Module 1:
Nerves and Impulses

Presented by: Ms. Camille Joyce Arquiza, MA, RN, LPT, RPSY

BIOLOGICAL PSYCHOLOGY

What is Biological Psychology?

01

Biological approach believes we are a consequence of genetics and physiology.

02

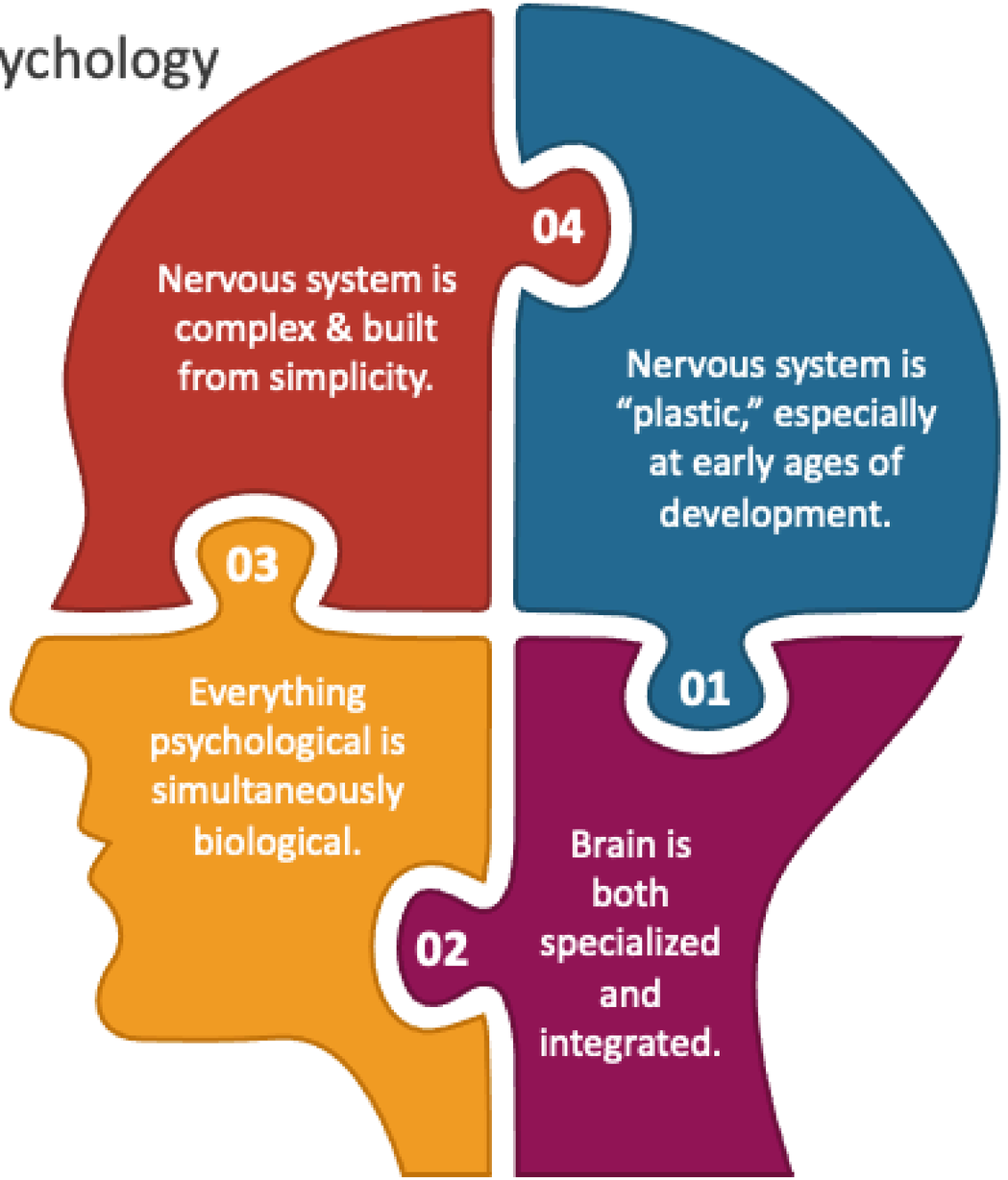
Only approach in psychology that examines thoughts, feelings, and behaviors from a biological and thus physical point of view.

03

Therefore, all that is psychological is first physiological. Thoughts, feelings & behavior ultimately have a biological cause.

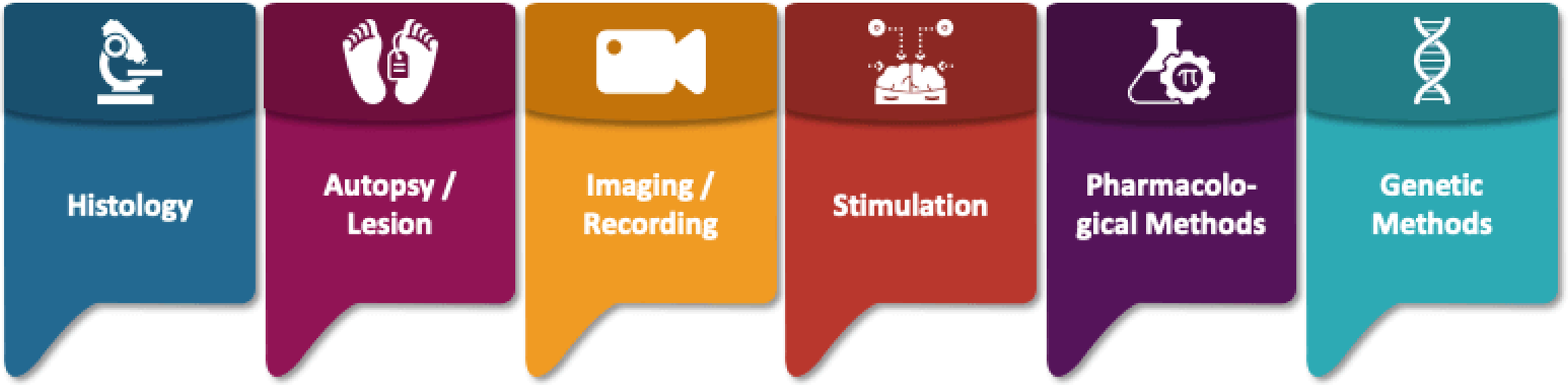
BIOLOGICAL PSYCHOLOGY

Principles of Biological Psychology



BIOLOGICAL PSYCHOLOGY

Diverse Research Methods are Used in Biological Psychology



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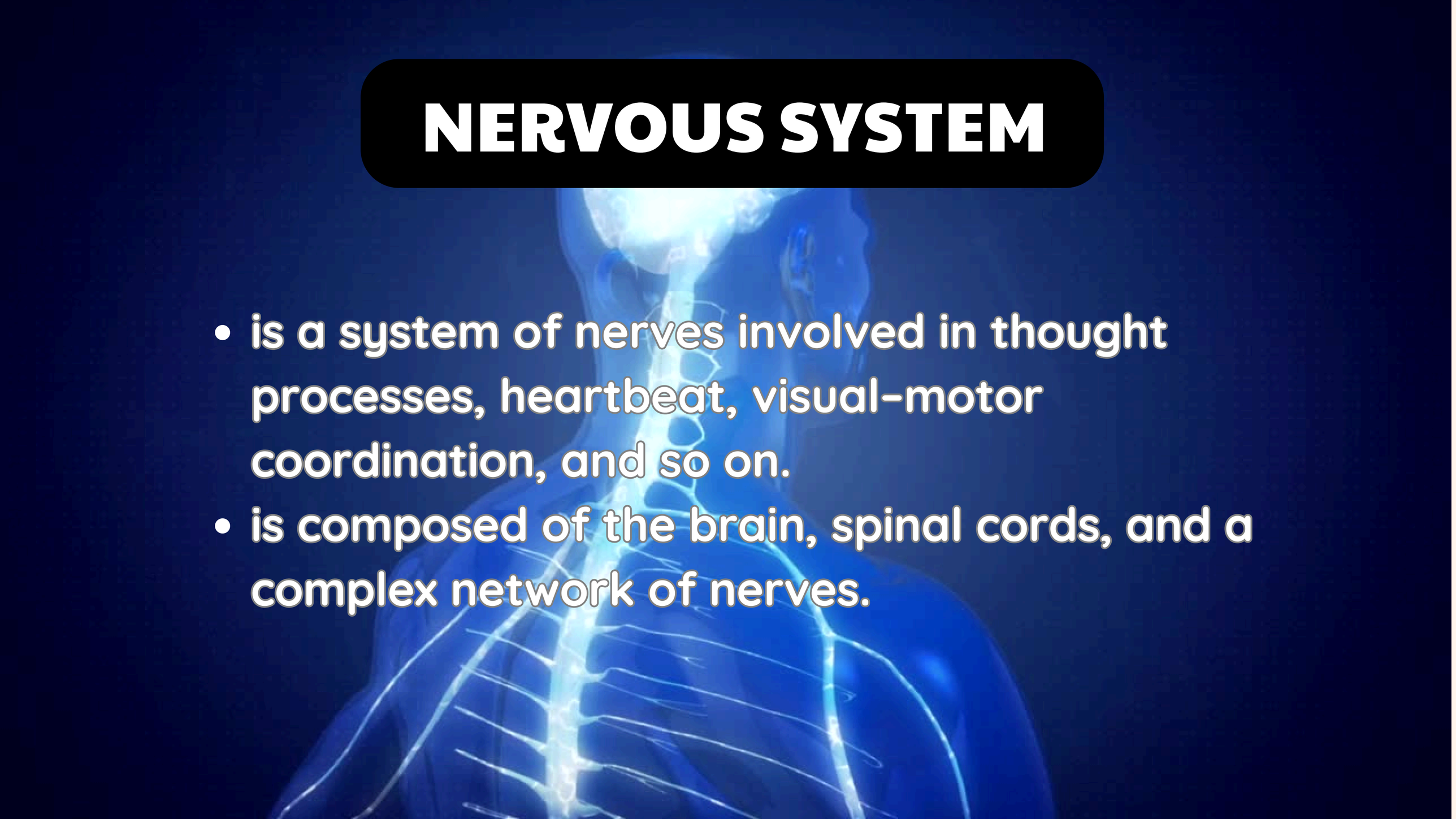
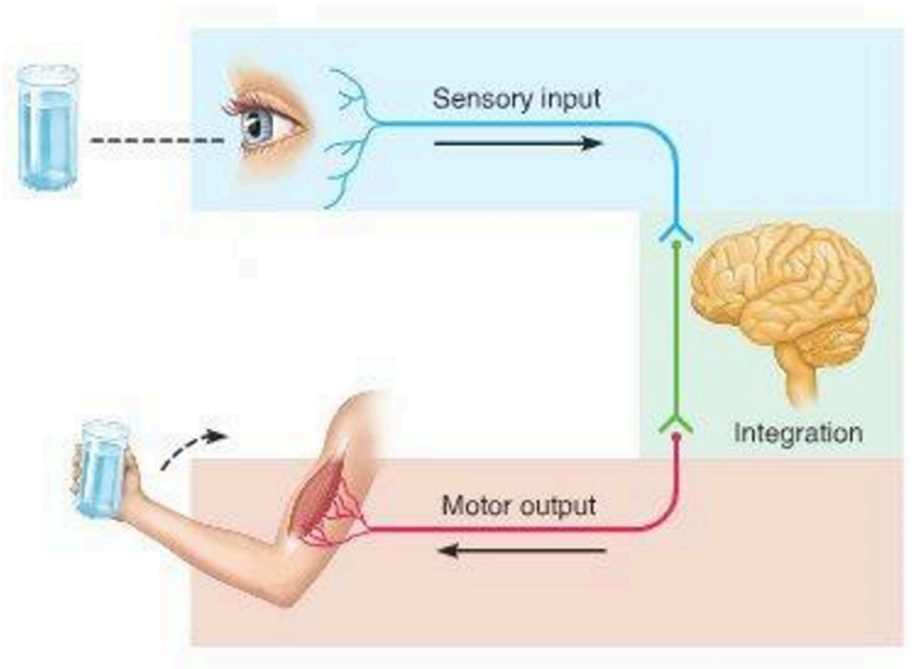
NERVOUS SYSTEM



- is a system of nerves involved in thought processes, heartbeat, visual-motor coordination, and so on.
- is composed of the brain, spinal cords, and a complex network of nerves.

