Good Morning!

Take out your notes and vocab 1-10!

Functions of the Nervous System

1. Sensory input – gathering information
   - To monitor changes occurring inside and outside the body (changes = stimuli)
2. Integration –
   - to process and interpret sensory input and decide if action is needed.
3. Motor output
   - A response to integrated stimuli
   - The response activates muscles or glands

Structural Classification of the Nervous System

- Central nervous system (CNS)
  - Brain
  - Spinal cord
- Peripheral nervous system (PNS)
  - Nerve outside the brain and spinal cord

Functional Classification of the Peripheral Nervous System

- Sensory (afferent) division
  - Nerve fibers that carry information *to* the central nervous system

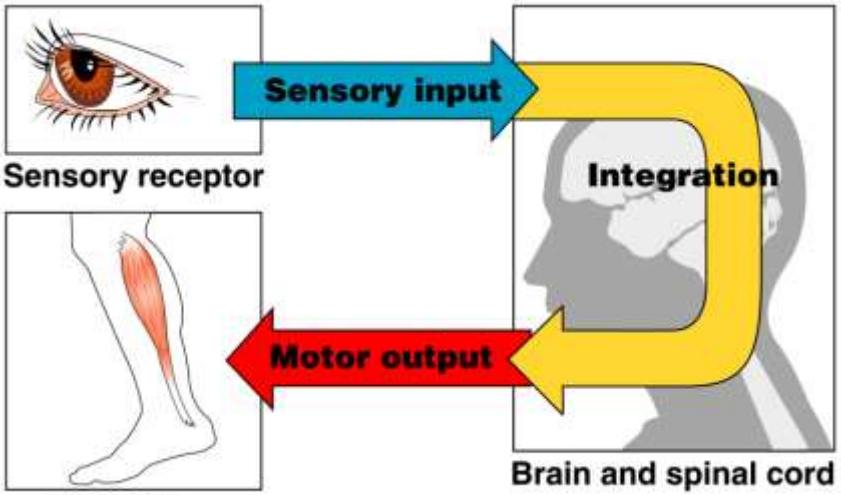


Figure 7.1

Functional Classification of the Peripheral Nervous System

- Motor (efferent) division
  - Nerve fibers that carry impulses *away from* the central nervous system

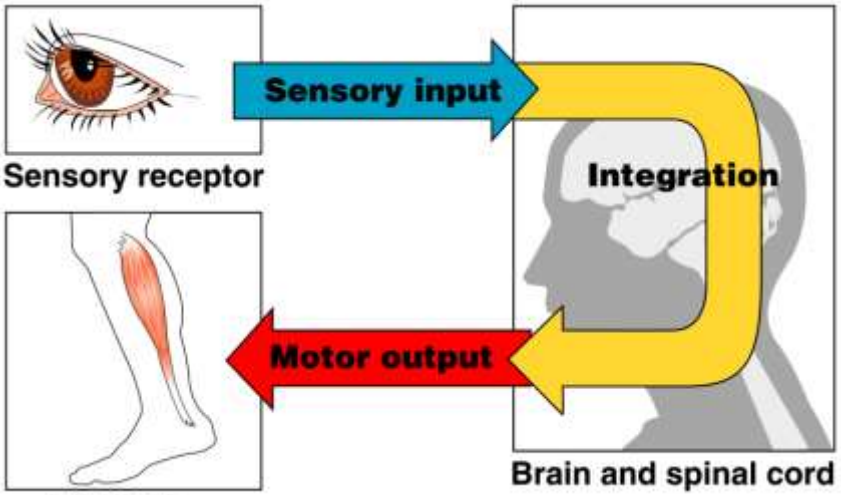


Figure 7.1

Functional Classification of the Peripheral Nervous System

- Motor (efferent) division
  - Two subdivisions
    - Somatic nervous system = voluntary
    - Autonomic nervous system = involuntary

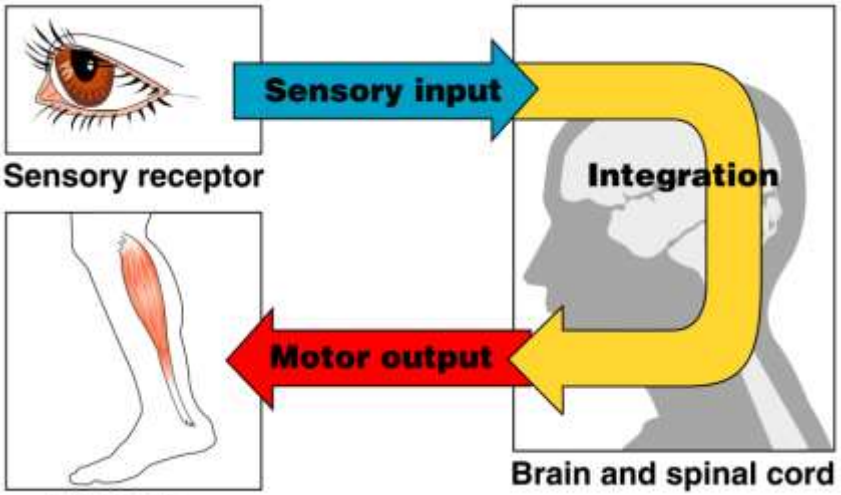


Figure 7.1

Organization of the Nervous System

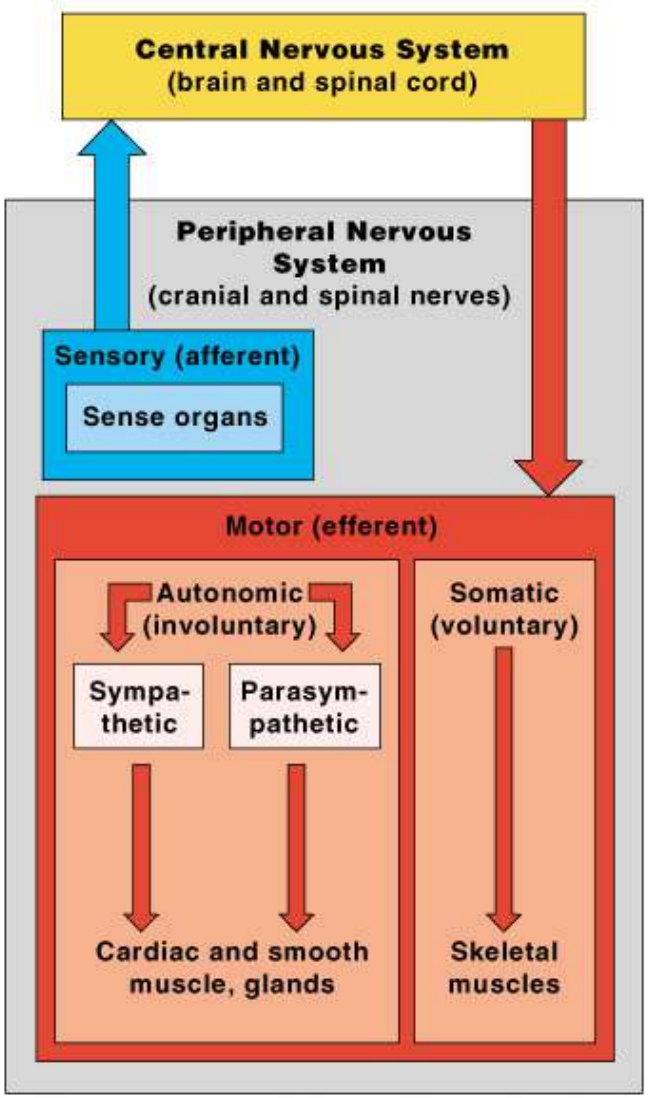


Figure 7.2

Neuroglia vs. Neurons

- Neuroglia divide.
- Neurons do not.
- Most brain tumors are “gliomas.”
- Most brain tumors involve the neuroglia cells, not the neurons.
- Consider the role of cell division in cancer!

Nervous Tissue: Support Cells (Neuroglia or Glia)

- Astrocytes
  - Abundant, star-shaped cells
  - Brace neurons
  - Form barrier between capillaries and neurons- Blood brain Barrier
  - Control the chemical environment of the brain (CNS)

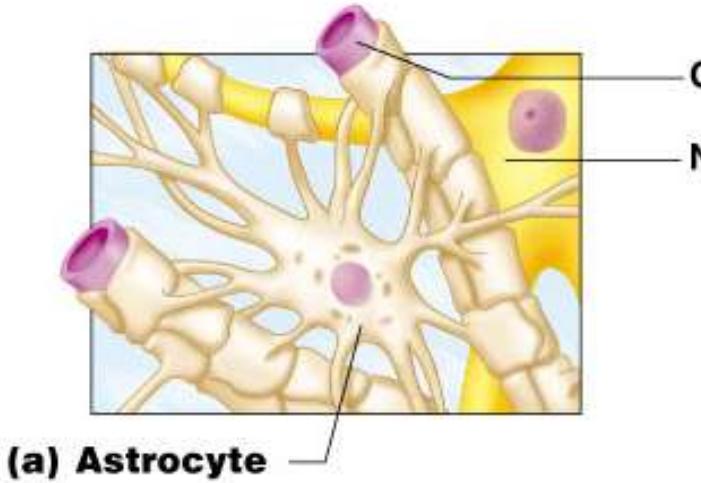


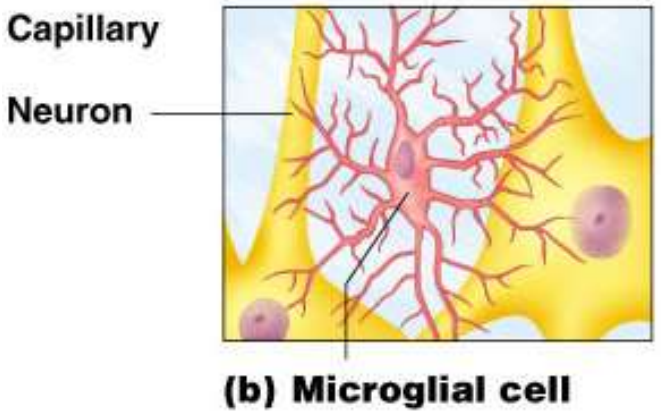
Figure 7.3a

Blood Brain Barrier

- Includes the least permeable capillaries of the body
- Excludes many potentially harmful substances
- Useless against some substances
  - Fats and fat soluble molecules
  - Respiratory gases
  - Alcohol
  - Nicotine
  - Anesthesia

Nervous Tissue: Support Cells

- Microglia (CNS)
  - Spider-like phagocytes
  - Dispose of debris
- Ependymal cells (CNS)
  - Line cavities of the brain and spinal cord
  - Circulate cerebrospinal fluid



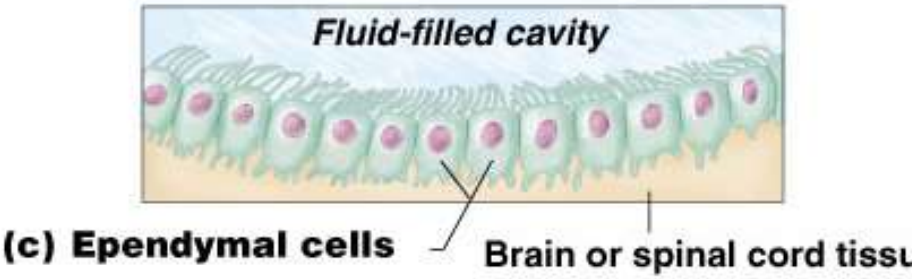


Figure 7.3b, c

Cerebrospinal Fluid

- Similar to blood plasma composition
- Formed by the choroid plexus
- Forms a watery cushion to protect the brain
- Circulated in arachnoid space, ventricles, and central canal of the spinal cord

Nervous Tissue: Support Cells

- Oligodendrocytes (CNS)
  - Produce myelin sheath around nerve fibers in the central nervous system

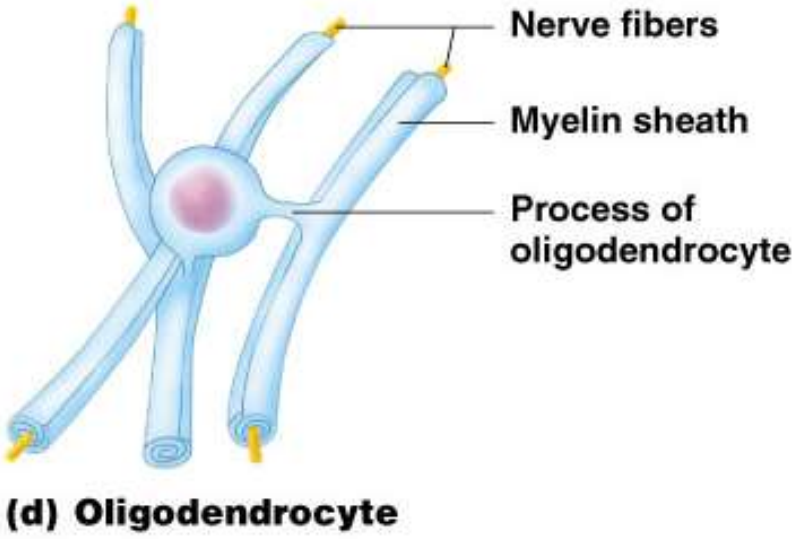


Figure 7.3d

Nervous Tissue: Neurons

- Neurons = nerve cells
  - Cells specialized to transmit messages
  - Major regions of neurons
    - Cell body – nucleus and metabolic center of the cell
    - Processes – fibers that extend from the cell body (dendrites and axons)

