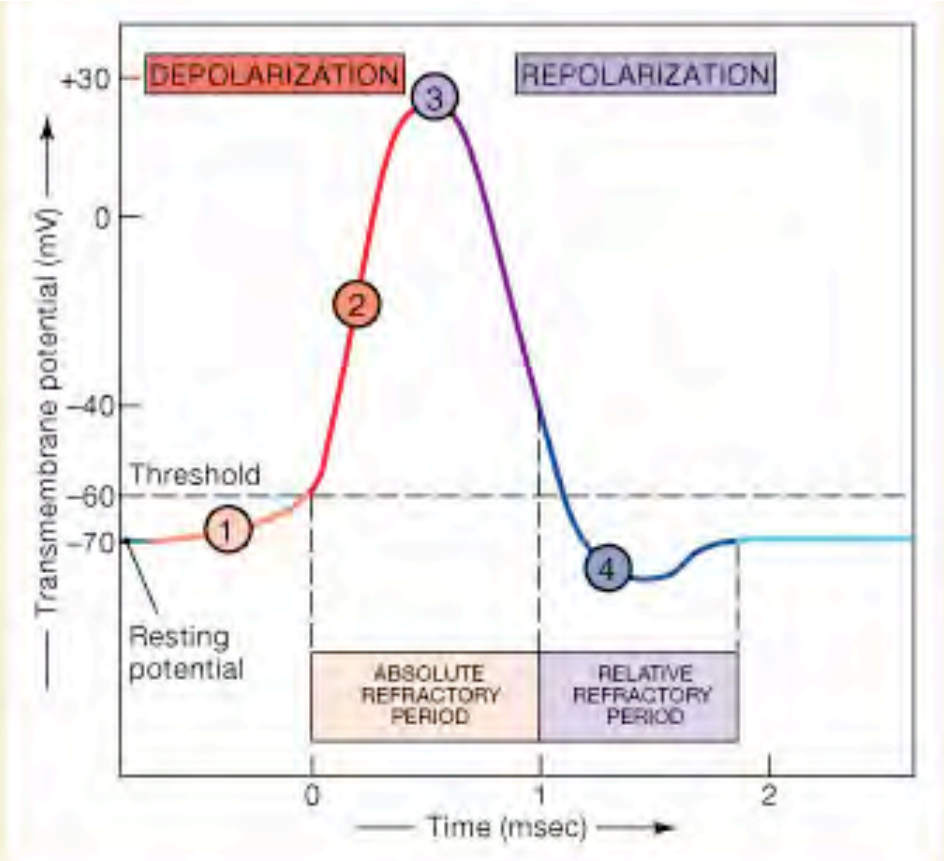
Neural Tissue: 2

Terms to review

- Action potential
  - Depolarization
  - Threshold
  - Repolarization
  - Hyperpolarization

Can neurons continually fire?

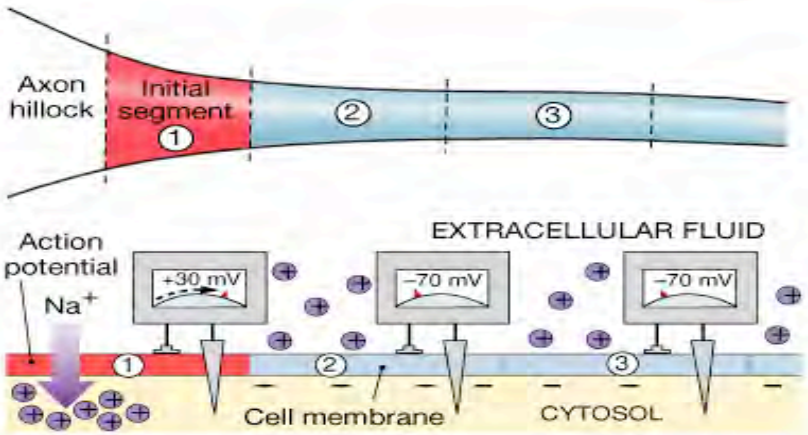
- No!
- **Refractory period**: the time from the beginning of an action potential to the return of resting membrane potential
  - Absolute
  - Relative



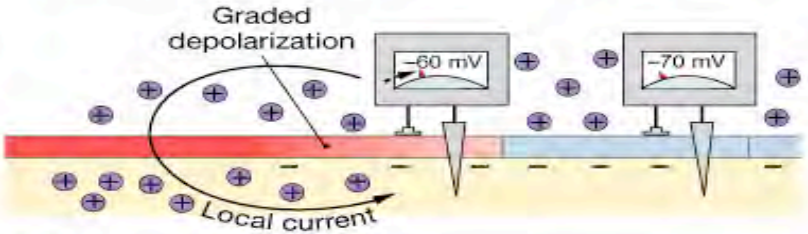
Can AP travel at different rates?