The Importance of the Nervous System

1) Detect stimuli in the environment
2) Determine the significance of the stimuli
3) Make a decision based on the stimuli
4) Execute a response



Organization of the Nervous System: Two Major Divisions

- Peripheral Nervous System (PNS)
  - Detects environmental information inside and outside the body, which is transmitted to the CNS
  - Executes responses to stimuli
- Central Nervous System (CNS)
  - Recognizes and analyzes information from the PNS
  - Makes and transmits decisions to glands, organs, and muscles for execution

Neurons

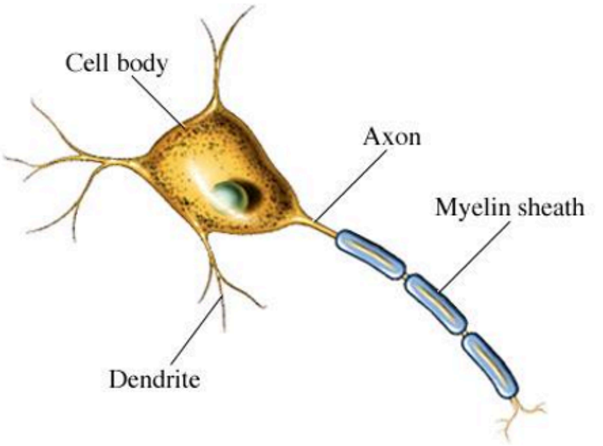
- a specialized cell of the nervous system that receives and transmits messages.
- Bundle of neurons are called NERVES
- About 100 billion neurons (nerve cells) in the human brain

Cells of the Nervous System:

Nerve cells – neurons perform the information processing and communication functions of the nervous system

Glial cells - supportive cells in the nervous system. The glial cells surround neurons and provide support for and insulation between them.

Cells of the Nervous System: Neurons



Perform information processing and communications functions of the nervous system

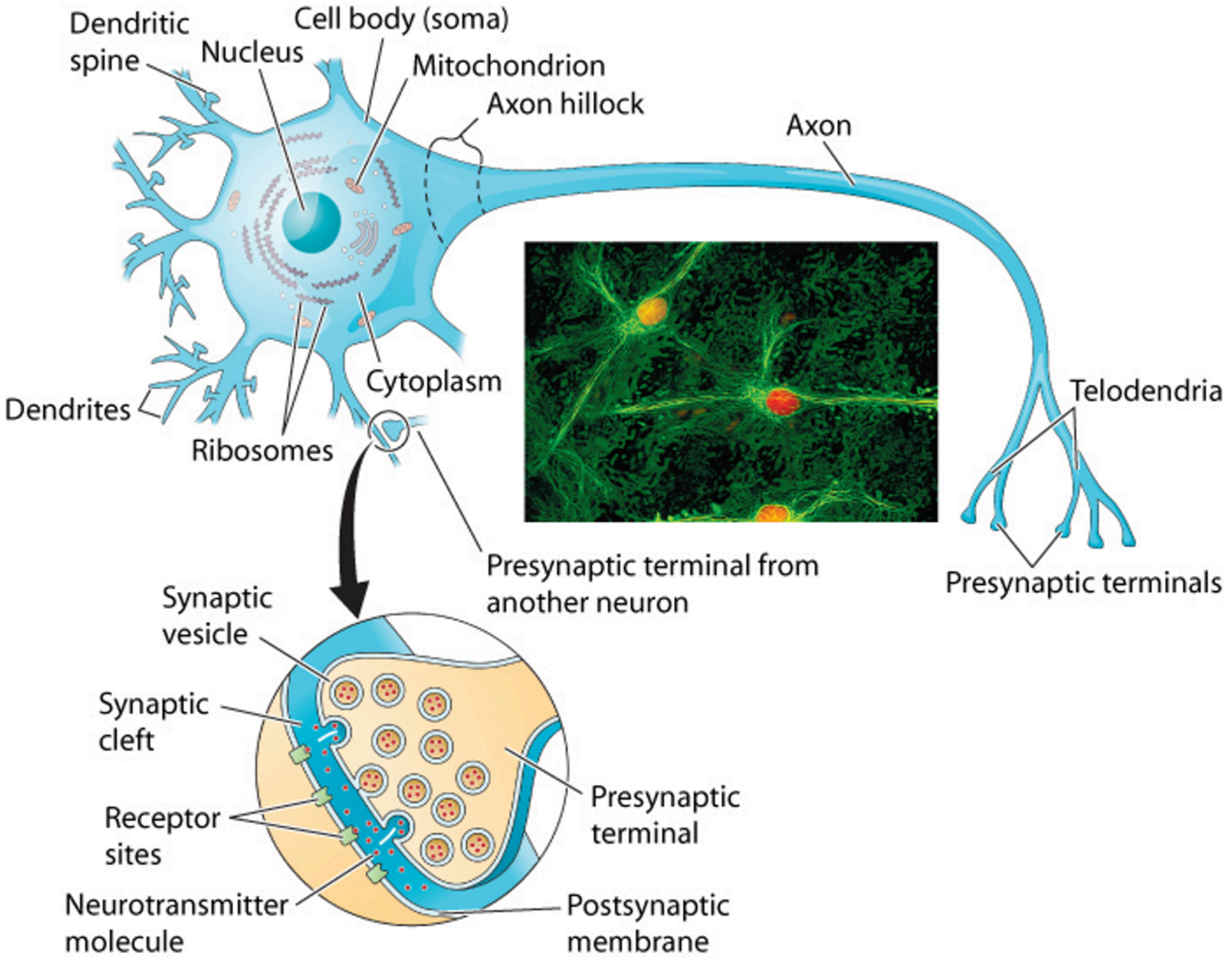
- Consist of three major parts:
  1. Soma - contains nucleus, mitochondria, and ribosomes
  2. Dendrites - portions of the neuron that transmit information toward the cell body
  3. Axon - a structure on the neuron which transmits information away from the cell body

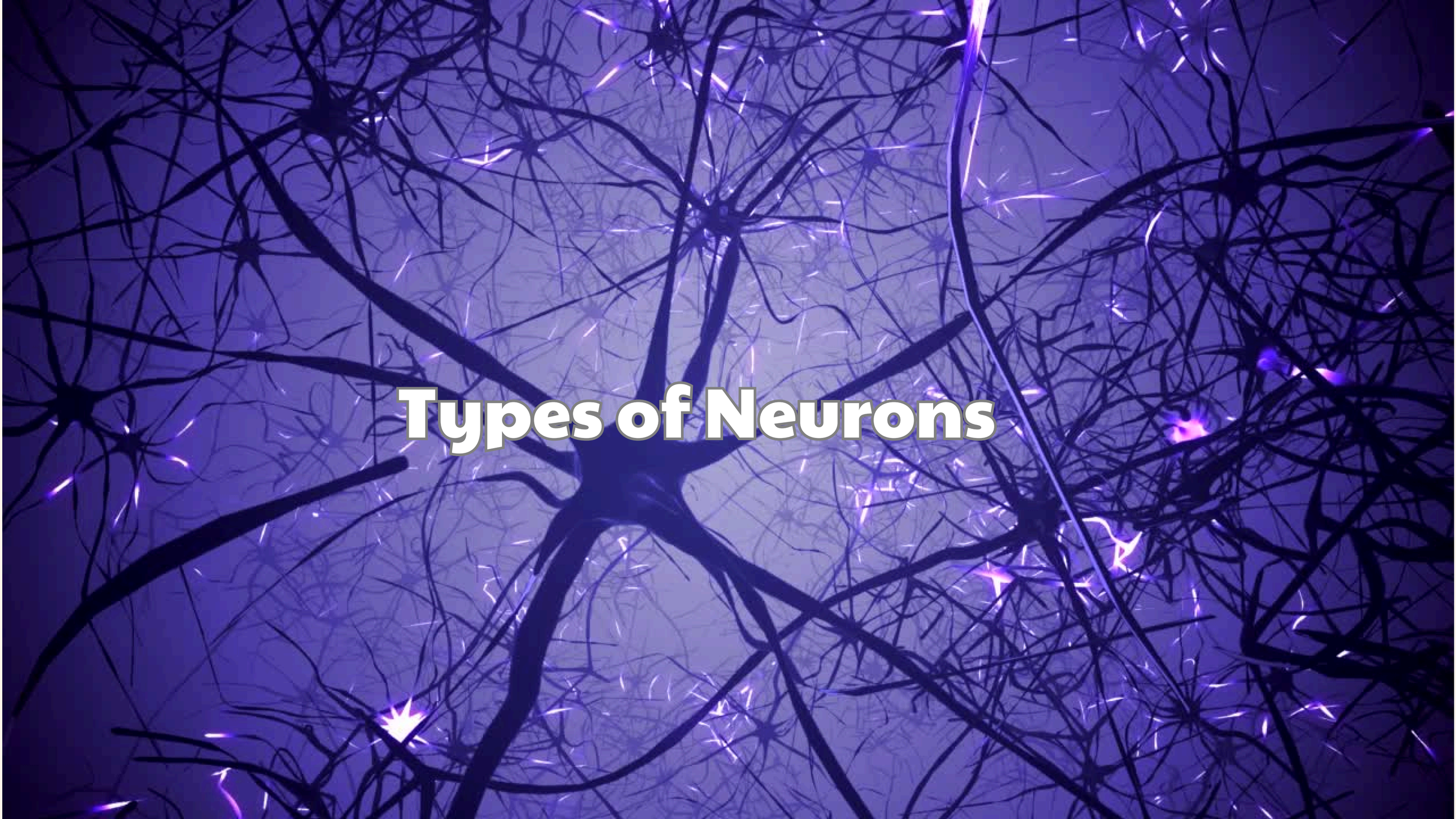
Cells of the Nervous System: Terminology

Groups of neurons form *four* functional groups:

- A collection of axons
  - Nerve – in the Peripheral Nervous System (PNS)
  - Tract – in the Central Nervous System (CNS)

- A collection of cell bodies
  - Ganglion – within the PNS
  - Nucleus - within the CNS


Dendritic spine
Nucleus
Cell body (soma)
Mitochondrion
Axon hillock
Axon
Dendrites
Ribosomes
Cytoplasm
Telodendria
Presynaptic terminal from another neuron
Presynaptic terminals
Synaptic vesicle
Synaptic cleft
Receptor sites
Neurotransmitter molecule
Presynaptic terminal
Postsynaptic membrane


