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.

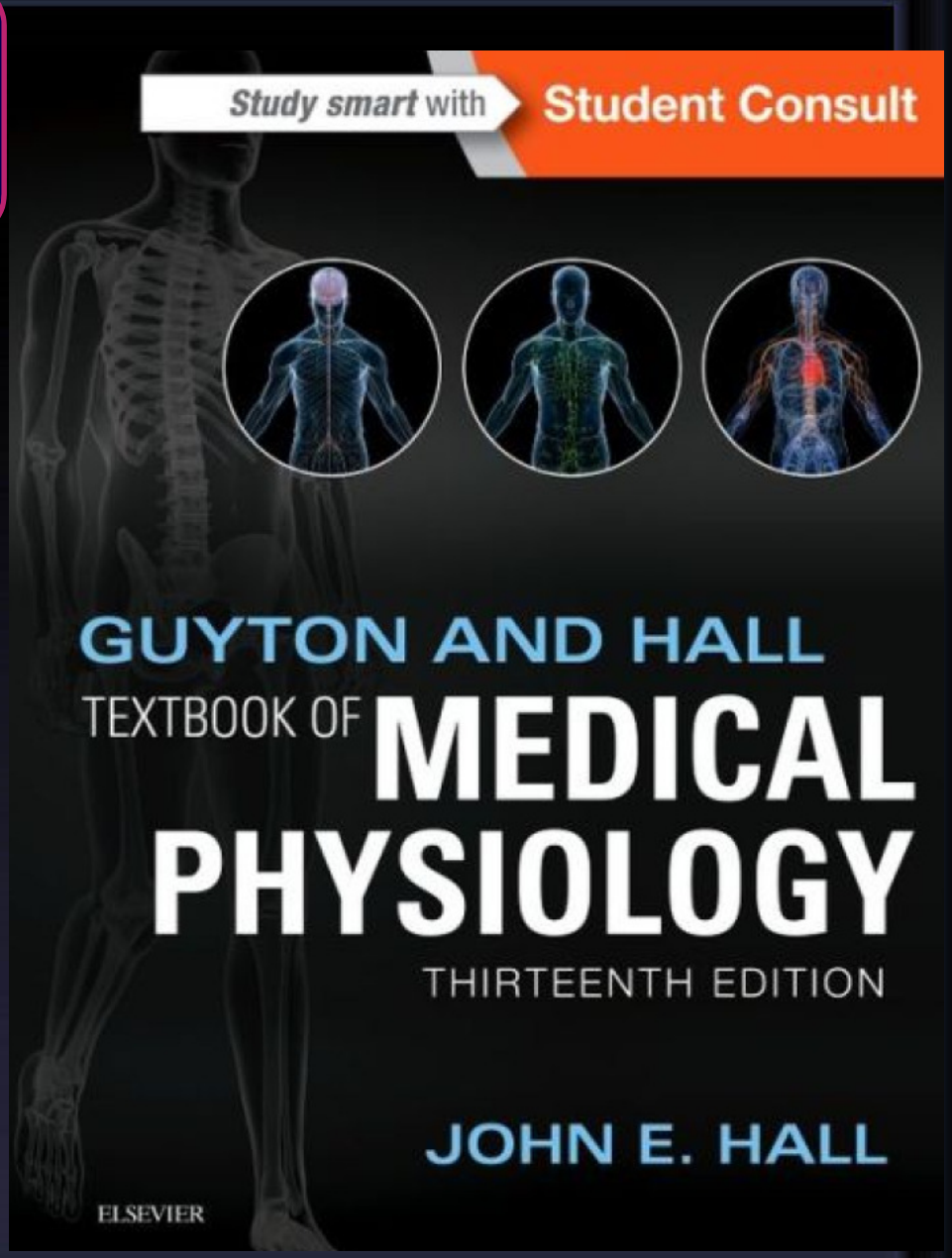
(3) Classify reflexes with examples and how they differ from each other .

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

REMEMBER

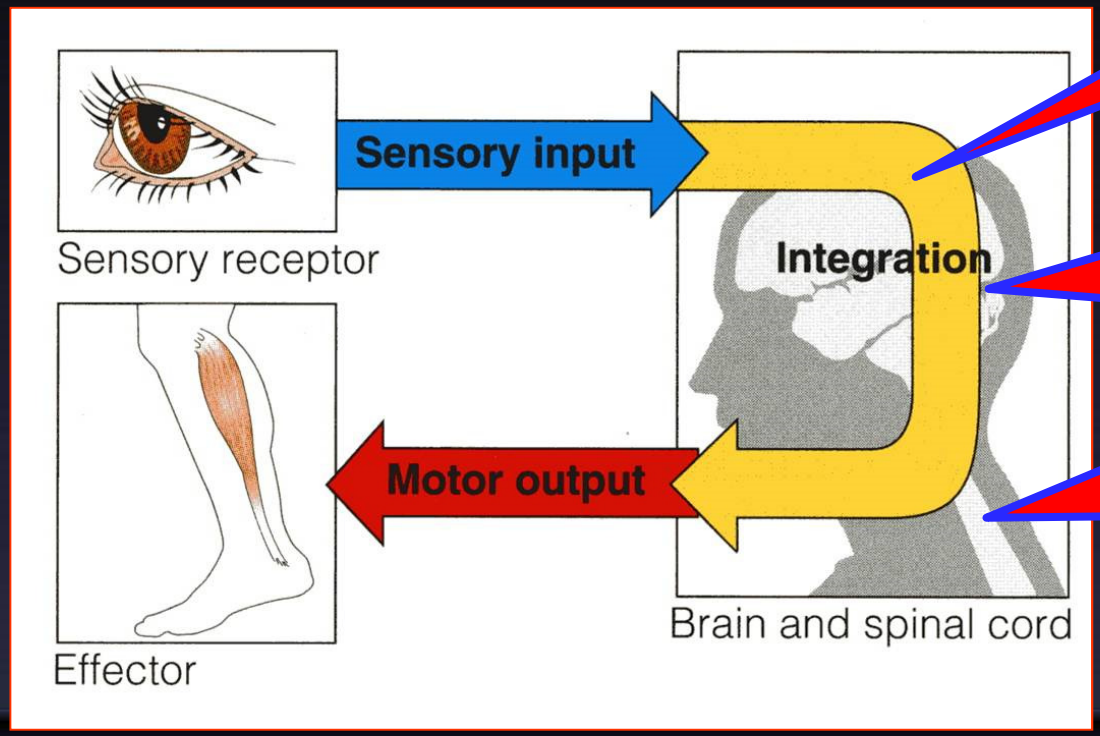
- These handouts will facilitate what you have to study and are not an alternative to your text book.
- The main source of this Lectures is from Guyton & Hall 13th Edition
- Ch55-Pages 695-705

9/2/2019



HOW NERVOUS SYSTEM FUNCTIONS?

- Collection of sensory input
- Central Integration
- Motor output



HIGHER BRAIN OR CORTICAL LEVEL

LOWER BRAIN OR SUBCORTICAL LEVEL

SPINAL CORD LEVEL

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.

