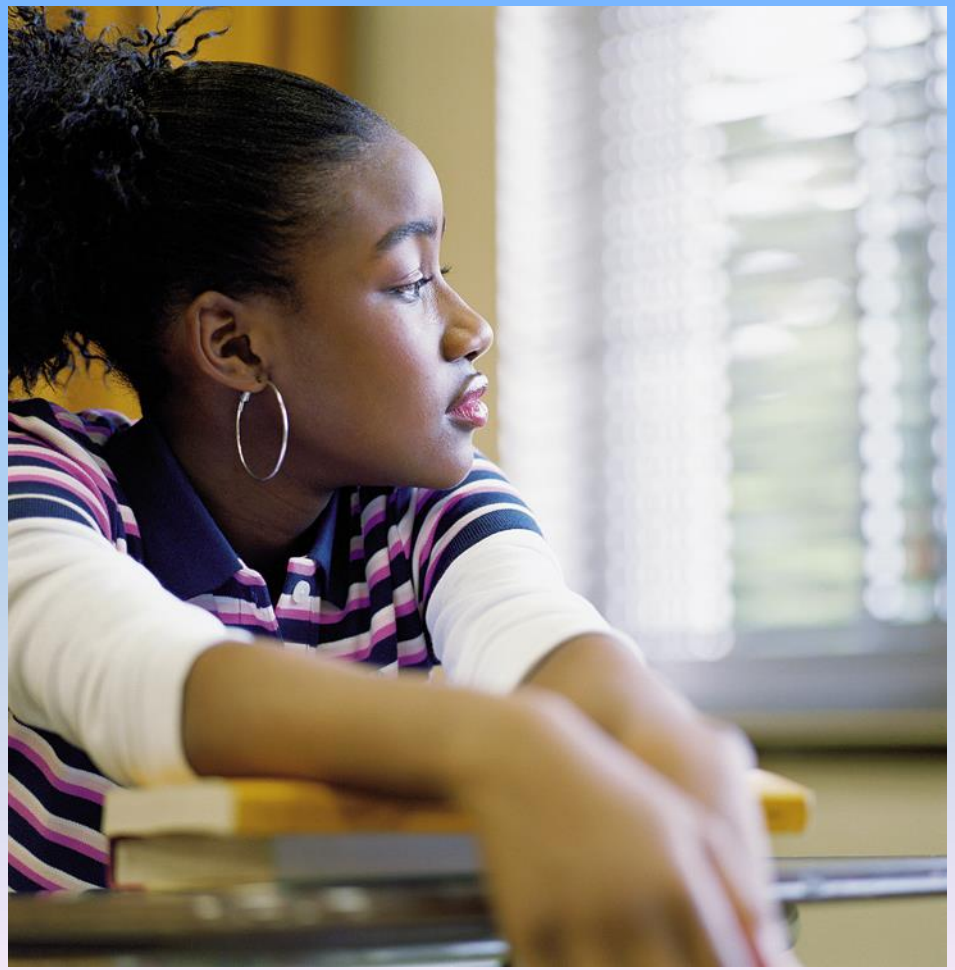
Biopsychological Domain

The Biological Bases of Behavior Chapter



Module 06

The Nervous System and the Endocrine System

Neurons: The Building Blocks of the Nervous System

Nervous System

- The electrochemical communication system of the body
- Sends messages from the brain to the body for movement
- Brings information to the brain from the senses

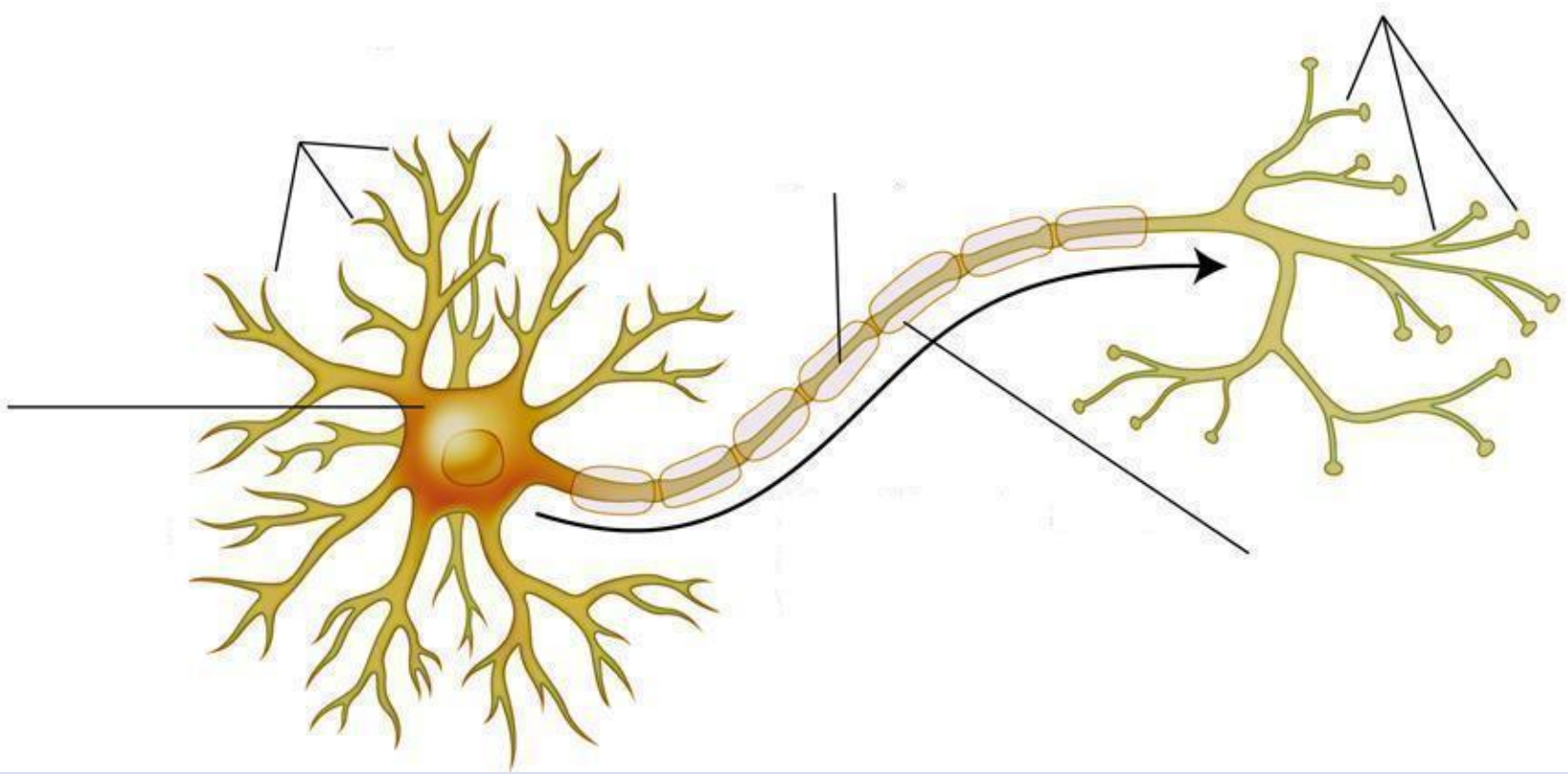
Neuron

- A nerve cell; the basic building block of the nervous system
- While neurons vary in shape and size, they all have essentially the same structure, and they all send messages in essentially the same way.
- *Nerves* are bundles of many neurons

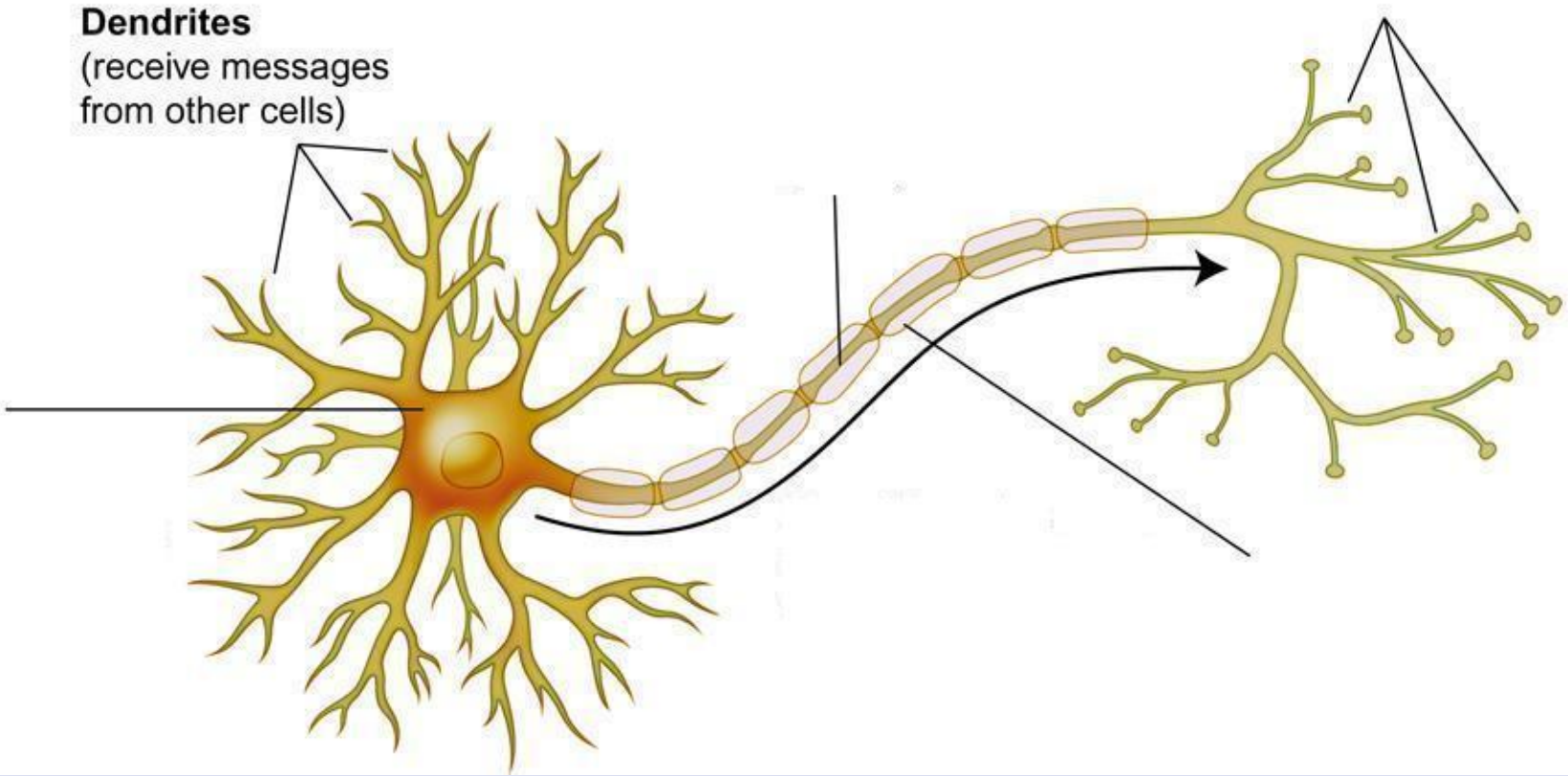
What do neurons do?

