Homeostasis

Lecture 1:
- Structure = Function
- Concentration Gradients
- Physiology
  - Cells
  - Tissues
  - Organs
  - Organ Systems
  - Organism

Lecture 2:
- Mammalian Temperature Control System

Lecture 3:
- Blood Glucose
- Altered Blood Glucose, Hormones, & Homeostasis
- Diabetes Mellitus (Sweet Urination)
- Paradox found in Diabetes
- Water Homeostasis

Jan 24 - Jan 25

Week 1

Lecture 1: Introduction to Physiology & Homeostasis

Anatomy: Study of structure
Physiology: Study of function

Structure = function
(ex: micheal phelps swimming)
cells

Structure/function relationship between epithelial tissues stratified squamous (protective)

- Multi-layered w/ overlapping cells
- High degree of regenerative capacity
- Protective, barrier function
- Found in surface of skin, parts of GI tract

ex

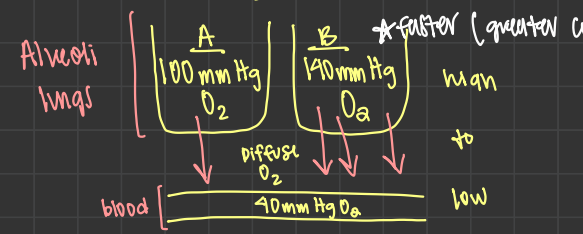
	SKIN	LUNGS (alveolar)
function	Barrier	easy gas exchange
structure	multiple layers	1 layer very little matrix

Structure/function relationship between epithelial tissues simple squamous (exchange)

- Thin cells, relatively leaky junctions between cells
- Ideal for exchange
- Line blood vessels & lung alveolar cells

Concentration Gradients

- naturally go high to low concentration [high] → [low] ← energy
  - ex respiratory system (high to low w/ tissues)
    - O_2 moves from atmosphere to cells down its concentration gradient
    - P_{O_2} in atmosphere around 160mm Hg; moves into alveoli
    - P_{O_2} in alveoli equilibrates at around 100mm Hg



Physiology
- Cells
- Tissues
- Organs
- Organ systems
- Organism

Cells
- basic unit of life
- collection of molecules separated from external environment by cell membrane

Tissue: Epithelia
- make up of different cells
- epithelial cells attach to the basal lamina using adhesion molecules
- Basal lamina is an acellular matrix layer that is secreted by the epithelial cells

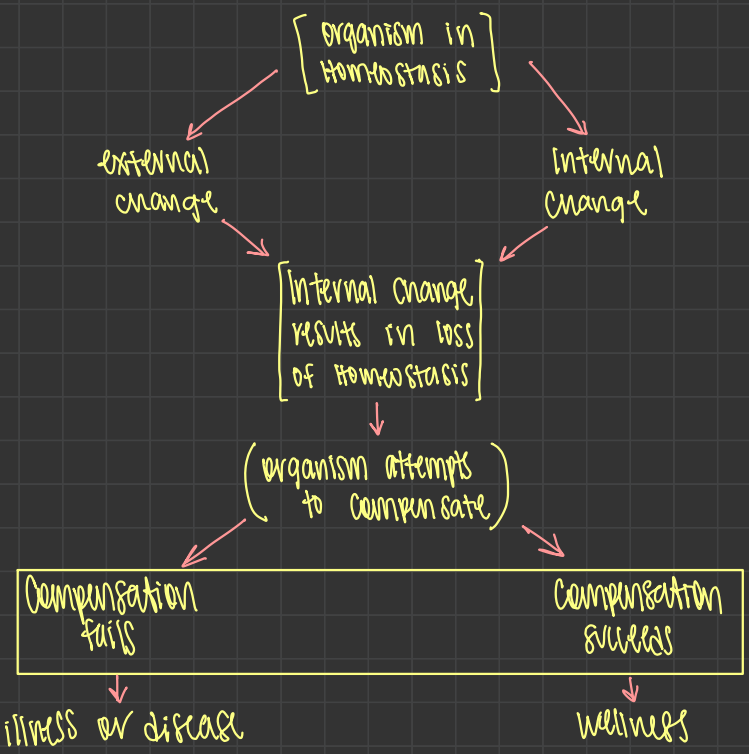
Organs
- collection of tissues that carries out related functions
  - (ex) Skin
    - largest organ of the body
    - organ made of different types of tissues

