Synapses & Neurotransmitters

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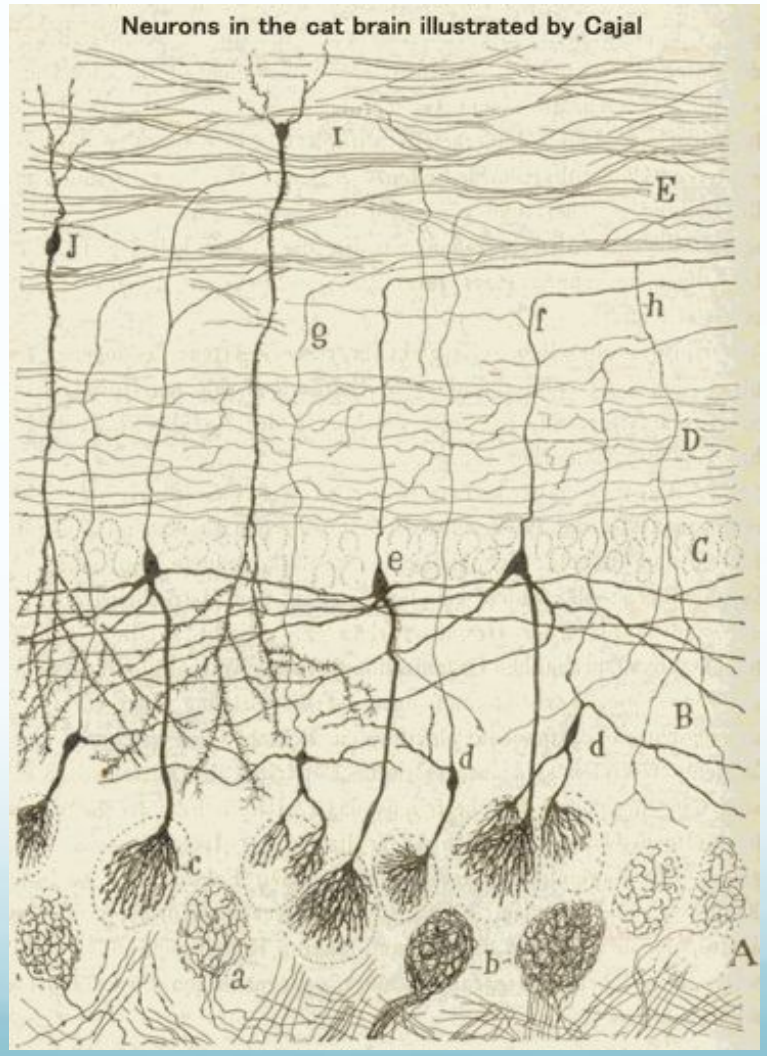
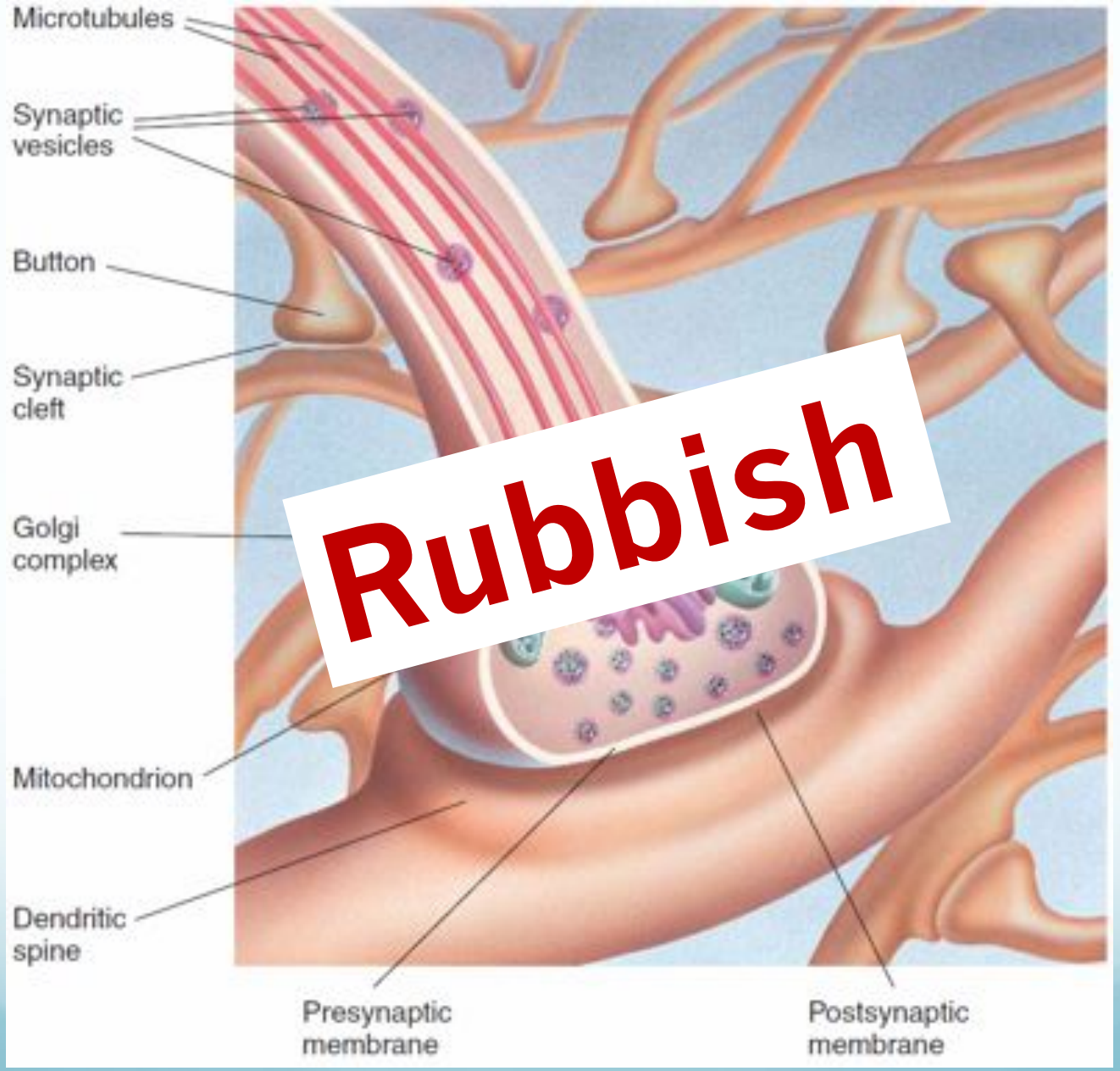
Material to Cover

