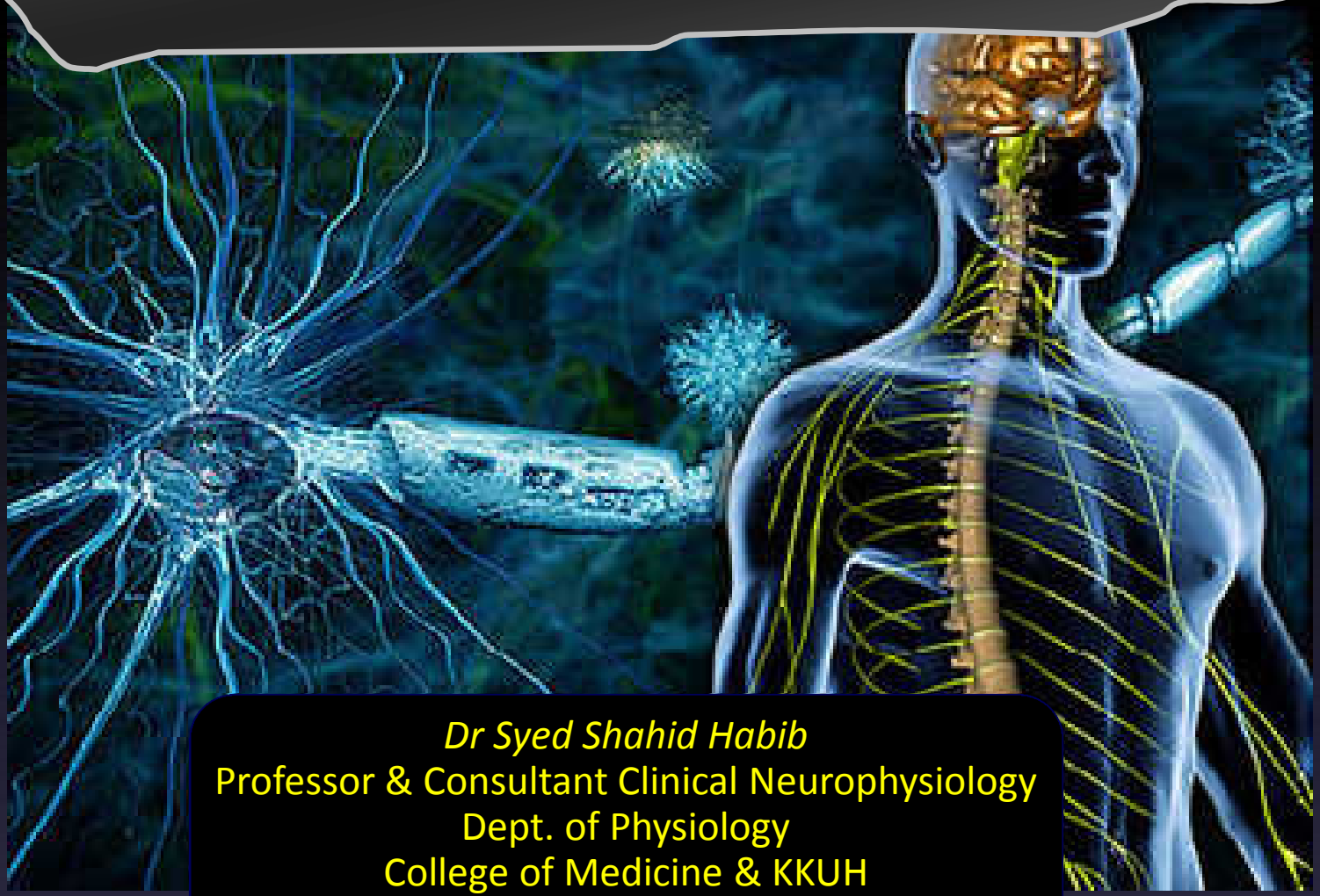
Spinal cord functions & reflexes



Dr Syed Shahid Habib
Professor & Consultant Clinical Neurophysiology
Dept. of Physiology
College of Medicine & KKUH
King Saud University

OBJECTIVES

At the end of this lecture the student should be able to :

(1) Know levels of nervous control and Enumerate functions of spinal cord

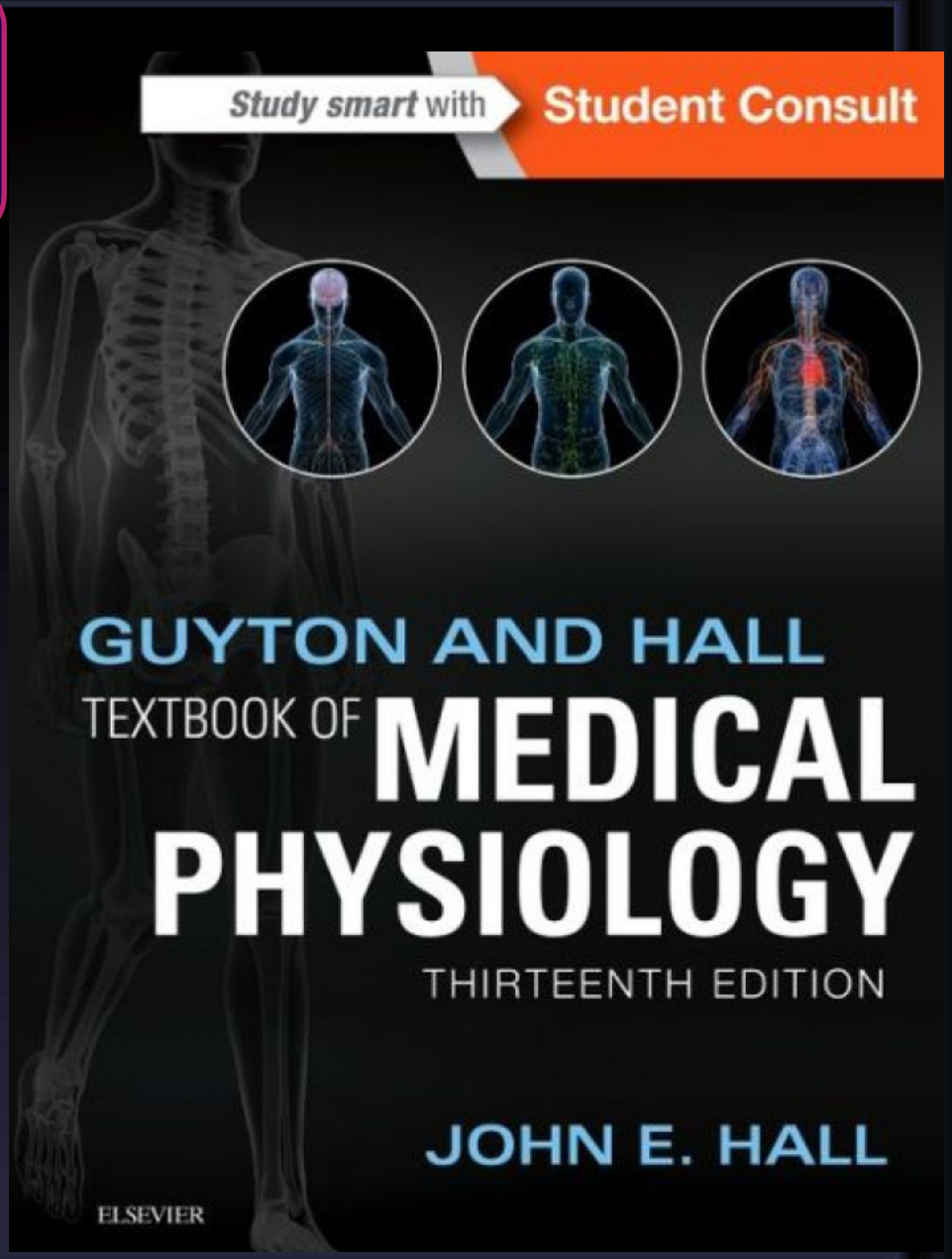
(2) Define the reflex arc and its components.

(3) Classify reflexes with examples and how they differ from each other .

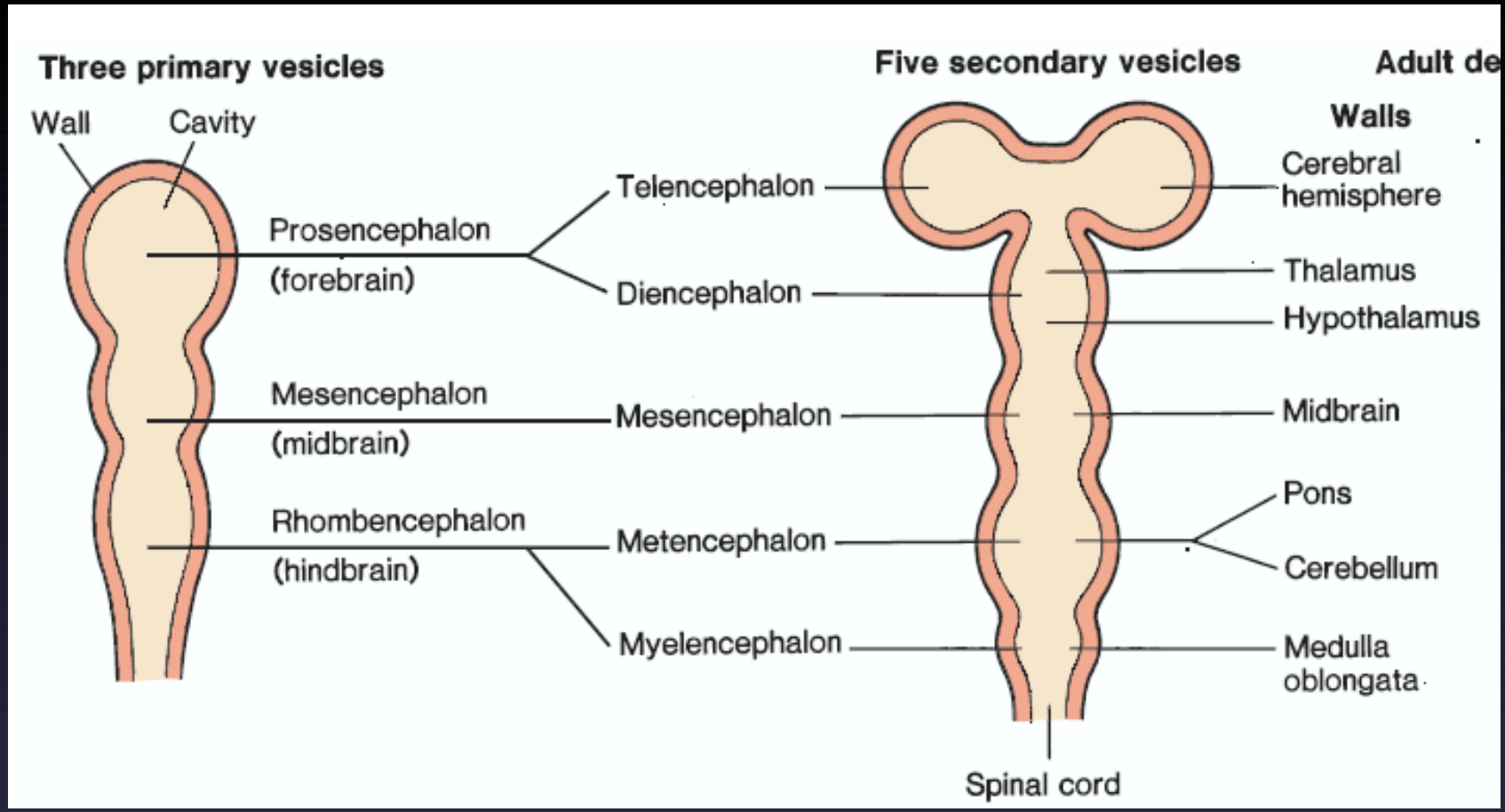
(4) Describe the spinal cord reflexes, their significance & pathways

REMEMBER

- These handouts will facilitate what you have to study and are not an alternative to your text book.
- The main source of this Lectures is from Guyton & Hall 13th Edition
- Ch55-Pages 695-705



Embryonic Development



HIGHER BRAIN OR CORTICAL LEVEL

Control all lower centers, thought processes, memory

LOWER BRAIN OR SUBCORTICAL LEVEL

Subconscious activities of the body are controlled in the lower areas of the Brain; the medulla, pons, mesencephalon, hypothalamus, thalamus, cerebellum, and basal ganglia.

