The cell

Dr Shahab
Associate Professor
Anatomy Dept. KGMC.

LEARNING OBJECTIVES

By the end of this lecture students shall be able to:

- Define cell.
- Know Origin of the word “cell”
- Know the cell theory
- Identify different types of cells
- Know the basic structure of cell

What is a cell?

- Cell : a cell is a basic unit of structure and function of life.
- In other words, cells make up living things and carry out activities that keep a living thing alive.

- A cell is a living thing.
- Cells are able to make more cells like themselves.
- Interesting fact! New cells can only come from existing cells (cells that are already made).

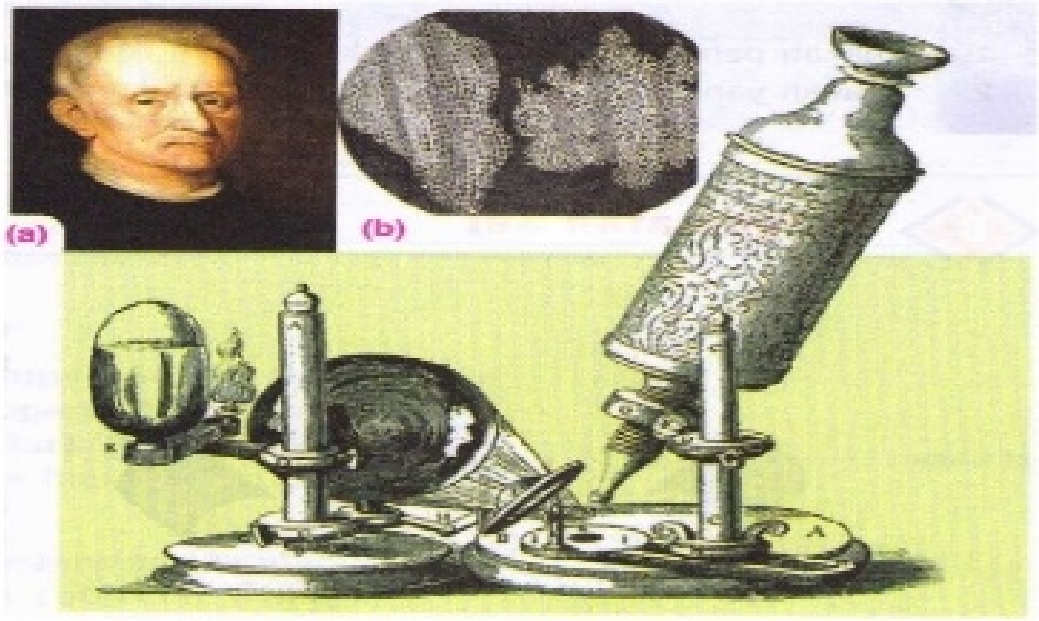
I am sure you are all asking yourselves,

“Who was the first person to look at cells.

- In the 1660s there was a man named *Robert Hooke.*
- Robert lived in Britain and was a scientist. He was the first person to observe cells. Robert took a piece bark from an old oak tree and looked at it through a microscope.
- The bark looked like it was made up of many small rooms (kind of like a house with many bedrooms). He named the rooms, or structures, he saw under the microscope cells.
- THIS IS HOW THE WORD CELLS CAME TO BE!! …….EXCITING STUFF ISN'T IT !!

Discovery of Cells

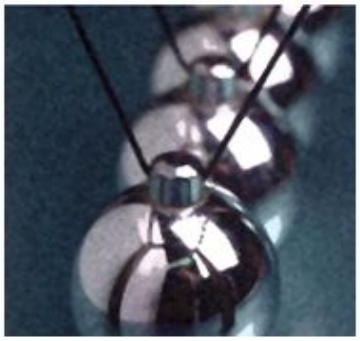
- 1665- English Scientist, **Robert Hooke,** discovered cells while looking at a thin slice of cork.
- He described the cells as tiny boxes or a honeycomb
- He thought that cells only existed in plants and fungi



Theodor Schwann

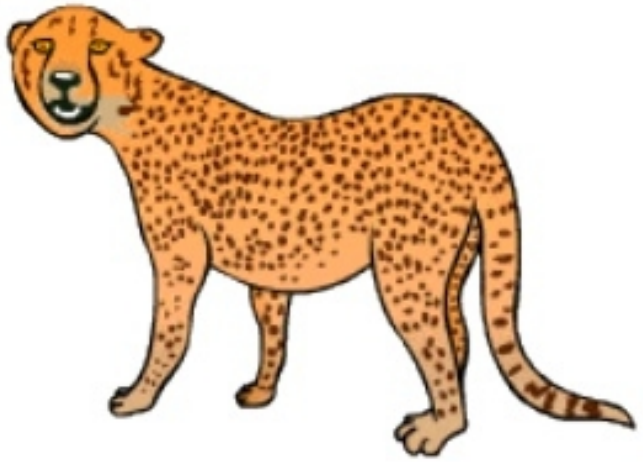
http://www.nndb.com/people/357/000096069/

- Born: December 7, 1810
- Died: January 11, 1882
- German zoologist
- Concluded that all animals are made of cells.
- Contributed to the creation of the cell theory



Development of Cell Theory

Theodor Schwann



All animals were made of cells.

Matthias Schleiden

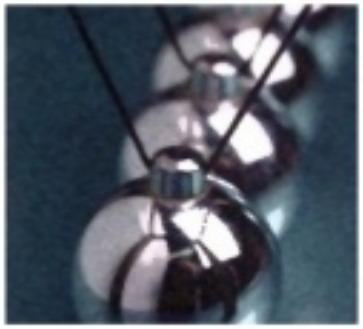
http://www.britannica.com/eb/article-9066147/Mathias-Jacob-Schleiden

- Born: April 5, 1804
- Died: June 23, 1881
- German botanist
- Discovered that all plants were made of cells
- Contributed to the creation of the cell theory

Robert Hooke

- Born: July 18, 1635
- Died: March 3, 1703
- Wrote and published "*Micrographia*"
- Known as the "English Father of Microscopy"

http://www-groups.dcs.st-and.ac.uk/~history/PictDisplay/Hooke.html

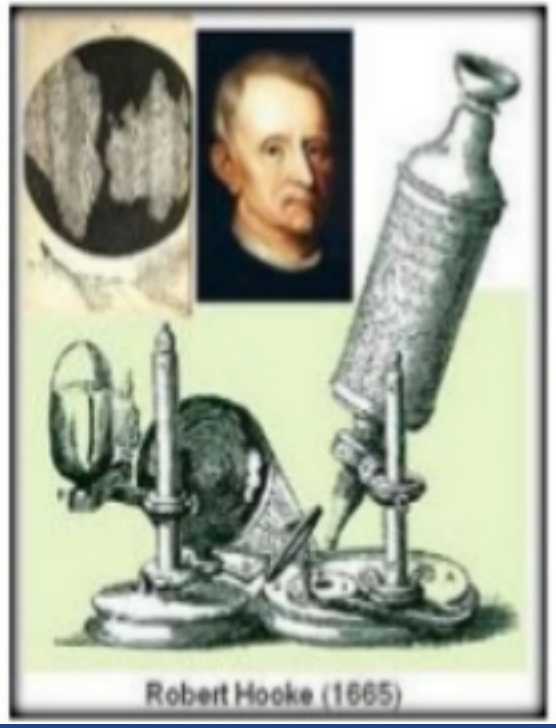


Development of the cell theory:

Robert Hooke in 1663, observed cork (plant): named the cell

Robert Brown observed and named nucleus

Theodor Schwann in 1800's states: all animals are made of cells



CELL THEORY:

1. All living things are composed of cells.
2. Cells are the basic units of structure and function in living things.
3. All cells are produced from other cells.

