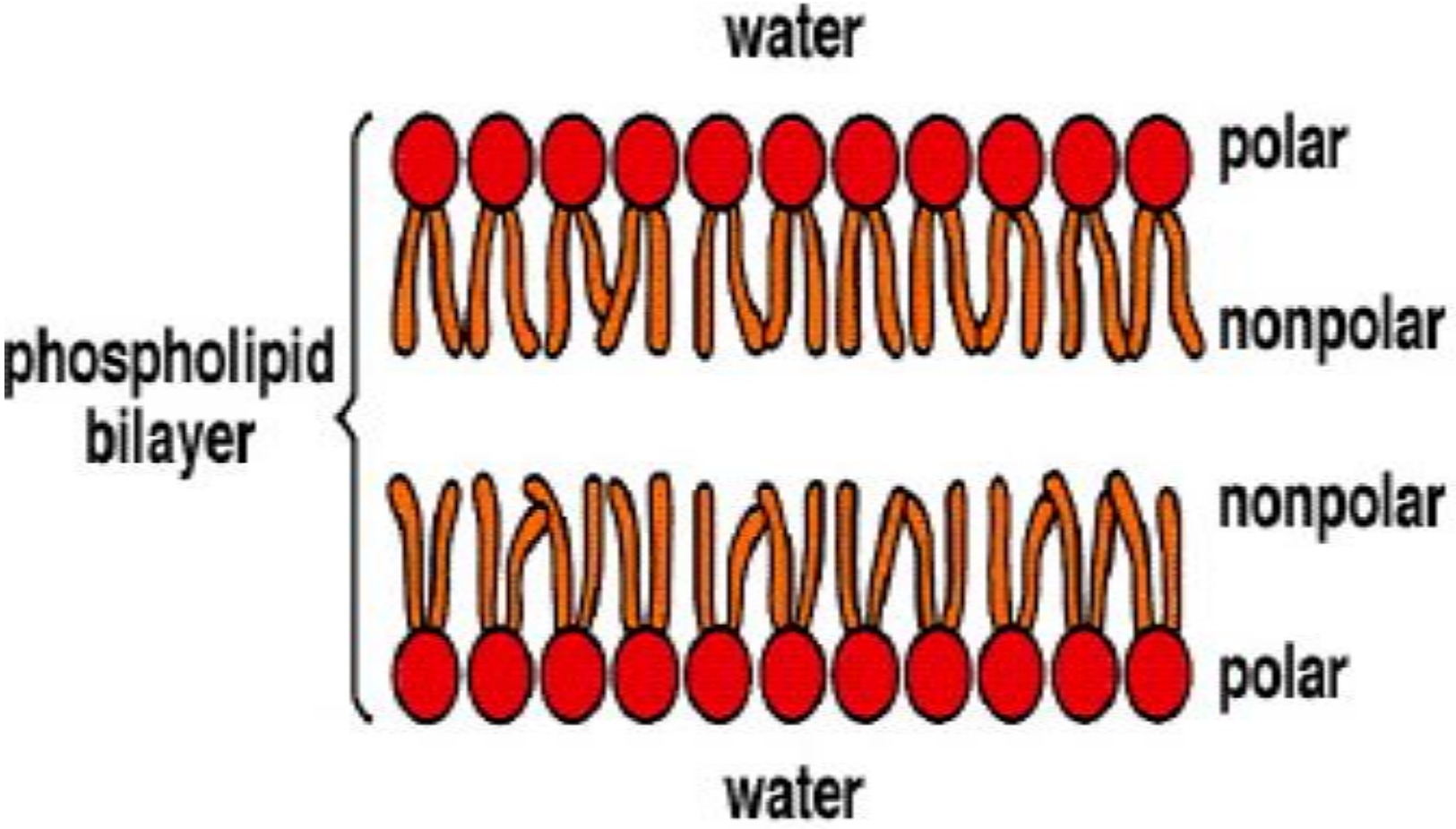
BCM 226 LECTURE

SALEMCITY, A.J

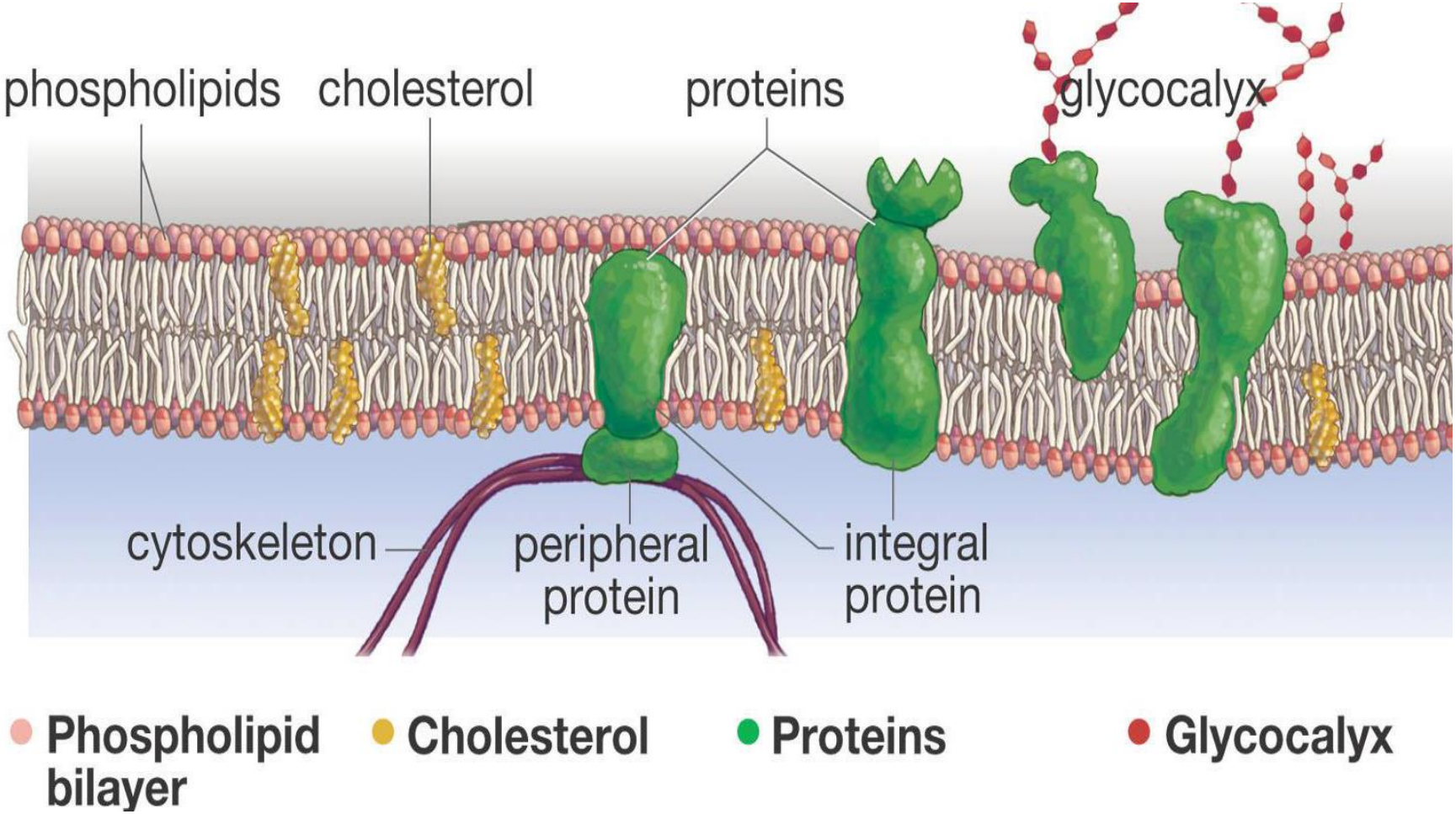
BIOLOGICAL MEMBRANE

- Biological membranes are composed of proteins associated with a lipid bilayer matrix.
- They are the molecular gateway to the cell.
- Viewed under electron microscope, plasma membrane is a trilaminar structure.

Phospholipid bilayer



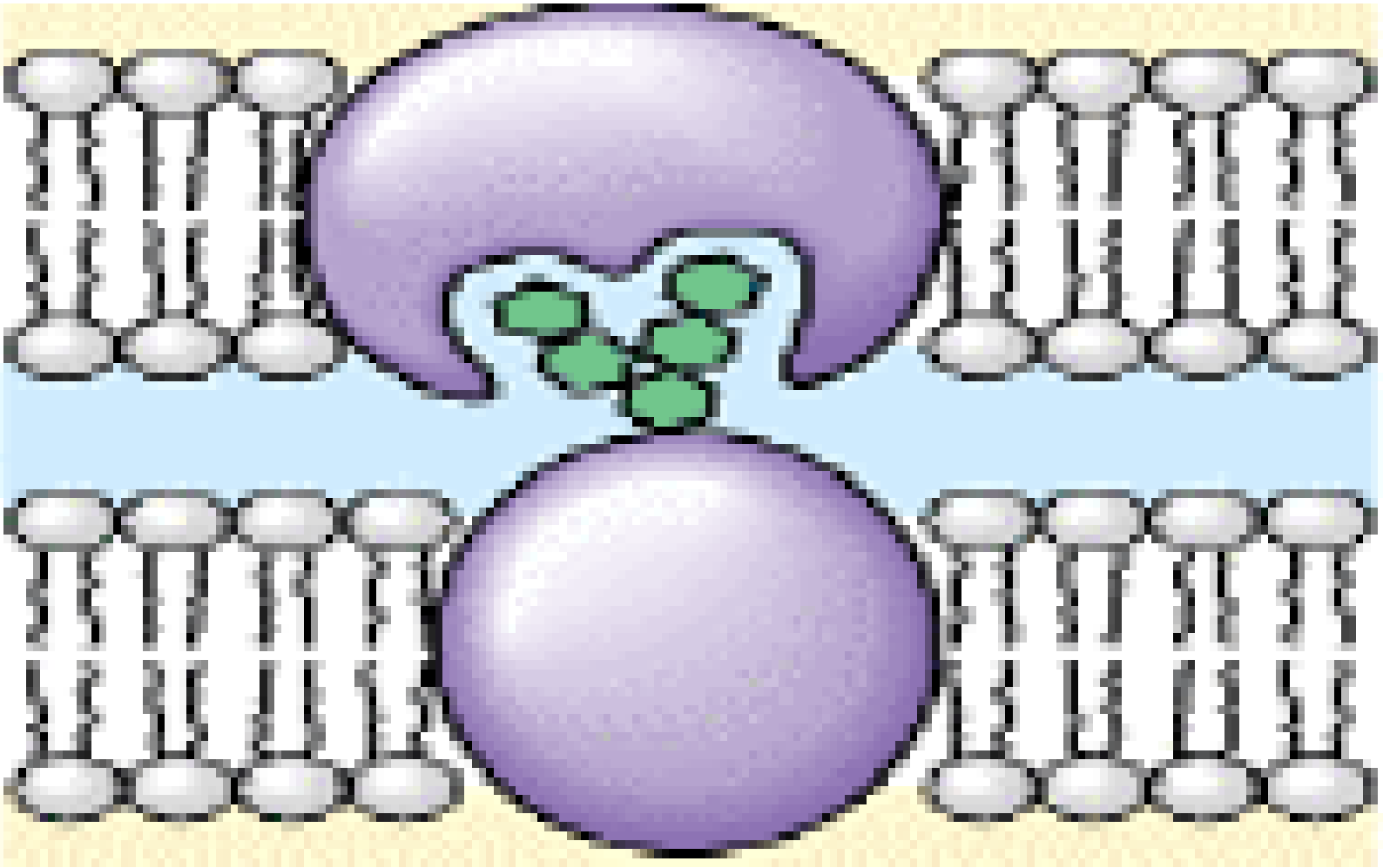
Membrane Components



MEMBRANE FUNCTION

- Compartmentalization and Protective barrier
- Regulate transport in and out of cell
- Allow cell recognition e.g. cell recognition protein (MHC)
- Provide anchoring sites for filaments of cytoskeleton and scaffold for biochemical reactions
- Provide a binding site for enzymes (receptor)
- Intercellular interaction (interlocking surface or junctions connector)
- Contains the cytoplasm
- Signal transduction
- Enzymatic activity

