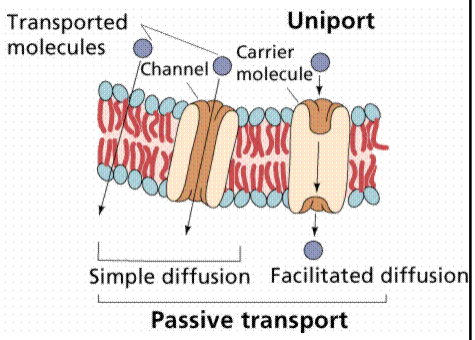
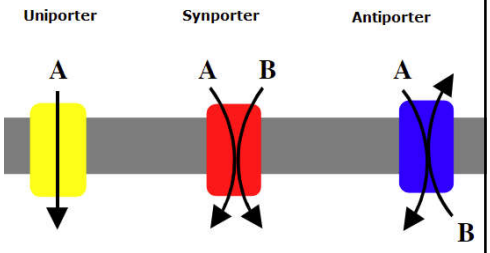
Types of transport

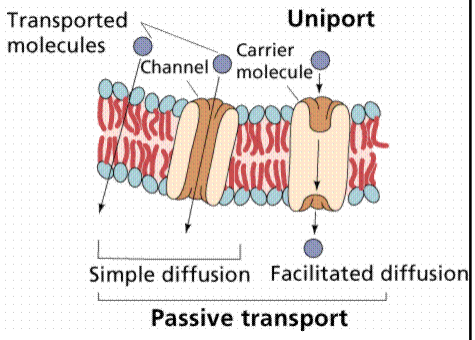
- **Passive** - Osmosis and diffusion
  - No cost
  - Move with electrical and chemical gradient
  - Rates governed by Fick's law
- **Facilitated diffusion (uniport)**
  - No cost
  - Move with gradients
  - Rates increased by membrane proteins

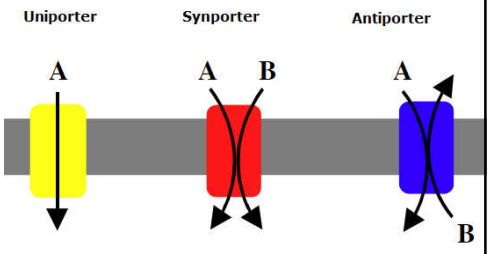




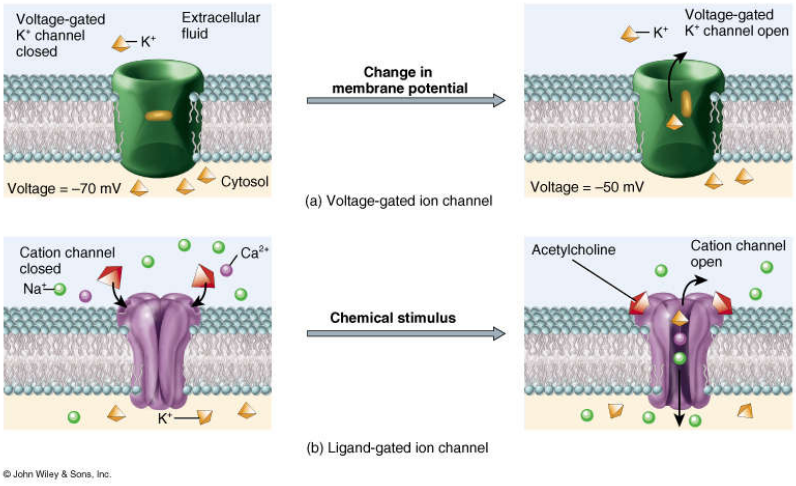
Types of Transport

- **Active transport**
  - Use ATP
  - Move against gradients
  - **Primary**
    - Various ion pumps, **electrogenic**
  - **Secondary**
    - **Symporters** – two substances move in the same direction
      - Marine invertebrates take in Na and AA, presence of both required
    - **Antiporters** – two substances go in opposite directions
      - NA^+/H^+ antiporters maintain cell pH