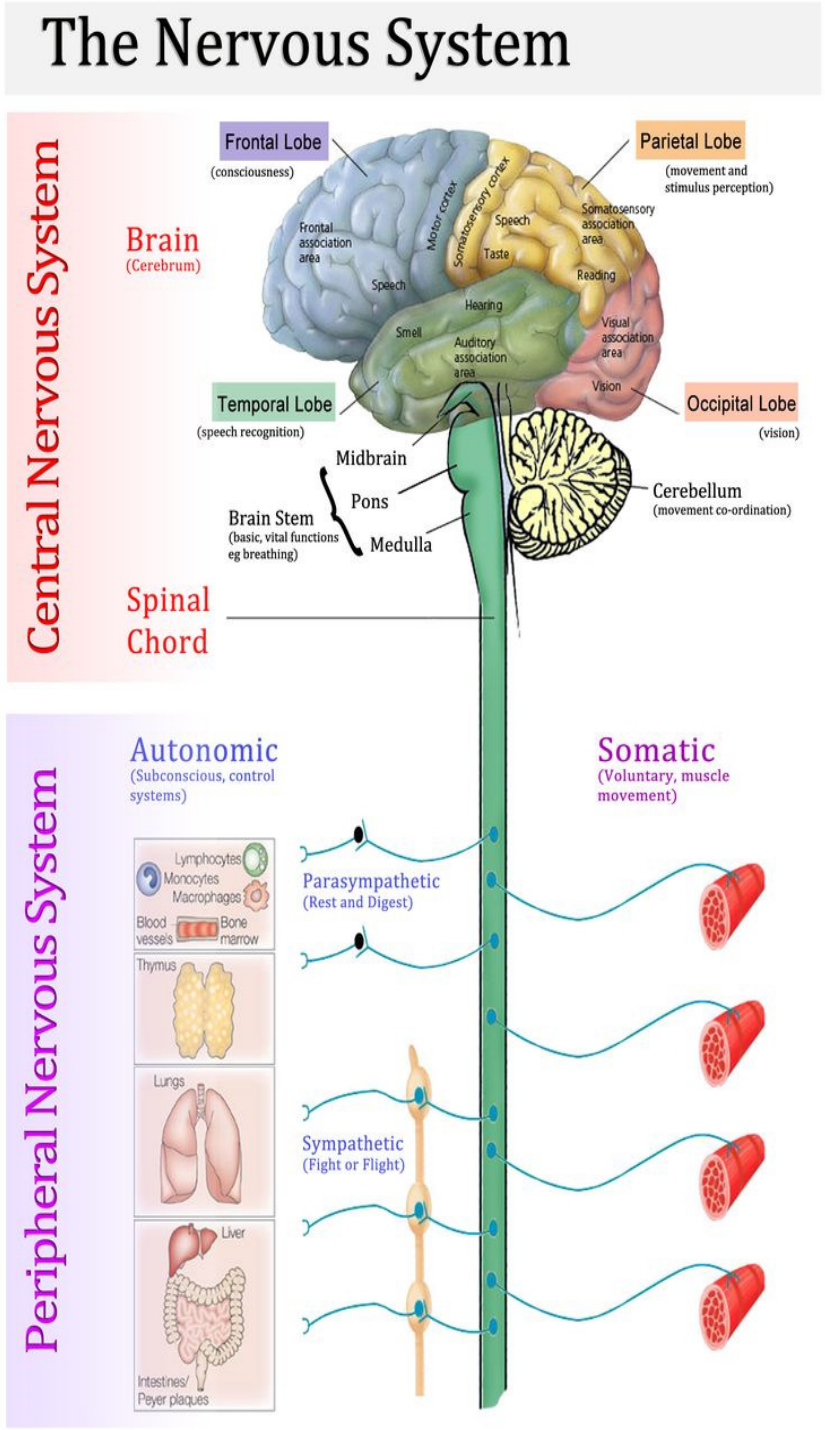
SPINAL CORD LEVEL

(1) walking

(2) withdrawal

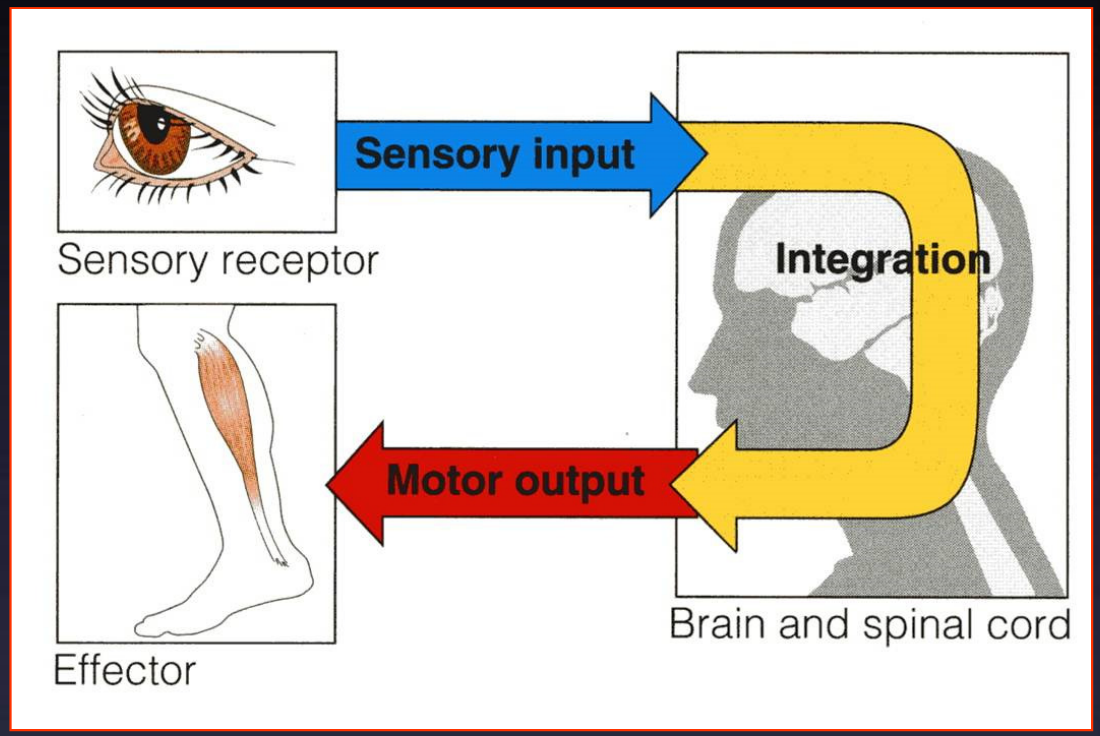
(3) anti gravity reflexes

(4) local blood vessels gastrointestinal, urinary/defecation.



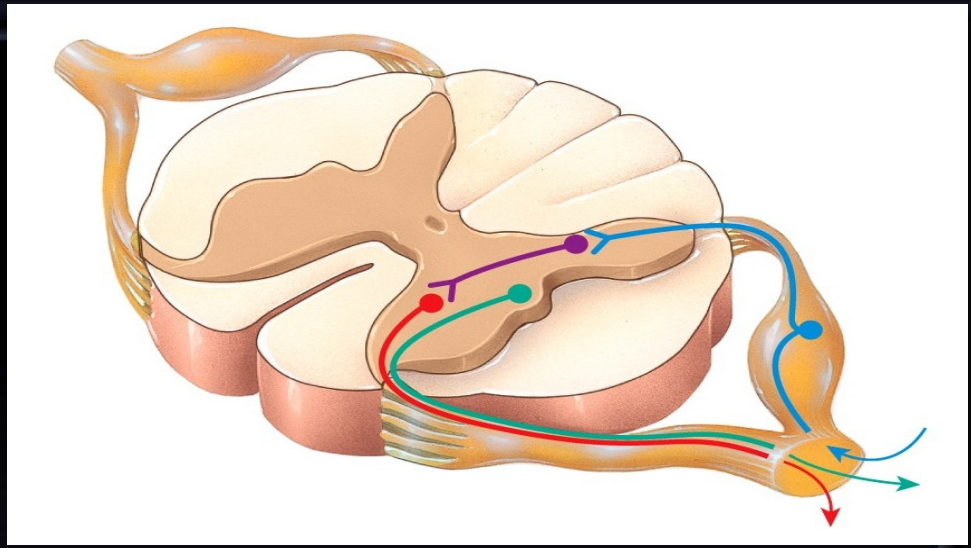
HOW BRAIN FUNCTIONS?

