

# 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 disequilibrium

## 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**

- modulating the activity of a specific 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

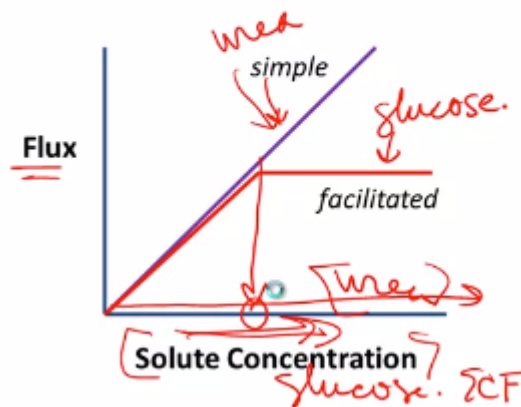
**characteristic of simple diffusion**

- 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

## SIMPLE VS FACILITATED DIFFUSION



- 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 enzyme, 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<sup>+</sup> 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 =  $6 \times 10^{23}$  molecules)
  - osmolarity: (#molecule/vol) \* (# particles/molecule)
  - osmolality: kg of water
- tonicity & cell volume
  - always comparative
  -

## non-penetrating molecules/volume

- changes in body fluid compartements