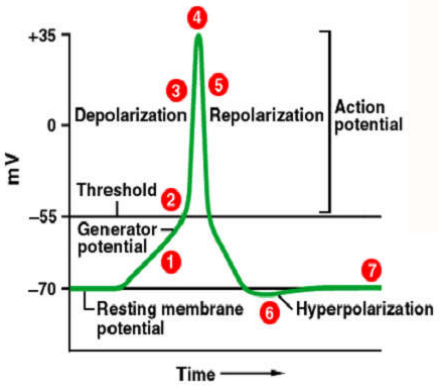


Ligand, voltage or mechanically gated channels

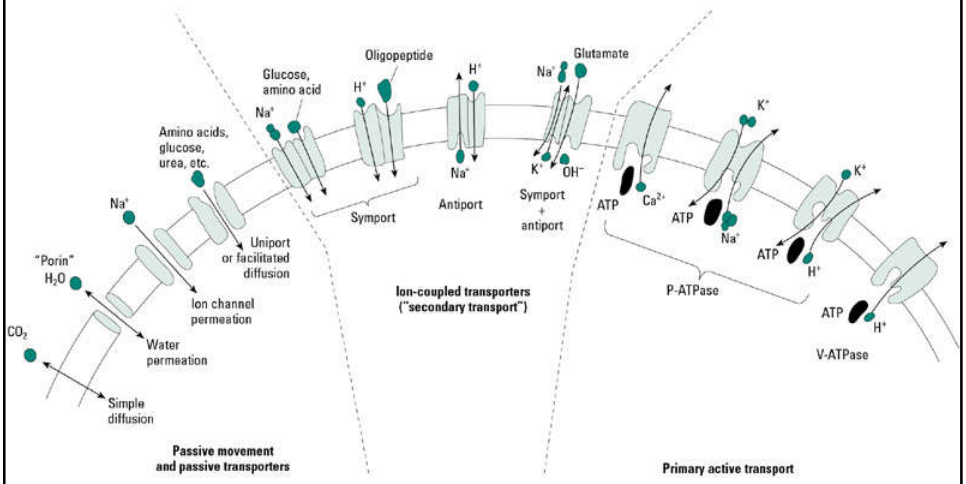


Example - Action Potentials

- Threshold potential ~ -55mV
- Voltage-gated Na+ channels open (depolarization)
- Na+ channels close (peak ~ +35)
- K+ gates open (repolarization)
- Negative overshoot produces hyperpolarization

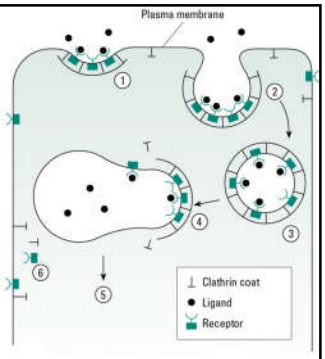


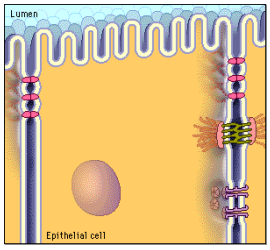
Overview of membrane transport

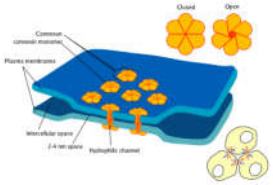


Cellular and tissue level movement

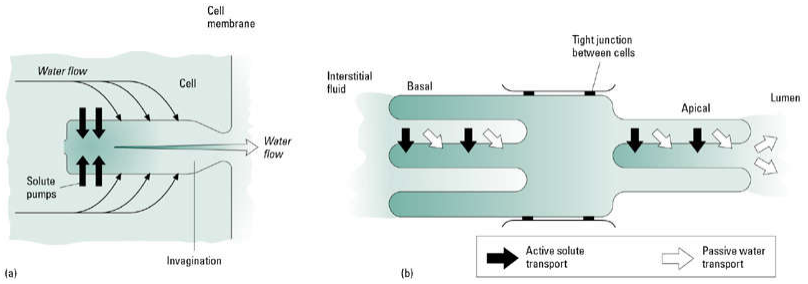
- **Endocytosis** and **exocytosis**
  - May be receptor (ligand) mediated
- **Cell junctions**
  - Tight junction
  - Gap junction





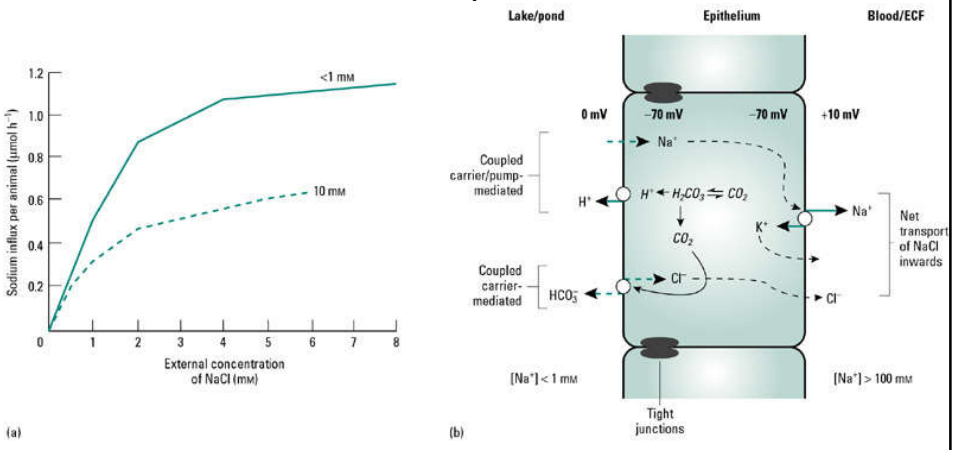


Epithelial Tissue Solute Linked Water Balance



- Active transport of ions facilitates passive water movement
- Importance of simple cell invaginations or tube lumen