- Yes!
- Depends on presence of **myelin** around the axon; produces **nodes**
  - What kinds of cells are responsible for myelination in the CNS? PNS?
- Depends on **diameter** of axon

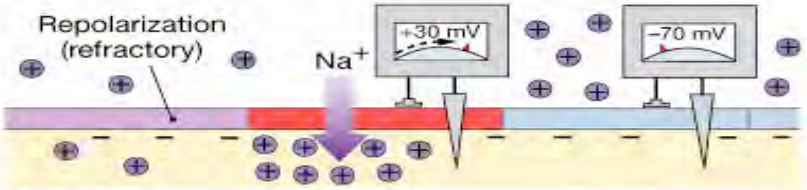
Continuous propagation



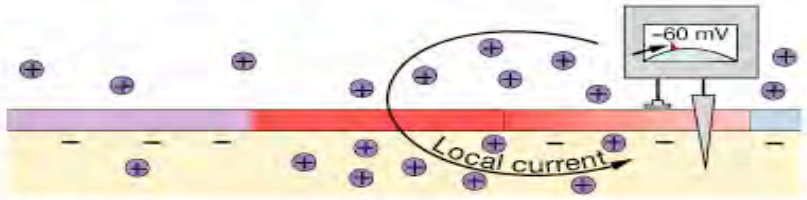
STEP 1:
As an action potential develops in the initial segment, the transmembrane potential depolarizes to +30 mV.



STEP 2:
A local current depolarizes the adjacent portion of the membrane to threshold.

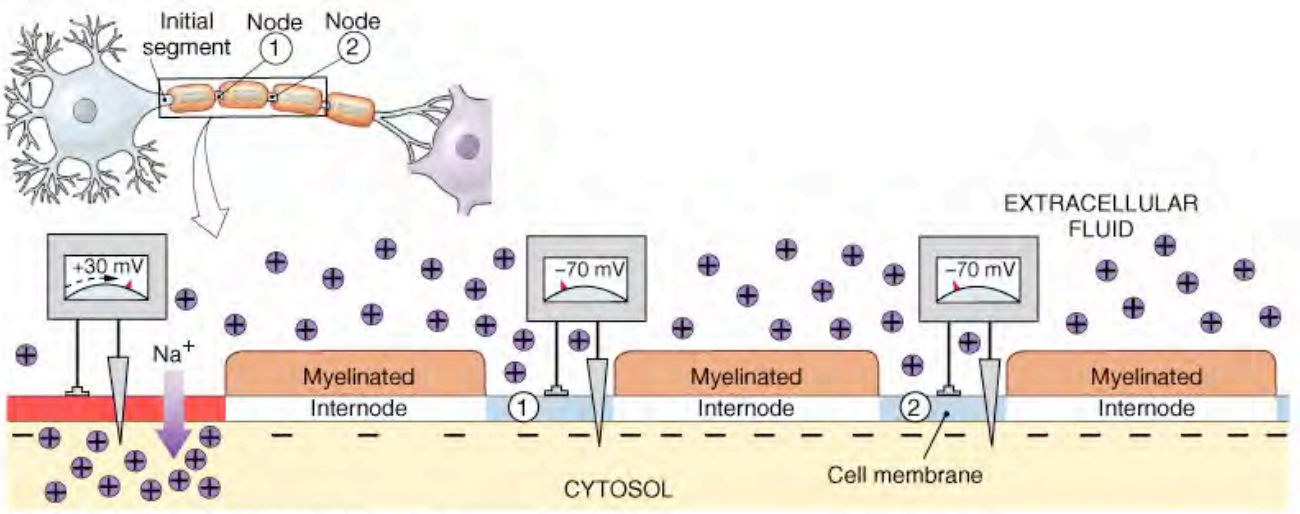


STEP 3:
An action potential develops at this location, and the initial segment enters the refractory period.

