

REFLEX

Dr.Yashoda.K.

Dept. of Physiology

Competency

PY. 10.2 Functions and properties of reflex

SLO:

- **Define reflex, reflex arc**
- **Describe components of reflex arc**
- **Describe Classification of reflexes**
- **Describe monosynaptic reflex - stretch reflex and Inverse stretch reflex**
- **Describe polysynaptic reflex – withdrawal reflex & cross extensor reflex**
- **Enumerate properties of reflex**

INTRODUCTION

REFLEX—an involuntary response to a threshold stimulus obtained by stimulating a sensory receptor

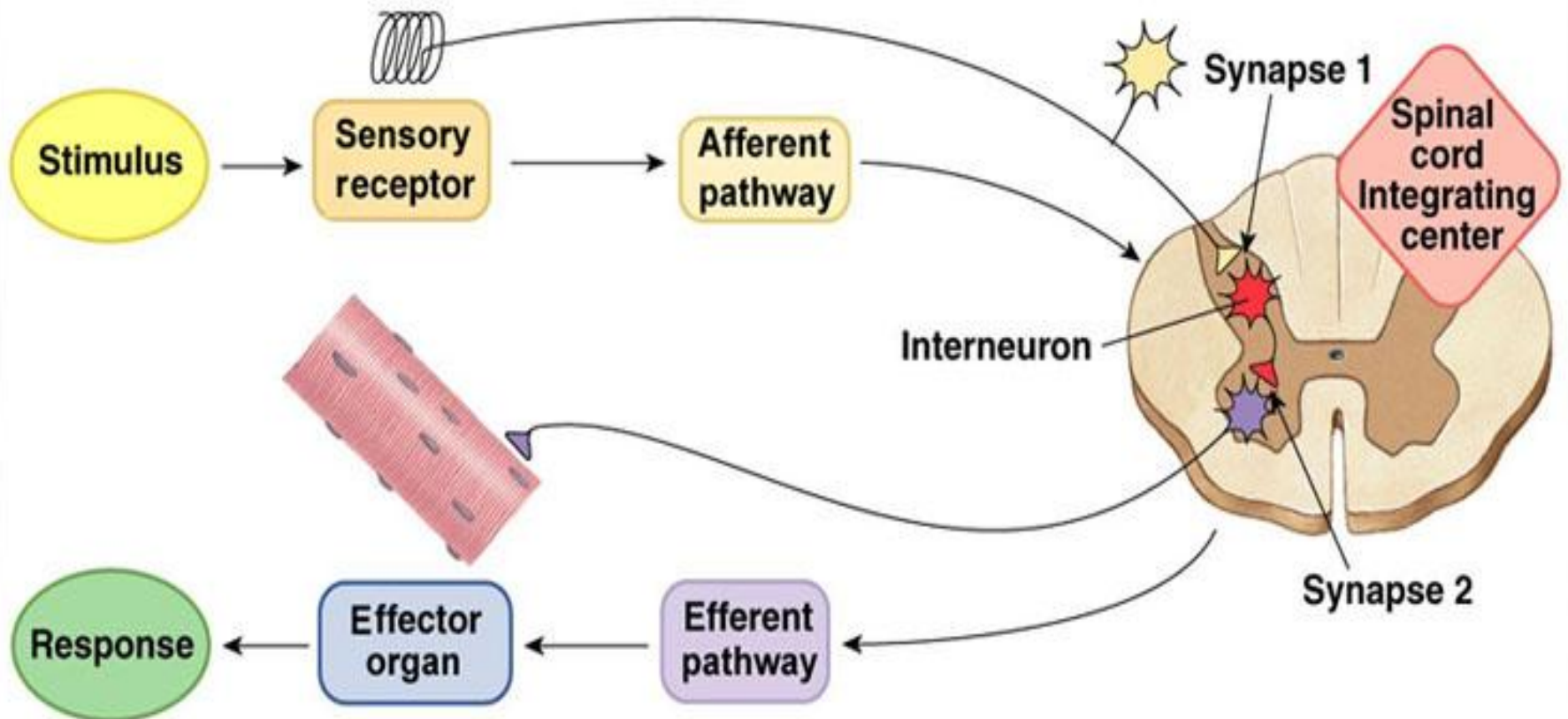
The **reflex arc** is the basic unit of integrated neural activity.

The arc consist of

- sense organ(receptor)
- an afferent path
- one or more synapses in a central
integrating station
- an efferent path
- the effectors

Reflex arc

(b) Polysynaptic reflexes have two or more synapses.