Neuron Anatomy

- Cell body
  - Nucleus
  - Large nucleolus

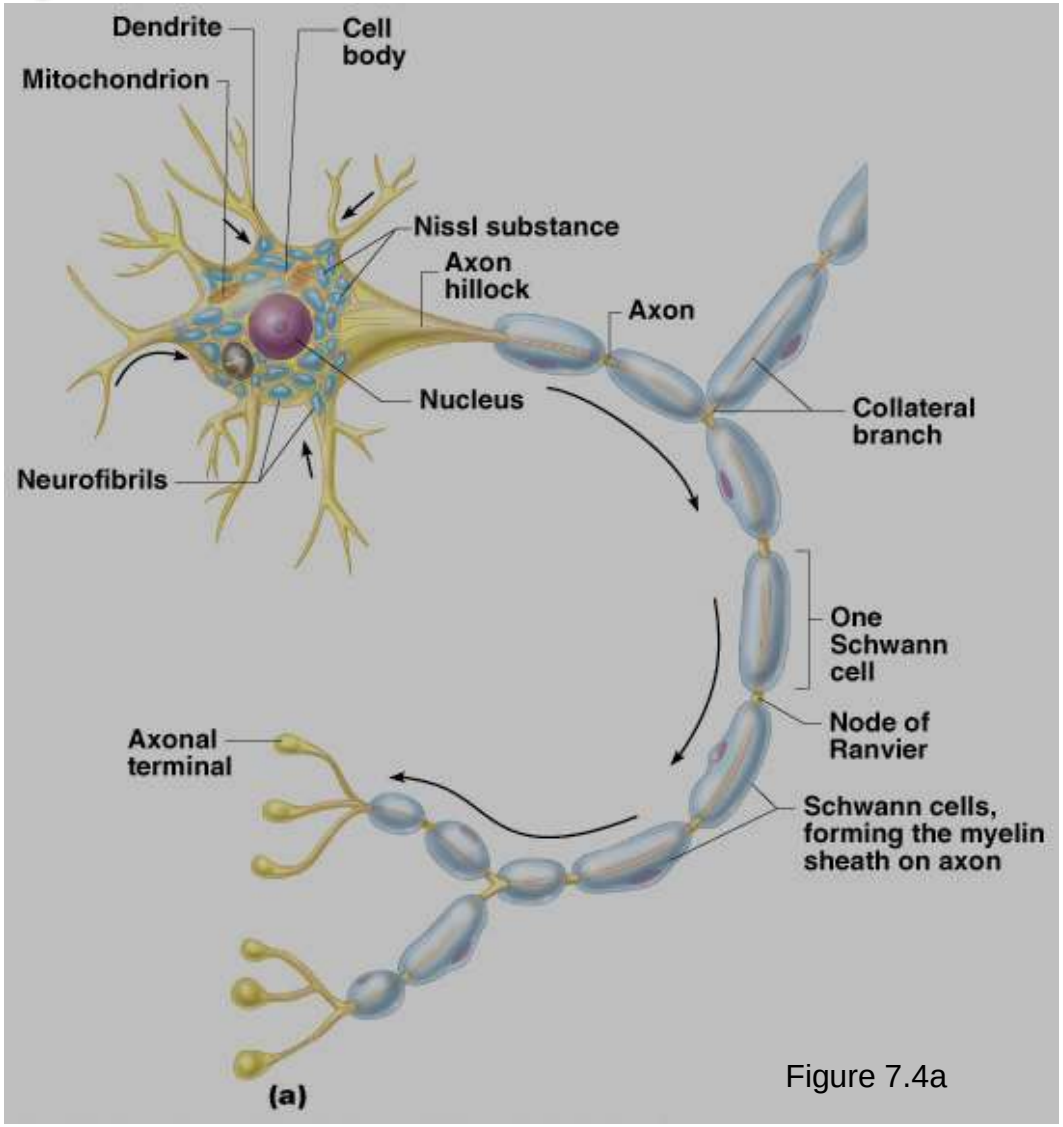


Figure 7.4a

Neuron Anatomy

- Extensions outside the cell body
  - Dendrites – conduct impulses toward the cell body
  - Axons – conduct impulses away from the cell body (only 1!)

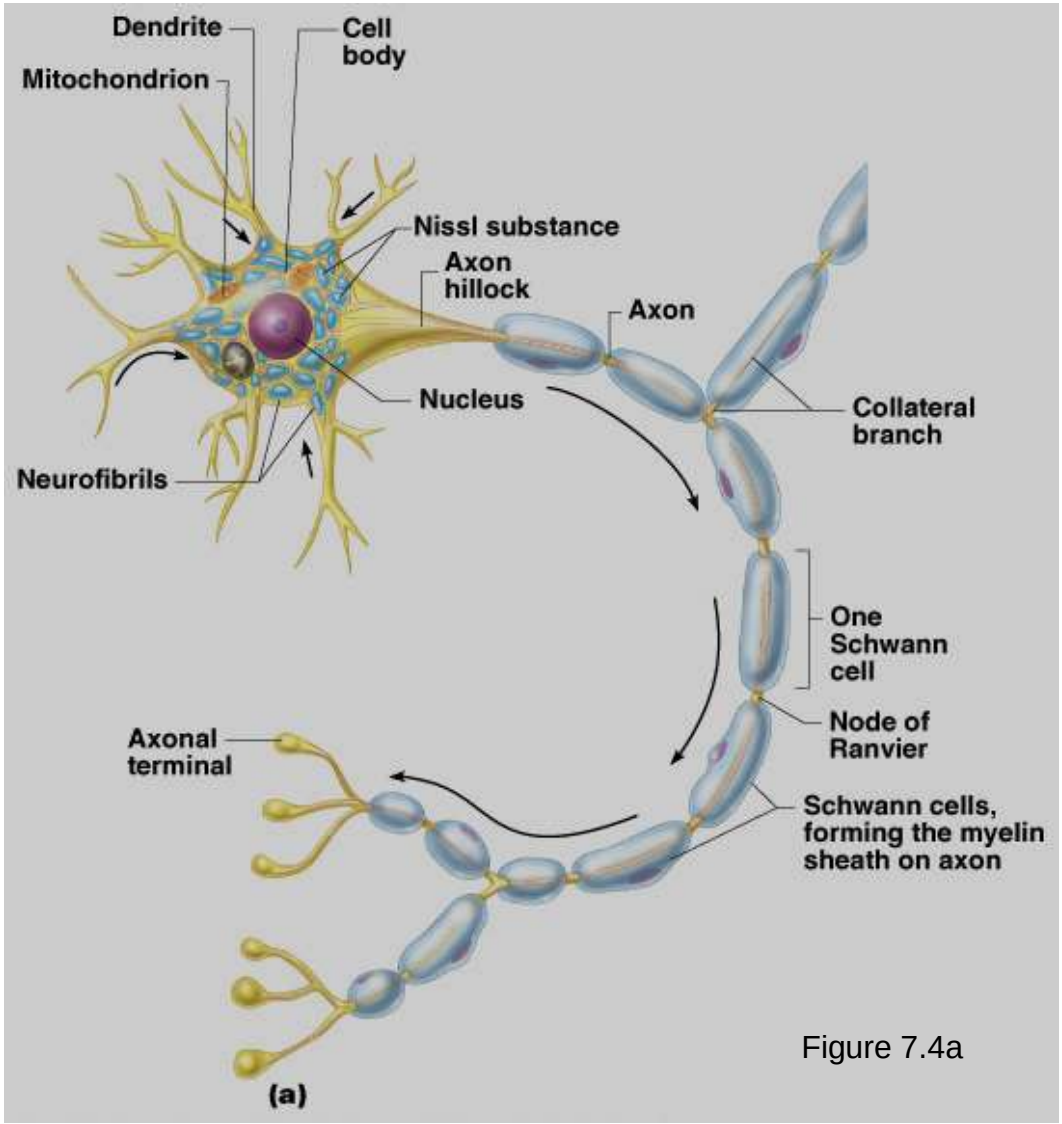
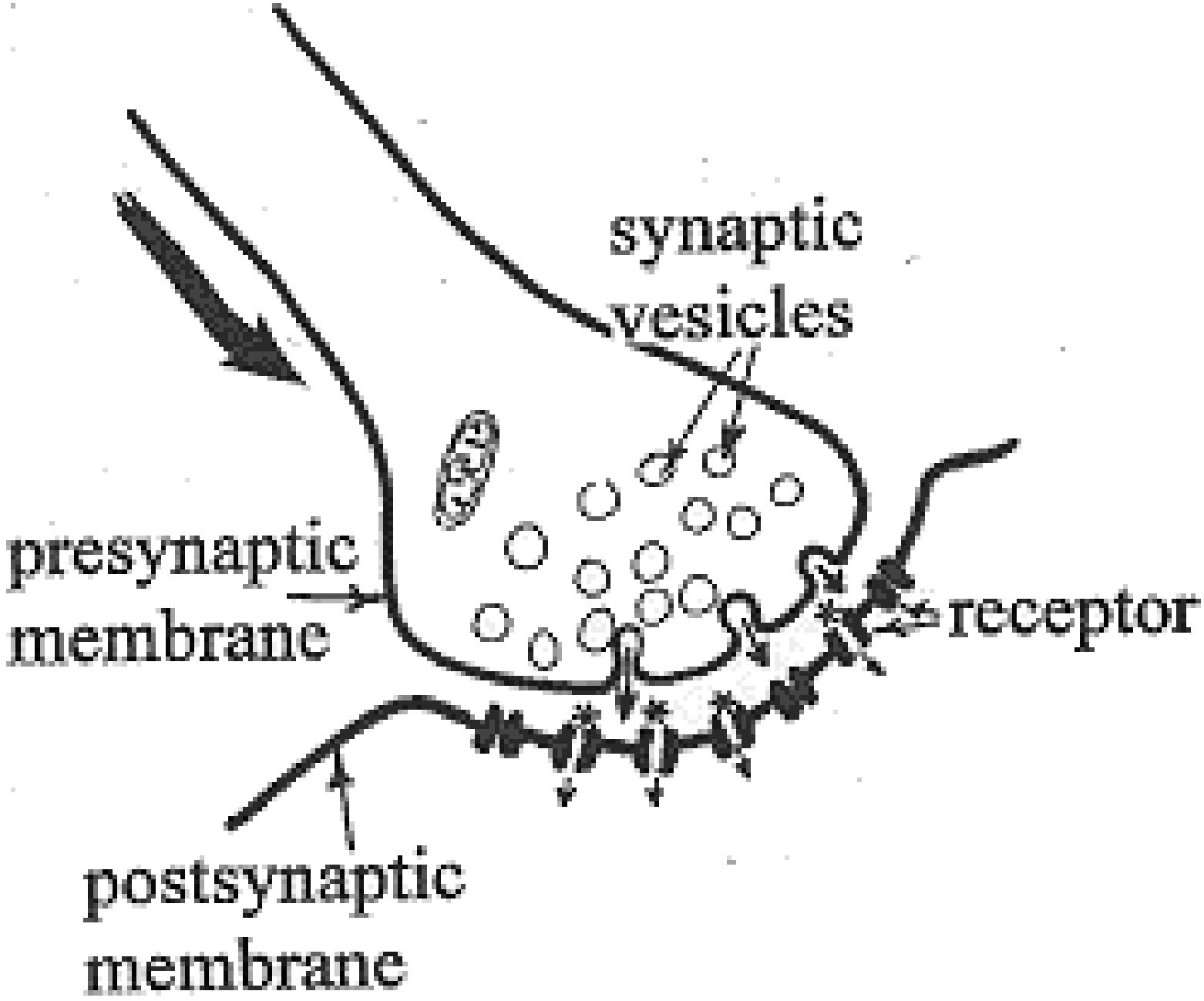


Figure 7.4a

Axons and Nerve Impulses

- Axons end in axonal terminals
- Axonal terminals contain vesicles with neurotransmitters
- Axonal terminals are separated from the next neuron by a gap
  - Synaptic cleft – gap between adjacent neurons
  - Synapse – junction between nerves


synaptic
vesicles
presynaptic
membrane
receptor
postsynaptic
membrane

Nerve Fiber Coverings

- Schwann cells – produce myelin sheaths in jelly-roll like fashion
- Nodes of Ranvier – gaps in myelin sheath along the axon

