Explain how neurons communicate via synapses and neurotransmitters.

1. A neuron that is in its *resting state* is _____ charged with _____ ions on the ***outside*** of the membrane, and _____ charged with _____ ions on the ***inside*** of the membrane.
   A. negatively, sodium, positively, potassium
   B. negatively, potassium, positively, sodium
   C. positively, sodium, negatively, potassium
   D. positively, potassium, negatively, sodium

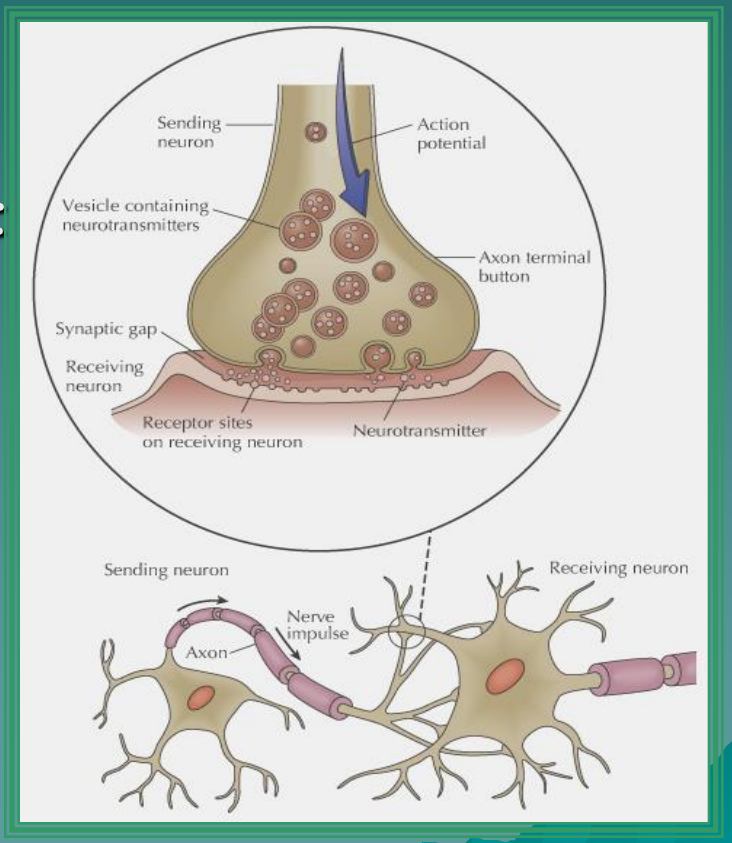
2. The myelin sheath is made up of 80 % lipid and 20 % protein.

3. Action potential occurs when a neuron becomes
   A. Depolarized
   B. Repolarized

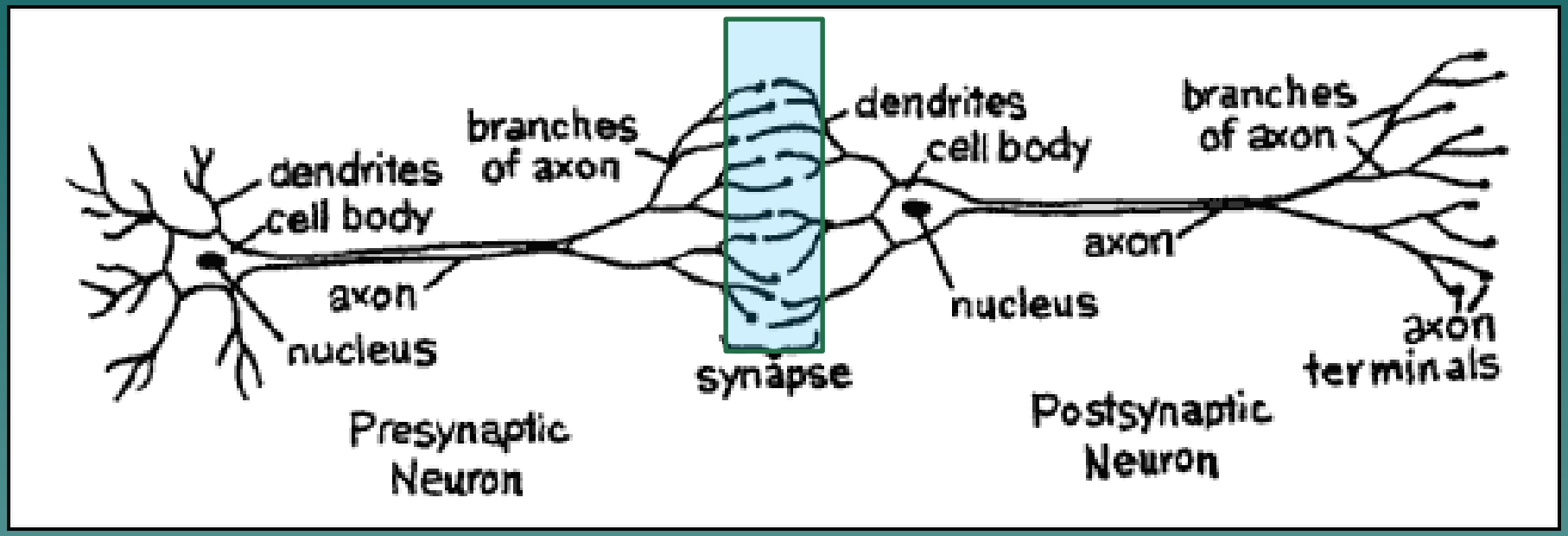
4. Participants that are working with the experimenter, often unknown to the subject, are called confederates

Neural Bases of Psychology: Neural Communication

- *Between* neurons, communication occurs through transmission of neural information across a **synapse** by **neurotransmitters** (chemicals released by neurons that alter activity in other neurons).