CLASSIFICATION

Reflexes can be classified in different ways

I. Clinical classification

1. Superficial reflexes– e.g. : abdominal reflex planter reflex
2. Deep reflexes -- e.g. : knee jerk, ankle jerk
3. Visceral reflexes-- e.g. :mituration reflex, baroreceptor reflex
4. Pathological reflexes-e.g. :babinski sign, clonus, pendular reflex

Superficial reflexes

Plantar Reflex: Babinski Response



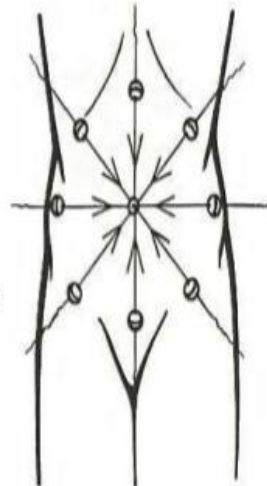
- Stroke lateral aspect of sole of foot
- NORMAL response → plantar FLEXION
- BABINSKI response → pathological in adult
 - POSITIVE BABINSKI: Dorsiflexion of great toe with fanning of other toes
 - Indicates upper motor neuron disease

B. Abdominal reflexes

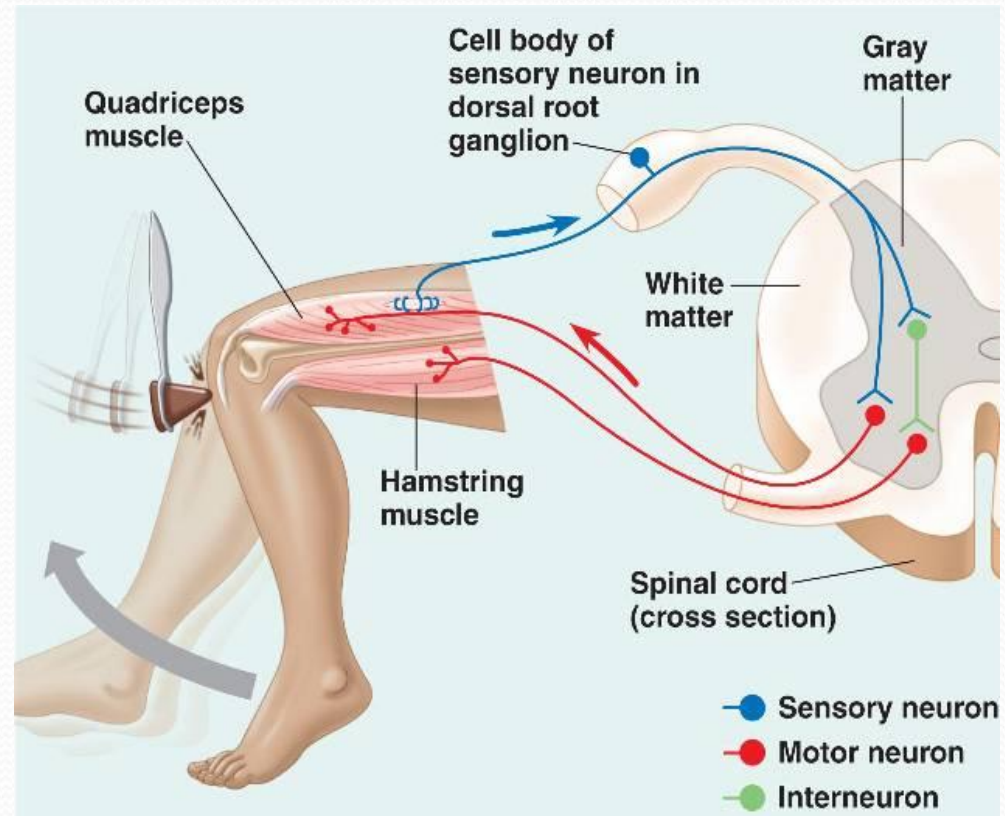
The patient should be supine and relaxed.

Use an orange stick and stroke briskly but lightly in a medial direction across the upper and lower quadrant of the abdomen.

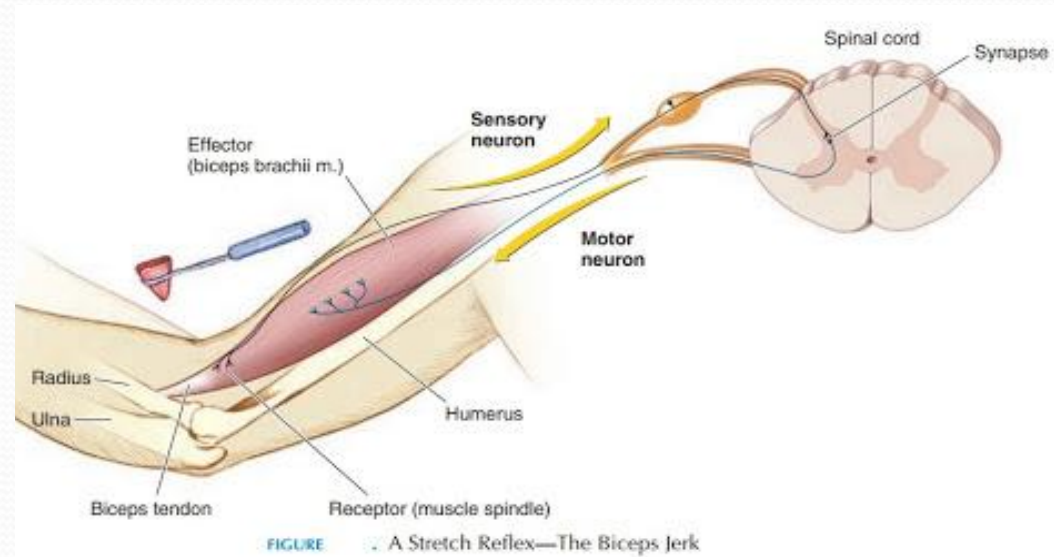
The normal responses is contraction of the underlying muscle with the umbilicus moving laterally and up or down depending upon the quadrant tested.



