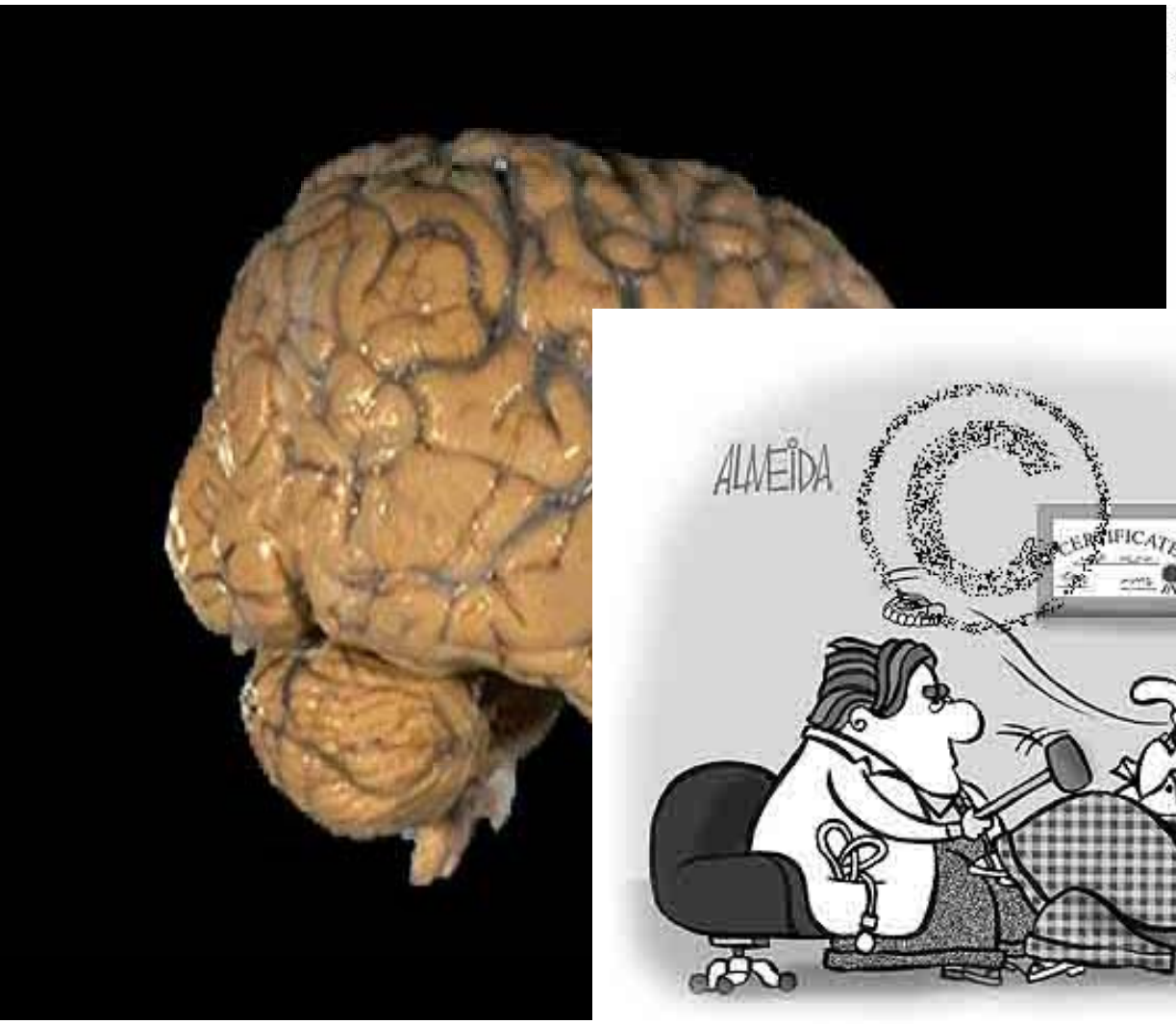


Reflexes

DANIL HAMMOUDI.MD

Reflexes

- A reflex is a rapid, predictable motor response to a stimulus
- Reflexes may:
  - Be inborn (intrinsic) or learned (acquired)
  - Involve only peripheral nerves and the spinal cord
  - Involve higher brain centers as well

Newborn Reflexes

- **Foot**
- Stroke Inner Sole
  - Toes curl around ("grasp") examiner's finger
- Stroke Outer Sole (Babinski)
  - Toes spread, great toe dorsiflexion

Doll's Eyes

- Give one forefinger to each hand - baby grasps both
  - Pull baby to sitting with each forefinger
- Eyes open on coming to sitting (Like a Doll's)
  - Head initially lags
  - Baby uses shoulders to right head position

Walking Reflex

- Hold baby up with one hand across chest
- As feet touch ground, baby makes walking motion

Protective Reflex

- Soft cloth is placed over the babies eyes and nose
- Baby arches head and turns head side to side
- Brings both hands to face to swipe cloth away

Rooting Reflex

- Touch newborn on either side of cheek
- Baby turns to find breast
- Sucking mechanism on finger is divided into 3 steps
  - Front of Tongue laps on finger
  - Back of Tongue massages middle of the finger
  - Esophagus pulls on tip of finger

Tonic Neck (Fencing) Reflex

- If the Babies' head is rotated leftward
  - The left arm (face side) stretches into extension
  - The right arm flexes up above head
- Opposite reaction if head is rotated rightward

Moro Reflex (Startle Reflex)

- Hold supine infant by arms a few inches above bed
  - Gently drop infant back to elicit startle
- Baby throws Arms out in extension and baby grimaces

Hand-to-Mouth (Babkin) Reflex

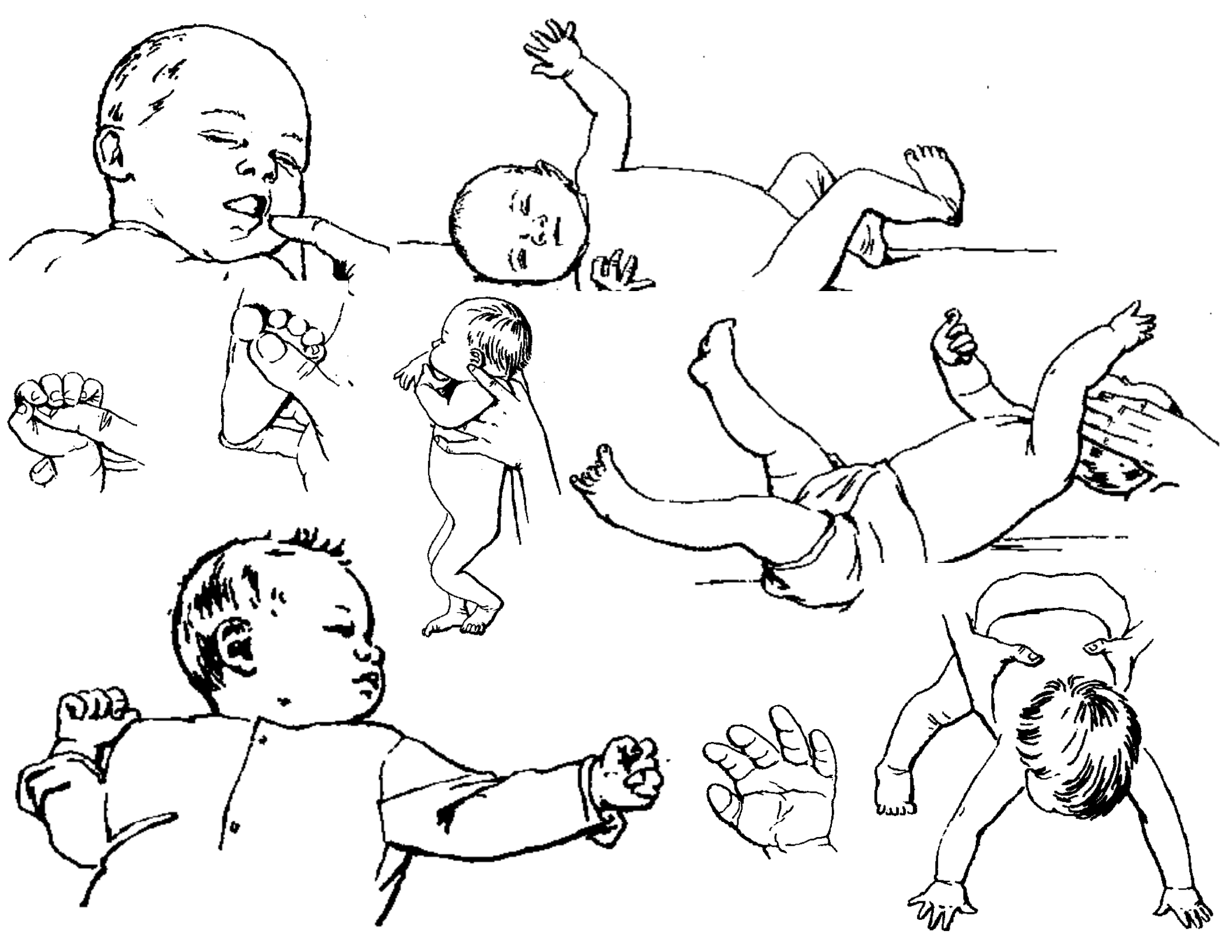
- Stroke newborns cheek or put finger in babies palm
- Baby will bring his fist to mouth and suck a finger

Swimmer's (Gallant) Response

- Hold baby prone while supporting belly with hand
  - Stroke along one side of babies' spine
- Baby flexes whole body toward the stroked side