- In simplest terms, a neuron is merely a cell specialized to receive, process, and transmit information to other cells.
- Neurons perform three basic tasks
  - Receive information
  - Carry the information
  - Pass the information on to the next neuron

Parts of the Neuron

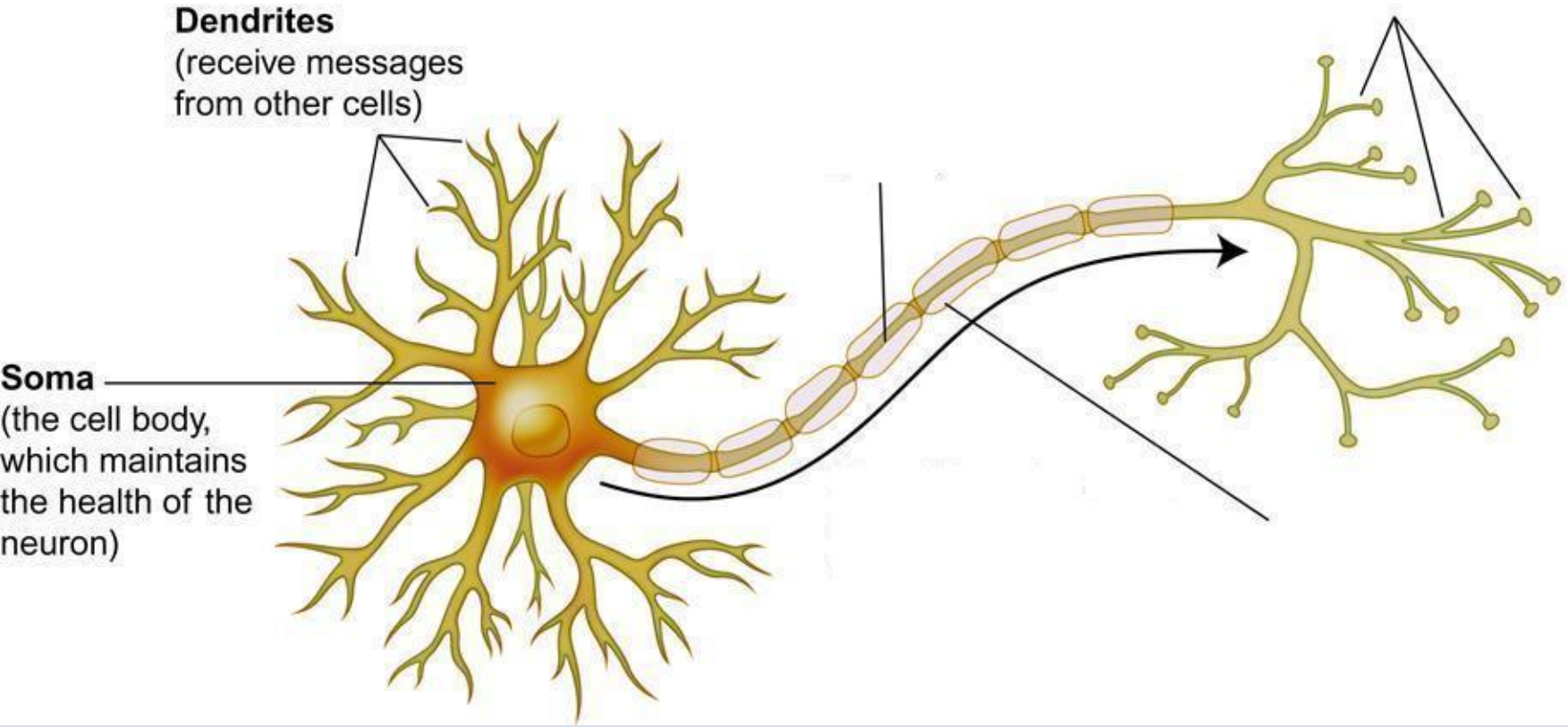


Parts of the Neuron - Dendrites



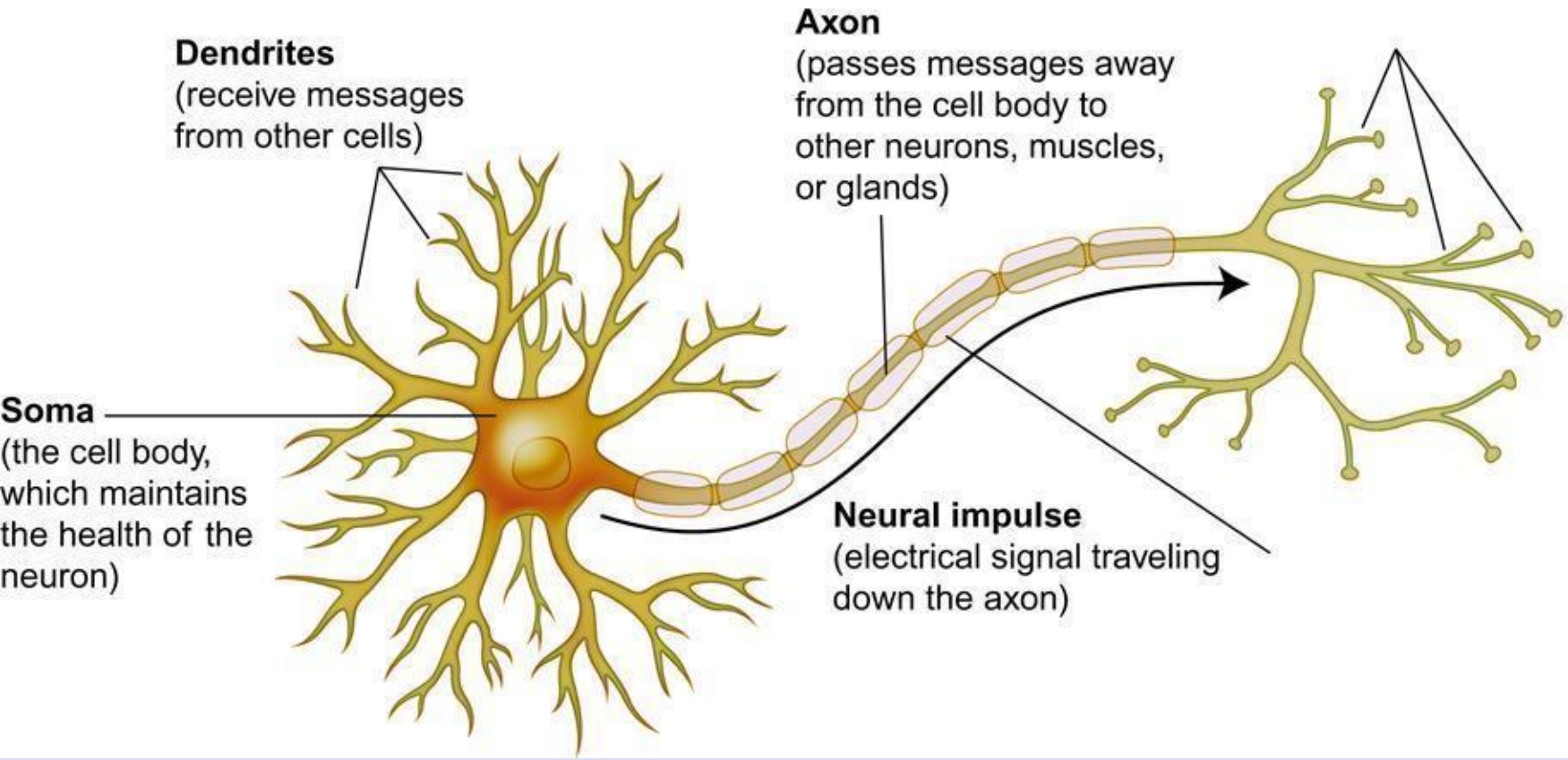
Dendrite – The branching extensions of a neuron that receive information and conduct impulses toward the cell body

Parts of the Neuron - Soma



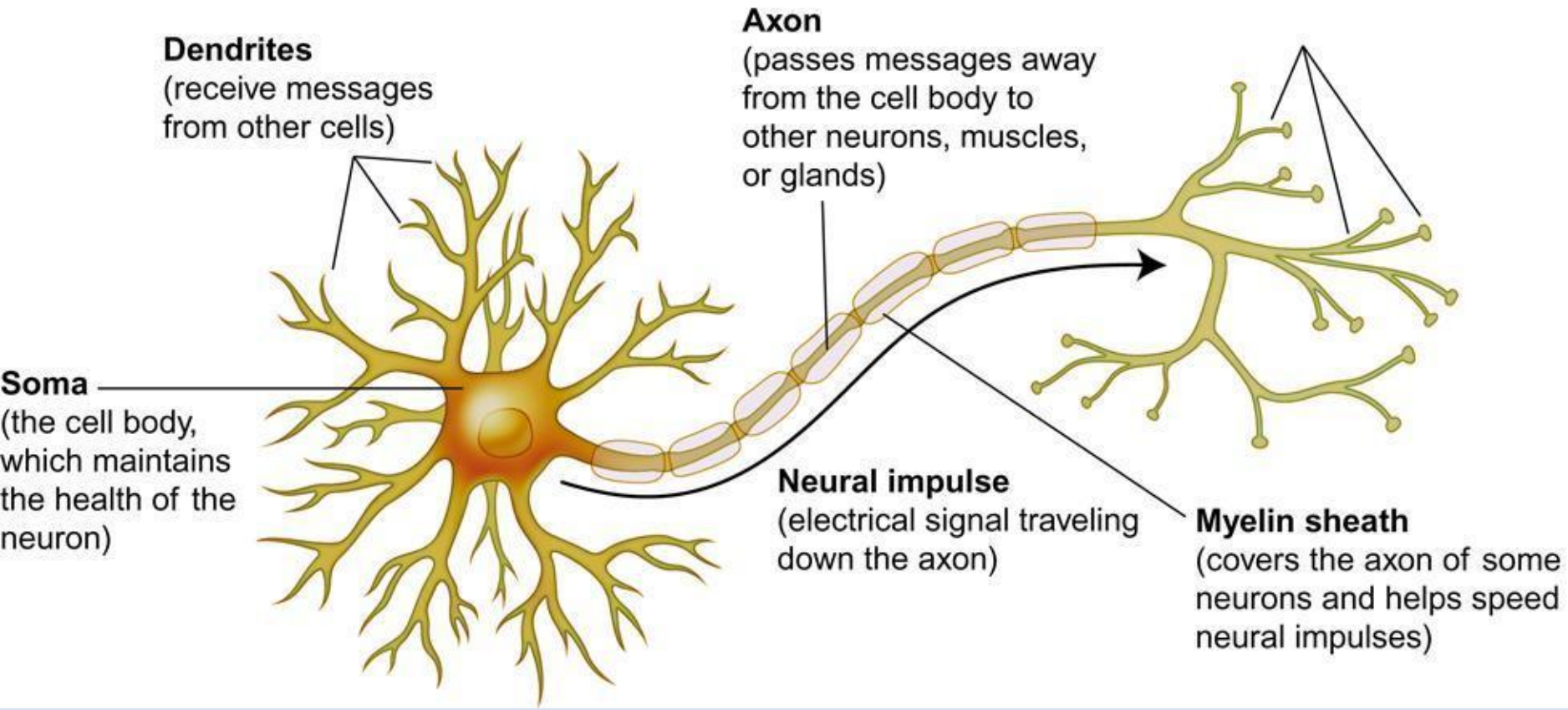
Soma – The cell body of a neuron, which contains the nucleus and other parts that keep the cell healthy