Deep reflexes -- knee jerk



Deep reflexes -- Biceps jerk



II. Anatomical classification

based on the region of spinal cord involved

- 1. *Segmental reflex*** : the reflex arc passes through only one segment of spinal cord
e.g. knee jerk
- 2. *Intersegmental reflex*** : the reflex involves more than one segment of spinal
e.g. withdrawal reflex
- 3. *Suprasegmental reflex*** : these reflexes involves nuclei above the cord and neurons of the segments of spinal cord itself
e.g. postural reflexes, righting reflexes

III. Based on no. of synapses

Reflex	No. of synapses	Examples
Asynaptic reflex	Nil	Axon reflex
Monosynaptic reflex	One	Stretch reflex (deep tendon reflex)
Bisynaptic reflex	Two	Reciprocal innervation Inverse stretch reflex
Polysynaptic reflex	More than two	Withdrawal reflex Cross extensor reflex Superficial reflex

IV. According to development

- a) unconditional reflex : inborn or inherent reflex
- b) conditional reflex : acquired reflex (after learning)

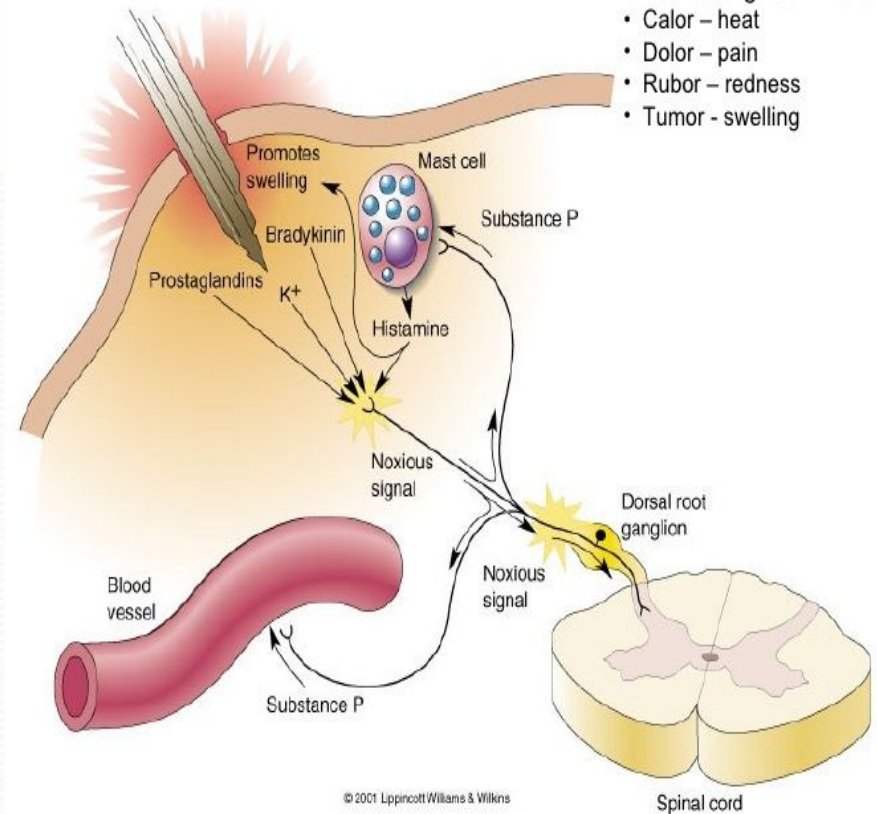
TRIPLE RESPONSE

- When skin stroke more firmly with pointed objects
- 3 vascular response occurs
- **Red reaction**
- **Flare**
- **Wheal**



Axon reflex

Local chemical mediators of pain and hyperalgesia.



Monosynaptic reflex

Stretch reflex -best known ,studied monosynaptic reflex in the body.

When a skeletal muscle with intact nerve supply is stretched ,it contracts. This is known as stretch reflex.