- Synapse
  - Structure and function of major components
- Neurotransmitters (abbrev. NT)
  - Synthesis, packaging, and transport of NT
  - Release of NT molecules
  - NT docking with receptors
  - Removing NT from the synaptic cleft

Background: Golgi Stain

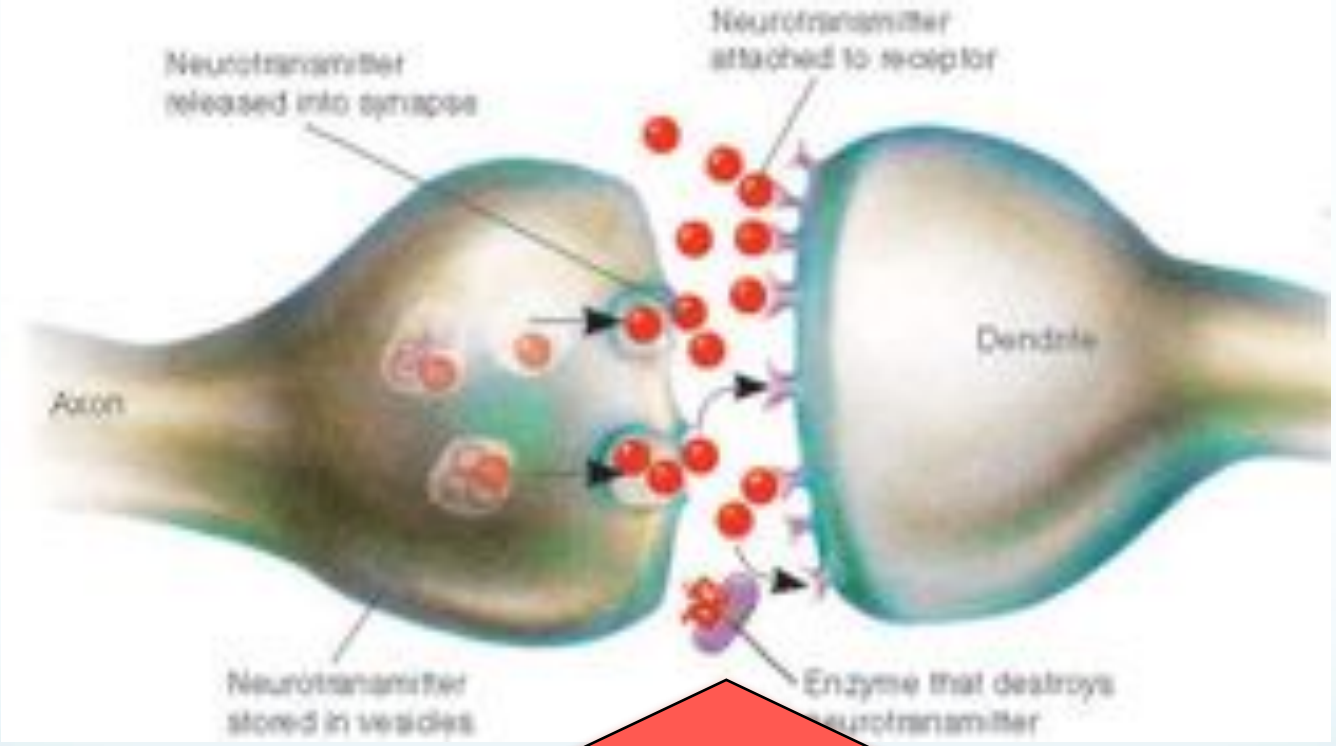


Synapses


Microtubules
Synaptic vesicles
Button
Synaptic cleft
Golgi complex
Mitochondrion
Dendritic spine
Presynaptic membrane
Postsynaptic membrane
Rubbish