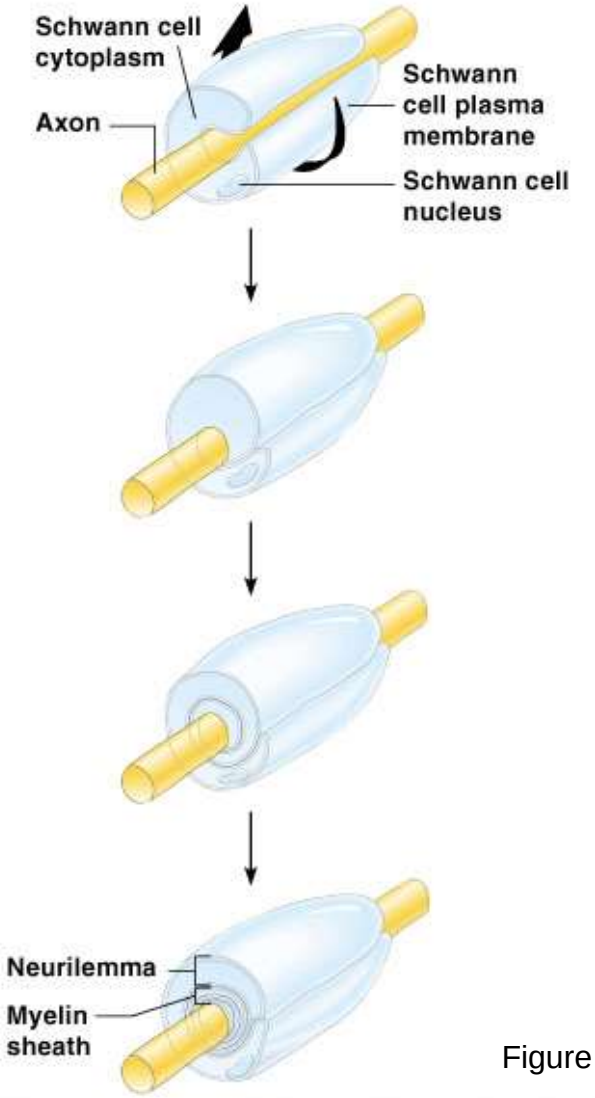


Figure 7.5

Application

- In Multiple Scleroses the myelin sheath is destroyed.
- The myelin sheath hardens to a tissue called the scleroses.
- This is considered an autoimmune disease.
- Why does MS appear to affect the muscles?

Neuron Cell Body Location

- Most are found in the central nervous system
  - Gray matter – cell bodies and unmylenated fibers
  - Nuclei – clusters of cell bodies within the white matter of the central nervous system
- Ganglia – collections of cell bodies outside the central nervous system

Functional Classification of Neurons

- Sensory (afferent) neurons
  - Carry impulses from the sensory receptors
    - Cutaneous sense organs
    - Proprioceptors – detect stretch or tension
- Motor (efferent) neurons
  - Carry impulses from the central nervous system

Functional Classification of Neurons

- Interneurons (association neurons)
  - Found in neural pathways in the central nervous system
  - Connect sensory and motor neurons

Neuron Classification

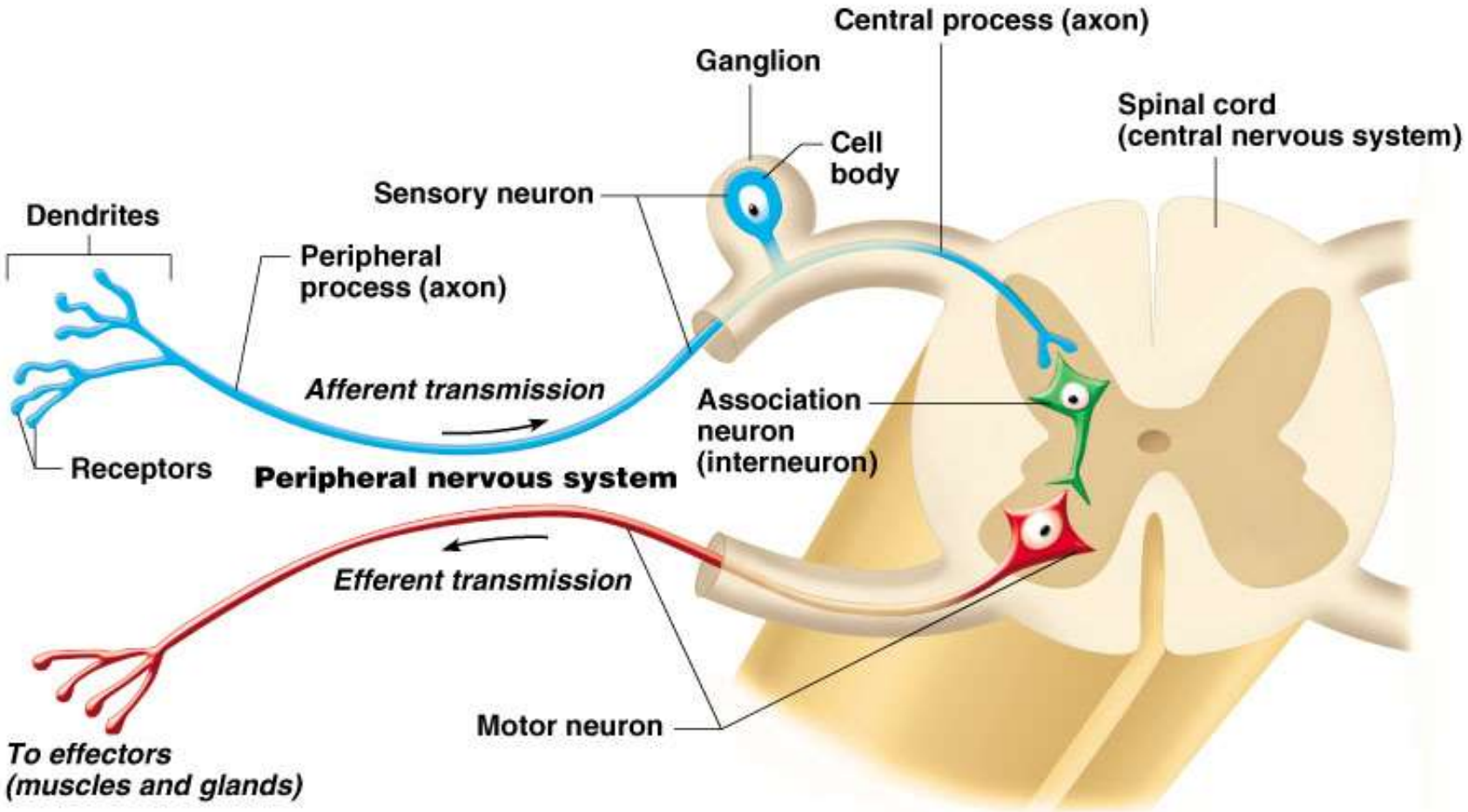
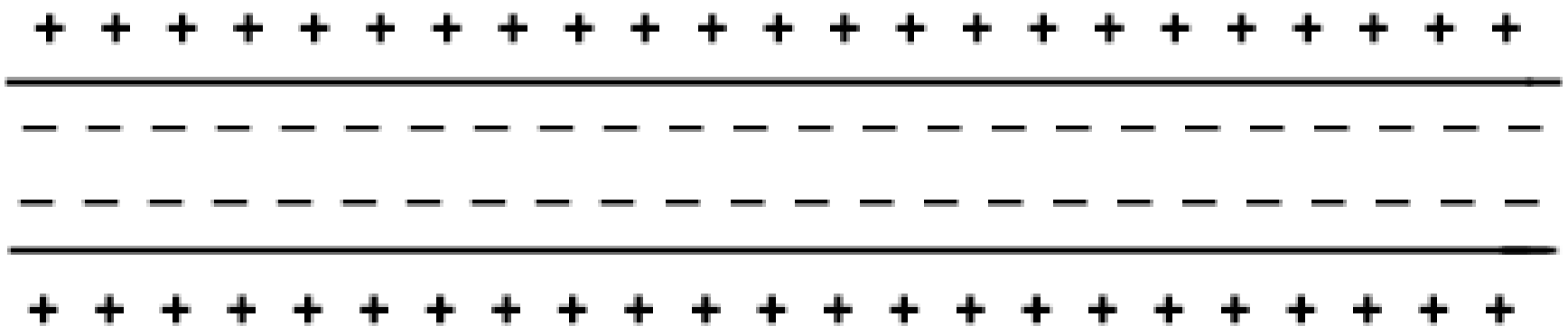


Figure 7.6

How Do Neurons Operate?

- Neuron at Rest → Resting Potential
  - Occurs when the neuron is at rest.
  - A condition where the *outside* of the membrane is *positively(+)* charged compared to the inside which is *negatively(-)* charged.
  - Neuron is said to be ***polarized.***



Section of an axon during the resting potential.

Starting a Nerve Impulse

- Depolarization – a stimulus causes sodium (Na^+) to flow inside the axon
- The exchange of ions initiates an action potential in the neuron
- Called depolarization

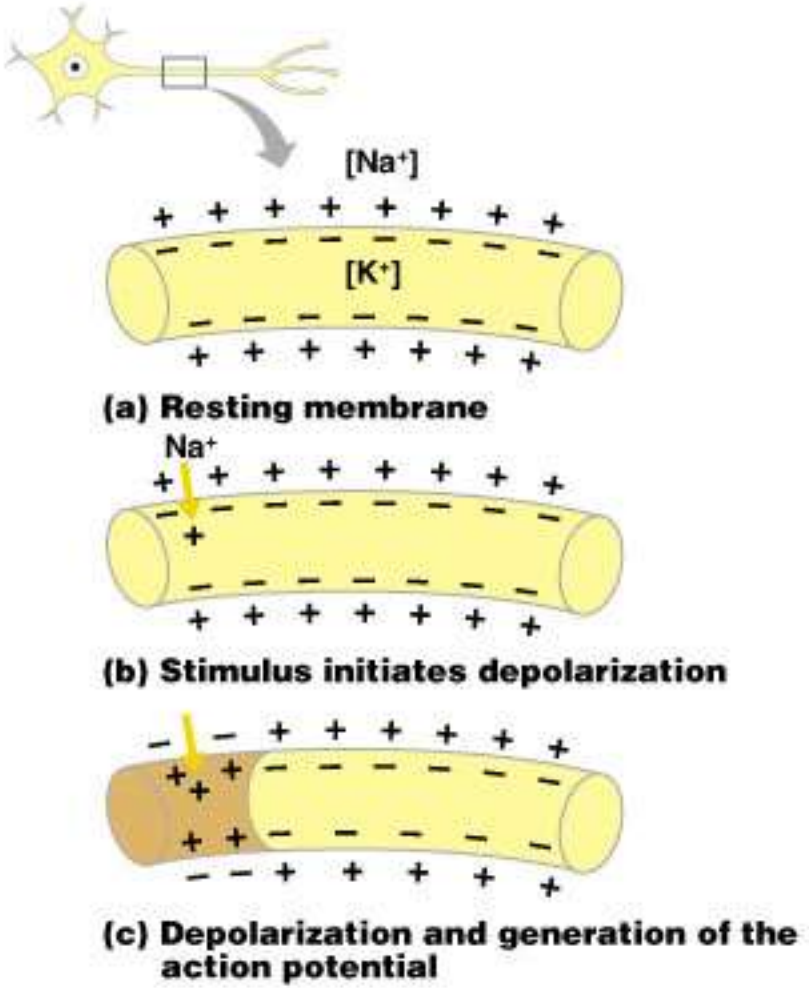


Figure 7.9a–c

The Action Potential

- If the action potential (nerve impulse) starts, it is propagated over the entire axon
- After depolariztion→ Potassium ions rush out of the neuron after sodium ions rush in, which repolarizes the membrane
- The sodium-potassium pump restores the original configuration
  - This action requires ATP

Nerve Impulse Propagation

- The impulse continues to move toward the cell body
- Impulses travel faster when fibers have a myelin sheath

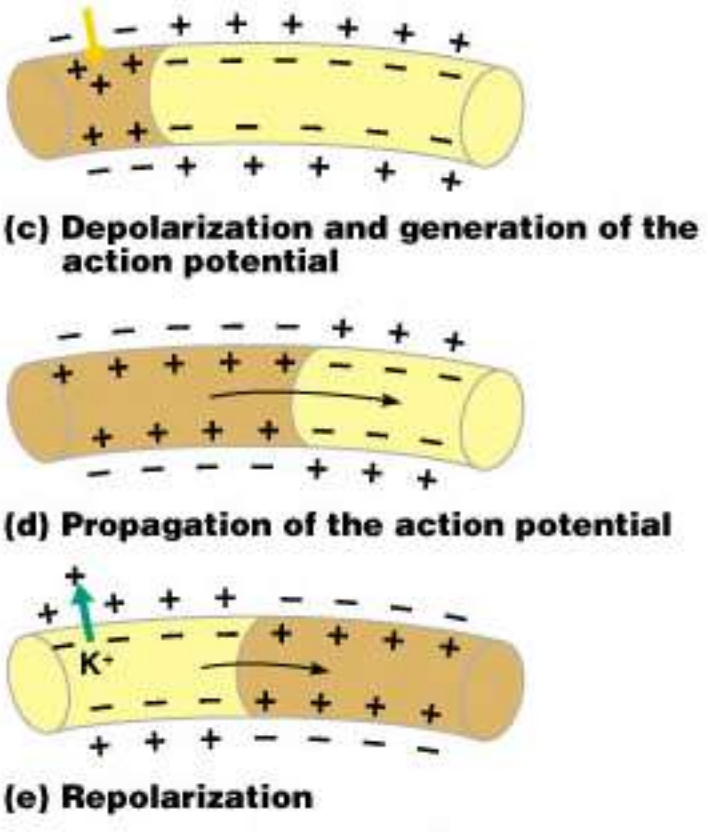


Figure 7.9c–e

Refractory Period

- Brief period of time between the triggering of an impulse and when it is available for another.
  - NO NEW action potentials can be created during this time.