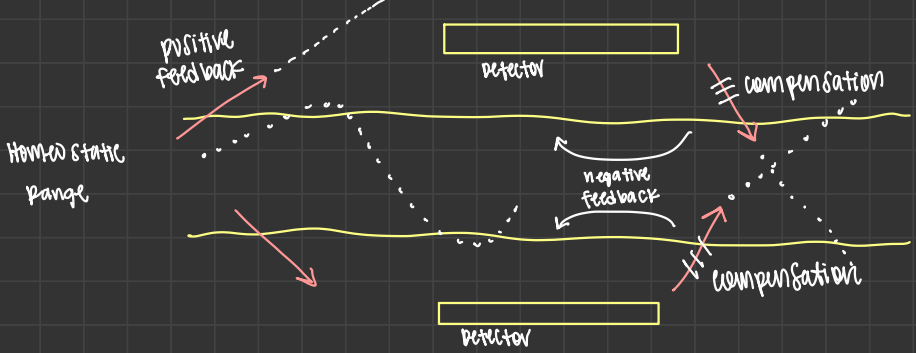
Organ Systems
- Groups of organs that function together

1. Integumentary system:
   - Skin
   - protective boundary between internal & external environment
2. musculoskeletal system
   - Support and movement
3. Respiratory system
   - Gas exchange
4. Digestive system
   - Uptake of nutrients & water & waste elimination
5. Urinary system
   - Waste & excess liquid disposal

6. Reproductive System
   - Production of eggs & sperm
7. Circulatory System
   - Heart & blood vessels
   - Deliver nutrients & carry waste from every cell in the body
8. Nervous System
   - Brain, spinal cord, & Trillions of nerve cells
   - designed for rapid control of body functions
9. Endocrine System
   - Hormone-secreting glands
   - designed for slower, longer-lasting control of body functions
10. Immune System
   - Body's defense system

How have we evolved to survive in a hostile environment?
- Homeostasis



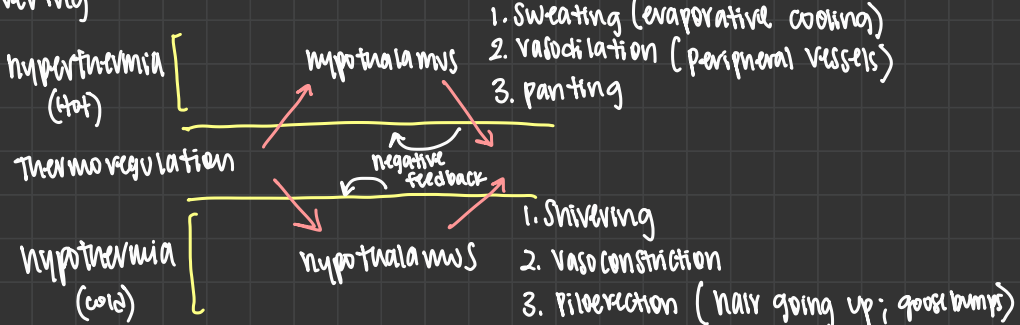


- negative feedback
  - Body compensates to change
  - shuts down response
- Positive feedback
  - not homeostasis
    - ex) having a baby & blood clots

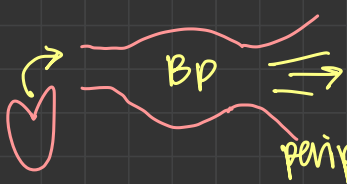
Lecture 2: Homeostasis II

Mammalian temperature control system

- hypothalamus
  - contains thermoregulatory sensors when cool-sensors are activated, will cause warming processes
- vasoconstriction of peripheral vessels
- piloerection
- shivering



hyperthermia
↓
compensation
↓
blood pressure ?
& heart rate ?
↓ BP (decrease)
↑ (increase)