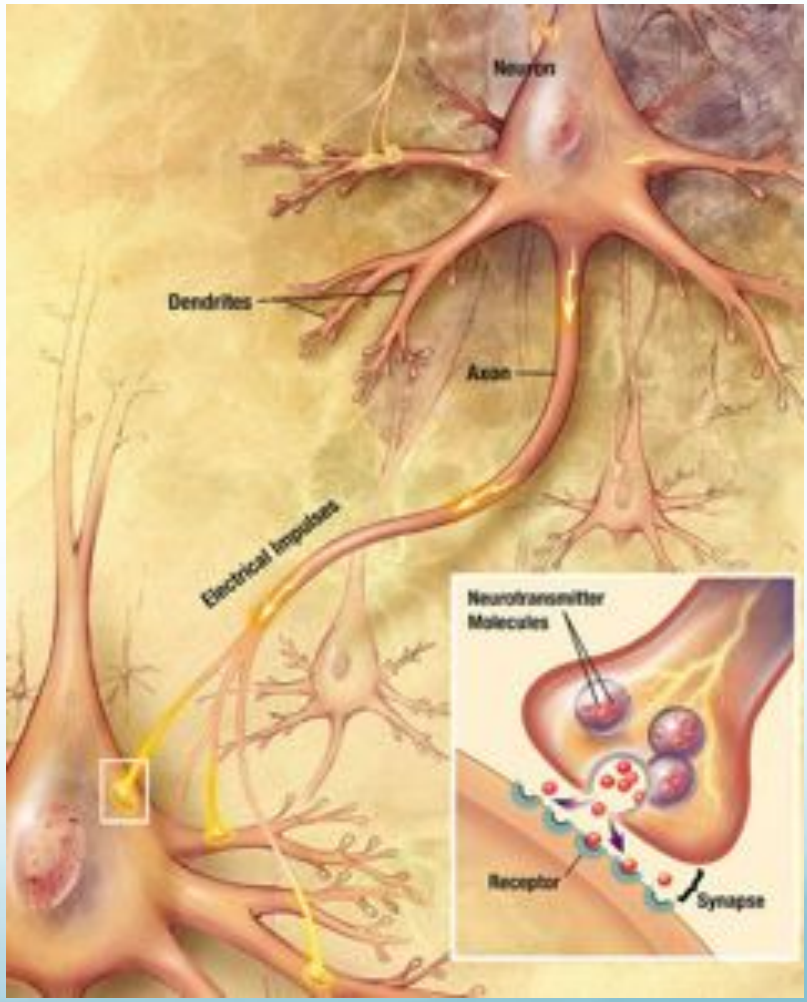
- Picture Time!

The Synapse


Neurotransmitter released into synapse
Neurotransmitter attached to receptor
Dendrite
Axon
Neurotransmitter stored in vesicles
Enzyme that destroys neurotransmitter

The Synapse

- Electrical → Chemical signaling
- Many possible synapse points exist
- Directed vs. Nondirected synapses
  - Dependent on proximity between NT and receptor