Continuation of the Nerve Impulse between Neurons

- Impulses are able to cross the synapse to another nerve
  - Neurotransmitter is released from a nerve's axon terminal
  - The dendrite of the next neuron has receptors that are stimulated by the neurotransmitter
  - An action potential is started in the dendrite

How Neurons Communicate at Synapses

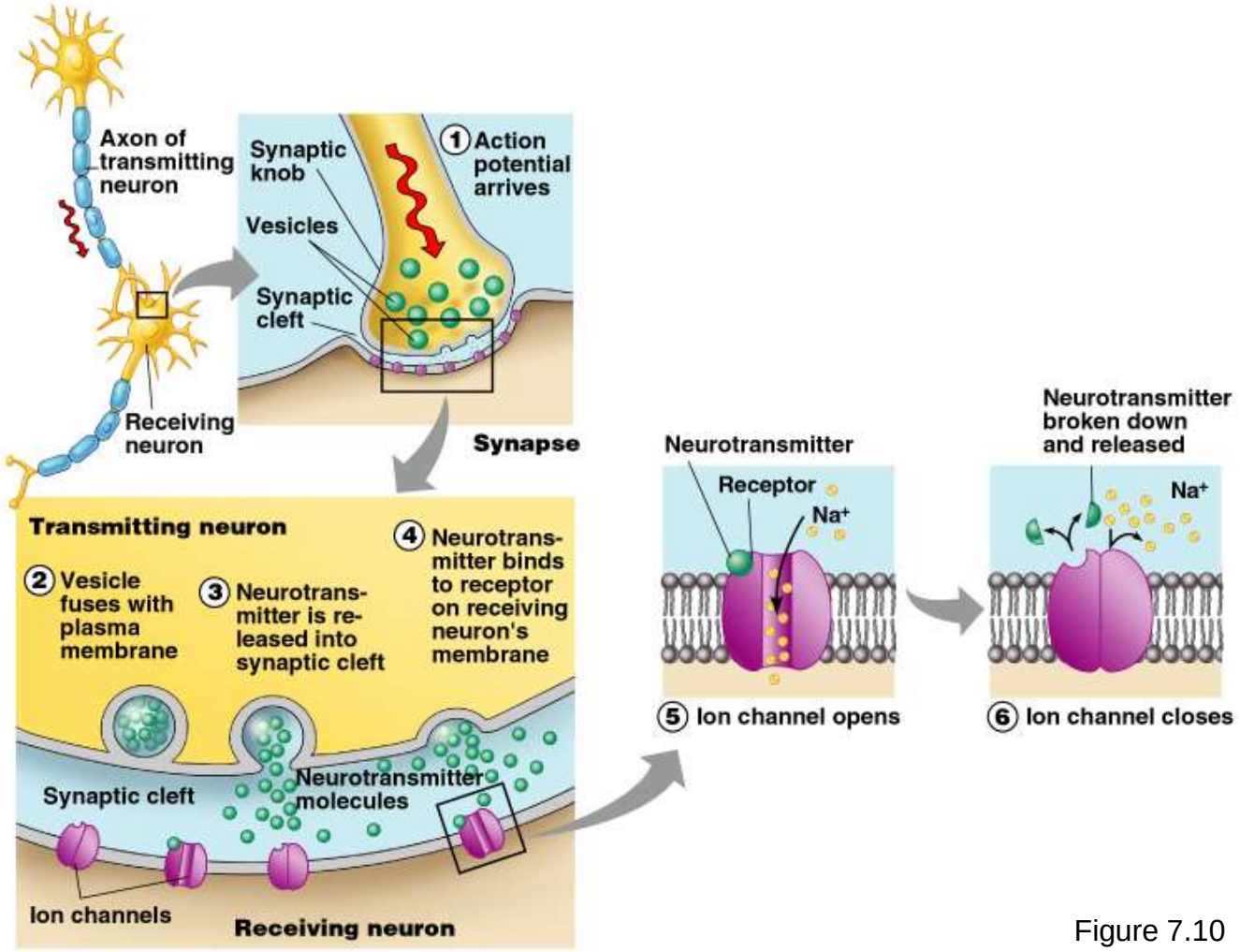


Figure 7.10

The Reflex Arc

- Reflex – rapid, predictable, and involuntary responses to stimuli
- Reflex arc – direct route from a sensory neuron, to an interneuron, to an effector

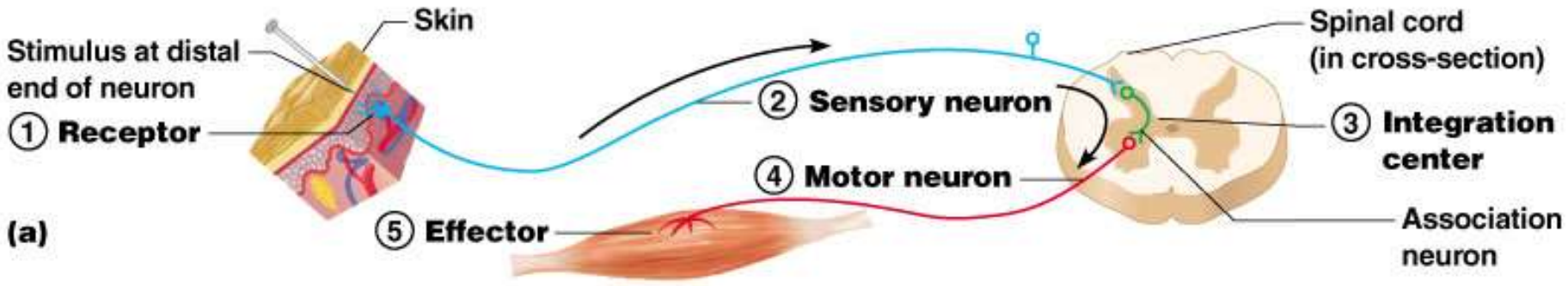


Figure 7.11a

Simple Reflex Arc

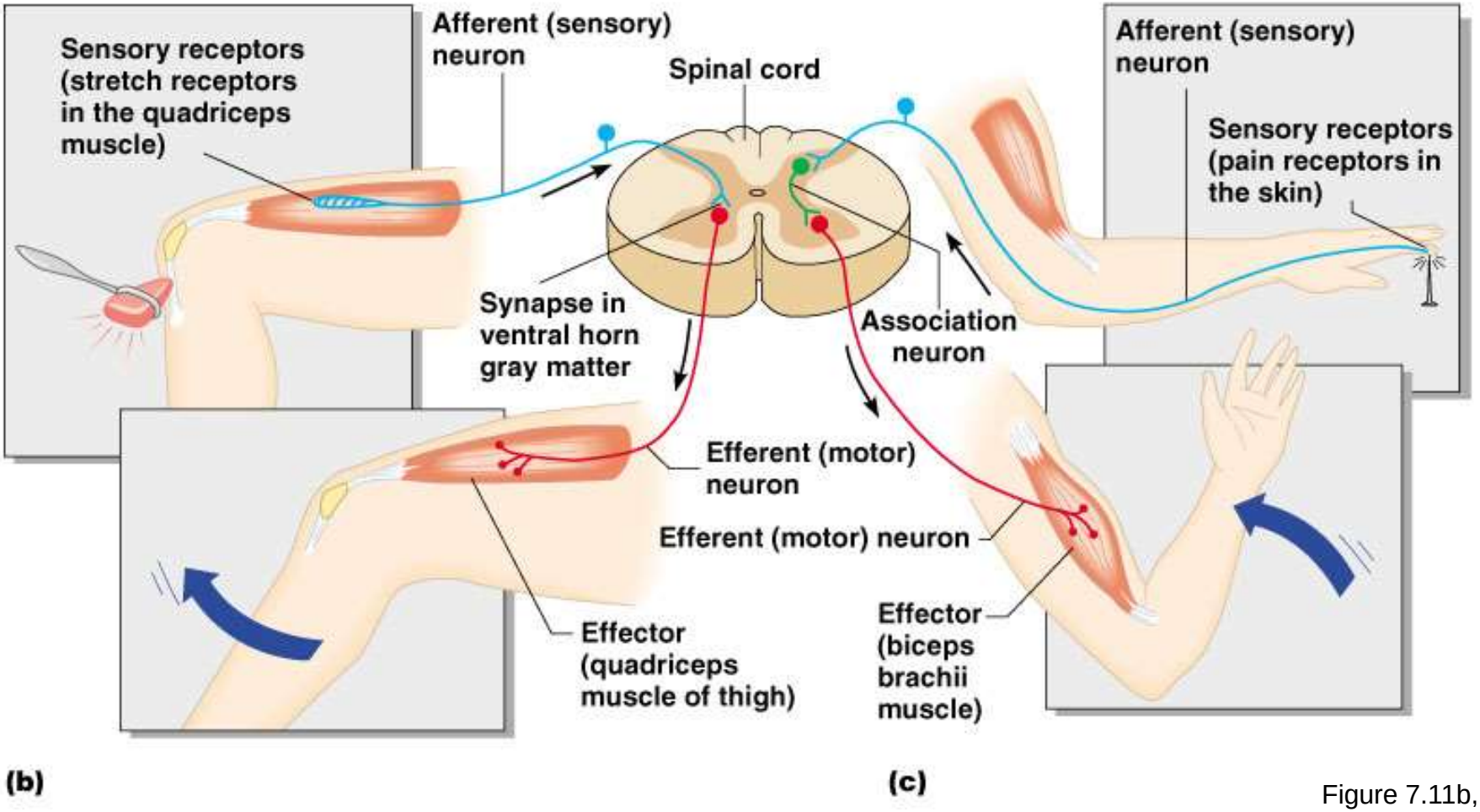


Figure 7.11b, c

Types of Reflexes and Regulation

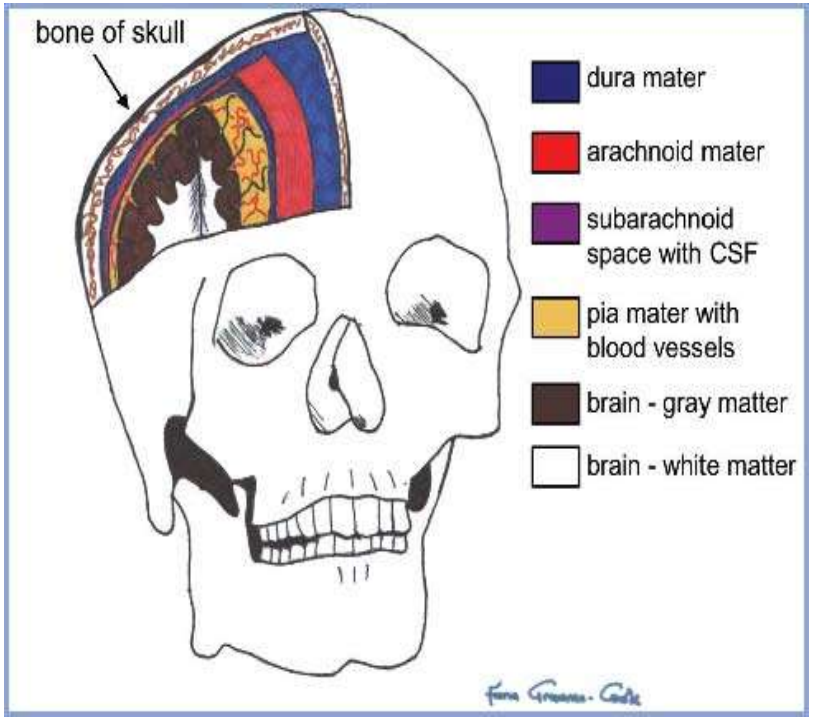
- Autonomic reflexes
  - Smooth muscle regulation
  - Heart and blood pressure regulation
  - Regulation of glands
  - Digestive system regulation
- Somatic reflexes
  - Activation of skeletal muscles