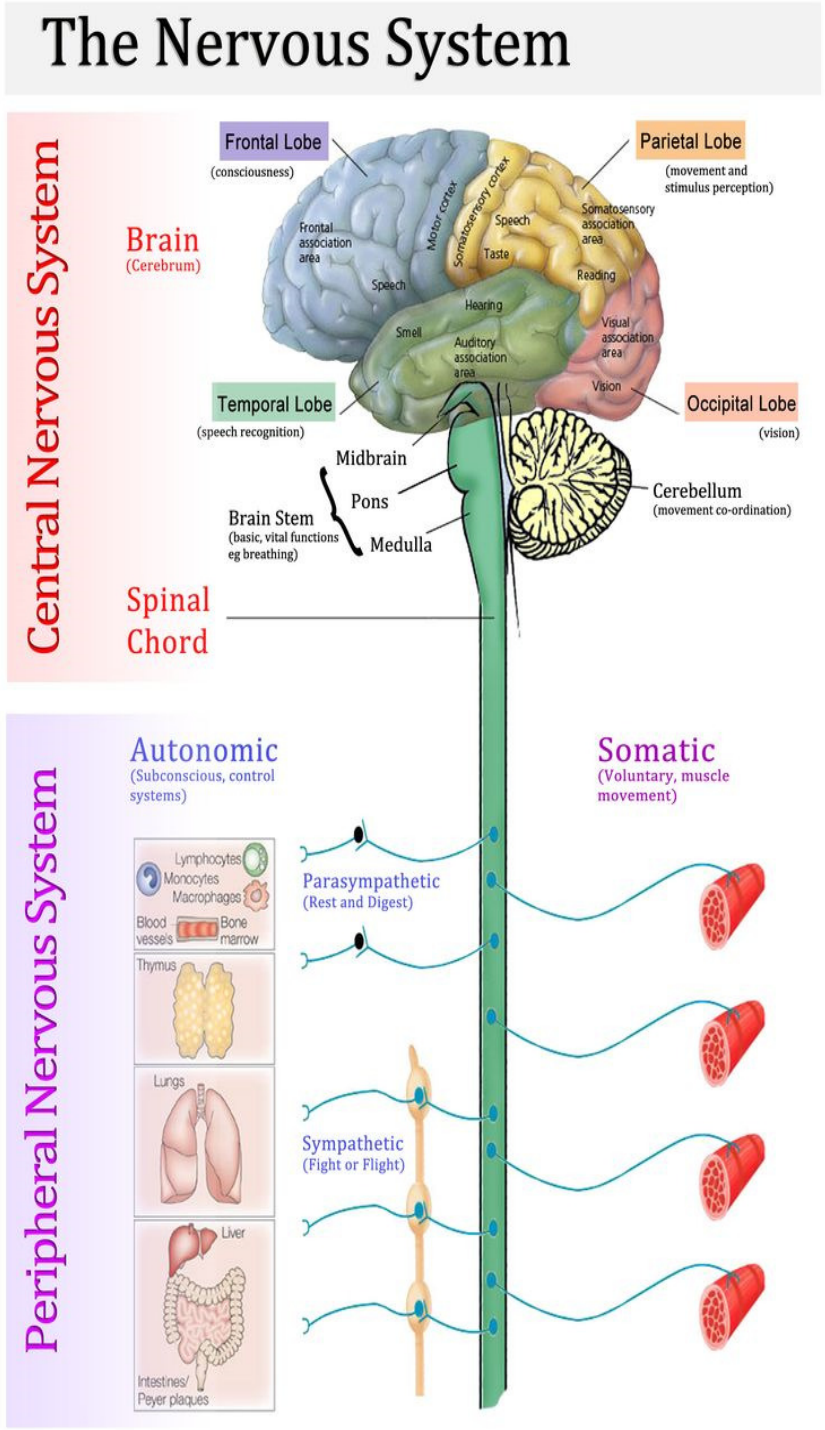
SPINAL CORD LEVEL

(1) walking reflexes

(2) withdrawal reflexes

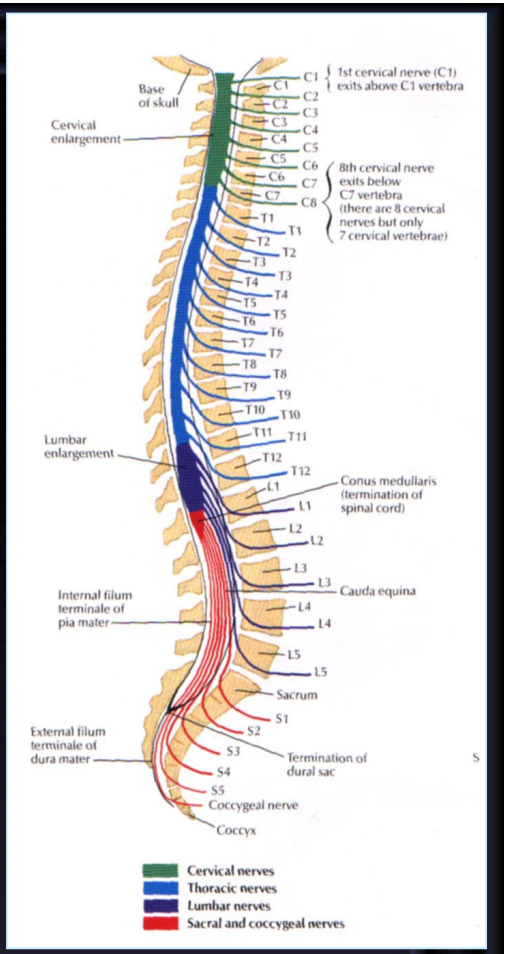
(3) anti gravity reflexes

(4) Reflexes that control of blood vessel gastrointestinal, urinary/defecation.



SPINAL CORD FUNCTIONS

1. Center for Spinal Cord Reflexes (Somatic & Autonomic)
2. Gateway and Conduction Pathways for all tracts
3. Gateway for Pain control systems



What is a Reflex?

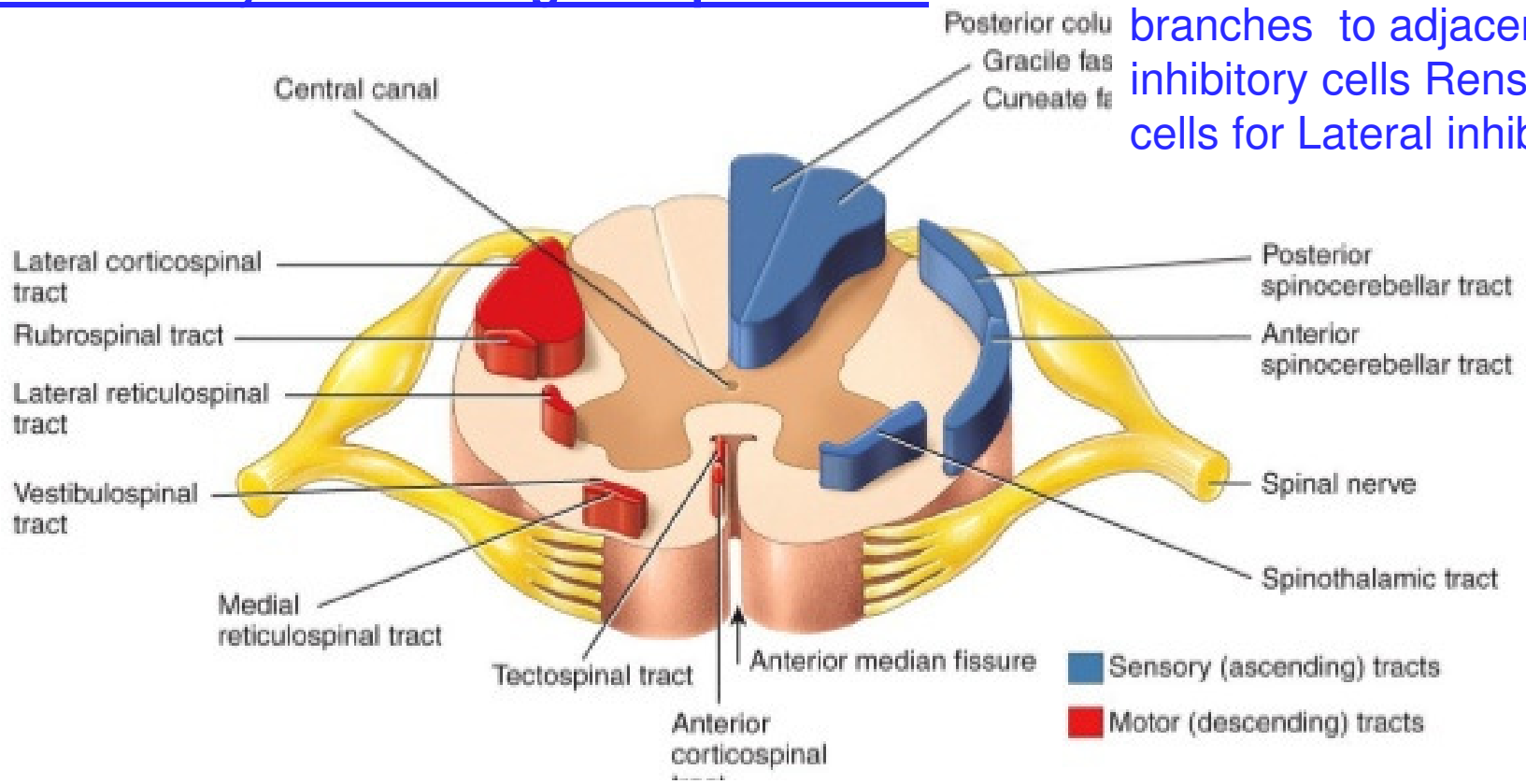
A reflex is a fast, predictable, automatic (involuntary) response to a stimulus (change in the environment)

