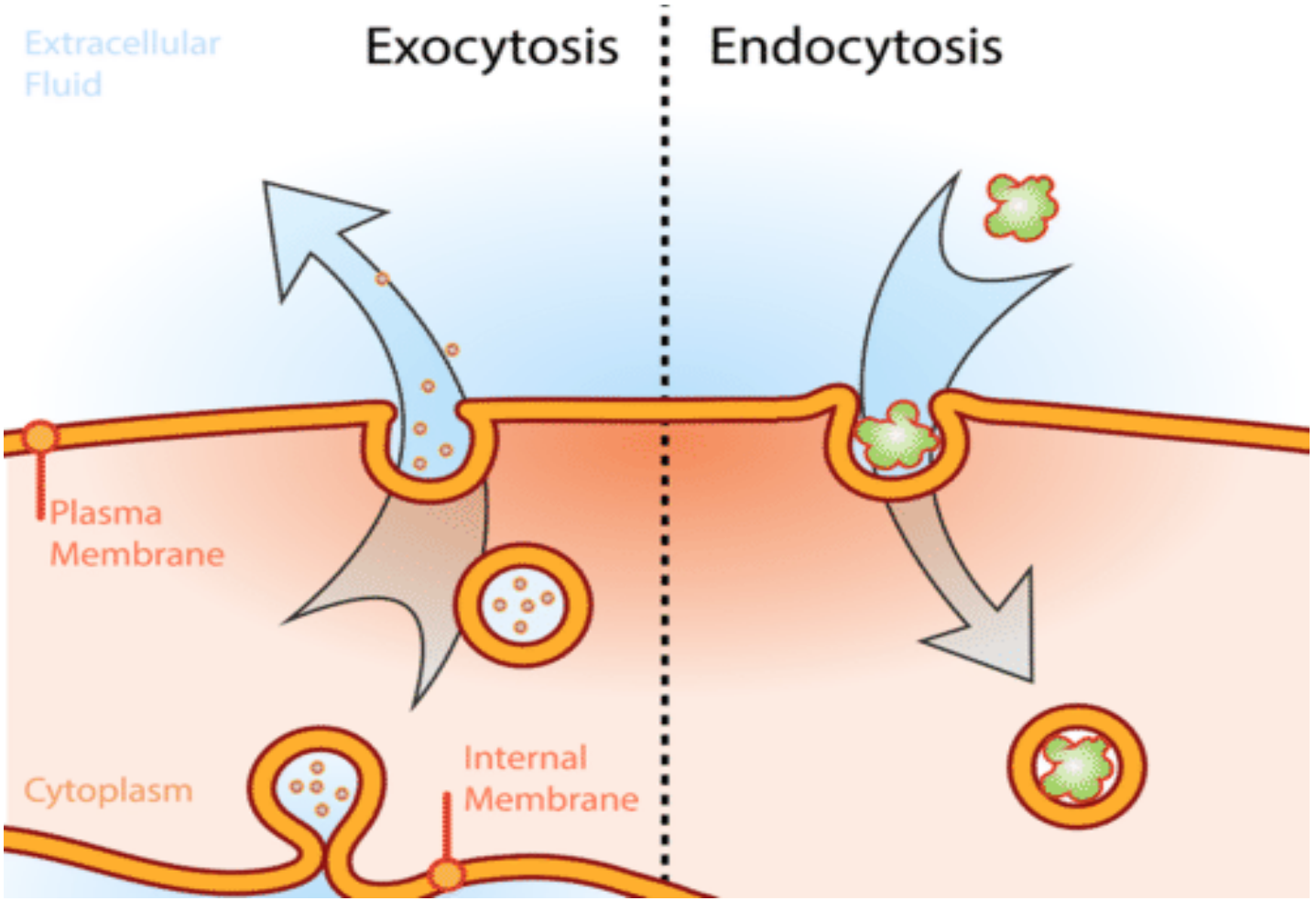
Endocytosis & Exocytosis

Dr. S.D. Saraswathy
Assistant Professor
Department of Biomedical Science
Bharathidasan University, Tiruchirappalli

Endocytosis & Exocytosis



Endocytosis & Exocytosis

- The movement of macromolecules such as proteins or polysaccharides into or out of the cell is called bulk transport.
- **This bulk transport across the plasma membrane occurs by exocytosis and endocytosis**
- Both require the expenditure of energy (ATP).
- Small molecules and water enter or leave the cell through the lipid bilayer or by transport proteins.
- Large molecules, such as polysaccharides and proteins, cross the membrane via vesicles.