- Collection of sensory input
- Central Integration
- Motor output



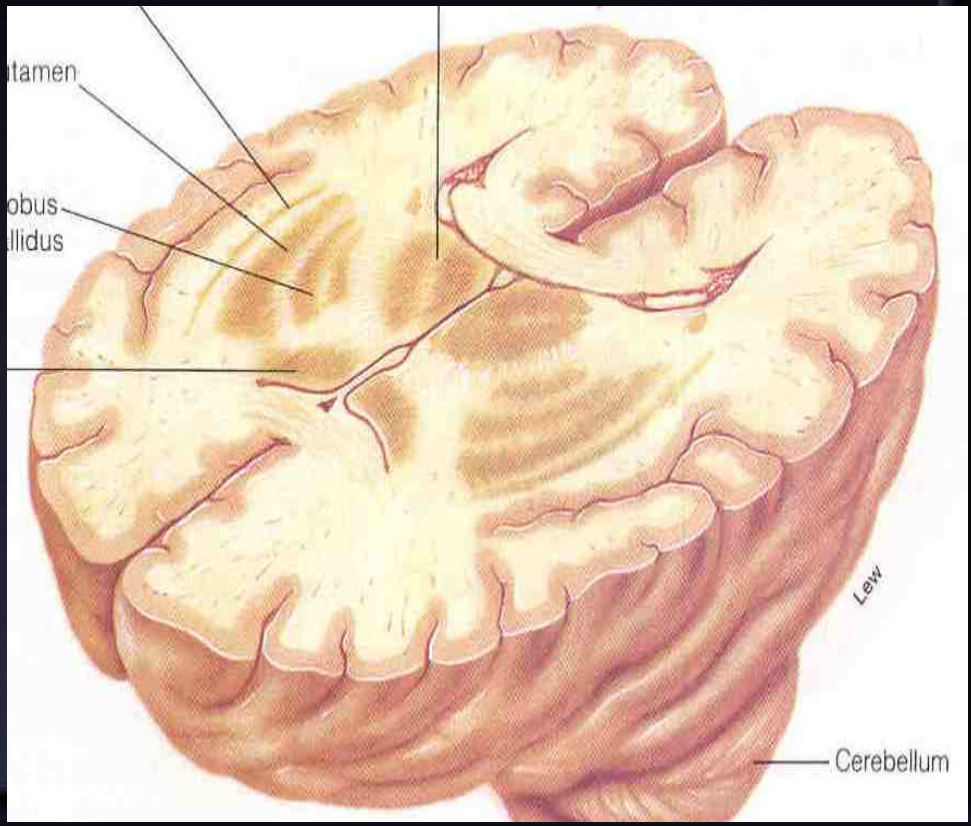
GREY MATTER

The grey matter consists of neuron cell bodies and dendrites and is found in the cortex (surface layer) of the brain and deep within brain nuclei.

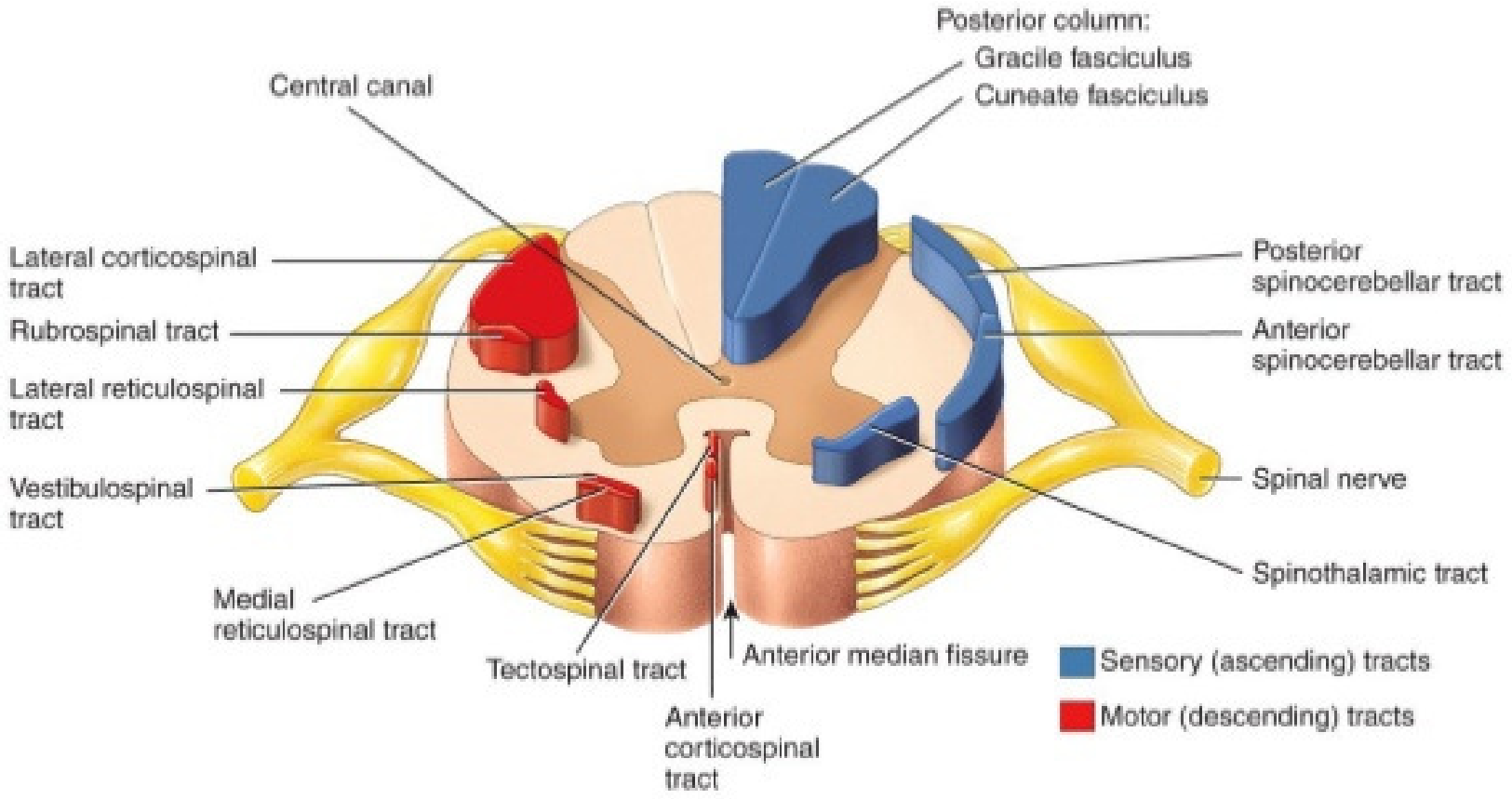


WHITE MATTER

White matter consists of axon tracts (the myelin produces the white color). The adult brain consists of an estimated 100 billion (10^{11}) neurons, and weighs about 1.5 kg. The cerebral blood flow receives 20% of the total cardiac output.

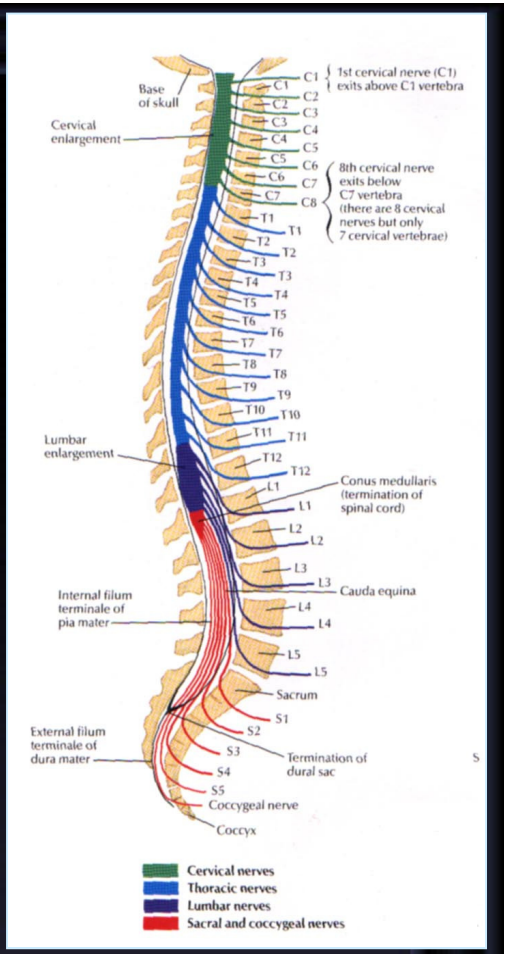


Sensory and Motor Tracts



SPINAL CORD FUNCTIONS

- Center for Spinal Cord Reflexes (Somatic & Autonomic)
- Gateway and conduction pathway for all tracts
- Gateway for Pain control systems

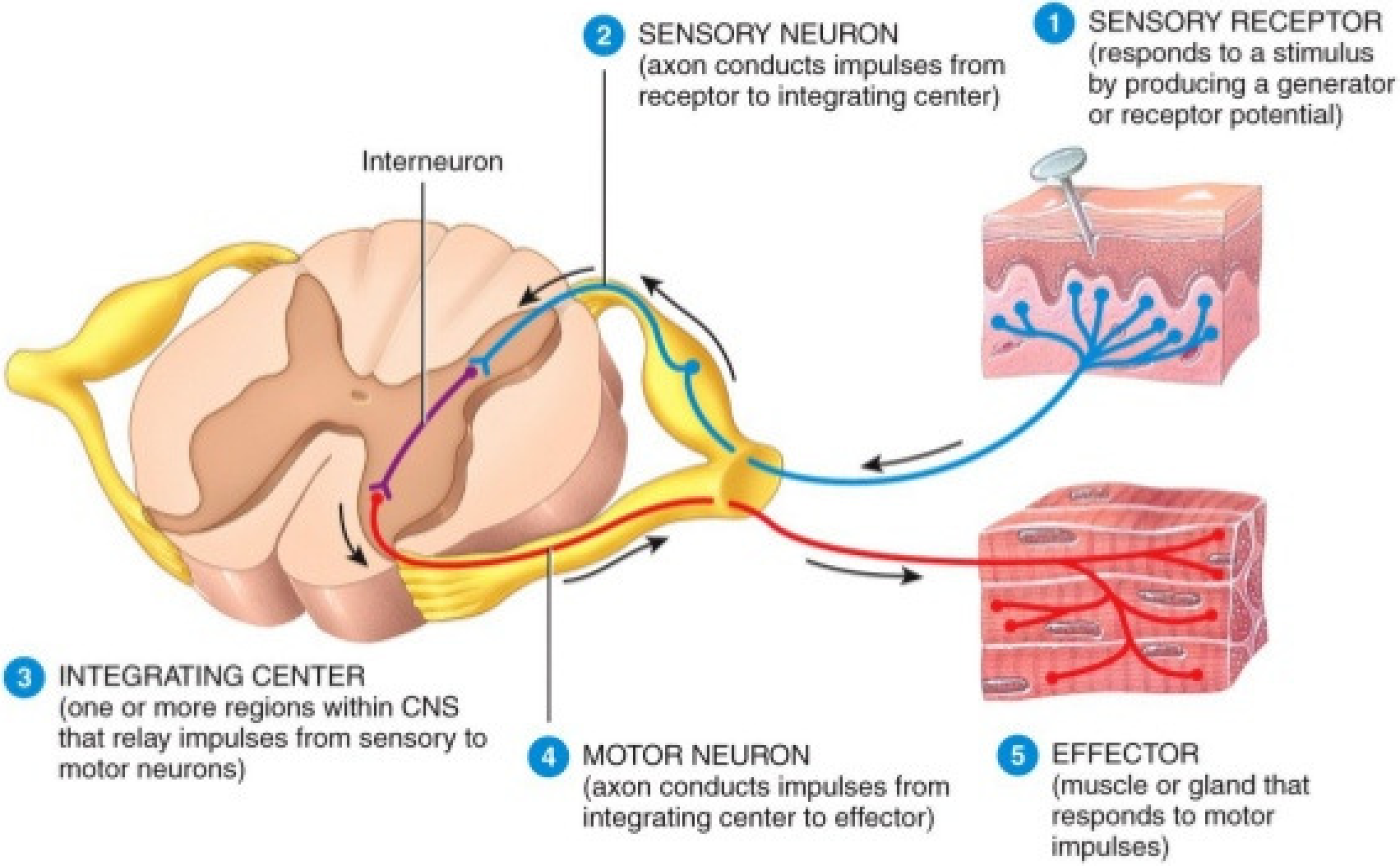


What is a Reflex?