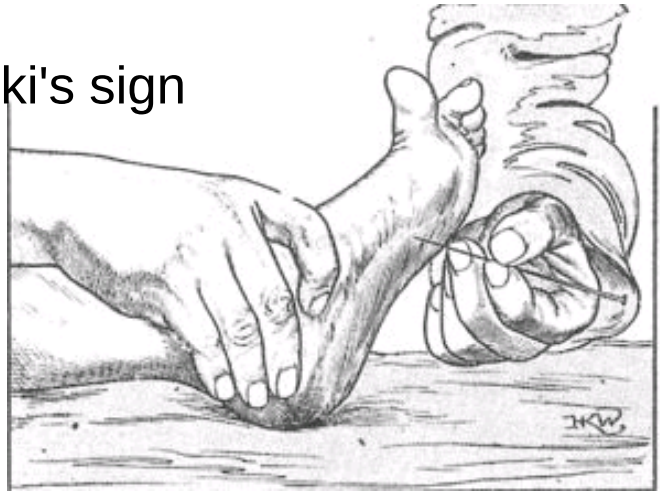
Crawling Reflex

- Newborn placed on abdomen
- Baby flexes legs under him and starts to crawl



Pathological reflexes

Babinski's sign

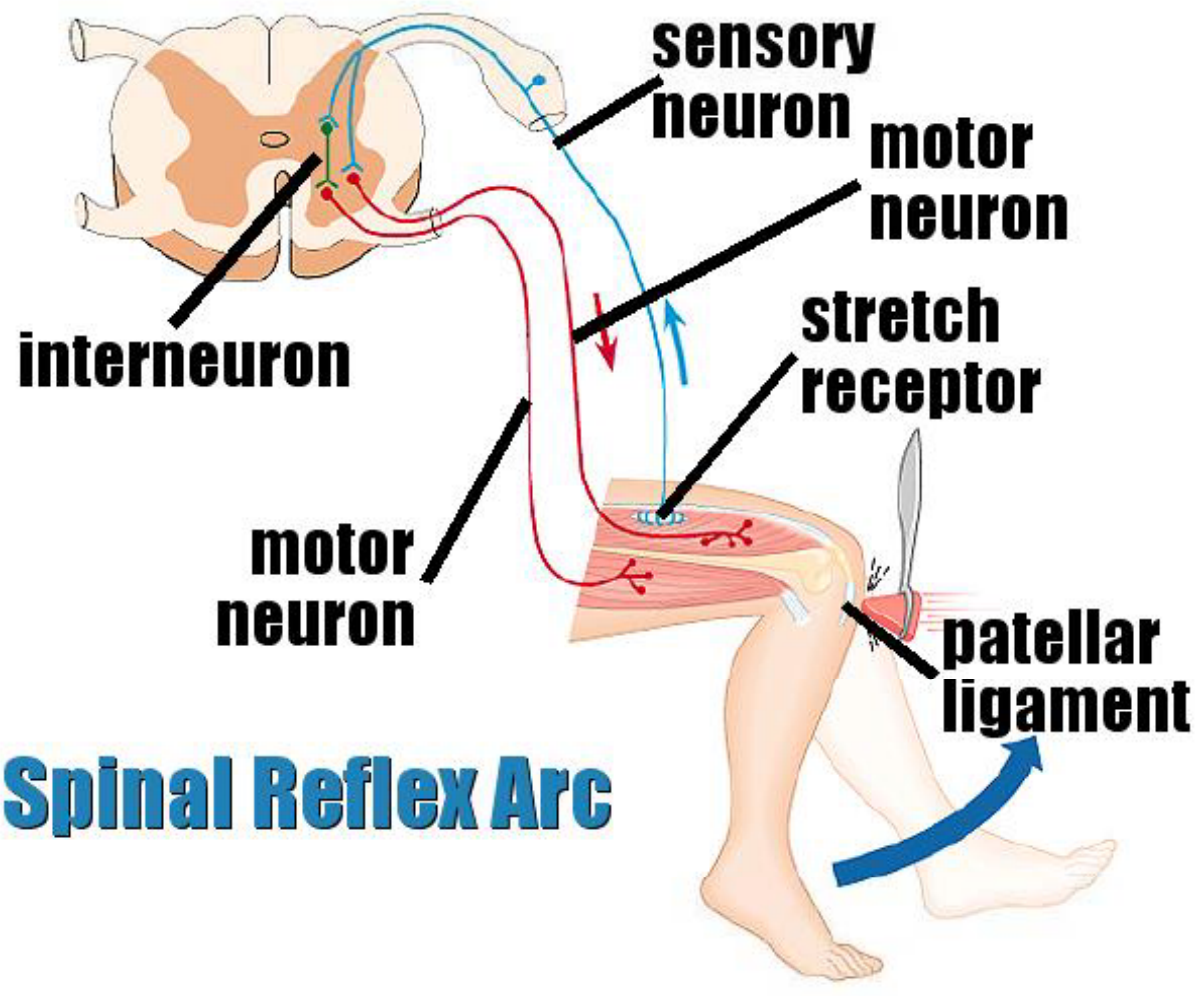


Hoffmann sign

The Hoffmann sign, also known as the finger flexor reflex, is occasionally said to be the upper limb equivalent of the Babinski's sign because both indicate upper motor neuron dysfunction. Mechanistically, they differ significantly; the finger flexor reflex is a simple monosynaptic spinal reflex involving the flexor digitorum profundus that is normally fully inhibited by upper motor neurons. The pathway producing the plantar response is more complicated, and is certainly not monosynaptic. This difference has led some neurologists to reject strongly any analogies between the finger flexor reflex and the plantar response.

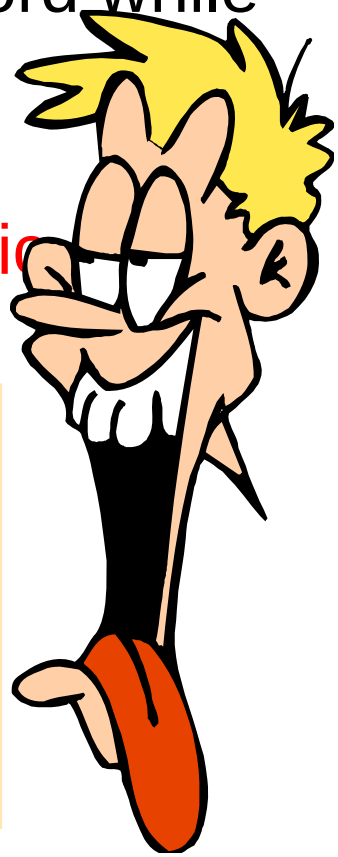
Reflex Arcs

- A reflex is a rapid, predictable motor response to a stimulus. Unlearned and involuntary.
- Example?
- Components of a reflex arc:
  - Receptor → site of stimulus
  - Sensory neuron → transmits afferent info to CNS
  - Integration center → 1 or more interneurons
  - Motor neuron → transmits efferent signals to effector
  - Effector → muscle or gland



Reflexes

- Reflexes involving skeletal muscles and somatic motor neurons are somatic.
- Reflexes controlled by autonomic neurons are autonomic.
- Spinal reflexes are integrated w/i the spinal cord while cranial reflexes are integrated in the brain.
- Reflexes may be inborn or learned.
- Reflexes may be monosynaptic or polysynaptic
  - Difference?



Reflex Arc

- There are five components of a reflex arc
  - Receptor – site of stimulus
  - Sensory neuron – transmits the afferent impulse to the CNS
  - Integration center – either monosynaptic or polysynaptic region within the CNS
  - Motor neuron – conducts efferent impulses from the integration center to an effector
  - Effector – muscle fiber or gland that responds to the efferent impulse

Reflex Arc

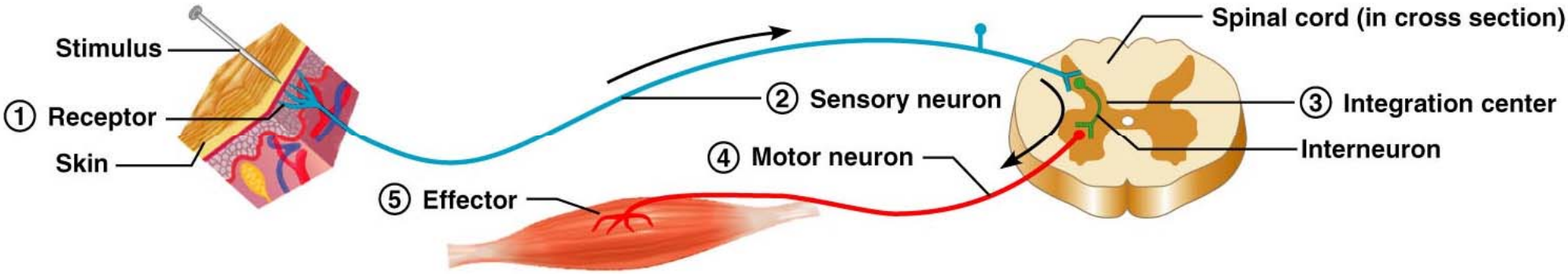
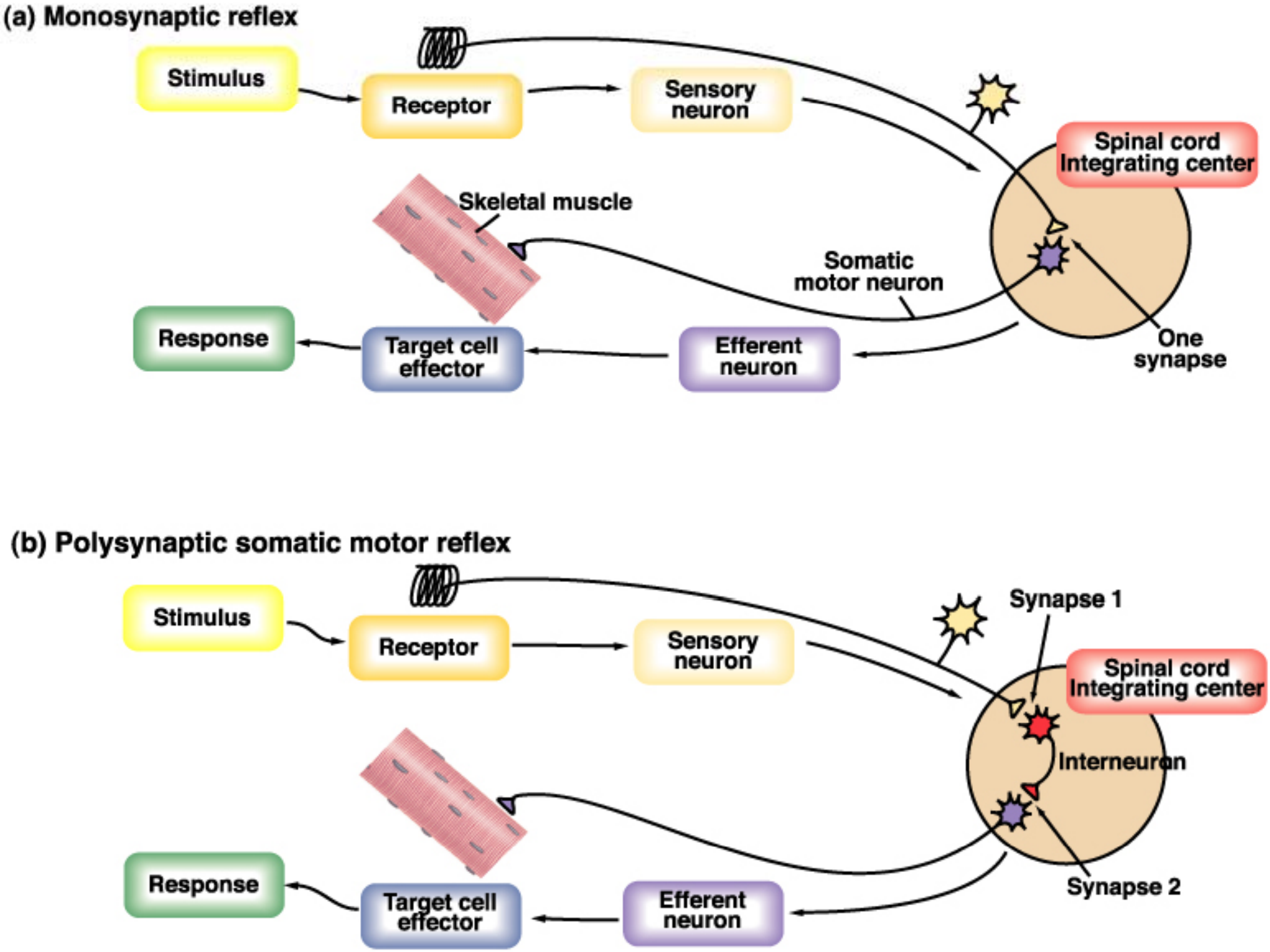


