homeostasis & fluid compartements

basic organization of the body

- tissue types
  - muscle
  - nervous
  - connective
  - epithelium
- organ: functional unit
- organ system: several organs acting together

Fluid compartments

- intra cellular fluid compartement
  - bounded by plasma membrane
  - the largest, 2/3 of the total fluid of the body
  - high potassium K
  - low sodium Na
- extra cellular fluid compartement
  - 1/3 in size
  - High sodium Na
  - Low potassium K
  - Intravascular compartment
    - has proteins
    - 1/12
  - intrastitial fluid space (connecitve tissue)
    - 3/12

self-regulating mechanisms

- equilibrium
  - equal amount of substance
  - no energy expenditure to maintain
  - no barrier to movements
  - no net transfer of substance or energy
- steady state
  - between extra and intra cellular space
  - constant amount of substance in compartements
  - input = output
  - requires energy to maintain
  - maintain gradient

what is homeostatis

- central theme of physiology
  - extracellular fluid is the buffer zoneA

  - input/output analogy
- homeostatic control & reflex loops
  - sensor: detect stimulus -> send to integration center (brain) <- contains set points, evaluates incoming signal
  - effector: efferent path -> generates response to maintain normal condition
- high salt diet
  - NaCL -> diet == urine :: neutral balance
  - NaCL -> diet > urine :: positive balance
  - NaCL -> diet == urine :: neutral balance
  - Increased total amount of sodium
  - stays in the ECF; water also goes to the ECF
  - concentration is maintained at a cost
    - vasculature: increased volume of blood (thus, increased pressure)

general concepts

- interdependent
- maintain internal environment
- homeostatis, balancing input and outputs
  - epithelium is leaky
- ATPase
  - uses energy to move 3 sodium / every 2 potassium entering
  - keep ions at a desequilibrium

Regulation of homeostasis

- local response
  - cell 1 -> chemical -> cell 2 (becomes activated) :: paracrine control
  - cell 1 -> chemical -> cell 1 (becomes activated) :: autocrine control
  - cell 1 -> physical connection (gap junction, nexus) -> cell 1 (becomes activated) :: gap junction
- endocrine system
  - endocrine cell -> chemical secreted to bloodstream -> target cell
  - neuron -> synapse (neurotransmitter) -> effector cell
- reflex components
  - stimulus -> sensor -> integration center -> effectors
- external change
  - stimulus::bodytemp=340 -> thermal sensors::peripheral & central -> integration center::hypothalamus (370 signal) -> effector::muscle shivering; vasoconstriction in skin) -> generate heat
  - FEVER, macrophage -> pyrogen -> hypothalamus 40c -> brain interprets body as being cold -> shivering + vasoconstriction in skin

negative feedback

- removes initializing stimulus

positive feedback

- increase

tonic control

- modulatiing the activity of a specfic cell
- hold specific state for longer muscle

antagonistic control

- parasympathetic
  - slow the heart rate
- sympathetic
  - increase the hear rate

circadian rhythms

- growth hormone -> released during early sleep
- cortisol -> increases just before waking up
- dictated by sleep/wake, not by light/dark

transporters pumps & channels

simple diffusion & gap junctions

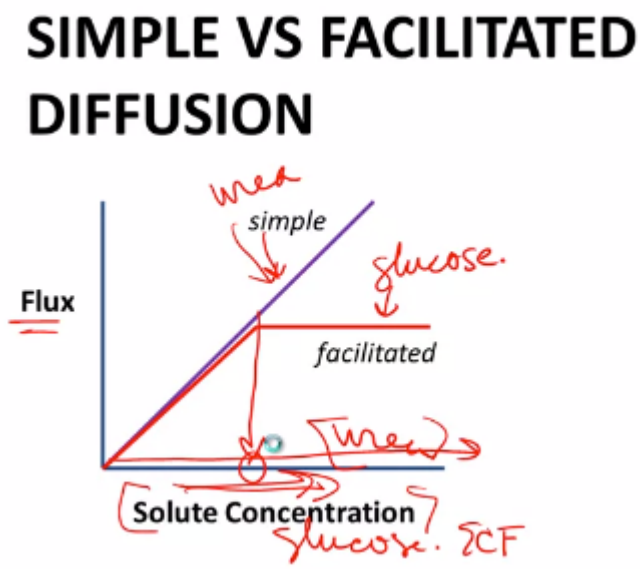
- flux: random movement of molecules across a surface per unit time
  - simple diffusion
- gap junctions: permits diffusion of ions between coupled cells

characteristic of simple diffusion

- from high to low concentration
- no energy
- rapidly over short distance, slow over long distances
- continues until equilibrium is reached
- directly related to temperature
- inversely related to the size of the molecule
- is dependent on the total surface area and thickness of the membrane barrier

facilitated diffusion

- not lipo-soluble, charged molecules, can't move through the plasma membrane through simple diffusion
- integral membrane protein
  - can change conformation to external or internal cellular space
  - glucose transporters -> net flux determined by gradient



- co-transporters
  - move more than one solute at any time
  - symporter -> move in same direction
  - antiporter -> move in different directions
- channels
  - aquaporine -> move water across the membrane
  - regulated opening is called gating
    - if opened movement is due to diffusion
  - gating of channels
    - ligand gating -requires binding of specific chemical to open
    - voltage
      - requires specific gradient of electrical charge
    - mechanical
      - requires specific tension to open
- pump mediate active transport
  - pumps actively moves solute against concentration gradient
  - pumps are ezyme, cleave atp -> undergo different conformation
- transcellular transport
  - movement across the cell into the bloodstream
  - secondary active transport
    - transporter in the basal and apical side