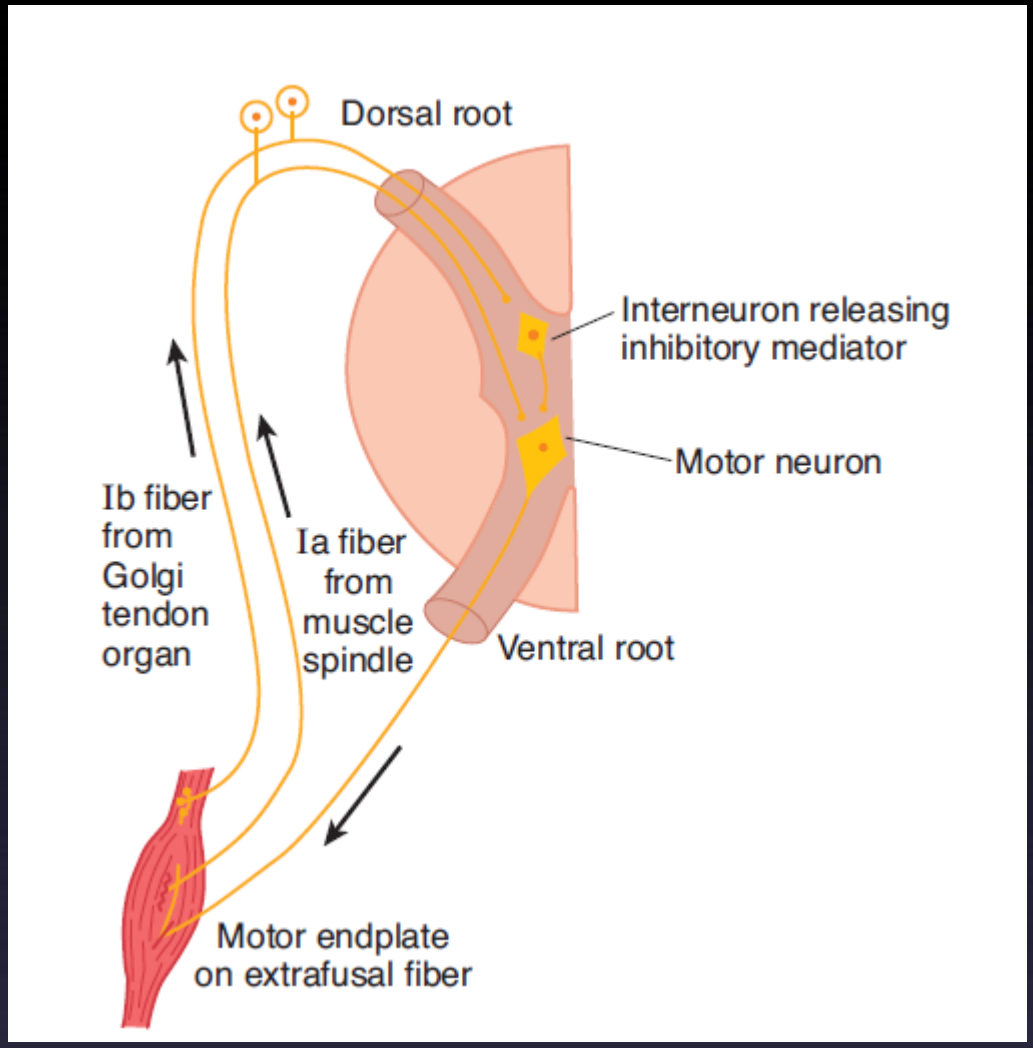
A reflex is a fast, predictable, automatic response to changes in the environment

Terms to remember
Reflex Arc, ipsilateral, contralateral, monosynaptic, polysynaptic and reciprocal innervation

General Components of a Reflex Arc

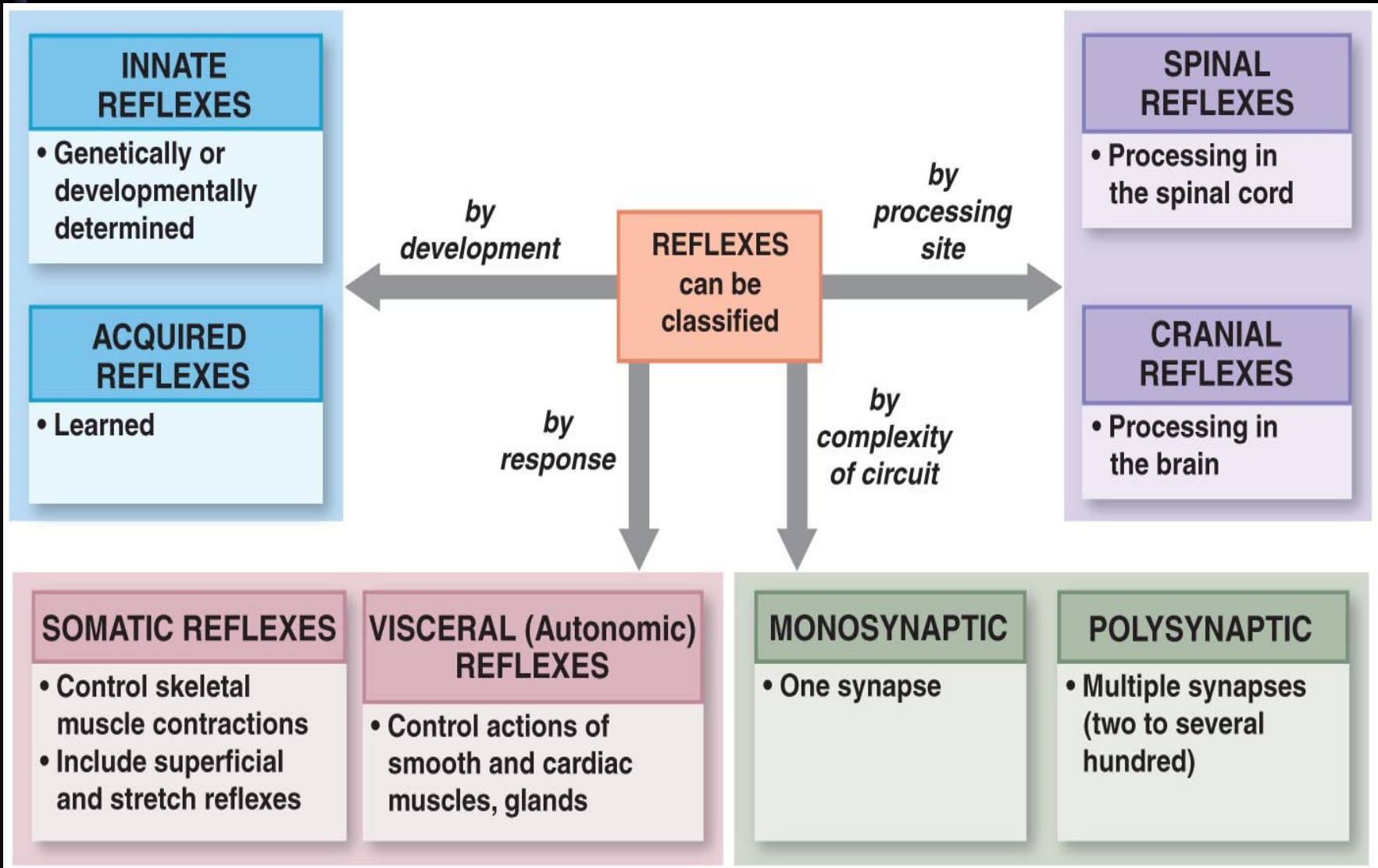


WHAT IS STRETCH REFLEX?



Pathways responsible for the stretch reflex and the inverse stretch reflex

Classification of reflexes



Spinal Cord Reflexes

Somatic

- Stretch → Ms Tone
- Fexor → Withdrawal
- Extensor → Standing/Posture/Stepping
- Rhythmic → Walking/Scratching

Autonomic (Vegetative)

- Vasomotor → vascular tone
- Micturition/Defecation → Bladder/Bowl

Classification of reflexes

- **Monosynaptic or stretch reflex or tendon jerk**

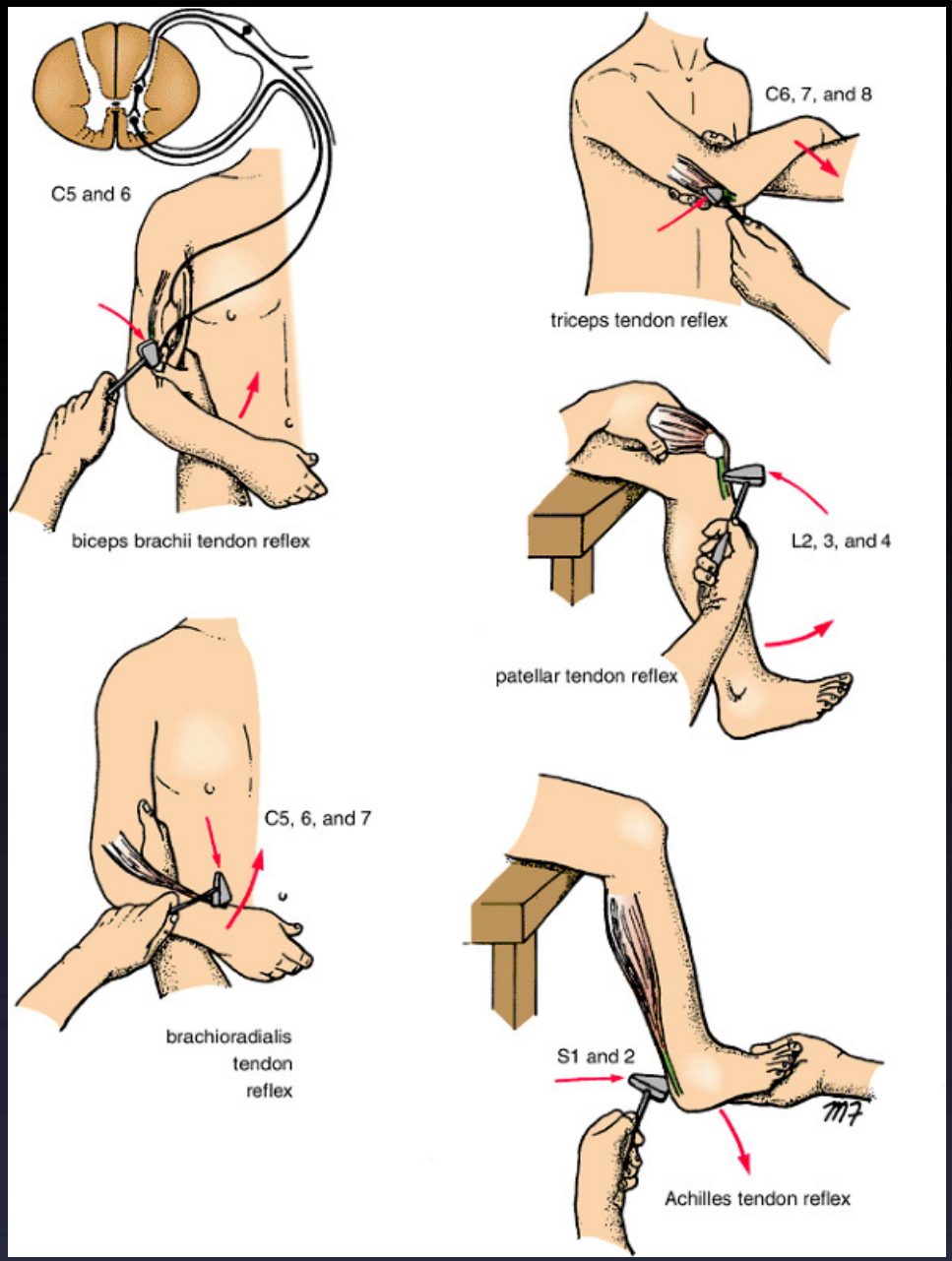
eg. Bicep jerk tricep jerk, supinator jerk
knee jerk, ankle jerk