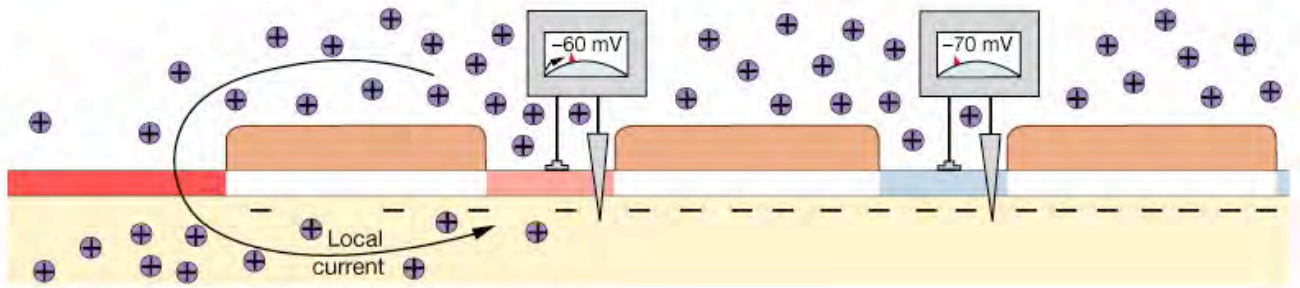


STEP 4:
A local current depolarizes the adjacent portion of the membrane to threshold, and the cycle is repeated.