Endocytosis

- During endocytosis, a cell brings in macromolecules and particulate matter by forming new vesicles from the plasma membrane.
- Endocytosis is a reversal of exocytosis, although different proteins are involved in the two processes.
  - A small area of the plasma membrane sinks inward to form a pocket.
  - As the pocket deepens, it pinches in to form a vesicle containing the material that had been outside the cell.

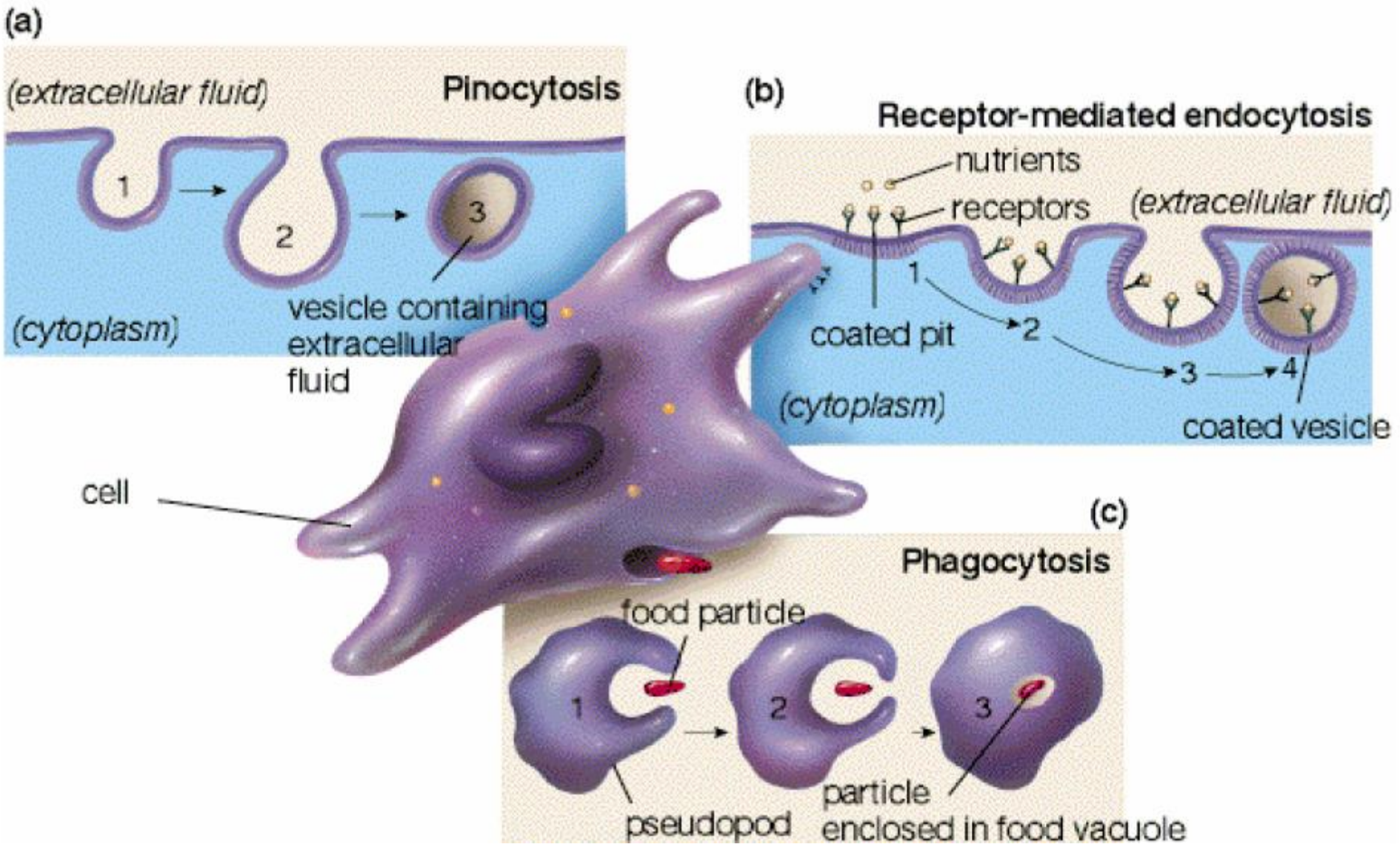
Types of Movement Across Membranes:

1) Passive Transport
2) Active Transport
3) Endocytosis
   - Movement of large particles into cells (vesicle formation)
     1) Pinocytosis ("cell drinking")
        - Uptake of fluid droplets
     2) Receptor-mediated Endocytosis:
        - Uptake of specific molecules via coated pits
     3) Phagocytosis ("cell eating")
        - Uptake of large particles (e.g. bacteria)

Endocytosis

- There are three types of endocytosis: phagocytosis (“cellular eating”), pinocytosis (“cellular drinking”), and receptor-mediated endocytosis.
- In phagocytosis, the cell engulfs a particle by extending pseudopodia around it and packaging it in a large vacuole.
- The contents of the vacuole are digested when the vacuole fuses with a lysosome.

Endocytosis:



Endocytosis

- **In pinocytosis,** a cell creates a vesicle around a droplet of extracellular fluid. All included solutes are taken into the cell in this nonspecific process.

  Ex: Uptake of Albumin by cells

- Receptor-mediated endocytosis allows greater specificity, transporting only certain substances.
- This process is triggered when extracellular substances, or ligands, bind to special receptors on the membrane surface.
- The receptor proteins are clustered in regions of the membrane called coated pits, which are lined on their cytoplasmic side by a layer of coat proteins.

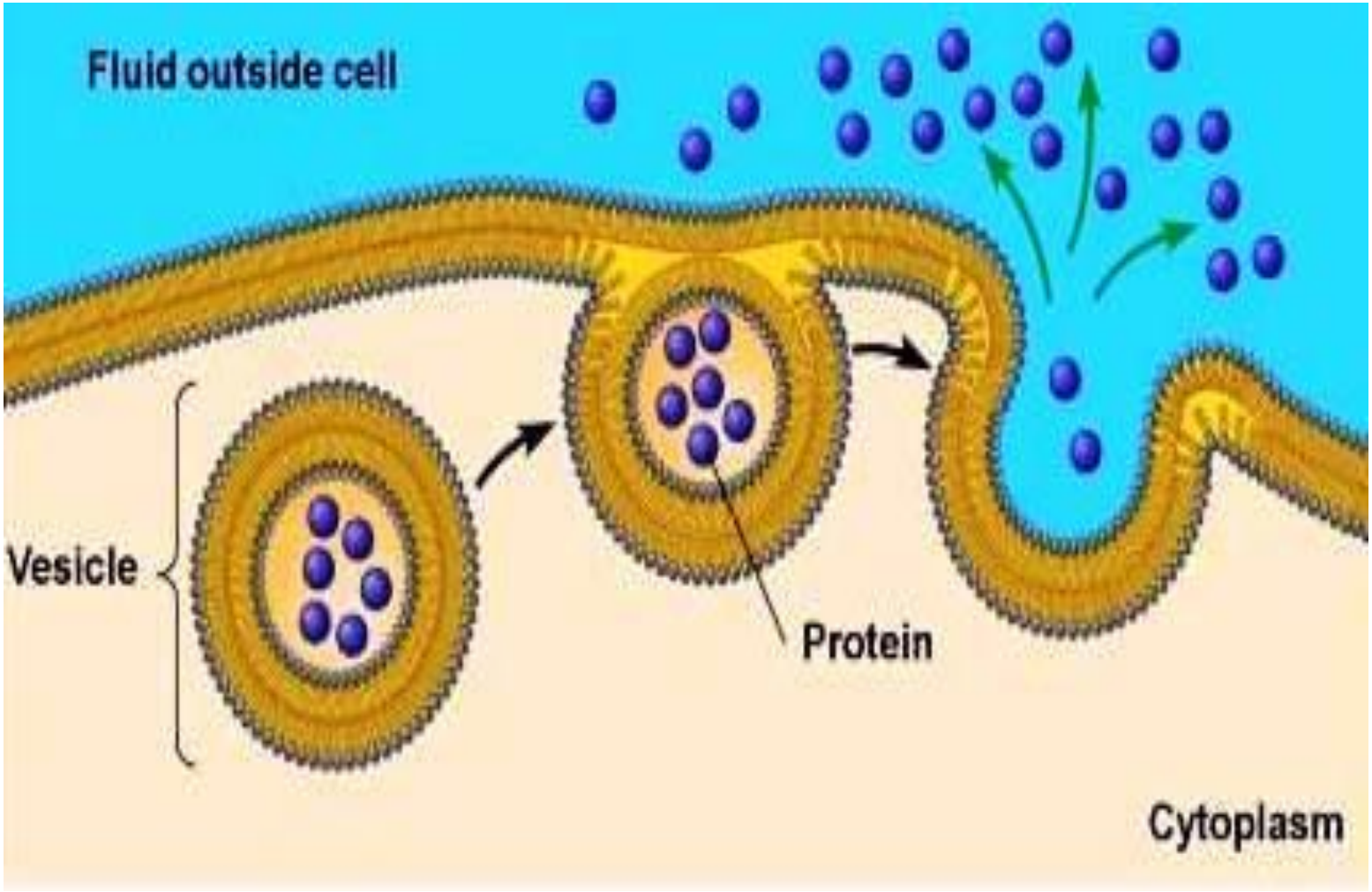
Endocytosis

- **Receptor-Mediated Endocytosis**. This process is similar to phagocytosis, except that the cell uses receptor proteins embedded within the cell membrane.
- These proteins target specific molecules or substances, attracting then seizing hold of them and pulling them into the cell within a fold of the cell membrane.

Exocytosis

- **Exocytosis** and its counterpart, endocytosis, are used by all cells because most chemical substances **important** to them are large polar molecules that cannot pass through the hydrophobic portion of the cell membrane by passive means.
- **Exocytosis** is a process by which a cell transports secretory products through the cytoplasm to the plasma membrane. Secretory products are packaged into transport vesicles (membrane-bound spheres).

Exocytosis:

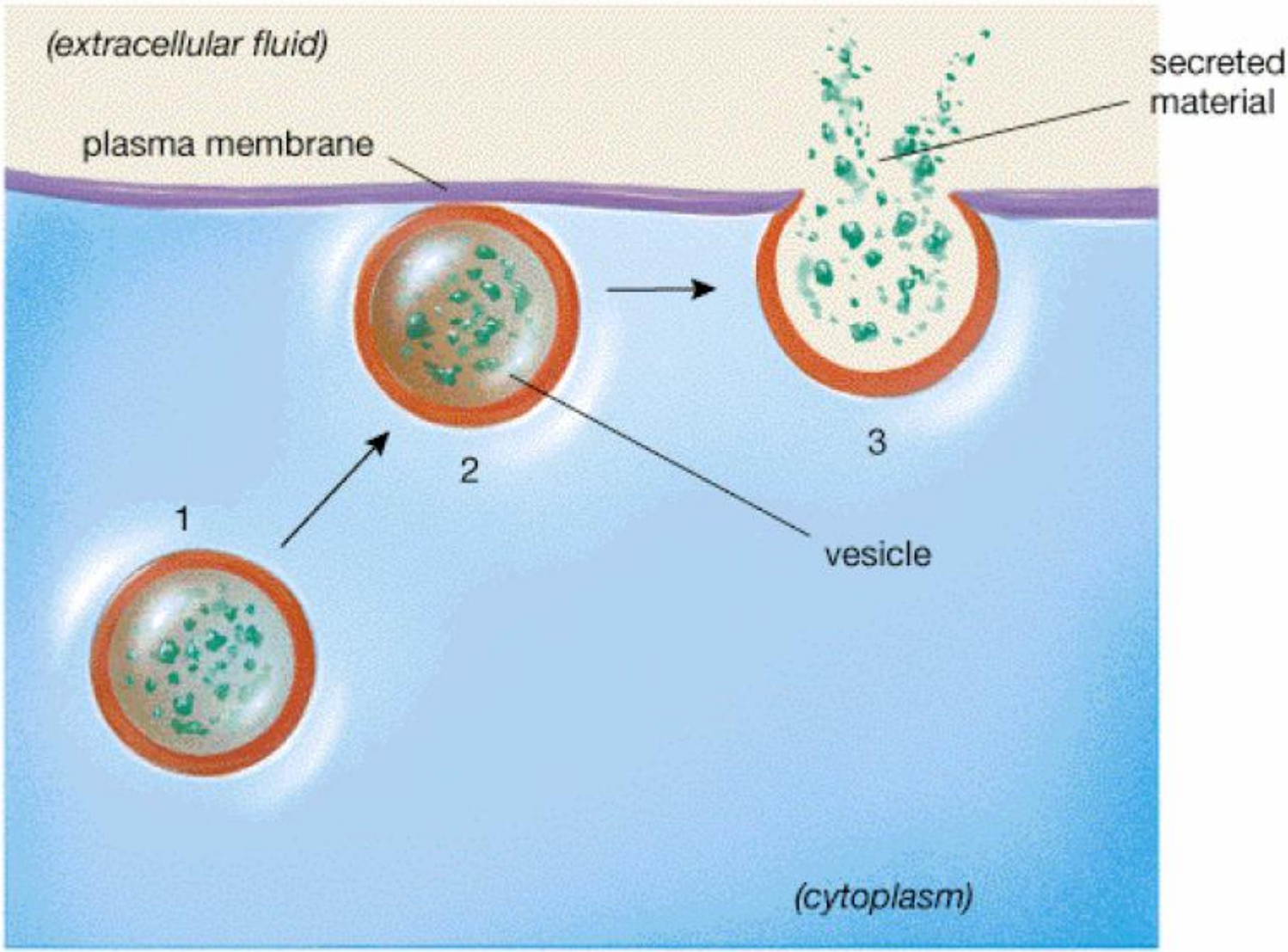


Exocytosis

- **Exocytosis** is the cellular process in which intracellular vesicles in the cytoplasm fuse with the plasma membrane and **release** or "secrete" their contents into the extracellular space.

- In **exocytosis**, materials are exported out of the cell via secretory vesicles (e.g. Hormones).
- It also require the expenditure of energy (ATP).
- At the level of the cellular components and organelles involved in the process of exocytosis are : **ribosomes**, **endoplasmic reticulum**, **Golgi** apparatus, **vesicles** (transport and **secretory**)

Exocytosis:

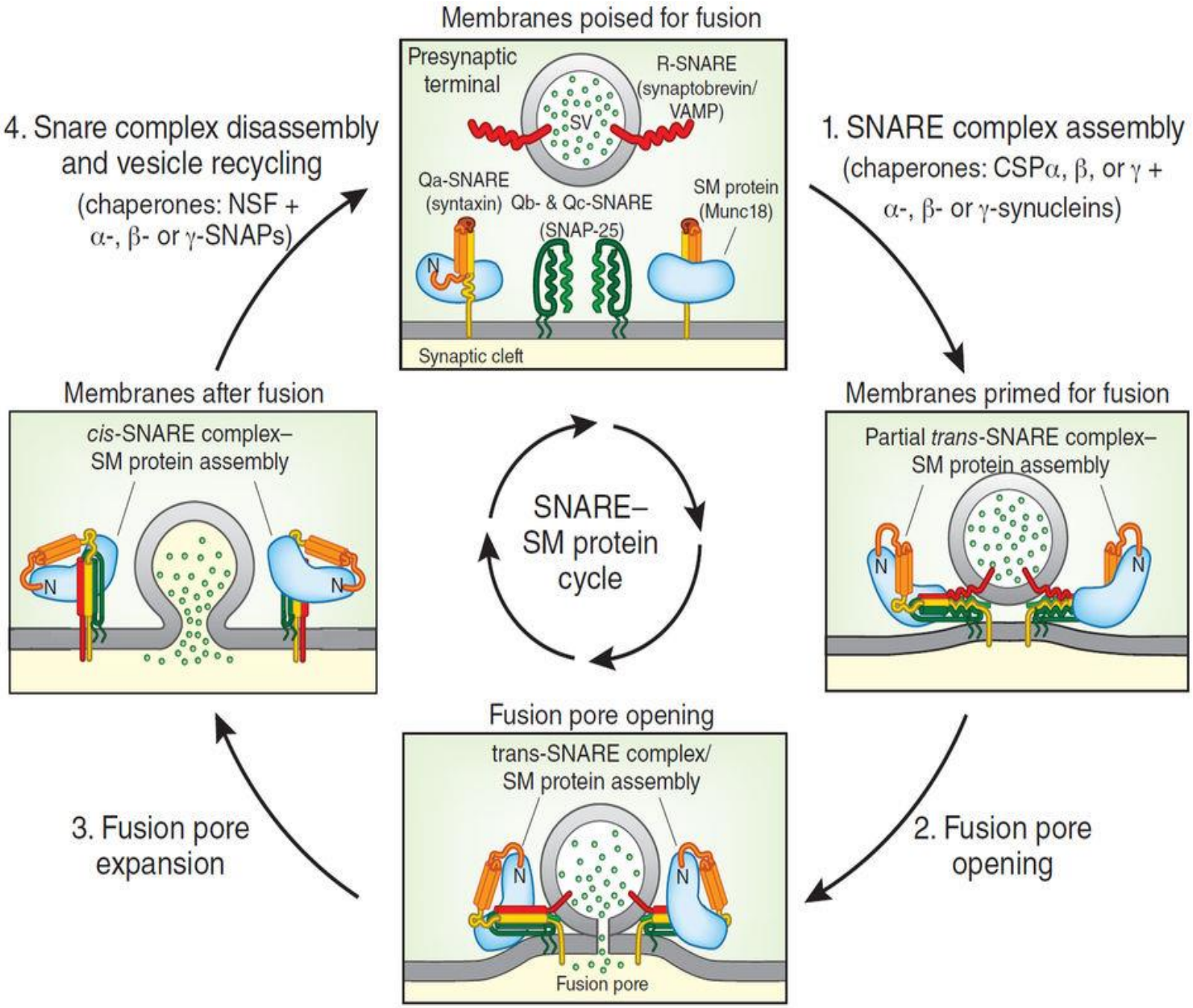

(extracellular fluid)
plasma membrane
secreted material
1
2
3
vesicle
(cytoplasm)

Exocytosis

- Secretory products are packaged into transport vesicles (membrane-bound spheres).
- In this process, the Golgi complex packages macromolecules into transport vesicles that travel to and fuse with the plasma membrane. This fusion causes the vesicle to spill its contents out of the cell.
- **Exocytosis** can be constitutive (occurring all the time) or regulated.
- For **example** a few of the processes that use **exocytosis** are: secretion of proteins like enzymes, peptide hormones and antibodies from cells. Turnover of plasma membrane.