Figure 13.14

Superficial Reflexes

- Initiated by gentle cutaneous stimulation
- Example:
  - Plantar reflex is initiated by stimulating the lateral aspect of the sole of the foot
  - The response is downward flexion of the toes
  - Indirectly tests for proper corticospinal tract functioning
  - Babinski's sign: abnormal plantar reflex indicating corticospinal damage where the great toe dorsiflexes and the smaller toes fan laterally

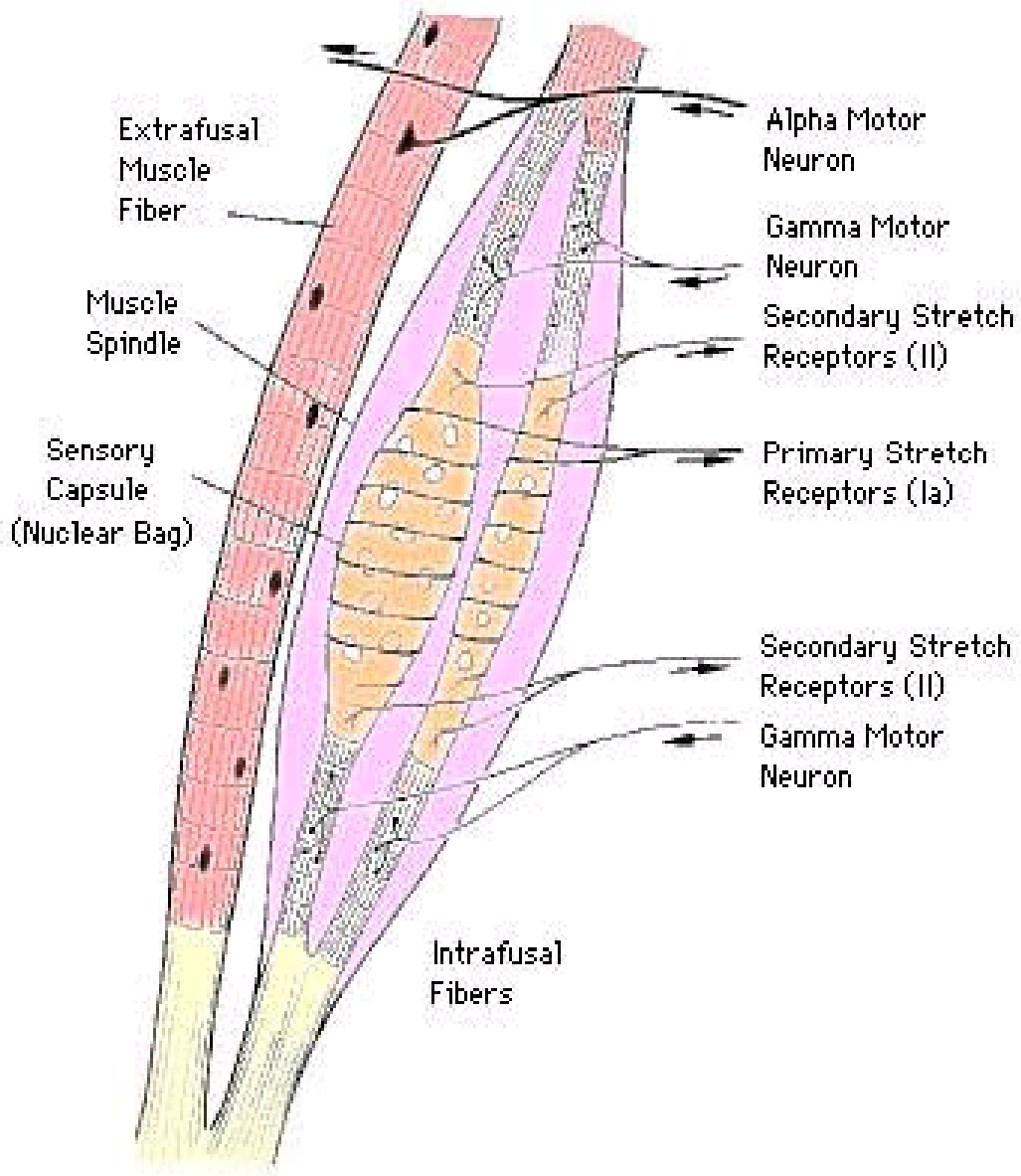

(a) Monosynaptic reflex
Stimulus
Receptor
Sensory neuron
Spinal cord Integrating center
Skeletal muscle
Somatic motor neuron
Response
Target cell effector
Efferent neuron
One synapse
(b) Polysynaptic somatic motor reflex
Stimulus
Receptor
Sensory neuron
Synapse 1
Spinal cord Integrating center
Interneuron
Response
Target cell effector
Efferent neuron
Synapse 2