Types of Neurons

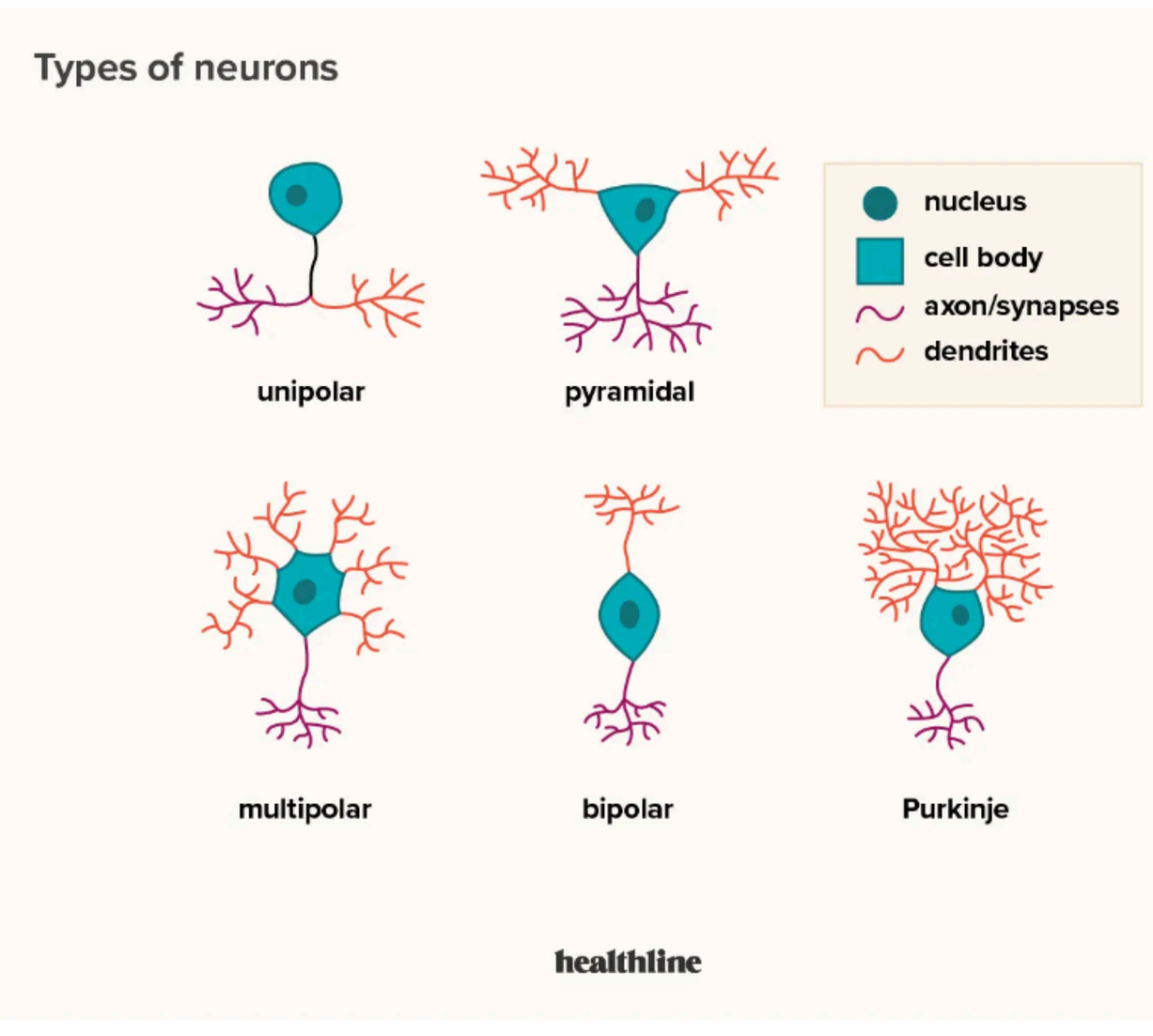
A. BASE ON STRUCTURE

Multipolar neurons

- These neurons have a single axon and symmetrical dendrites that extend from it.
- most common form of neuron in the central nervous system.

Unipolar neurons

- only found in invertebrate species, these neurons have a single axon.



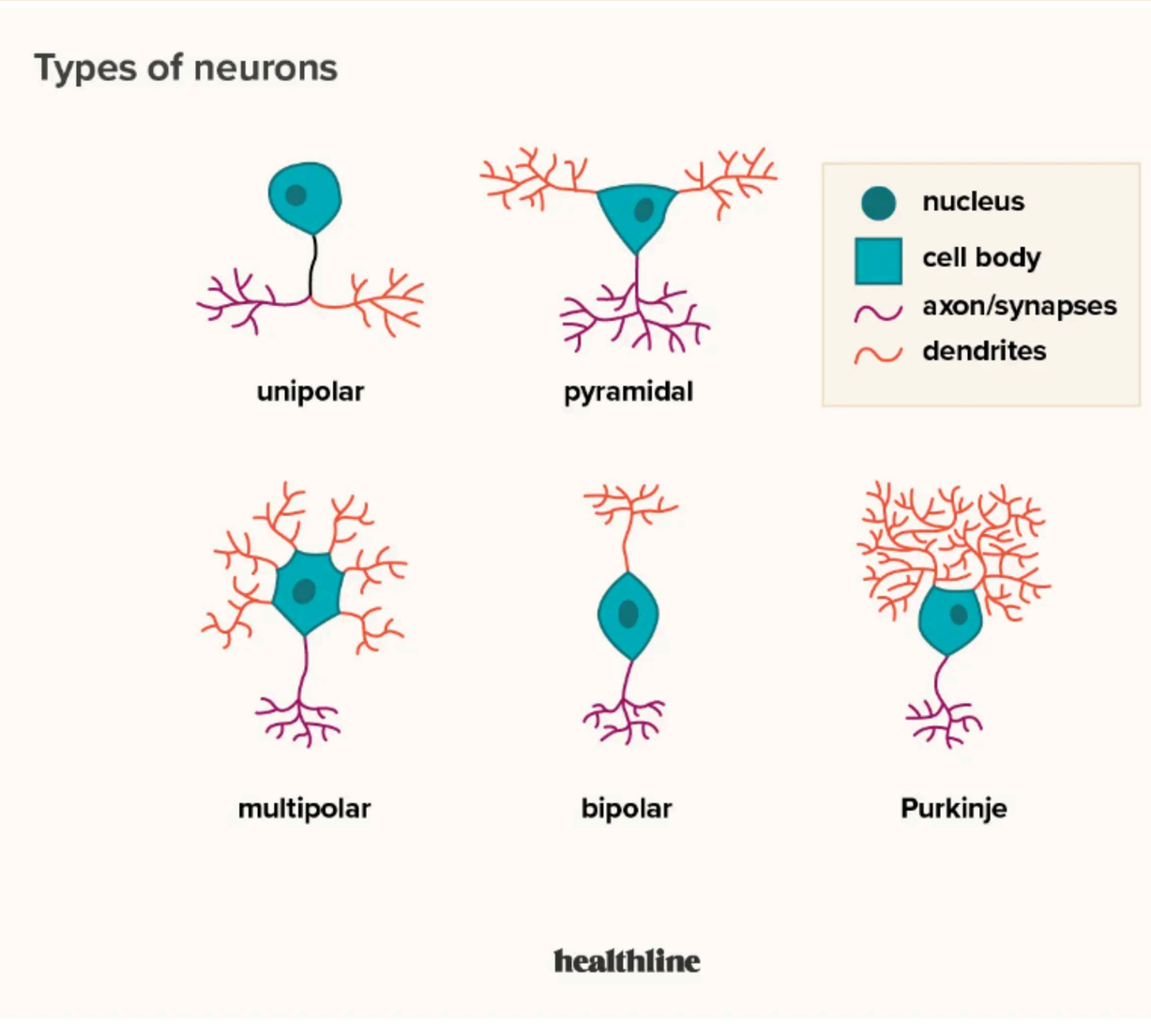
A. BASE ON STRUCTURE

Bipolar neurons.

- have two extensions extending from the cell body.
- At the end of one side is the axon, and the dendrites are on the other side.
- mostly found in the retina of the eye.
- help the nose and ear function.

Pyramidal neurons.

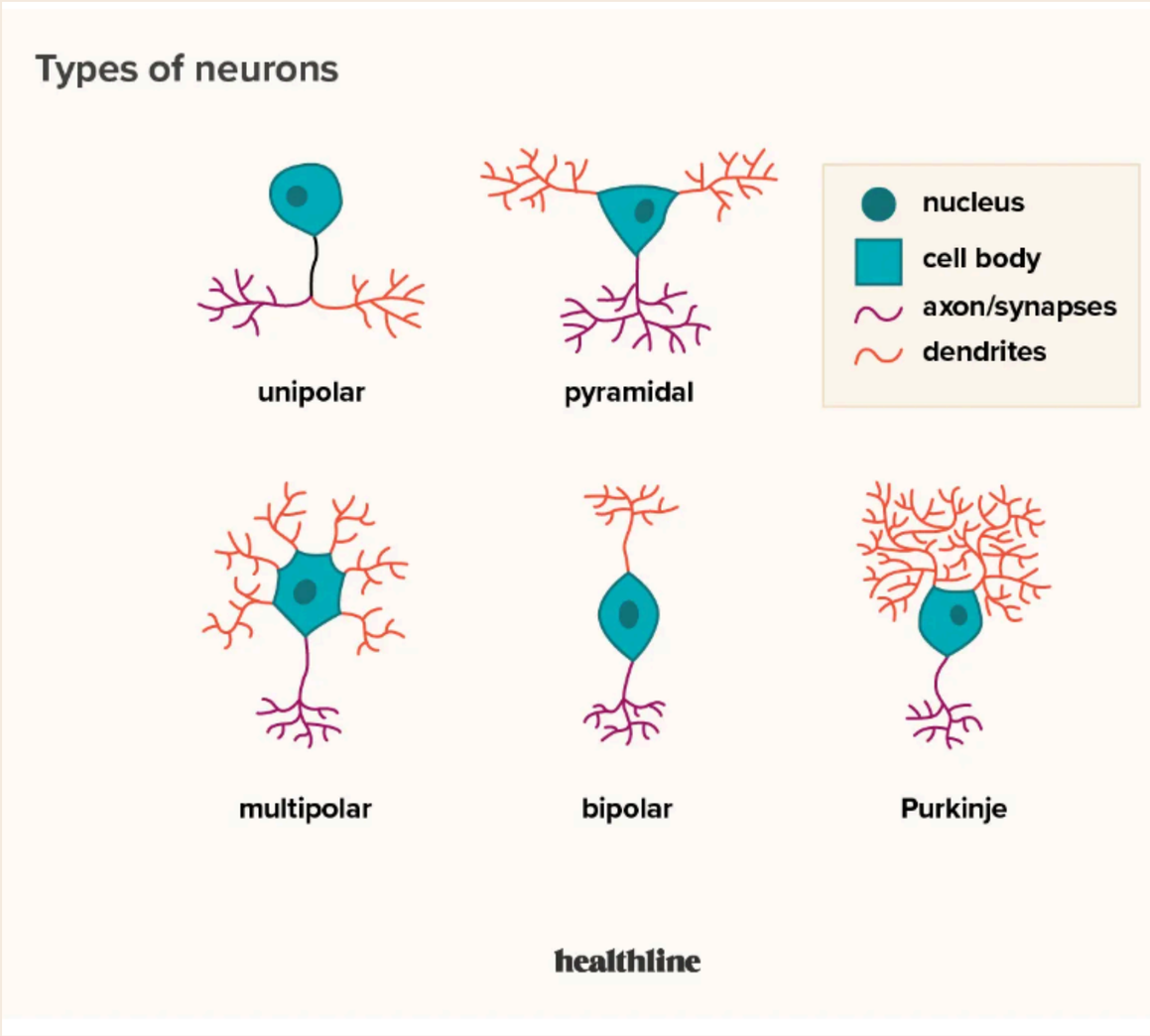
- have one axon but several dendrites to form a pyramid-type shape.
- are the largest neuron cells
- mostly found in the cortex. (responsible for conscious thoughts)