Components of reflex arc are

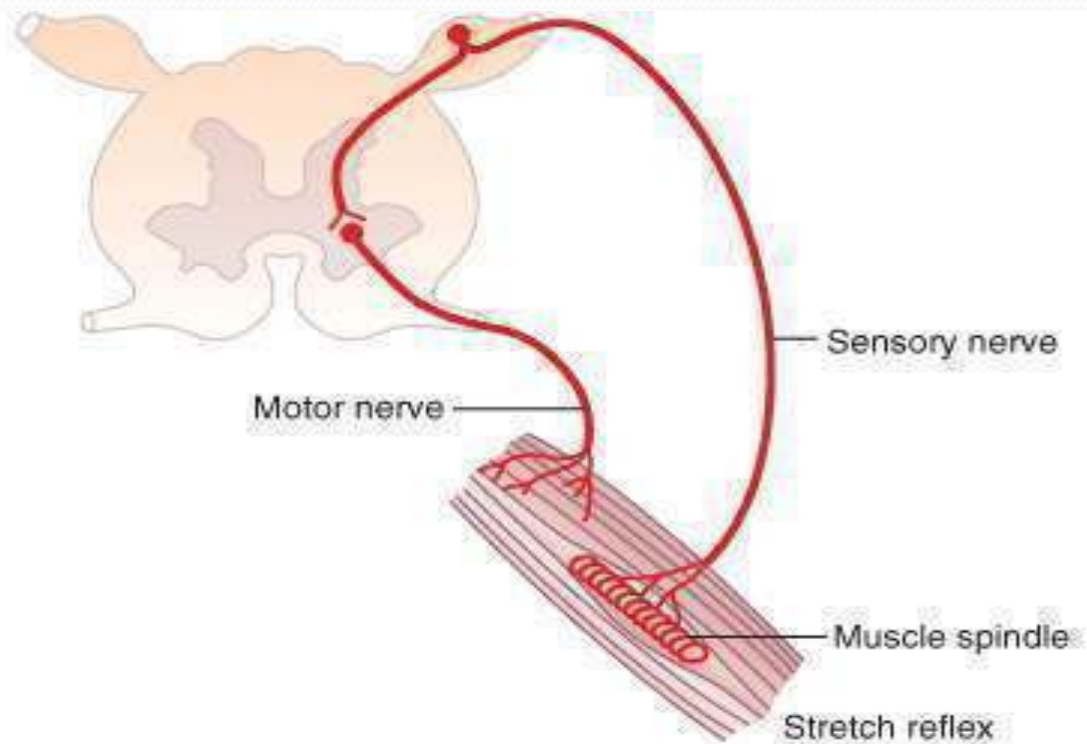
Sense organ-*muscle spindle (proprioceptor)*

Afferent - *primary & secondary endings*

Centre - *spinal motor neuron*

Efferent -*motor fiber supplying same muscle*

Neuronal circuit of the stretch reflex.

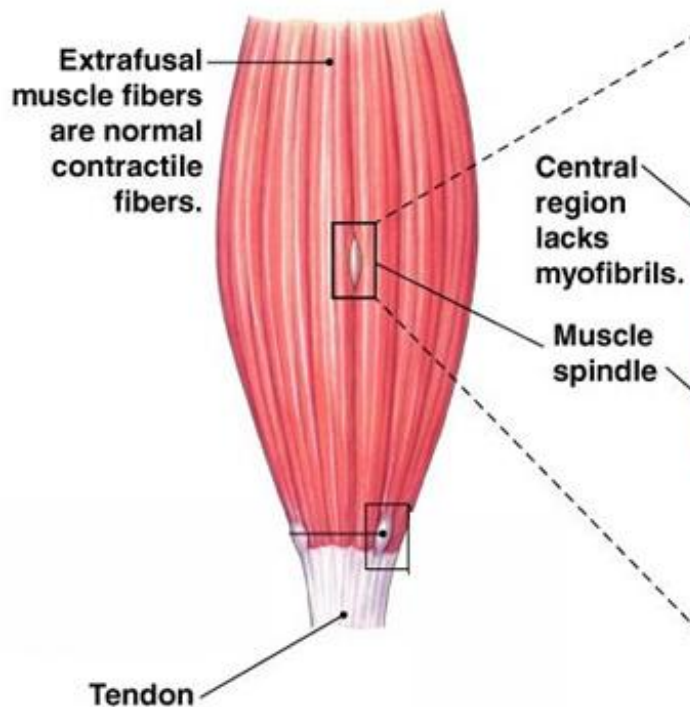


Muscle spindle

- Sensory receptor-proprioceptor
- Present throughout the belly of the muscle
- Operate at subconscious level
- Send information about muscle length or rate of change of length
- Send information to spinal cord ,cerebellum ,even cerebral cortex

Muscle spindle

(a) Muscle spindles are buried among the extrafusal fibers of the muscle.