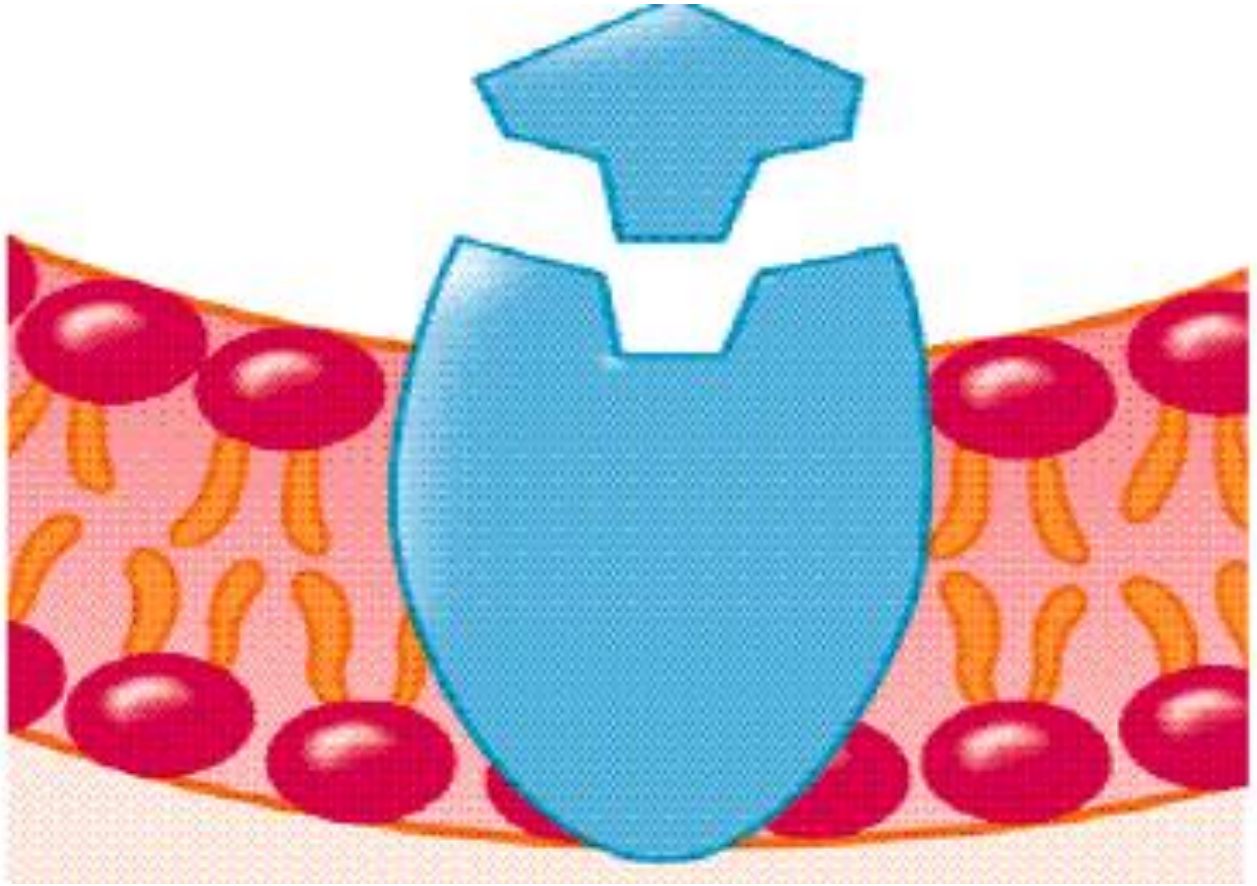
Cell recognition



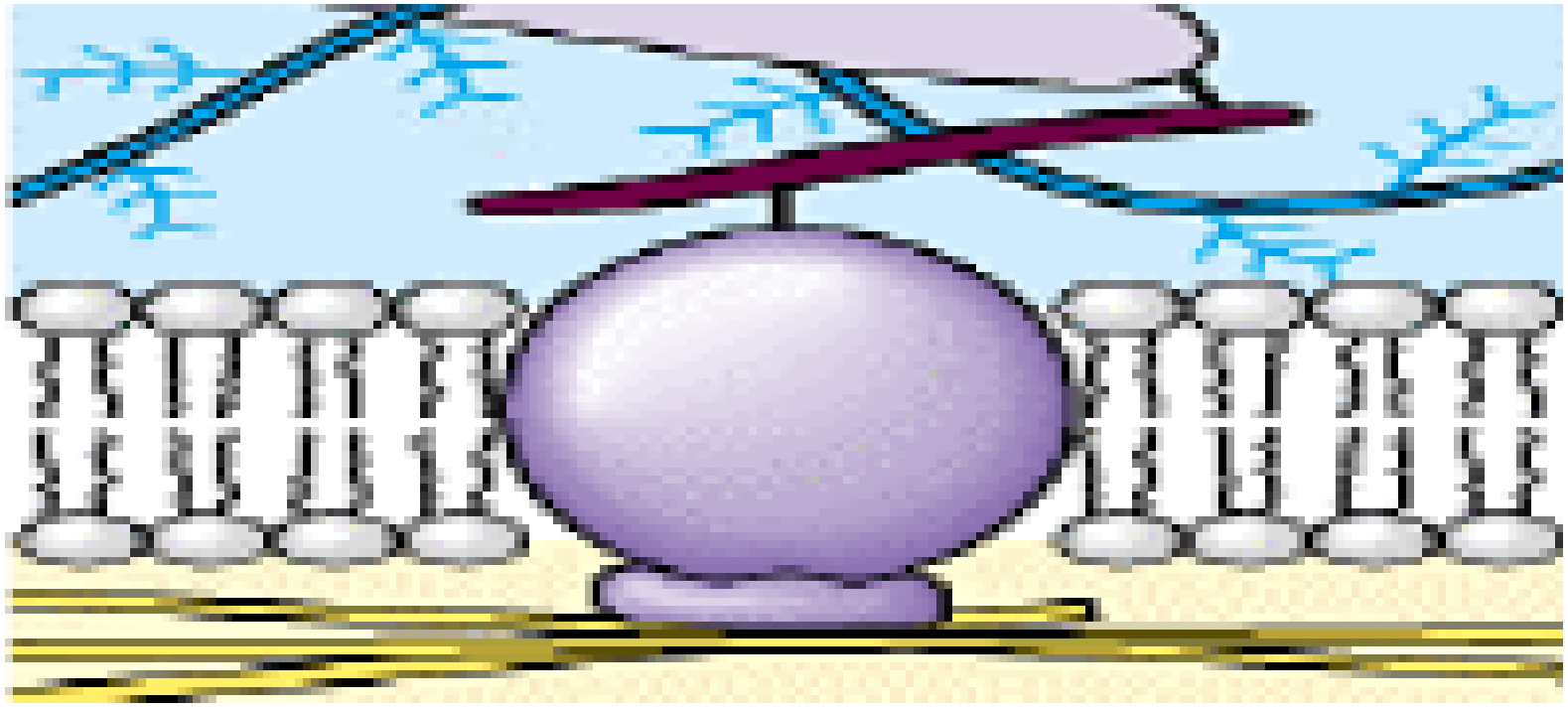
Membrane Transport

Membrane transport may be mediated by the carrier proteins e.g GLUT 2

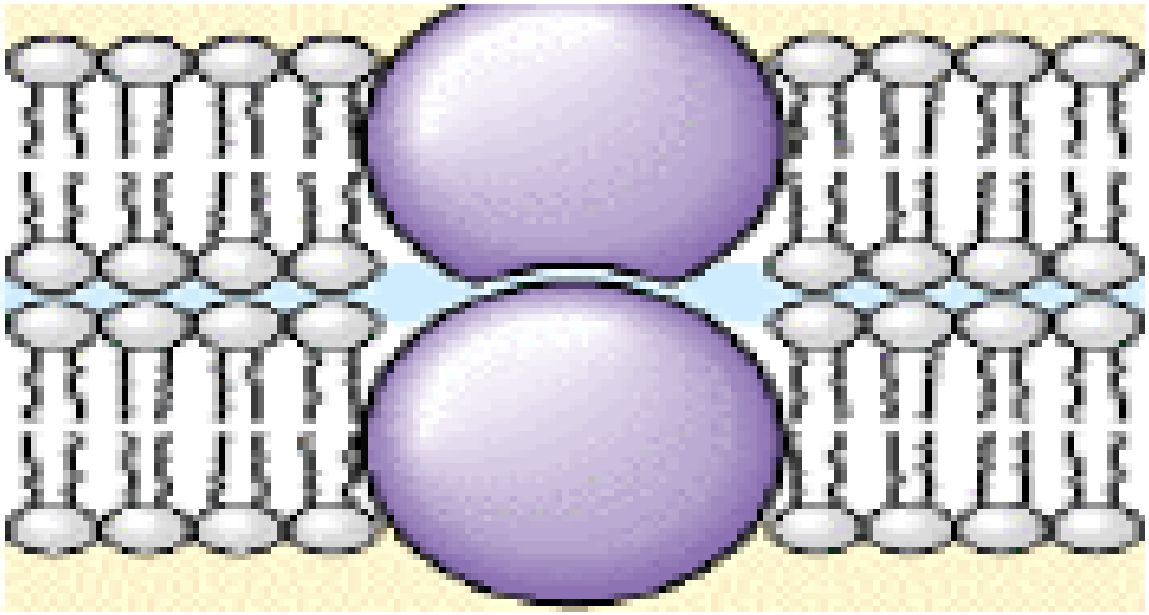
Binding site for enzyme



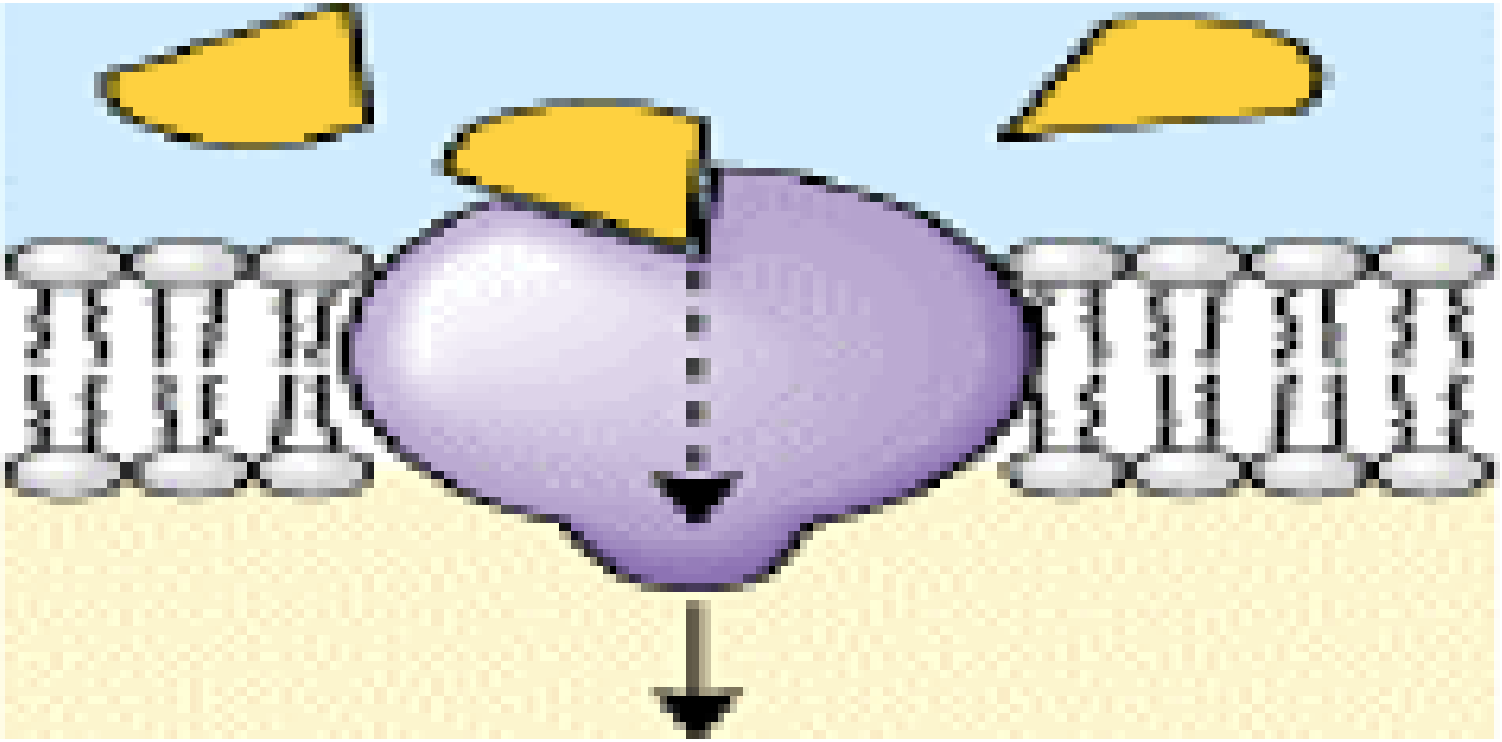
Anchoring and scaffold



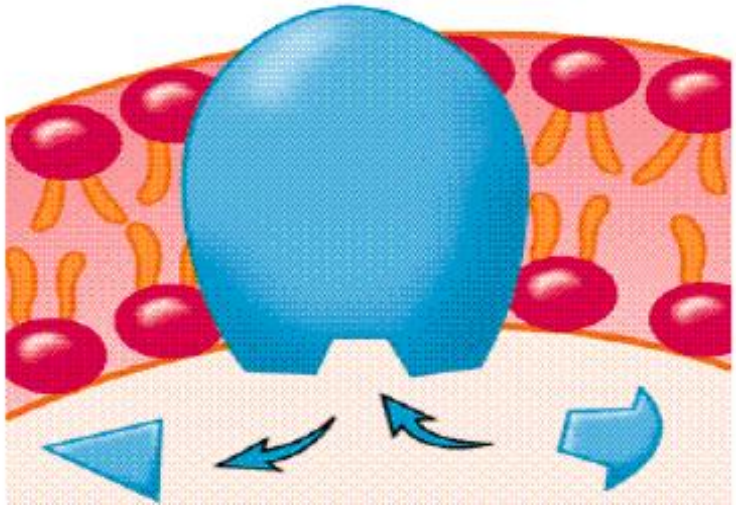
Intercellular interaction



Signal transduction



Enzymatic Activity



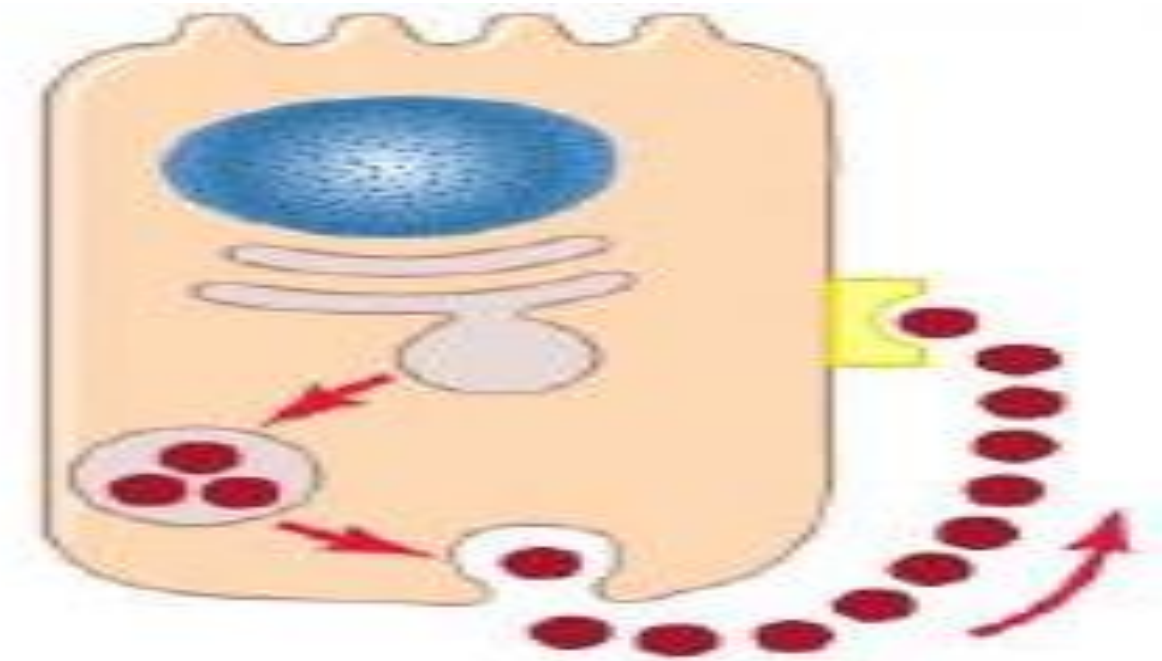
- For example, the membrane protein, adenylyl cyclase, is involved in ATP metabolism.