Development of the Cell Theory

Matthias Schleiden in 1800's states: all plants are made of cells

Louis Pasteur's work with bacteria ~ 1860 disproved idea of spontaneous generation (living things from nonliving)

Rudolf Virchow observes cells dividing and states all cells come from preexisting cells

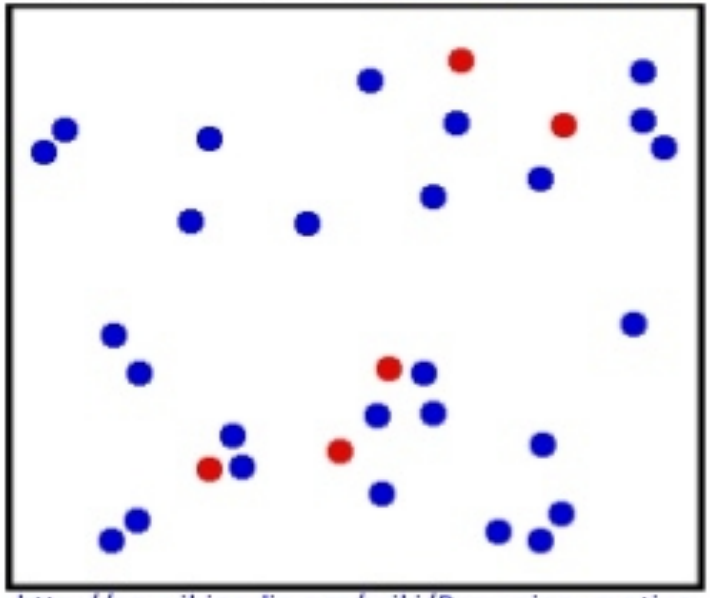
1833

Robert Brown **names** the **cell nucleus**.

Cells are the smallest units of life.

Robert Brown: http://en.wikipedia.org/wiki/Robert_Brown_(botanist)

He also discovered Brownian motion:



http://en.wikipedia.org/wiki/Brownian_motion

Developing the Cell Theory

- Matthias **Schleiden**: all plants were made of cells (1838)
- Theodor **Schwann**: all animals were made of cells (1839).
- Rudolph **Virchow**: new cells were created only from division of pre-existing cells (1855).

- These discoveries led to the cell theory.

Theodore Schwann

Matthias Schleiden

Development of Cell Theory

Robert Brown

Noticed small, dense centers in cells (nucleus), but function was not known

1839 German physiologist Theodor Schwann, after a lovely dinner with his mate Schleiden and a chat about nuclei, realised that animals were comprised of cells too and stated: **"All living things are composed of cells and cell products"**

He was also responsible for the discovery of Schwann cells in the PNS, pepsin in the gut, the fact that yeast is organic… and he made up the word 'metabolism'. What a legend! Or, as they say in German, *legende!*

http://en.wikipedia.org/wiki/File:Schwann_Theodore.jpg

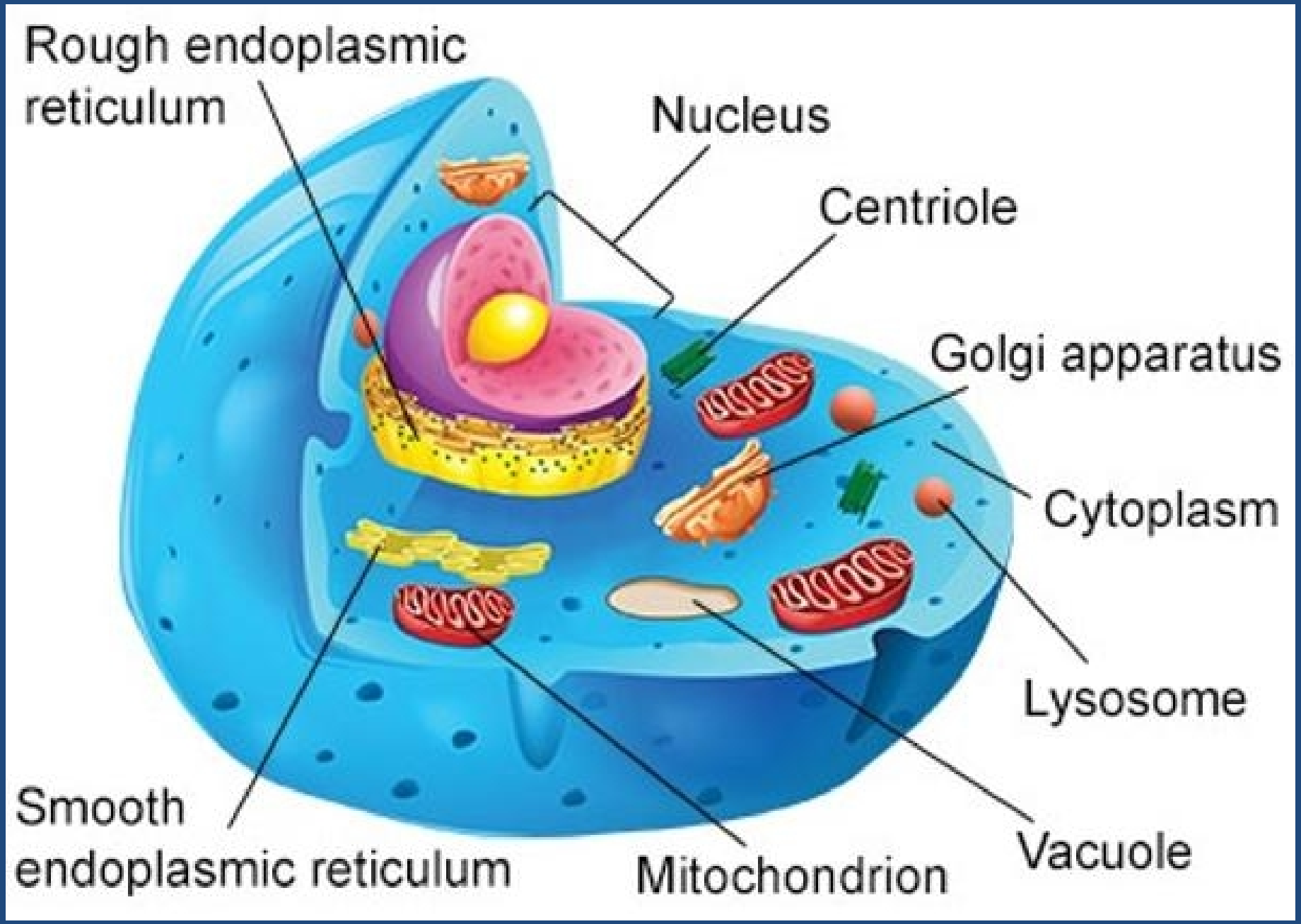
I. The Development of the Cell Theory

1. Robert Hooke (1665) - observed cork

2. Anton van Leeuwenhoek (1673) saw microscopic life - blood cells, single cell organisms

3. Mathias Schleiden, Botanist & Theodor Schwann, Zoologist, (1839) published their cell theory …"The cells are organisms, and animals as well as plants are aggregates of these organisms arranged in accordance with definite laws."