Neurotransmitters

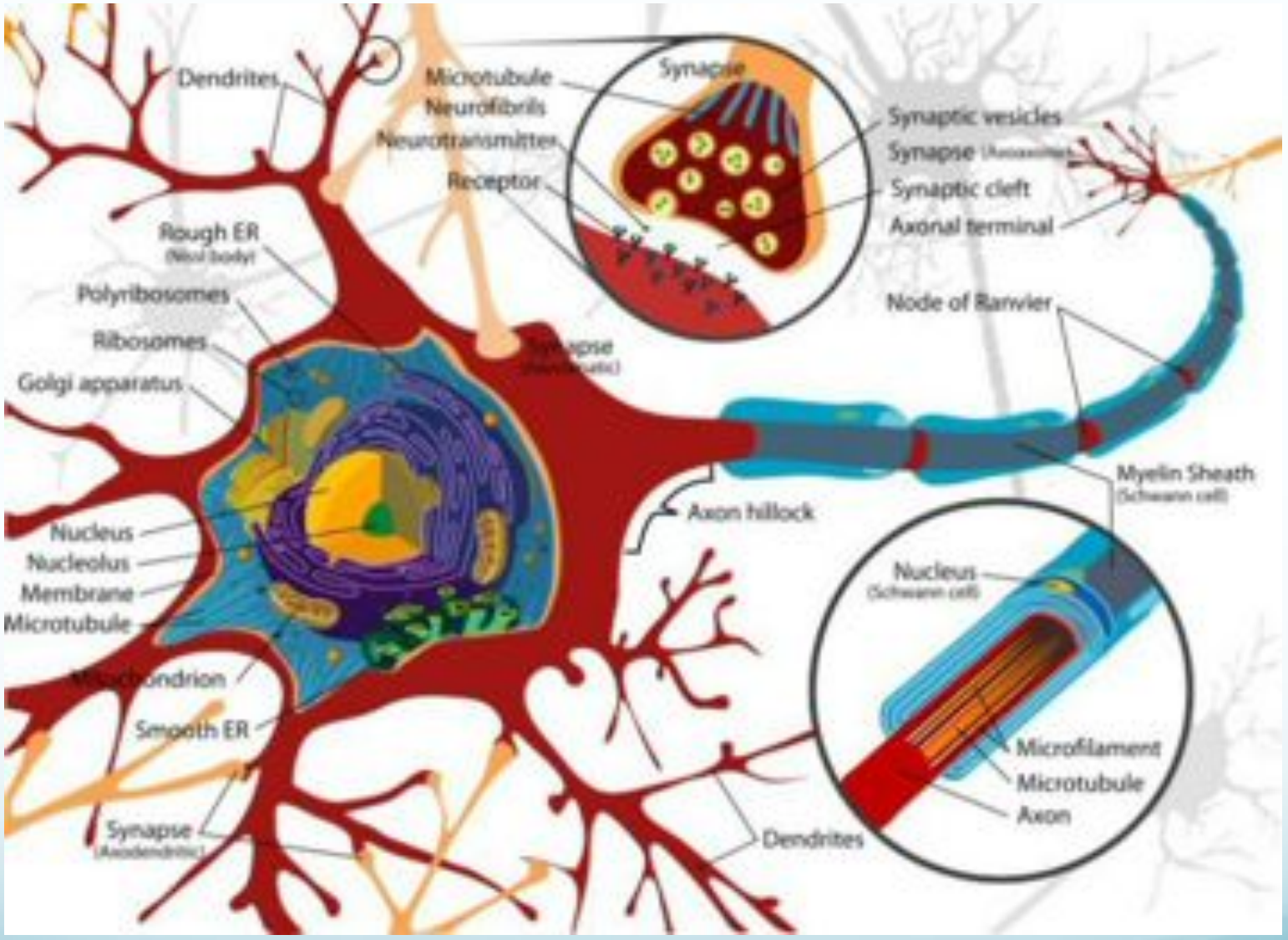
Neurotransmitters

NT Introduction

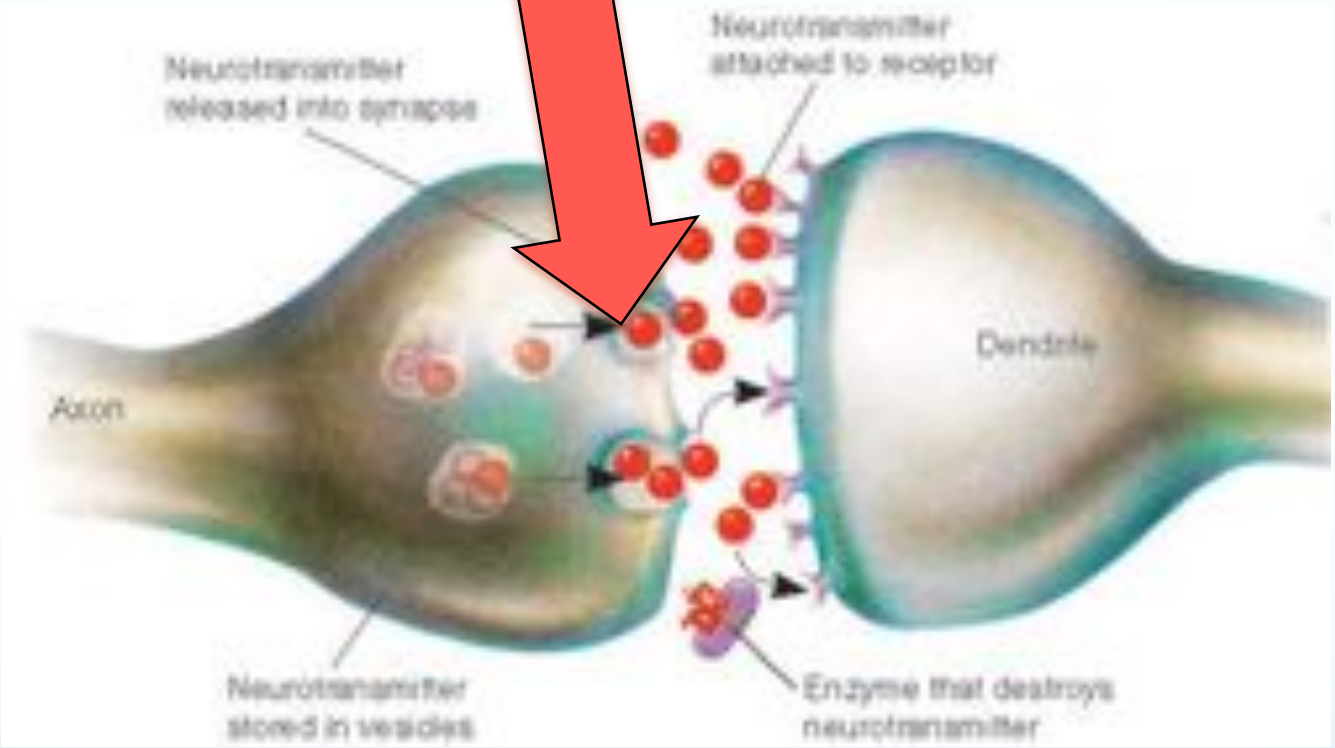
- The “communication device” between neurons
- May be either excitatory or inhibitory
  - Excitatory= Will cause the cell to depolarize and increase the likelihood of an AP
  - Inhibitory= Will cause the cell to hyperpolarize and decrease the likelihood of an AP
  - PSP= Postsynaptic potential