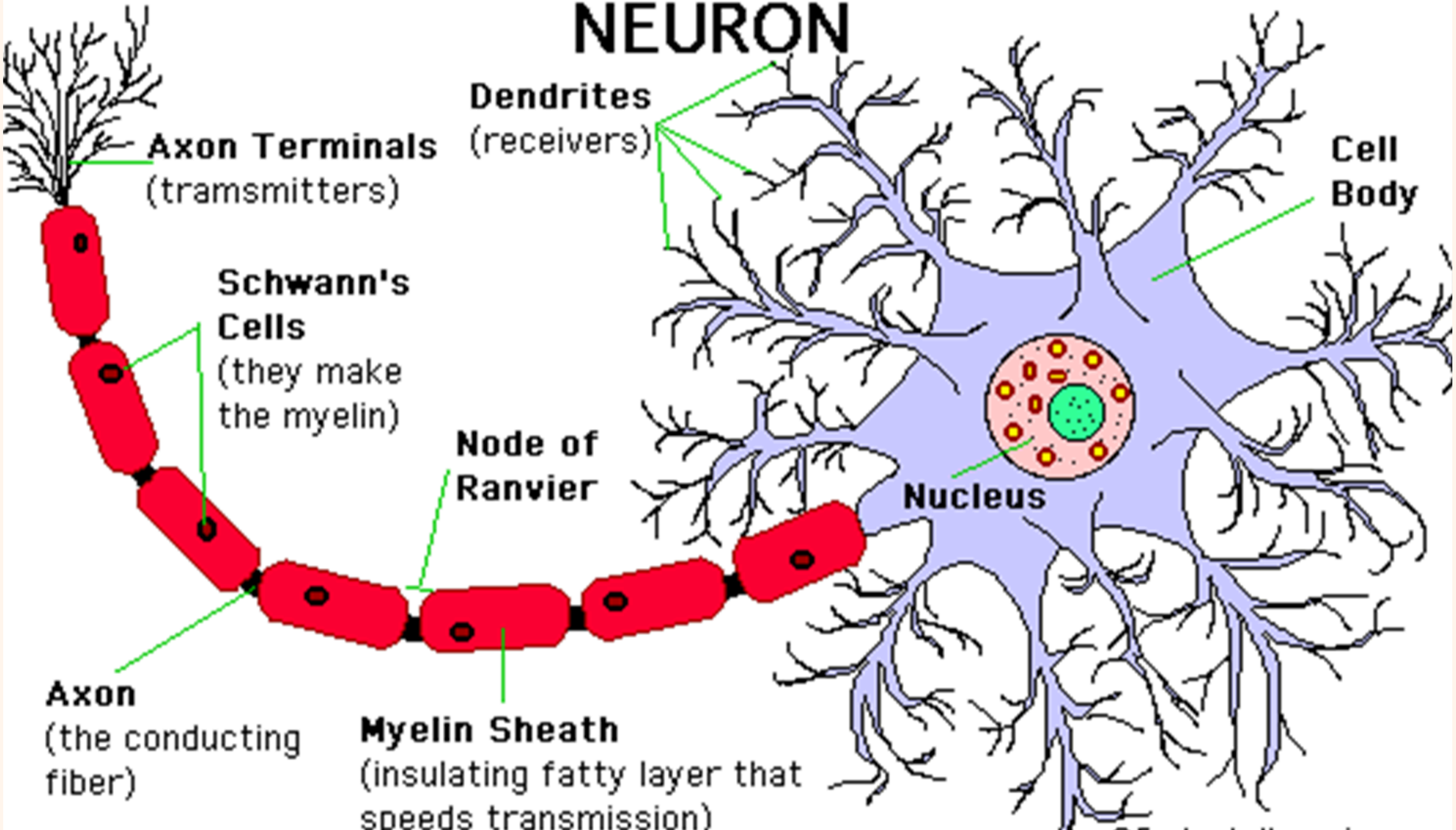


A. BASE ON STRUCTURE

Purkinje neurons.

- **have multiple dendrites that fan out from the cell body.**
- **are inhibitory neurons, (release neurotransmitters that keep other neurons from firing)**



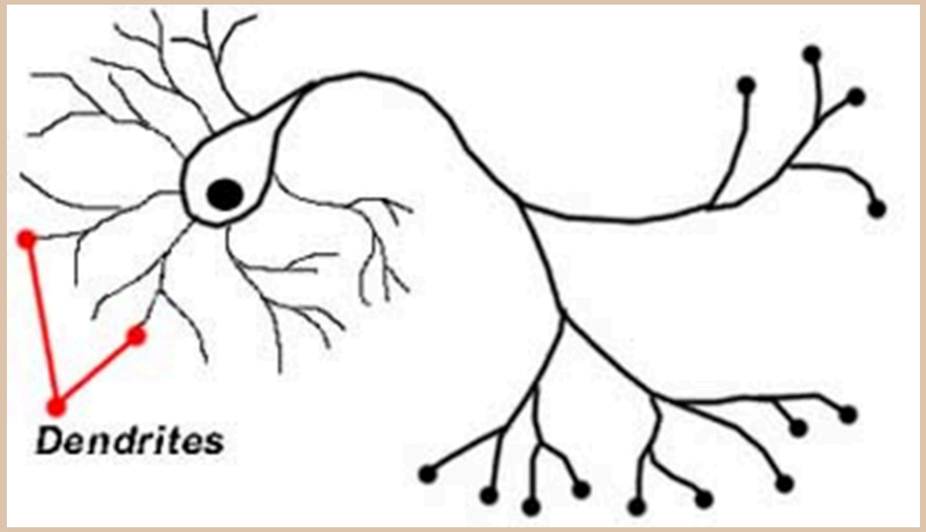

NEURON
Dendrites
(receivers)
Axon Terminals
(tramsmitters)
Cell
Body
Schwann's
Cells
(they make
the myelin)
Node of
Ranvier
Nucleus
Axon
(the conducting
fiber)
Myelin Sheath
(insulating fatty layer that
speeds transmission)

DENDRITES

•The dendrite, or “receiver” part of the neuron, which accepts most of the incoming messages.

-Consists of finely branched fibers.

-Selectively permeable



DENDRITES

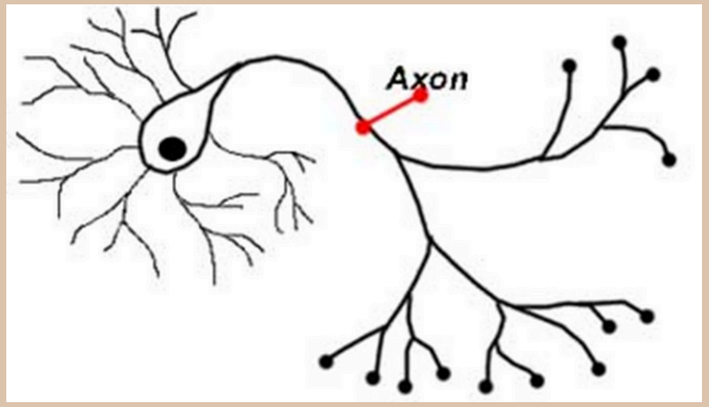
•Dendrites complete their job by passing the incoming message on to the central part of the neuron called the soma.

•The soma, or cell body, contains the cell's nucleus and life-support machinery.

–The function of the soma is to assess all messages the cell receives and pass on the appropriate information, at the appropriate time.

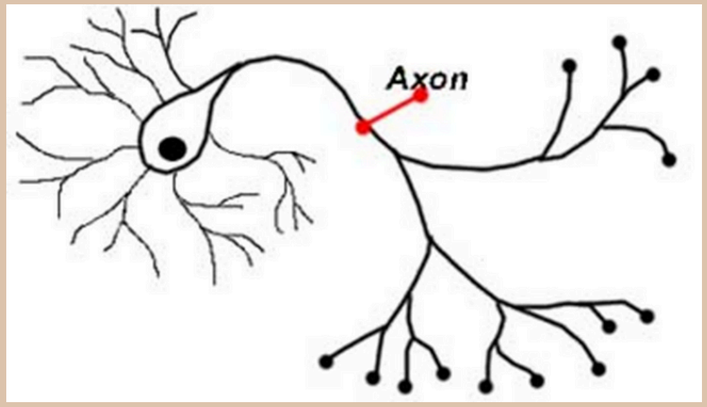
AXON

•When the soma decides to pass-on a message, it sends the message down the axon.
•The axon is a single, larger “transmitter” fiber that extends from the soma.
–This is a one way street



AXON

- The axon is the extension of the neuron through which the neural impulses are sent.
- Carries information to the next cell
- In some neurons, like those of the brain, the axons are very short.
- In others, like those in the leg, they can reach 3 feet long.



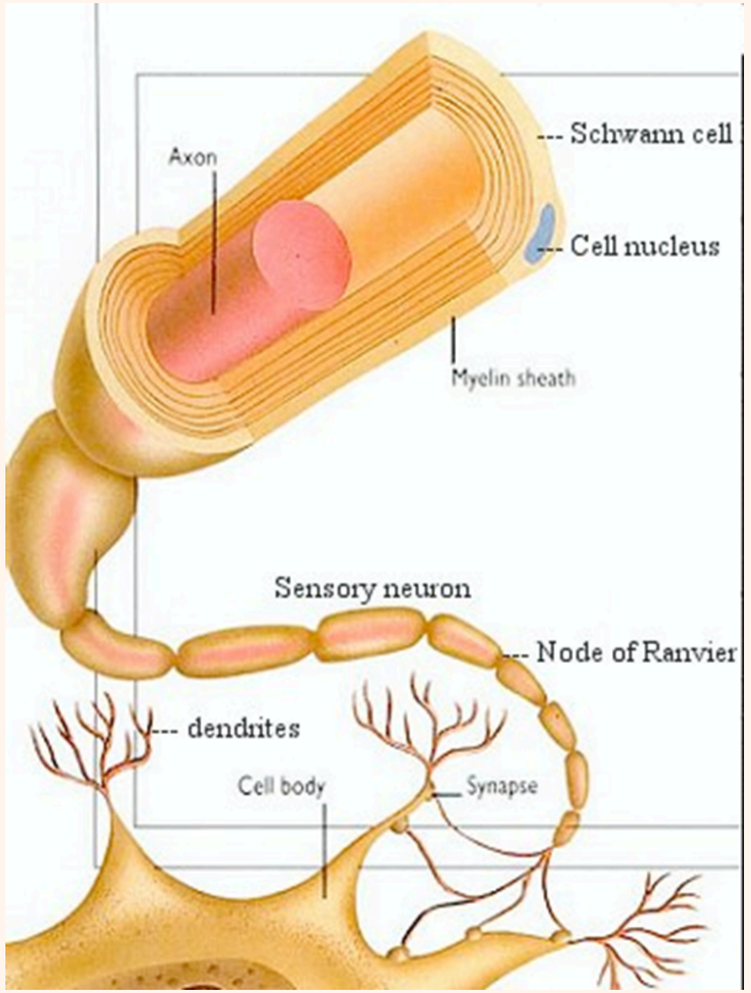
MYELIN SHEATH

••Protects & insulates the axon and the electric signal

•E.g. the orange plastic coating on an electrical cord.

