (ECF) - term coined by Dr Walter B. Cannon – fluctuations range around desired value called “set point” (98.6°F = 37°C)
- Loss of homeostatic control causes illness or death (hypothermia vs. hyperthermia)
- Physiology is focused on understanding mechanisms that promote homeostasis

Negative Feedback Loops (16-18)
- Most common type of feedback loop in physiology
- Body senses a change & activates mechanism to reverse or negate it
- Mechanisms used to keep variable close to the set point
- Provides order or balance (homeostasis)

Negative Feedback Loop: Correcting Hyperglycemia (654-5, 674-5, 687 & 1037)
- The set point for ECF glucose (dextrose) concentration is ~ 90 mg/dl (normal range: 70-110 mg/dl).
- Eating a meal or sugary snack (absorptive state) will raise glucose levels (hyperglycemia).
• Insulin is a hormone that is released by β cells in the pancreas in response to high glucose concentrations in ECF.
• Insulin binds to “insulin receptors” on target or effector cells (liver, skeletal muscle, adipose & most cells except nerve cells, kidney cells & rbc’s)
• Insulin activates up to 20-fold increase in glucose uptake from ECF into intracellular fluid – where it is used or stored. Thus insulin lowers ECF glucose levels.
• Type I diabetes mellitus (childhood or insulin-dependent) lack pancreatic β cells (5-10%).
• Type II diabetes mellitus (adult-onset or insulin-resistant) target cells lose sensitivity to insulin (90-95%).

Negative Feedback Loop: Correcting Hypoglycemia (654 & 1038)
• Fasting (postabsorptive state) will lower blood glucose levels (hypoglycemia).
• Glucagon is a hormone that is released by α cells in the pancreas in response to low blood glucose.
• Glucagon binds to glucagon receptors on effector cells (liver, adipose & skeletal muscle)
• Activates glucose (and fatty acid) release into ECF

Cell-Cell Communication (638, 640-1, 670, 851)
• 1st cell: 4 Types of Extracellular Chemical Messengers
  1) Neurotransmitters:
     • Produced by nerve cells
     • Acts on nerves, glands or muscles
     • Usually relatively rapid, local effect.
     • Over 100 different neurotransmitters
     • Examples include: acetylcholine, norepinephrine & GABA
  2) Hormones:
     • Produced by endocrine glands
     • Released into the blood plasma
     • Potentially long-lasting, widespread effects.
     • Examples include: insulin, glucagon & estrogens.
  3) Paracrines:
     • Produced by cells (NOT neurons or glands)
     • Act on adjacent or nearby cells.
     • Examples: histamine & prostaglandins.
     • Histamine
       • Released locally by defense/immune cells (Mast cells) in response to inflammation
       • Effect (fluid secretion, irritation, itching) is designed to eliminate the irritating agent.
       • Histamine causes many symptoms of colds, allergies & asthma.
       • Blocked by antihistamines
2nd or Target Cells: “Receptor Theory” (576-77, 664)
- Endogenous extracellular chemical messengers or ligands (neurotransmitters, hormones & paracrine) bind to and activate specific targets called receptors.
- Receptors are made of specific proteins (encoded by genes – genetic code)
- Mechanism analogous to a “Lock & Key”
- Interactions are specific – forms the basis for most pharmacology/therapeutics
- Many therapeutic drugs bind specific receptors – two major classes:
  1) **Agonists** activate the receptor, and mimic the effect (example: estrogens in birth control pill)
  2) **Antagonists** bind receptors do not activate AND prevent binding of endogenous activating ligands (example: antihistamines: *Benadryl™* or *Claritin™*). These “keys” fit into the “lock” but are unable to “open” it.

Positive Feedback Loops (18-19, 1093)
- Physiological change that leads to an even greater change in the **same** direction
- Acts “positively” meaning it **TURNS ON** the initial stimulus
- Produces rapid irreversible change.
- Examples: childbirth, ovulation & blood clotting

Positive Feedback Loop: Childbirth (18-19, 1103)
- **Oxytocin** is a hormone that is produced by hypothalamus & released by posterior pituitary gland (Pitocin™ is synthetic oxytocin)
- Oxytocin stimulates uterus to contract.
- Uterine contraction stretches the cervix, which in turn stimulates the brain (hypothalamus) and causes more oxytocin to be released.
- More and more (and MORE) oxytocin is released as uterine contractions become stronger and stronger (and STRONGER).