Parts of the Neuron - Axon

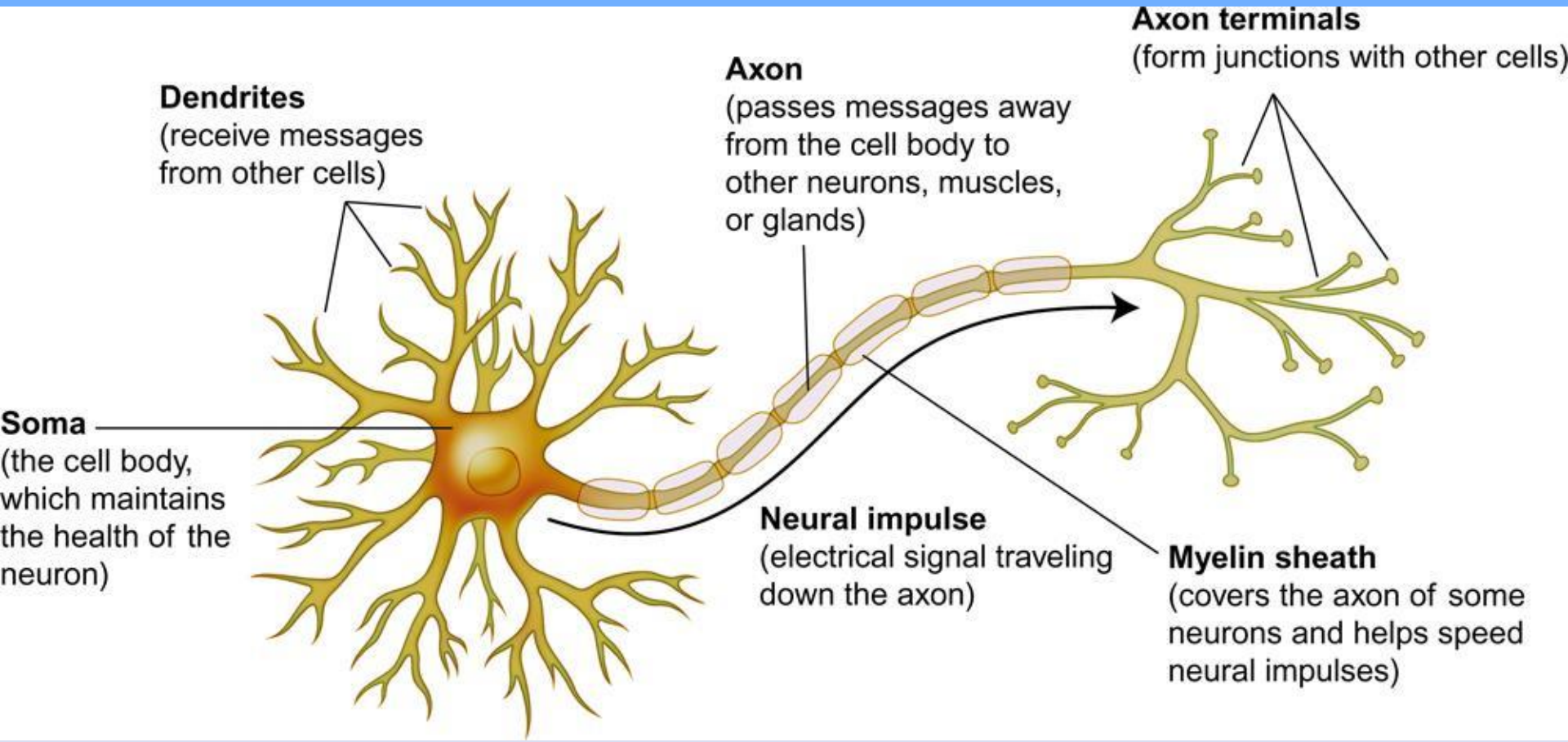


Axon – The extension of a neuron through which neural impulses are sent

Parts of the Neuron – Myelin Sheath



Parts of the Neuron - Terminals



Axon terminals (or terminal buttons)– The endpoint of a neuron where neurotransmitters are stored

How Neurons Communicate: The Neural Impulse

Action Potential

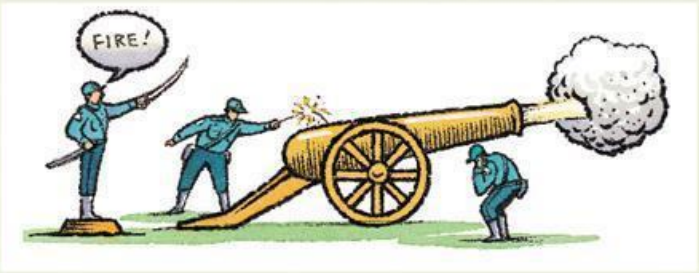
- A neural impulse; a brief electrical charge that travels down the axon of a neuron
- Considered an “on” condition of the neuron

Action Potential

Table 6.1

Three Phases of Communication within a Neuron

Action potential



The neural impulse created when a neuron "fires." The impulse travels from the dendrites down the axon to the axon terminals.

Refractory Period

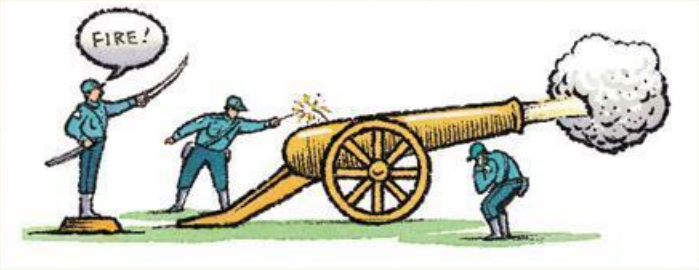
- The “recharging phase” during which a a neuron, after firing, cannot generate another action potential
- Once the refractory period is complete the neuron can fire again

Refractory Period

Table 6.1

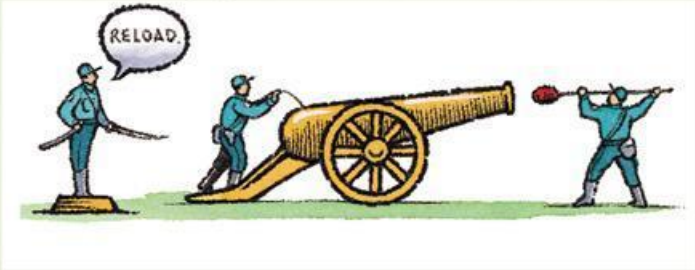
Three Phases of Communication within a Neuron

Action potential



The neural impulse created when a neuron "fires." The impulse travels from the dendrites down the axon to the axon terminals.

Refractory period



The brief instant when a new action potential cannot be generated because the neuron is "recharging" after the previous action potential.

Resting Potential

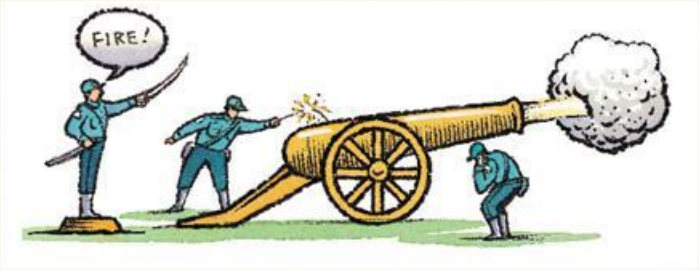
- The state of a neuron when it is at rest and capable of generating an action potential
- The neuron is set and ready to fire

Resting Potential

Table 6.1

Three Phases of Communication within a Neuron

Action potential



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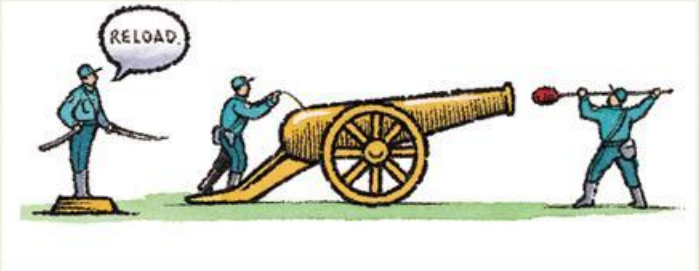

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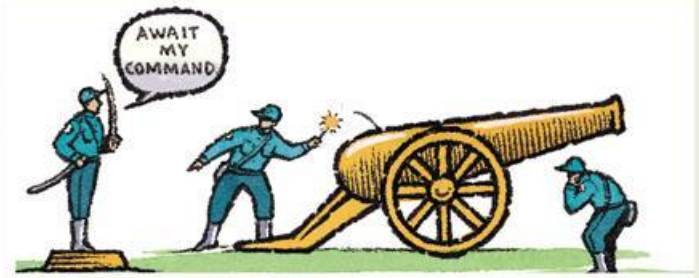
Resting potential



The state of a neuron when it is "charged" but waiting for the next action potential to be generated.

All-or-None Principle

- The principle stating that if a neuron fires it always fires at the same intensity
- All action potentials are of the same strength.
- A neuron does NOT fire at 30%, 45% or 90% but at 100% each time it fires.