- **Polysynaptic reflex**

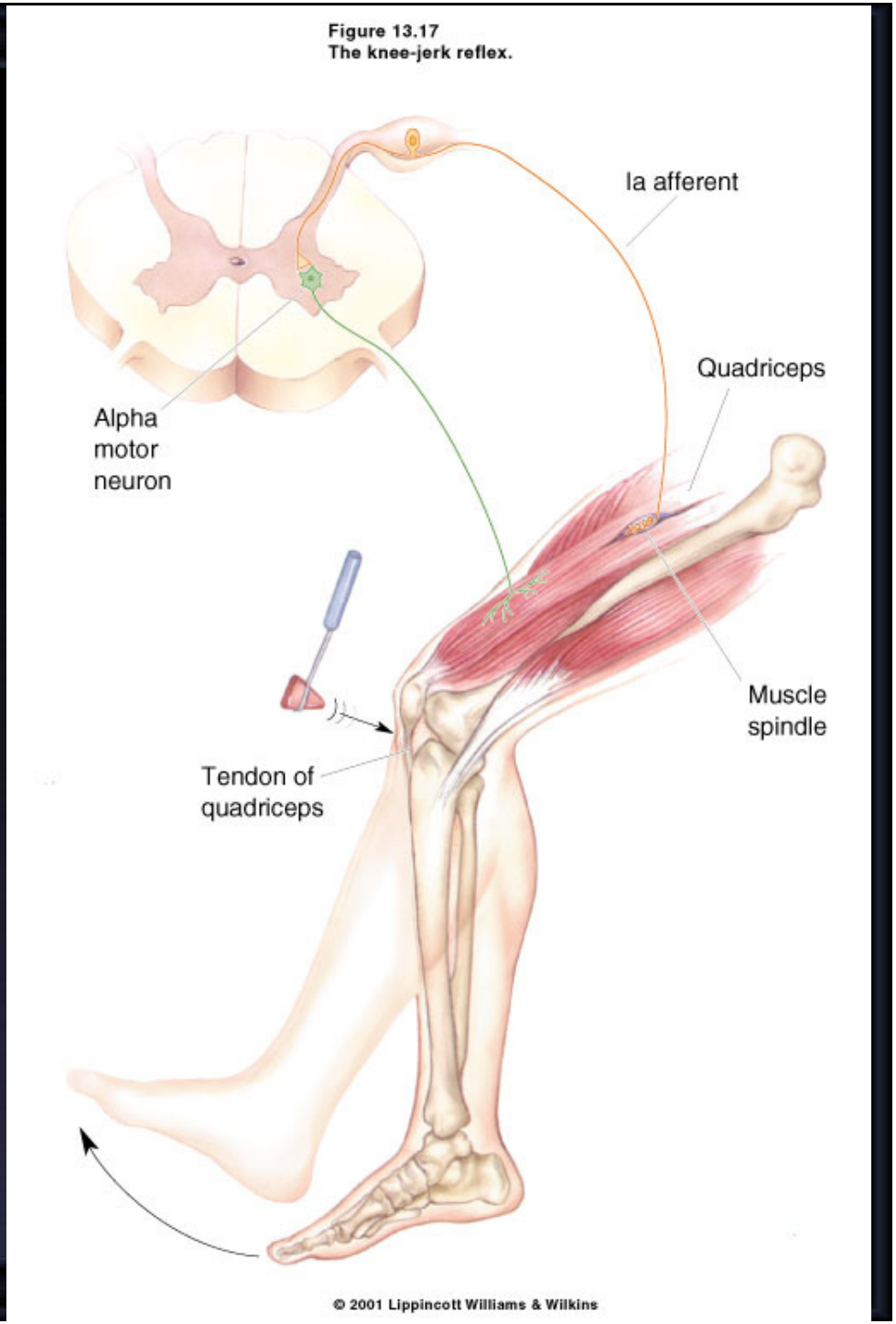
eg. Withdrawal reflex
Abdominal reflex
Plantar reflex

- **Visceral reflex**

eg. Micturation, defecation reflex


C5 and 6
biceps brachii tendon reflex
C6, 7, and 8
triceps tendon reflex
L2, 3, and 4
patellar tendon reflex
C5, 6, and 7
brachioradialis
tendon
reflex
S1 and 2
Achilles tendon reflex

KNEE JERK MONOSYNAPTIC REFLEX



RECIPROCAL INHIBITION AND RECIPROCAL INNERVATION

When a stretch reflex excites one muscle, it often simultaneously inhibits the antagonist muscles, which is the phenomenon of reciprocal inhibition, and the neuronal circuit that causes this reciprocal relation is called reciprocal innervation.

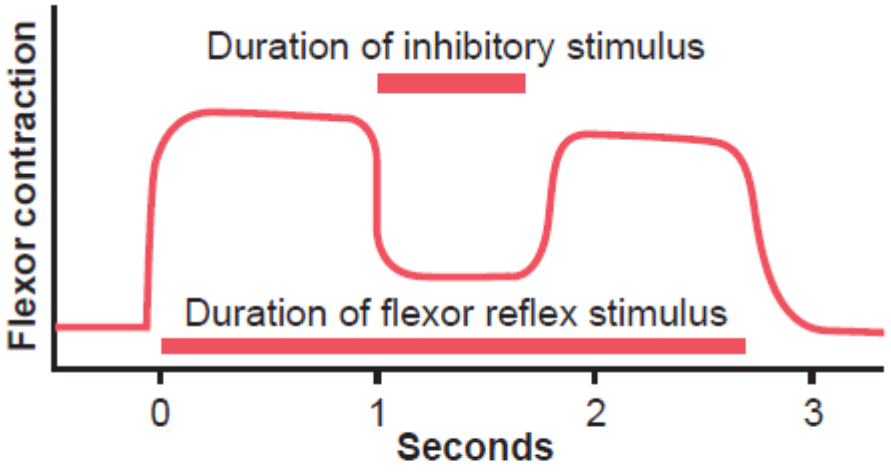
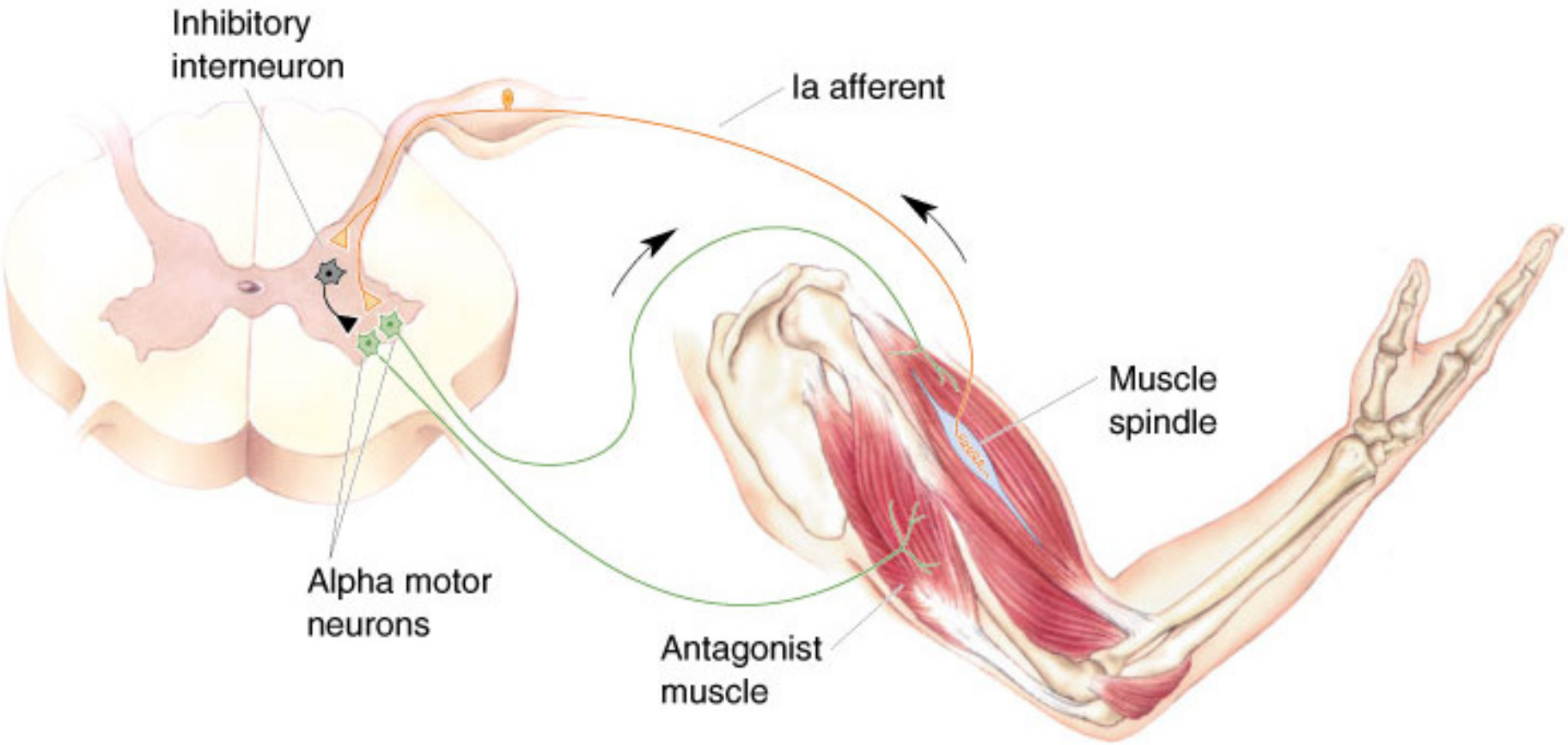
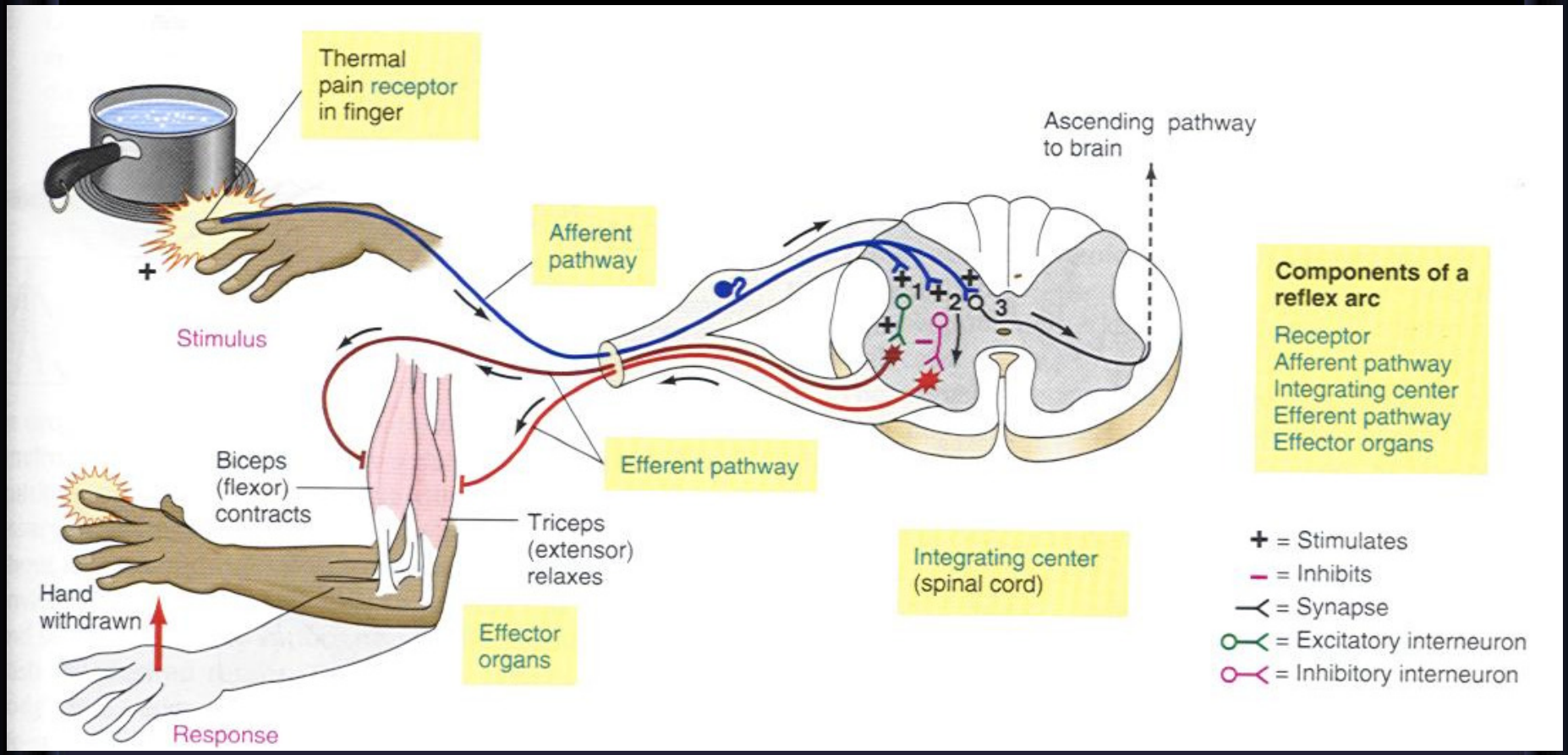