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

Sensory and Motor Tracts

Renshaw Cells :-
As the anterior motor neuron axon leaves the body of the neuron, sends collateral branches to adjacent inhibitory cells Renshaw cells for Lateral inhibition

The two-way traffic along the spinal cord

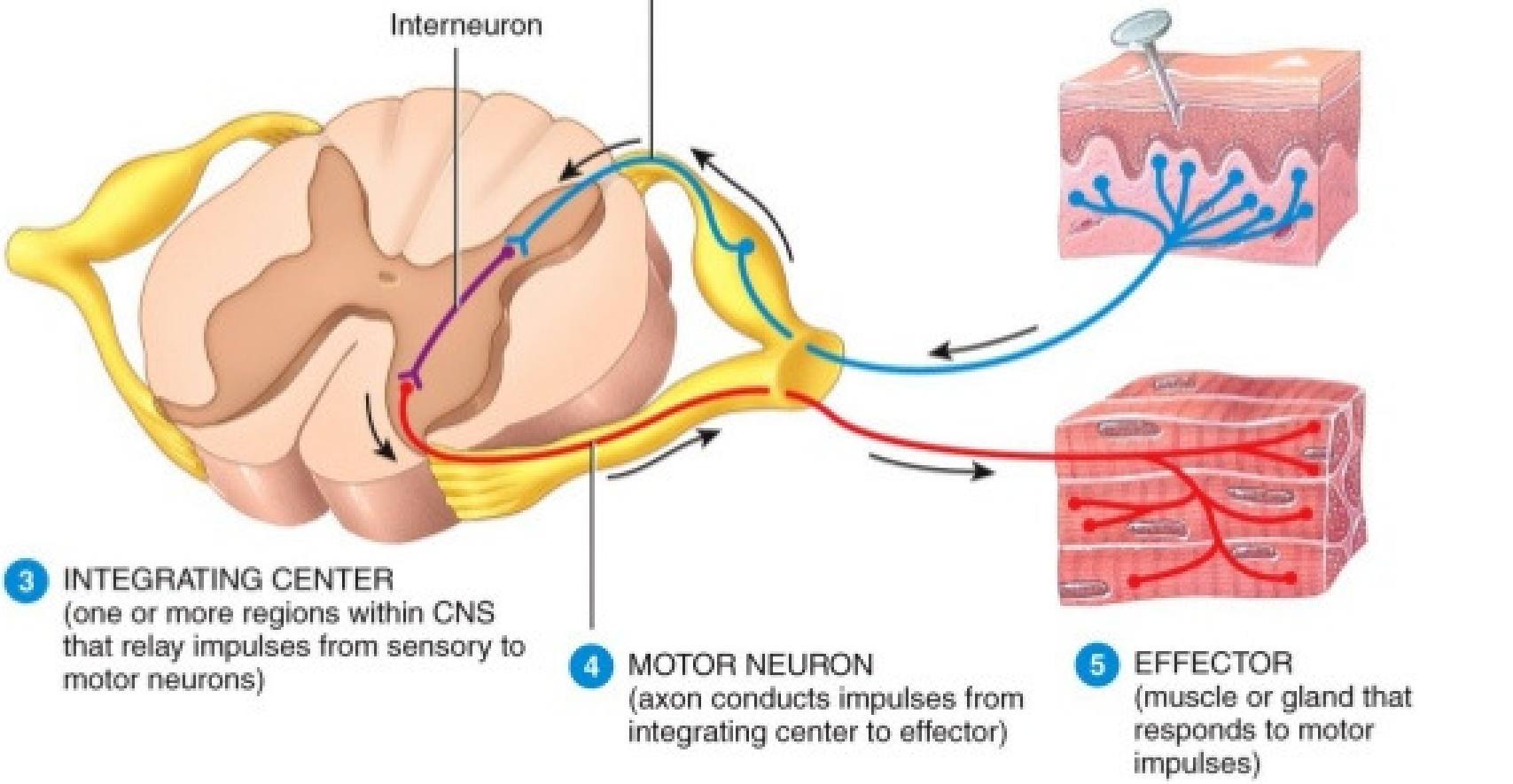


Alpha motor neurons: Large type A alpha motor nerve fibers supply extrafusal fibers

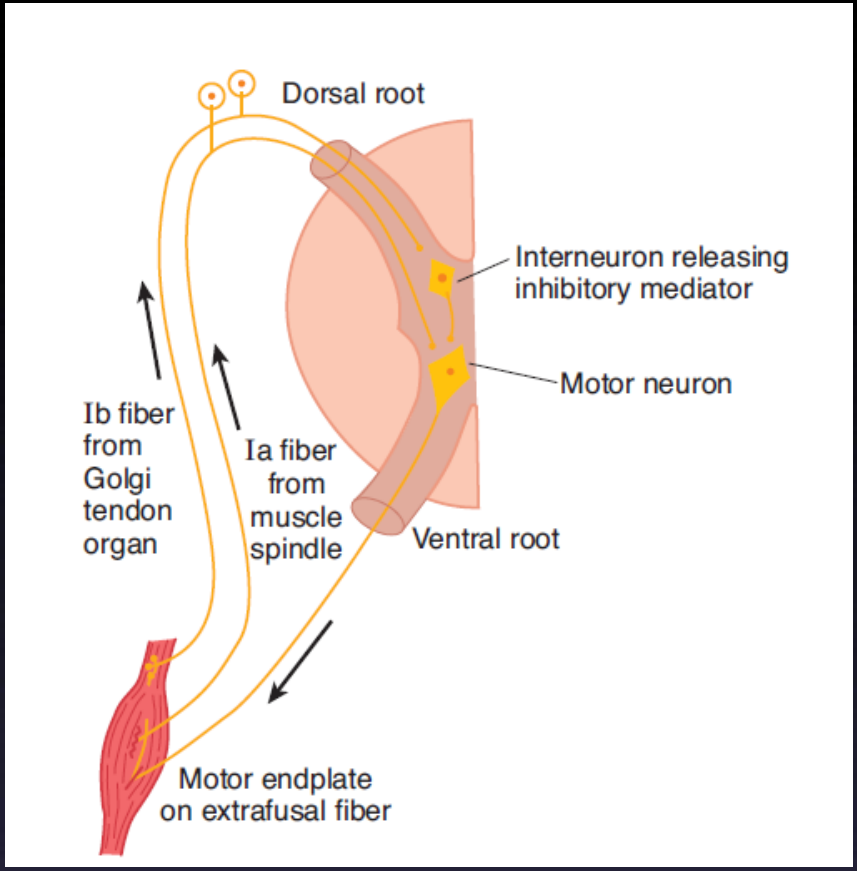
Gamma motor neurons smaller and supply intrafusal fibers

General Components of a Reflex Arc

Reflex Arc: direct route from a sensory neuron, to an interneuron, to an effector



WHAT IS STRETCH REFLEX?