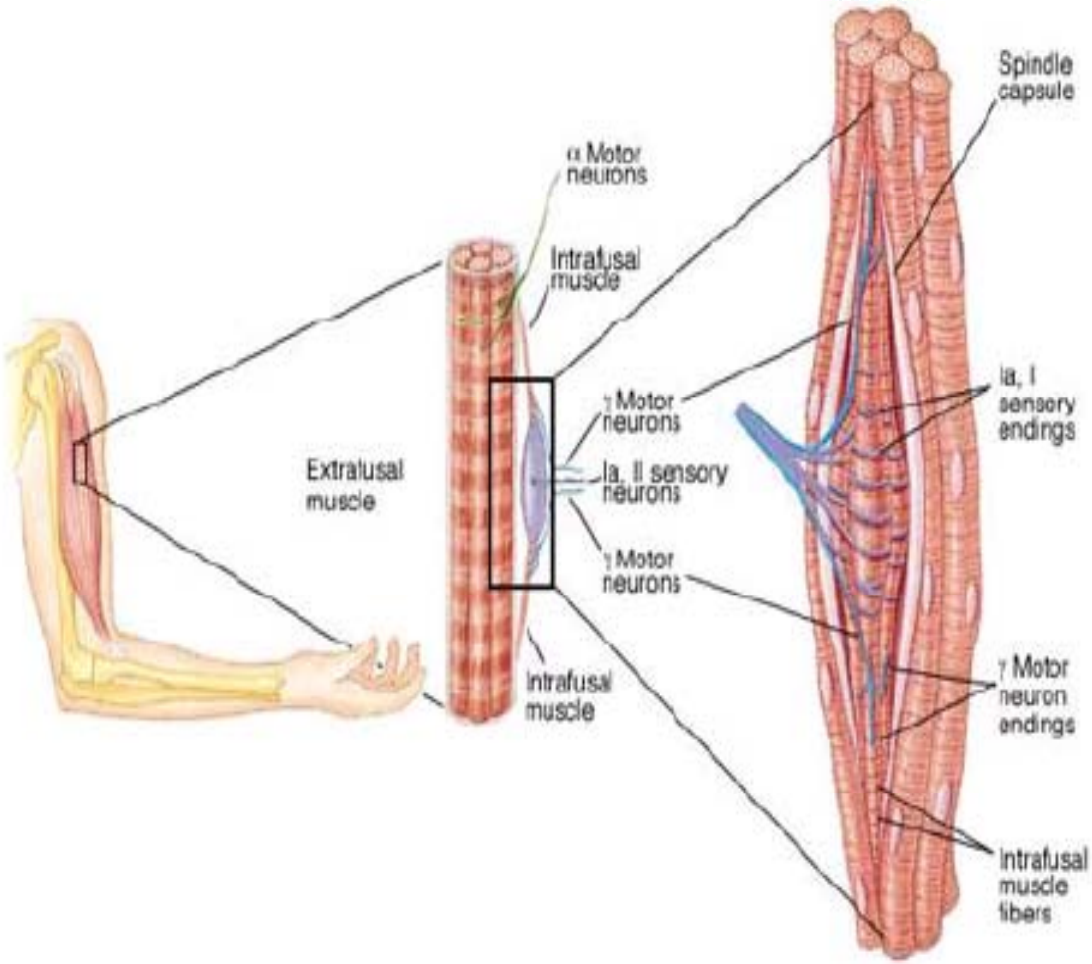
Stretch and Deep Tendon Reflexes

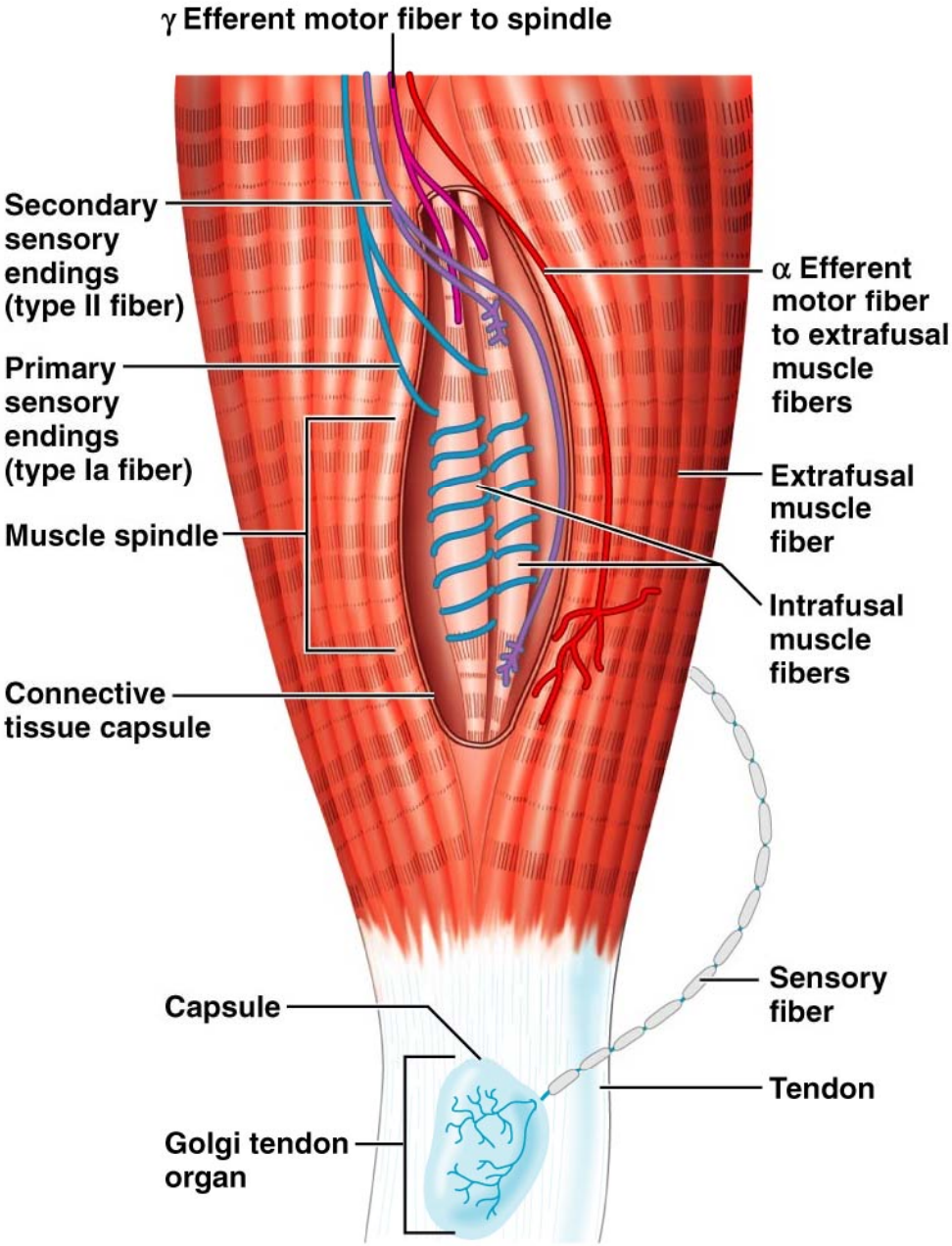
- For skeletal muscles to perform normally:
  - The Golgi tendon organs (proprioceptors) must constantly inform the brain as to the state of the muscle
  - Stretch reflexes initiated by muscle spindles must maintain healthy muscle tone

Muscle Spindles

- Are composed of 3-10 intrafusal muscle fibers that lack myofilaments in their central regions, are noncontractile, and serve as receptive surfaces
- Muscle spindles are wrapped with two types of afferent endings: primary sensory endings of type Ia fibers and secondary sensory endings of type II fibers
- These regions are innervated by gamma (γ) efferent fibers
- Note: contractile muscle fibers are extrafusal fibers and are innervated by alpha (α) efferent fibers





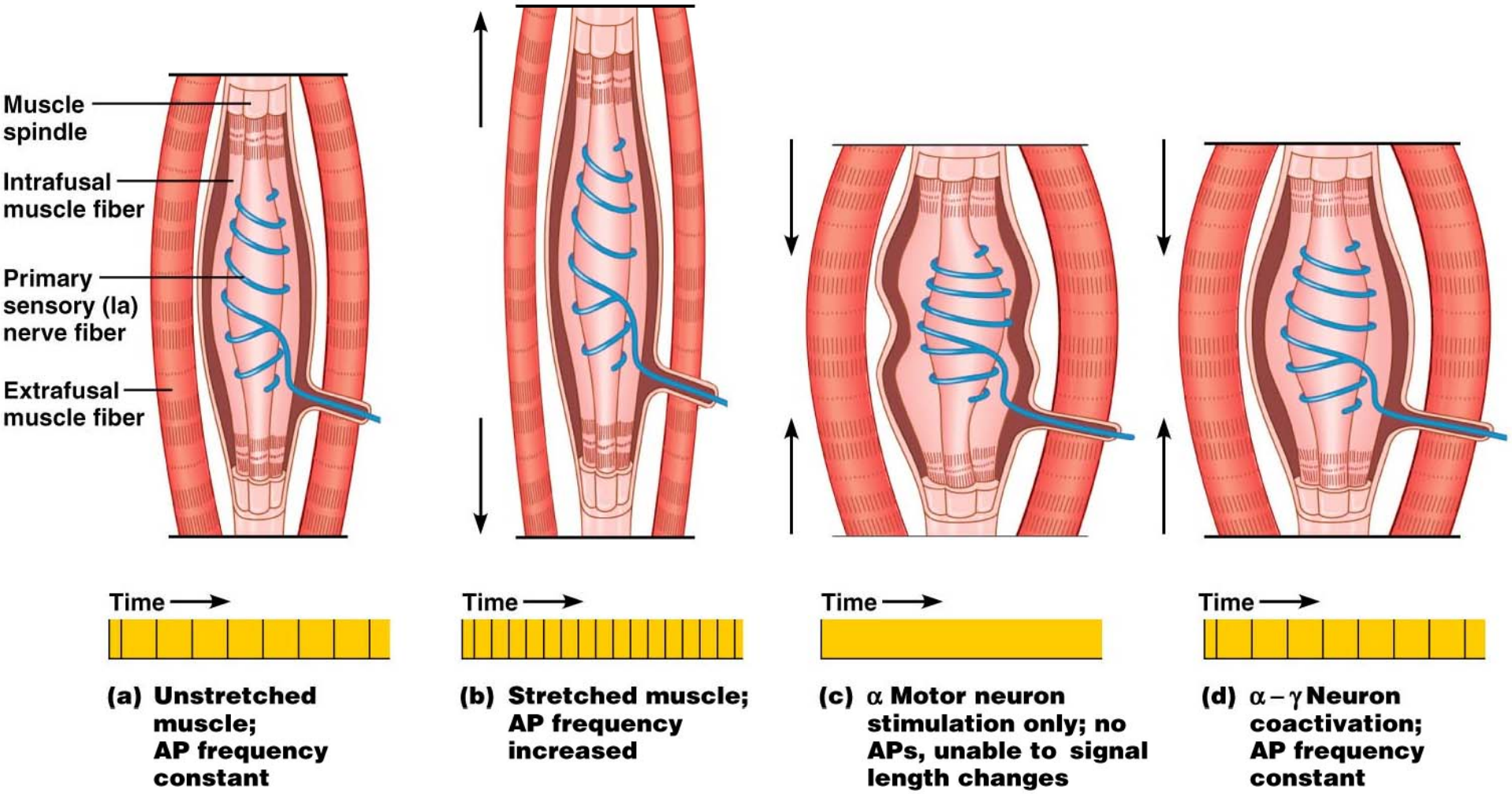


Muscle Spindles

Operation of the Muscle Spindles

- Stretching the muscles activates the muscle spindle
  - There is an increased rate of action potential in Ia fibers
- Contracting the muscle reduces tension on the muscle spindle
  - There is a decreased rate of action potential on Ia fibers

