membranes
chapter 11-12

membrane functions

• transporting solutes
  • facilitate the movement of substances between compartments

• external signalling
  • receptors respond to stimuli

• intracellular interaction
  • recognize and interact with cells

• energy transduction
  • photosynthesis
  • respiration

membrane functions

• compartmentalization
  • intracellular compartments

• scaffold for biochemical activities
  • organize enzymes

• selectively permeable membrane
  • allows control of movement of substances

basic structure

• trilaminar appearance
  • phospholipid bilayer
  • proteins interspersed

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**lipid bilayer**

- fluid-mosaic model

**membrane composition**

- lipid components
  - bound to proteins by non-covalent bonds
  - hydrophobic interactions
  - movement
  - **amphipathic lipids**
    - phosphoglycerides
    - sphingolipids
    - cholesterol
    - in animals

**loxoscelism**

- action of venoms
  - *Loxosceles sp.*
    - sphingomyelinasial-D
      - acts on sphingolipids
      - sphingomyelin
      - lysophosphatidylcholine

**cholesterol**

- smaller lipid
  - less amphipathic
  - only found in animals
  - sterol
  - fluidity
  - hinders movement of lipids
**fluidity**

- liquid layer
  - phospholipids move
  - lateral shift
  - transverse diffusion
- liquid-crystal or gel
  - depends on temp
  - depends on lipids
- 2D fluid
- selective rearrangement
  - ER - addition of new PL
  - scramblases

- structure depends on temperature
  - tightly packed lipids become more solid
  - altering lipid structure affects fluidity

**dynamic properties**

- movement
- fusion
- division

**fluidity**

- Lipid rafts
  - Outer layer contains specialized regions
  - Cholesterol and sphingolipids pack together
    - form highly ordered microdomains
    - lipid rafts
  - cell-surface receptors
  - GPI-anchored proteins
**chemical composition**

- asymmetry of membrane lipids
  - inner and outer membranes have different lipids
  - phosphatidylcholine
- membrane carbohydrates
  - oligosaccharide
  - glycolipid
  - glycoprotein

**membrane proteins**

- integral proteins
  - amphipathic
    - hydrophilic
    - hydrophobic

**membrane proteins**

- peripheral proteins
  - completely outside membrane
  - attached by weak bonds

**membrane proteins**

- lipid-anchored proteins
  - (Glycophosphatidylinositol) GPI-linked proteins
  - inner-leaflet proteins
protein movements
• control of protein mobility
  • proteins move slowly
  • limited by
    • cytoskeleton
    • other proteins
    • extracellular materials

distribution of proteins
• membrane domains / cell polarity
  • epithelia
    • apical membrane
    • lateral membrane
    • basal membrane

transport / permeability
• net flux
  • difference in influx and efflux
  • transport mechanisms

transport / permeability
• diffusion requires
  • permeability
  • electrochemical / concentration gradient
**osmosis**

- diffusion of water
  - water crosses plasma membrane quickly
    - aquaporins

**osmosis**

- plant cells
  - osmosis
    - hyperosmotic -- plasmolysis
    - hypoosmotic -- turgid
  - Water potential
    - moves from high water potential to low water potential
    - pure water $\rightarrow \psi = 0$
    - solutes $\rightarrow$ negative
    - pressure $\rightarrow$ positive
    - negative pressure?

**diffusion of ions**

- ion channels
  - selective
  - bidirectional
  - diffusion
  - can be gated or ungated

- gated-channels
  - voltage-gated potassium channels

**potassium channels**

- $K_v$ channels
  - 6 membrane-associated helices
    - pore domain
    - voltage-sensing domain
**potassium channels**

- Eukaryotic Kv channels
  - 4 subunits
  - 6 membrane-associated helices
    - pore domain
    - voltage-sensing domain

**glucose**

- facilitated diffusion
  - passive
  - specific
  - saturable
  - regulated

**active transport**

- sodium-potassium pump
  - major electrogenic pump
  - membrane bound enzyme

**active transport**

- proton pumps
  - H^+ATPase
  - main electrogenic pump for plants, fungi, bacteria
**active transport**

- **H⁺/K⁺ ATPase**
  - controls production of stomach acid

**coupling transport**

- **co-transport**
  - also called secondary transport
  - indirect use of ATP
  - can be symport or antiport

**membrane potential**

- **gated channels**
  - most channels are gated - mechanical, chemical, voltage
  - *Mimosa pudica*

**membrane potential**

- **neurons**
  - cell body
  - dendrites
  - axon
**membrane potential**

- resting potential
- Nernst equation
  - \( E_{\text{ion}} = \frac{RT}{zF} \log \left( \frac{[\text{ion} \text{ outside}]}{[\text{ion} \text{ inside}]} \right) \)
  - \( E_K = -90 \text{ mV} \)
- actual resting potential (around -70mV)
- graded potentials - relative to stimulus
  - hyperpolarization
  - depolarization
    - usually caused by Na\(^+\) influx

**membrane potential**

- action potential
  - all or none

**membrane potential**

- impulse propagation
- refractory period
- saltatory conduction

**membrane potential**

- synapses
  - Electrical Synapses
  - Chemical Synapses
    - Postsynaptic chemically-gated channels
membrane potential

- neurotransmitters
  - bind with receptors on postsynaptic cell
  - different types of receptors - different cells
  - eliminated by enzymes and reuptake