(b) Muscle spindle sends information about muscle stretch to the CNS.

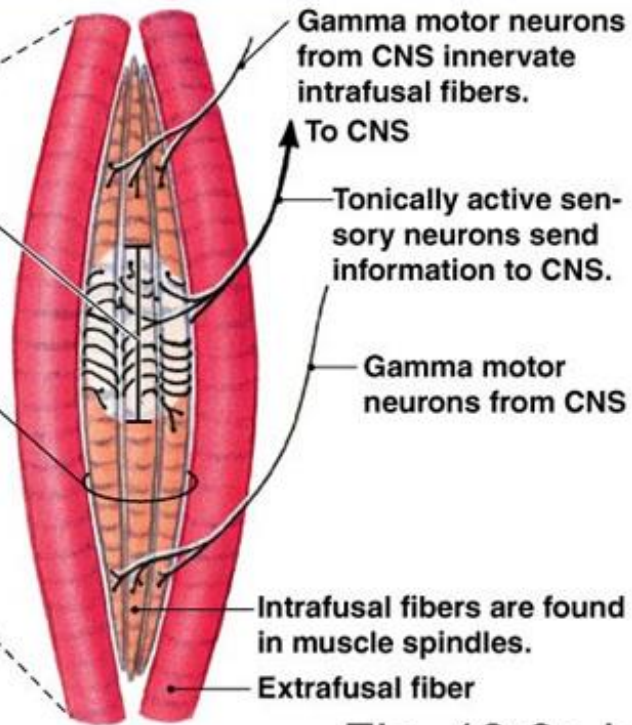
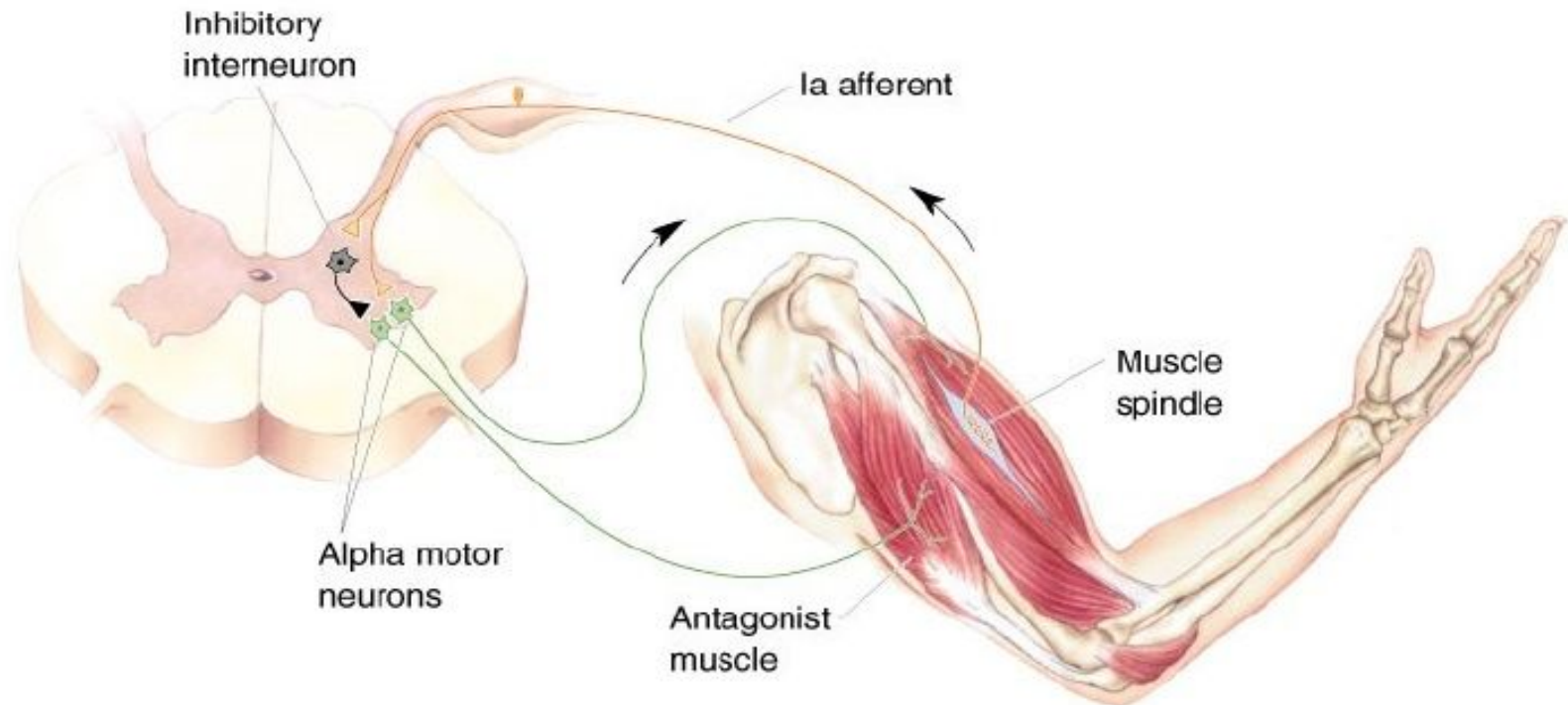