Pathways responsible for the stretch reflex (Tendon jerks) and the inverse stretch reflex (Golgi Tendon reflex)

Types of reflexes
Clinical classification

1-Superficial reflexes:

* Receptors in skin or mucous membrane.
* Are usually multisynaptic .
* Usually involve moving away from stimulus
* E.g. **plantar response**, **withdrawl, abdominal** corneal and conjunctival reflexes.

2- Deep reflexes:

* Receptors deep in muscles (Spindles & Golgi Tendon Organs)
* Are Stretch reflexes called **tendon reflexes**
* E.g. knee jerk, ankle jerk etc.

3- Visceral reflexes:

* Are the reflexes where at least one part of the reflex arc is autonomic nerve
* Stimulatin receptors in viscera.
* E.g, pupillary reflex, carotid sinus reflex

Spinal Cord Reflexes

Somatic Reflexes Integrated in Spinal Cord

- Stretch → Maintain Muscle Tone
- Flexor → Withdrawal
- Extensor → Standing/Posture/Stepping
- Rhythmic → Walking/Scratching

Autonomic (Visceral) Integrated in Spinal Cord

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

Classification of reflexes

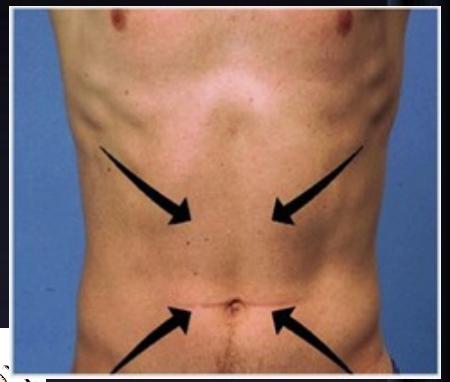
By Complexity

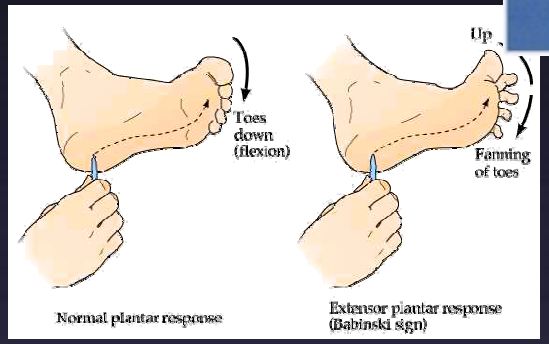
- **Monosynaptic or stretch reflex or tendon jerk**

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

- **Polysynaptic reflex**

eg. Withdrawal reflex
Abdominal reflex
Plantar reflex





These reflexes are mediated by the spinal cord, but influenced by higher centers

Spinal cord levels of the tendon reflexes

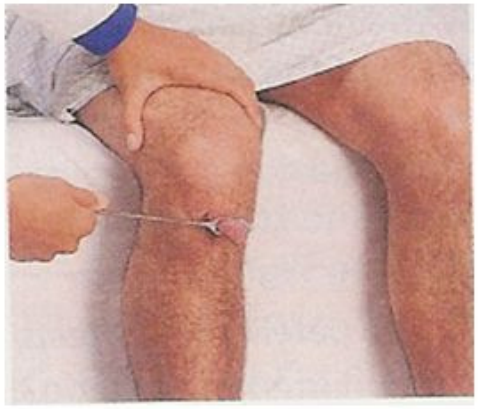
- Biceps

- Brachioradialis

- Achilles

- Triceps

- Patellar



Reflex	*Cord level*
Biceps (elbow)	*C5,6*
Brachioradialis	*C5,6*
Triceps	*C6,7*
Long finger flexors	*C8-T1*
Hip Abductors	*L2,3,4*
Quadriceps (knee)	*L2,3,4*
Gastrocnemius-soleus (ankle)	*S1,2*