        * glucose transported by the sodium Na+ gradient, 'free ride'
- general concepts
  - movement across the bi lipid layer is dependent in size, charge and solubility
  - net flux determined by gradient
  - permeable solute crosses the membrane by simple diffusion, moving down its concentration gradient
  - a non-permeable solute cross the membrane by facilitated diffusion, requires gradient, specific, and its saturable
  - primary active transport moves a solute against its concentration gradient, requires ATP, specific, and is saturable
  - secondary active transport couples the activity of a co-transporter with a pump. This is used for transcellular transport of a solute.

effective solutes & water transport

- concentration of water
  - osmosis
    * change in compartment size when membrane is impermeable to solute
    * occurs by diffusion only
    * uses aquaporin channels
    * has highest concentration when pure water
- important terms
  - molarity: mole/vol (1 mole = 6 x 10^23 molecules)
  - osmolarity: (#molecule/vol) * (# particles/molecule)
  - osmolality: kg of water
- tonicity & cell volume
  - always comparative
  -

non-penetrating molecules/volume

- changes in body fluid compartements # endocrine system general concepts

homeostatic control

- local response
  - occurs at target cells
    * paracrine/autocrine not considered hormones
    * hormone is considered when is released into the blood
- reflexes
  - response made is distant from target cell
  - low concentration / high affinity

  - in contrast, the nervous system, works with high concentration. Receptor with low affinity
  - high concentration / low affinity

endocrine glands

- ductless glands
- specific homeostatic mission:
  - sodium/water
  - calcium
  - energy
  - cope with stress
  - growth
  - reproduction

concentration of hormone in blood

- rate of production
  - most regulated
  - mediated by + and - feedback
- rate of delivery
  - dependent on perfusion and blood flow
  - follow mass action laws (carriers)
    - lipids and steroid bind to protein carrier, carriers have low affinity
      - H * C -> H + C -> H * R
- rate of degradation and/or excretion

peptide protein hormones

- peptide 3+ aminos
  - made in rough endoplasmic reticulum
    - preprohormone
      - inactive
      - packaged and moved to the golgi
      - cleaved to prohormone
    - prohormone
      - almost always inactive
      - secretory vesicle
    - hormone
      - active
      - happens within the secretory vesicle
      - delivered via +calcium Ca or cyclic AMP (adenosin monophosphate) signal
      - prepackaged, released as needed
      - once they are in the blood, the half life is short
      - do not require carriers, because they are soluble

- steroid hormones
  - adrenal, gonads, placenta
  - not soluble in plasma, lipid plasma
  - use carriers, because they are soluble in lipid
  - synthesized on demand
  - concerted to active in target tissues
  - testosterone -> DHT ; testosterone -> estrogen, depending upon the target
- amino acid derivatives
  - insoluble in plasma
  - transported via carrier
  - long half life
  - conversion in target tissues

transport carriers

- extend live of the hormone
- sequester the hormone from its target cell receptor

receptor types

- soluble in plasma:: hydrophilic, receptor in the cell surface
  - integral membrane proteins
    - tyrosine kinase (puts phosphate) <- growth hormone -> when binded, then second msgr start the chain
    - inherent tyrosine kinase <- insulin -> phosphorilation
    - g protein coupled <- glucagon
    - steroid & thyroid hormone, can cross plasma membrane -> nuclear receptor -> changes to DNA

target cell sensitivity

- affinity
- receptor number
- competition
- saturation

types of stimuli

- Stimuli -> neuron (sense sodium concentration) -> secrete hormone -> anti diuretic hormone -> kidney -> dilutes sodium concentration :: neural control
- hormonal control
- low blood calcium -> paratyroid -> paratyroid hormone -> bone -> release calcium :: substrate control

inactivation of hormone signaling

- receptor desensitization ex: type II diabetes
  - sequestration
    - remove the receptor from the surface
  - degradation
    - destroy receptor
- negative feedback
  - removes initial stimulus

general concepts

- peptide hormones are soluble in plasma, bind cell surface receptor, are fast-acting and are short-lived
- thyroid hormones and steroid hormones are insoluble in plasma, act via intracellular receptor to change transcription, are slow acting and long lived
- binding proteins (carriers) regulate hormone availability, physiologic function, and half lives
- hormone release is under neural, hormonal, nutrient and ion regulation
- signaling is regulated by changing plasma hormone concentration and by changing target cell receptor sensitivity

Endocrine system assessment & pathology

assessment of function

- too much -> hyper secretion, hormone excess
- too little -> hypo-secretion, hormone insufficiency
- target cell resistance -> unresponsive
- just right -> normal or eu-secretion, works fine

competitive binding assay

- high sensitivity and high specificity
- specific antibody -> marks the hormone -> labeled hormone
  - unlabeled hormone competes, then via subtraction we find how much unlabeled hormone there was, because we know the initial labeled hormone concentration

bioassay = function?

- low plasma glucose -> hypothalamus -> CRH (cortico trophin) -> anterior pituitary -> ACTH (adreno cortico throphin) -> adrenal cortex -> cortisol -> negative feedback anterior pituitary + hypothalamus

- if high cortisol -> high plasma glucose -> give dexamethasone to inhibit ACTH -> ACTH lvl should fall -> - cortisol; if not -> problem with the adrenal gland
- low plasma + low cortisol -> give ACTH -> cortisol should rise -> problem was with hypothalamus or anterior pituitary

general concepts

- pathology happens when theres too much or too little hormone or resistance to the hormone due to receptor dysfunction
- interpretation of hormone levels requires consideration of either the trophic hormone or of the ios/nutrient controlled by the hormone