Fig. 13-3a,b

Reciprocal innervation and Reciprocal inhibition

- When the stretch reflex occurs, the muscles that antagonize the action of involved muscles are relaxed. This phenomenon is called **“reciprocal inhibition”**.
- Impulses in group Ia fibers from muscle spindle of protagonist muscle cause inhibition of motor neuron to antagonists.
- A collateral from each Ia fiber passes to spinal cord to an inhibitory inter neuron (Golgi bottle neuron) that synapse directly on the motor neuron supplying antagonist muscle. this is known as **“reciprocal innervation”**.

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

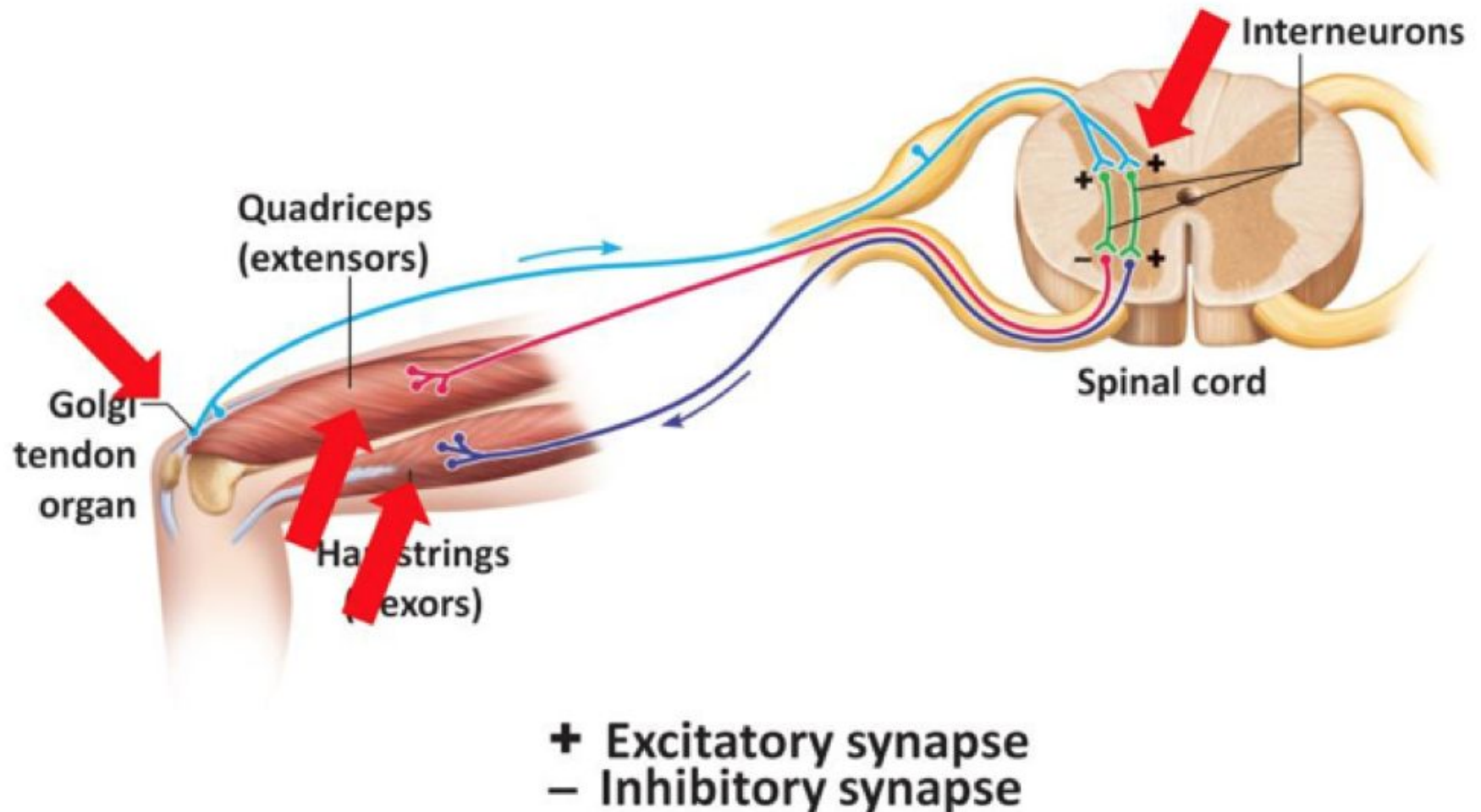