- Cholera bacteria release a toxin that interferes with the proper functioning of adenylyl cyclase, thus making sodium ion and water leave intestinal cells and the individual dies from severe diarrhea and dehydration.

CELL COMMUNICATION

- Cell communication is very essential for multicellular organisms. For instance, response to pain signals by the muscle cells.
- Why do cells communicate?
- How do cell communicate?
- Cells communicate through any of four basic mechanisms, depending primarily on the distance between the signaling and responding cells.
- In addition, some cells send signals that bind to specific receptors on their own plasma membrane. This is called autocrine signaling which is believed to play an important role in reinforcing developmental process.

Autocrine signaling



- External signals on the cell surface are converted into cellular responses by signal transduction pathways.
- These signals are in form of chemical messengers.
- A hormone is a chemical released by a cell in one part of the body, that sends out messages that affect cells in other parts of the organism.
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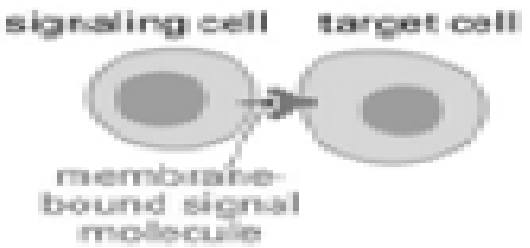
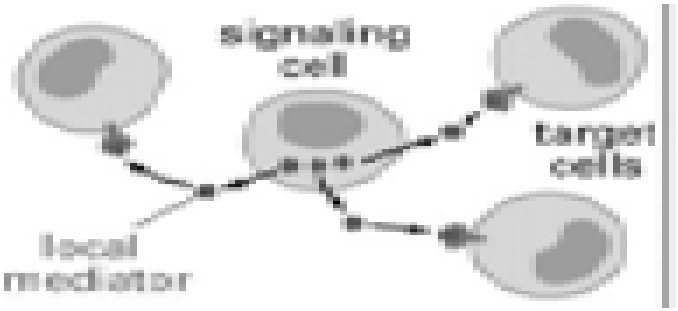
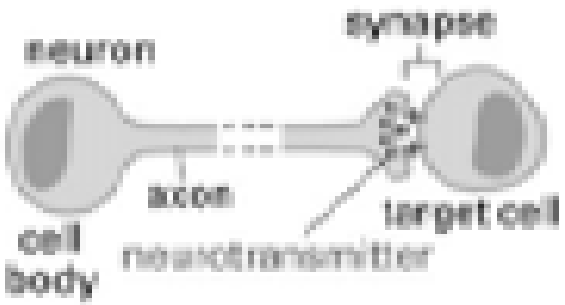
Types of cell signaling