How Neurons Communicate: Communication Between Neurons

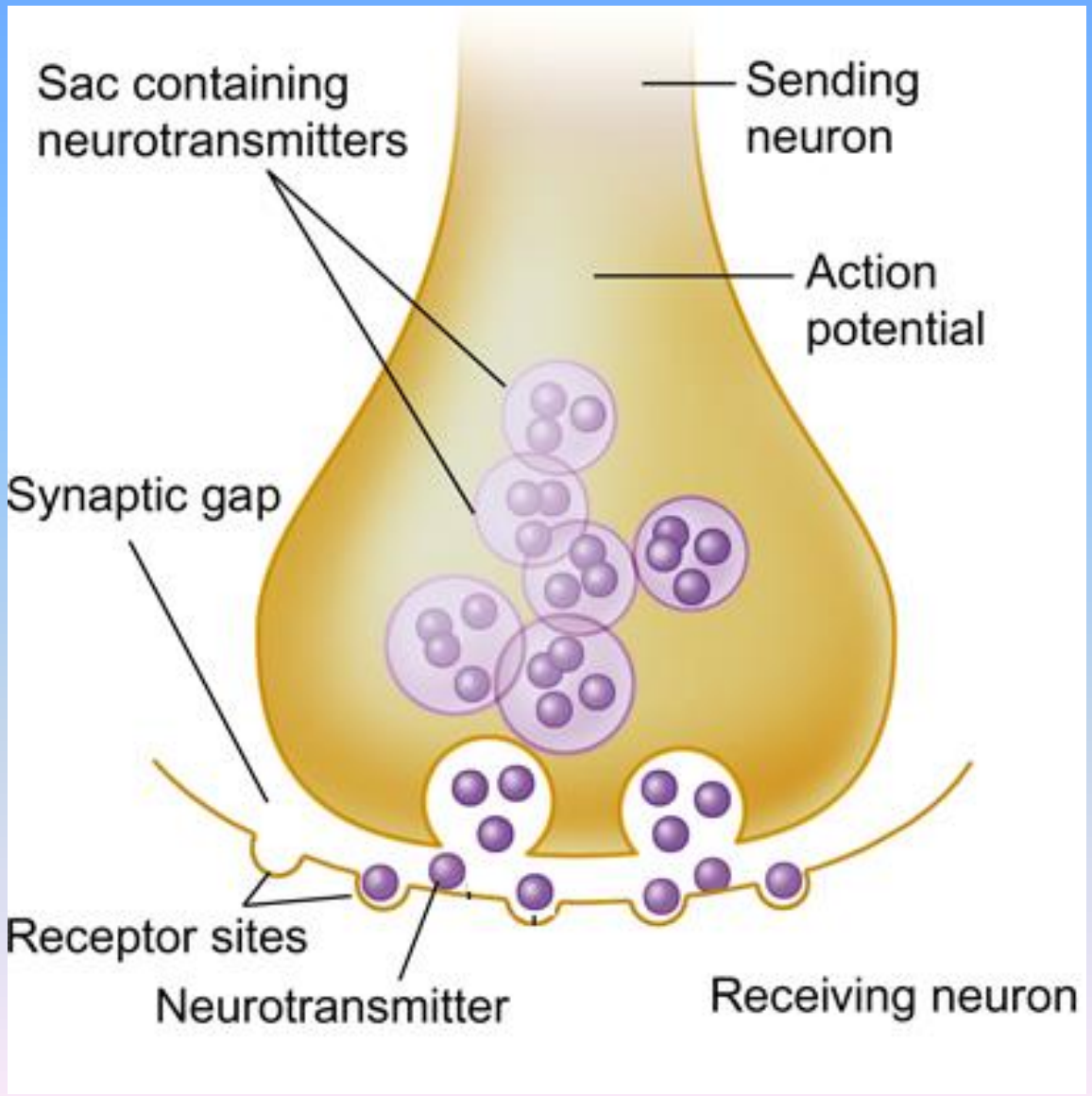
Synapse

- The tiny, fluid filled gap between the axon terminal of one neuron and the dendrite of another neuron
- The action potential cannot jump the gap

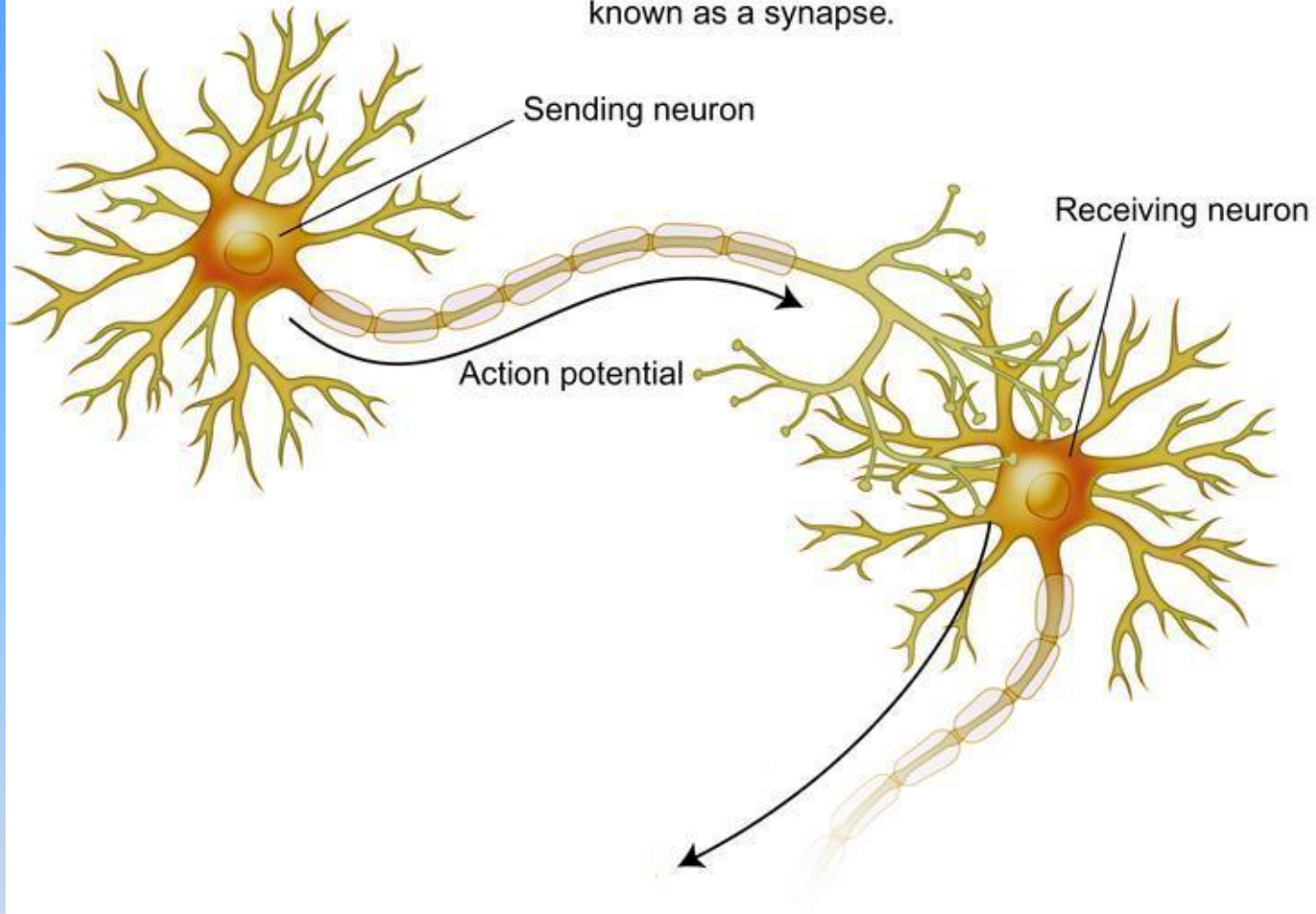
Neurotransmitters

- A chemical messenger that travels across the synapse from one neuron to the next
- Can influence whether the second neuron will generate an action potential or not

Neurotransmitters



1. Electrical impulses (action potentials) travel from one neuron to another across a tiny gap known as a synapse.



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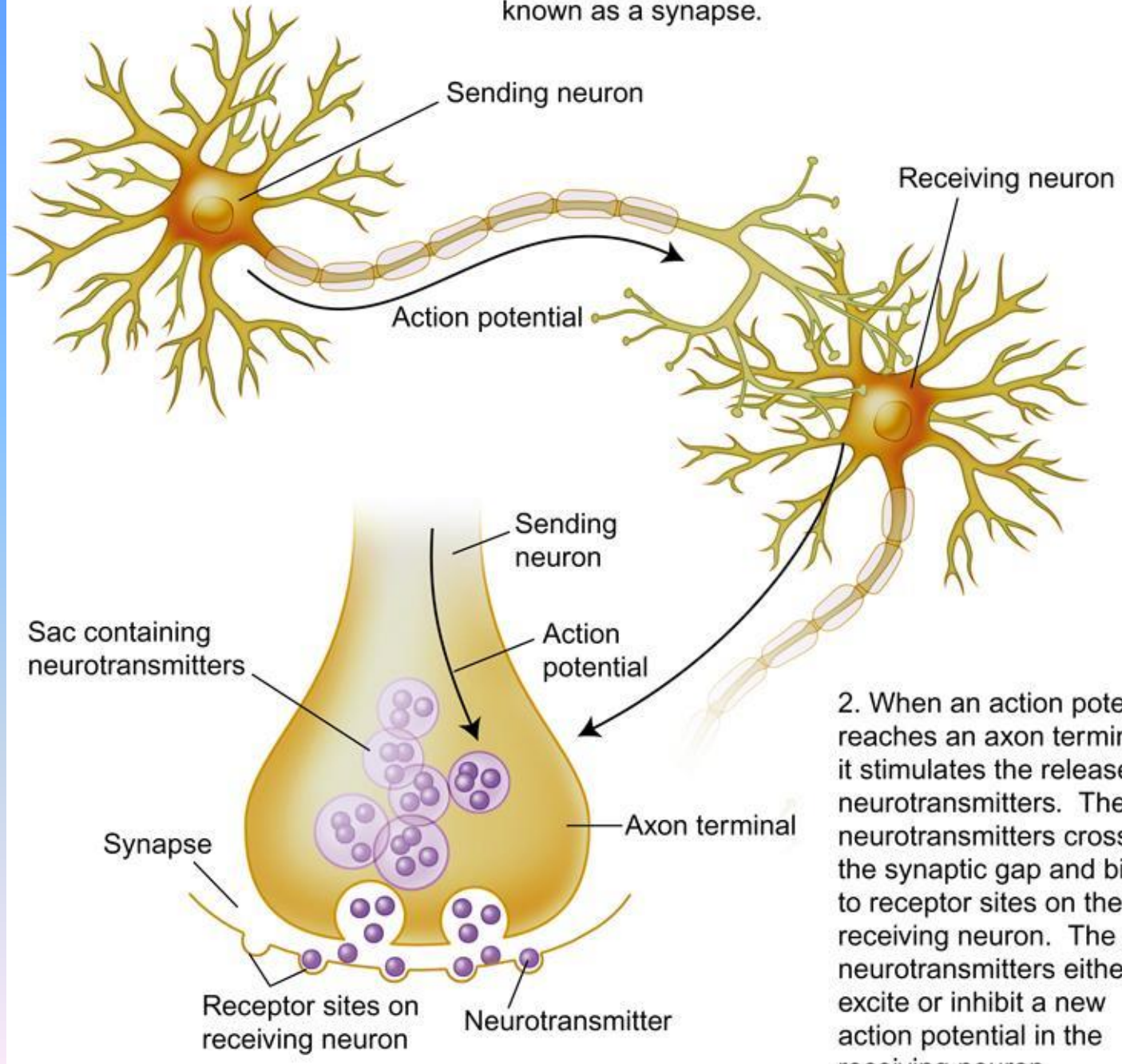


2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitters. These neurotransmitters cross the synaptic gap and bind to receptor sites on the receiving neuron. The neurotransmitters either excite or inhibit a new action potential in the receiving neuron.