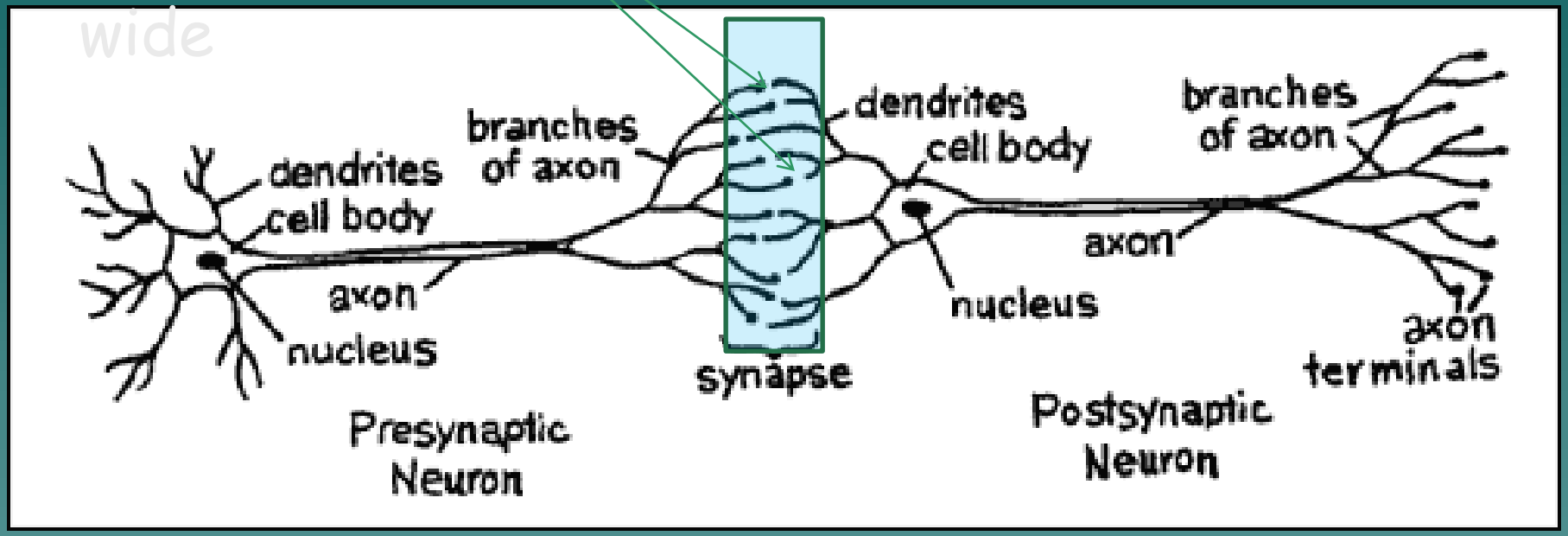
Transmission between neurons



Neurons transmit information to other neurons. Information passes from the terminal buttons of the presynaptic neuron to the dendrites of the postsynaptic neuron.

Transmission between neurons

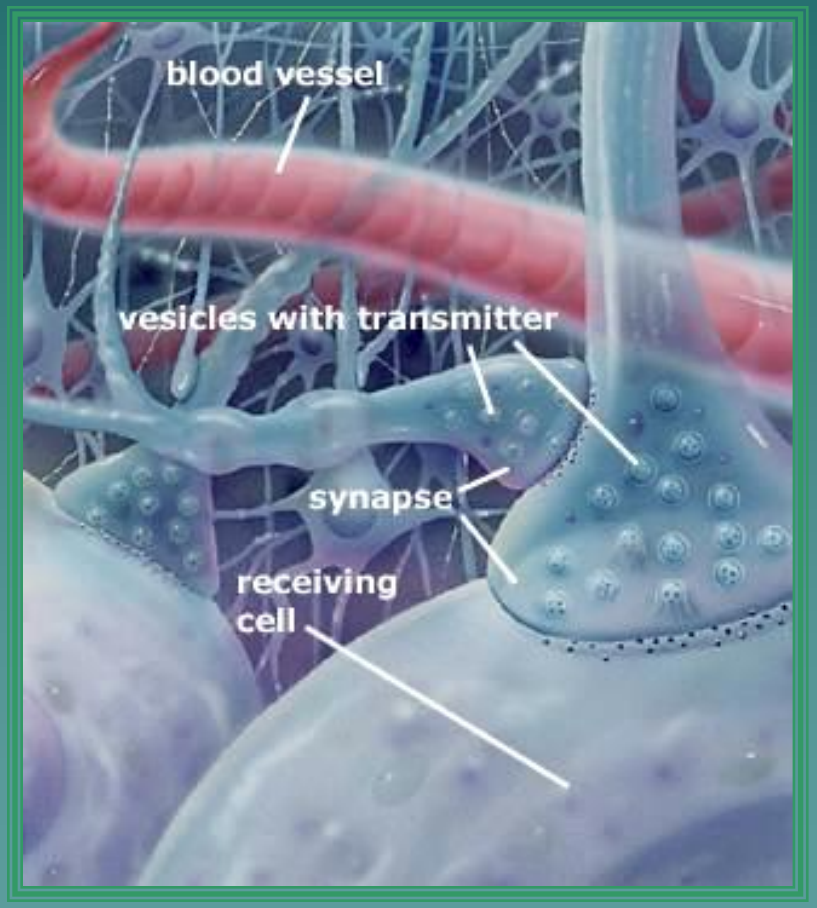
Synaptic gap – less than 1 millionth of an inch wide