KNEE JERK MONOSYNAPTIC REFLEX

9/2/2019

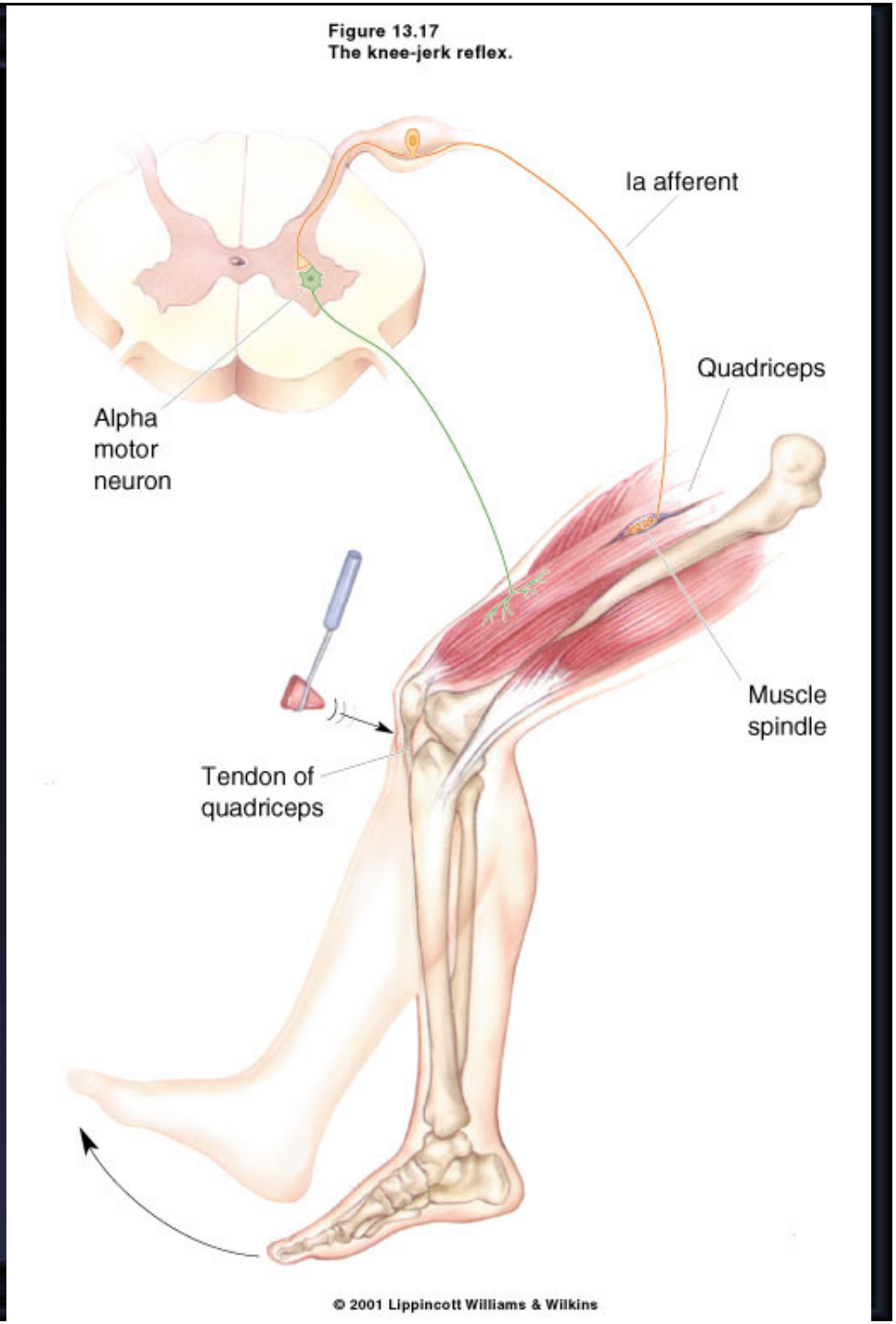
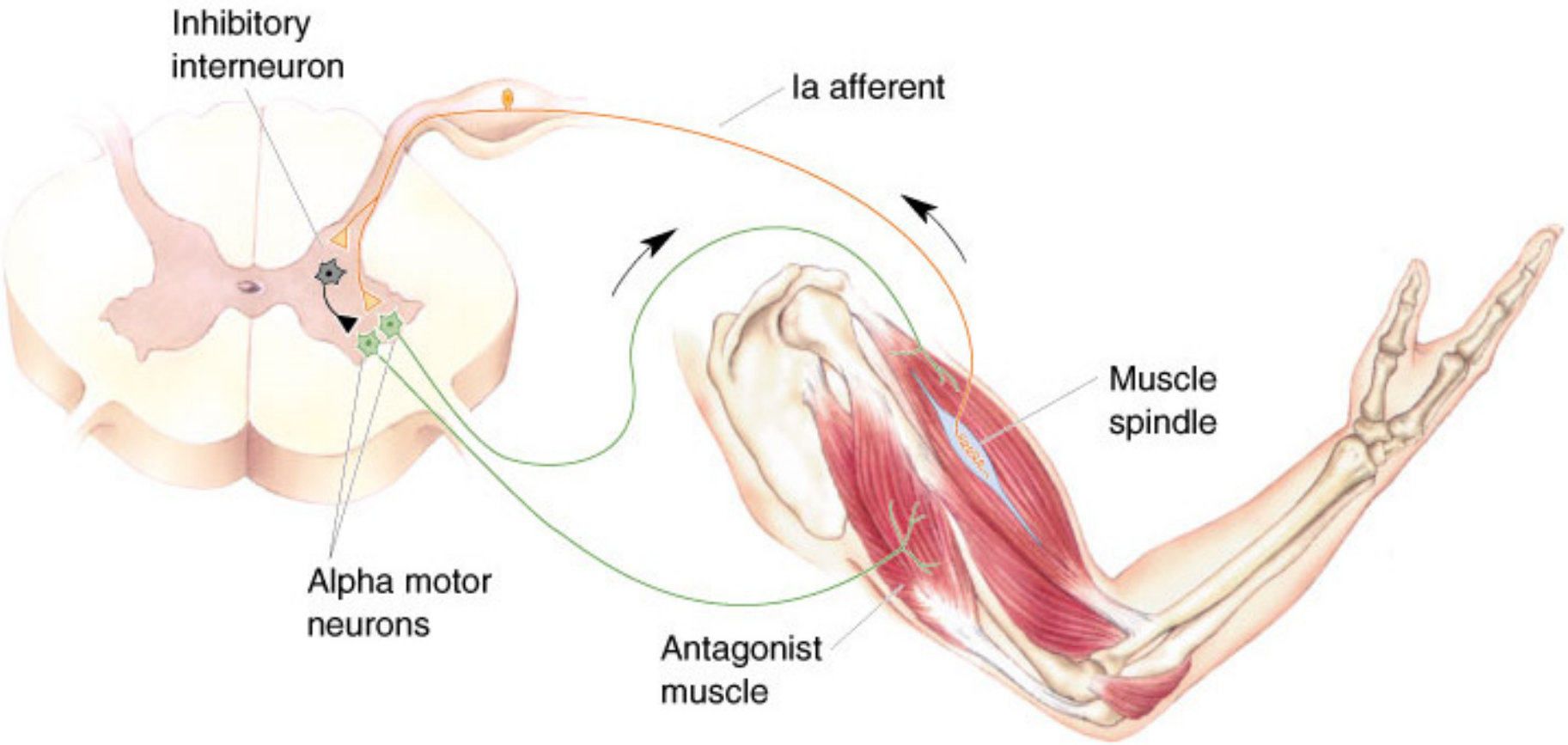
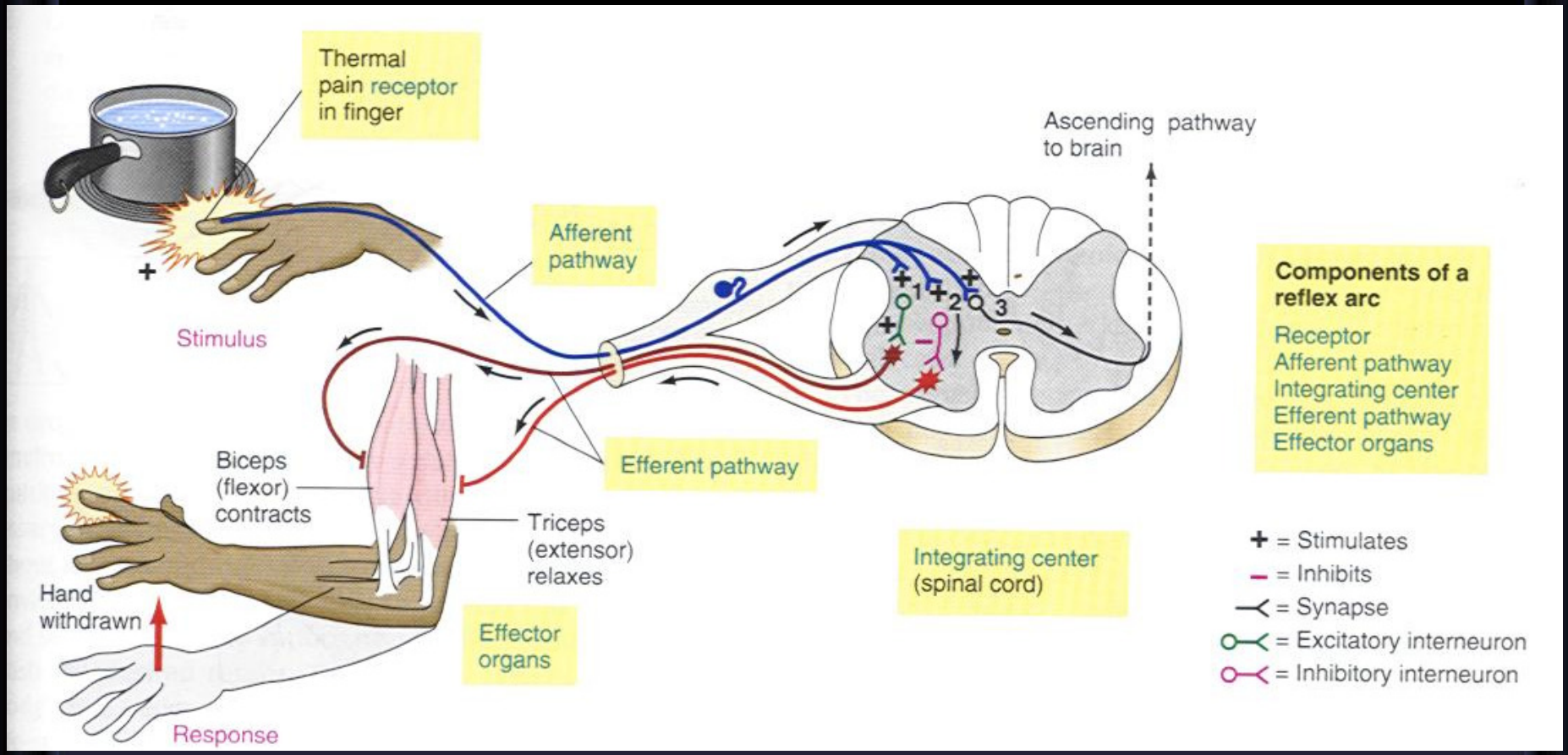


Figure 13.23
Reciprocal inhibition of flexors and extensors of the same joint.