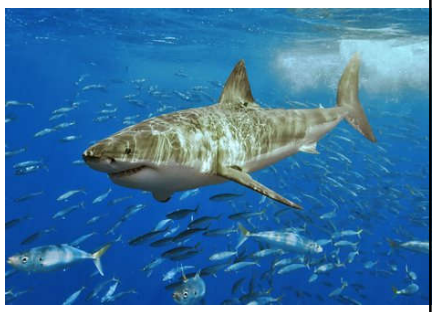
Acclimation and ionic transport



Freshwater crustacean (hyperosmotic) rate of salt ion intake changes with acclimation. Faster intake after acclimation to low salinity.

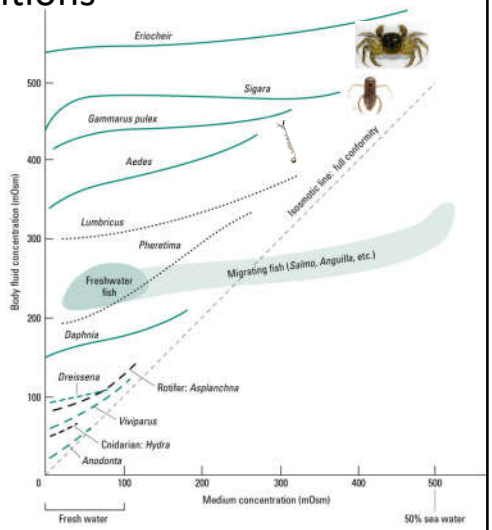
Compensatory Osmolytes

- Some ions are more detrimental to cell function (**salting out**)
- **Compensatory osmolytes** – accumulate non-damaging molecules to increase osmotic pressure, lowering concentrations of damaging ions (osmoconformers)
- Invertebrates – often accumulate AA
- Elasmobranchs – nearly isoosmotic with TMAO and urea, relatively little salt



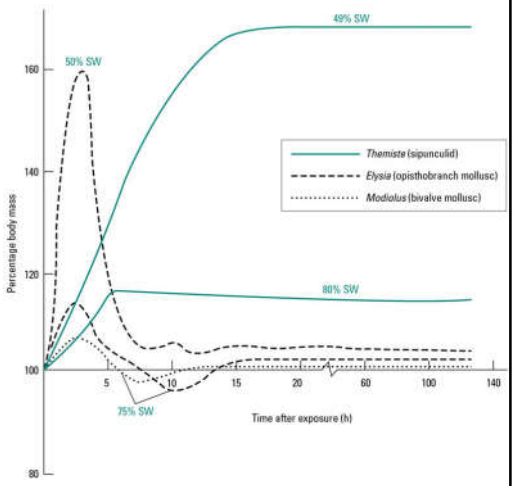
Intracellular Osmotic Conditions

- Oceans: 1000-1150 m*Osm*
  - Inverts 1040-1200
  - Teleost – 300-350
  - Elasmobranch 1000-1200
- Freshwater: 0-100 mOsm
  - Teleost – 200-300
  - Elasmobranch – loss of compensatory osmolytes



Cell or body volume regulation

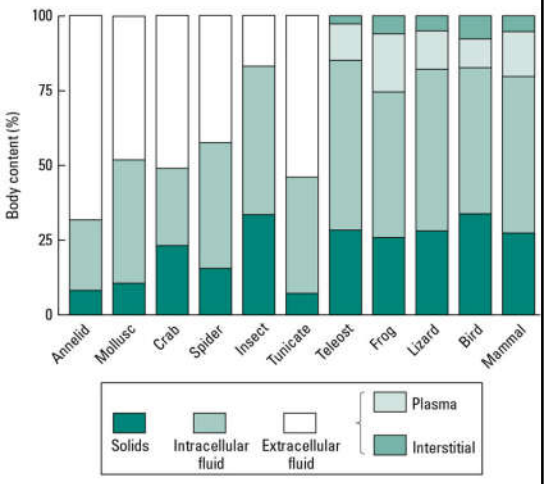
- If cell or organism is put in non-isoosmotic condition, swelling or shrinking occurs.
- Ability to regulate ~ ratio of predicted osmotic gain to actual gain
- Unregulated body volume = perfect osmometer



- **Hyponatremia** – water intoxication
  - Drink excessive water
  - Blood Osm drops
  - Cell volume up, cell Na levels down
  - Tissue swelling, fluid in lungs, nervous tissue damage

Water Content in Animals

- Intra vs. intercellular fluid
- Extracellular is typically a “buffer” against desiccation



Water Budgets