Saltatory Propagation

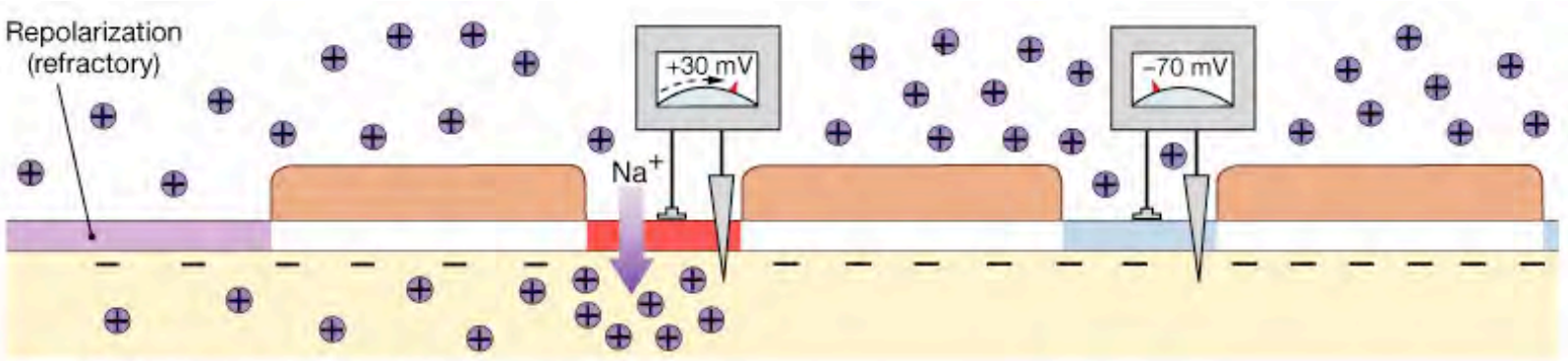


STEP 1: Action potential at initial segment

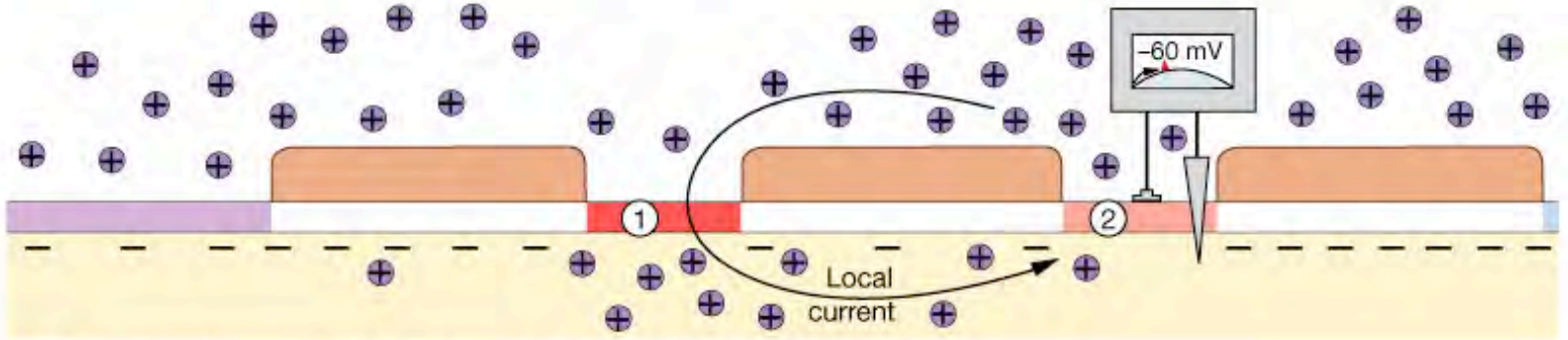


STEP 2: Depolarization to threshold at node 1

Saltatory Propagation



STEP 3: Action potential at node 1



STEP 4: Depolarization to threshold at node 2

Axons differ in diameter

- Type A fibers
  - Large myelinated; carry CNS sensory for delicate touch, position and balance, and motor neurons
- Type B fibers
  - Small myelinated; carry pressure, pain, temperature sensation info to the CNS and instruction to smooth, cardiac, and glands
- Type C fibers
  - Small unmyelinated; carry sensory info to the CNS and instruction to smooth, cardiac, and glands

The Synapse

- **Two** kinds of synapses
  - Electrical: direct connections
  - Chemical: indirect connections

Electrical Synapses

- Occur in **both** PNS and CNS
- Rare
- Cells usually attached to each other by gap junctions
- Promotes easy transfer of ions between two cells

Chemical Synapses

- Most common type of synapse
- Response of the postsynaptic cell is **dependent on the neurotransmitter AND** the **type of receptor** found in cell membrane of the postsynaptic cell