Neurotransmitters

Table 6.2

Examples of Neurotransmitter Functions

Neurotransmitter	Affected Functions	Associated Problems
Acetylcholine (ACh)	• Muscle action • Learning • Memory	ACh-producing neurons have deteriorated in people with Alzheimer's disease.
Dopamine	• Learning • Attention • Emotion	Excess dopamine activity is associated with schizophrenia.
Serotonin	• Hunger • Sleep • Arousal • Mood	Low levels of serotonin are associated with depression.

Excitatory Effect

- A neurotransmitter effect that makes it *more* likely that the receiving neuron will generate an action potential or "fire"
- The second neuron is more likely to fire.

Inhibitory Effect

- A neurotransmitter effect that makes it *less* likely that the receiving neuron will generate an action potential or “fire”
- The second neuron is less likely to fire.

How Neurons Communicate: The Neural Chain

3 Major Types of Neurons

- Biopsychologists distinguish three major classes of neurons according to their location and function:
- Sensory neurons
- Motor neurons
- interneurons

Receptor Cells

- Specialized cells in the sensory systems of the body that can turn other kinds of energy into action potentials (neural impulses) that the brain can process
- For example, receptor cells in the eye turn light into a neural impulse the brain understands.

Sensory (or Afferent) Neurons

- Sensory neurons act like one-way streets that carry information *from* the sensory receptors *to* the spinal cord and brain.
- These neurons treat the brain to all your sensory experience, including vision, hearing, taste, touch, smell, pain, and balance.
- For example, when you test the water temperature in the shower with your hand, sensory neurons carry the message toward the brain.

Interneurons

- The brain itself is mostly a network of billions of intricately connected interneurons.
- These nerve cells in the brain and spinal cord are responsible for *processing information* and *relaying messages* from sensory neurons to other interneurons or to motor neurons.
- After receiving sensory input they help determine the motor output sent along the motor neurons.

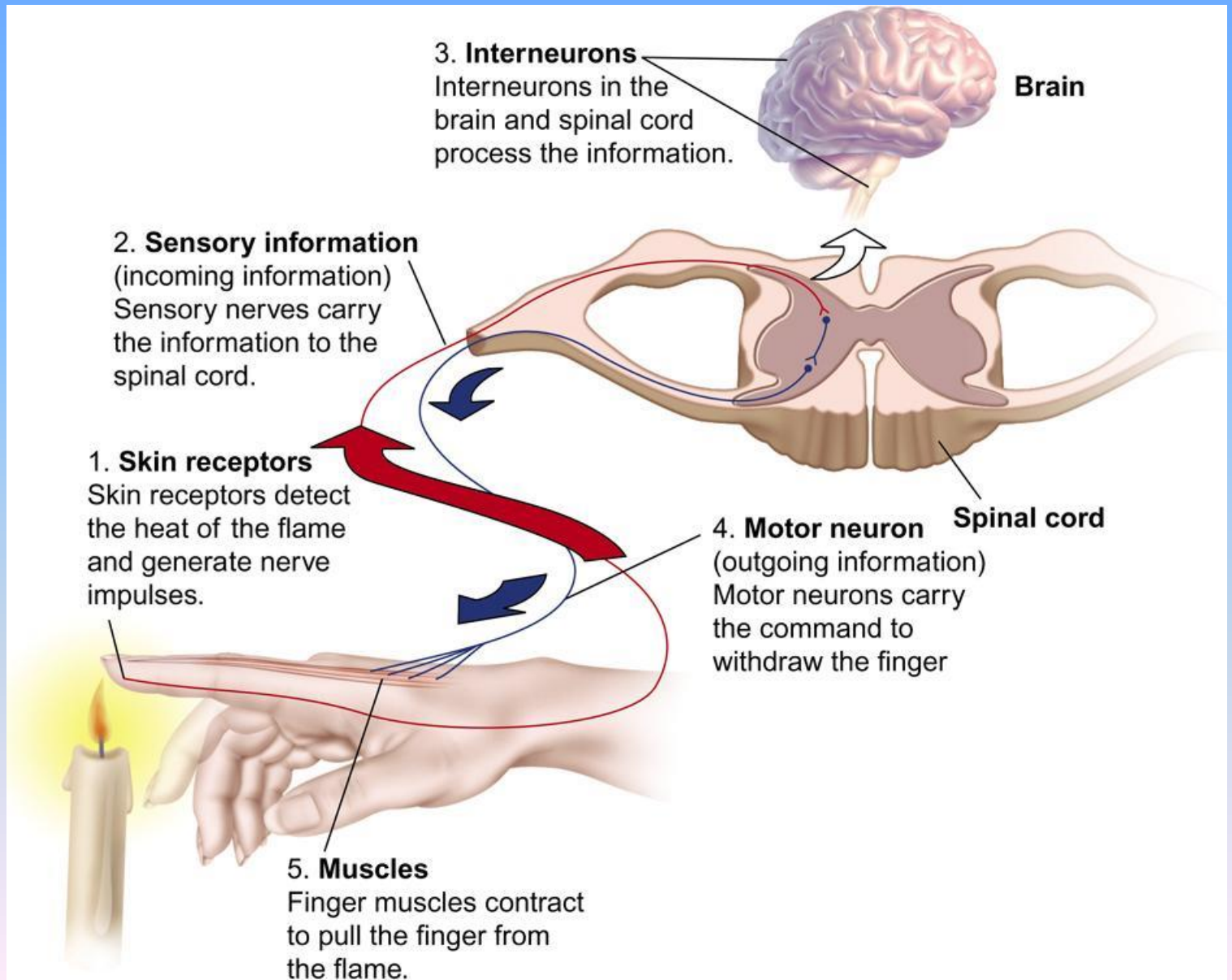
Motor (or Efferent) Neurons

- In contrast to sensory neurons, these nerves form the one-way route that carry messages *away* from the brain and spinal cord *to* the muscles, organs, and glands.
- So, in the shower example, the motor neurons deliver the message from the brain that tells your hand just how much to move the shower control knob.

The Neural Chain

- The neural chain describes the path information follows as it is processed by the nervous system.
- First, **receptor cells** gather the information from your information.
- Second, **sensory nerves** carry that information from the sense receptors to the brain and spinal cord.
- Third, **interneurons** in your brain and spinal cord process that information and decide what action is necessary to deal with the incoming information.
- Lastly, your motor nerves carry information from your brain and spinal cord to the muscles and glands so that they can take action.

A Neural Chain

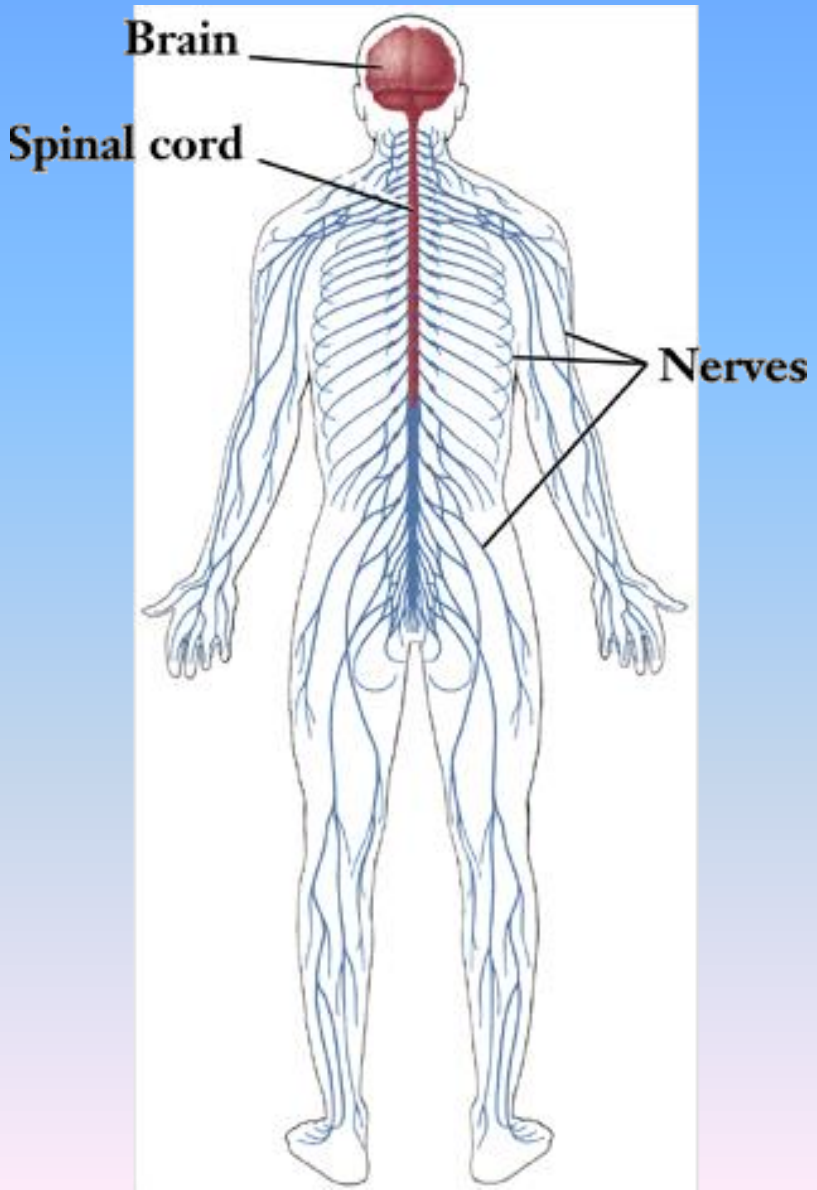


Plasticity
(not in your textbook!)