Synapse [SIN-aps] A junction between the terminal buttons of the sending neuron and the dendrite of the receiving neuron. This tiny gap is called the *synaptic gap* or *cleft*.

Neurons and Neurotransmitters

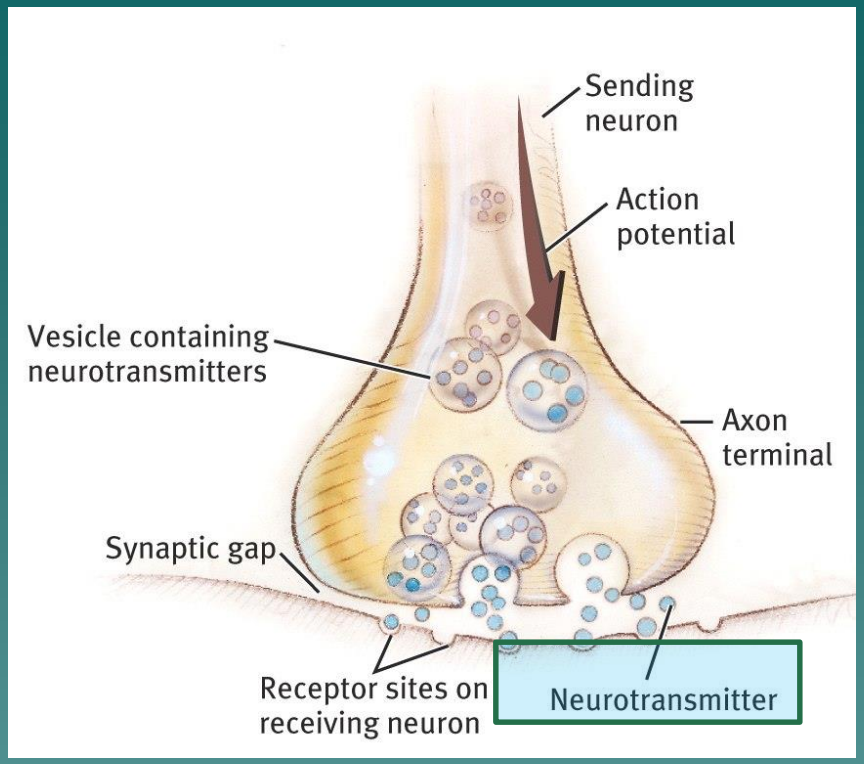
Neural Bases of Psychology: Neural Communication



- Receiving neurons receive **multiple messages** from other neurons, and these messages determine if an **action potential** occurs or not.

Neurotransmitters

(chemicals) released from the sending neuron travel across the synapse and bind to receptor sites on the receiving neuron, thereby influencing it to generate an action potential.



Much like a key fits into a lock, the neurotransmitter molecules cross the synaptic gap and bind to receptor sites on the receiving neuron. This happens in about 1/10,000 of a second.