The Life of the NT

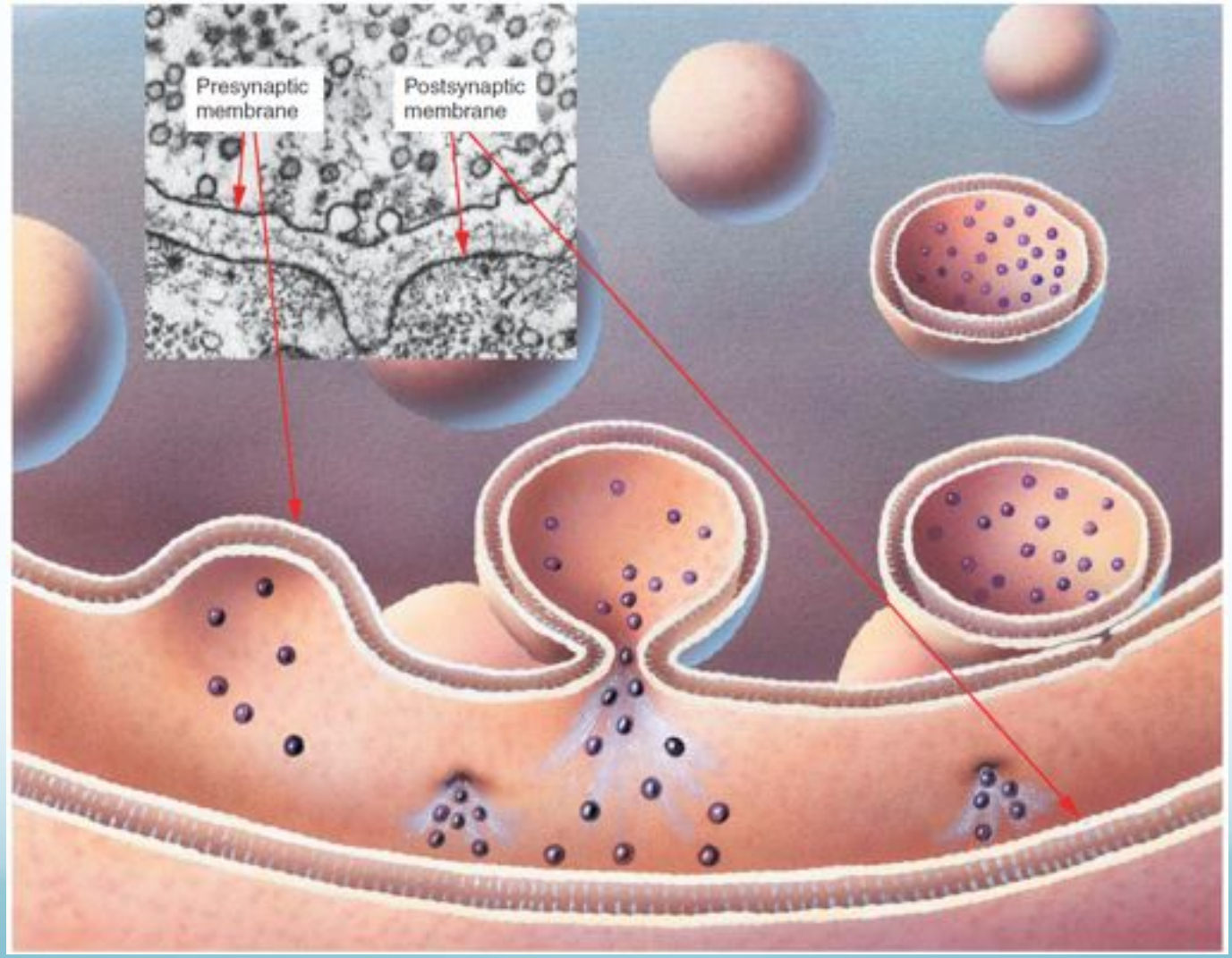
	Small NT	Large NT
Synthesis	In cytoplasm of axon terminal	On ribosomes in cytoplasm of cell body
Packaging into vesicles	By Golgi complex in axon terminal	By Golgi complex of cell body
Transport	Not needed	By microtubules in axon
Storage	Next to presynaptic membrane	Not as close to membrane as small NT


Dendrites
Microtubule
Neurofibrils
Neurotransmitter
Receptor
Synapse
Synaptic vesicles
Synapse
Synaptic cleft
Axonal terminal
Rough ER
Polyribosomes
Ribosomes
Golgi apparatus
Node of Ranvier
Myelin Sheath
Axon hillock
Nucleus
Nucleolus
Membrane
Microtubule
Smooth ER
Synapse
Nucleus
Microfilament
Microtubule
Axon
Dendrites