- Neurons have the ability to send messages that produce simple reflexes, as when you automatically withdraw your finger from a painfully hot candle.
- But neurons also have *the ability to change* – to *make new connections* or to strengthen old ones.
- This means that the nervous system, and especially the brain, has the *ability to adapt* or *modify itself* as the result of experience.
- For example, new connections may be made among neurons – as when neurons sprout new dendrites

The Structure of the Nervous System

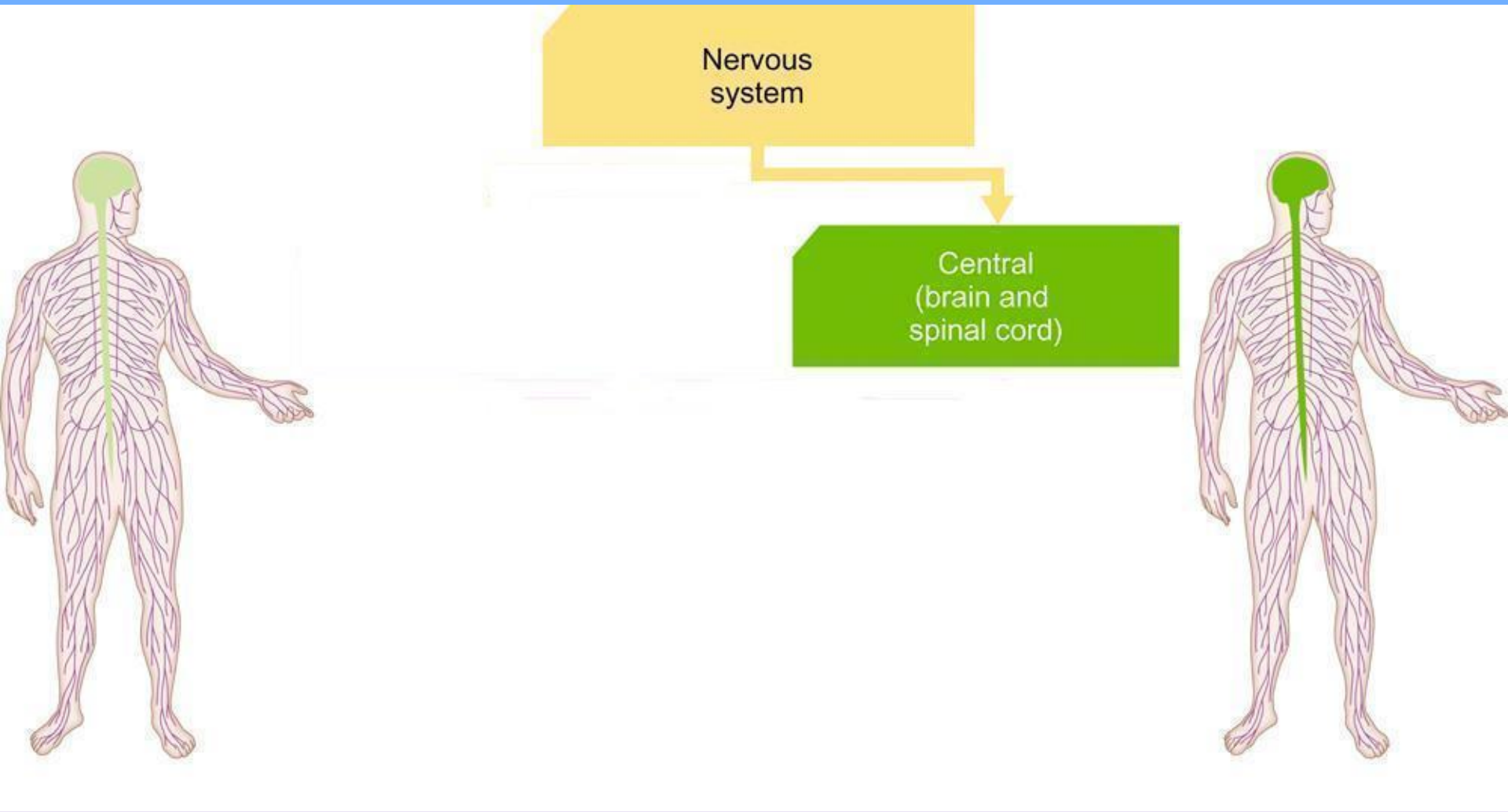
The Nervous System



Central Nervous System (CNS)

- The brain and spinal cord
- The brain is the location of most information processing.
- The spinal cord is the main pathway to and from the brain.

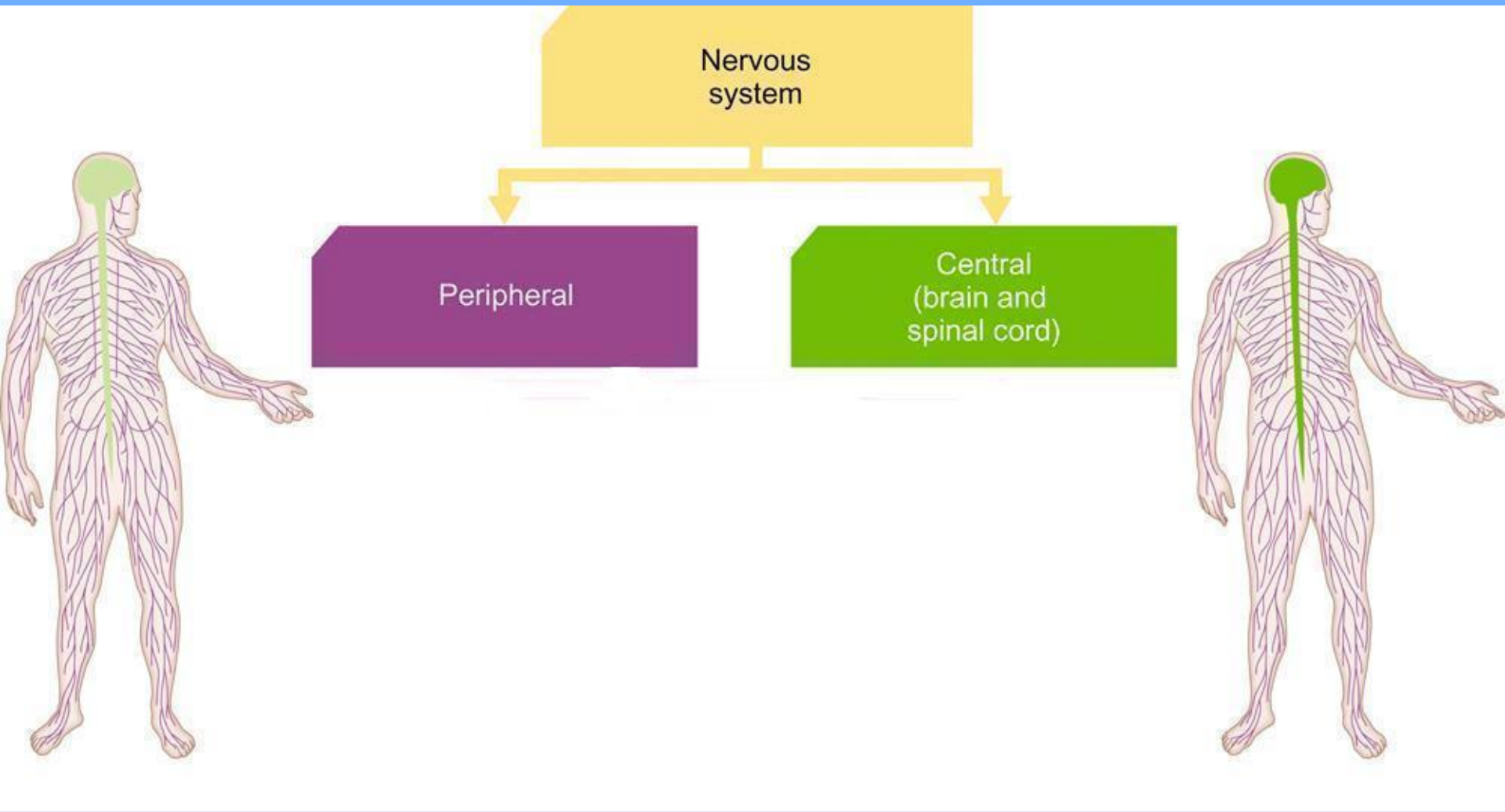
Divisions of the Nervous System



Peripheral Nervous System (PNS)

- The sensory and motor nerves that connect the brain and the spinal cord to the rest of the body
- Peripheral means “outer region”
- The system is subdivided into the *somatic* and *autonomic* nervous systems.

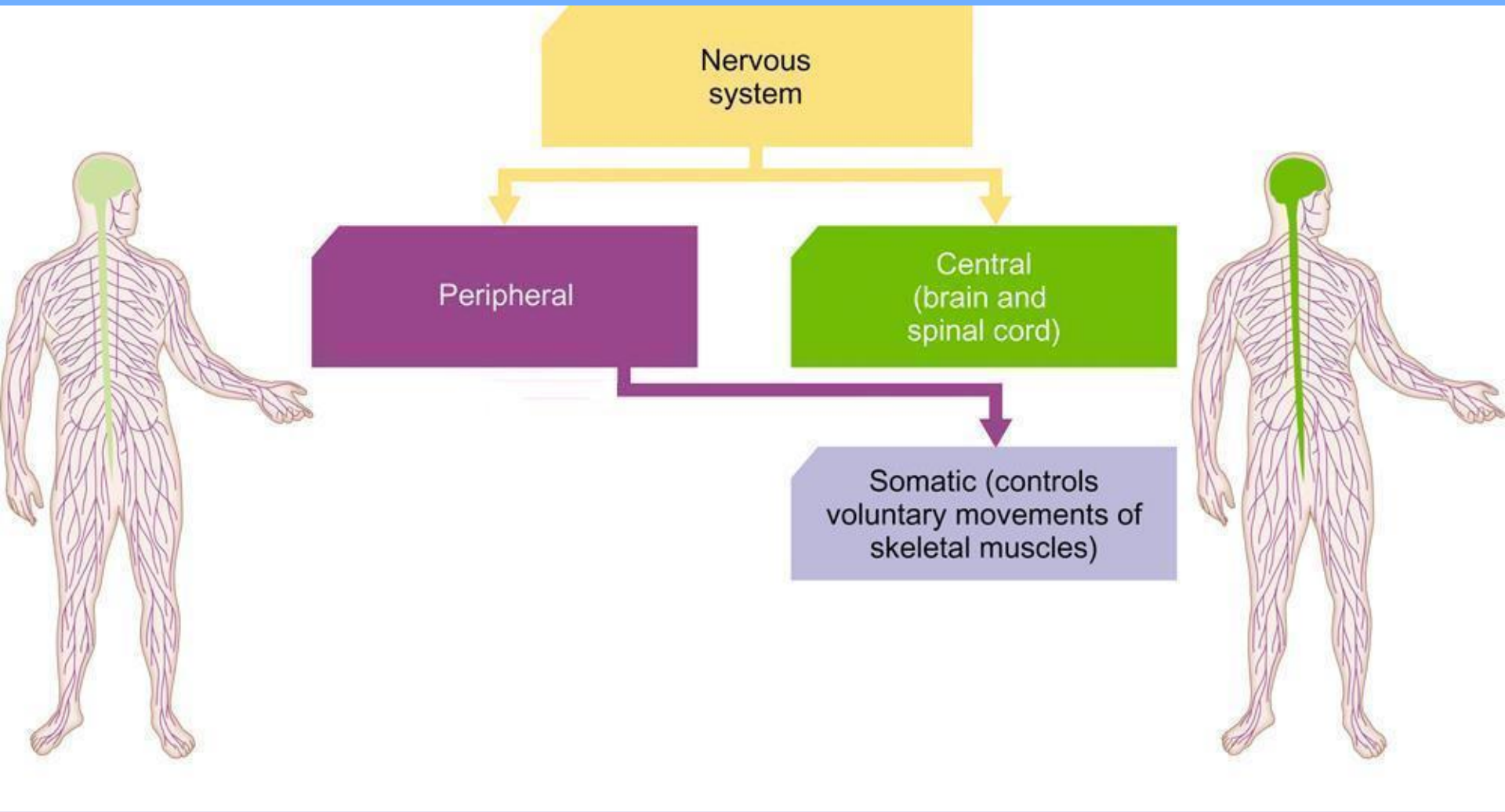
Divisions of the Nervous System



Somatic Nervous System

- The division of the peripheral nervous system that controls the body's *skeletal muscles*
- Contains the motor nerves needed for the voluntary muscles