Neurotransmitters

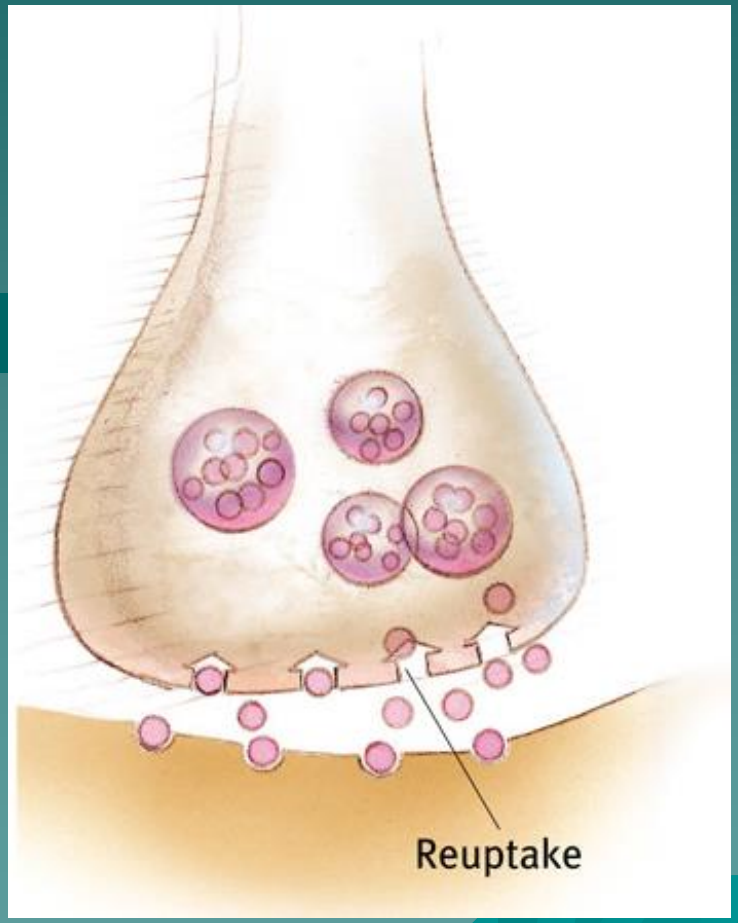
SOME NEUROTRANSMITTERS AND THEIR FUNCTIONS

Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory.	With Alzheimer's disease, ACh-producing neurons deteriorate.
Dopamine	Influences movement, learning, attention, and emotion.	Excess dopamine receptor activity linked to schizophrenia. Starved of dopamine, the brain produces the tremors and decreased mobility of Parkinson's disease.
Serotonin	Affects mood, hunger, sleep, and arousal.	Undersupply linked to depression; Prozac and some other antidepressant drugs raise serotonin levels.
Norepinephrine	Helps control alertness and arousal.	Undersupply can depress mood.
GABA (gamma-aminobutyric acid)	A major inhibitory neurotransmitter.	Undersupply linked to seizures, tremors, and insomnia.
Glutamate	A major excitatory neurotransmitter; involved in memory.	Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food).

Neurotransmitter and ADHD

Reuptake

Neurotransmitters in the synapse are reabsorbed into the sending neurons through the process of **reuptake**. This process applies the brakes on neurotransmitter action.

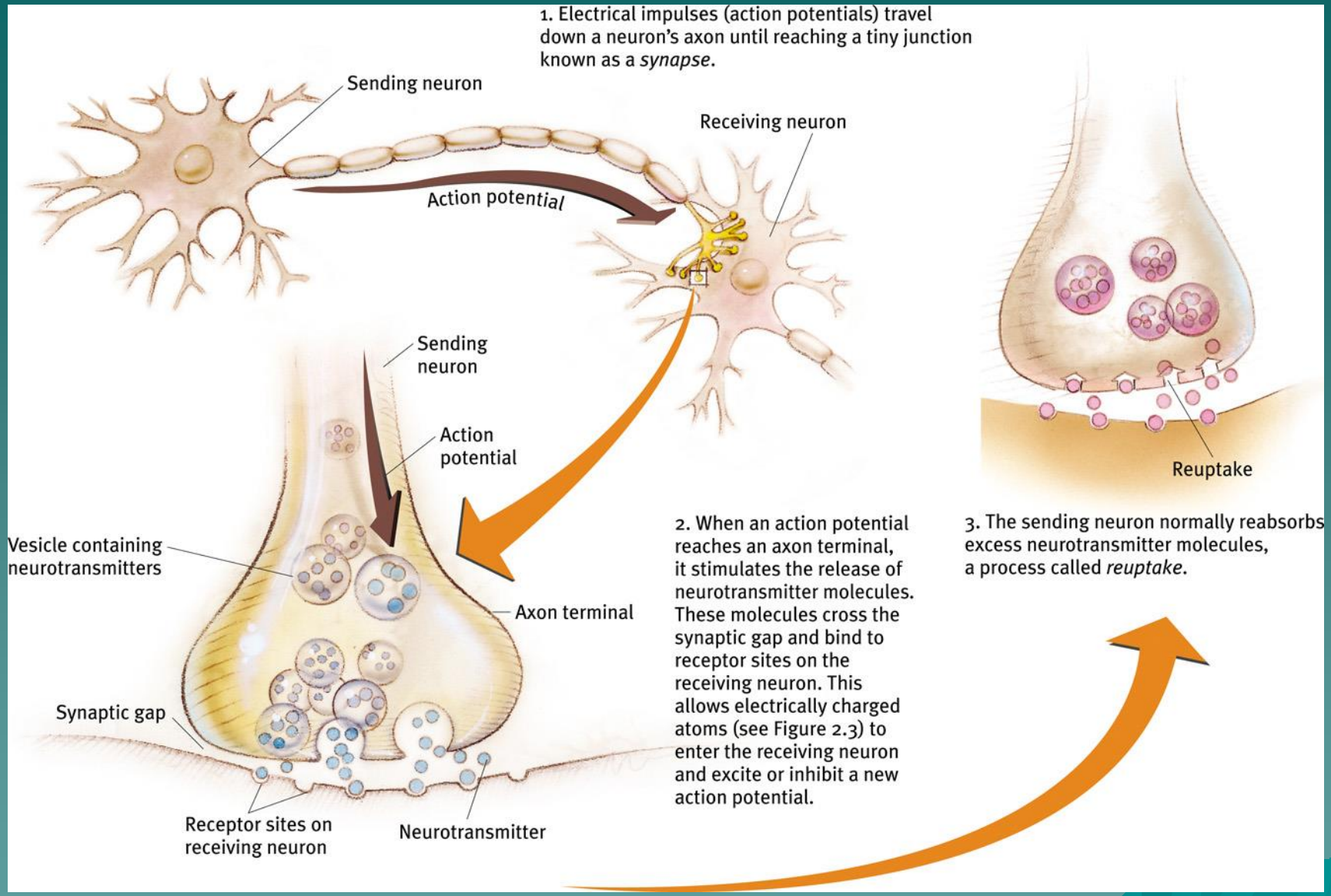


OBJECTIVE:

Outline effects of neurotransmitters in order to explain how they effect behavior

Review: How Neurons Communicate

- Synaptic cleft/gap: space between neurons, discovered by Sir Charles Sherrington
- Neurotransmitters:
  - Unlock channels at the receiving site allowing ions into the receiving neuron.
  - Excitatory role: positive ions allowed in causes firing
  - Inhibatory role: negative ions allowed in prevents firing
  - ACh (acetycholine): excitor
  - GABA: inhibator – keeps brain calmed down and not firing out of control


1. Electrical impulses (action potentials) travel down a neuron's axon until reaching a tiny junction known as a *synapse*.
Sending neuron
Receiving neuron
Action potential
Sending neuron
Action potential
Vesicle containing neurotransmitters
Axon terminal
Synaptic gap
Receptor sites on receiving neuron
Neurotransmitter
2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitter molecules. These molecules cross the synaptic gap and bind to receptor sites on the receiving neuron. This allows electrically charged atoms (see Figure 2.3) to enter the receiving neuron and excite or inhibit a new action potential.
Reuptake
3. The sending neuron normally reabsorbs excess neurotransmitter molecules, a process called *reuptake*.

Neurotransmitters you need to know

- ***Acetylcholine***- Plays a role in learning, memory, and rapid eye movement sleep and cause the skeletal muscle fibers to contract.
- ***Monoamines***- Produces both excitatory and inhibitory effects.
- 1. ***Serotonin***- Plays an important role in regulating mood, sleep, impulsivity, aggression, and appetite.

  2. ***Dopamine***-Affects learning, attention, movement, and reinforcement.

  3. ***Norepinephrine***-Effects eating habits and plays a role in alertness.

Neurotransmitters you need to know

- ***Amino Acids***

  1. ***Glutamate***- Active in areas of the brain involving learning, thought and emotion.

  2. ***GABA***- Facilitates neural inhibition in the central nervous system. Thought to control anxiety.

- ***Endorphins***- Provide relief from pain or stress of vigorous exercise and produce feeling of well-being known as the "endorphin response." (Runner's high.)

Neural Bases of Psychology: Receptor Sites

- **normal** message

- **blocked** message (wrong shape)

- **agonistic drugs** mimic shape and enhance neurotransmitter

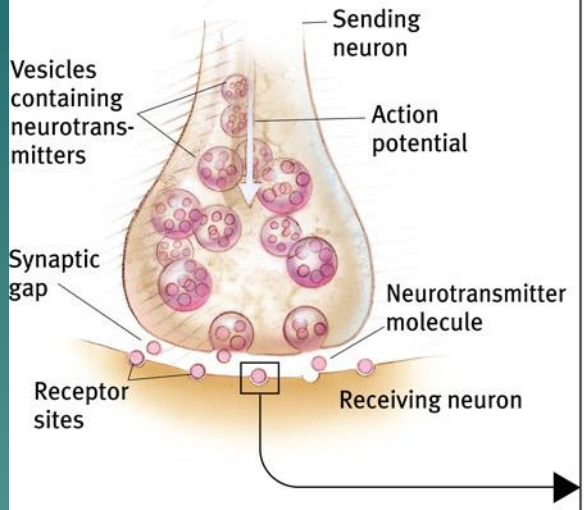
- **antagonistic drugs** fill the site and block neurotransmitter

OBJECTIVE:

Explain how drugs and other chemicals affect neurotransmission.

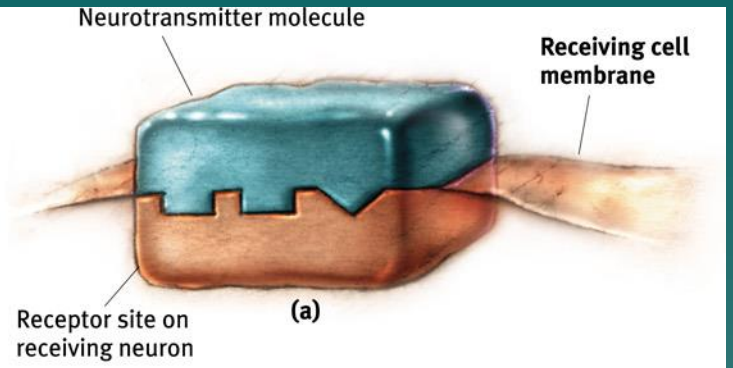
DRUGS

- Every drug that affects motor behavior works at the synapse
  - **Agonist:** helps NT do its job by *increasing release of the neurotransmitter* or increasing uptake
  - **Antagonist:** blocks NT from doing its job by *blocking the receptors* of a neurotransmitter

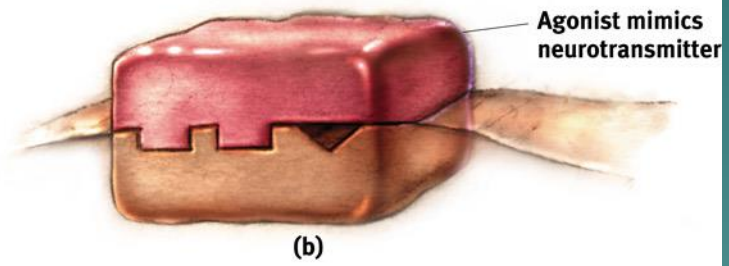


Neurotransmitters carry a message from a sending neuron across a synapse to receptor sites on a receiving neuron.