blood flowing

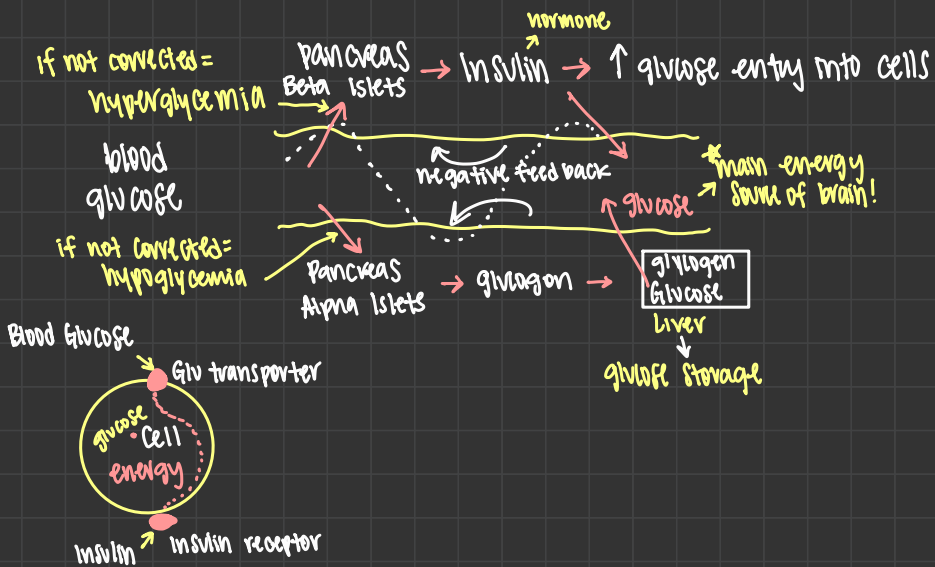
(blood pressure goes down, heart compensates by increasing pumps)

hyperthermia
↓
vasodilation ↑ correct
↓ over compensation
↓ blood pressure
↓
↑ heart rate ↔ may cause tachycardia

Lecture 3: Homeostasis III

Blood Glucose

Stimulus: increase in blood glucose
Reaction: Pancreas produces insulin; insulin promotes decrease in blood glucose
Negative feed back results in: decreases insulin release



Stimulus: Decrease in blood glucose
Reaction: Pancreas produces glucagon; glucagon promotes increase in blood glucose
Negative feedback results in: decreases glucagon release

Altered blood glucose, hormones, & homeostasis

- Relative levels of blood glucose, insulin, & glucagon can be used to distinguish between different abnormalities using concepts of homeostasis & compensation.
- These include:
  - Type I Diabetes
  - Type II Diabetes
  - Destruction of either alpha or beta islets
  - Endocrine tumors affecting either alpha or beta islets.

ENDOCRINE TUMORS

- Overproduction of hormones
- Do not respond effectively to negative feedback

Endocrine Destruction

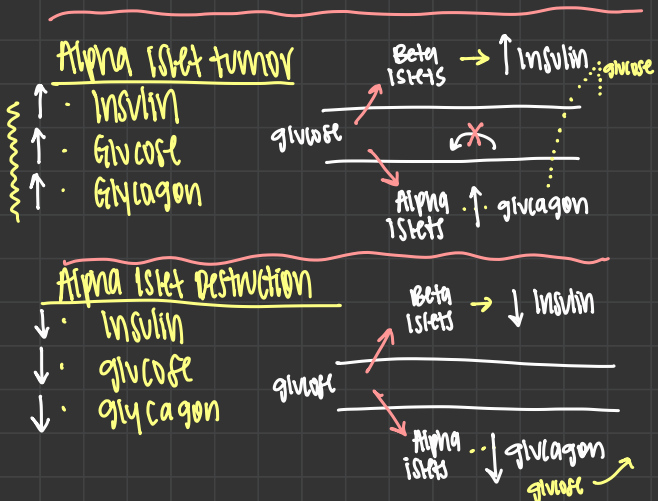
- Underproduction of hormones
- Do not respond effectively to stimulation

Ex

Alpha islet destruction vs. Alpha islet tumor

What would the levels be for?