Operation of the Muscle Spindle



(a) Unstretched muscle; AP frequency constant

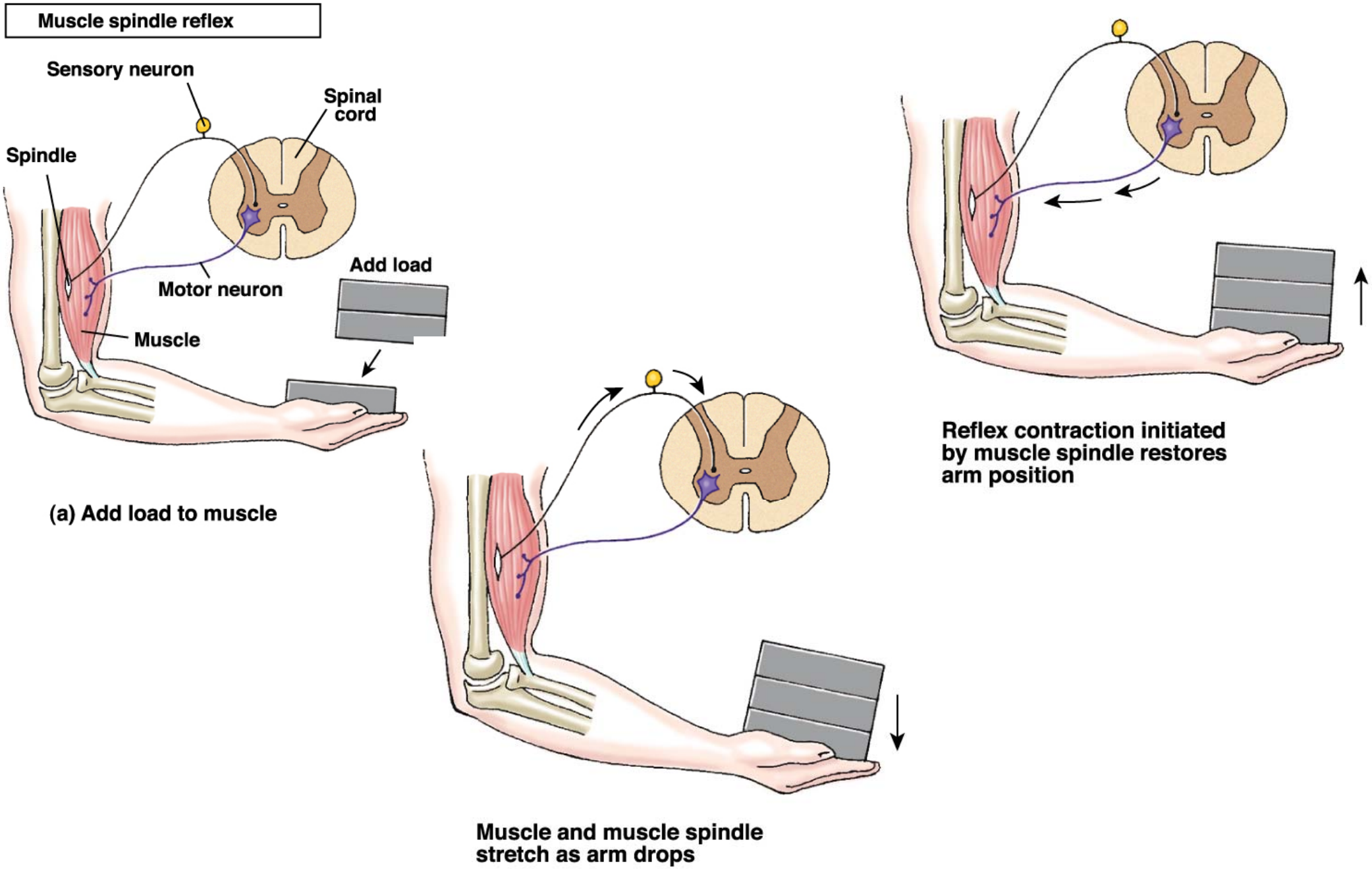
(b) Stretched muscle; AP frequency increased

(c) α Motor neuron stimulation only; no APs, unable to signal length changes

(d) α – γ Neuron coactivation; AP frequency constant

Figure 13.17

Muscle Spindle Reflex



Stretch Reflex

- Stretching the muscle activates the muscle spindle
- Excited γ motor neurons of the spindle cause the stretched muscle to contract
- Afferent impulses from the spindle result in inhibition of the antagonist
- Example: patellar reflex
  - Tapping the patellar tendon stretches the quadriceps and starts the reflex action
  - The quadriceps contract and the antagonistic hamstrings relax

Stretch Reflex

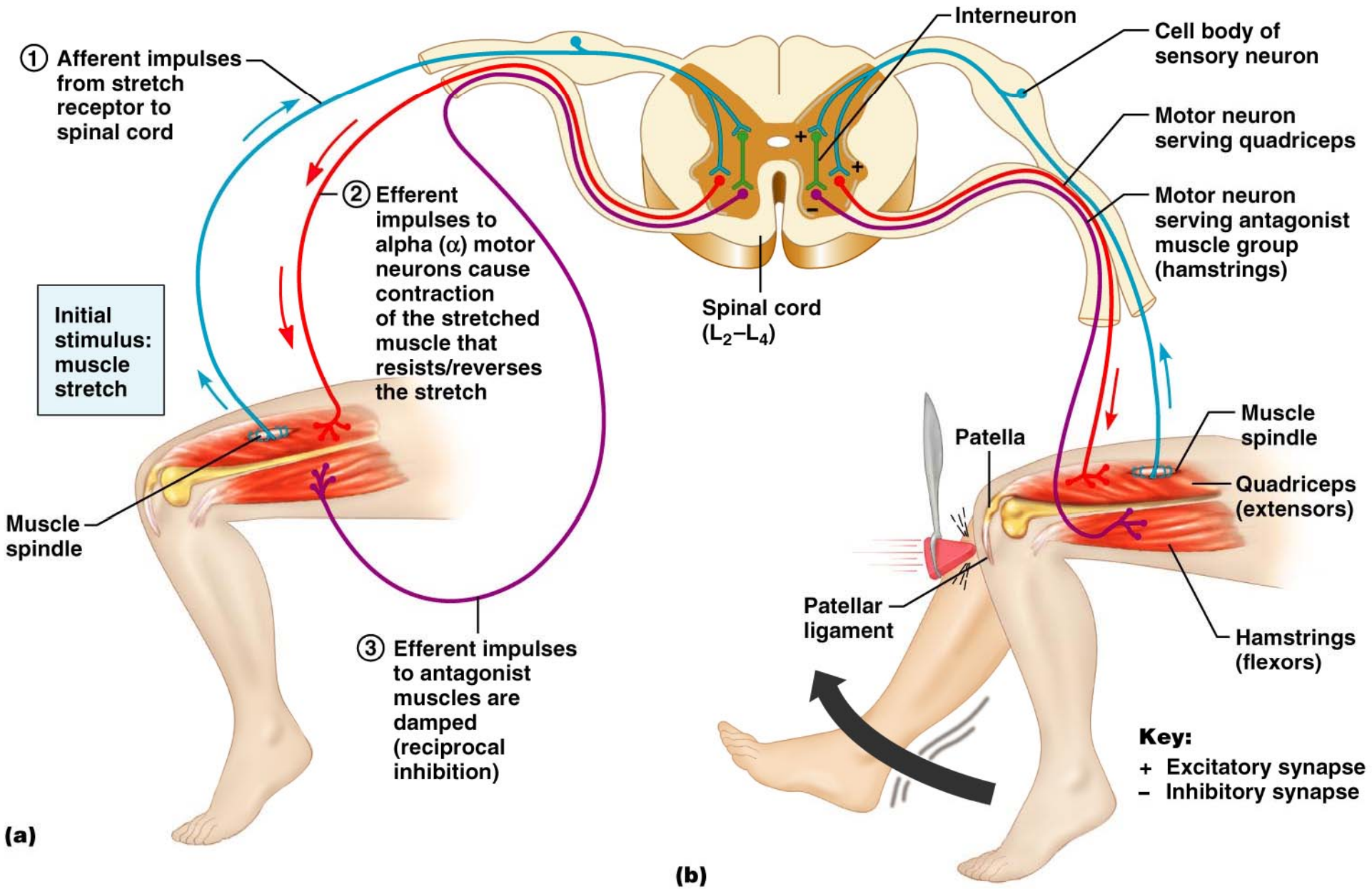
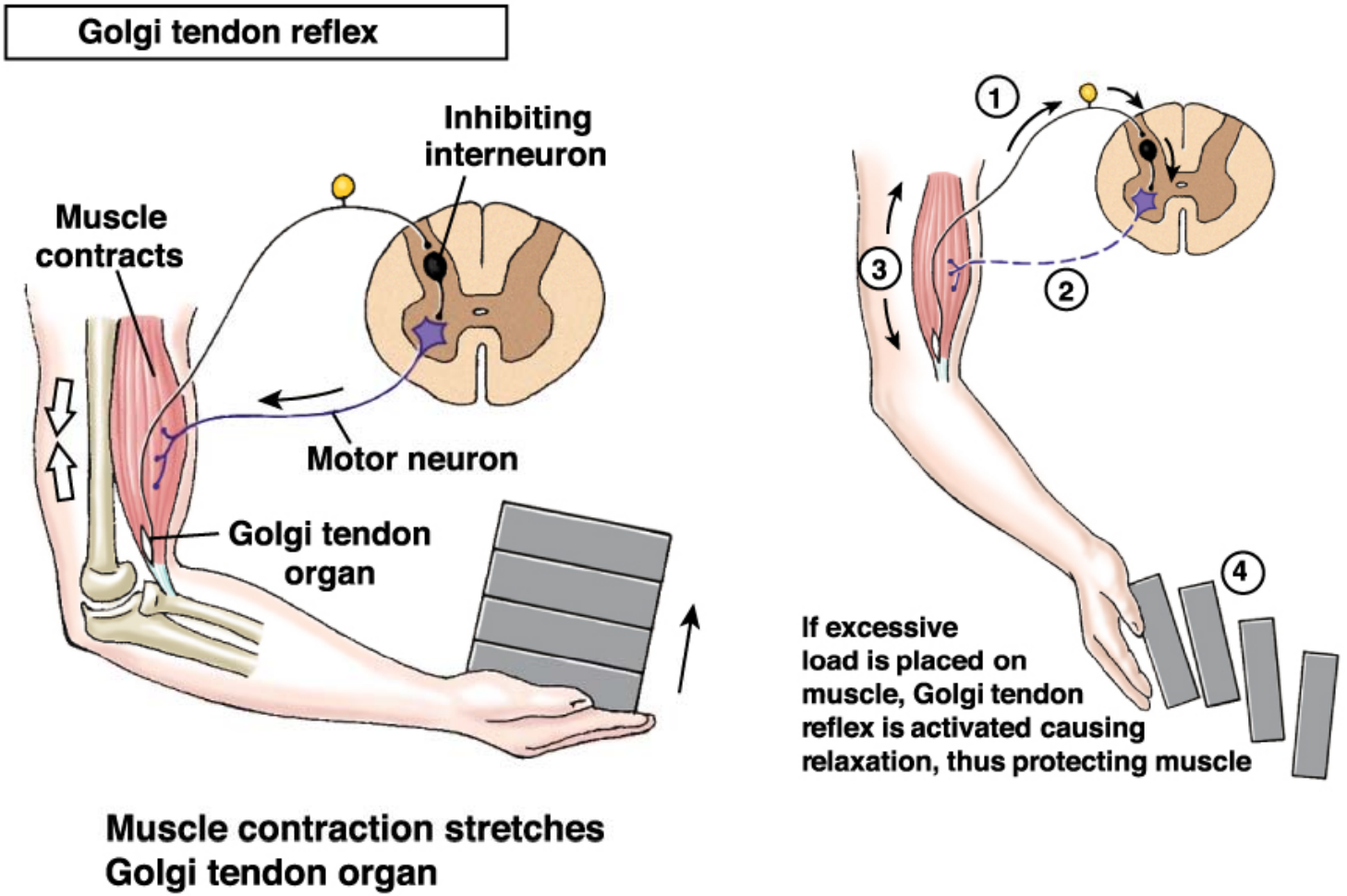