Reciprocal inhibition is required with the monosynaptic reflex

Inverse stretch reflex or Golgi tendon reflex

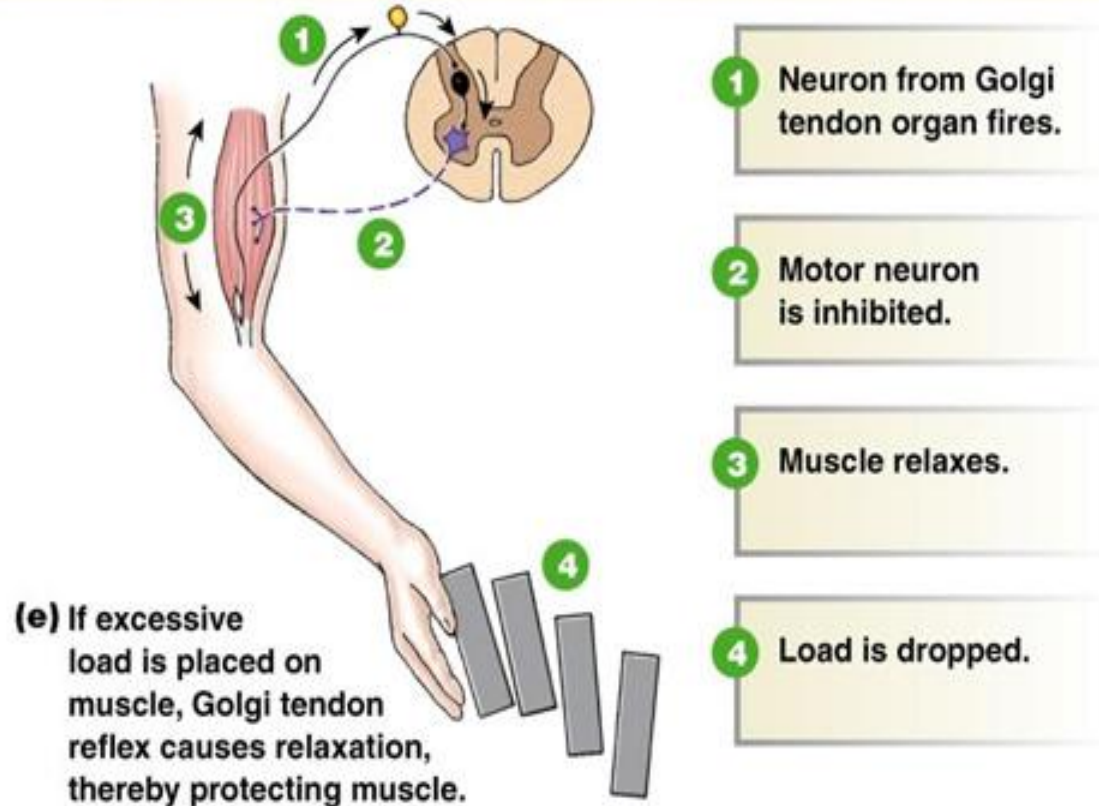
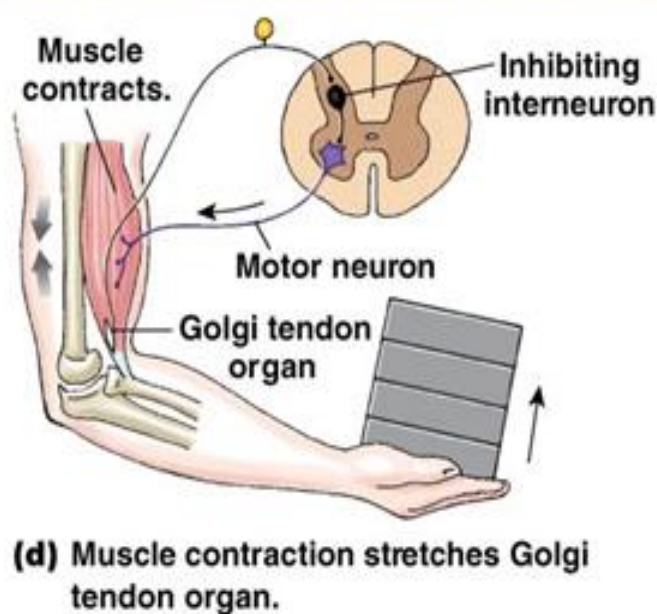
- Up to a point ,harder the muscle is stretched ,stronger is the reflex contraction. But when tension in the muscle become great enough ,contraction suddenly ceases and muscle relaxes. This relaxation of the muscle in response to strong stretch is called as “inverse stretch reflex”.
- **Stimulus**-tension in tendon
- **Receptor**-golgi tendon organ
- **Afferents**-gp Ib fibers
- **Center**-spinal cord ,(inhibitory inter neuron and alpha motor neuron)
- **Efferents**-motor fibers supplying the same muscle.