4. Rudolph Virchow (1858) "omnis cellula e cellula" - -all cells come from cells


Rough endoplasmic reticulum
Nucleus
Centriole
Golgi apparatus
Cytoplasm
Lysosome
Vacuole
Mitochondrion
Smooth endoplasmic reticulum

Cell composition

Protoplasm - The term ″protoplasm,″ from proto, first, and plasma, formed substance, was coined by the botanist *Hugo von Mohl*, in 1846, for the ″tough, slimy, granular, semi-fluid“ -

It was used 1839 by Czech physiologist *Johannes Evangelista Purkinje* (1787-1869) to denote the gelatinous fluid found in living cell. - Compose of inorganic and organic compounds like carbohydrates, proteins, lipids and nucleic acids

Cell Membrane/ Plasma membrane / plasmolemma:

Bi-lipid layer

- Semi permeable
- Serves as boundary between the outside environment and the inside environment
- Outer membrane of cell that controls movement in and out of the cell

Fluid mosaic model – (S.J. Singer and Garth Nicolson in 1972)

fluid because of its hydrophobic components

- such as lipids and membrane proteins that move laterally or sideways throughout the membrane. That means the membrane is not solid, but more like a fluid.-mosaic that is made up of many different parts the plasma membrane is composed of different kinds of macromolecules

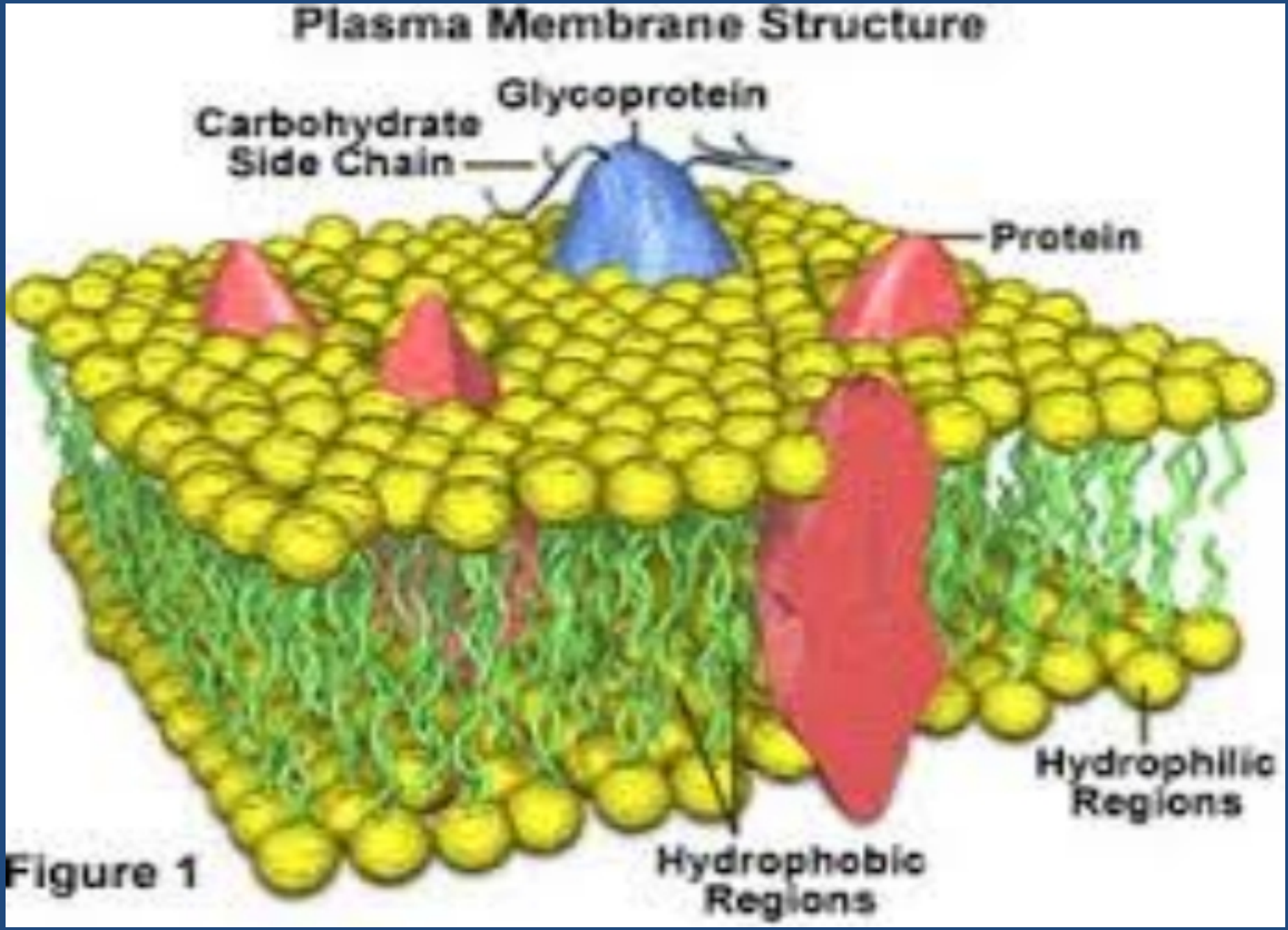
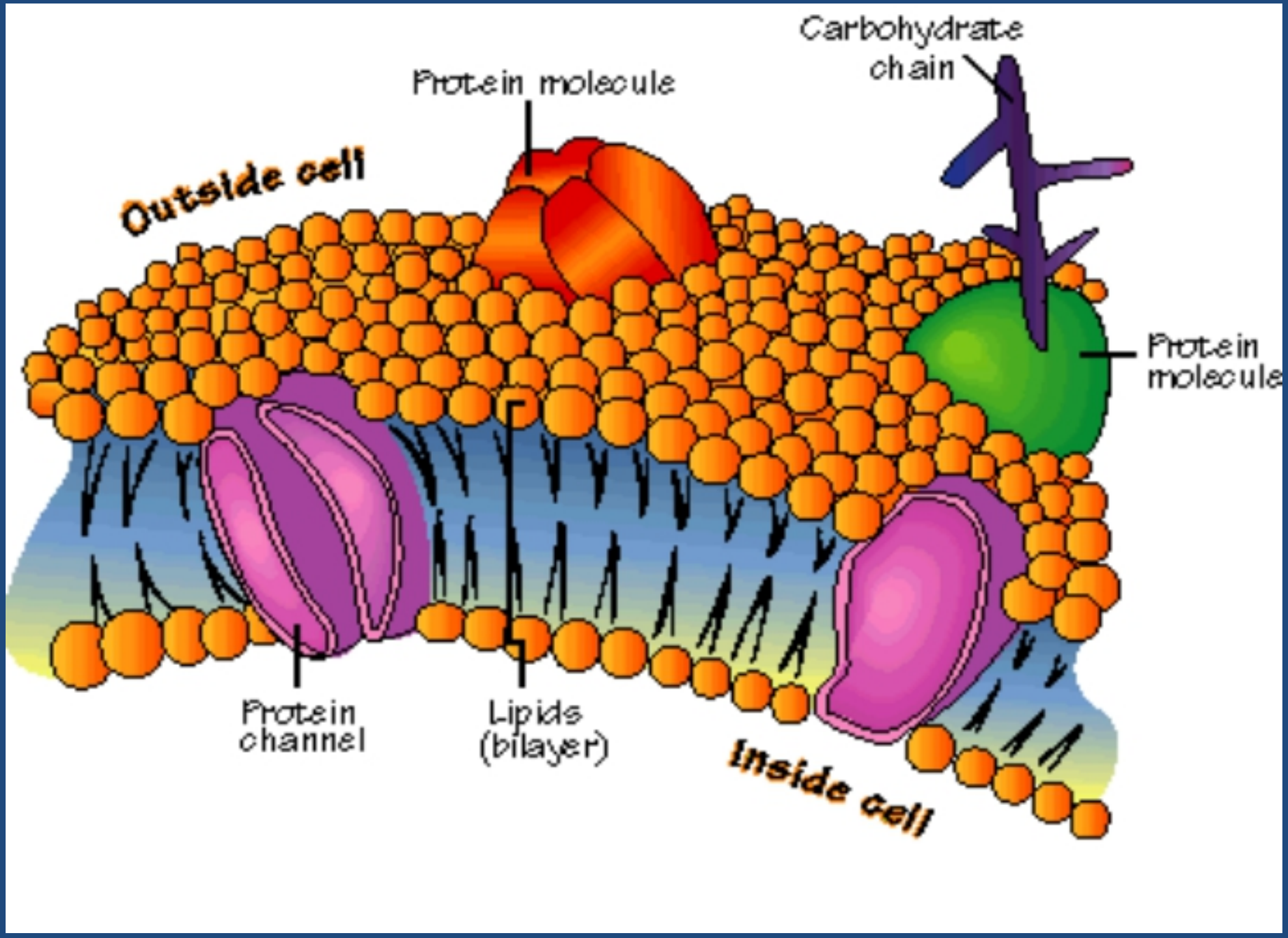