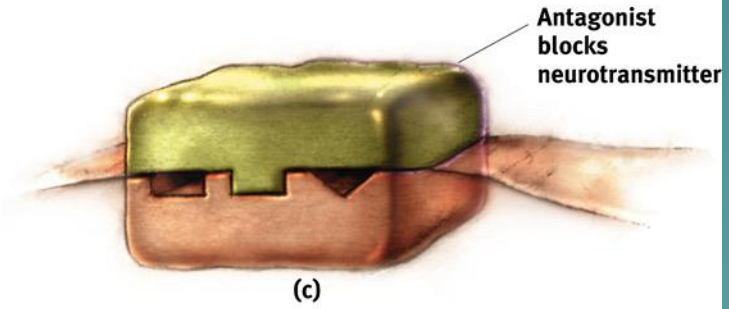
This neurotransmitter molecule fits the receptor site on the receiving neuron, much as a key fits a lock.



This agonist molecule excites. It is similar enough in structure to the neurotransmitter molecule to mimic its effects on the receiving neuron. Morphine, for instance, mimics the action of endorphins.



This antagonist molecule inhibits. It has a structure similar enough to the neurotransmitter to occupy its receptor site and block its action, but not similar enough to stimulate the receptor. Curare poisoning paralyzes its victims by blocking ACh receptors involved in muscle movement.



Examples

- **Curare (used by natives on poison darts):**
  - Stops ACh from fitting into receptor sites
- **Black Widow venom:**
  - Is similar to Ach having an agonistic effect and accelerates movement

    (seizures and convulsions)

DRUGS

- Endorphins: natural pain killing NT
  - Toughens the membrane of neurotransmitter sacs preventing them from breaking
    - Pain signal is stopped
  - Morphine: mimics endorphins (agonist)

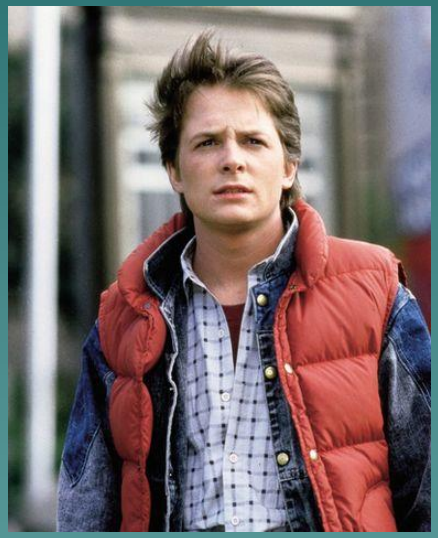
DRUGS

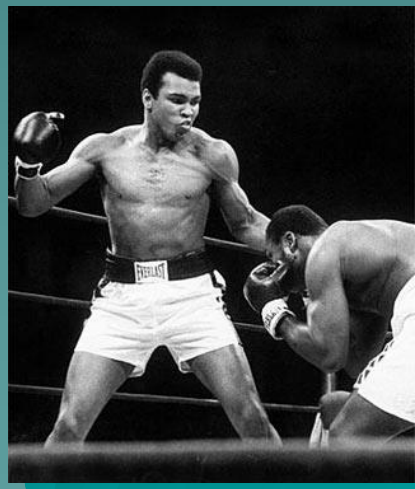
- Dopamine (NT): excessive levels in the brain associated with schizophrenia and low levels associated with Parkinson's disease
  - Thorazine used for schizophrenia patients b/c it blocks dopamine (antagonist)
  - L-Dopa used for Parkinsons (agonist)
    - Patients develop tolerance

Parkinson's Disease and Neurotransmitters

1. When the *dopamine* level drops below 80%, symptoms of Parkinson's disease begin to emerge.
2. The loss of dopamine causes the nerve cells of the basal ganglia to fire out of control, leaving patients unable to direct or control their movements in a normal manner.

SOME PEOPLE WITH PARKINSON"S DISEASE

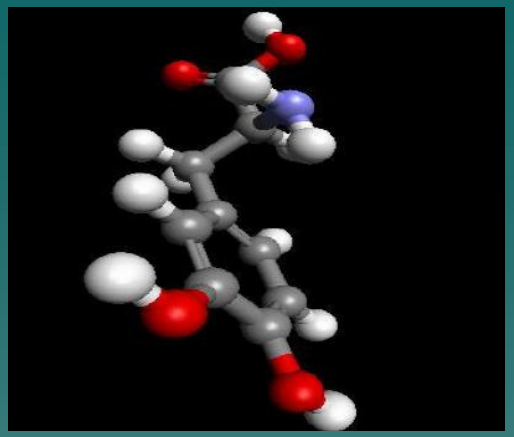




Dr. Oliver Sacks

- Dr. Oliver Sacks documented one patient.
- The patient would move his arm so slowly, it was virtually undetectable.
- AM – hand on knee
- Noon – Hand halfway to face
- Evening – at his nose
- After administering L-Dopa, patient told him "I was merely wiping my nose."