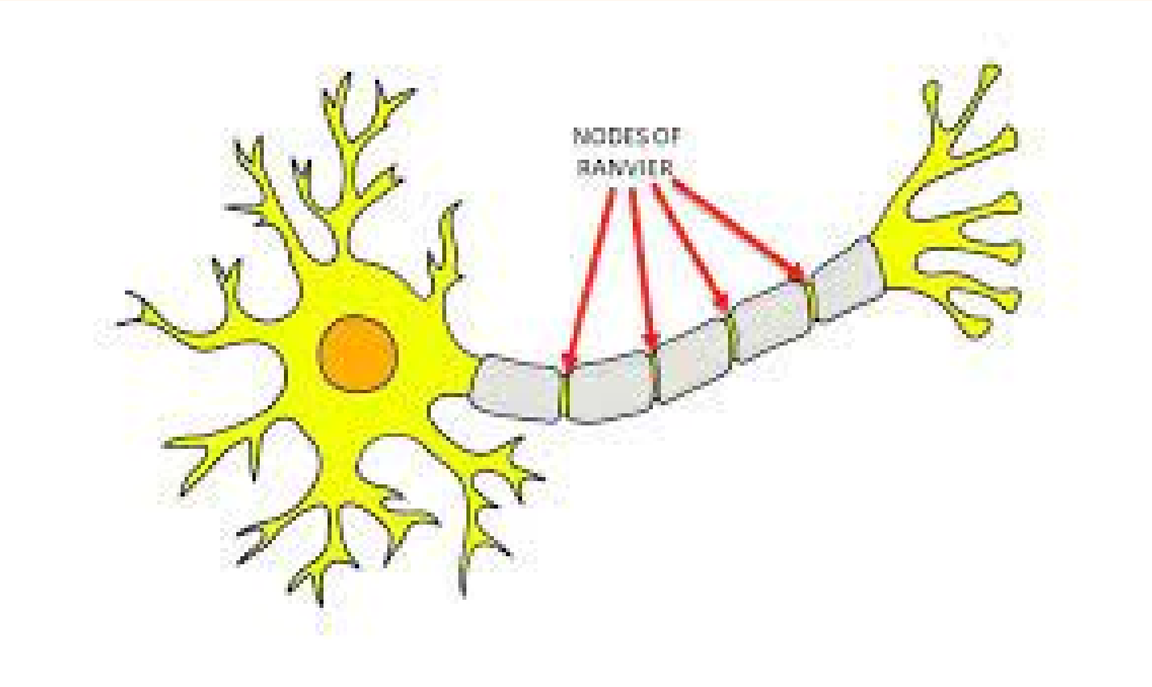
•Speeds up the neural impulse

•Made up of Schwann cells (specific type of glial cells)



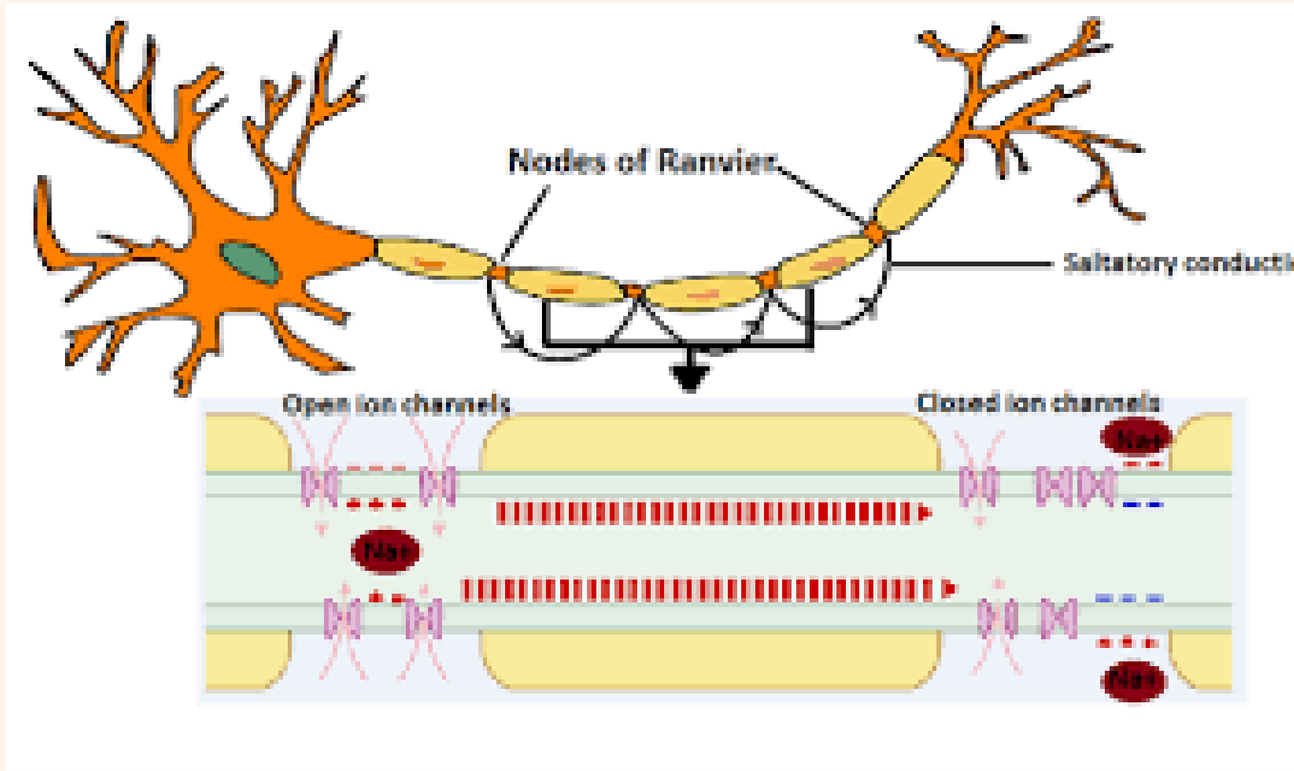
NODES OF RANVIER

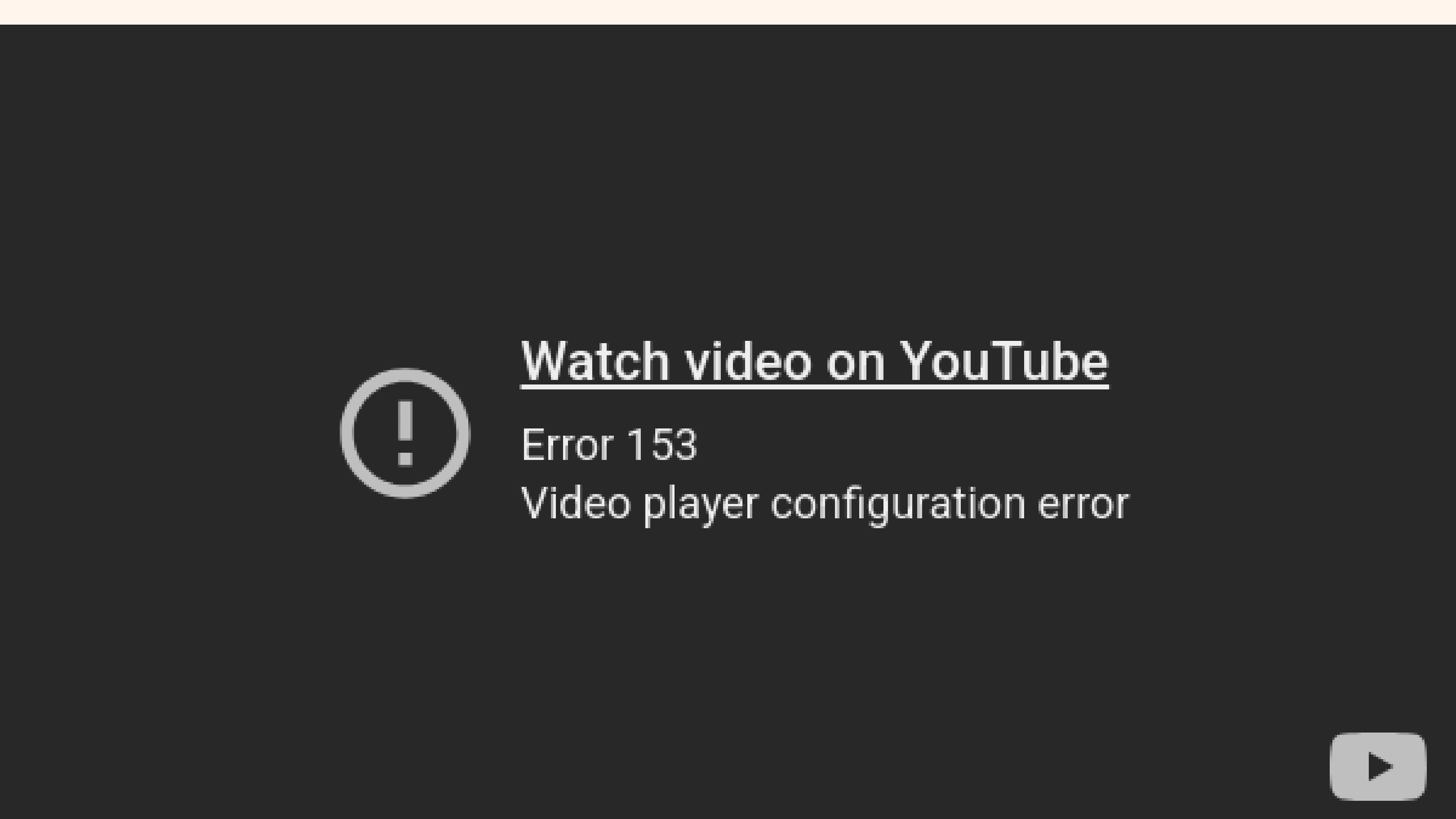
•• the gaps formed between the myelin sheath where the axons are left uncovered



SALTATORY CONDUCTION

• describes the way an electrical impulse skips from node to node down the full length of an axon,

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B. BASE ON FUNCTIONS

- While neurons can be different sizes and shapes, they all share a similar structure and function in a similar way.

– Neurons are broken into three categories based on their location and function:

- Sensory Neurons
- Motor Neurons
- Interneurons

SENSORY NEURONS

- ***Sensory neurons*, or *afferent neurons*, act like one-way streets that carry traffic from the sense organs *toward* the brain.**

The sensory neurons communicate all of your sensory experience to the brain, including vision, hearing, taste, touch, smell, pain, and balance.

MOTOR NEURONS

- ***Motor neurons,*** **or *efferent neurons*, form the one-way routes that transport messages *away* from the brain to the muscles, organs and glands.**

.