Release of NT molecules

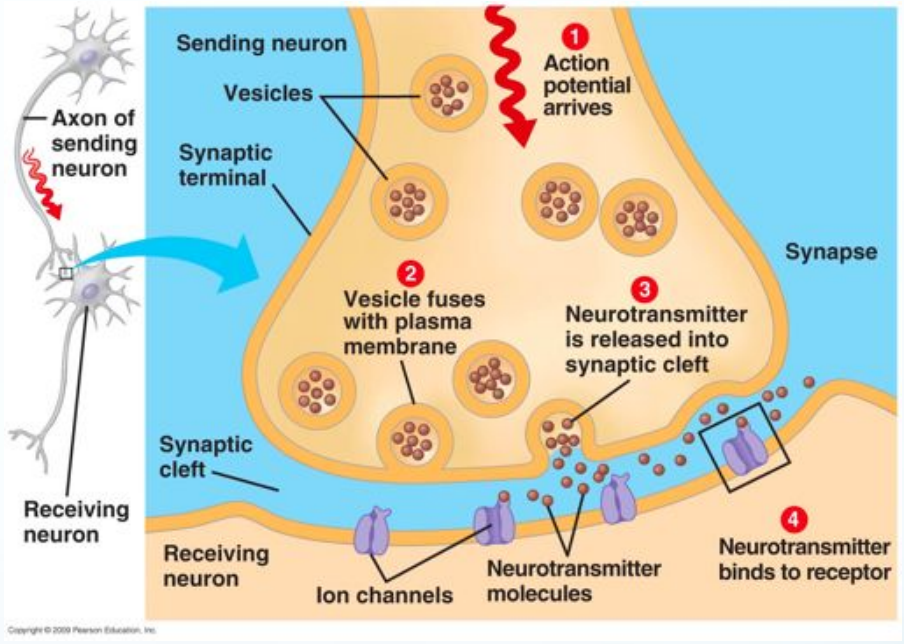


Release of NT molecules

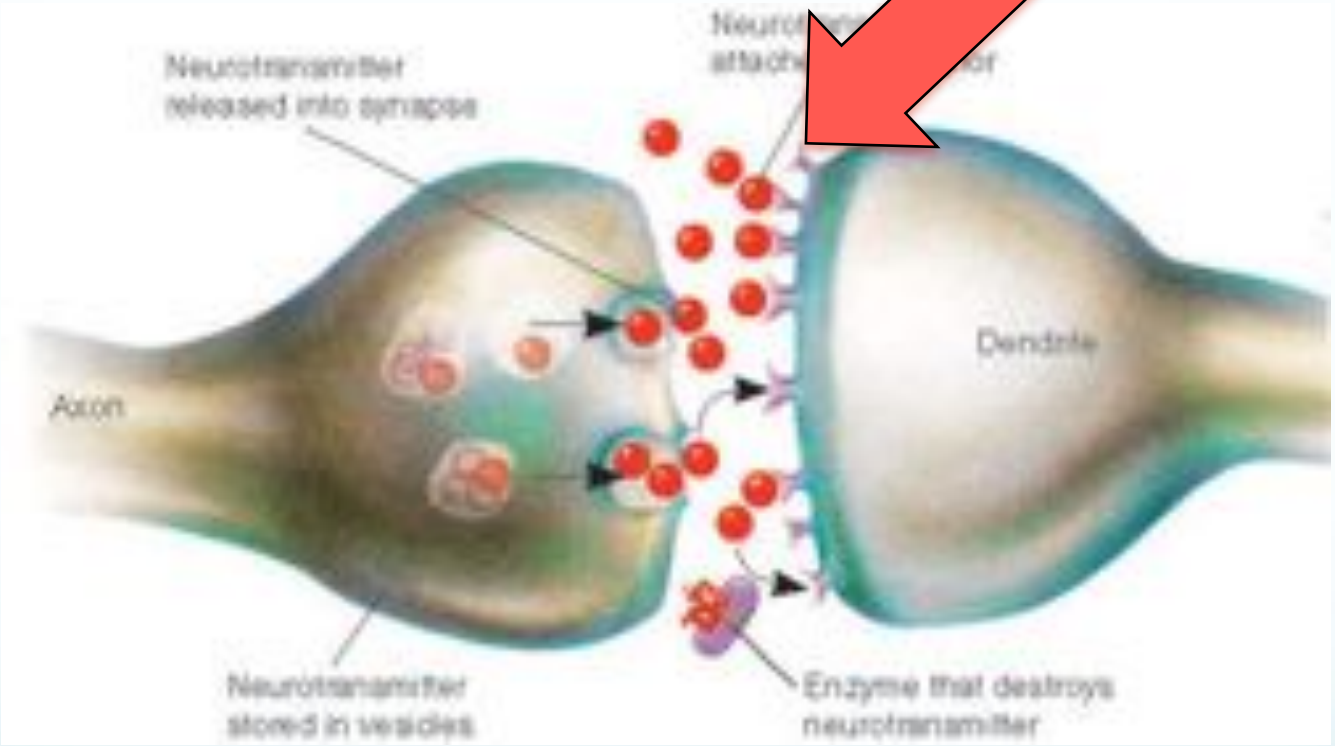


Release of NT molecules

- Exocytosis
  - The process of NT release
- The role of voltage gated Ca^{2+} channels