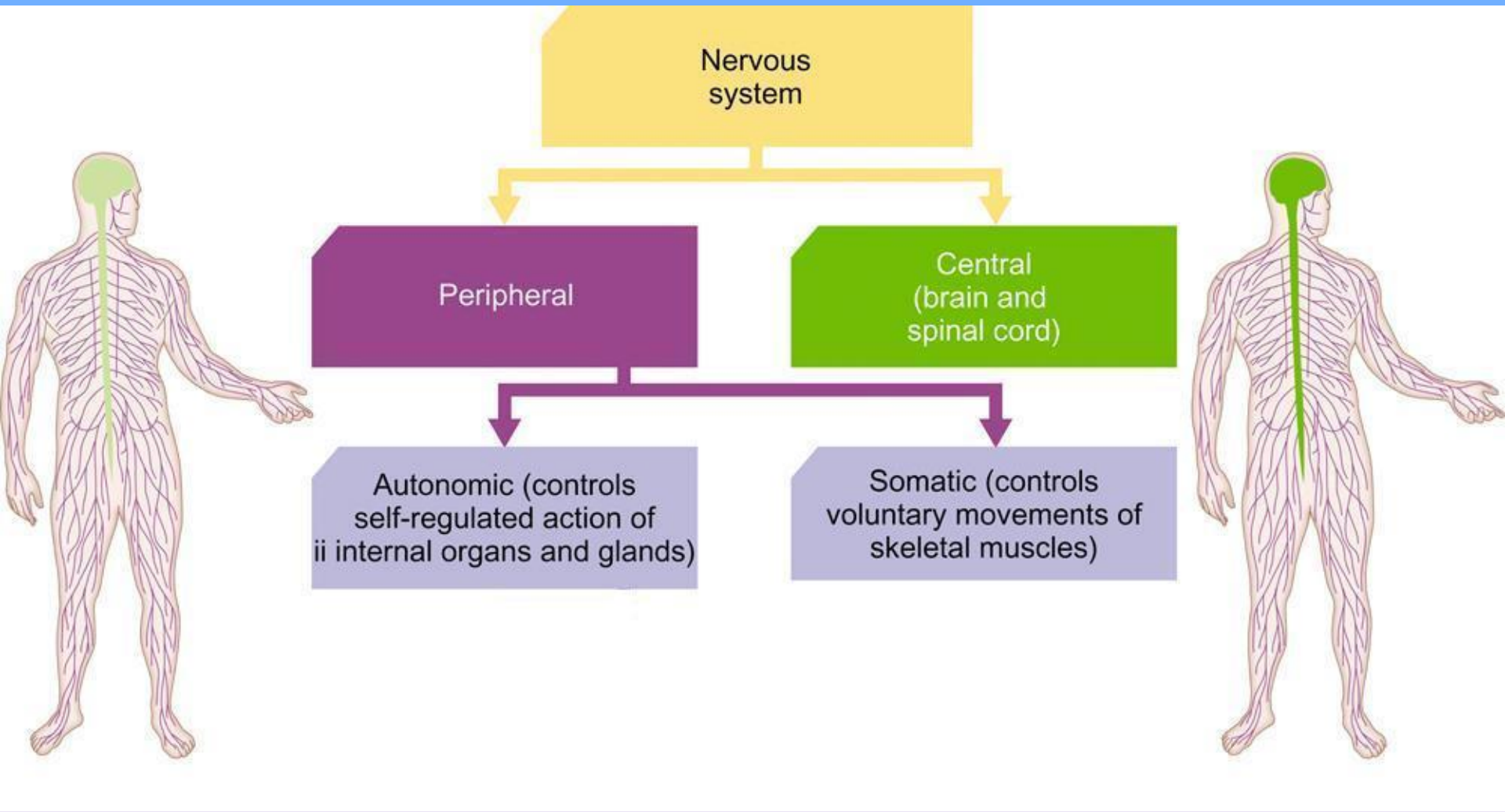
Divisions of the Nervous System



Autonomic Nervous System

- The division of the peripheral nervous system that controls the *glands* and *muscles of the internal organs*
- Monitors the autonomic functions
- Controls breathing, blood pressure, and digestive processes
- Sub-divided into the sympathetic and parasympathetic nervous systems

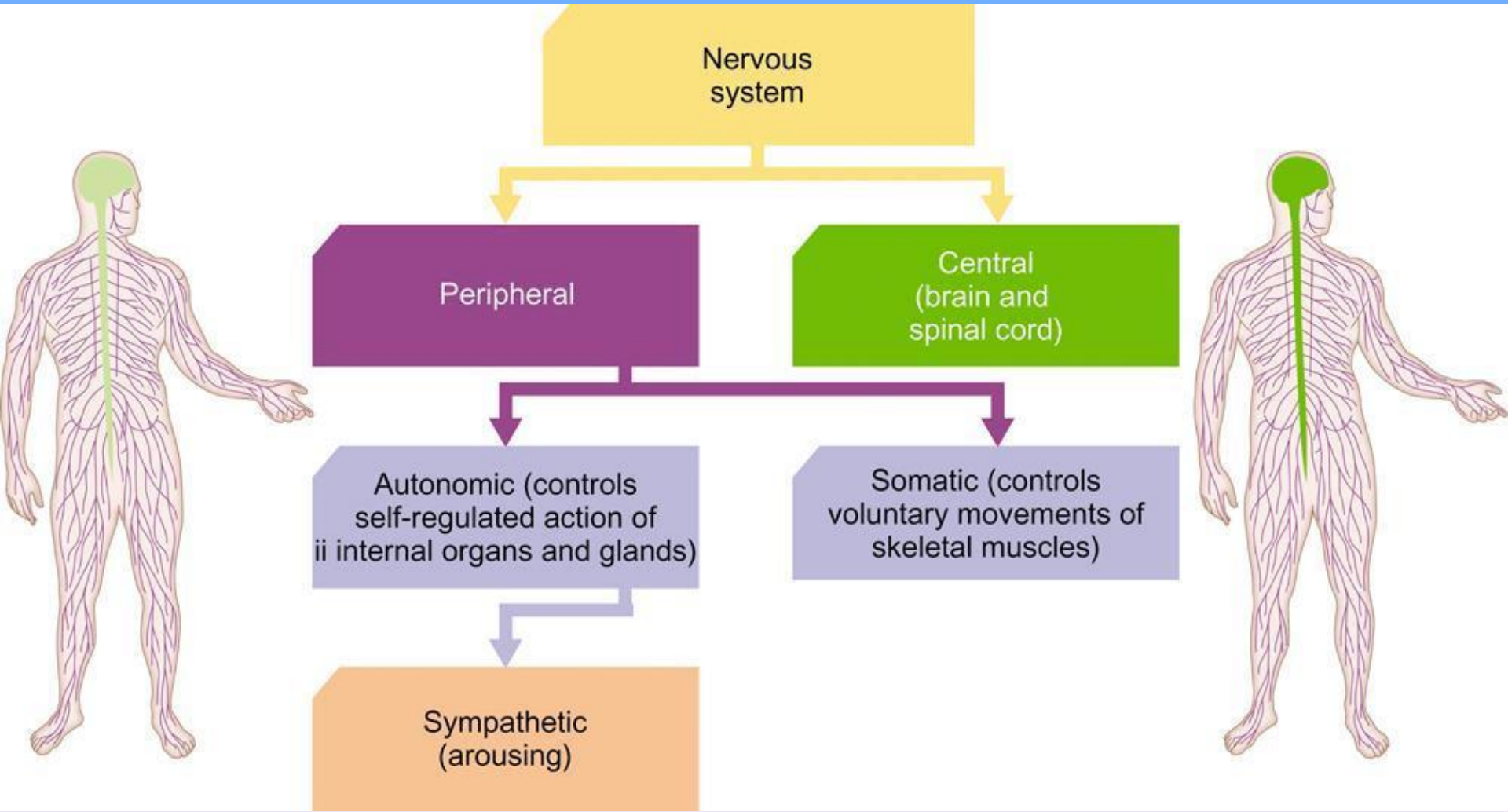
Divisions of the Nervous System



Sympathetic Nervous System

- The part of the autonomic nervous system that *arouses* the body to deal with perceived threats
- Fight or flight response