Plasma Membrane Structure
Glycoprotein
Carbohydrate
Side Chain
Protein
Hydrophilic
Regions
Hydrophobic
Regions

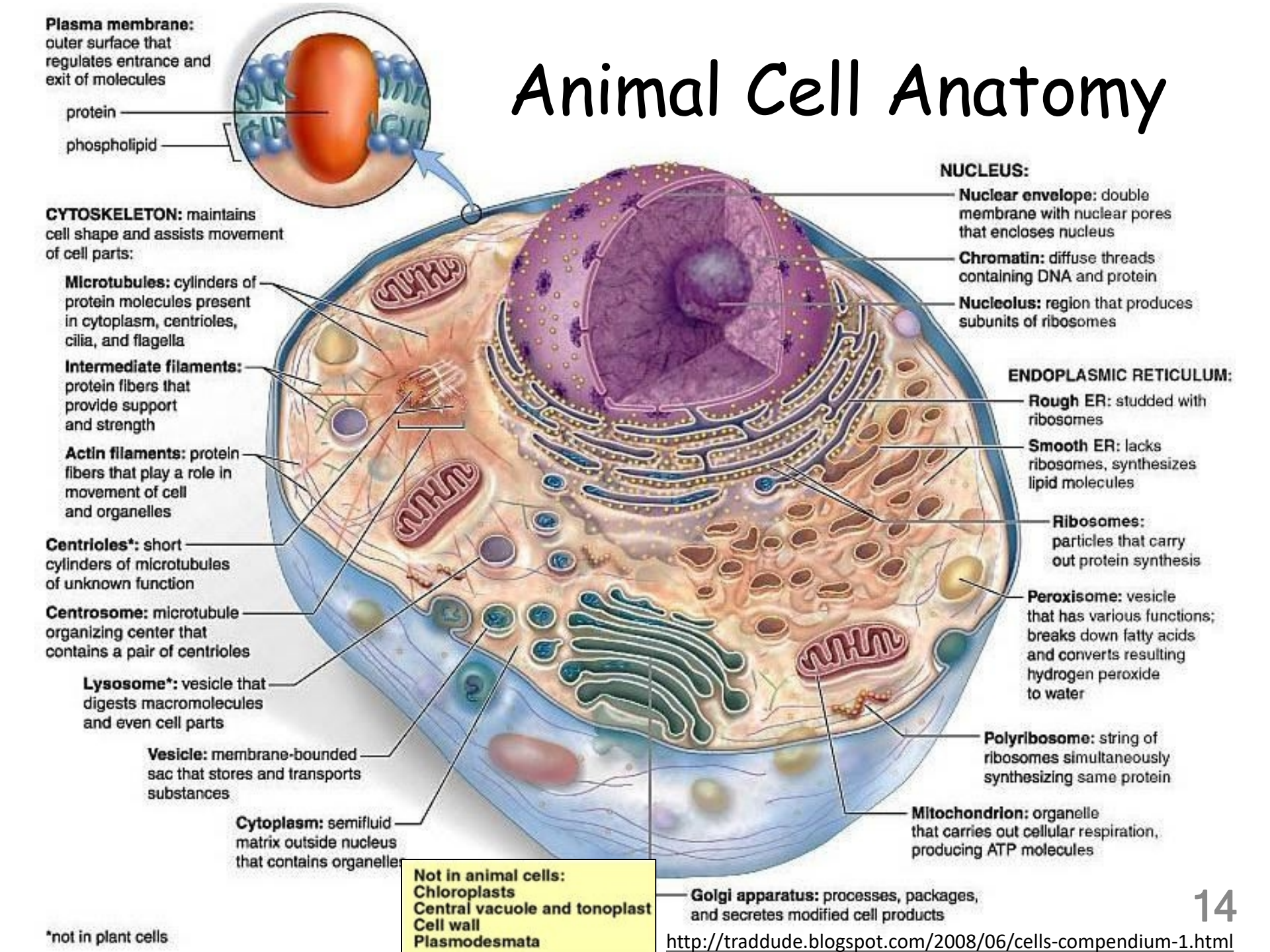
Figure 1


Carbohydrate chain
Protein molecule
Outside cell
Protein molecule
Protein channel
Lipids (bilayer)
Inside cell

Cell Vocabulary

- Unicellular: one cell
- Multicellular: more than one cell
- Prokaryote: cells that do not have defined cell organelles or nuclei
- Eukaryote: cells that do have defined cell organelles and nuclei