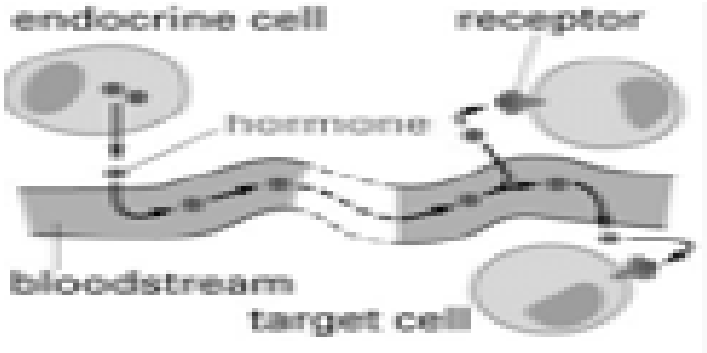
Direct contact



Paracrine signaling



Synaptic signaling



Endocrine signaling

- **Paracrine signaling**

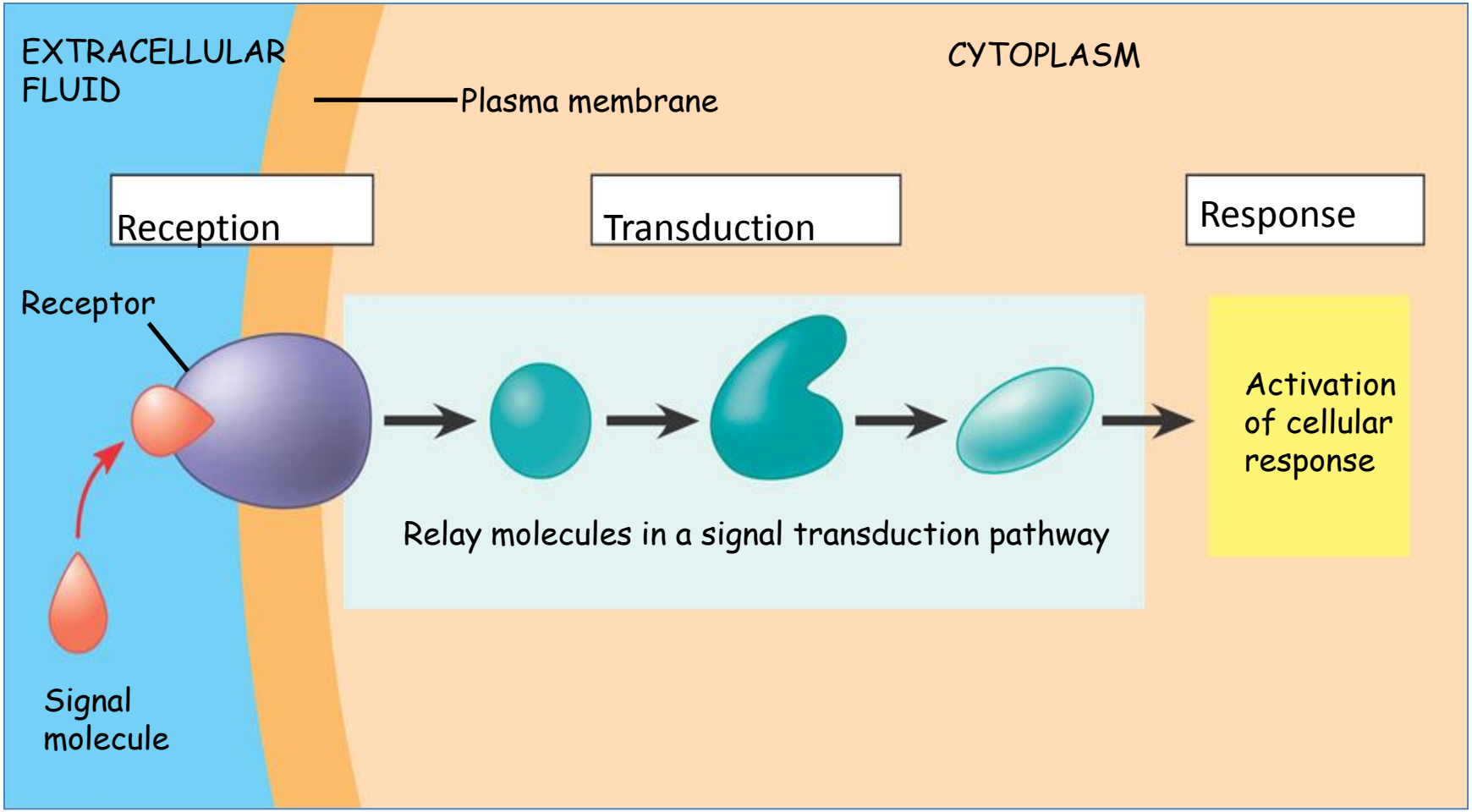
- Paracrine signals are released by cells into the extracellular fluid in their neighborhood and act locally (short distant). E.g. PGE1

- **Endocrine signaling**: hormone produced in endocrine glands are secreted into the bloodstream and are often distributed widely throughout the body.

- **Direct contact**: Cells that maintain an intimate membrane-to-membrane interface can engage in contact-dependent signaling.

- **Synaptic signals** are transmitted along axons to remote target cells.