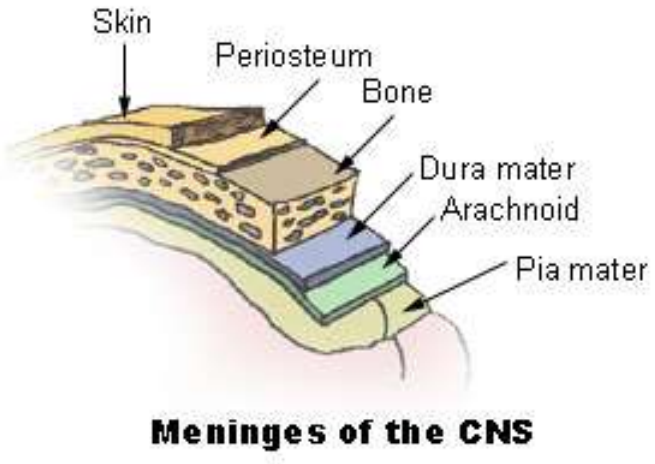
The Meninges

Dura mater - outermost layer

Arachnoid mater - no blood vessels, in between layer (resembles a spider web)

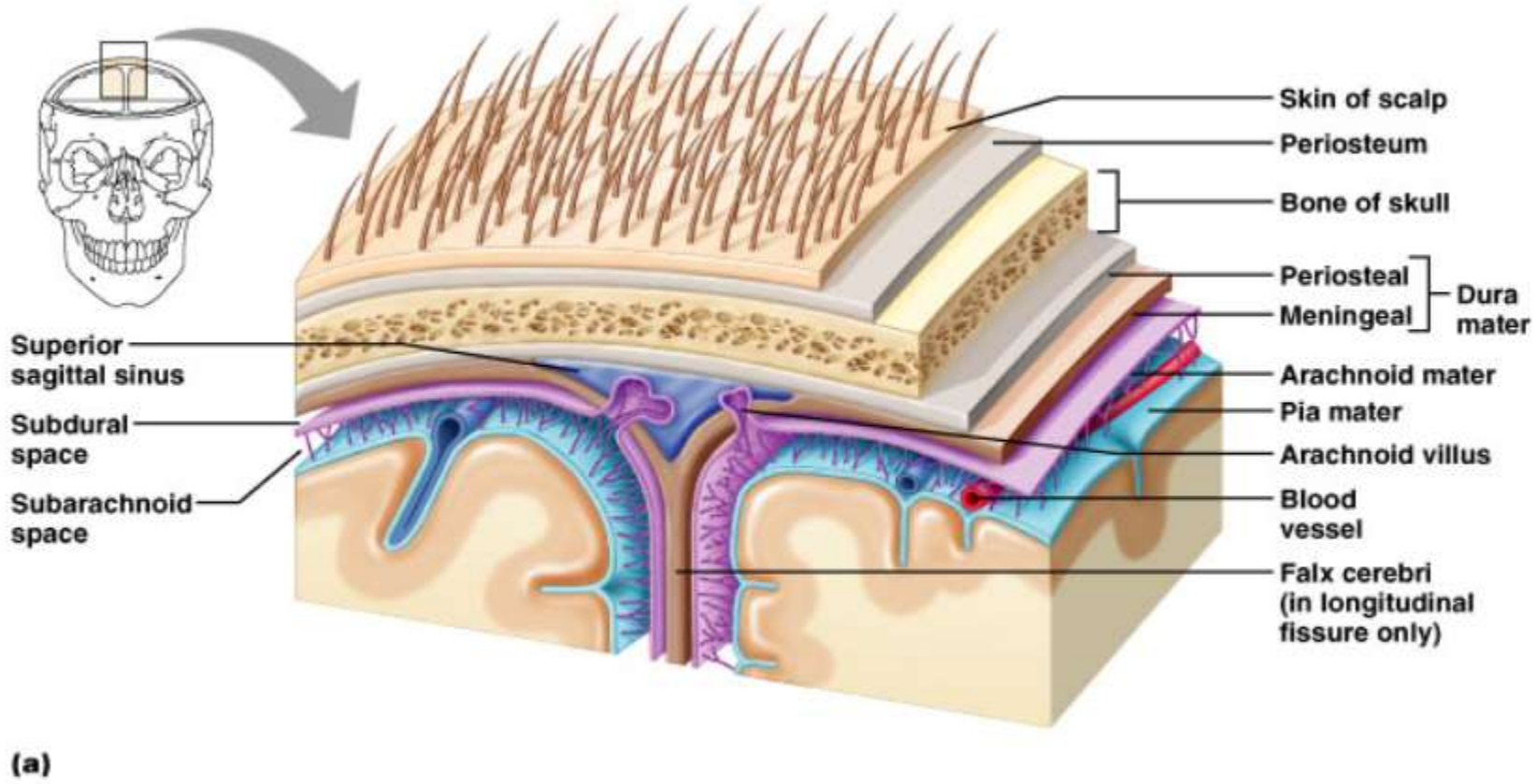
Pia mater -inner membrane, contains nerves and blood vessels to nourish cells





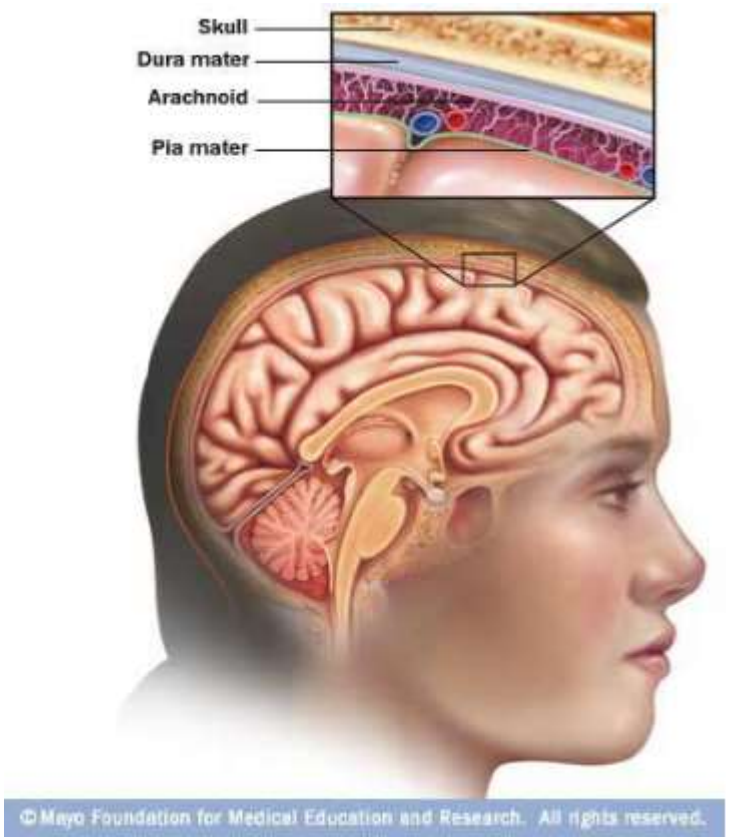
Meninges of the CNS

The Meninges

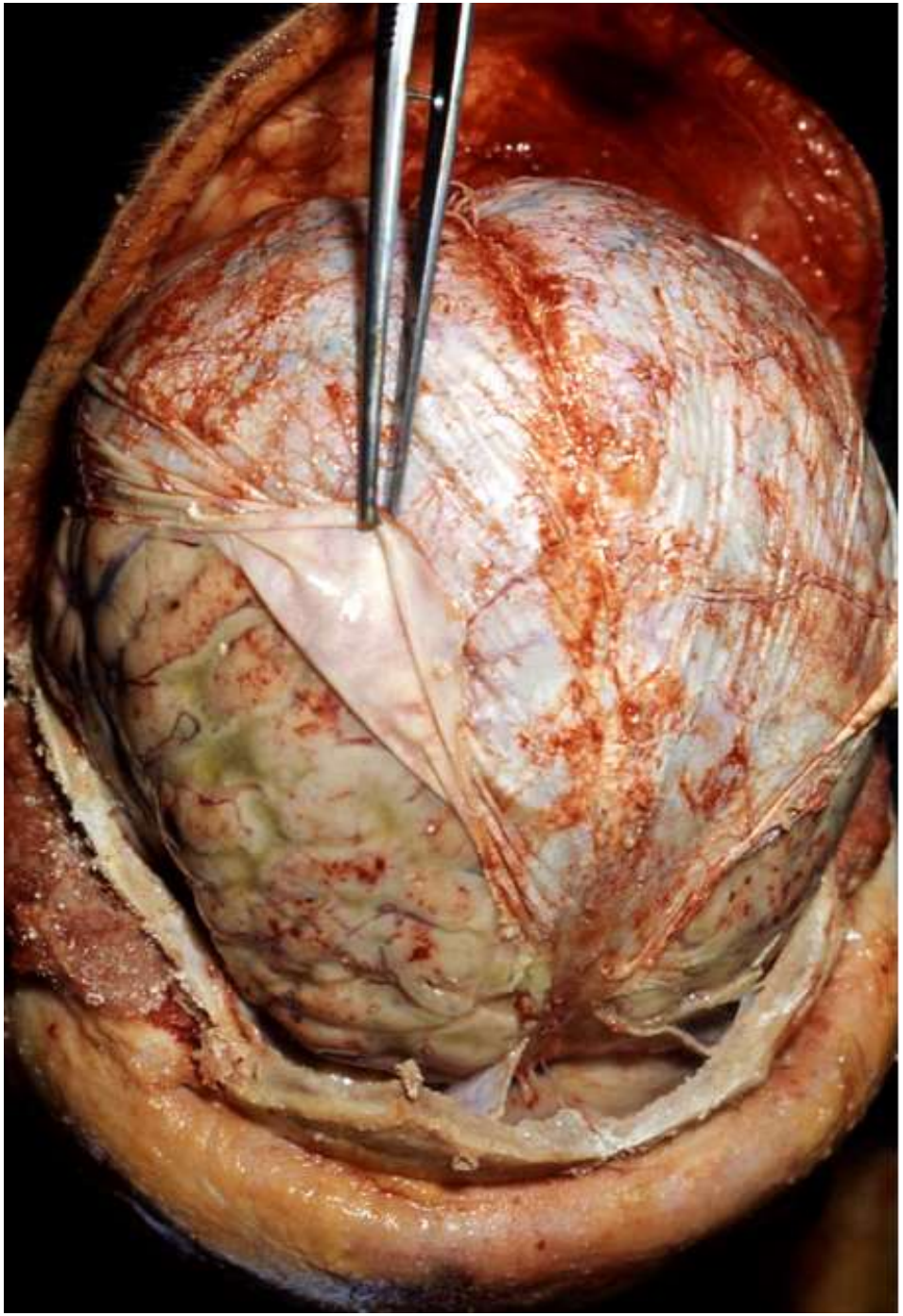


CSF = cerebrospinal fluid

Figure 13.25a



Dura mater is being peeled away in this photo.



Regions of the Brain

- Cerebral hemispheres
- Diencephalon
- Brain stem
- Cerebellum

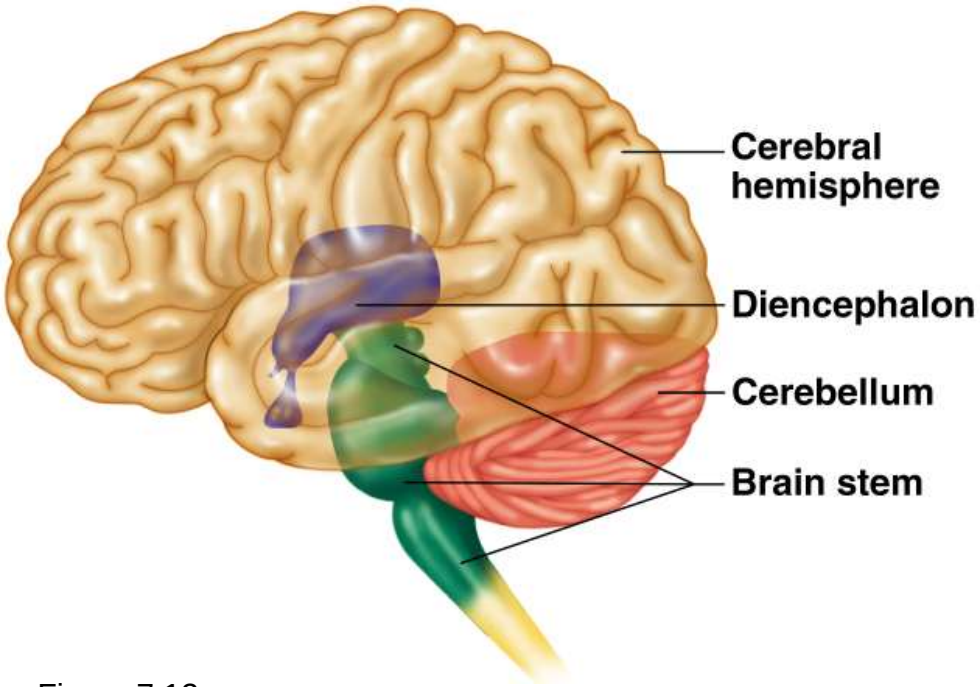


Figure 7.12

Cerebral Hemispheres (Cerebrum)

- Paired (left and right) superior parts of the brain
- Include more than half of the brain mass