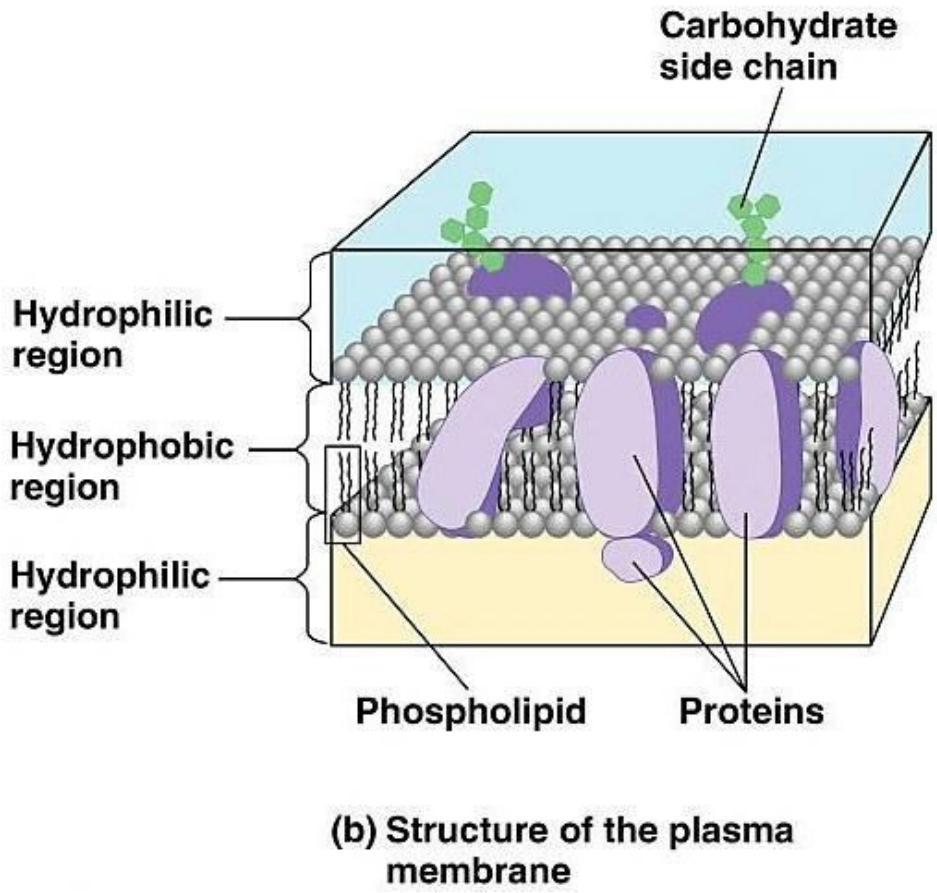
Animal Cell Anatomy



http://traddude.blogspot.com/2008/06/cells-compendium-1.html

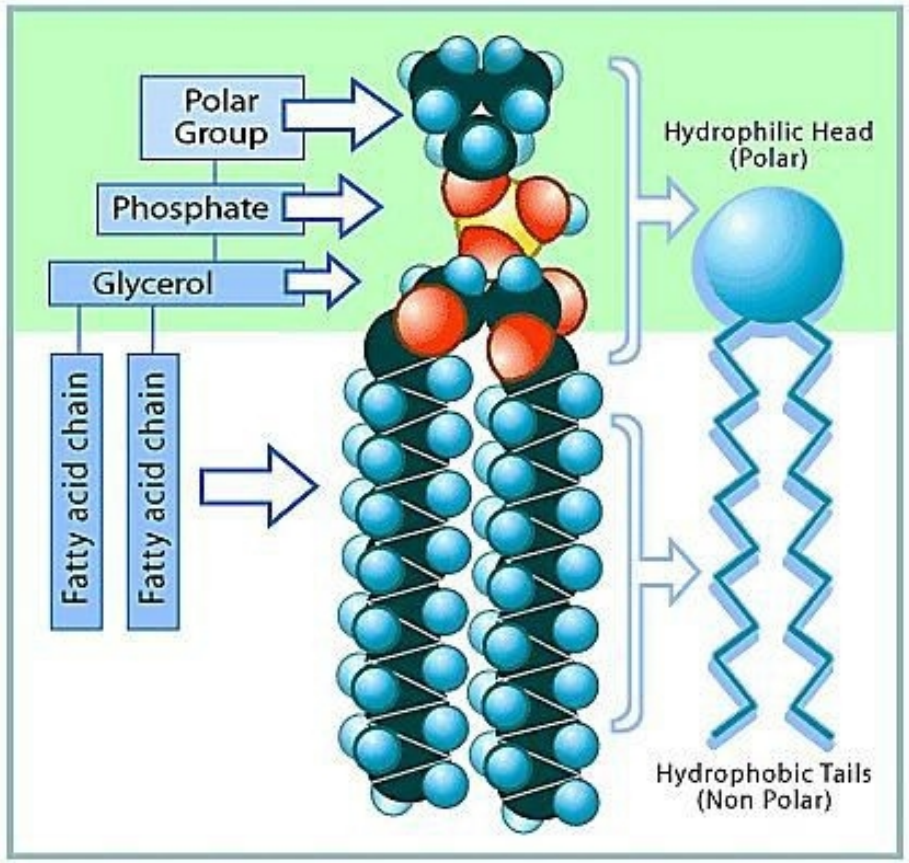
Plasma membrane

- Fluid mosaic model
  - Phospholipid bilayer acts more like a fluid than a liquid
- Contains integral and peripheral proteins
- Semi permeable membrane
- Like a city border they surround the cell and are able to regulate entrance and exit

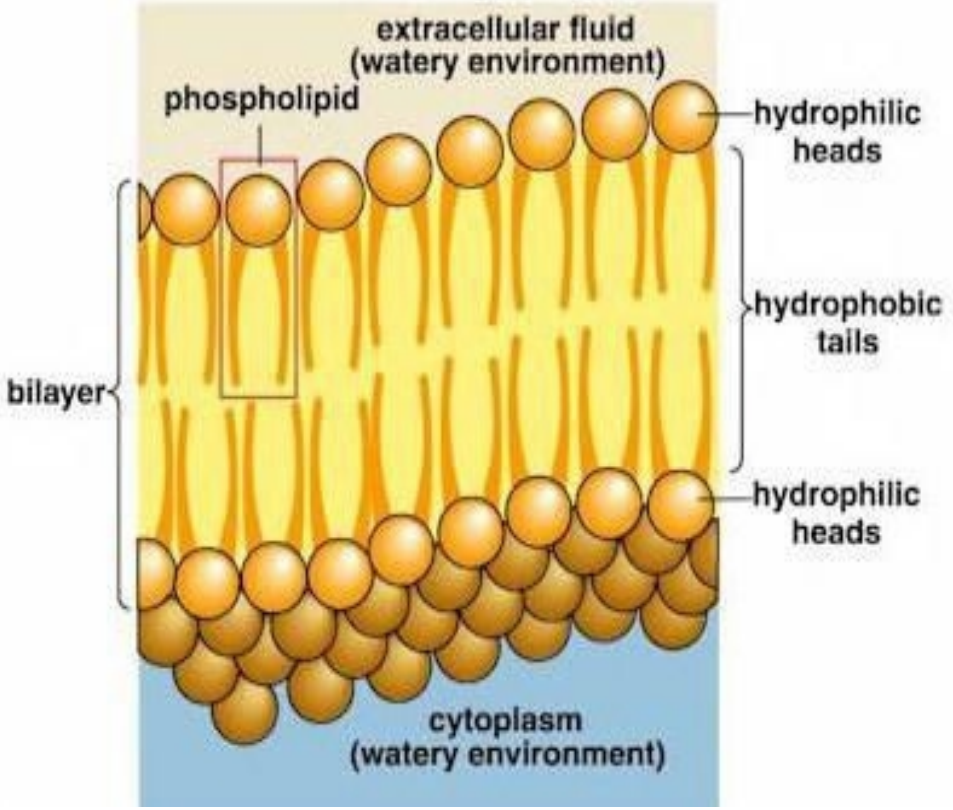


Campbell *et al*, Biology; 2009.