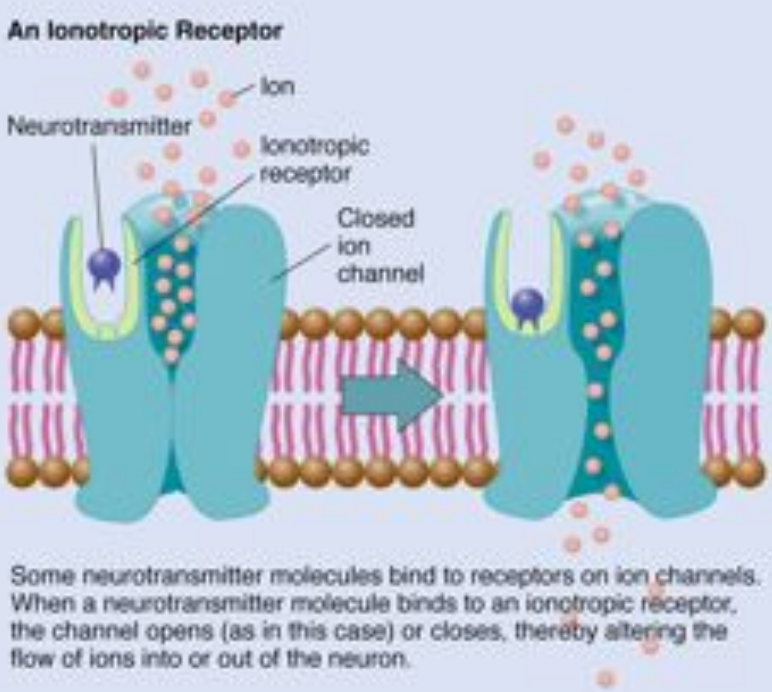
Activation of Receptors by NT

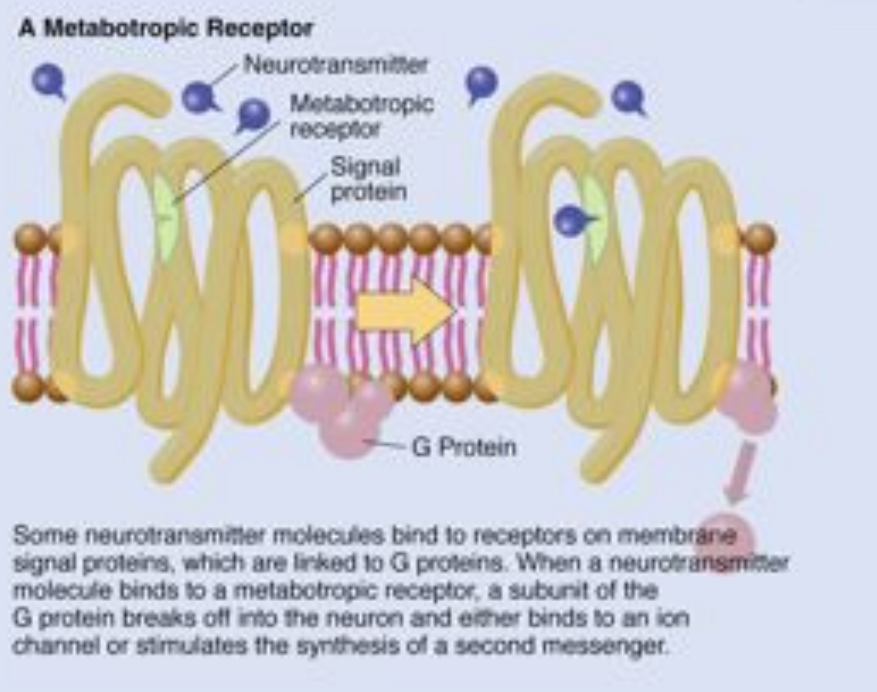


Activation of Receptors by NT

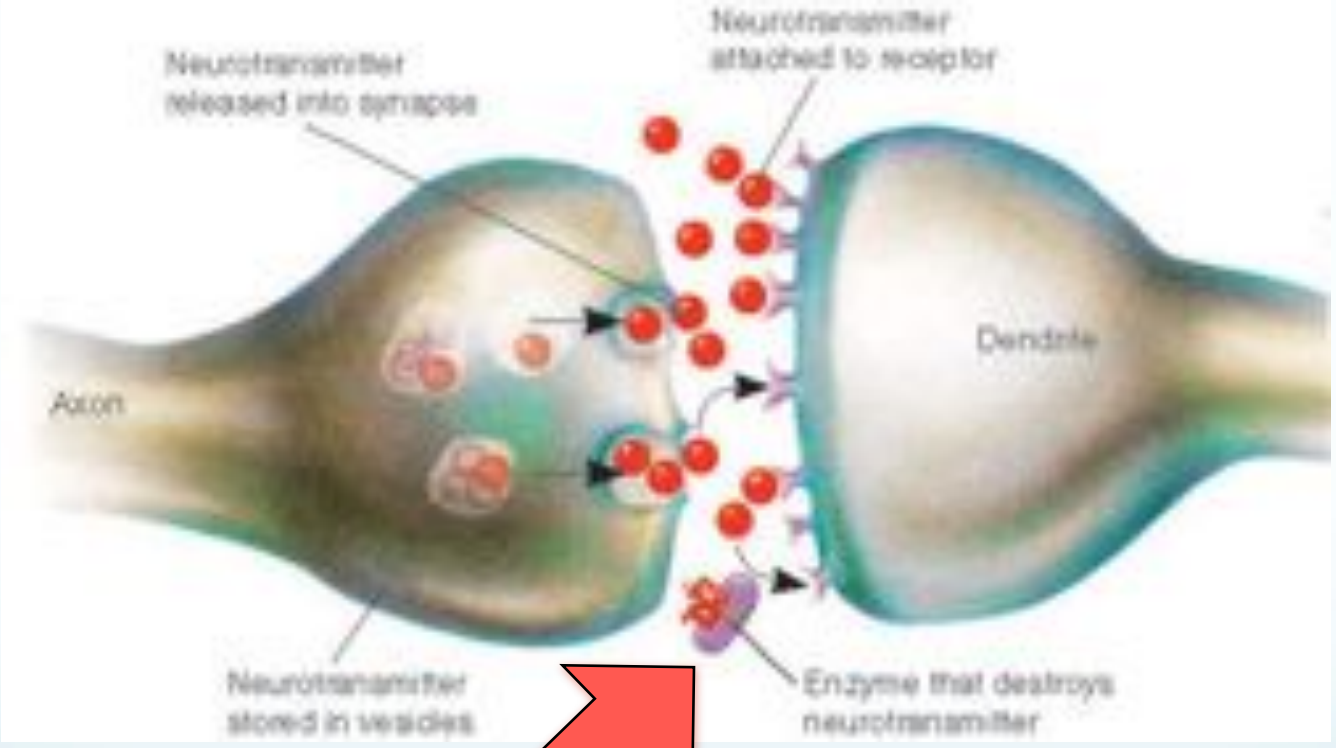
- Fundamental law of receptors
  - NT can only influence those cells with a receptor for it
- Two types of receptors