Reciprocal inhibition is required with the monosynaptic reflex



WITDRAWEL REFLEX - POLYSYNAPTIC REFLEX

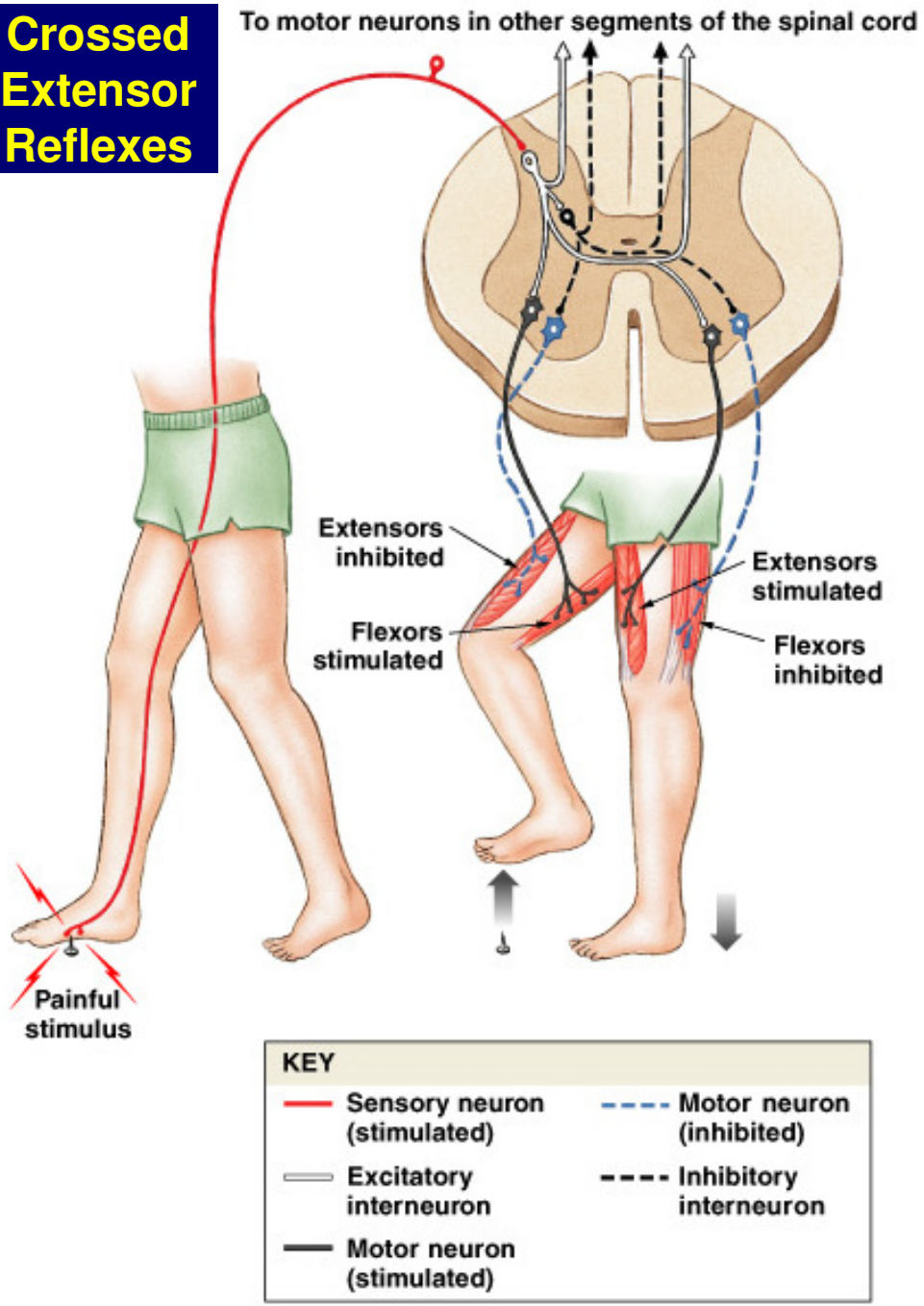
FLEXOR REFLEX AND THE WITHDRAWAL REFLEXES

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



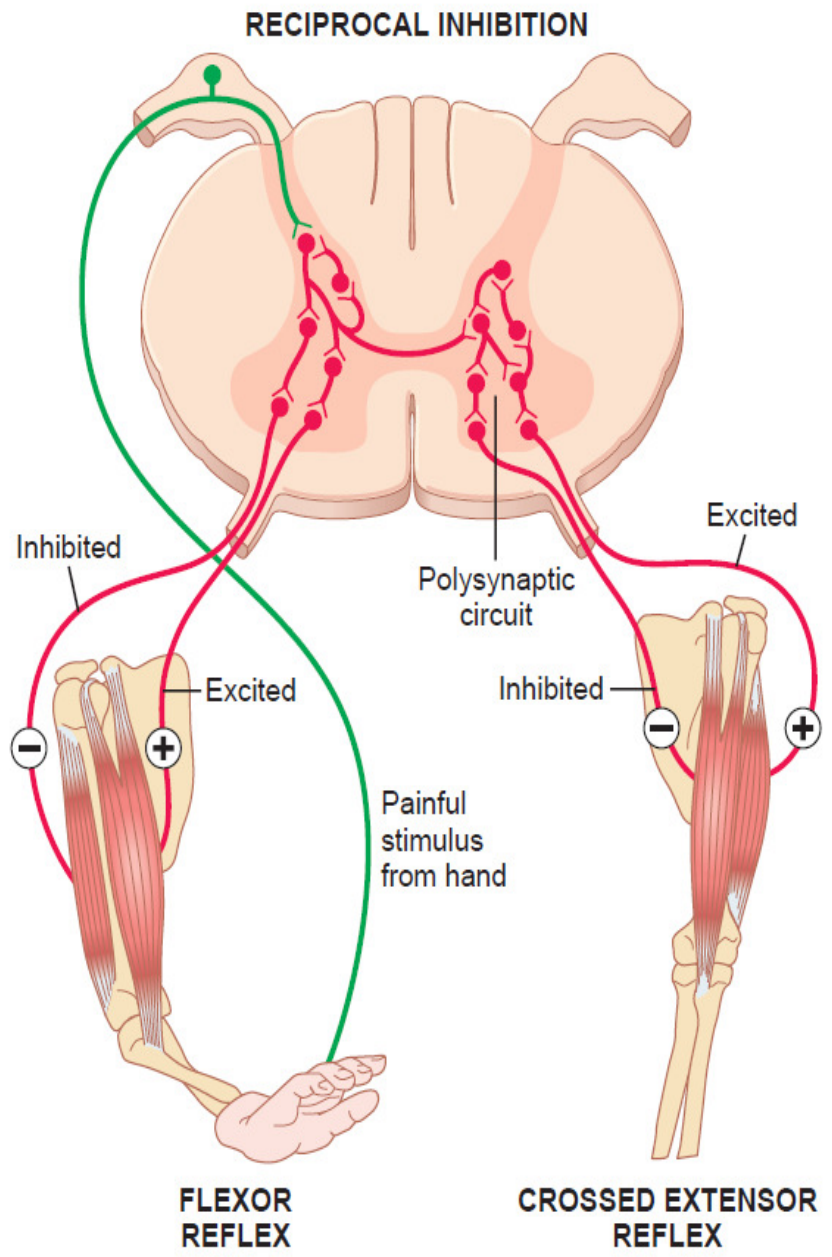


Figure 55-9. Flexor reflex, crossed extensor reflex, and reciprocal inhibition.