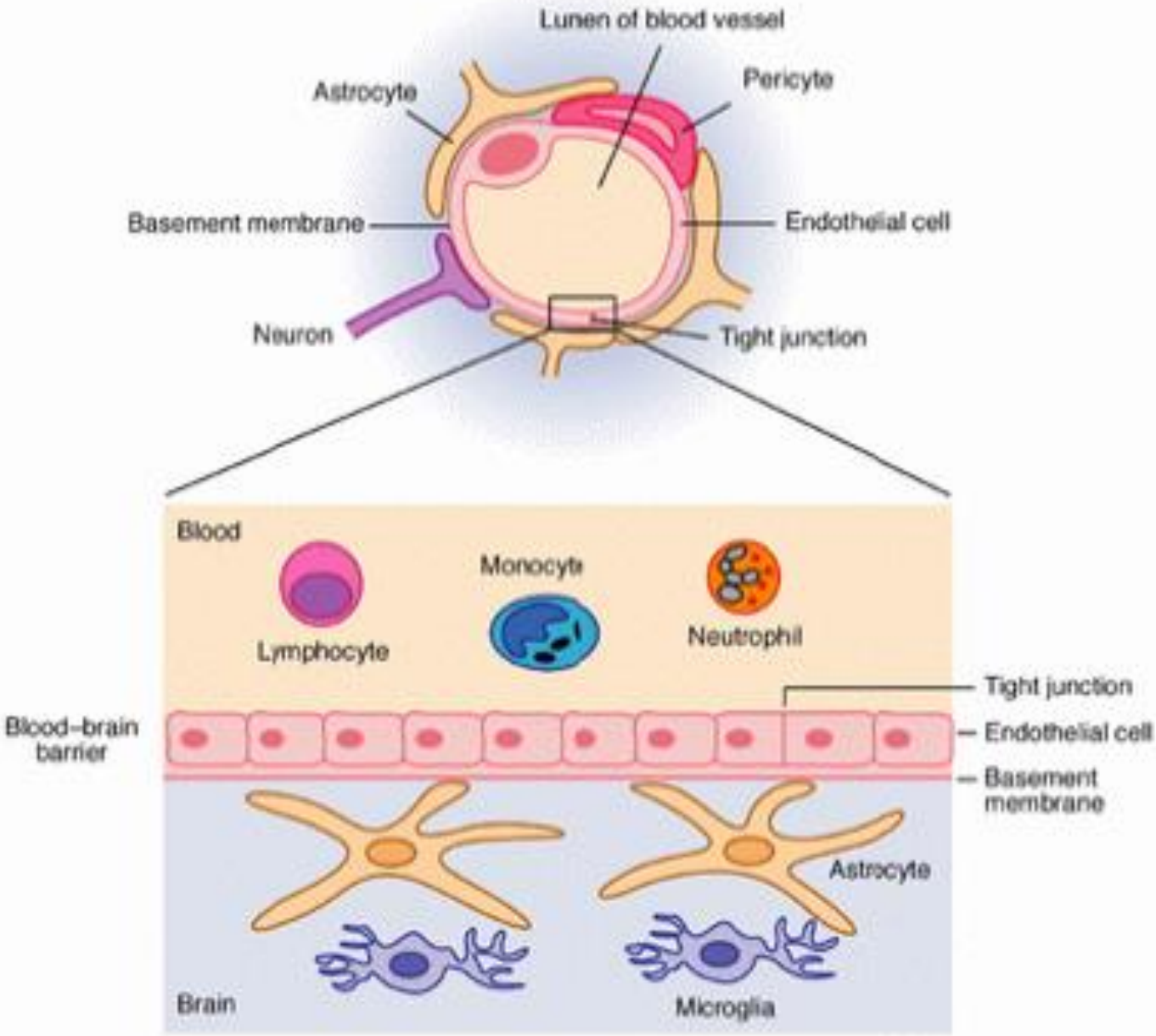
L-Dopa



- Dr. Sacks treated his patients with the then-experimental drug, L-dopa
- L-Dopa is an *amino acid and* absorbed by the digestive system
- Pharmacologists found that

  L-dopa could cross the blood- brain barrier, whereas, *dopamine* treatments could not.

•The blood-brain barrier prevents many low-life forms, such as toxins, that make it into the blood stream from tainting the brain's pristine nerve cell habitat.



L-Dopa and Dr. Sacks

- L-DOPA is able to pass the bloodbrain barrier.
- In this way, L-DOPA can replace the some of the deficit in dopamine seen in parkinsonism.

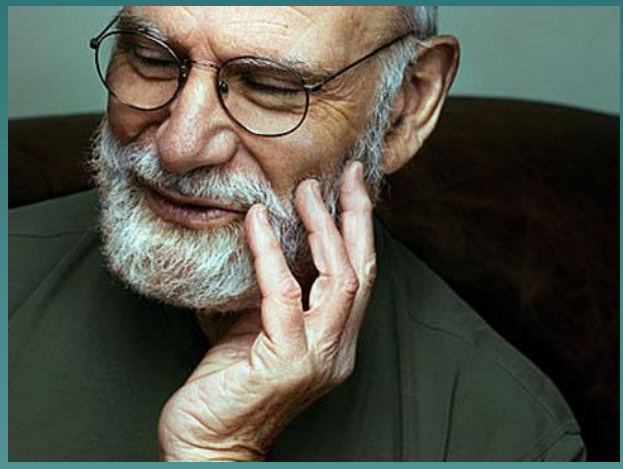
- Sacks' case study showed that it may be possible to correct a brain disorder by replenishing the supply of a missing neurotransmitter.