Figure 55-12. Myogram of a flexor reflex showing reciprocal inhibition caused by an inhibitory stimulus from a stronger flexor reflex on the opposite side of the body.

Figure 13.23
Reciprocal inhibition of flexors and extensors of the same joint.



Reciprocal inhibition is required with the monosynaptic reflex



WITDRAWEL REFLEX - POLYSYNAPTIC REFLEX

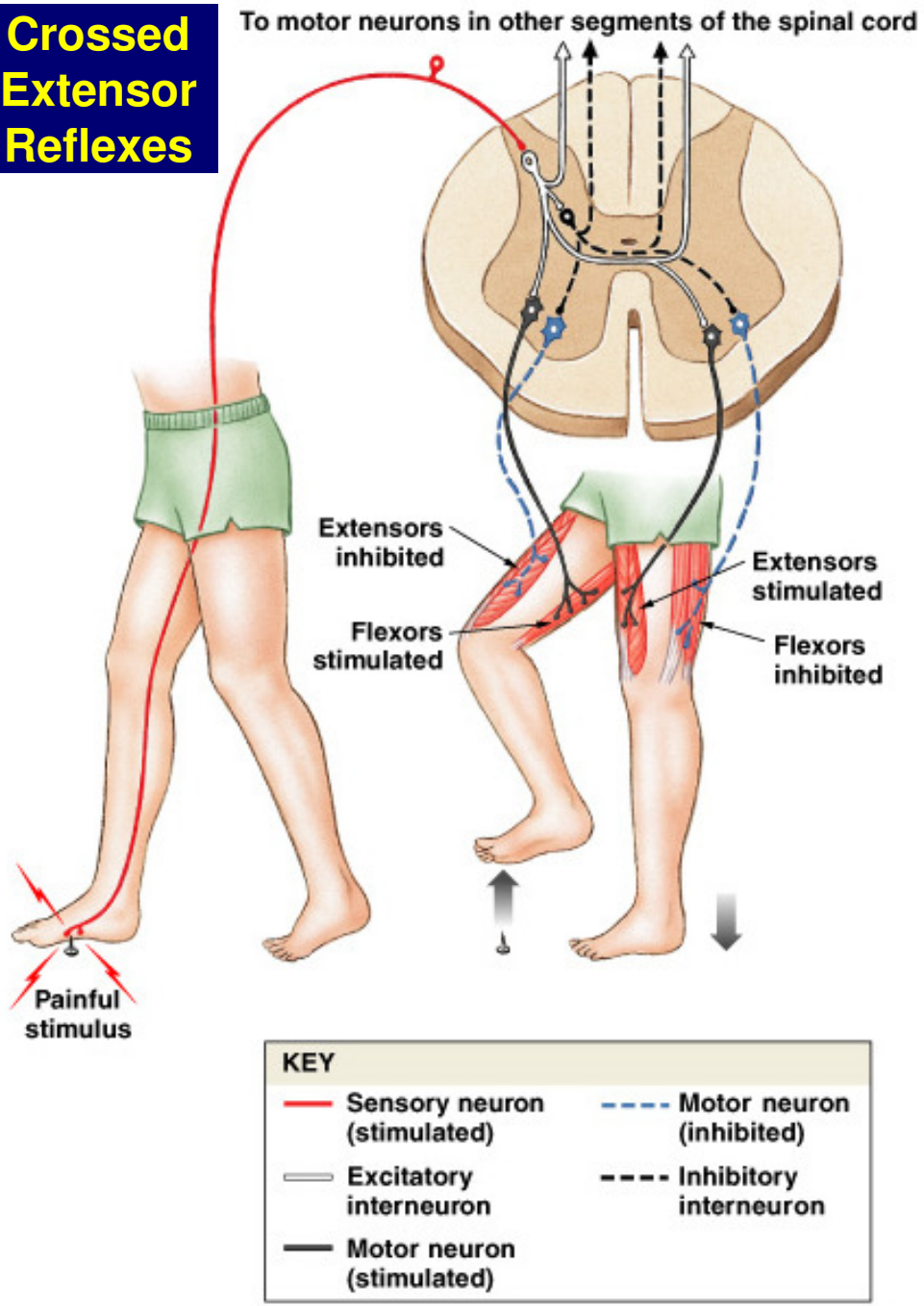
FLEXOR REFLEX AND THE WITHDRAWAL REFLEXES

In the spinal or decerebrate animal, almost any type of cutaneous sensory stimulus from a limb is likely to cause the flexor muscles of the limb to contract, thereby with drawing the limb from the stimulating object. This reflex is called the flexor reflex.

CROSSED EXTENSOR REFLEX

About 0.2 to 0.5 second after a stimulus elicits a flexor reflex in one limb, the opposite limb begins to extend. This reflex is called the crossed extensor reflex. Extension of the opposite limb can push the entire body away from the object, causing the painful stimulus in the with-drawn limb.

Crossed Extensor Reflexes



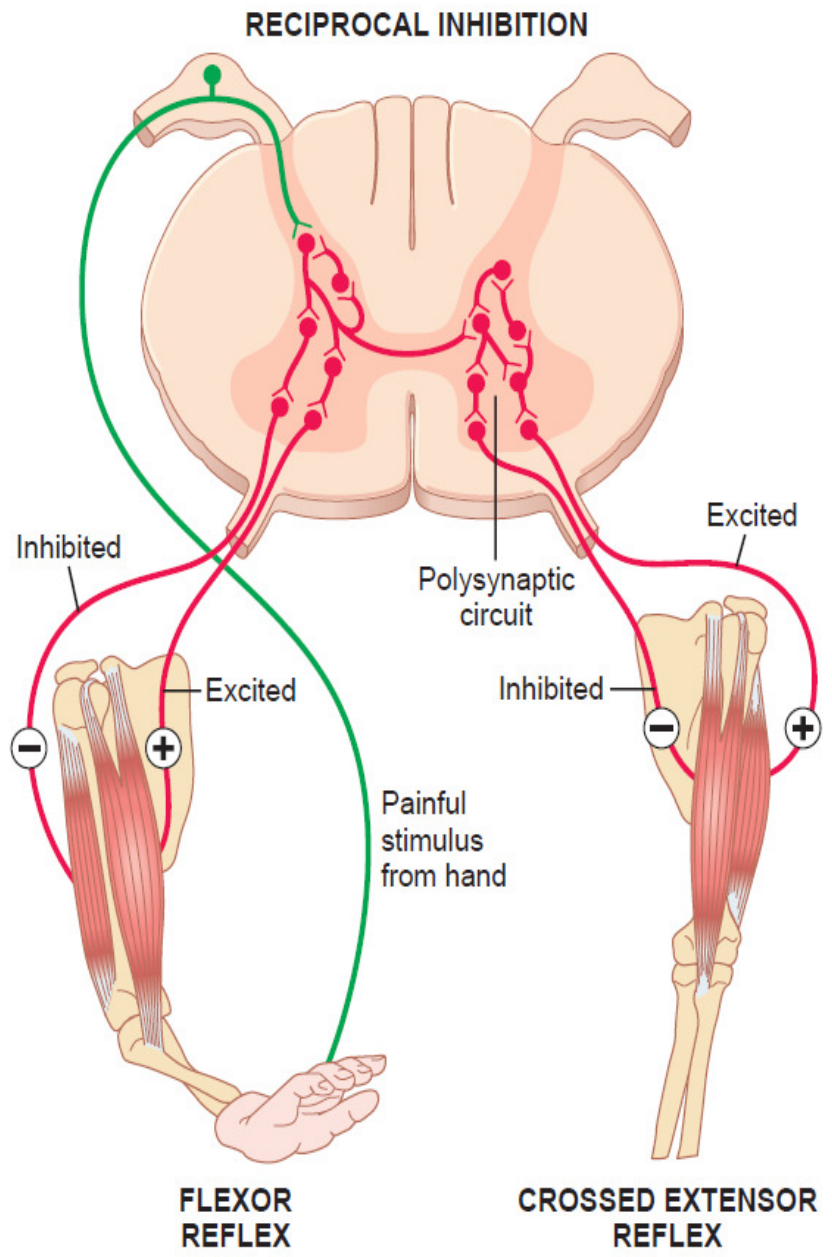


Figure 55-9. Flexor reflex, crossed extensor reflex, and reciprocal inhibition.