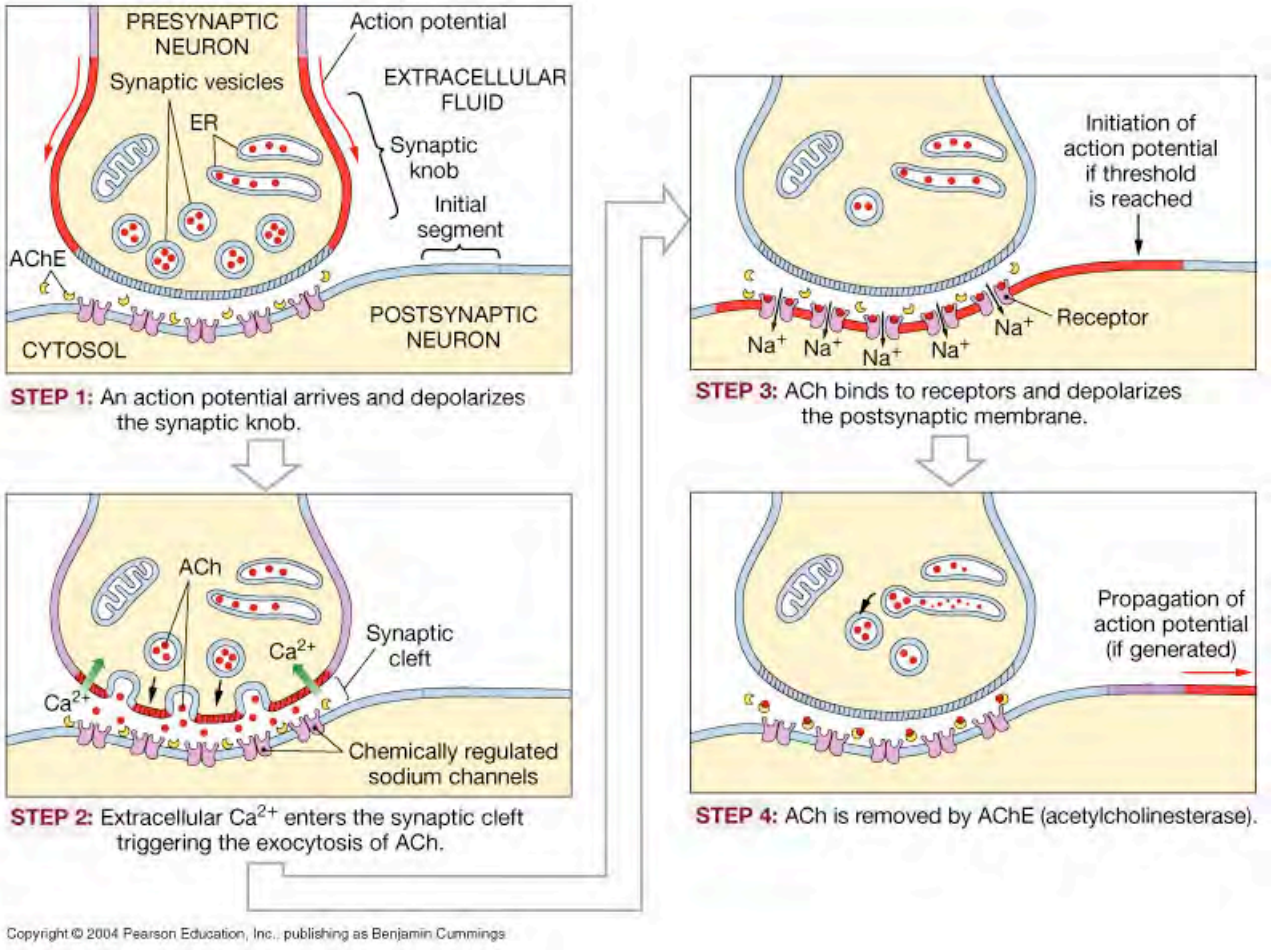
An example

- **ACh** causes a depolarization in the membrane of skeletal muscles, BUT, ACh causes a transient hyperpolarization in cardiac muscle cell
- Response to ACh depends on the receptor in the membrane of the post-synaptic cell!

Acetylcholine

- Synapses that release ACh are called **cholinergic** synapses
  - Neuromuscular junctions of skeletal muscles
  - Synapses in CNS
  - Neuron-neuron synapses in PNS
  - All neuromuscular and neuroglandular junctions in Parasympathetic Nervous System (division of the autonomic NS)

What happens at a cholinergic synapse?



Acetylcholine (ACh)

- **Two types** of receptors bind ACh
  - Nicotinic
  - Muscarinic

Other neurotransmitters

- Biogenic Amines: derived from amino acids
  - Tyrosine is used to generate dopamine, norepinephrine, and epinephrine
  - **Norepinephrine** is found in the brain and Autonomic Nervous System
  - **Dopamine** regulates precise control of movement

Other neurotransmitters

- Biogenic Amines
  - Serotonin is synthesized from the amino acid tryptophan
    - Stabilizes mood; sleep and wake cycles
  - Histamine is synthesized from the amino acid histidine

Other neurotransmitters

- Neuropeptides
  - Substance P
    - Important in pain sensation
  - Opioids - inhibit release of Substance P
    - Endorphin = pain control
    - Opiates (morphine) bind to the same receptors as Substance P.