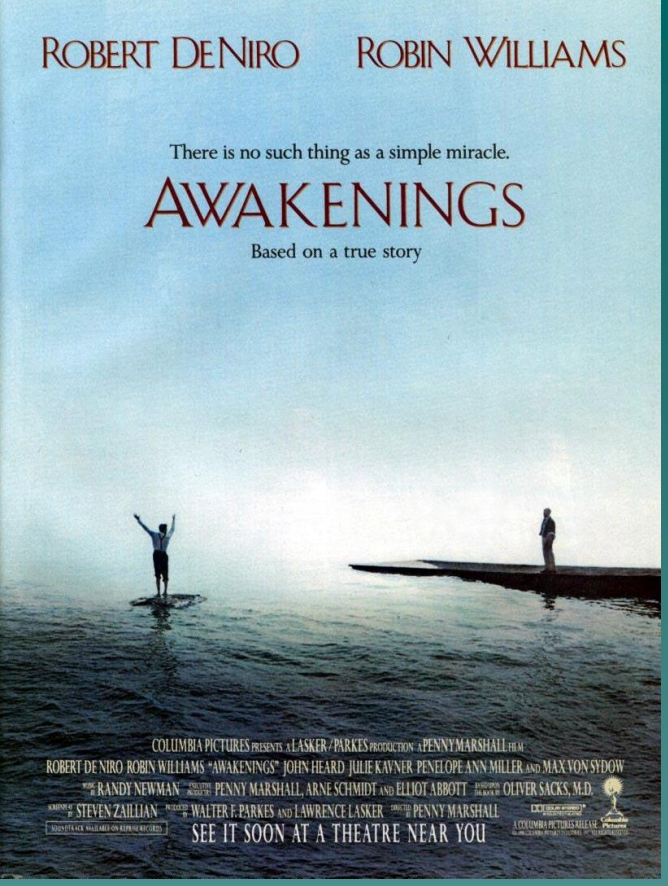
Unpredictable side effects

•Dr. Sacks: "Yo-yo reactions began occurring in a majority of my patients; and along with these, there increasingly occurred an extreme and ever increasing sensitivity to L-dopa…"

• Symptoms included nausea, anxiety, irritability, hyperactivity, clumsiness,
hallucinations, and uncontrollable movement

• Patients who had "awakened" in response to the drug, were taken off it, and returned to
their original state.



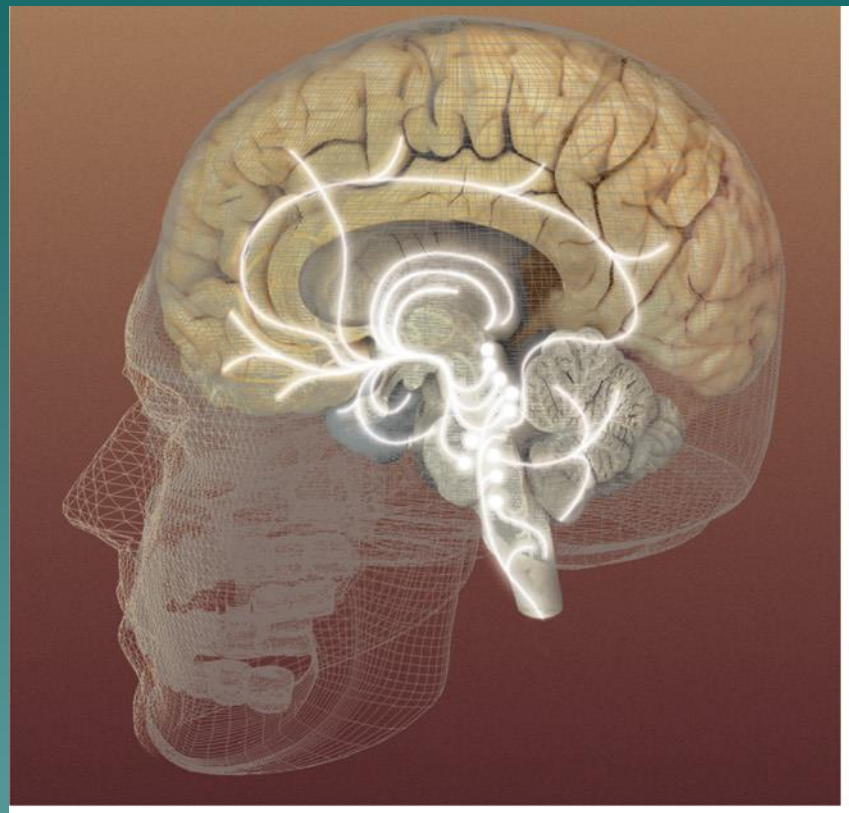


Currently, there is no cure for Parkinson's disease.
The goals of treatment are:

- 1) to minimize disability
- 2) reduce the possible side effects of drug therapy
- 3) help the patient maintain the highest possible quality of life.

Seratonin (NT)

- Low levels associated with depression
- Administer prozac – prevents reuptake (agonist)
- M.A.O.'s breakdown seratonin
  - M.A.O. inhibitors help seratonin (agonist)
- S.S.R.I. (selective seratonin reuptake inhibator)



Serotonin pathways

Dopamine pathways