INTERNEURONS

Sensory and motor neurons do not communicate directly with each other. Instead, they rely on a middle-man.

Interneurons

- **Make up the majority of our neurons**
- **Relay messages from sensory neurons to other interneurons or motor neurons in complex pathways.**

Q

A

How does neuron fire?

HOW DOES NEURONS FIRE?

- **Resting potential**

–The axon gets its energy from charged chemicals called ions.

–Has a slight negative charge

This negative balance can be easily upset

- **Action potential**

–When the cell becomes excited, it triggers, which reverses the charge and causes the electrical signal to race along the axon.

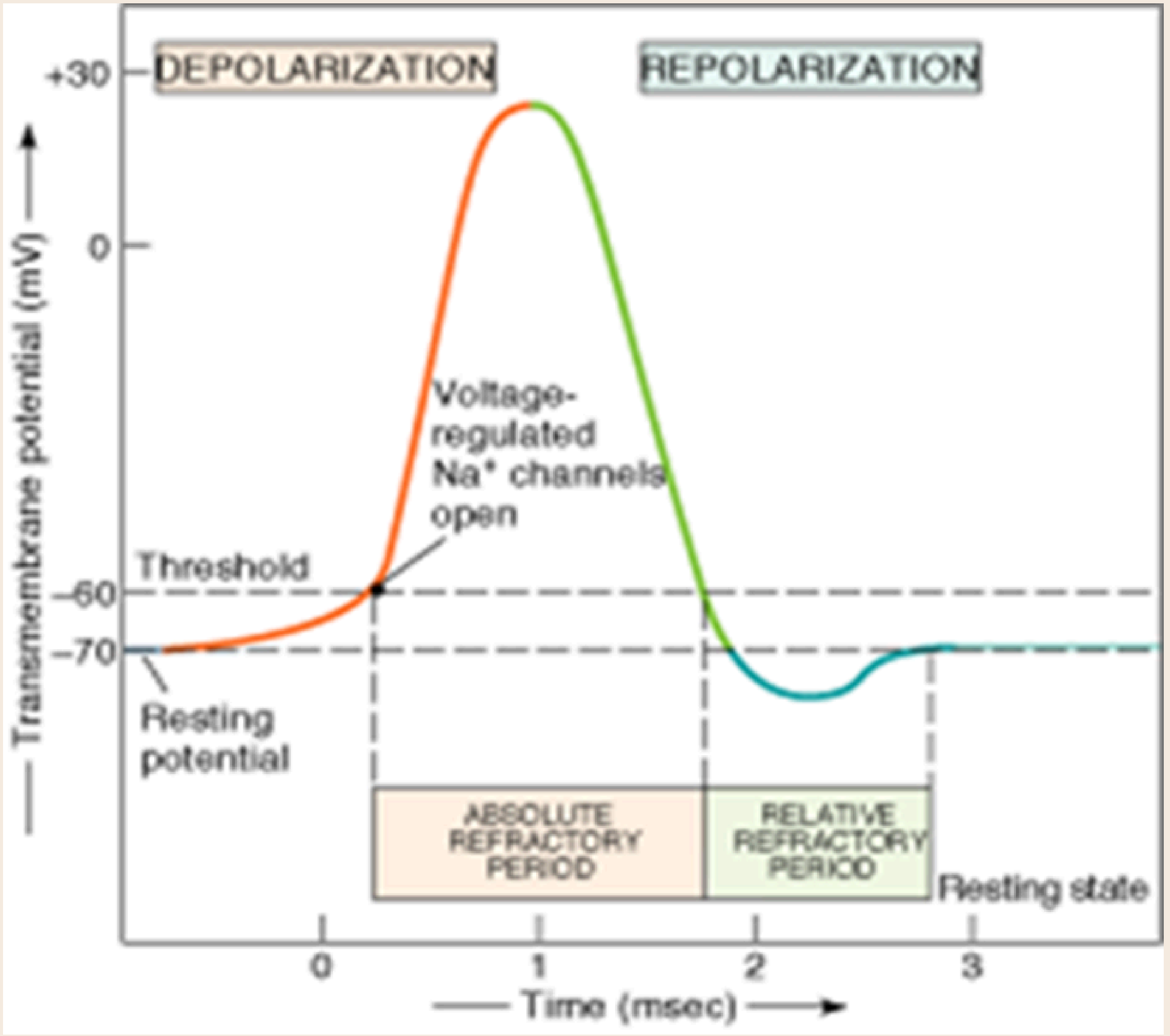
ABSOLUTE THRESHOLD

- a minimum amount of stimulus that receptors can actually detect

REFRACTORY PERIOD

- **Each action potential is followed by a brief *recharging period* known as the refractory period.**

- **After the refectory period, the neuron is capable of another action potential.**
  - **Much like waiting for the flash to recharge on a disposable camera before you can take another picture.**


DEPOLARIZATION
REPOLARIZATION
+30
0
–60
–70
Transmembrane potential (mV)
Voltage-regulated Na⁺ channels open
Threshold
Resting potential
ABSOLUTE REFRACTORY PERIOD
RELATIVE REFRACTORY PERIOD
Resting state
0
1
2
3
Time (msec)

ALL OR NOTHING

•Once the action potential is released, there is no going back.

•The axon either “fires” or it does not. This process is called the all-or-none principle.

–How do we detect a gentle touch from a slap?

A strong stimulus, like a slap, can trigger more neurons to fire, more often, but not any stronger.
•Squeezing a trigger harder won't make the bullet go faster.

Depolarization and Polarization

•Depolarization

-Depolarized describes an axon that is firing

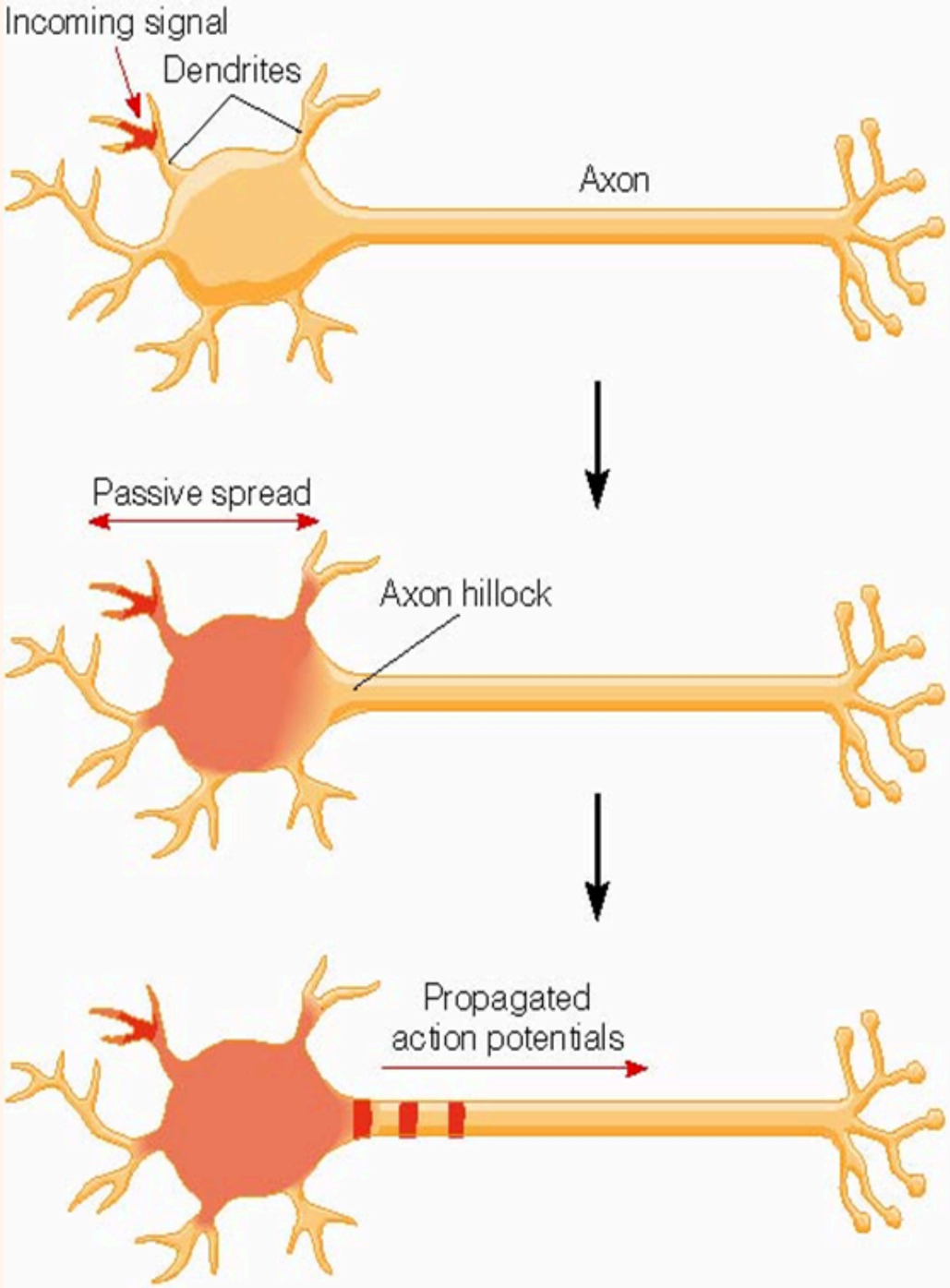
-Positive ions enter the axon, and cause other positive ions to move into the axon in the form of a neural impulse down the axon.

•Polarization

"Polarized" describes an axon that is not firing

Outside Axon = + ions

Inside Axon= - ions


Incoming signal
Dendrites
Axon
Passive spread
Axon hillock
Propagated
action potentials