Afterdischarge

The ability of neurons to rhythmically discharge impulses for a relatively longer time after cessation of the stimulus

Short term afterdischarge is produced by successive depolarization of the membrane of the neuron after prolonged rhythmic stimulation

Prolonged afterdischarge results from recurrent pathways that initiate oscillation in reverberating interneuron circuits stimulating AHCs

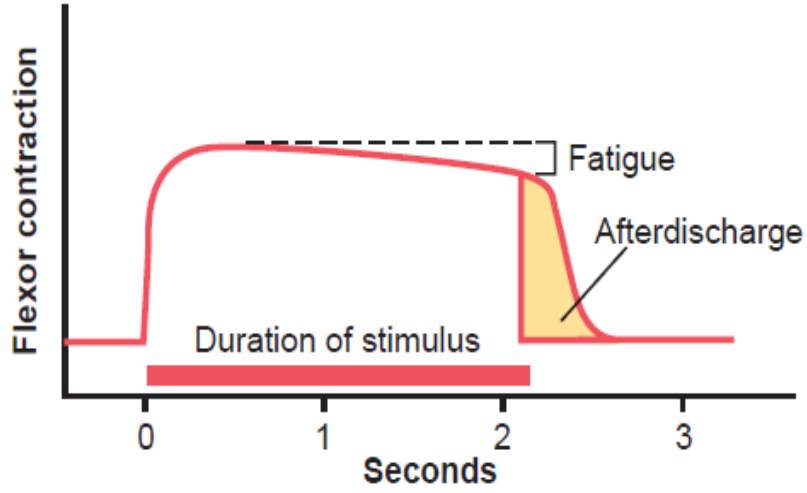


Figure 55-10. Myogram of the flexor reflex showing rapid onset of the reflex, an interval of fatigue, and, finally, afterdischarge after the input stimulus is over.

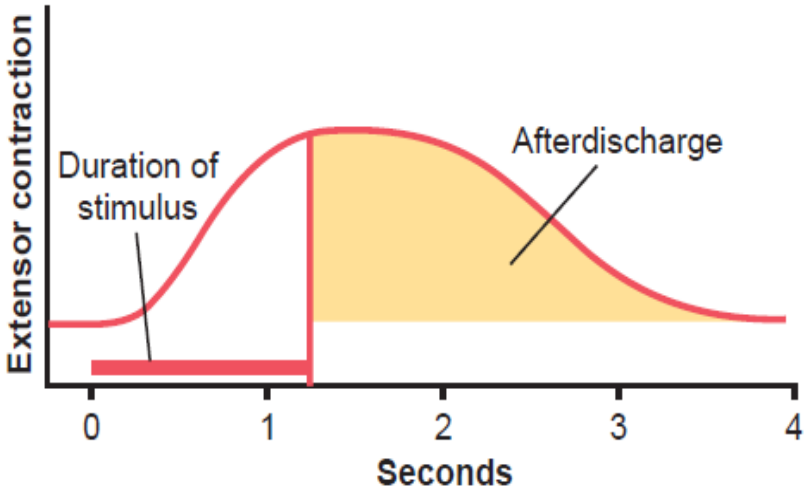
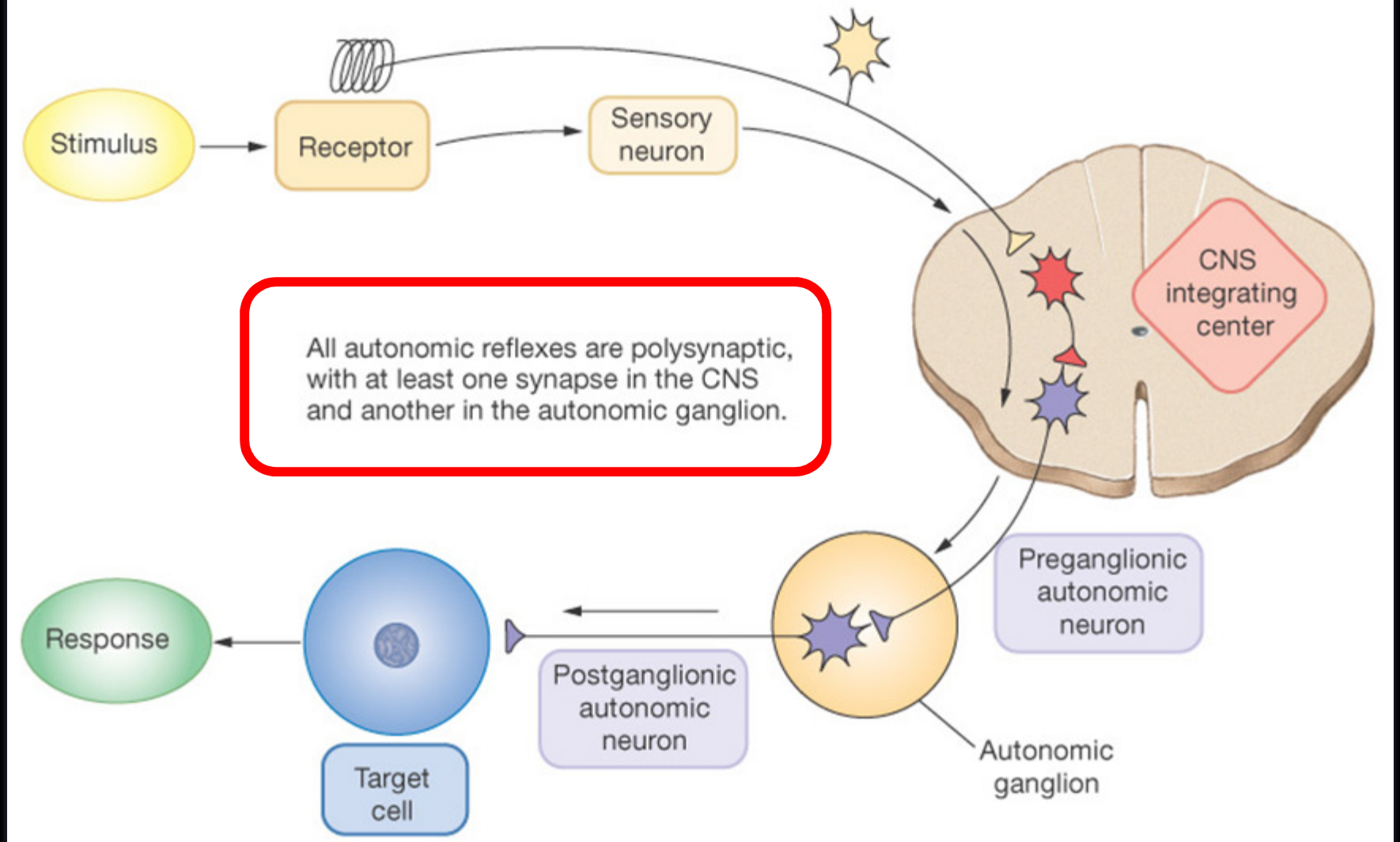


Figure 55-11. Myogram of a crossed extensor reflex showing slow onset but prolonged afterdischarge.