Steps of Exocytosis

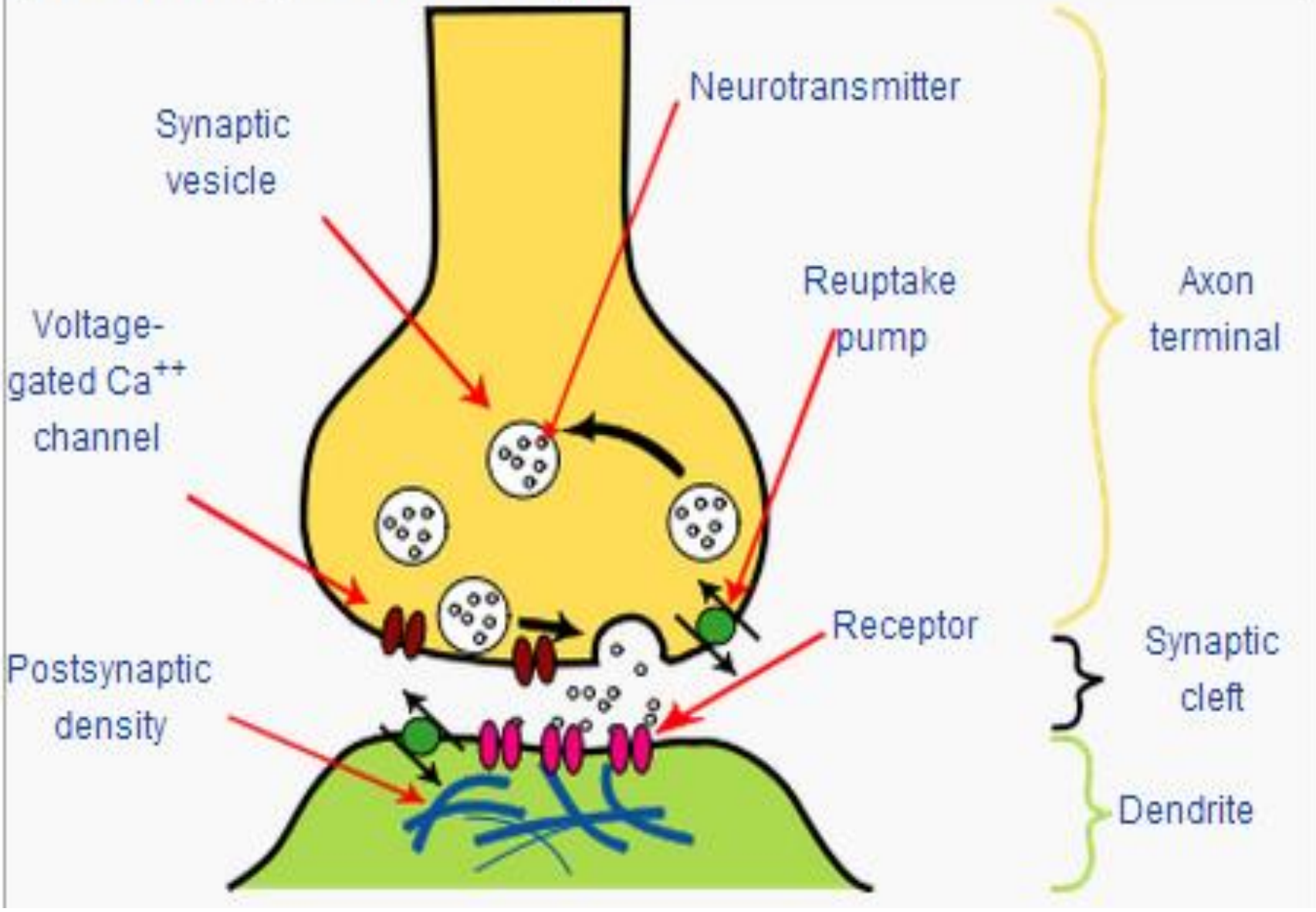
- Trafficking. Vesicles are transported to the cell membrane along microtubules of the cytoskeleton. ...
- Tethering. Upon reaching the cell membrane, the vesicle becomes linked to and pulled into contact with the cell membrane.
- Docking. ...
- Priming. ...
- Fusion.