Phospholipid bilayer

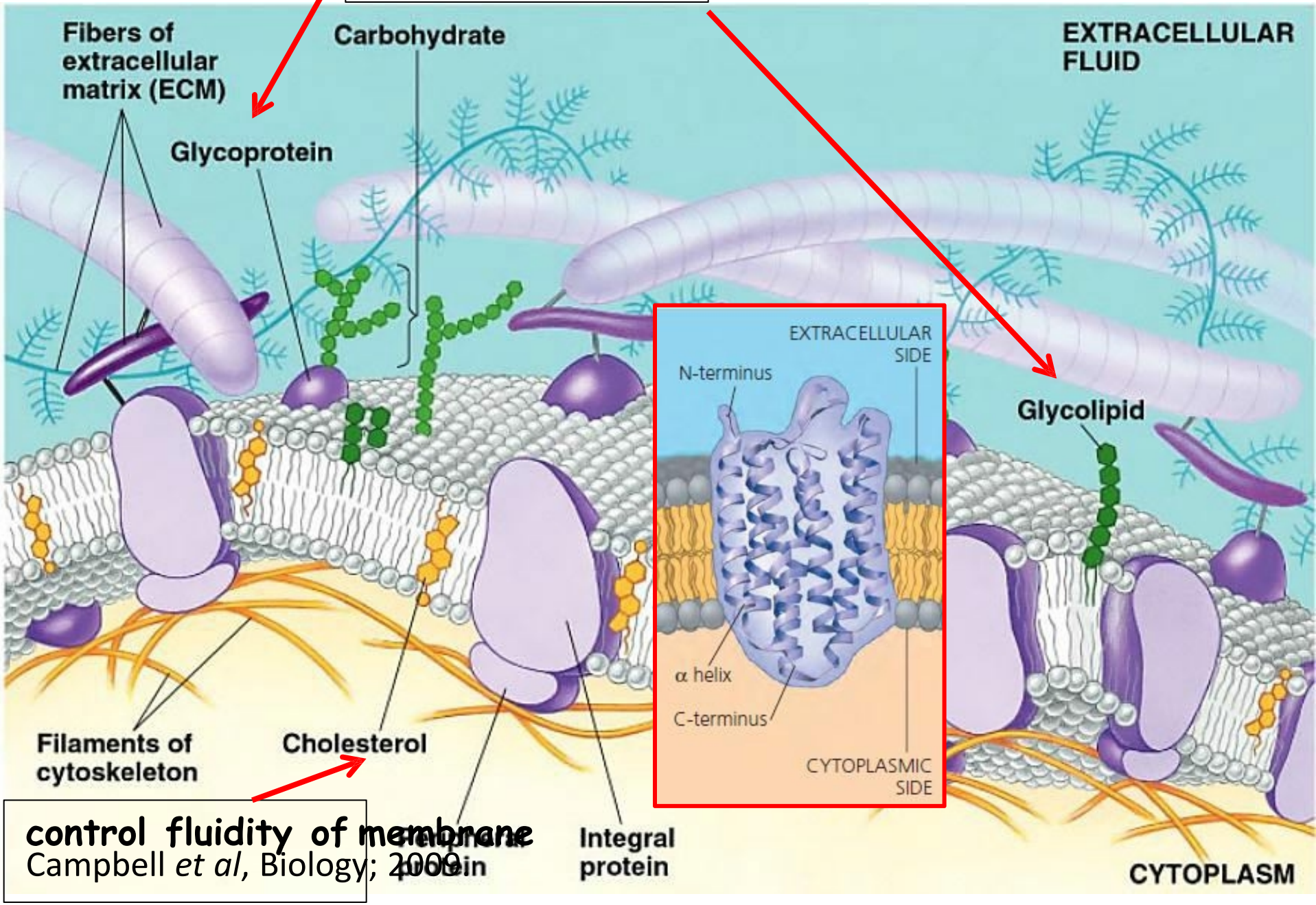


http://alevelnotes.com/content_images/i38_phospholipid.gif



http://online.morainevalley.edu/WebSupported/BIO111-Gibbons/membra29.jpg

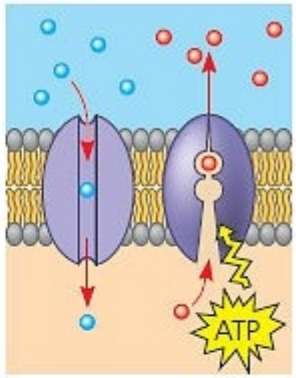
- polar heads face outward towards the watery environments both inside and outside the cell
- non polar tails face inward away from the watery environment



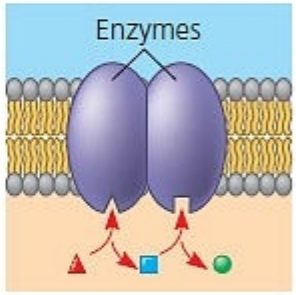
Campbell *et al*, Biology; 2009

Function of membrane protein

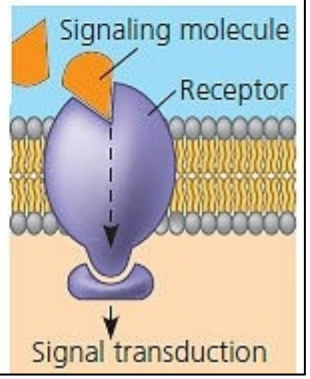
(a) Transport. *Left:* A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute. *Right:* Other transport proteins shuttle a substance from one side to the other by changing shape (see Figure 7.17). Some of these proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.



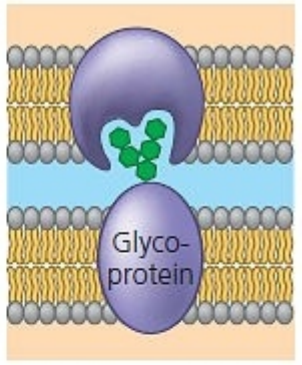
(b) Enzymatic activity. A protein built into the membrane may be an enzyme with its active site exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane are organized as a team that carries out sequential steps of a metabolic pathway.



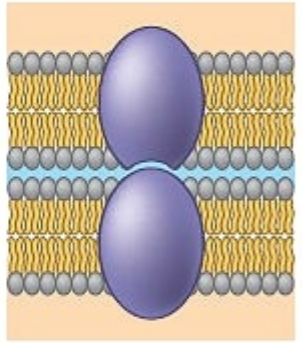
(c) Signal transduction. A membrane protein (receptor) may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external messenger (signaling molecule) may cause the protein to change shape, allowing it to relay the message to the inside of the cell, usually by binding to a cytoplasmic protein (see Figure 11.6).



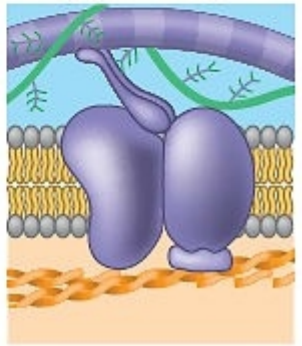
(d) Cell-cell recognition. Some glycoproteins serve as identification tags that are specifically recognized by membrane proteins of other cells. This type of cell-cell binding is usually short-lived compared to that shown in (e).



(e) Intercellular joining. Membrane proteins of adjacent cells may hook together in various kinds of junctions, such as gap junctions or tight junctions (see Figure 6.32). This type of binding is more long-lasting than that shown in (d).

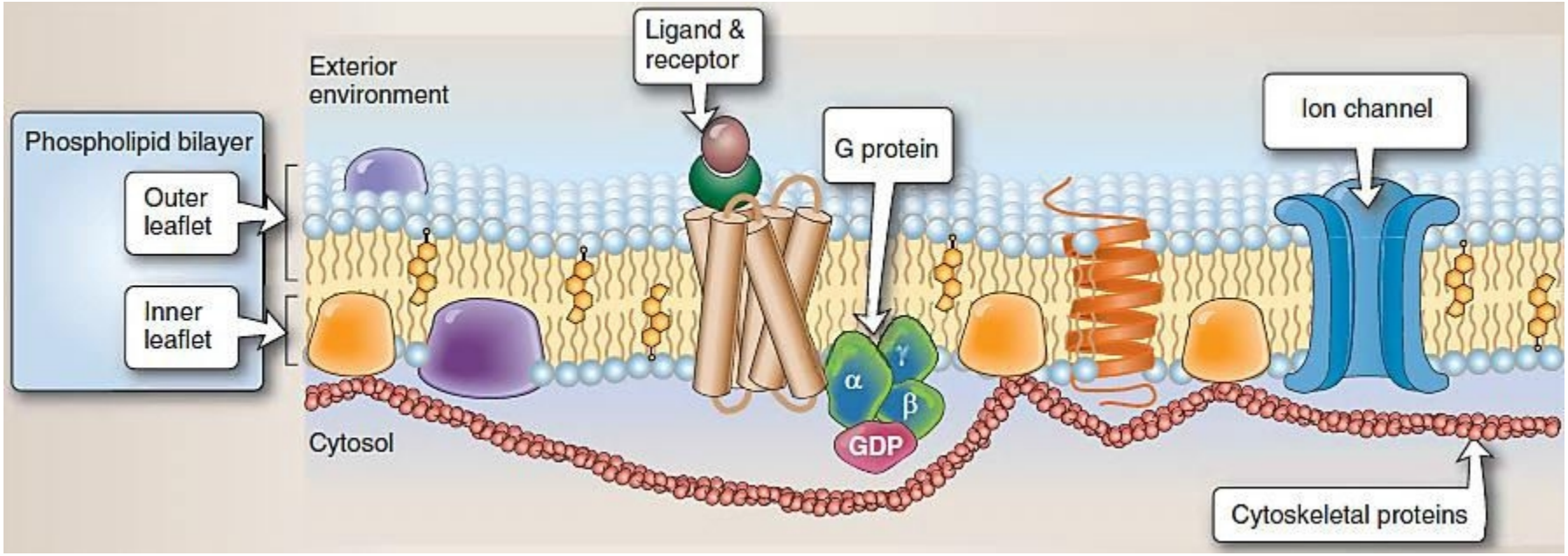


(f) Attachment to the cytoskeleton and extracellular matrix (ECM). Microfilaments or other elements of the cytoskeleton may be noncovalently bound to membrane proteins, a function that helps maintain cell shape and stabilizes the location of certain membrane proteins. Proteins that can bind to ECM molecules can coordinate extracellular and intracellular changes (see Figure 6.30).



