Biology 48 - Human Physiology
Lecture Summary Sheet - Norris

Cell: Membrane Transport / Potentials

I. Definitions
A. Solution
- solvent
- solute

B. Potential

II. Membrane Physiology - the plasma membrane acts as a selectively permeable barrier that regulates what may cross into or out of the cell.

1. Passive Transport
a. Simple Diffusion - *net movement of molecules from a region of high concentration to a region of lower concentration towards equilibrium*.

Influenced by: conc. gradient (molarity), permeability, temp., size (MW), surface area…

b. Facilitated Diffusion (involves a protein carrier = carrier mediated):

i. Characteristics of Protein Carriers (also enzymes, receptors…)
- specificity
- competition
- saturation

c. Osmosis - *net movement of water from a region of low solute concentration to a region of high solute concentration across a selectively permeable membrane towards equilibrium*.

Influenced by: conc. gradient (osmolarity), solute permeability, water permeability (aquaporins), temp., size (MW), surface area…

i. Osmotic Pressure

ii. Tonicity
- isotonic:
- hypertonic:
- hypotonic:

d. Filtration

2. Active Transport - requires energy from the cell (carrier mediated)

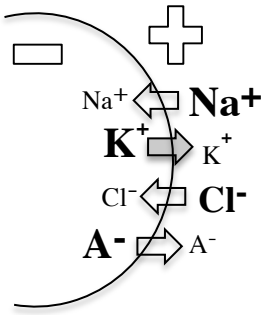
a. Protein Carrier ("pump"):
i. Primary Active Transport

ii. Secondary Active Transport

b. Bulk Transport (transport across, but not through, membranes):

III. Ion Distribution

Ion	Inside	Outside
Sodium (Na^+)	12 mEq/L	145 mEq/L
Potassium (K^+)	150 mEq/L	5 mEq/L
Chloride (Cl^-)	5 mEq/L	105 mEq/L
Impermeable Anions (A^-)	155 mEq/L	45 mEq/L



Note: potassium is permeable at rest resulting in outward diffusion and a negative resting mermbrane potential

IV. Equilibrium Potentials

A. Goldman-Hodgkin-Katz Equation (multiple ions)

$$EMF = -61 \log \frac{[Na^+]_{in} P_{Na} + [K^+]_{in} P_K + [Cl^-]_{out} P_{Cl}}{[Na^+]_{out} P_{Na} + [K^+]_{out} P_K + [Cl^-]_{in} P_{Cl}}$$

The Goldman-Hodgkin-Katz equation describes the effect of membrane permeability to different ions on membrane potential. This equation can be used to determine the membrane potential at any given time.

B. Nernst Equation (single ion)

$$EMF = 61\ (Z) \log \frac{[Ion]_{outside}}{[Ion]_{inside}}$$

Where: EMF = equilibrium potential for the ion measured in millivolts (mV)
Z = valence of the ion
[Ion] = Ion concentration in milliequivalents inside or outside the cell
61 = constant at body temperature (closer to 58 at room temperature)

The Nernst equation is derived from the Goldman-Hodgkin-Katz equation and indicates the effect of permeability of one ion alone. The Nernst equation can be used to determine the equilibrium potential that could be reached if the membrane became permeable to the given ion, which inturn indicates the driving force (both chemical and electrical) influencing ion movement.

V. Resting Membrane Potential

A. Sodium-Potassium Pump (3 Na^+ out: 2 K^+ in)

B. Potassium Leak Channels

VI. Excitation Potentials – Gated Channels

VII. Additional Key Terms

ATPase Brownian motion crenation electrochemical endocytosis exocytosis lysis milliequivalent phagocytosis pinocytosis

Study Questions – Cell: Membrane Transport / Potentials

1. Define "solution".
2. What is a solvent? What is a solute?
3. Define "Potential".
4. What does the term "gradient" mean?
5. Describe the structure and characteristics of phospholipids. How do phospholipids interact with water and each other?
6. Describe the relationship between phospholipids and the structure of cell membranes.
7. Describe how membrane proteins fit into the membrane.
8. List and describe the different functional types of membrane proteins. What do they do?
9. What other components make up the cell membrane? Describe the overall structure of the cell membrane. Identify all of the components and their orientation in the membrane.
10. What is the overall function of the cell membrane?
11. Compare and contrast "passive" and "active" membrane transport.
12. Define "diffusion".
13. Describe the factors that influence the rate of diffusion and the different forces that cause the movement?
14. Describe the different forms of passive membrane transport.
15. Describe the different characteristics of protein transporters (the same characteristics apply to enzymes).
16. How do cells regulate the diffusion of ions & molecules?
17. Define "osmosis".
18. What is osmotic pressure?
19. Define "hypertonic", "isotonic" and "hypotonic".
20. Explain how "hypertonic", "isotonic" and "hypotonic" solutions will affect the cell.
21. What is filtration? How is filtration similar to diffusion and osmosis? What is the driving force for molecular movement?
22. Define "active transport". What do cells use active transport for?
23. Briefly describe primary and secondary active transport. How are they similar, how are they different?
24. Name the different forms of bulk transport. Why is this sometimes NOT described as membrane transport?
25. In terms of molecular movement, what does "equilibrium" mean?
26. What is an "equilibrium potential"?
27. What is the Goldman-Hodgkin-Katz (GHK) equation is used to determine?
28. According to the GHK equation what is the significance of membrane permeability of an ion?
29. The Nernst equation is a simplification of the GHK equation – what is the Nernst equation used to determine?
30. The Nernst potential for sodium is +65mv and for potassium it is –90mv. At rest cells are not very permeable to sodium and have a membrane potential of –70mv. What does this tell you about potassium permeability?
31. When is the sodium-potassium pump actively pumping?
32. What is the significance of the sodium-potassium pump?