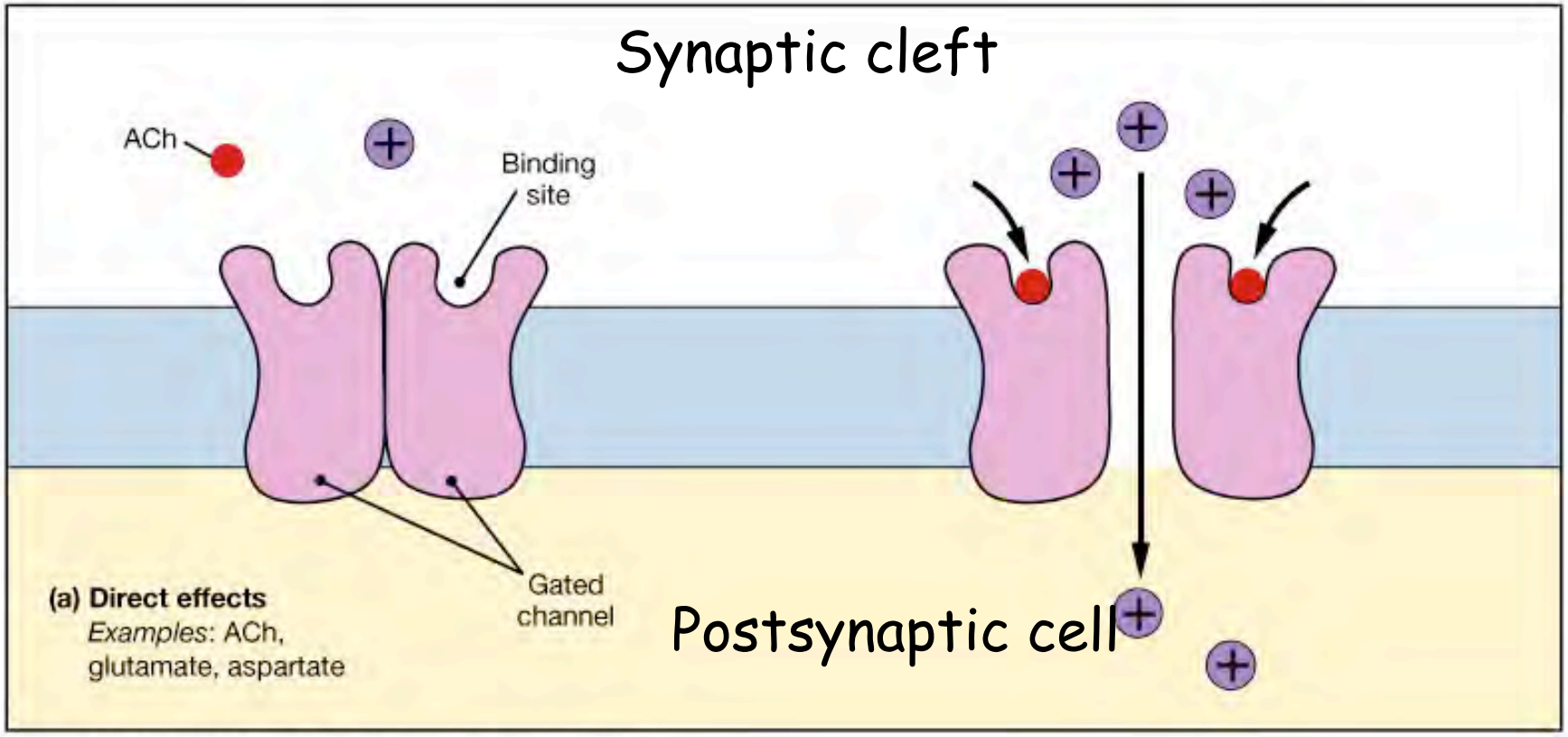
Other neurotransmitters

- Amino acids
  - Glutamate
    - Most important excitatory neurotransmitter in brain
    - learning and memory
  - Glycine
    - Inhibitory neurotransmitter
    - Strychnine (rat poison) blocks glycine receptors; results in fatal convulsions

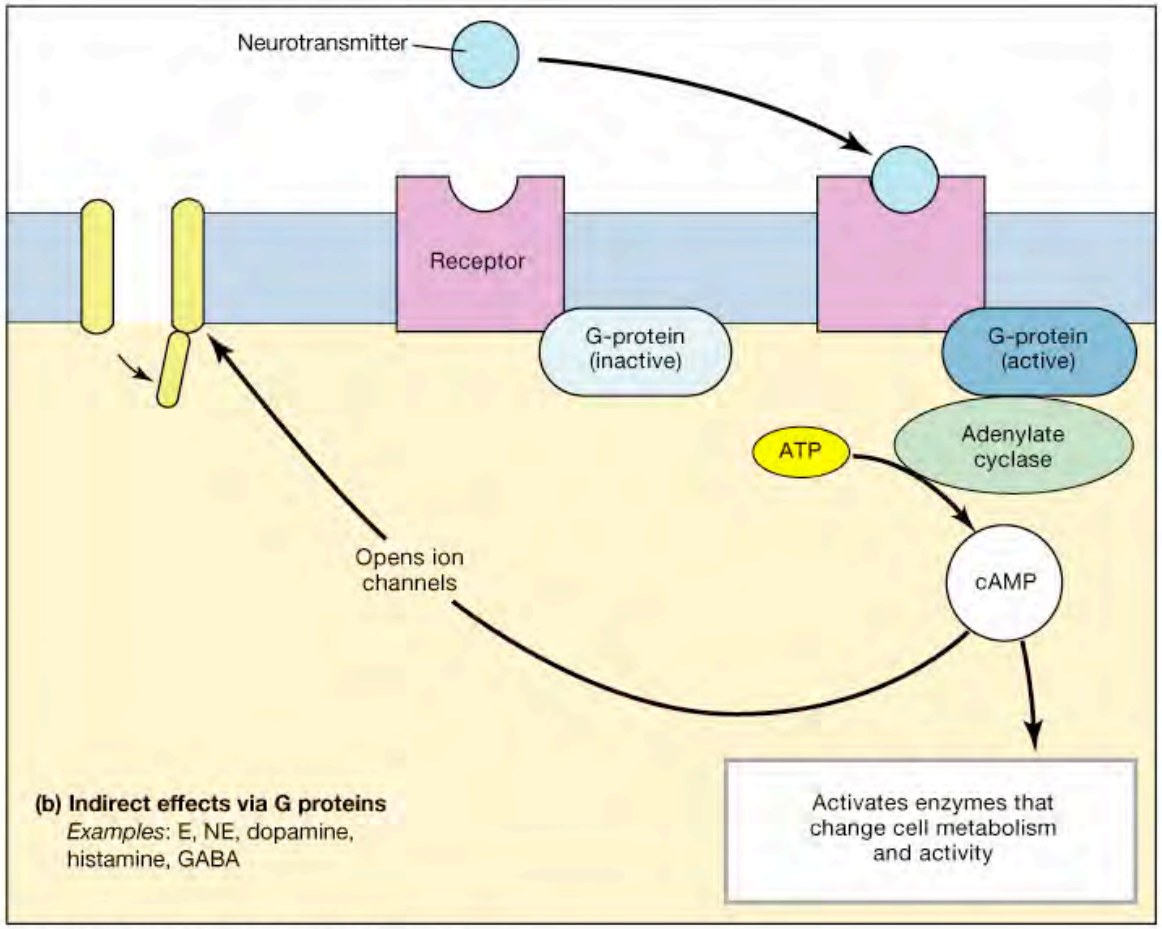
Neurotransmitters activate cells by 3 mechanisms