Campbell *et al*, Biology; 2009.

Function of membrane protein



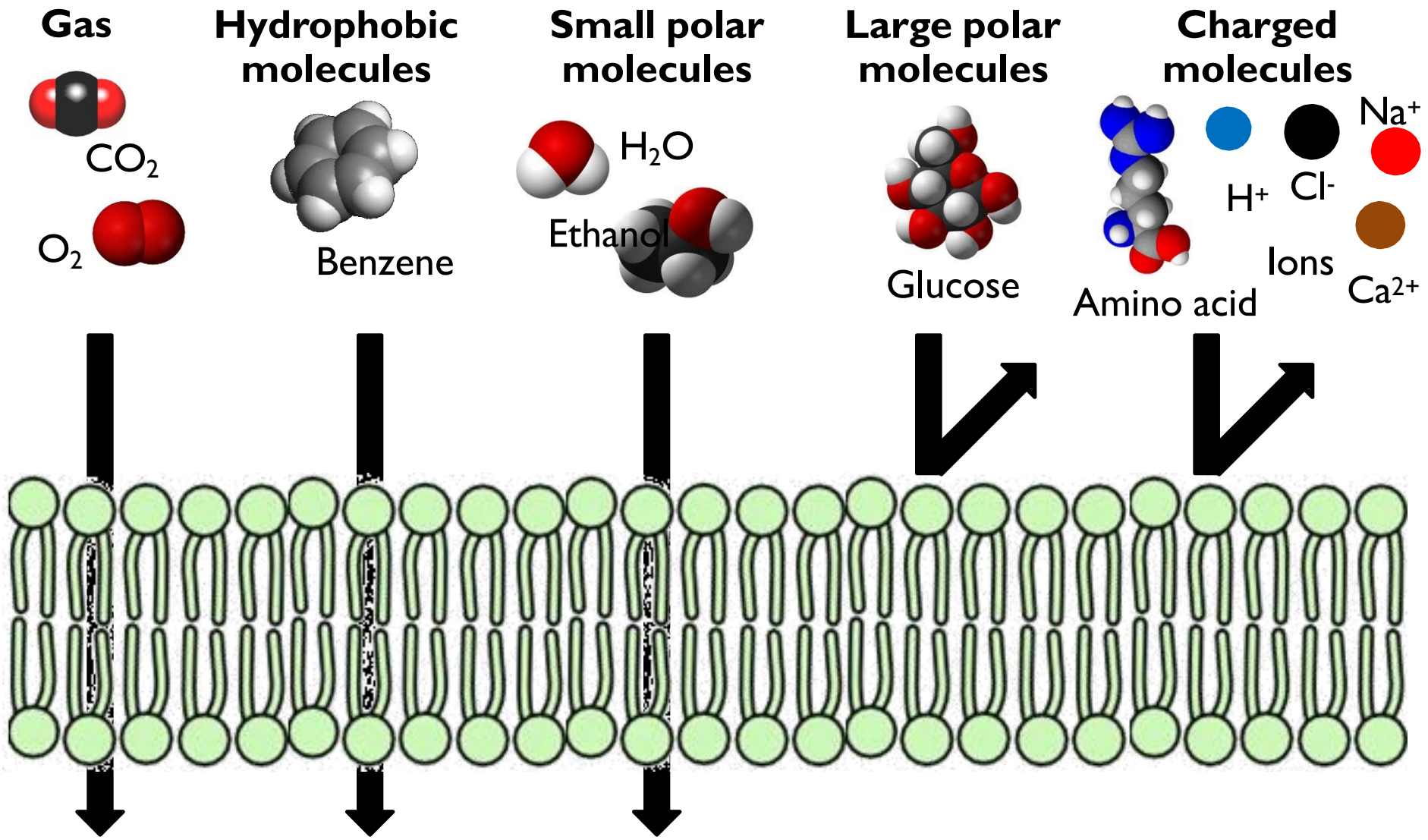
Chandar *et al*, Lippincott's Illustrated Reviews: Cell and Molecular Biology; 2010.

- Enzyme
- Mediate the passage of ions and most biological molecule
- Selective traffic of molecule
- Control the interactions between cells of multicellular organisms
- Serve as sensor (e.g. receptors, signal transductions)

Transport through membrane

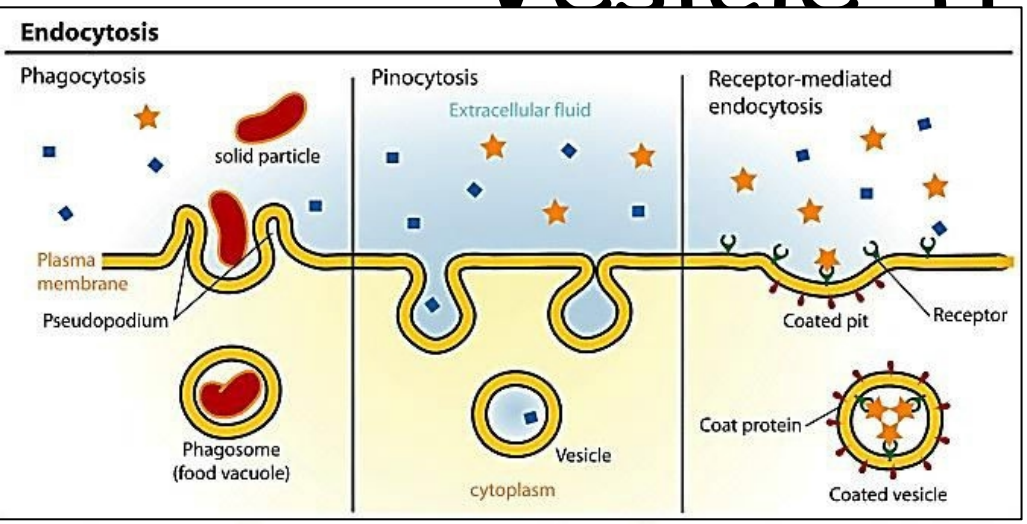
- Passive transport: need no energy, downhill
  - simple diffusion
  - facilitated diffusion: channel protein, carrier protein
- Active transport: need energy, uphill
  - primary active : direct hydrolysis of ATP
  - secondary active : symporters, antiporters
- Vesicle transport
  - endocytosis: receptor mediated, phagocytosis, pinocytosis
  - exocytosis