Figure 13.16

Golgi Tendon Reflex

- The opposite of the stretch reflex
- Contracting the muscle activates the Golgi tendon organs
- Afferent Golgi tendon neurons are stimulated, neurons inhibit the contracting muscle, and the antagonistic muscle is activated
- As a result, the contracting muscle relaxes and the antagonist contracts

Golgi Tendon Reflex



Golgi Tendon Reflex

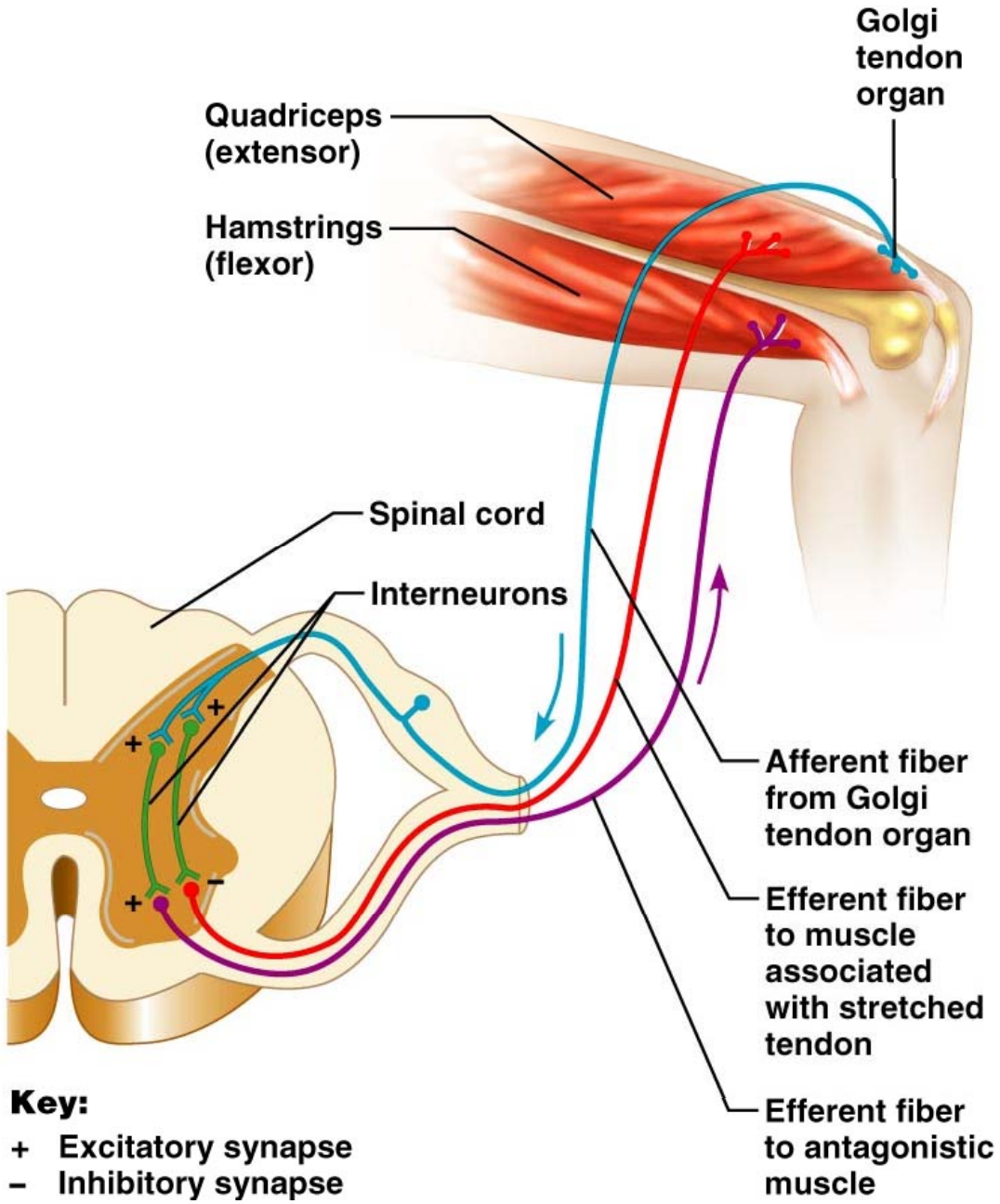


Figure 13.18

Flexor and Crossed Extensor Reflexes

- The flexor reflex is initiated by a painful stimulus (actual or perceived) that causes automatic withdrawal of the threatened body part
- The crossed extensor reflex has two parts
  - The stimulated side is withdrawn
  - The contralateral side is extended