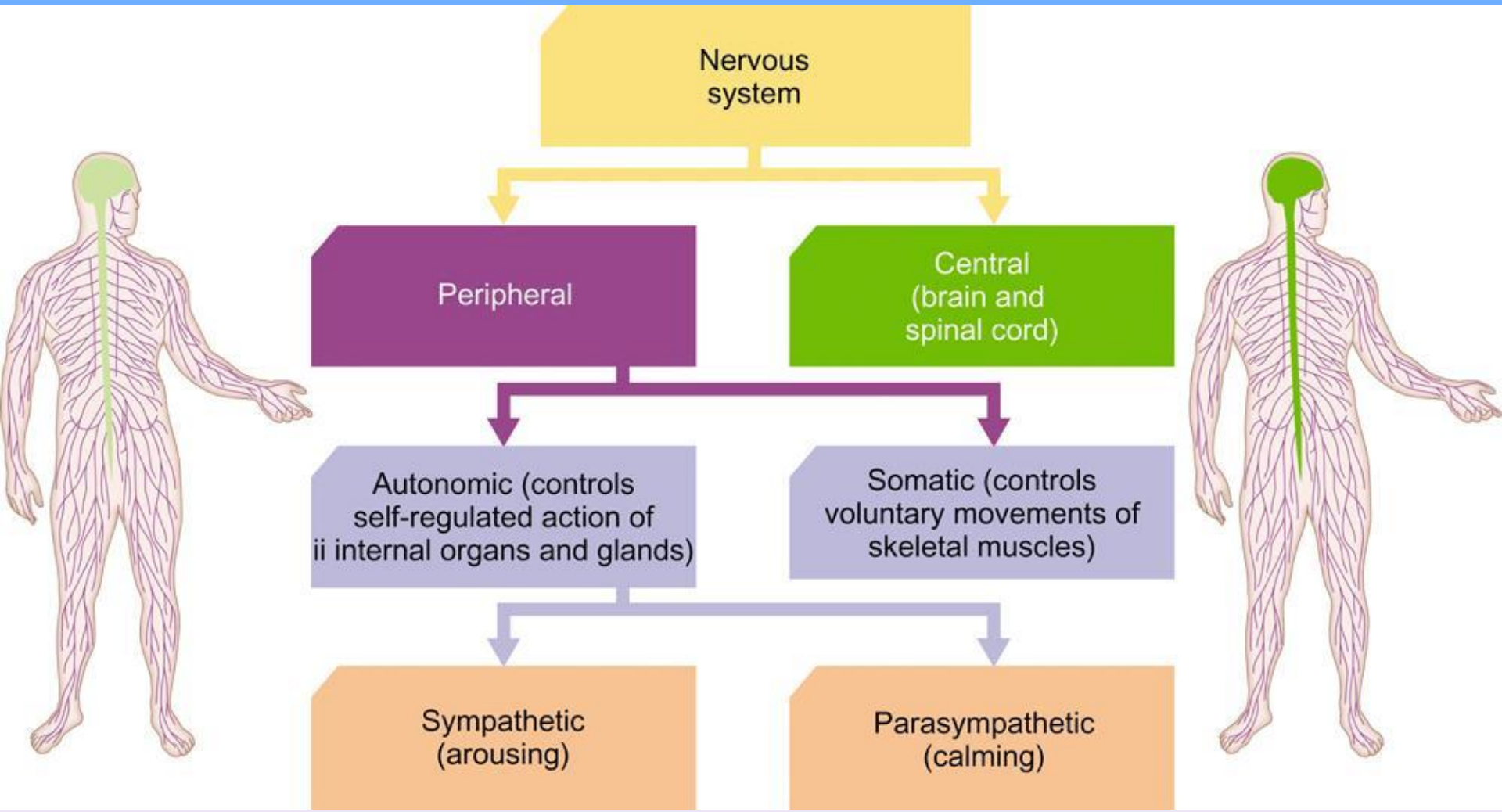
Divisions of the Nervous System



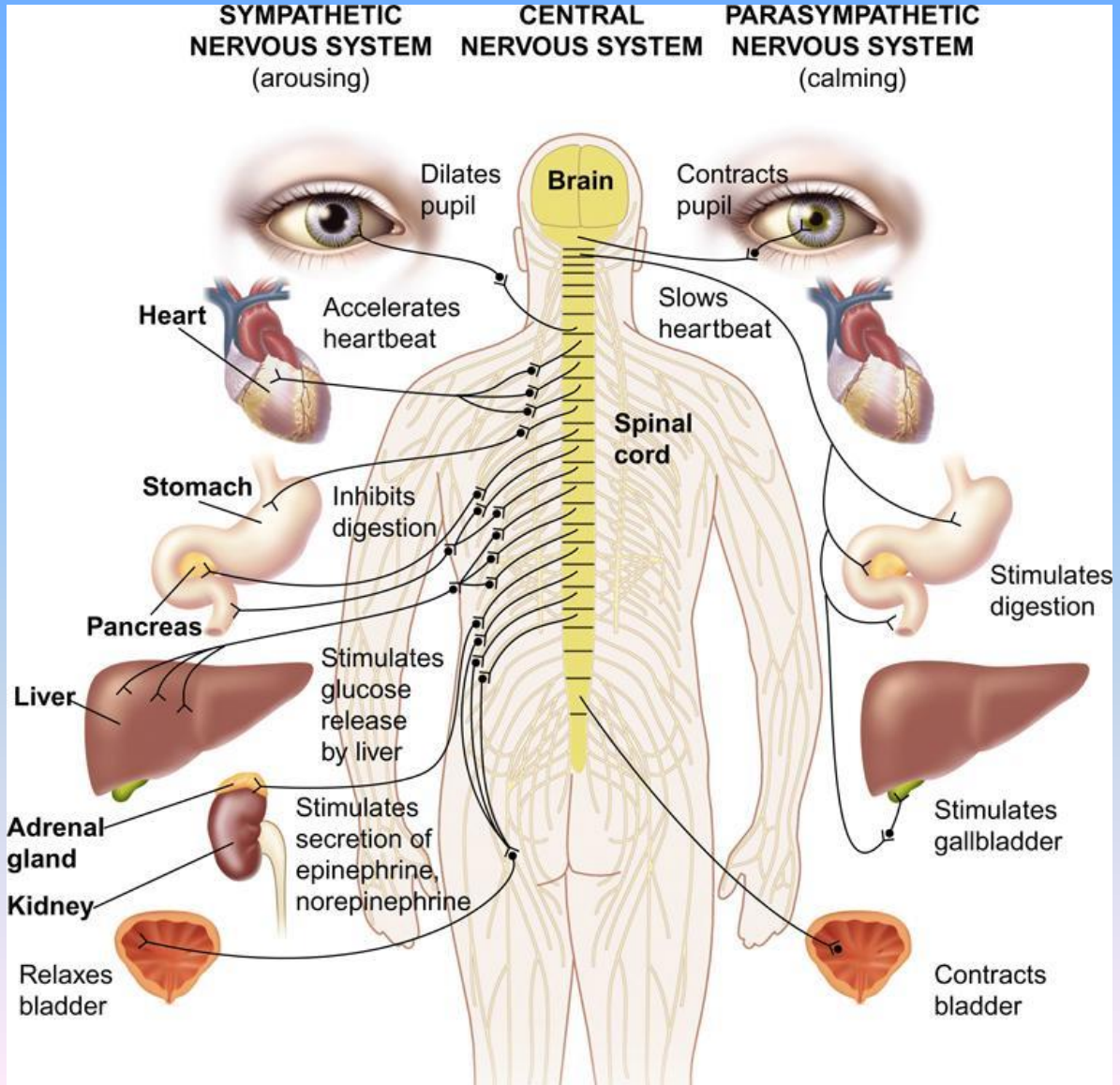
Parasympathetic Nervous System

- The part of the autonomic nervous system that *calms* the body
- Brings the body back down to a relaxed state

Divisions of the Nervous System



The Sympathetic and Parasympathetic Divisions of the Autonomic Nervous System



The Endocrine System

Endocrine System

(from the Greek *endo* for “within” and *krinein* for “secrete”)

- Consider this little-known fact: Your bloodstream carries *information*, along with oxygen and nutrients.
- It does so by serving as the communication pathway for the *endocrine system*
- The endocrine system *transmits information by releasing hormones into the bloodstream* just as the nervous system communicates information using neurotransmitters.

Hormone

- Chemical messenger produced by the endocrine glands and circulated in the blood until delivered to their target muscles, glands, and organs.
- Similar to neurotransmitters in that they are also *messengers* and influence not only body functions, but behaviors & emotions as well.
- Slower to awaken and slower to shut down (with longer lasting effects) than the nervous system

Pituitary Gland

- The endocrine system's gland that, in conjunction with the brain, *controls the other endocrine glands*
- Called the "master gland"
- Located at the base of the brain and connects to the hypothalamus

Thyroid Gland

- Endocrine gland that helps regulate the energy level in the body
- Located in the neck

Adrenal Gland

- Endocrine glands that help to arouse the body in times of stress
- Located just above the kidneys
- Release epinephrine (adrenaline) and norepinephrine (noradrenaline)

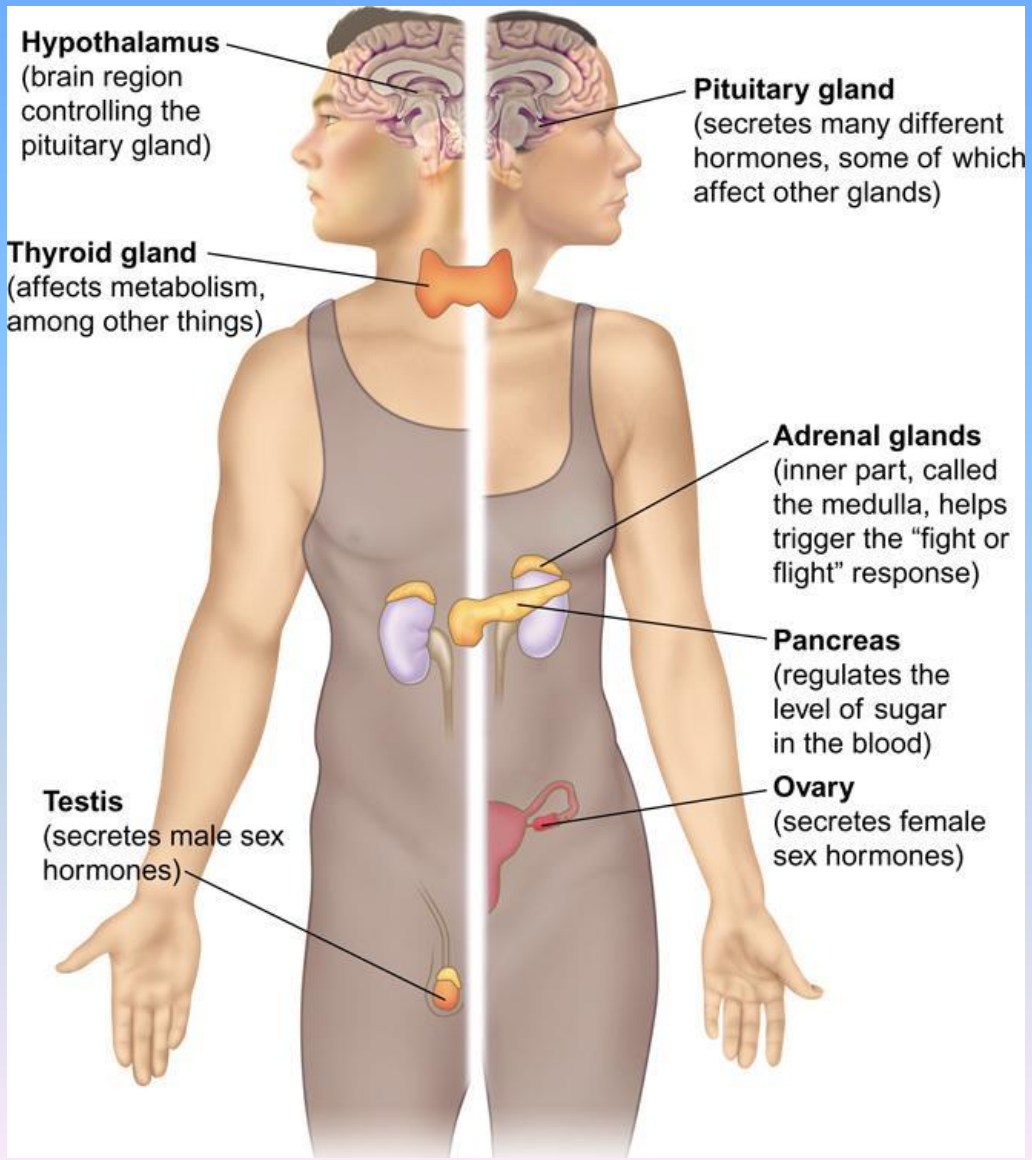
Pancreatic Gland

- Regulates the level of blood sugar in the blood

Sex Glands

- Ovaries (females) and testes (males) are the glands that influence emotion and physical development.
- *Testosterone* – primary males hormone
- *Estrogen* – primary female hormone
- Males and females have both estrogen and testosterone in their systems.

Endocrine System – Sex Glands



The End