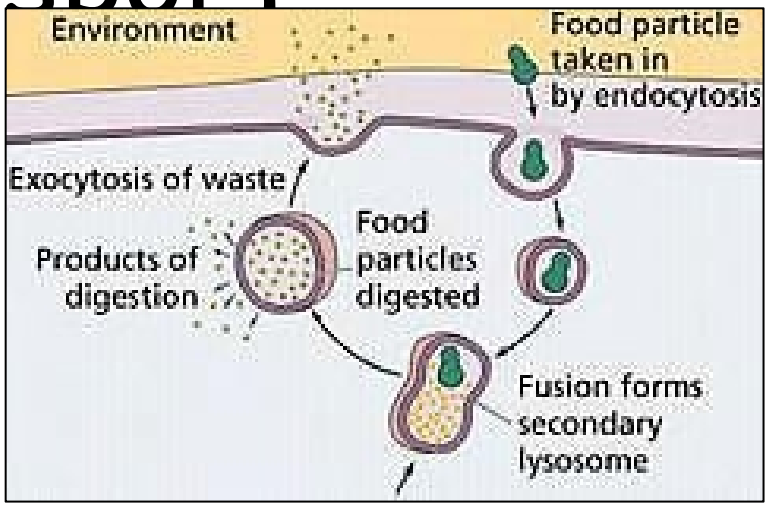
External environment



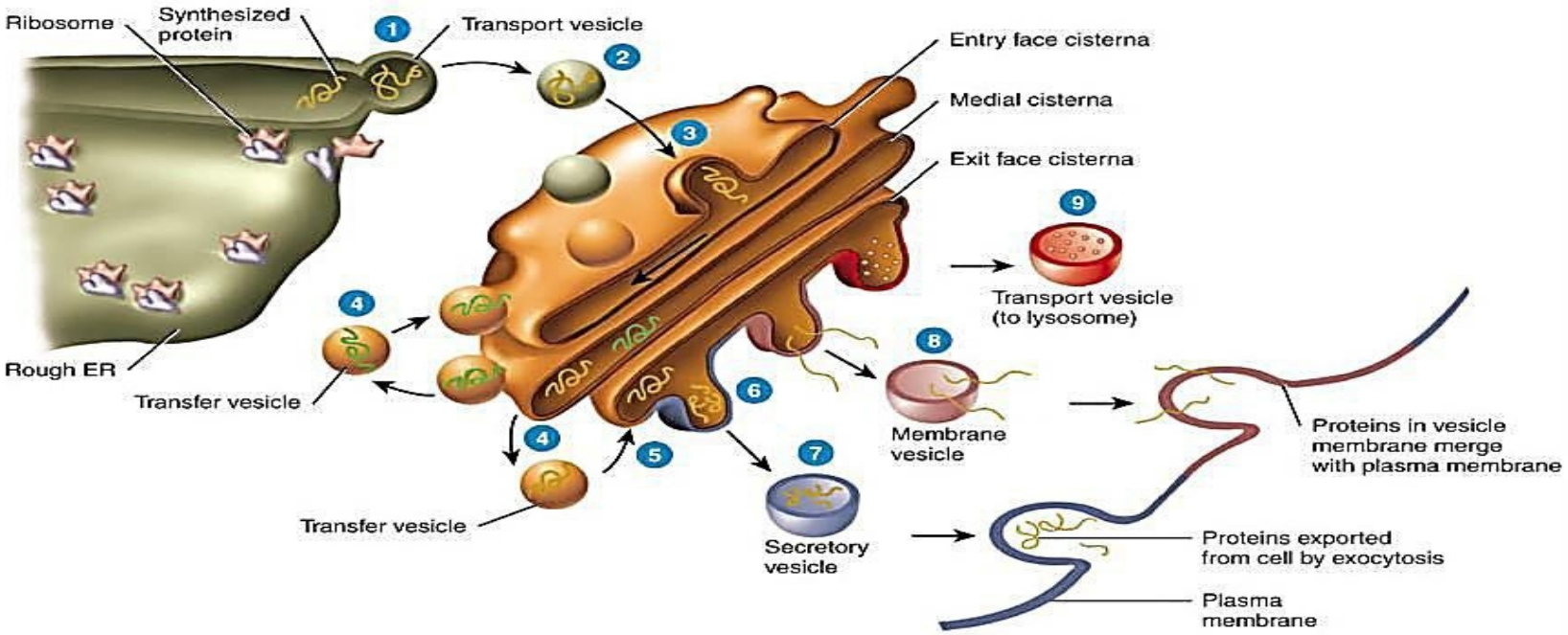
Cytoplasm

Vesicle Transport

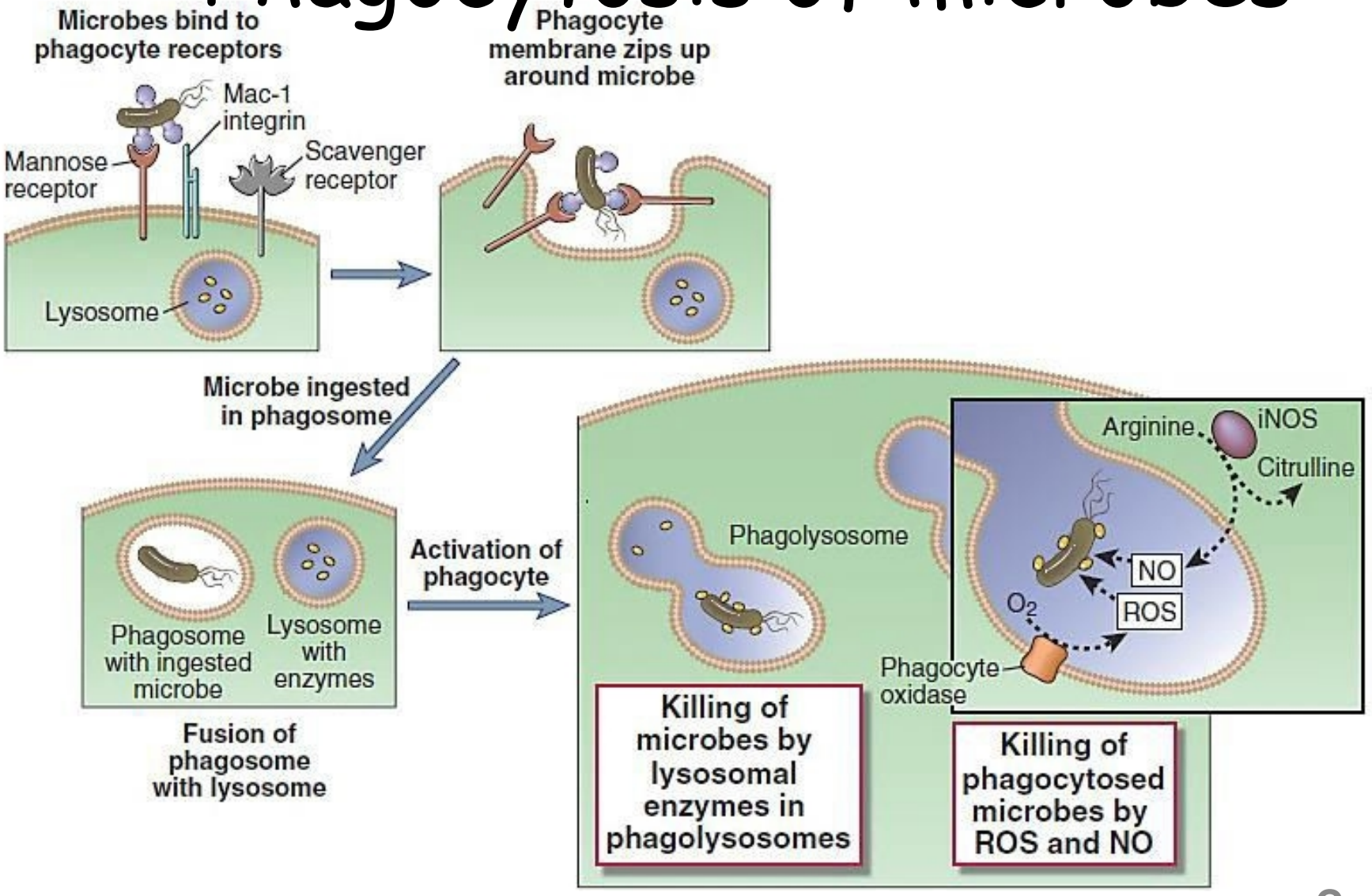




All proteins exported from the cell are processed in the Golgi complex.



Phagocytosis of microbes



Abbas *et al*, Cellular and Molecular Immunology; 2012.

Table 6.1 Characteristics of Transport Mechanisms

Characteristic	Passive Transport		Active Transport
	Simple Diffusion	Facilitated Diffusion	
Membrane component responsible for transport	Lipids	Proteins	Proteins
Binding of transported substance	No	Yes	Yes
Energy source	Concentration gradients	Concentration gradients	ATP hydrolysis or concentration gradients
Direction of transport	With gradient of transported substance	With gradient of transported substance	Against gradient of transported substance
Specificity for molecules or molecular classes	Nonspecific	Specific	Specific
Saturation at high concentrations of transported molecules	No	Yes	Yes

Russell *et al*, Biology the dynamic science; 2008.


Thank You!