Membrane Structure & Function (Outline)

• Basic function, biochemical composition, and physical fluid state
• Role of cholesterol for animal cells membranes.
• Summarize the functions of membrane proteins.
• Traffic of small and large molecules across the plasma membrane.
• Chemical and physical basis of selective membrane permeability
• Passive (diffusion and facilitated diffusion) and active transport.
• Osmosis (passive transport of water)
• Role of protein transporters in passive and active transport
• Role of ATP and phosphorylation in active transport.
• Movement of macromolecules and particles in and out of the cell
MEMBRANE STRUCTURE AND FUNCTION

• Membranes divide the cell into compartments
• The plasma membrane:
  • outer boundary of the cell
  • selectively permeable (controls the flow of substances into or out of the cell)
Membranes are made of phospholipids bilayer
One hydrophilic head
Two hydrophobic tails

Hydrophilic heads
Hydrophobic tails

Water

Hydrophilic head

Phosphate group

Symbol

Hydrophobic tails
In addition to phospholipids, membranes contain proteins that determine the function of the membrane.

- **Phospholipid bilayer**
- **Hydrophilic region of protein**
- **Hydrophobic region of protein**
Cholesterol is a steroid lipid with a carbon skeleton consisting of four fused carbon rings present in plasma membranes of animal cells.
• Cholesterol is wedged between phospholipid molecules in the plasma membrane of animals cells.
• At warm temperatures, it restrains the movement of phospholipids and reduces fluidity.
• At cool temperatures, it maintains fluidity by preventing tight packing.

(c) Cholesterol within the animal cell membrane
A fluid mosaic of phospholipids and proteins

Functions of plasma membrane proteins

(a) Transport

(b) Enzymatic activity

(c) Signal transduction
Receptors receive chemical messages from other cells.
Traffic Across Membranes

A. Non-polar, polar, ions and monomers (small molecules)
   Move physically through the membrane

B. Macromolecules and large particles move across inside vacuoles & vesicles
Selective permeability depends on interaction of that molecule with the **hydrophobic core** and presence of specific **proteins**

- non-polar molecules can pass unassisted
- polar and ionic molecules and inorganic ions are assisted by membrane proteins
Identify, by number, the non-polar molecules or structures. Do they pass through the plasma membrane unassisted?

What about the remaining molecules?
Traffic of ions and monomers

Selective permeability depends on interaction of that molecule with the **hydrophobic core** and presence of specific **proteins**

- non-polar molecules can pass: hydrocarbons, \( \text{CO}_2 \), and \( \text{O}_2 \)
- polar and ionic molecules and inorganic ions are assisted by membrane proteins
  - nutrients (monomers of sugars and amino acids) and metabolic waste products
  - \( \text{Na}^+ \), \( \text{K}^+ \), \( \text{Ca}^{2+} \), and \( \text{Cl}^- \)
Both diffusion and facilitated diffusion are forms of passive transport of molecules down their concentration gradient, while active transport requires an investment of energy to move molecules against their concentration gradient.
Movement across membranes

I. Passive transport
   From an area of high concentration to one with lower concentration, down a concentration gradient, no ATP required

II. Active transport
   From an area of low concentration to one with higher concentration, requires ATP
I. **Passive transport** is diffusion across a membrane without work by the cell. It spreads from areas of high concentration to areas of low concentration.

![Diagram of passive transport](Image)

**Figure 5.14A**

**Figure 5.14B**
I. Passive Transport

1. **Simple diffusion** (gases & hydrocarbons)

2. **Osmosis** diffusion of solvent (H₂O)

3. **Facilitated diffusion** (via protein transporters)
Solvation of ionic compounds in water

http://programs.northlandcollege.edu/biology/Biology1111/animations/dissolve.html
**Osmosis** is the diffusion of water across a membrane. Water travels from a solution of **lower solute concentration** to one of **higher solute concentration**.
Water balance between cells and their surroundings is crucial to organisms

Osmosis causes cells to
- shrink in hypertonic solutions
- swell in hypotonic solutions
- not change in isotonic solutions
In isotonic solutions
Animal cells are normal, but plant cells are limp

Figure 5.17
Transport proteins may facilitate diffusion across membranes by providing passages or channels.
II. Active transport uses cellular energy

– Transport proteins can move solutes against a concentration gradient

– ATP provides a phosphate group to change the shape of the transporter protein

Figure 5.18
B. Transport of large macromolecules across plasma membrane (Exocytosis and Endocytosis)

- Uptake of macromolecules is known as endocytosis
- Secretion or excretion of macromolecules is known as exocytosis e.g. insulin (protein hormone) by pancreatic cells.

Endocytosis and exocytosis

http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter6/animations.html#
In exocytosis, a vesicle fuses with the membrane and expels its contents.
In **endocytosis**, a membrane vesicle folds inward enclosing material from the outside.
Endocytosis can occur in three ways

- Phagocytosis
- Pinocytosis
- Receptor-mediated endocytosis
Faulty membranes can overload the blood with cholesterol

– Harmful levels of cholesterol can accumulate in the blood if membranes lack cholesterol receptors