Overview of cell signaling



- **Reception** occurs when a signal molecule binds to a receptor protein, causing a conformational change to occur.
- **Transduction:** The binding of the signal molecule alters the receptor protein in some way
- The signal usually starts a cascade of reactions known as a signal transduction pathway
- Multistep pathways can amplify a signal

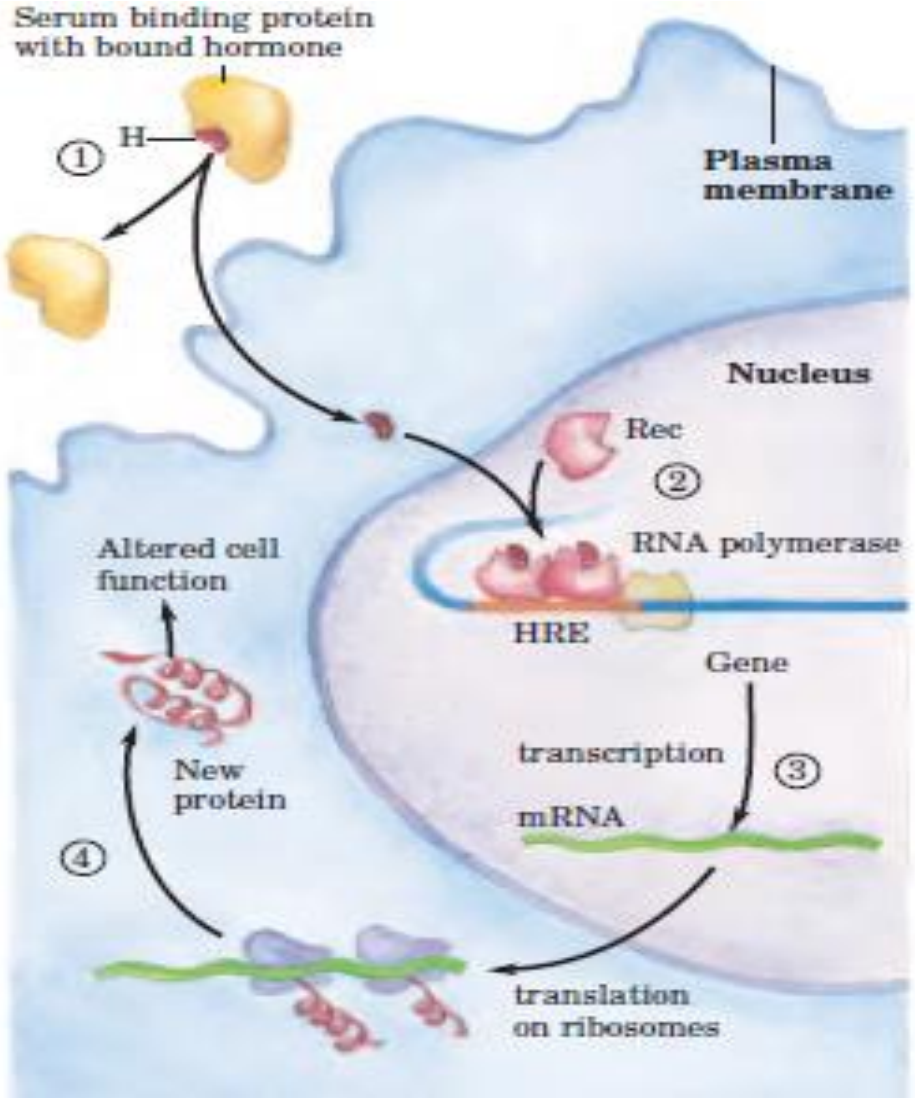
Response

- Cell signaling leads to regulation of cytoplasmic activities or transcription
  - Signaling pathways regulate a variety of cellular activities

Hormone Receptor

- Nuclear receptor: estrogen
- Cytoplasmic receptors: testosterone and thyroid hormones
- Cell surface receptor: peptide hormone and catecholamines

NUCLEAR RECEPTOR



① Hormone (H), carried to the target tissue on serum binding proteins, diffuses across the plasma membrane and binds to its specific receptor protein (Rec) in the nucleus.

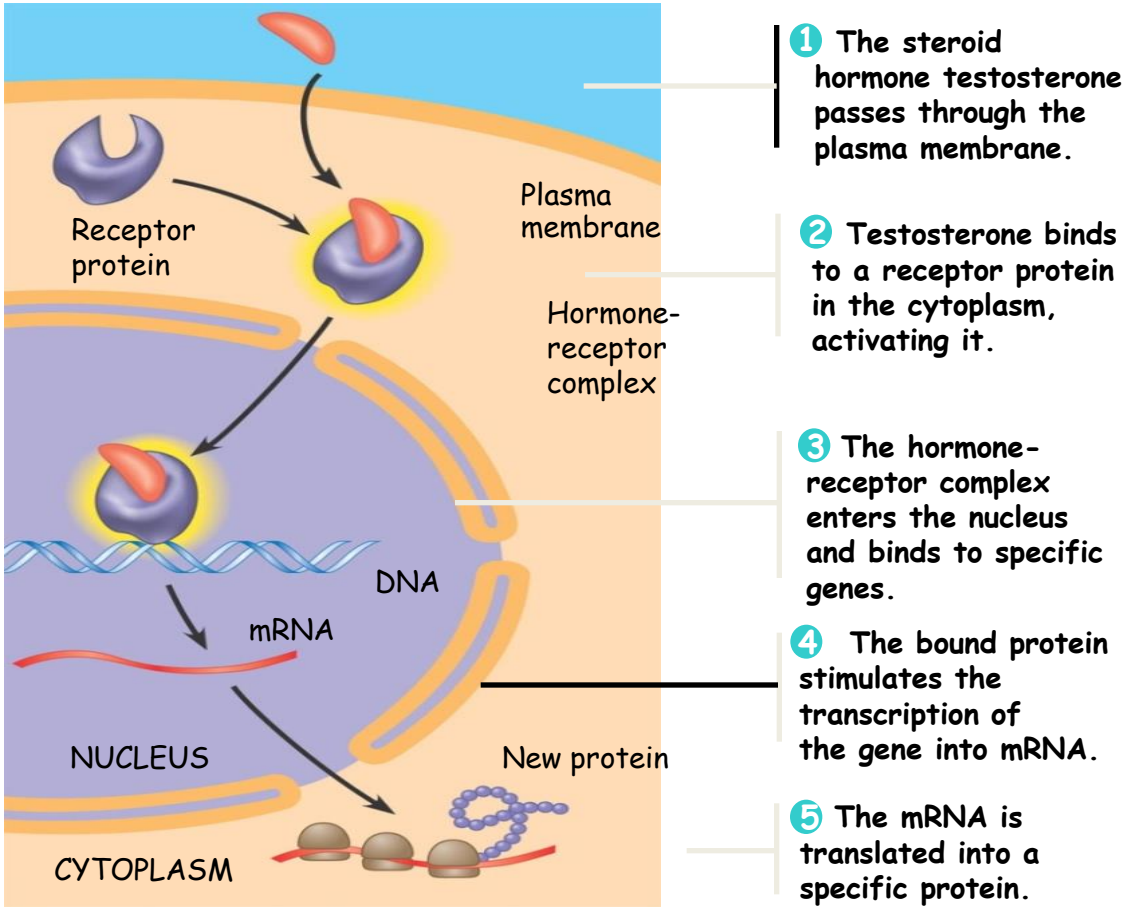
② Hormone binding changes the conformation of Rec; it forms homo- or heterodimers with other hormone-receptor complexes and binds to specific regulatory regions called hormone response elements (HREs) in the DNA adjacent to specific genes.