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

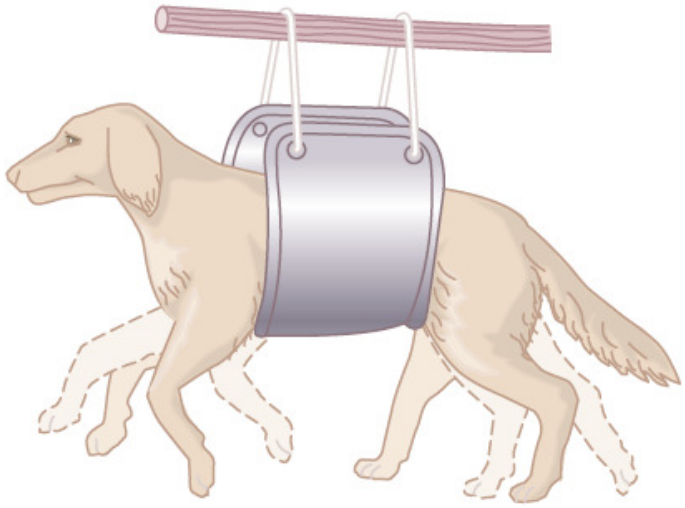


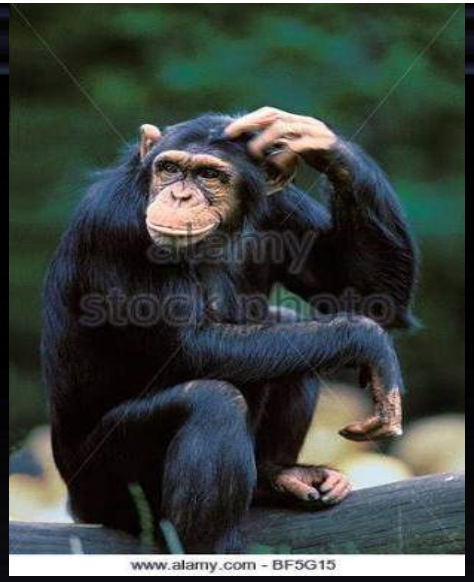
Figure 54–12

Diagonal stepping movements exhibited by a spinal animal.

Scratch Reflex

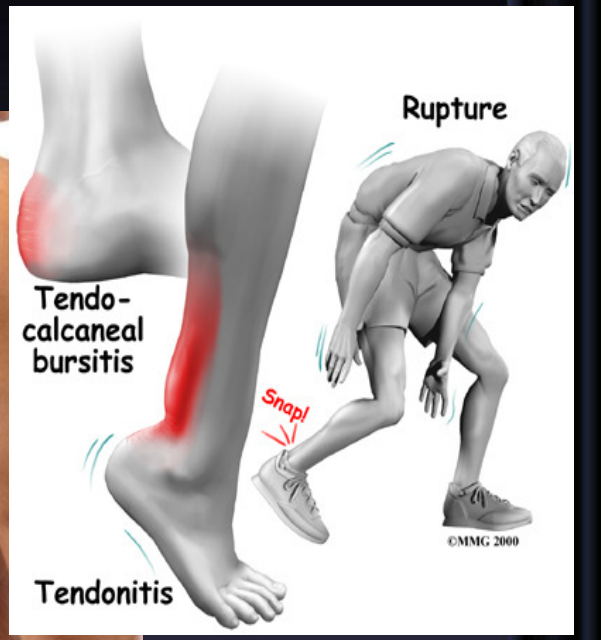
(1) Position sense that allows the paw to find the exact point of irritation on the surface of the body and

(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.



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

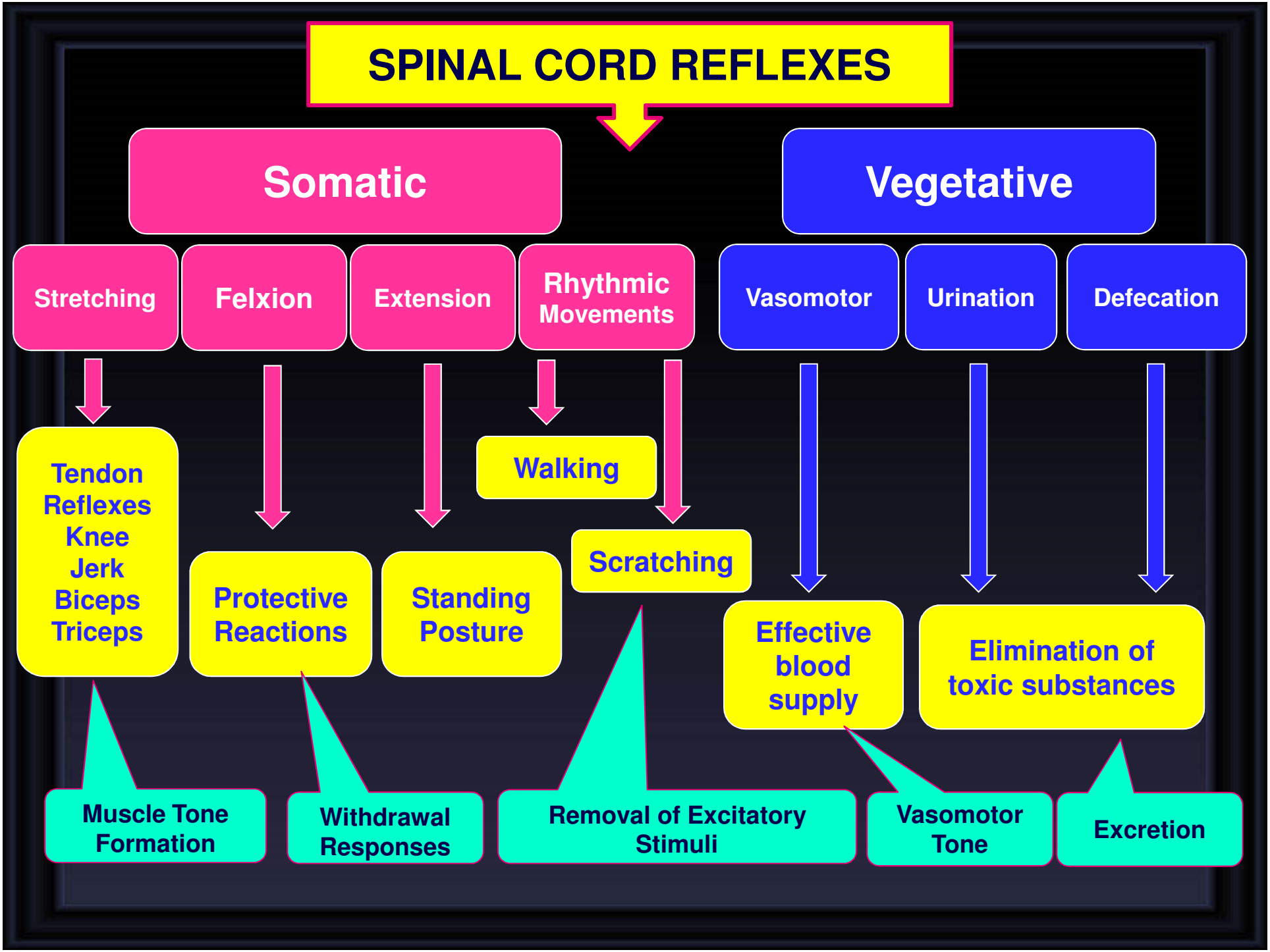
(3) intestinointestinal reflexes that control some motor functions of the gut

(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


SPINAL CORD REFLEXES
Somatic
Vegetative
Stretching
Felxion
Extension
Rhythmic Movements
Vasomotor
Urination
Defecation
Tendon Reflexes Knee Jerk Biceps Triceps
Protective Reactions
Standing Posture
Walking
Scratching
Effective blood supply
Elimination of toxic substances
Muscle Tone Formation
Withdrawal Responses
Removal of Excitatory Stimuli
Vasomotor Tone
Excretion