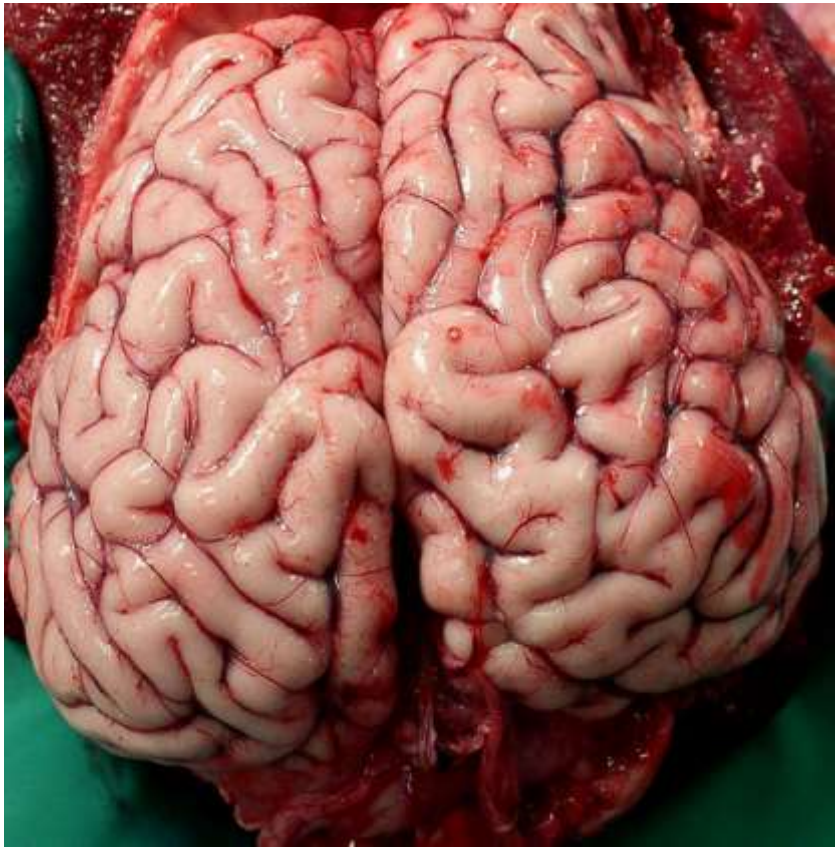


Figure 7.13a

Cerebral Hemispheres (Cerebrum)

- The surface is made of ridges (gyri) and grooves (sulci)

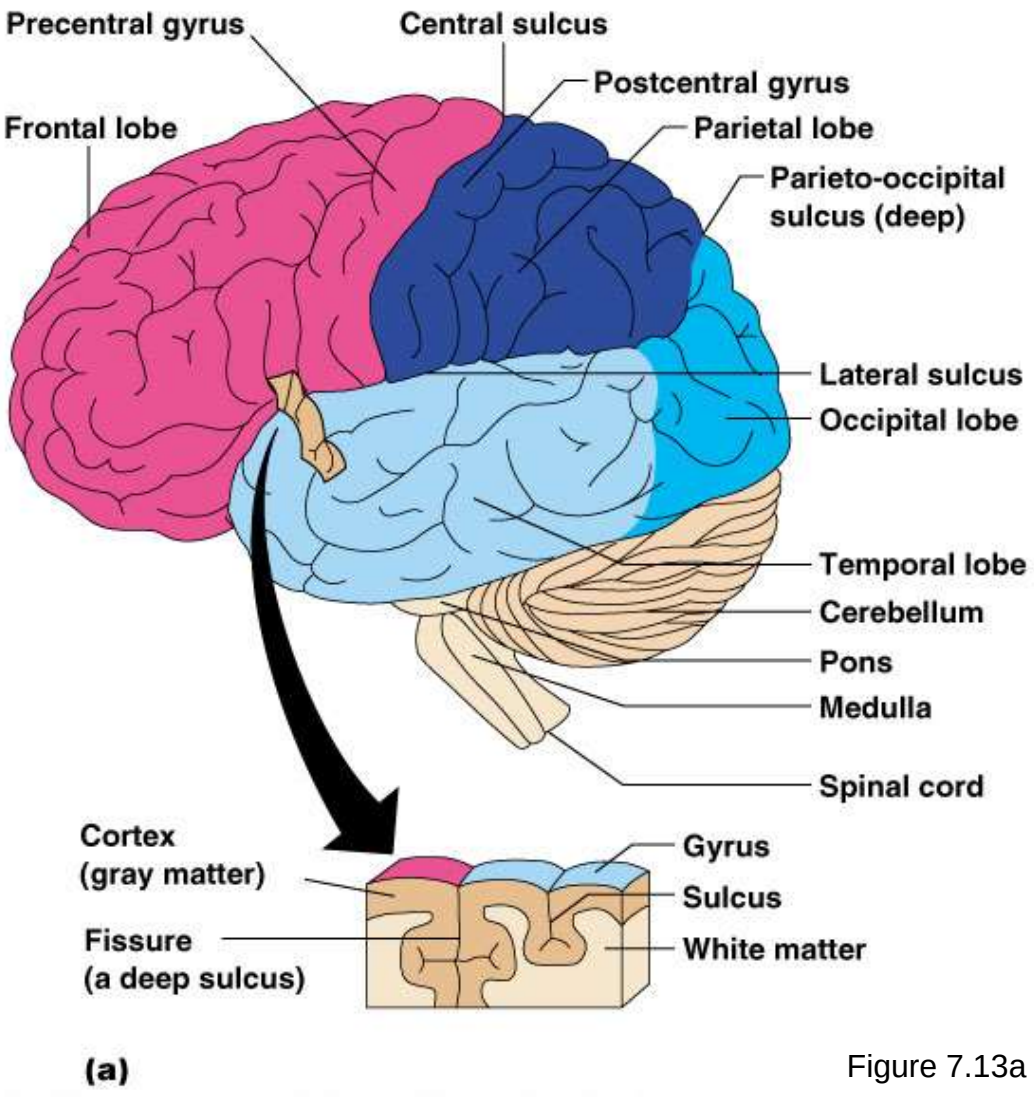


Figure 7.13a

Layers of the Cerebrum

- Gray matter
  - Outer layer
  - Composed mostly of neuron cell bodies, glial cells and unmyelinated axons.
- White Matter
  - axons and connections between neurons

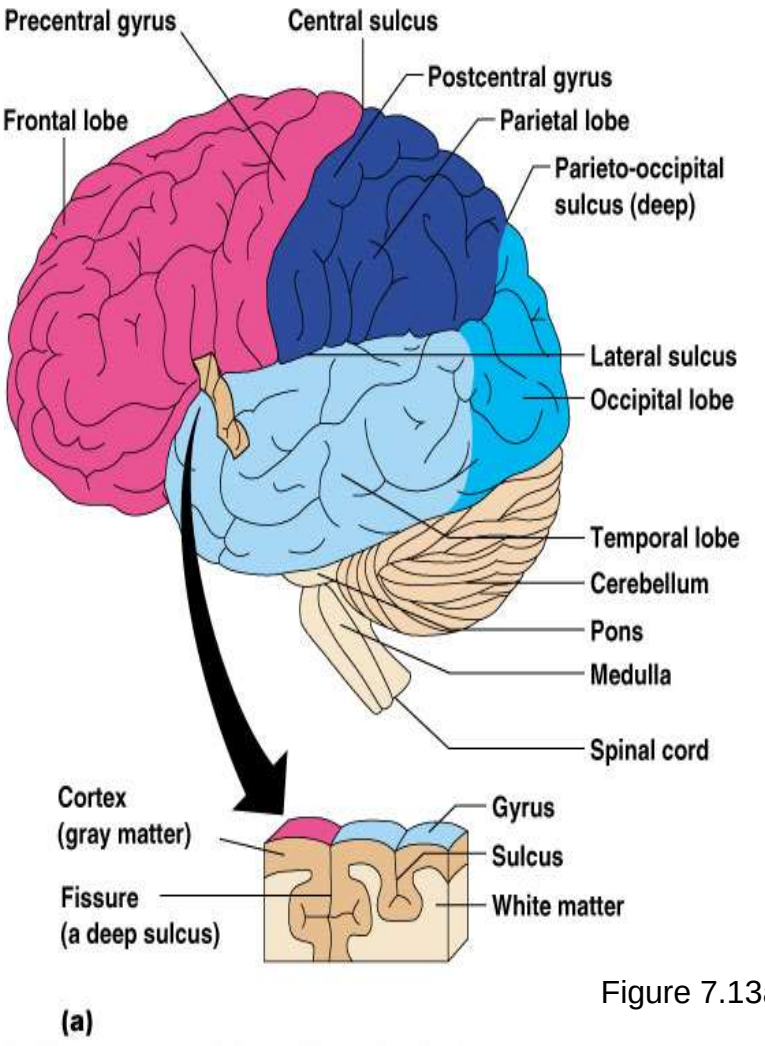


Figure 7.13a

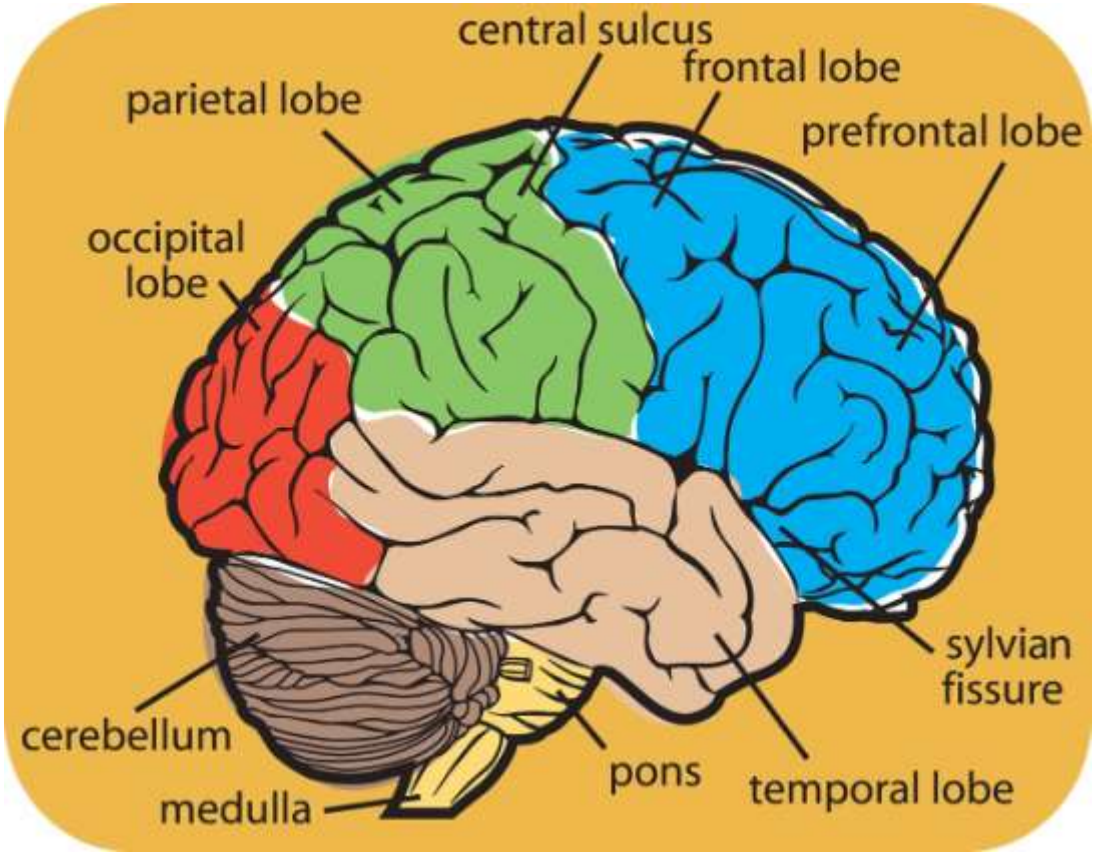
Lobes of the Brain
(general functions)

Frontal – reasoning, thinking, language

Parietal – touch, pain, relation of body parts (somatosensory)

Temporal Lobe – hearing, taste

Occipital – vision



Frontal Lobe

- Prefrontal cortex: abstract intellectual functions
- Gustatory cortex: taste
- Primary motor cortex: direct voluntary movement
- Premotor cortex: coordinating learned movements
- Speech center→ Broca's area (left hemisphere)→ processes the breathing and vocalization patterns required to speak
- Damage→ cause difficulty speaking or speaking the wrong words even when you know exactly what you want to say.