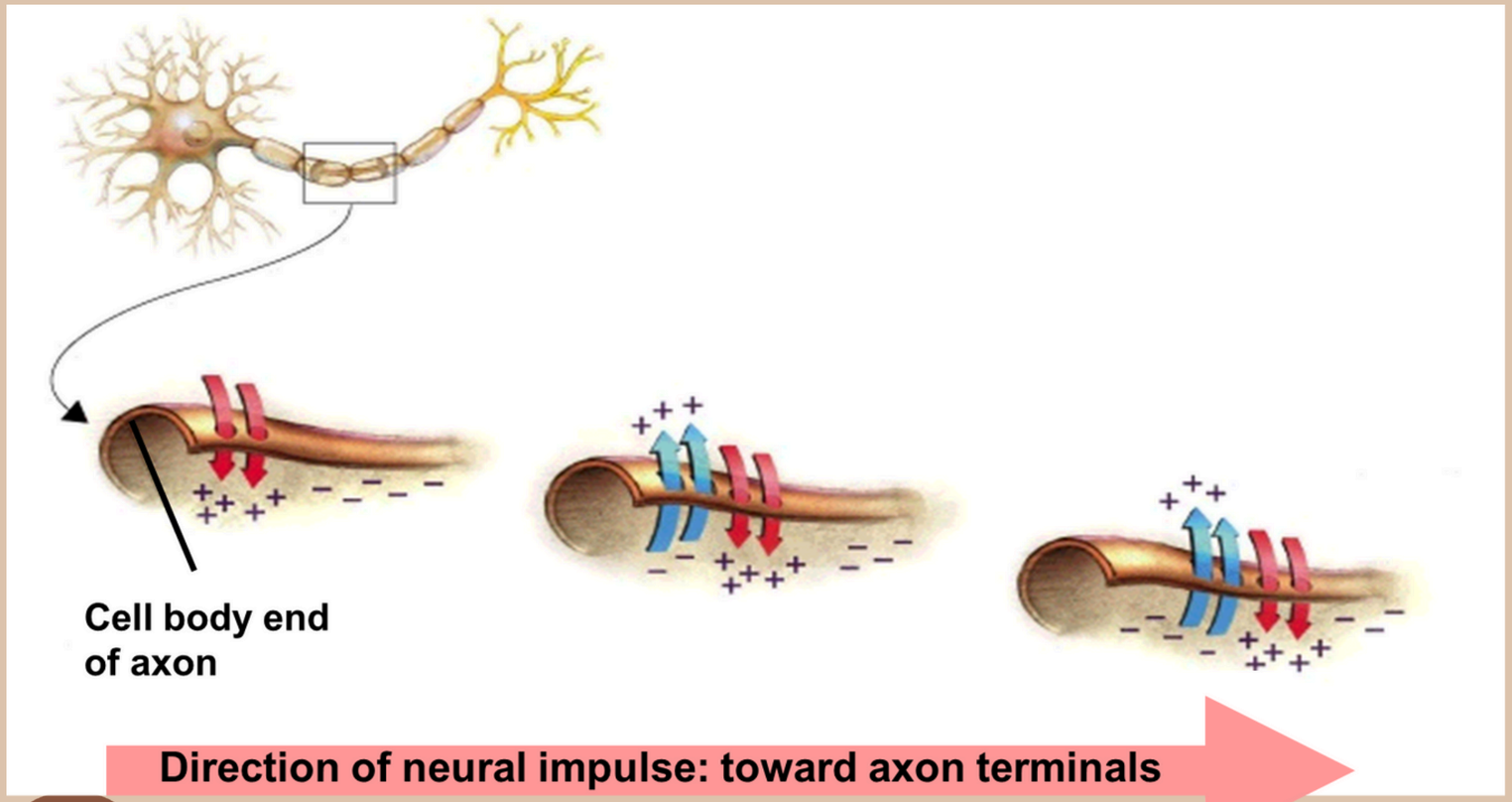
NEURAL IMPULSE

Graded Potentials

·A temporary shift in the electric charge in a tiny area of a neuron; transmitted along the cell membrane and may fade away if it doesn't reach its threshold of excitement

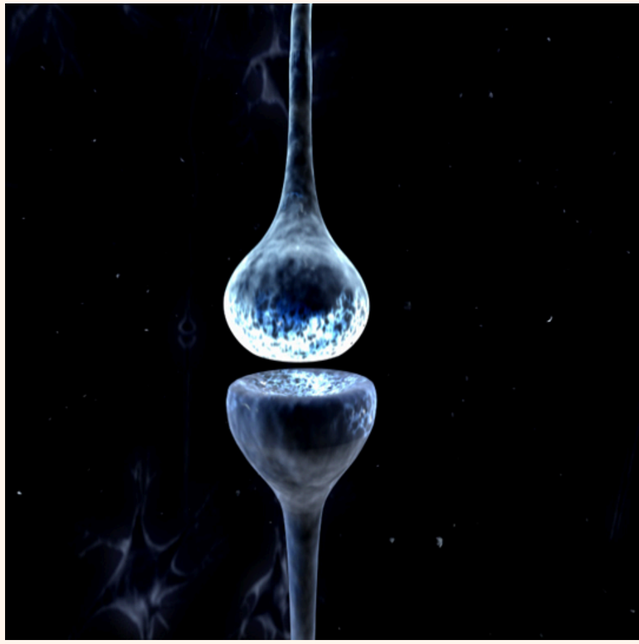
·Many subthreshold depolarizations are added together to produce an action potential (a process known as summation)

NEURAL COMMUNICATION



HOW CELLS CONNECT?

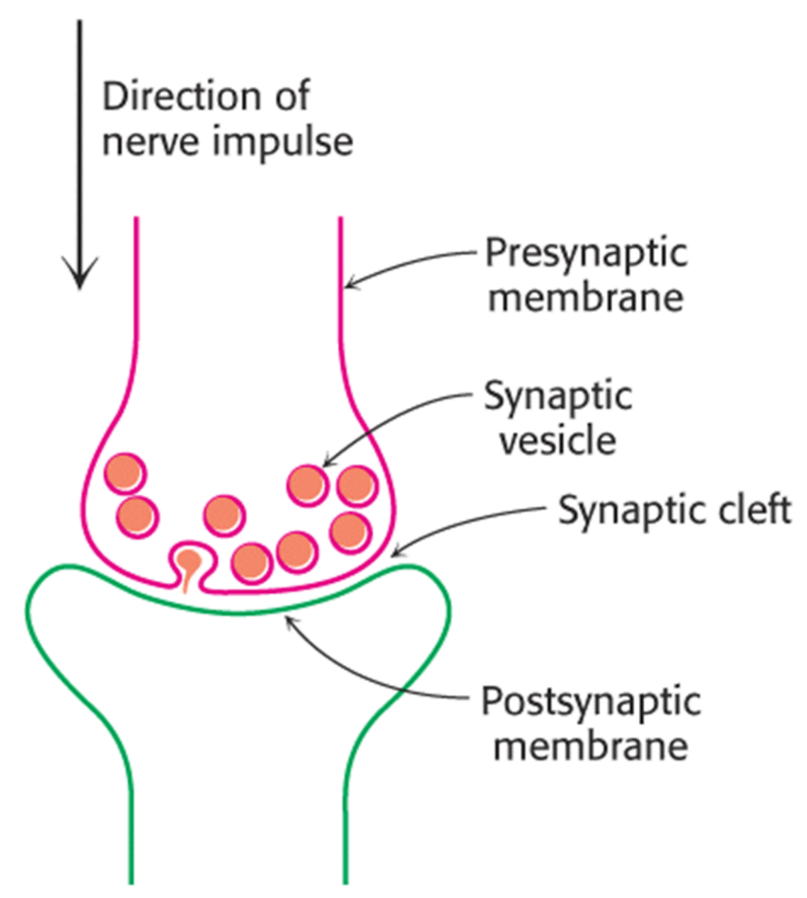
- **Neurons do not actually touch each other to pass on information.**
- **The gap between neurons is called the synapse, synaptic space or synaptic cleft**
- **The synapse acts as an electrical insulator, preventing an electrical charge from racing to the next cell.**
- **Composed of the terminal button of one neuron, the synaptic space, and the dendrites or cell body of the receiving neuron**



HOW CELLS CONNECT?

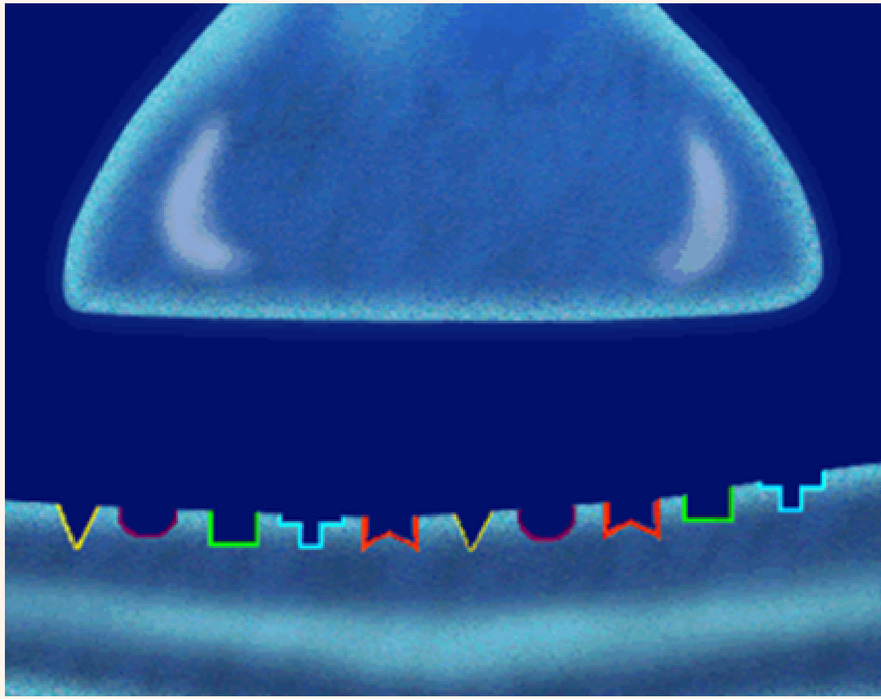
- To pass across the synaptic gap, or synaptic cleft, an electrical message must go through a change in the terminal buttons.

- This change is called synaptic transmission, and the electrical charge is turned into a chemical message that flows easily across the synaptic cleft.



HOW CELLS CONNECT?

- In the terminal buttons are small sacs called synaptic vesicles. These vesicles contain neurotransmitters (Chemicals released by synaptic vesicles) which are chemicals used in neural communication.

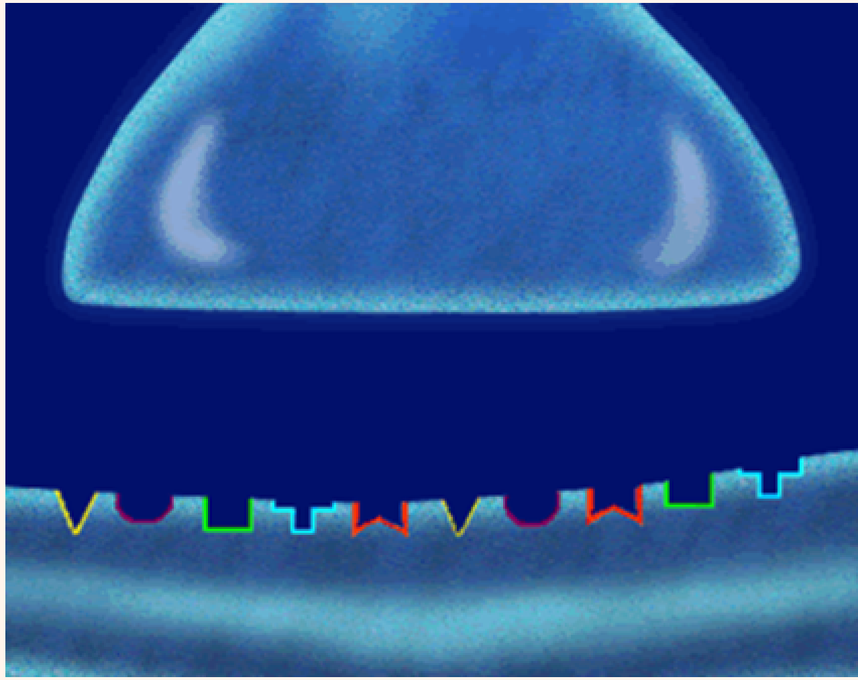


HOW CELLS CONNECT?

- Neurotransmitter molecules take 1/10 000th of a second to cross the synaptic gap

- When the action potential reaches the vesicles, theyare ruptured and the transmitters spill out. If they have the right fit, the transmitters fit into the receptors like a key into a lock.