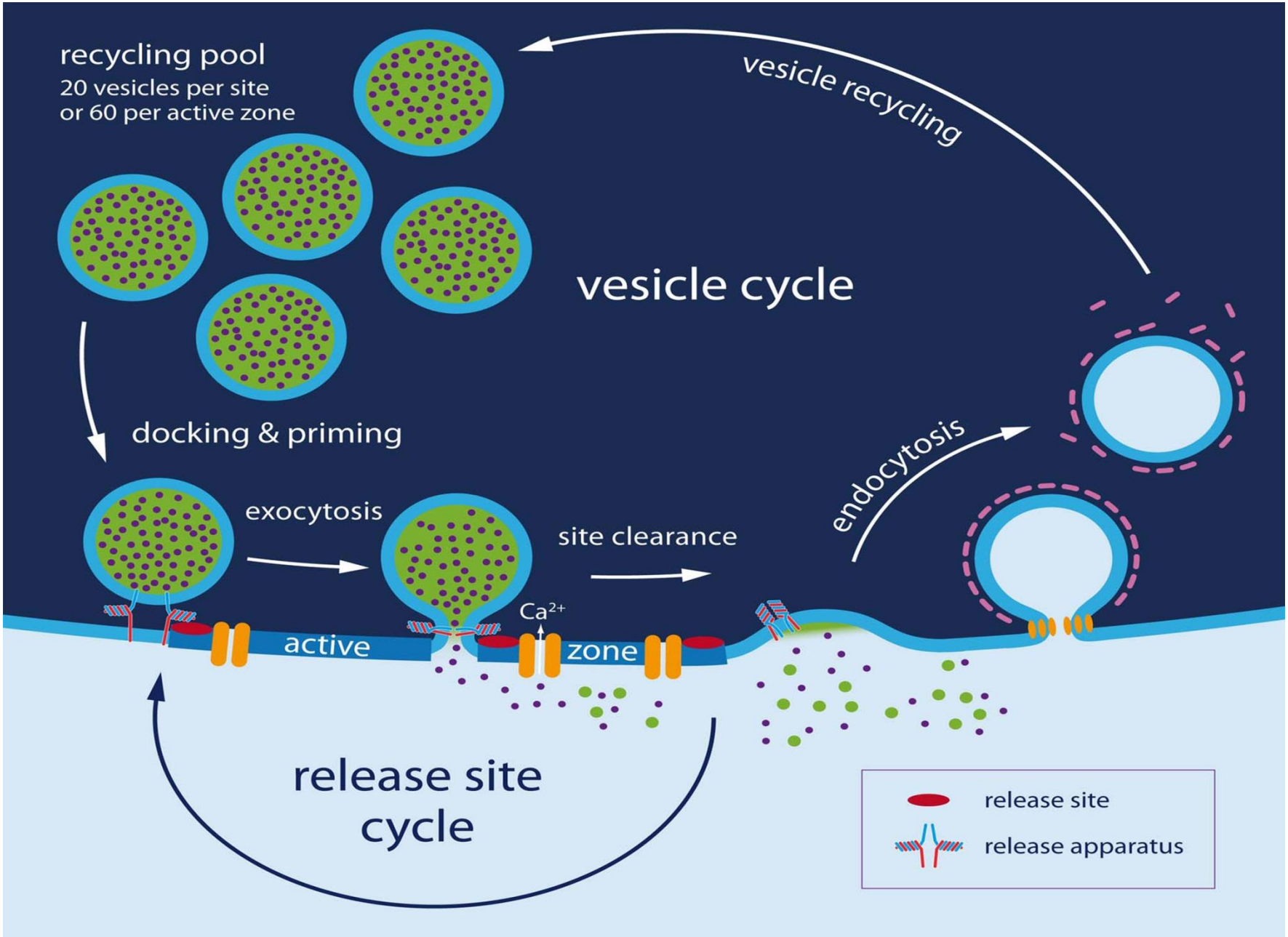

Membranes poised for fusion
Presynaptic terminal
R-SNARE (synaptobrevin/ VAMP)
SV
Qa-SNARE (syntaxin)
Qb- & Qc-SNARE (SNAP-25)
SM protein (Munc18)
N
Synaptic cleft
1. SNARE complex assembly (chaperones: CSPα, β, or γ + α-, β- or γ-synucleins)
Membranes primed for fusion
Partial trans-SNARE complex– SM protein assembly
N
N
2. Fusion pore opening
Fusion pore opening
trans-SNARE complex/ SM protein assembly
N
N
Fusion pore
3. Fusion pore expansion
Membranes after fusion
cis-SNARE complex– SM protein assembly
N
N
4. Snare complex disassembly and vesicle recycling (chaperones: NSF + α-, β- or γ-SNAPs)
SNARE– SM protein cycle

Example for Exocytosis

- **Release of neurotransmitters** from **Synaptic vesicles** (or **neurotransmitter vesicles**) at the **synapse**.
- The **release** is regulated by a voltage-dependent calcium channel.
- When an action potential depolarizes the presynaptic plasma membrane, Ca^{2+}-channels open, and Ca^{2+} flows into the nerve terminal to trigger the **exocytosis of synaptic vesicles**, thereby releasing their neurotransmitters into the **synaptic** cleft .

Structure of a typical chemical synapse




recycling pool
20 vesicles per site
or 60 per active zone
vesicle recycling
vesicle cycle
docking & priming
exocytosis
site clearance
endocytosis
Ca2+
active
zone
release site
cycle
release site
release apparatus

Endocytosis & Exocytosis