Membranes: Two meaning...

- Membraneus tissues:
  - Example: Pericardium
  - Epithelial tissues: A few cell-thick
- Cell membranes (plazmalemma)
Cell membrane: Summary

- Structural support for the cell
- Barrier between cells
  - Chemically
  - Physically
- Regulation of substance flow (semi-permeable)
- Cell to cell communication
### Structure of the membrane

- Phospholipid bilayer and cholesterol
- Membrane proteins
  - Peripheral
  - Integral

### Integral structural proteins of the cell membrane

- Structural integrity
- Polarity of the cell
- Phosphorilation
- Extracellular matrix
Integral structural proteins of the cell membrane

- **Extracellular fluid**
- **Membrane-spanning protein**
- **Cytoskeleton protein**
- **Peripheral protein** anchors the cytoskeleton to the cell membrane.

Integral structural proteins of the cell membrane

- **Carbohydrate**
- **Extracellular fluid**
- **COOH**
- **Cell membrane**
- **Intracellular fluid**
- **NH₂**
- **Phosphate**
- **Cytoplasmic loop**

This membrane-spanning protein crosses the membrane seven times.
Molecule-binding proteins of the cell membrane

- Membrane-attached enzymes
  - External reactions
  - Internal reactions
- Receptors, binding specific molecules Example: Hormones

Transport proteins

- Channels
  - Open
  - Closed/Gated
- Carrier proteins
  - Binds specific molecules
  - “Slow transport”
Transport proteins

A

B

Subunit
Amino acid chain

Transport proteins
Transport proteins

(a) Open channels have gates (not shown) but spend most of their time in the open state.

(b) Gated channels are usually closed. They open in response to chemical, mechanical, or electrical signals.

Channels

- Water channels
  - Aquaporins
- Ion channels
  - Specific ion channels
  - Non-specific ion channels
  - “Gated” channels
    - Chemically-gated
    - Voltage-gated
    - Mechanically-gated
Transport proteins

(a) Open channels create a water-filled pore.
(b) Carriers never form an open channel between the two sides of the membrane.

Cell membrane

ECF

ICF

Carrier open to ICF

Same carrier open to ECF

ENERGY REQUIREMENTS

Requires no energy other than that of molecular motion

Requires energy from ATP

Diffusion

Simple diffusion

Facilitated diffusion

Secondary active transport

Primary active transport

Endocytosis

Exocytosis

Phagocytosis

PHYSICAL REQUIREMENTS

Molecule goes through lipid bilayer

Mediated transport requires a membrane protein

Uses a membrane-bound vesicle
Diffusion

Factors affecting rate of diffusion through a cell membrane:
- Lipid solubility
- Molecular size
- Cell membrane thickness
- Concentration gradient
- Membrane surface area
- Composition of lipid layer

Fick's Law of Diffusion says:
Rate of diffusion = available surface area \times concentration gradient

Carrier-mediated transport

Uniport – Cotransport (Symport & Antiport)

(a) Uniport carriers transport only one kind of substrate.
(b) Symport carriers move two or more substrates in the same direction across the membrane.
(c) Antiport carriers move substrates in opposite directions.
Facilitated diffusion

• Facilitator carrier proteins

Facilitated diffusion brings glucose into the cell down its concentration gradient. Diffusion stops at equilibrium, when the glucose concentration inside and outside the cell is equal.

Facilitated diffusion

[Glucose]$_{in}$ stays low
Glycogen
G-6-P
Glycolysis

high [Glucose]$_{out}$
ATP
ADP
Primary active transport

- Energy!
- Against the gradient!

Membrane pumps

- \( \text{Na}^+/\text{K}^+ \text{ATPase} \)
- \( \text{Ca}^{2+} \)-ATPase
- \( \text{H}^+ \)-ATPase
- \( \text{H}^+/\text{K}^+ \text{ATPase} \)
Na\textsuperscript{+}/K\textsuperscript{+}ATPase pump

Secondary active transport

- “Cotransport”
- Kinetic energies of the molecules are used...
Vesicular transport through membranes

- Transport of particles
- Large molecules
- Phagosomes
- Phagocytosis

Endocytosis and exocytosis

- Pinocytosis: Non-selective
- Receptor-mediated: For specific substrates
Endocytosis and Clathrins

Inner Life of the Cell – Biovision, Harvard

http://www.youtube.com/watch?v=wJyUtbn0O5Y
Until next lecture...

Live as if you were to die tomorrow
Learn as if you were to live forever...