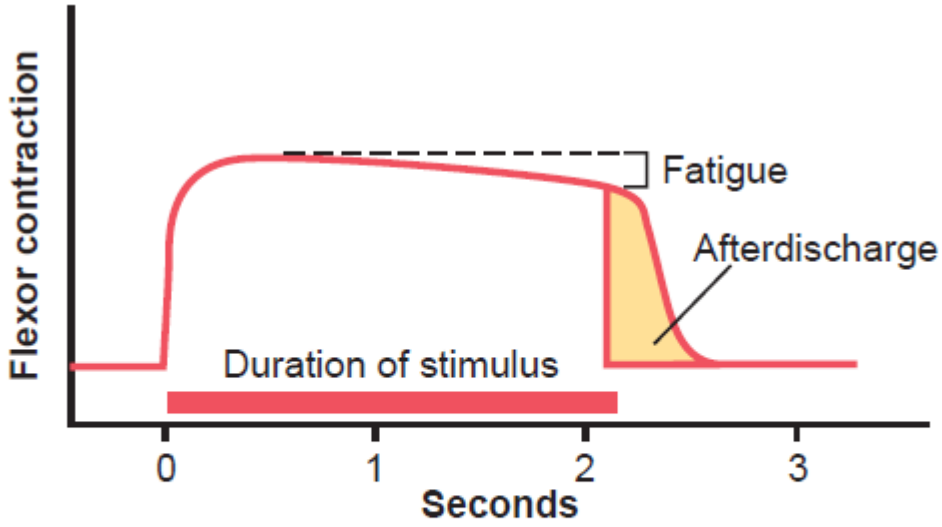


Figure 55-10. Myogram of the flexor reflex showing rapid onset of the reflex, an interval of fatigue, and, finally, afterdischarge after the input stimulus is over.

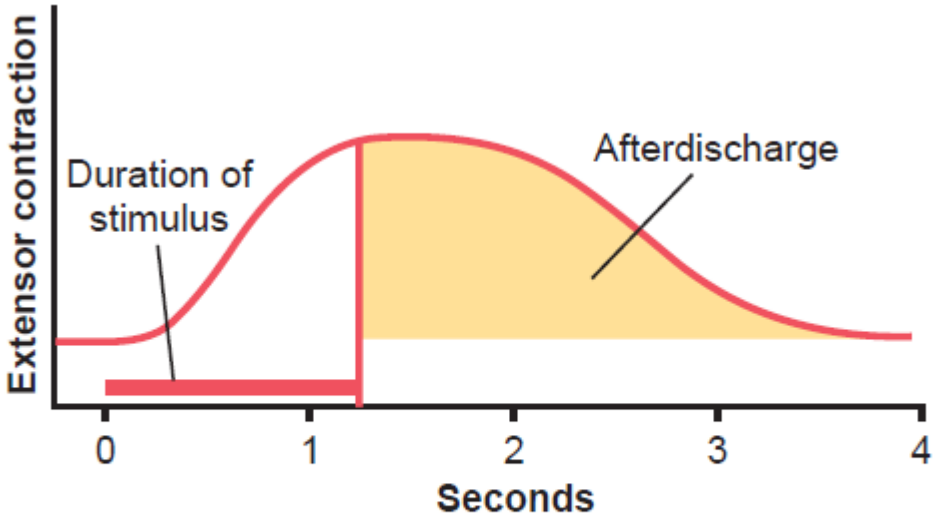
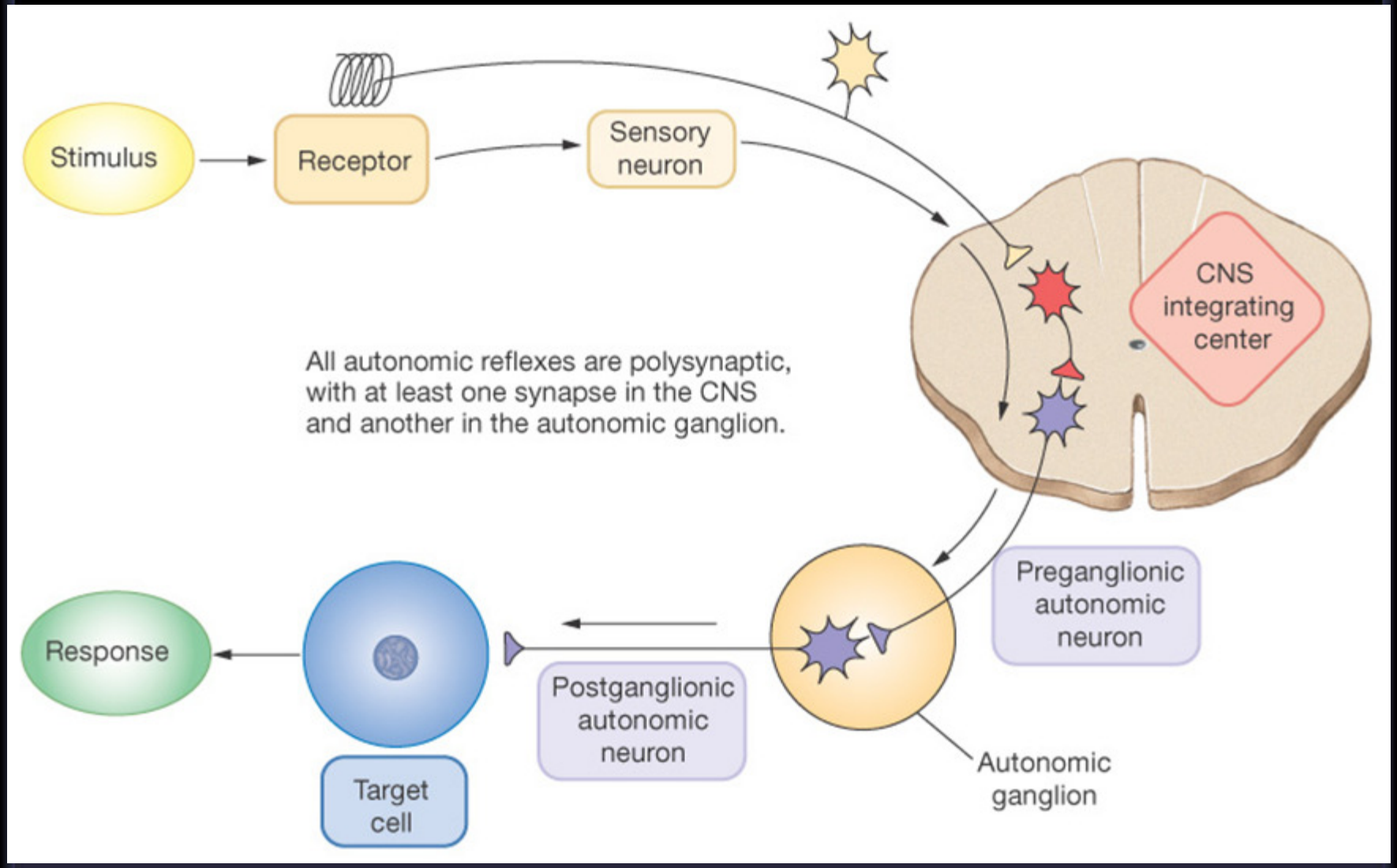


Figure 55-11. Myogram of a crossed extensor reflex showing slow onset but prolonged afterdischarge.


Stimulus
Receptor
Sensory neuron
CNS integrating center
All autonomic reflexes are polysynaptic, with at least one synapse in the CNS and another in the autonomic ganglion.
Preganglionic autonomic neuron
Response
Postganglionic autonomic neuron
Target cell
Autonomic ganglion

REFLEXES OF POSTURE AND LOCOMOTION

- Positive Supportive Reaction.
- Cord “Righting” Reflexes.

STEPPING AND WALKING MOVEMENTS

- Rhythmical Stepping Movements of a Single Limb.
- Reciprocal Stepping of Opposite Limbs.
- Diagonal Stepping of All Four Limbs—“Mark Time”Reflex.
- Galloping reflex

Scratch Reflex

(1) Position sense that allows the paw to find the exact point of irritation on the surface of the body and

(2) A to-and-fro scratching movement.

Spinal Cord Reflexes That Cause Muscle Spasm

- Muscle Spasm Resulting From a Broken Bone.
- Abdominal Muscle Spasm in Persons with Peritonitis.
- Muscle Cramps.

Autonomic Reflexes in the Spinal Cord (Cont)

Segmental autonomic reflexes are integrated in the spinal cord

(1) changes in vascular tone resulting from changes in local skin heat

(2) sweating, which results from localized heat on the surface of the body

(3) intestinointestinal reflexes that control some motor functions of the gut

(4) peritoneointestinal reflexes that inhibit gastrointestinal motility in response to peritoneal irritation

(5) evacuation reflexes for emptying the full bladder

Mass Reflex

In a spinal animal or human being, some times the spinal cord suddenly becomes excessively active, causing massive discharge in large portions of the cord by painful stimulus

The corticospinal tract from the brain is shown to terminate almost entirely on spinal interneurons, where the signals from this tract are combined with signals from other spinal tracts or spinal nerves before finally converging on the anterior motor neurons to control muscle function.