- blood glucose
- insulin
- glucagon



Diabetes Mellitus (Sweet Urination)

Type I: Auto-immune destruction of β-islet cells of pancreas:

- no insulin uptake by cells: less glucose taken in
- Juvenile-onset diabetes this class
- Insulin-dependent treatments
- Prone to ketoacidosis due to buildup of ketone bodies in blood to try to feed brain

Type II: Cells unable to respond to insulin; Insulin-Resistant

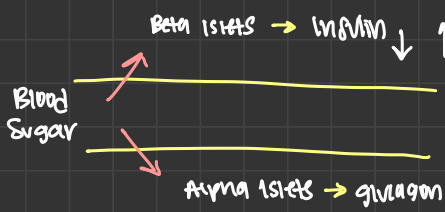
- Actually often have elevated insulin levels in early stages
- Accounts for 90% of cases

Type I Diabetes		Type II Diabetes
↓ Insulin		↑ Insulin → insulin receptor becomes non-responsive
↑ Glucose	⟷	↑ Glucose
↑ Glucagon		↑ Glucagon

↑ Hyperglycemia

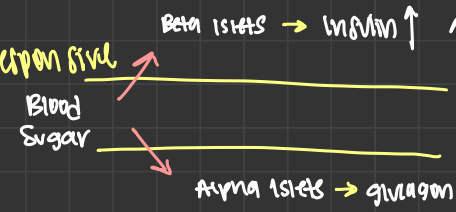
Altered blood Glucose, hormones, & Homeostasis: Paradox found in Diabetes

Type I:
↓ insulin
↑ glucagon

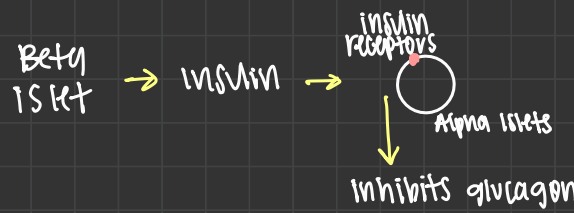


Destruction of β-islets = low insulin
A lack of insulin = high blood glucose

Type II:
↑ insulin: non responsive
↑ glucagon



Insulin resistance = high blood glucose
high blood glucose stimulates increase in insulin to attempt to lower blood glucose

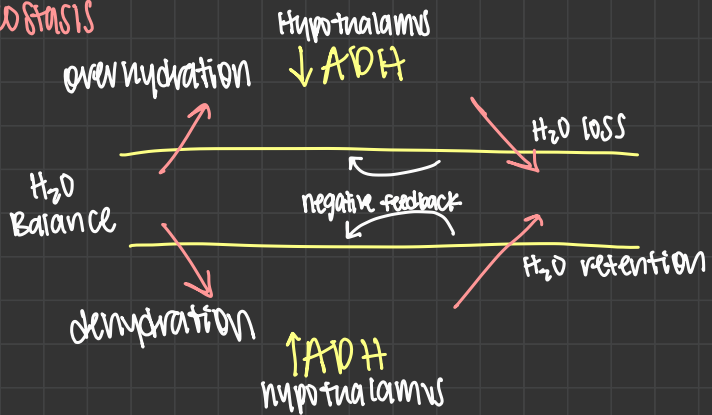


↑ insulin = ↓ Glucagon

Diabetes & Glucagon: The paradox

- While glucose levels regulate glucagon production (triggered by low glucose), insulin also inhibits glucagon production.
- So loss of insulin (type I diabetes) or insulin resistance (type II diabetes) results in less inhibition therefore more glucagon... exasperating problem!

Water Homeostasis



ADH = Anti-Diuretic Hormone

H_2O Balance → hydration
- BP?
- Salt (electrolytes)
  i.e: Na^+ Ca^{2+} Cl^-

Dehydration

↑ ADH = ↑ H_2O retention

Overhydration

↓ ADH = ↑ H_2O loss

Perfect Drink (margarita)
- Alcohol w/ salt
- losing water
- helping retain water
- makes you crave salty foods

Salt
↑ H_2O retention
↑ ADH release

Alcohol (diuretic)
↑ H_2O loss
mechanism ↓
inhibits ADH