Parietal and Occipital

- Primary sensory cortex:
- Touch, pressure, pain and temperature receptors
- Somatic Sensory association area: recognize different types of touch
- Visual Cortex/ Visual association area:
- Visual stimuli and process images

Temporal Lobe:

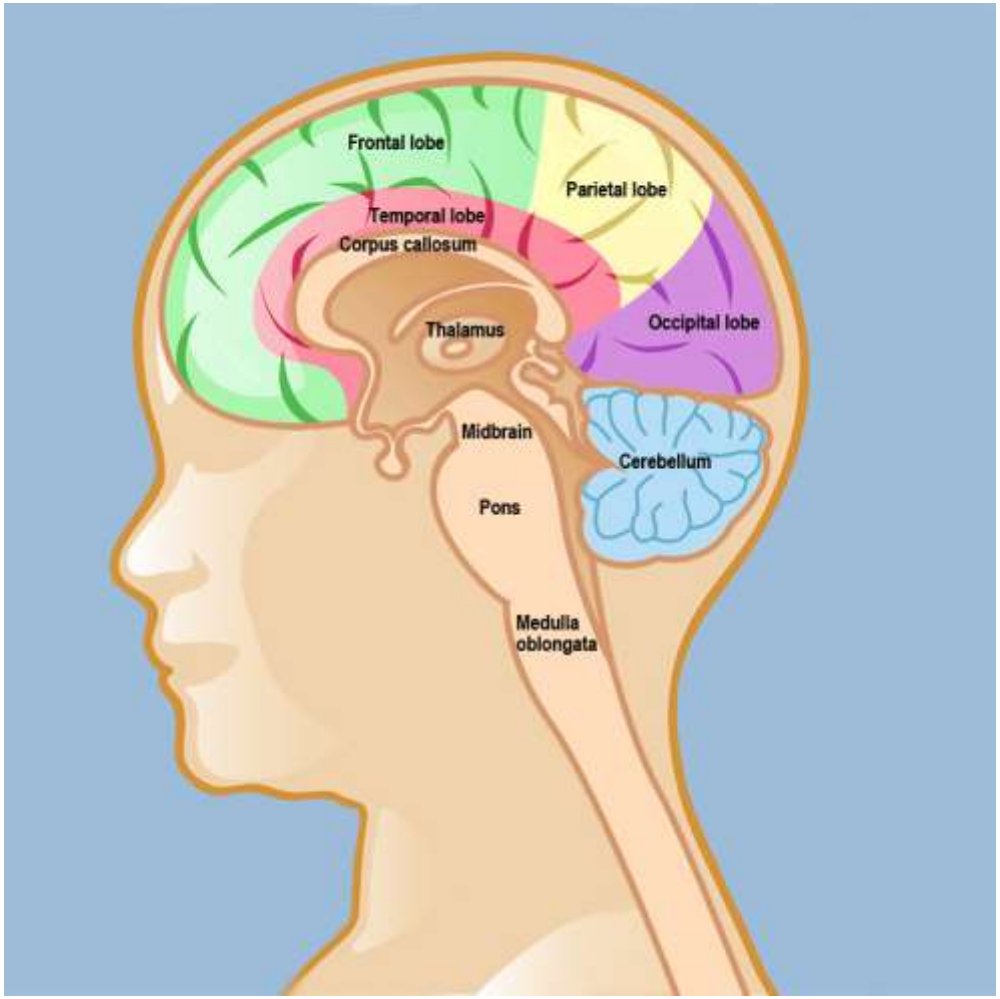
- Auditory and Olfactory cortex:
- Sound and Smell
- Left temporal lobe: general interpretive area→ recieves information from all association areas and processes information expecially sound
- Damage to G.I.A: cause inability to process the meanings of words put together.
- AKA→ Wernicke's area

Diencephalon

- Sits on top of the brain stem
- Enclosed by the cerebral hemispheres
- Made of three parts
  - Thalamus
  - Hypothalamus
  - Epithalamus

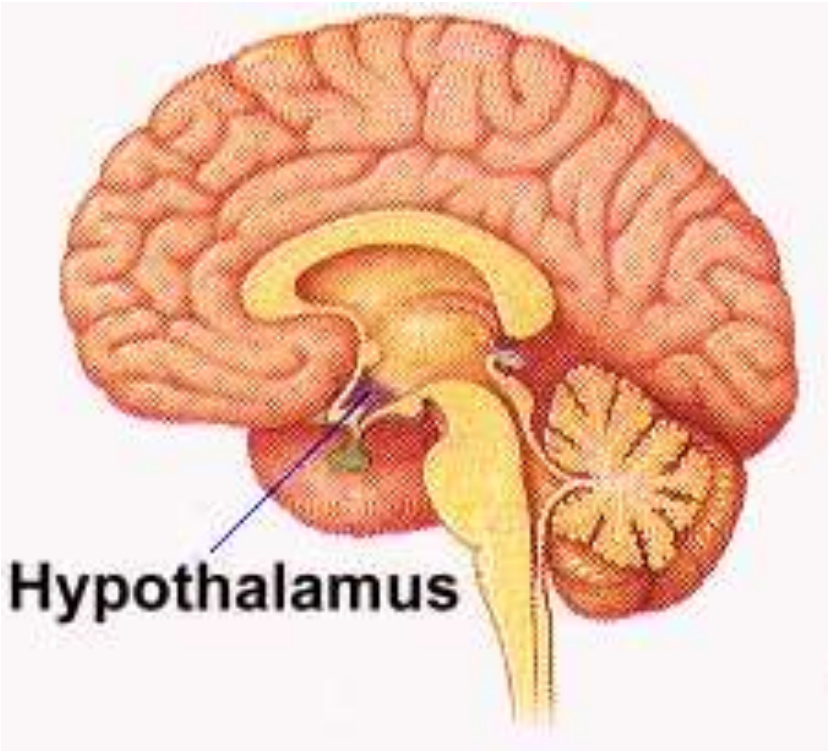
Thalamus

- Surrounds the third ventricle
- The relay station for sensory impulses
- Transfers impulses to the correct part of the cortex for localization and interpretation



Hypothalamus

- Under the thalamus
- Important autonomic nervous system center
  - Helps regulate body temperature
  - Controls water balance
  - Regulates metabolism

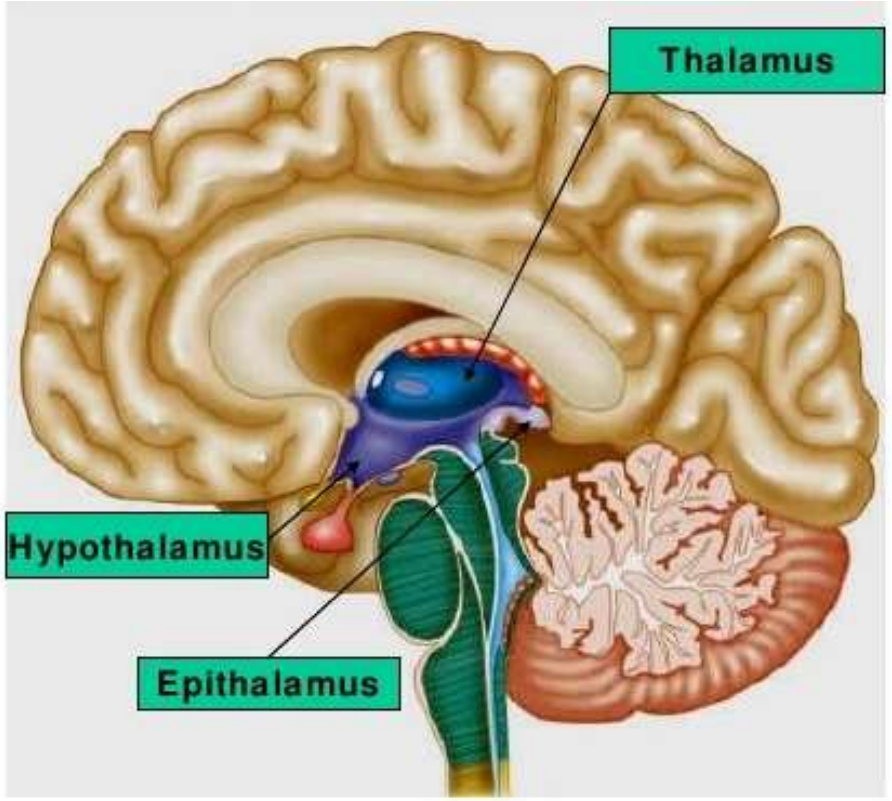


Hypothalamus

- An important part of the limbic system (emotions)
- The pituitary gland is attached to the hypothalamus

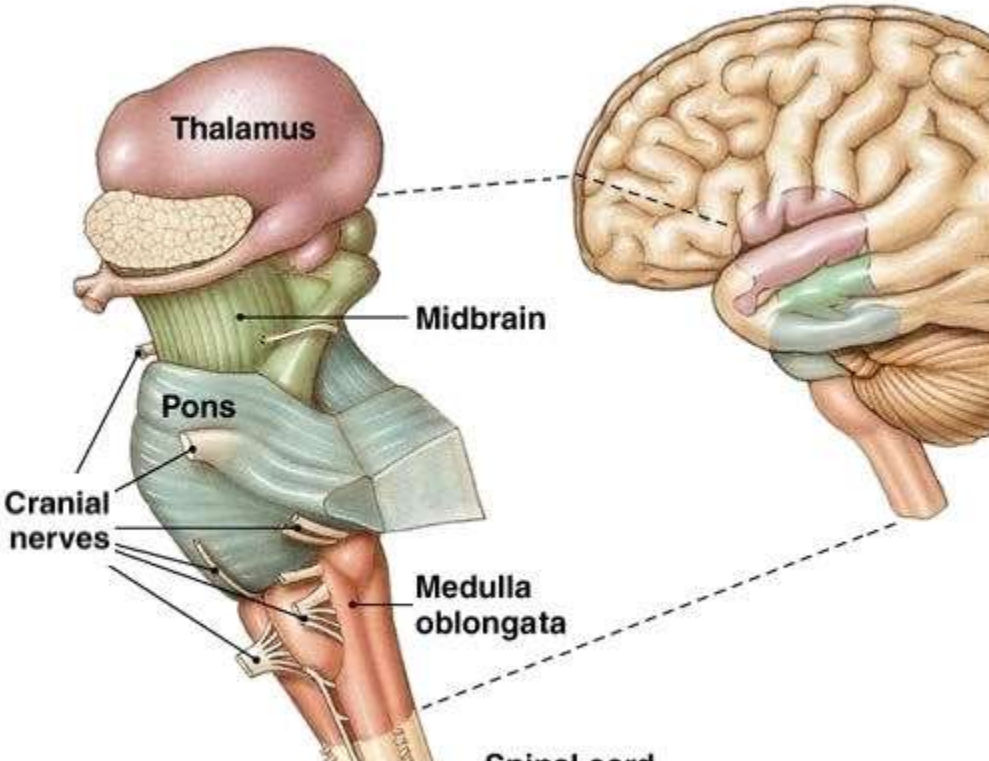
Epithalamus

- Forms the roof of the third ventricle
- Houses the pineal body (an endocrine gland)
- Includes the choroid plexus – forms cerebrospinal fluid



Brain Stem

- Attaches to the spinal cord
- Parts of the brain stem
  - Midbrain
  - Pons
  - Medulla oblongata



Midbrain

- Mostly composed of tracts of nerve fibers
  - Reflex centers for vision and hearing
  - Cerebral aquaduct – 3rd-4th ventricles

Pons

- The bulging center part of the brain stem
- Mostly composed of fiber tracts
- Includes nuclei involved in the control of breathing

Medulla Oblongata

- The lowest part of the brain stem
- Merges into the spinal cord
- Includes important fiber tracts
- Contains important control centers
  - Heart rate control
  - Blood pressure regulation
  - Breathing
  - Swallowing
  - Vomiting

Cerebellum

- Two hemispheres with convoluted surfaces
- Provides involuntary coordination of body movements