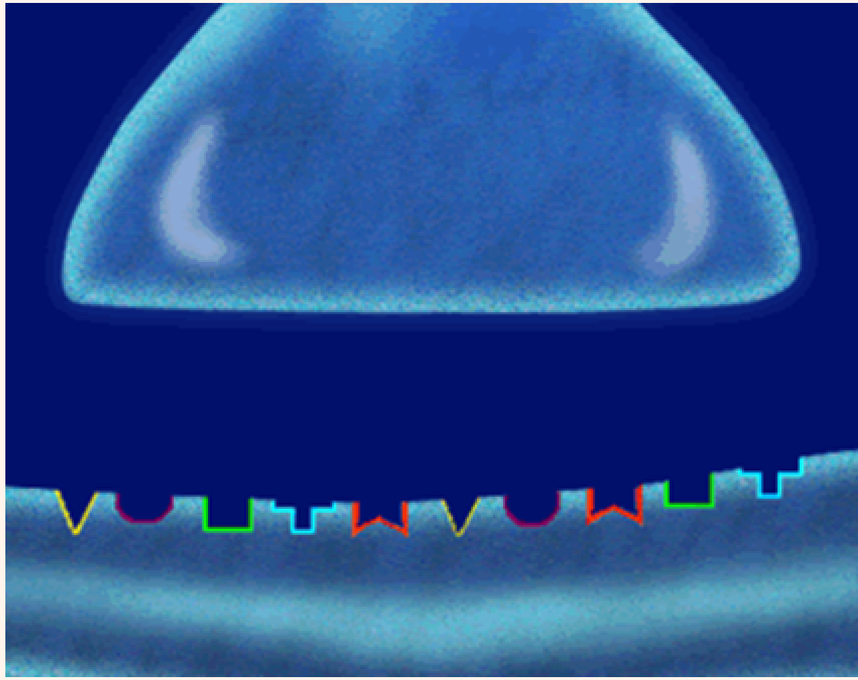
- Receptor sites: location on receptor neuron for specific neurotransmitter

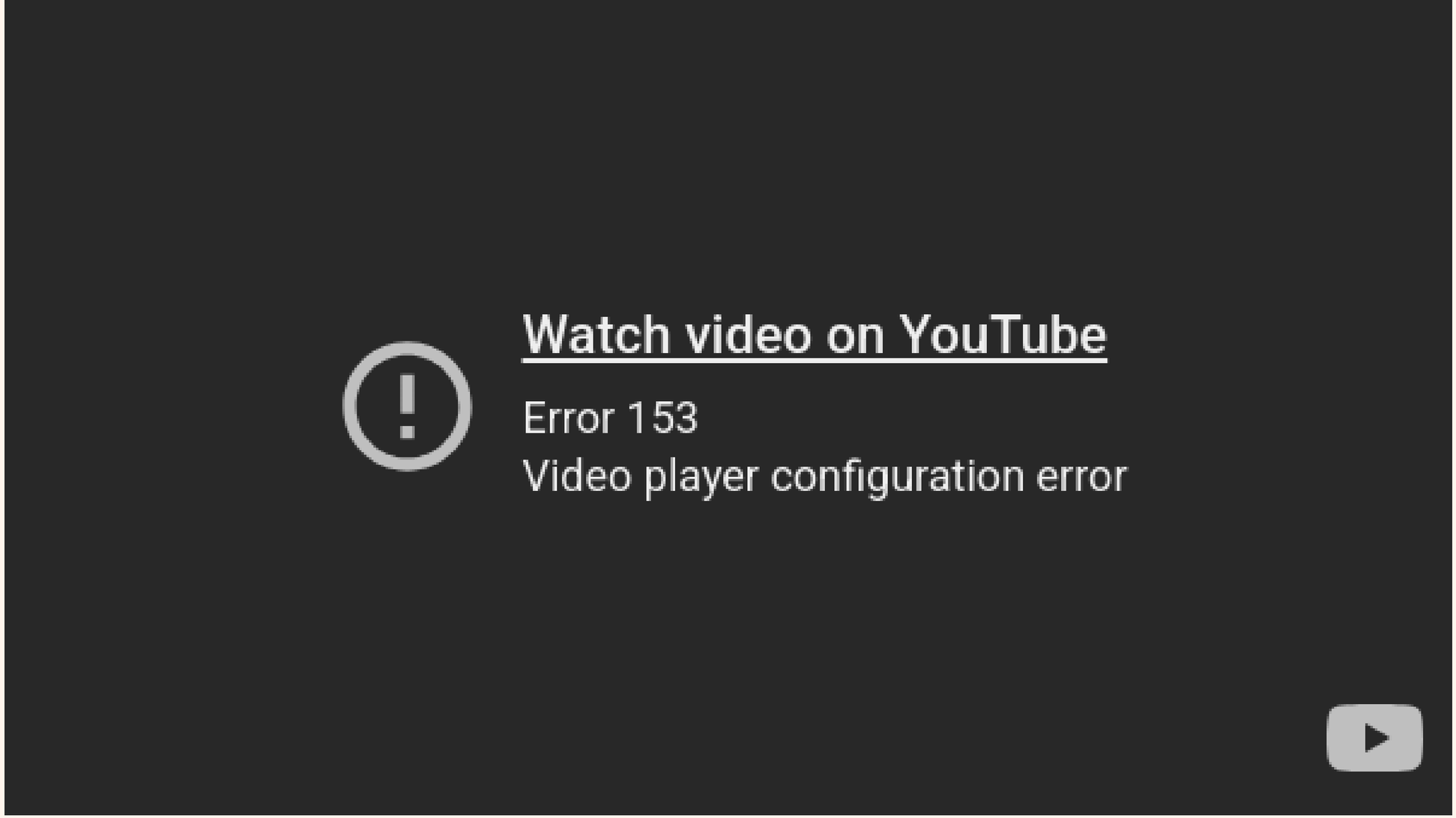


REUPTAKE

Neurotransmitters that are not absorbed by the connecting dendrite are reabsorbed by the sending neuron in a process called *reuptake*.

–The process of reuptake, for example, affects serotonin.

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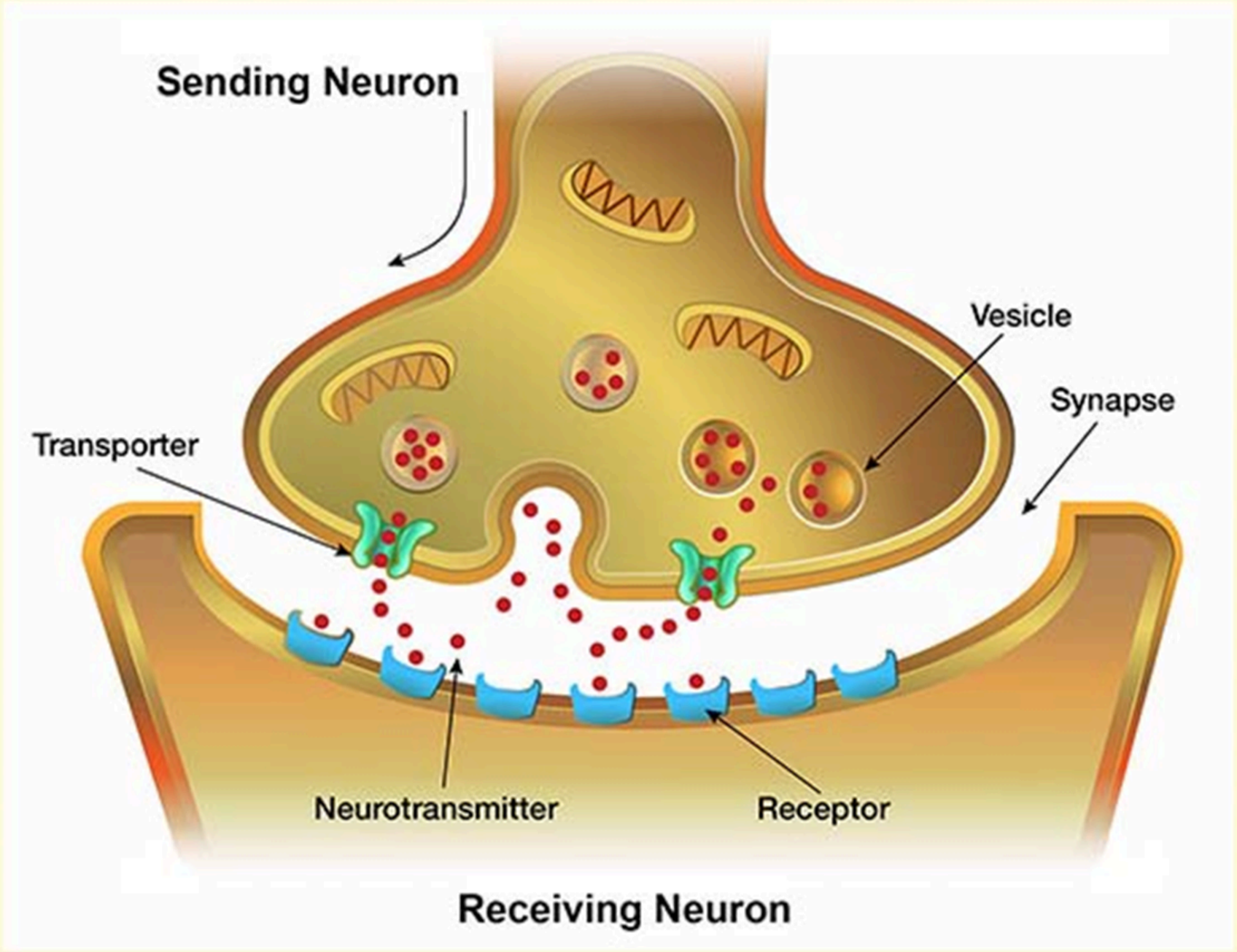
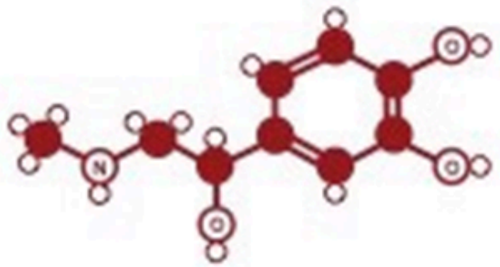

Sending Neuron
Vesicle
Synapse
Transporter
Neurotransmitter
Receptor
Receiving Neuron

ADRENALINE



Fight or flight neurotransmitter

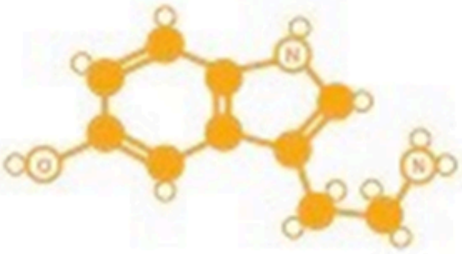
NORADRENALINE

Concentration neurotransmitter

DOPAMINE

Pleasure neurotransmitter

SEROTONIN



Mood neurotransmitter

GABA

Calming neurotransmitter

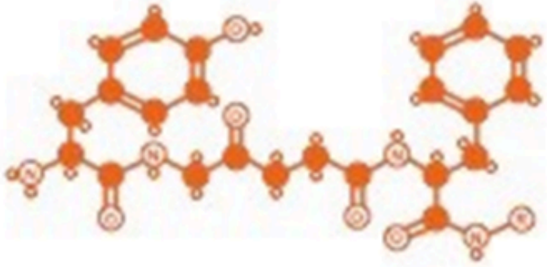
ACETYLCHOLINE

Learning neurotransmitter

GLUTAMATE

Memory neurotransmitter

ENDORPHINS



Euphoria neurotransmitter