- **Direct** effects
  - Acetylcholine (ACh)
- **Indirect** effects
  - via G proteins
  - via intracellular enzymes

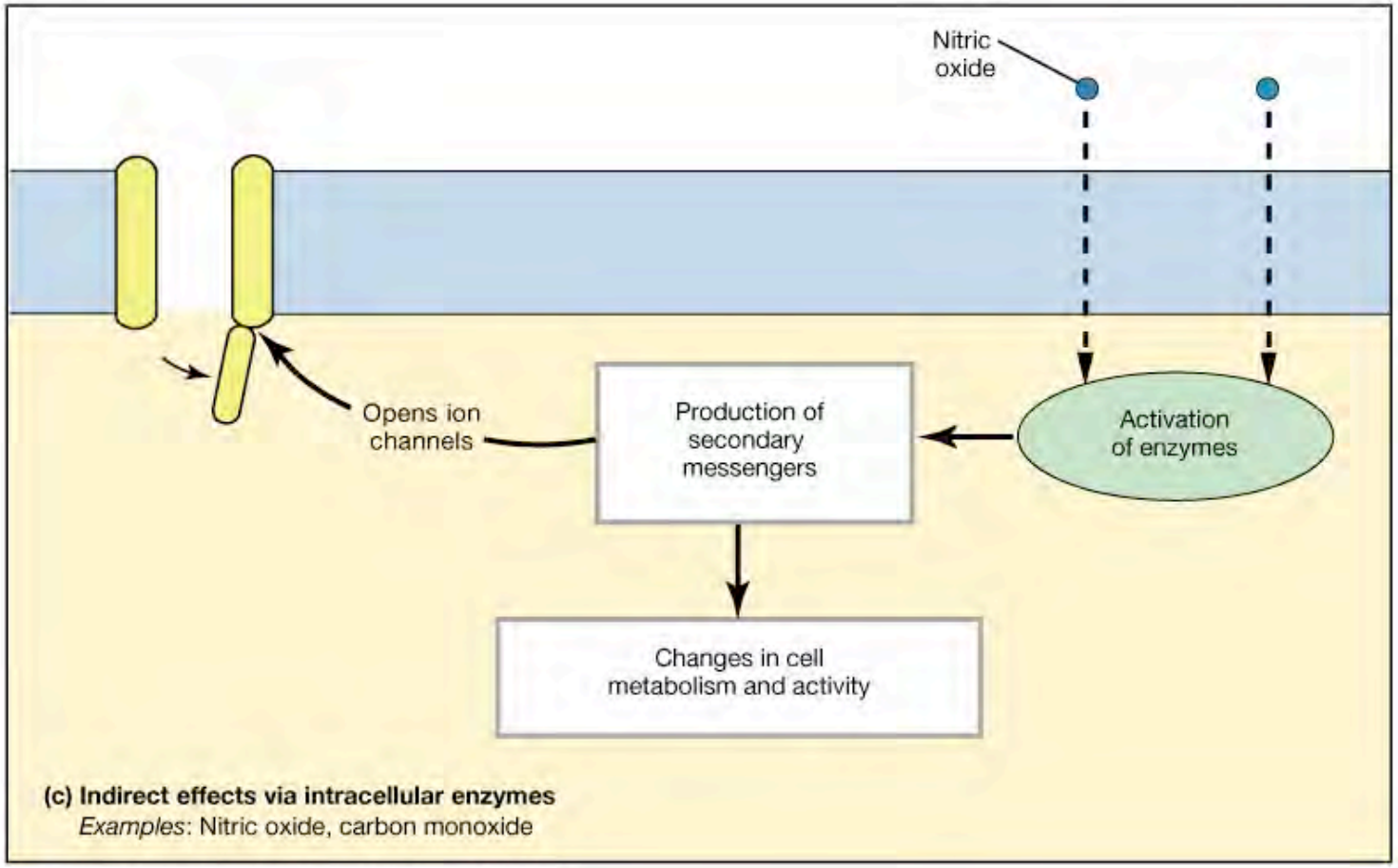
Direct Activation



Indirect via G proteins



Indirect via intracellular proteins



Information Processing

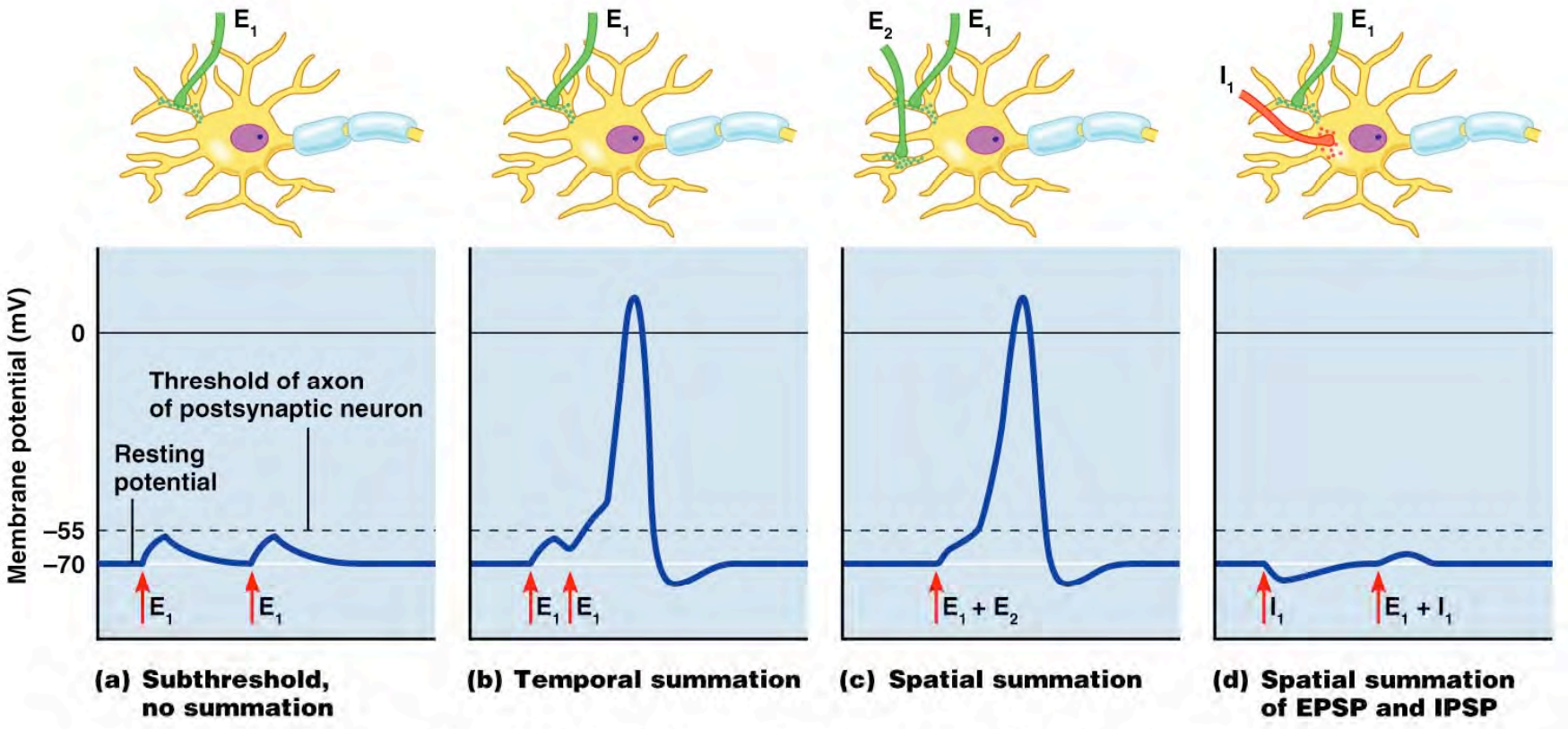
- Do I generate an AP?
- How frequently do I generate them?

- **Postsynaptic potentials**: Graded potentials that develop in post-synaptic membrane in response to neurotransmitter.

EPSP & IPSP

- **Excitatory** PSP: neurotransmitter causes depolarization (ACh causes Na^+ to enter)
- **Inhibitory** PSP: neurotransmitter causes hyperpolarization (K^+ channels open)
  - Now, a LARGER than normal stimulus is required to produce an AP

Summation



Stimulus intensity