Crossed Extensor Reflex

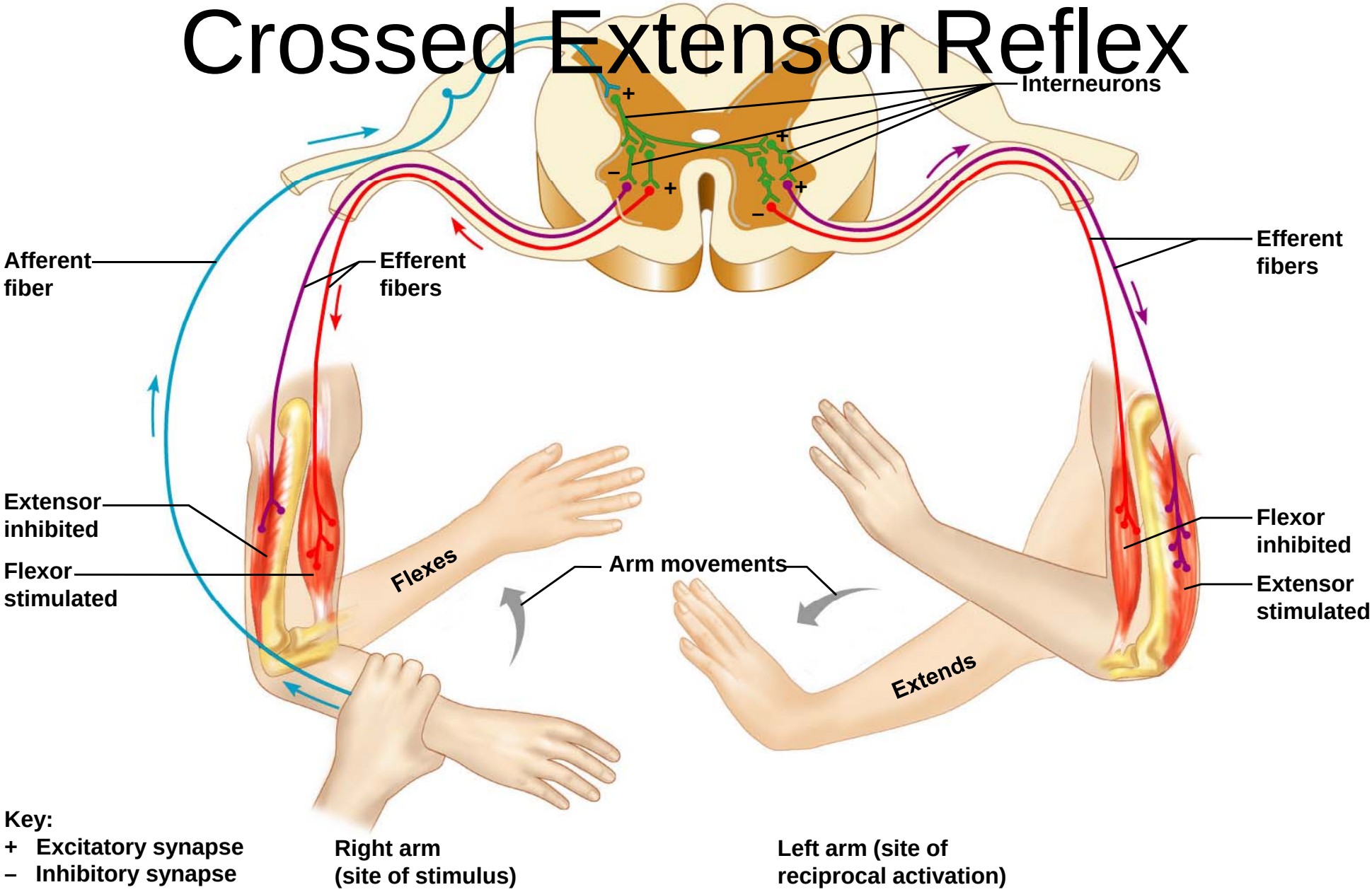


Figure 13.19

Crossed Extensor Reflex

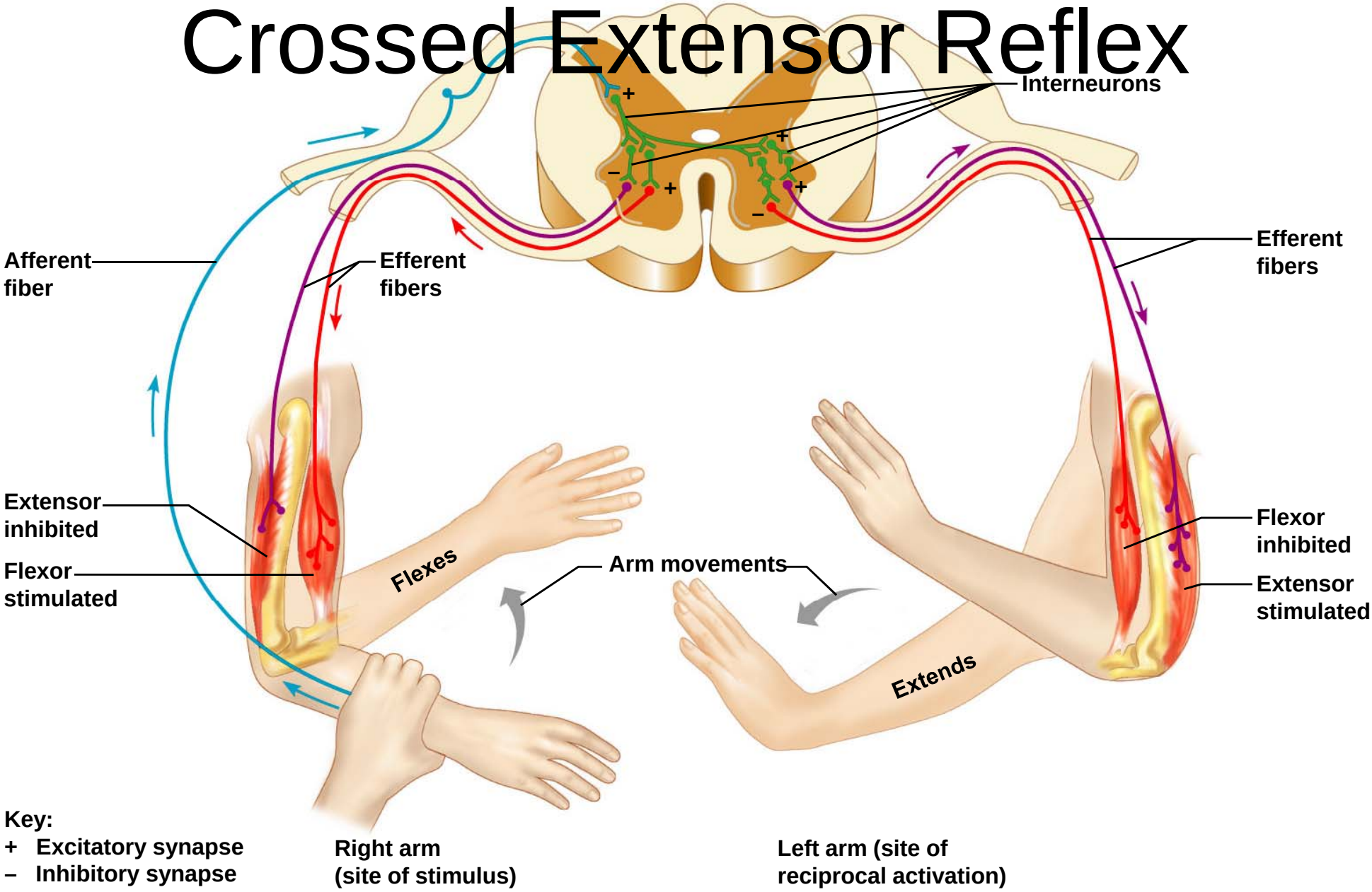
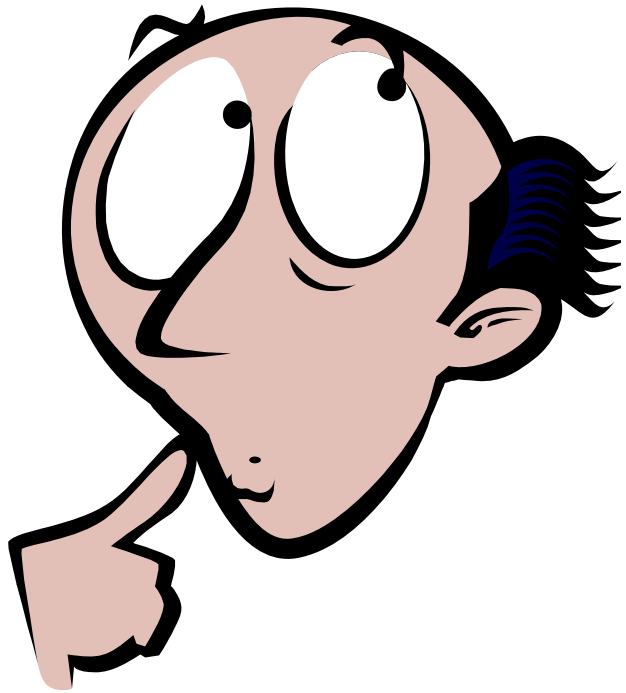
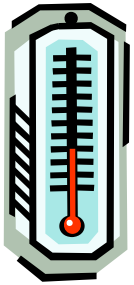


Figure 13.19

Somatic Reflexes

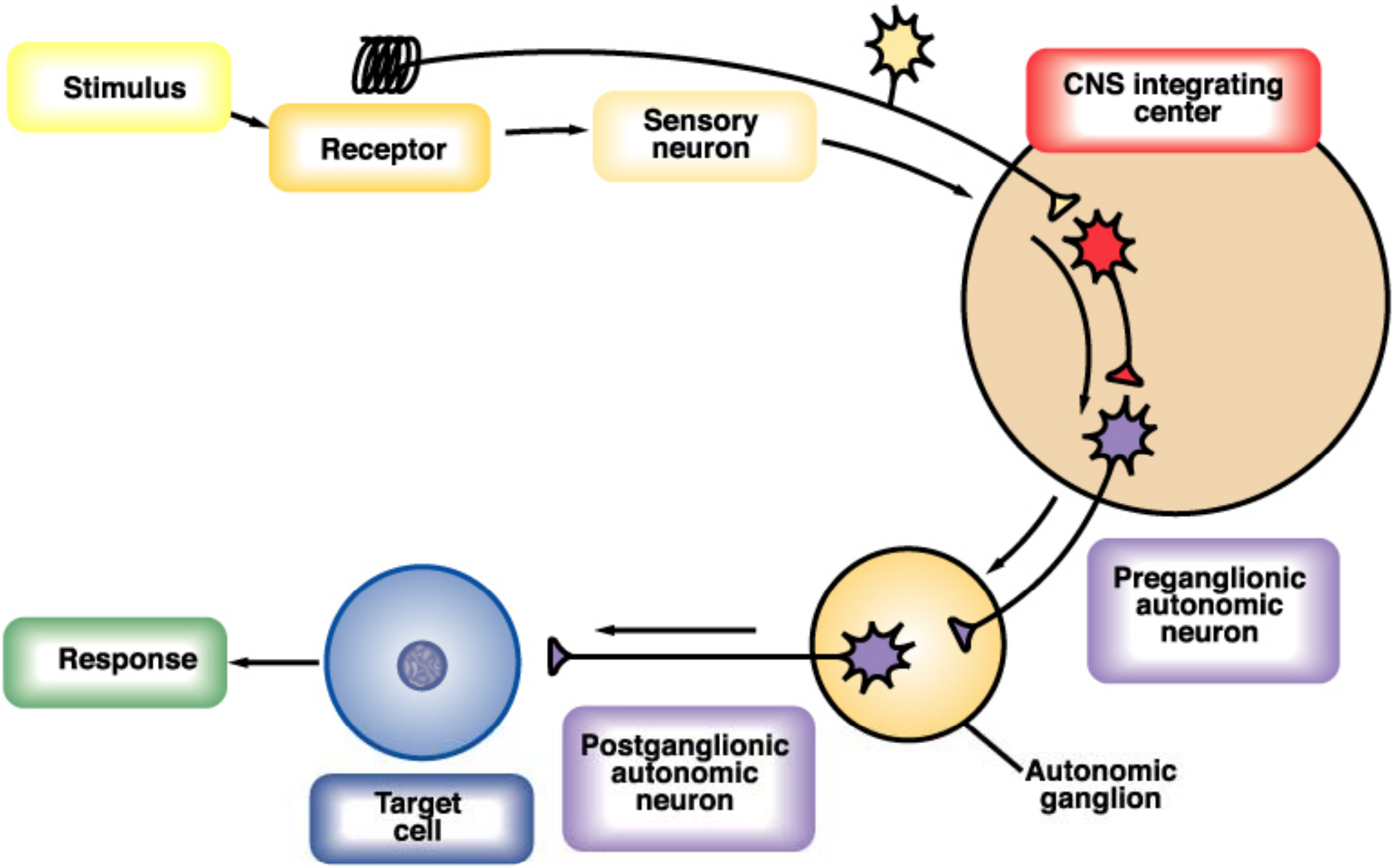
- Let's look at the muscle spindle reflex and the Golgi tendon reflex and figure out:
  - What they are?
  - Why are they somatic?
  - Are they mono- or polysynaptic?
  - Are they ipsilateral or contralateral reflexes?



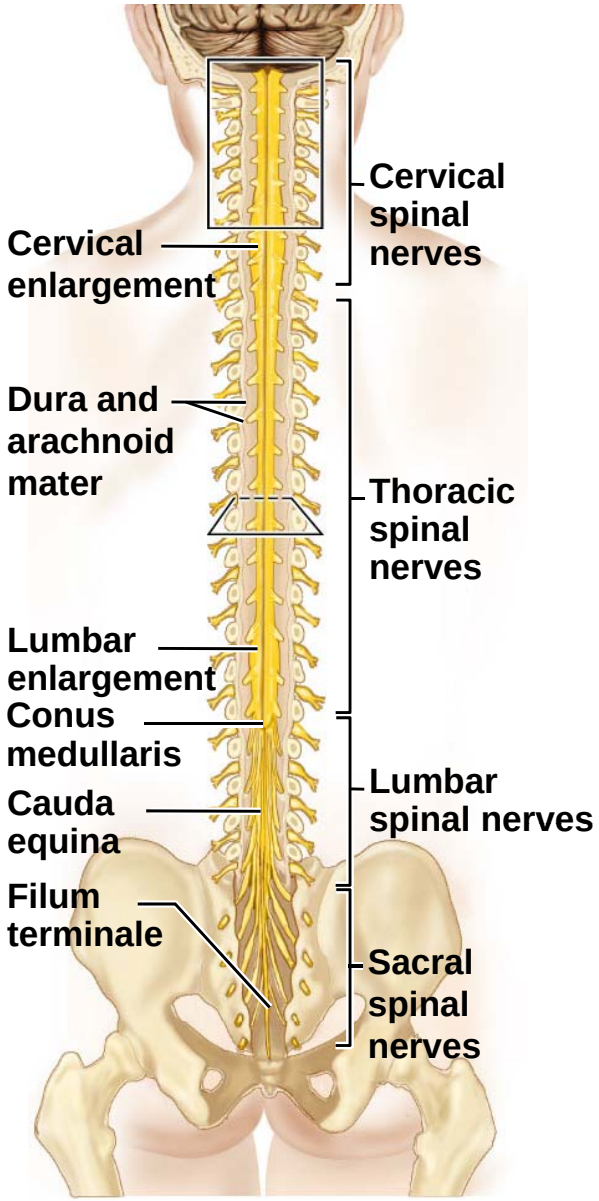


Autonomic Reflexes

- May be spinal (e.g., urination and defecation) or modified by higher brain structures.
- The thalamus, hypothalamus and brain stem are in charge of multiple reflexes – HR, BP, breathing, eating, osmotic balance, temperature, vomiting, gagging, sneezing.
- All are polysynaptic.