Cerebellum

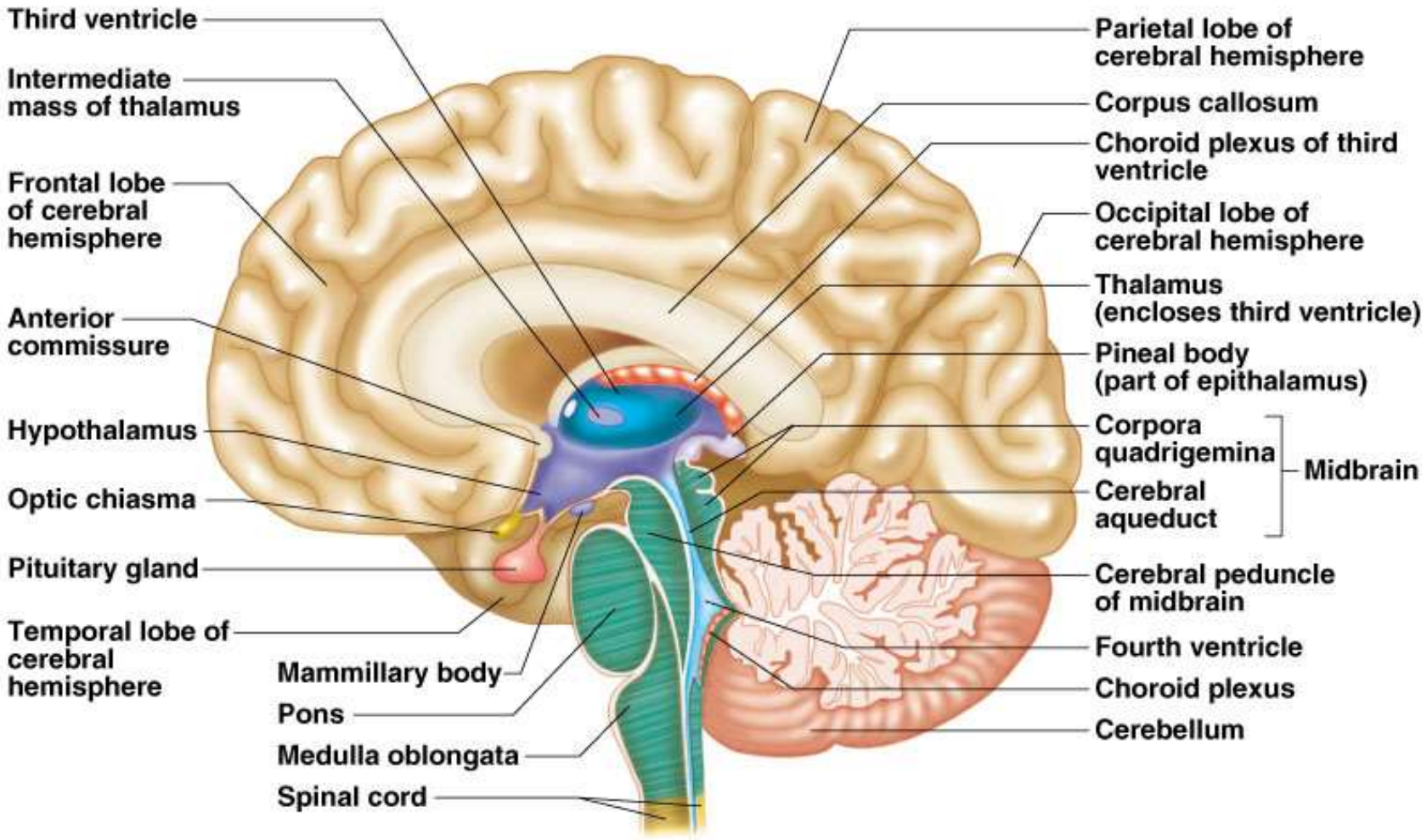


Figure 7.15a

Ventricles and Location of the Cerebrospinal Fluid

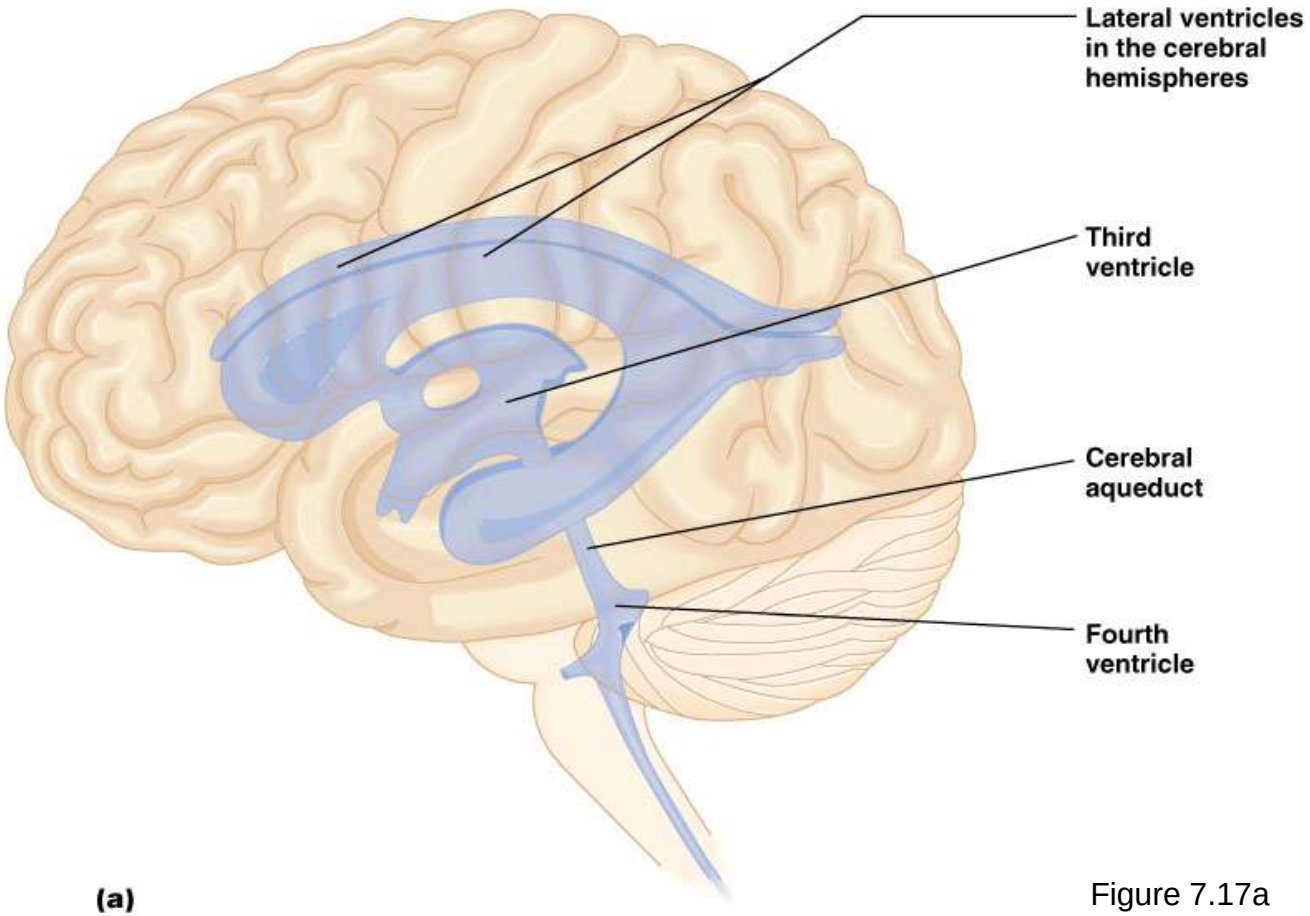


Figure 7.17a

Ventricles and Location of the Cerebrospinal Fluid

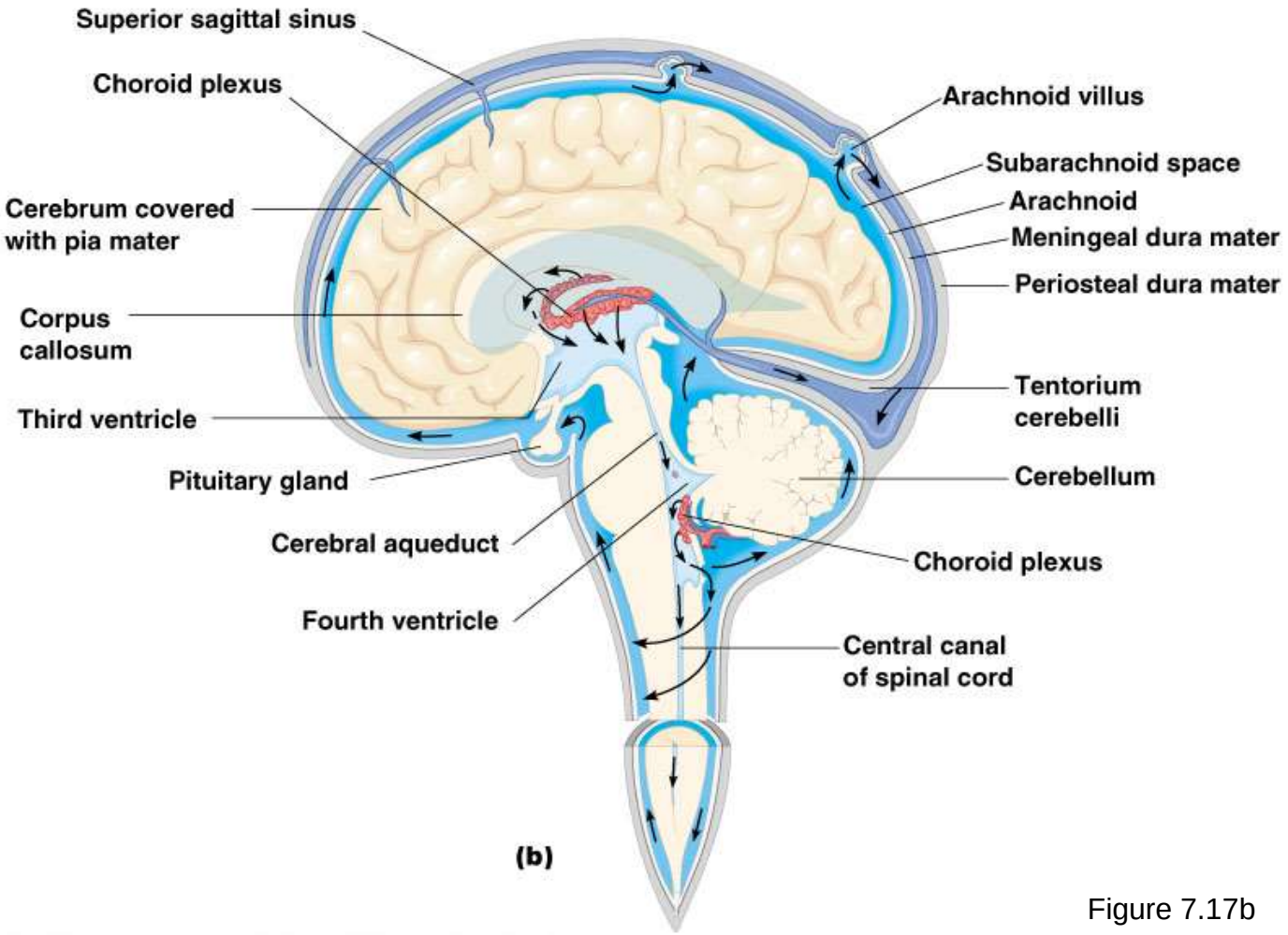


Figure 7.17b

Structure of a Nerve

- Endoneurium surrounds each fiber
- Groups of fibers are bound into fascicles by perineurium
- Fascicles are bound together by epineurium

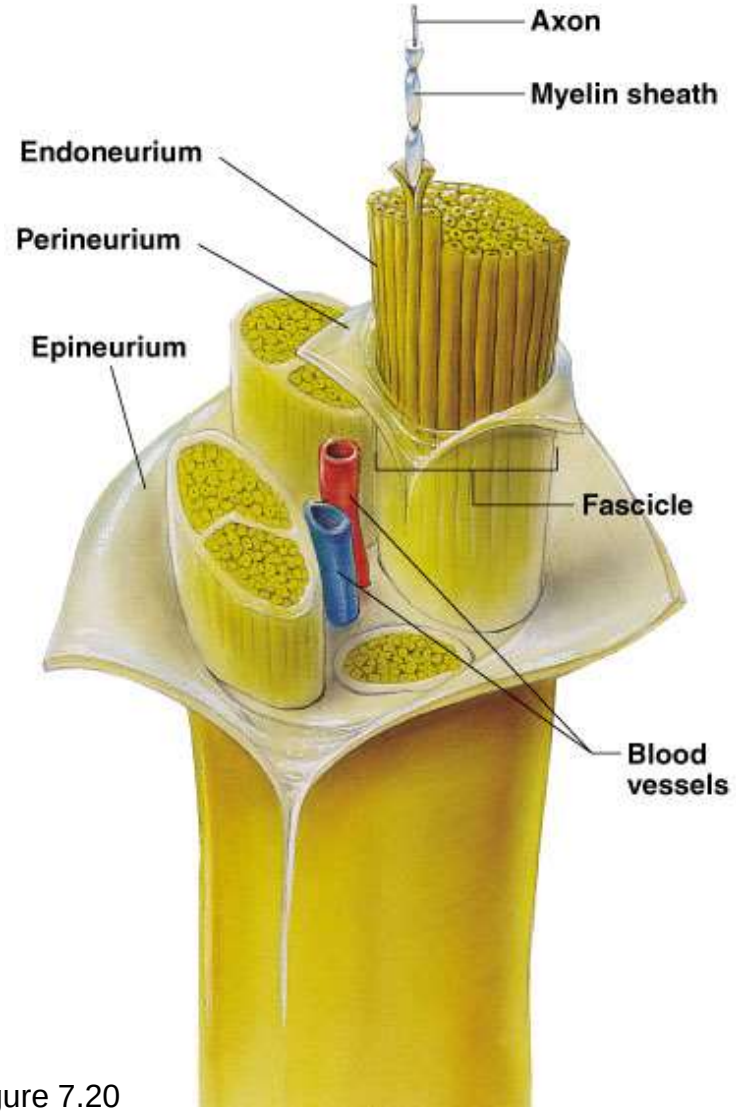


Figure 7.20

Development Aspects of the Nervous System

- The nervous system is formed during the first month of embryonic development
- Any maternal infection can have extremely harmful effects
- The hypothalamus is one of the last areas of the brain to develop

Development Aspects of the Nervous System

- No more neurons are formed after birth, but growth and maturation continues for several years (new evidence!)
- The brain reaches maximum weight as a young adult
- However, we can always grow dendrites!