ORGANIZATION OF THE SPINAL CORD FOR MOTOR FUNCTIONS

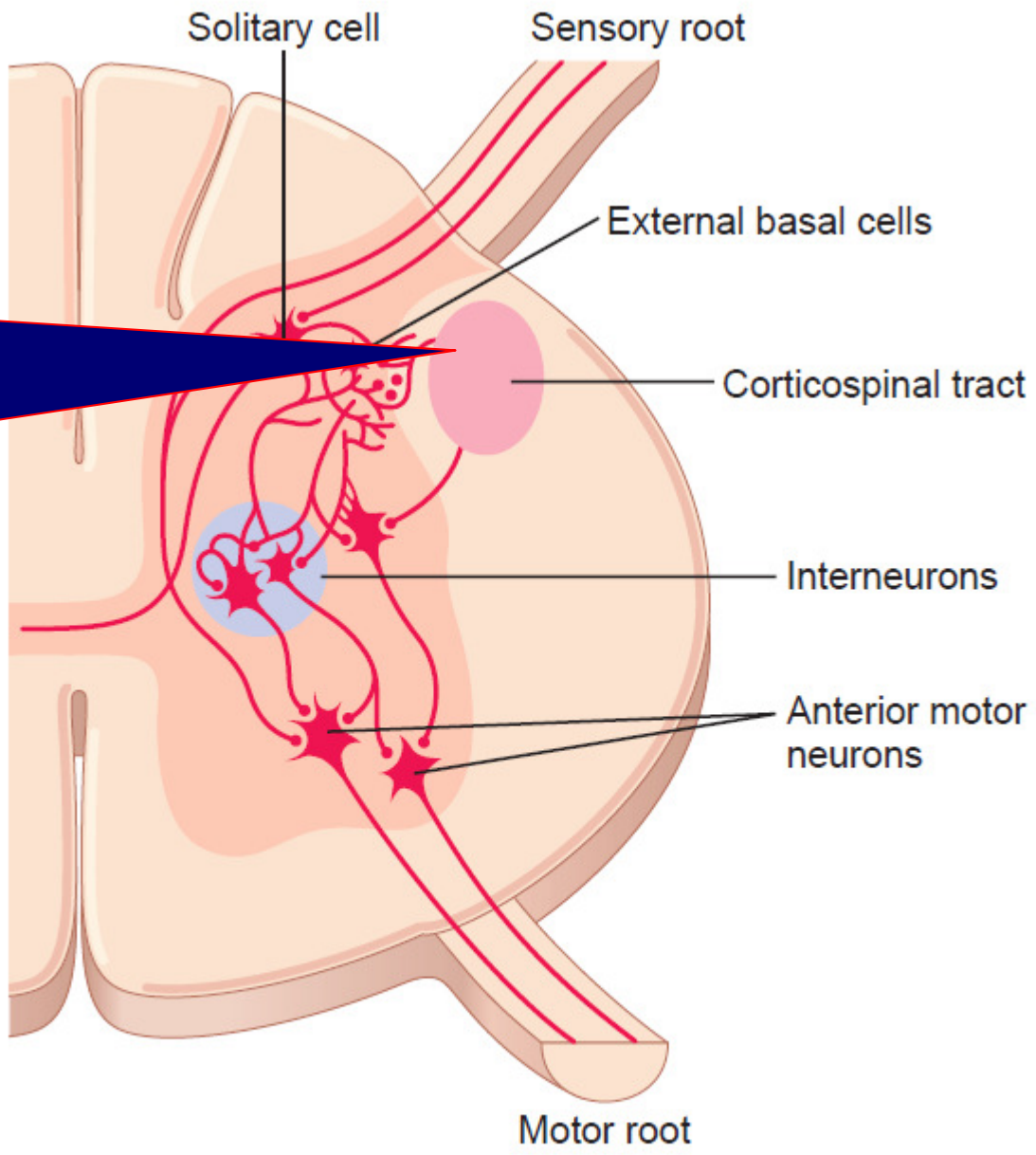


Figure 55-1. Connections of peripheral sensory fibers and corticospinal fibers with the interneurons and anterior motor neurons of the spinal cord.

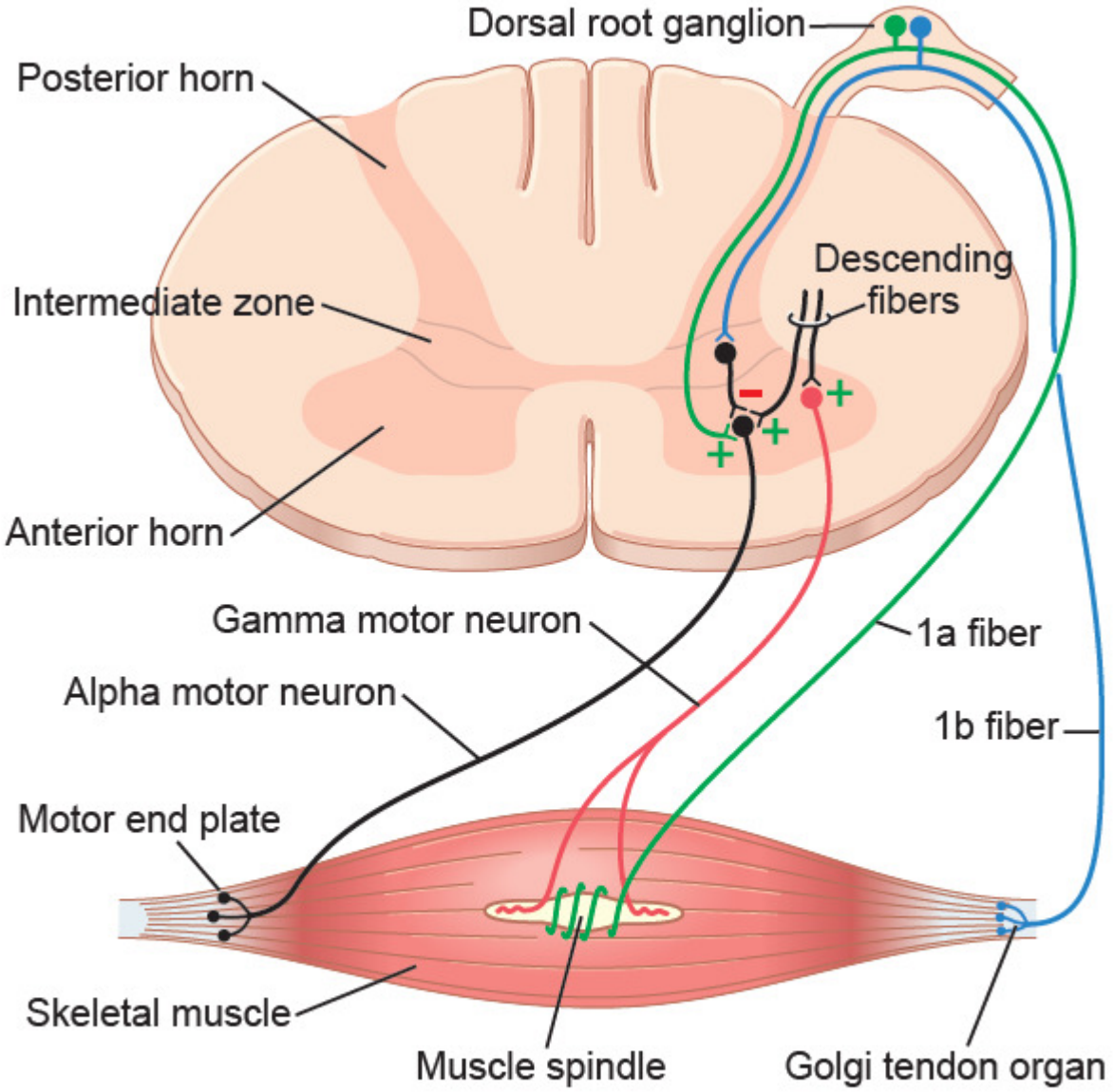
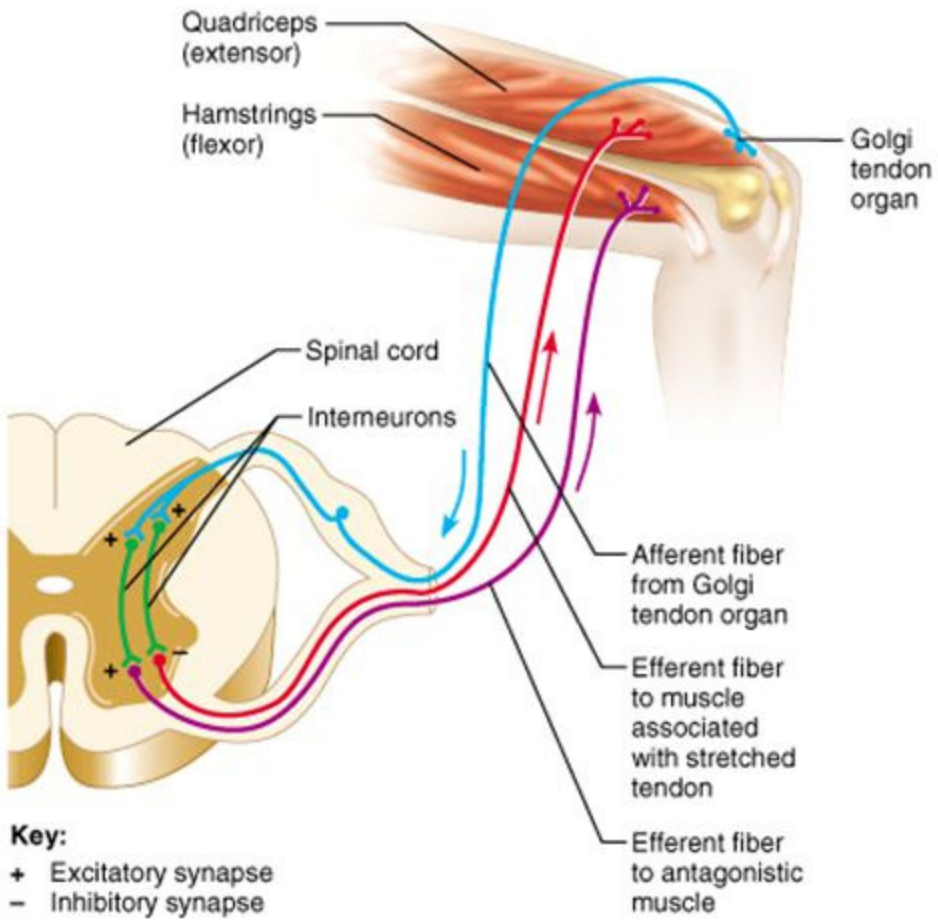


Figure 55-2. Peripheral sensory fibers and anterior motor neurons innervating skeletal muscle.

Golgi (Deep) Tendon Reflex

- Receptor: Golgi tendon organ
  - Mechanoreceptor that responds to muscle tension (via the tendon)
  - Stimulus: increased tension (increased nerve impulses to spinal cord)
  - Response: muscle relaxes (decreased nerve impulses to spinal cord)
    - **Inhibits the agonist**
    - **Reciprocal path: activates the antagonist**
- Polysynaptic, ipsilateral, and segmental




THANKS