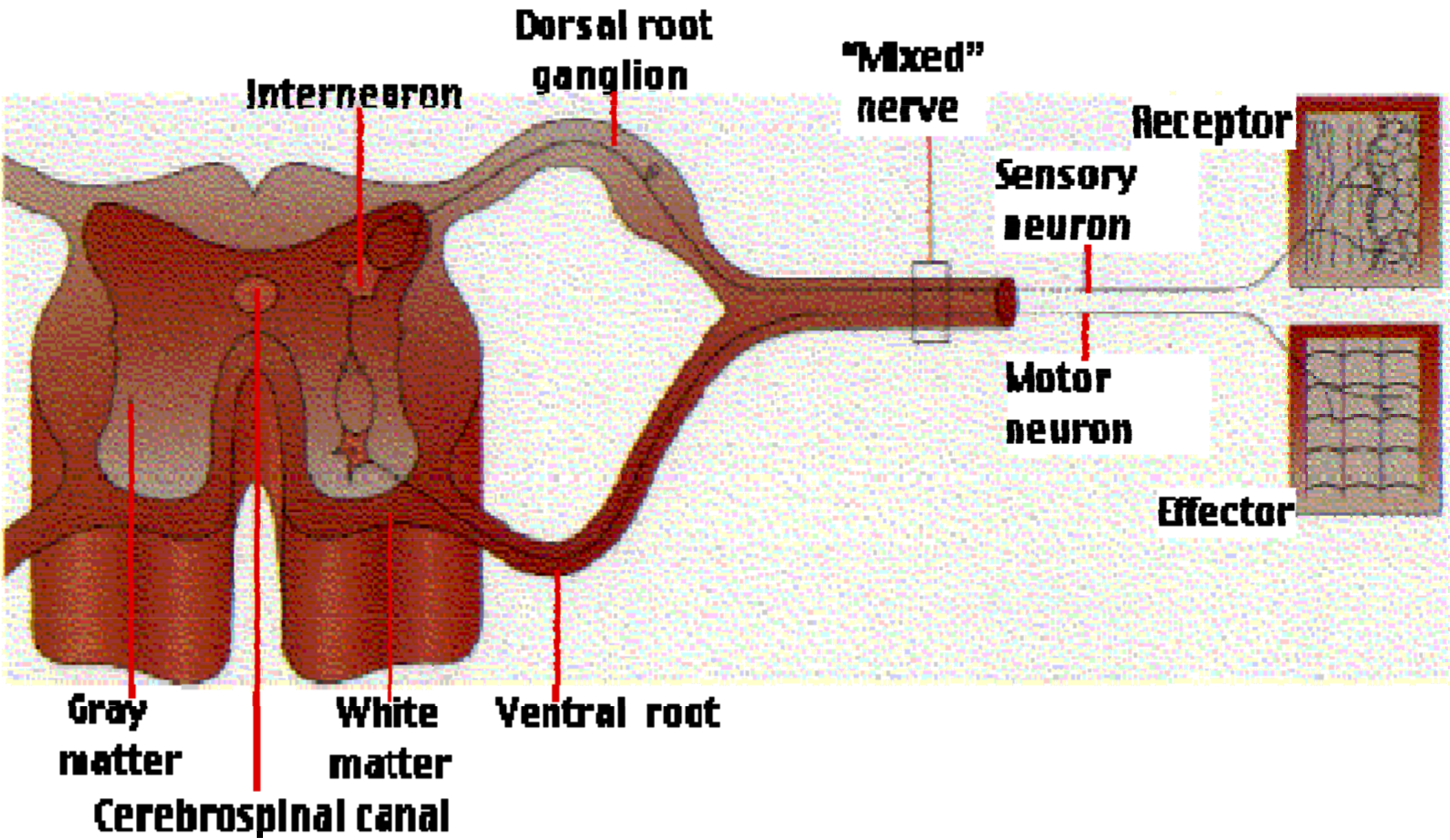

Stimulus
Receptor
Sensory neuron
CNS integrating center
Preganglionic autonomic neuron
Response
Target cell
Postganglionic autonomic neuron
Autonomic ganglion

Gross structure of the spinal cord, posterior view,



(a)

Spinal cord


Dorsal root ganglion
"Mixed" nerve
Interneuron
Receptor
Sensory neuron
Motor neuron
Effector
Gray matter
White matter
Ventral root
Cerebrospinal canal

The spinal cord extends from the skull (foramen magnum) to the first lumbar vertebra.

Like the brain, the spinal cord consists of gray matter and white matter.

The gray matter (cell bodies & synapses) of the cord is located centrally & is surrounded by white matter (myelinated axons).

The white matter of the spinal cord consists of ascending and descending fiber tracts, with the ascending tracts transmitting sensory information (from receptors in the skin, skeletal muscles, tendons, joints, & various visceral receptors) and the descending tracts transmitting motor information (to skeletal muscles, smooth muscle, cardiac muscle, & glands).

The spinal cord is also responsible for spinal reflexes.

Reflex- rapid (and unconscious) response to changes in the internal or external environment needed to maintain homeostasis

Reflex arc - the neural pathway over which impulses travel during a reflex. The components of a reflex arc include:

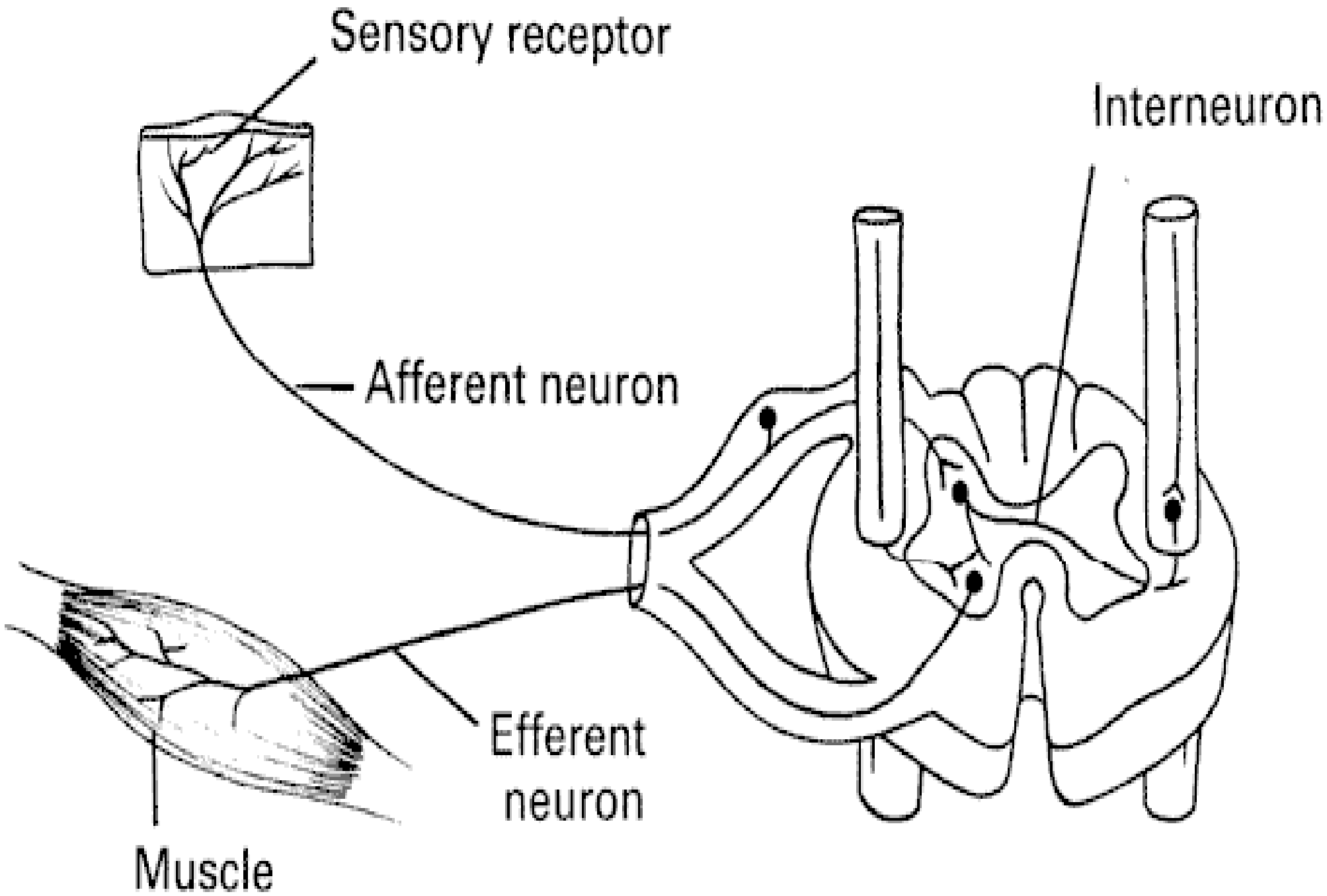
1 - receptor - responds to the stimulus

2 - afferent pathway (sensory neuron) - transmits impulse into the spinal cord

3 - Central Nervous System - the spinal cord processes information

4 - efferent pathway (motor neuron) - transmits impulse out of spinal cord

5- effector - a muscle or gland that receives the impulse from the motor neuron & carries out the desired response


Sensory receptor
Interneuron
Afferent neuron
Efferent
neuron
Muscle

Developmental Aspects of the PNS

- Spinal nerves branch from the developing spinal cord and neural crest cells
  - Supply motor and sensory function to developing muscles
- Cranial nerves innervate muscles of the head

Developmental Aspects of the PNS

- Distribution and growth of spinal nerves correlate with the segmented body plan
- Sensory receptors atrophy with age and muscle tone lessens
- Peripheral nerves remain viable throughout life unless subjected to trauma