Ionotropic Receptors	Metabotropic receptors
•Ligand gated not voltage gated •NT binds to receptor. Associated ion channel either opens or closes •For example •If Na^+ channels are opened, then an EPSP occurs •If K^+ channels are opened, then and IPSP occurs	•Effects are slower, longer lasting, more diffuse, and more varied •1) NT 1st messenger binds •2) G Protein subunit breaks away •3) Either an ion channel OR a 2nd messenger is synthesized •4) 2nd messengers may have a wide variety of effects, for example binding to DNA and influencing genetic expression



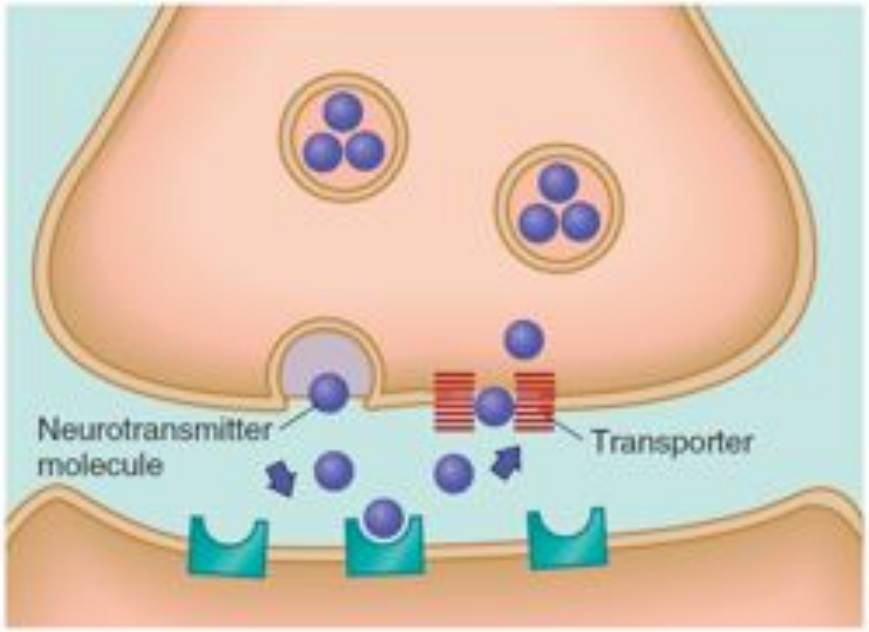


Removing NT from the synapse

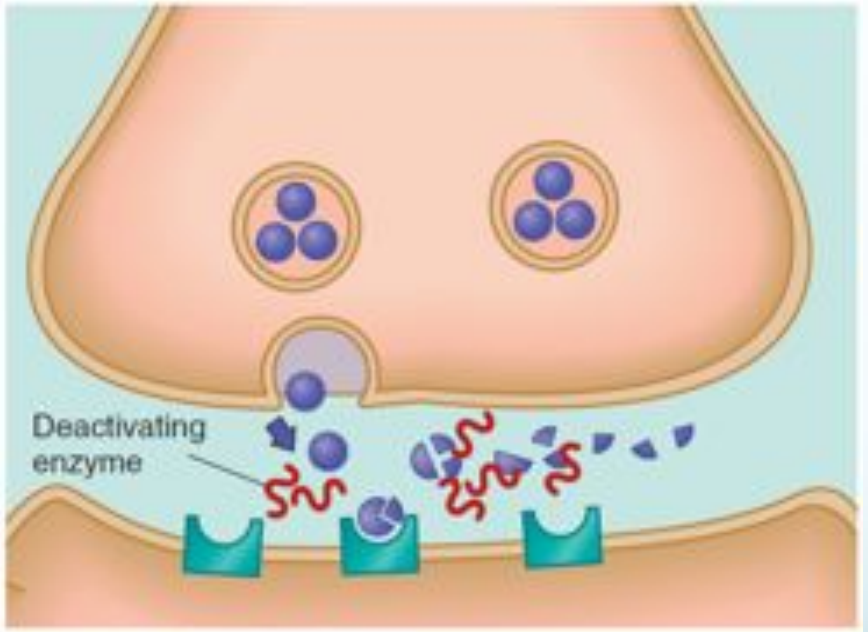


Removing NT from the synapse

- NT is active as long as it is in the synapse
- Three events exist to remove NT
  - Diffusion
  - Reuptake
  - Enzymatic degradation



Reuptake



Enzymatic Degradation

Clicker Question

Clicker Question

- SSRIs (selective serotonin reuptake inhibitors) are a class of pharmaceutical drugs that inhibit the reuptake of serotonin (NT). What does this cause?
  - A) More serotonin at the synapse, more activation of receptors
  - B) More serotonin at the synapse, less activation of receptors
  - C) Less serotonin at the synapse, less activation of receptors
  - D) Less serotonin at the synapse, more activation of receptors

Thank you for listening