③ Binding regulates transcription of the adjacent gene(s), increasing or decreasing the rate of mRNA formation.

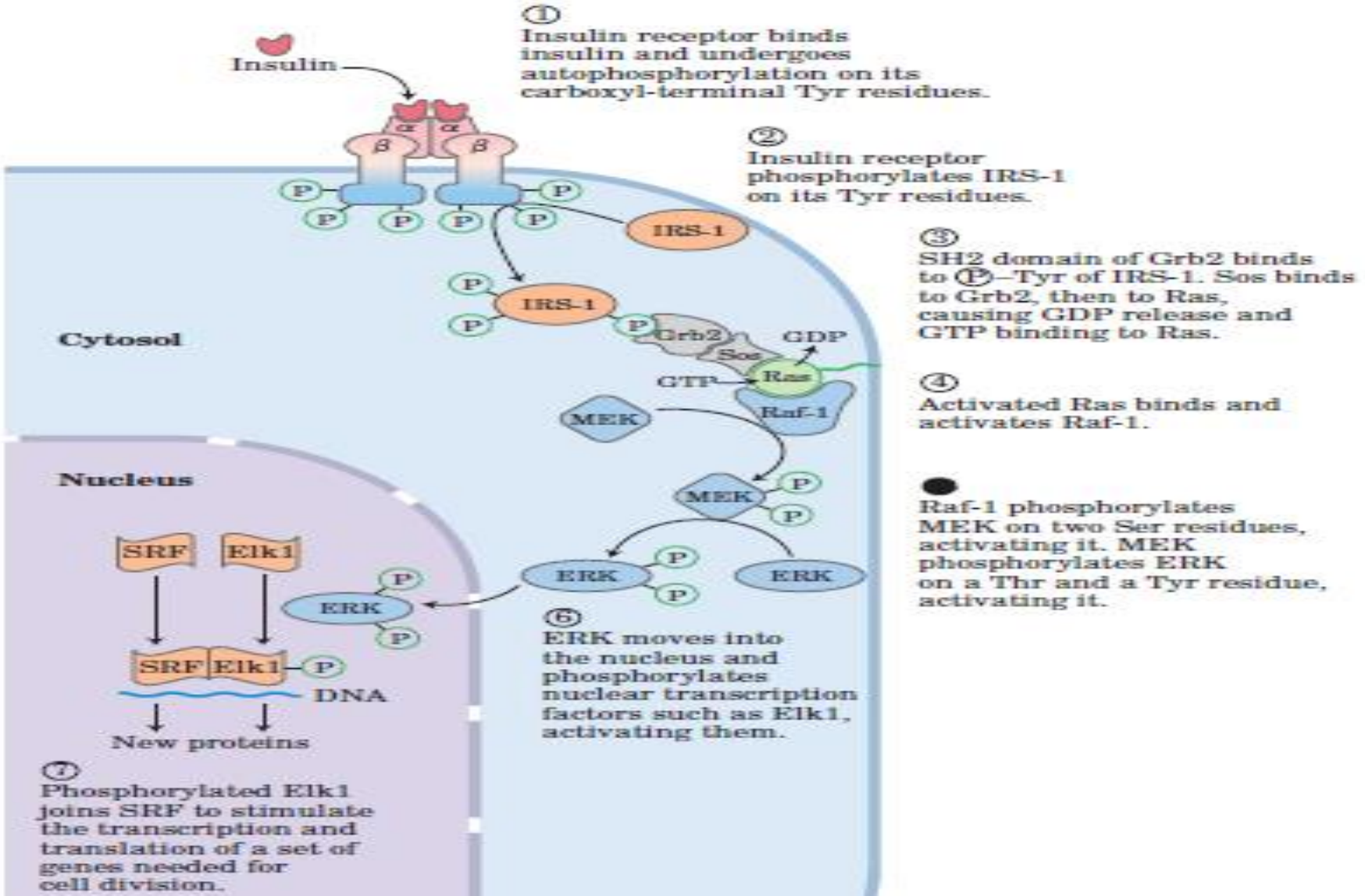
④ Altered levels of the hormone-regulated gene product produce the cellular response to the hormone.

CYTOPLASMIC RECEPTOR

Steroid hormones bind to intracellular receptors



CELL SURFACE RECEPTOR: Receptor Tyrosine Kinase



Signal Molecule	Site of Origin	Chemical Nature	Some Actions
Hormones			
Adrenaline	adrenal gland	derivative of the amino acid tyrosine	increases blood pressure, heart rate, and metabolism
Cortisol	adrenal gland	steroid (derivative of cholesterol)	affects metabolism of proteins, carbohydrates, and lipids in most tissues
Estradiol	ovary	steroid (derivative of cholesterol)	induces and maintains secondary female sexual characteristics
Glucagon	alpha cells of pancreas	peptide	stimulates glucose synthesis, glycogen breakdown, and lipid breakdown in, e.g., liver and fat cells
Insulin	beta cells of pancreas	protein	stimulates glucose uptake, protein synthesis, and lipid synthesis in, e.g., liver cells
Testosterone	testis	steroid (derivative of cholesterol)	induces and maintains secondary male sexual characteristics
Thyroid hormone	thyroid gland	derivative of the amino acid tyrosine	stimulates metabolism of many cell types