Golgi tendon reflex opposes contraction



Inverse stretch reflex

Golgi tendon reflex protects the muscle from excessively heavy loads by causing the muscle to relax and drop the load.



Importance

- The reflex is entirely inhibitory , provides negative feedback mechanism that prevents the development of too much tension on the muscle.
- This reflex has protective mechanism to prevent tearing of muscle or avulsion of tendon from its attachment to the bone,
- However , the functions of this reflex actually complements that of stretch reflex.

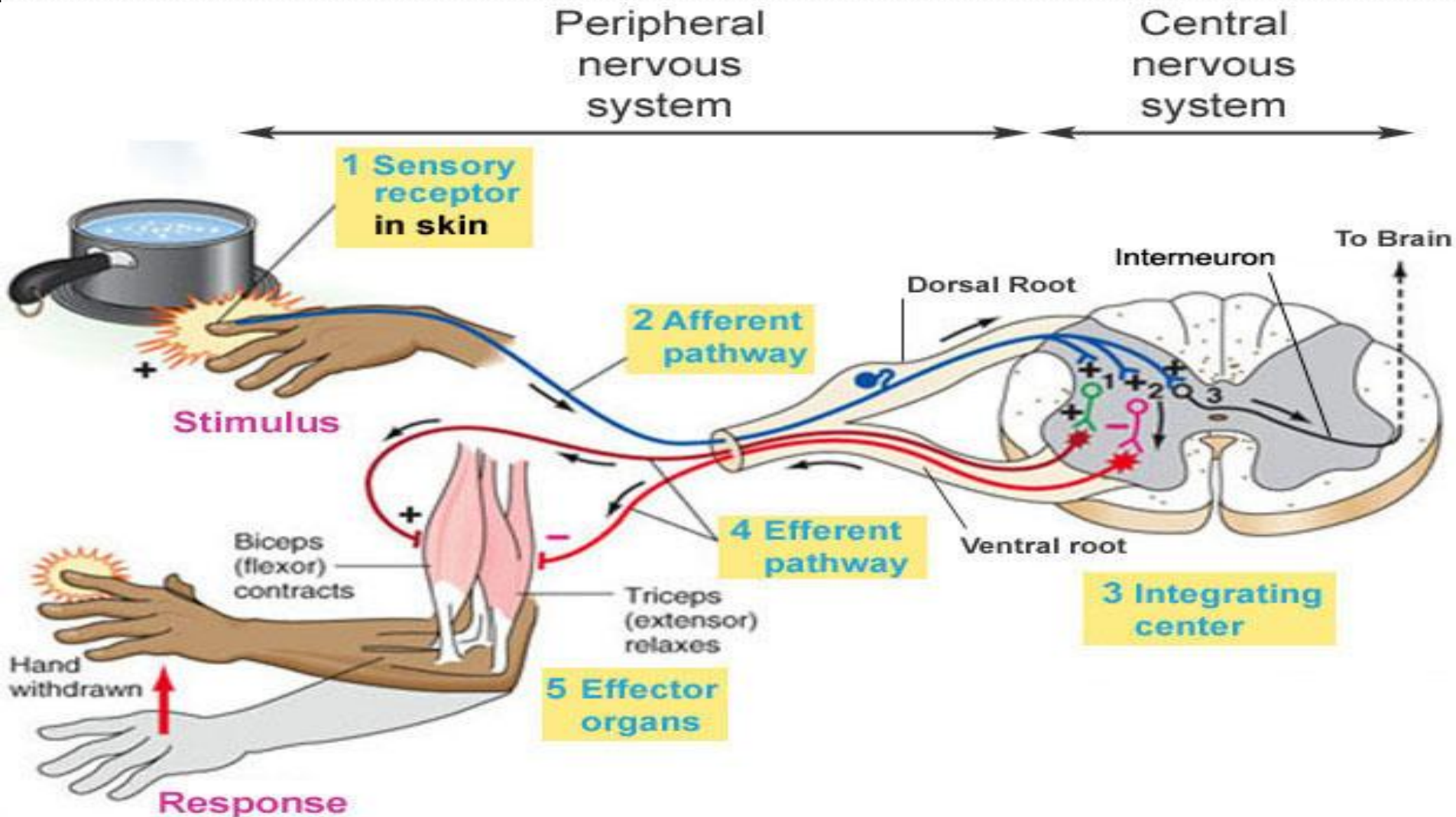
Polysynaptic reflexes

Withdrawal reflex

- The withdrawal reflex is a typical polysynaptic reflex that occurs in response to a noxious and painful stimulus to the skin or subcutaneous tissues and muscle.
- In this, there is a flexor muscle contraction and extensor muscle inhibition in response to a painful stimuli ,thereby withdrawing the limb from the stimulus.
- This is know as “*flexor reflex*” .

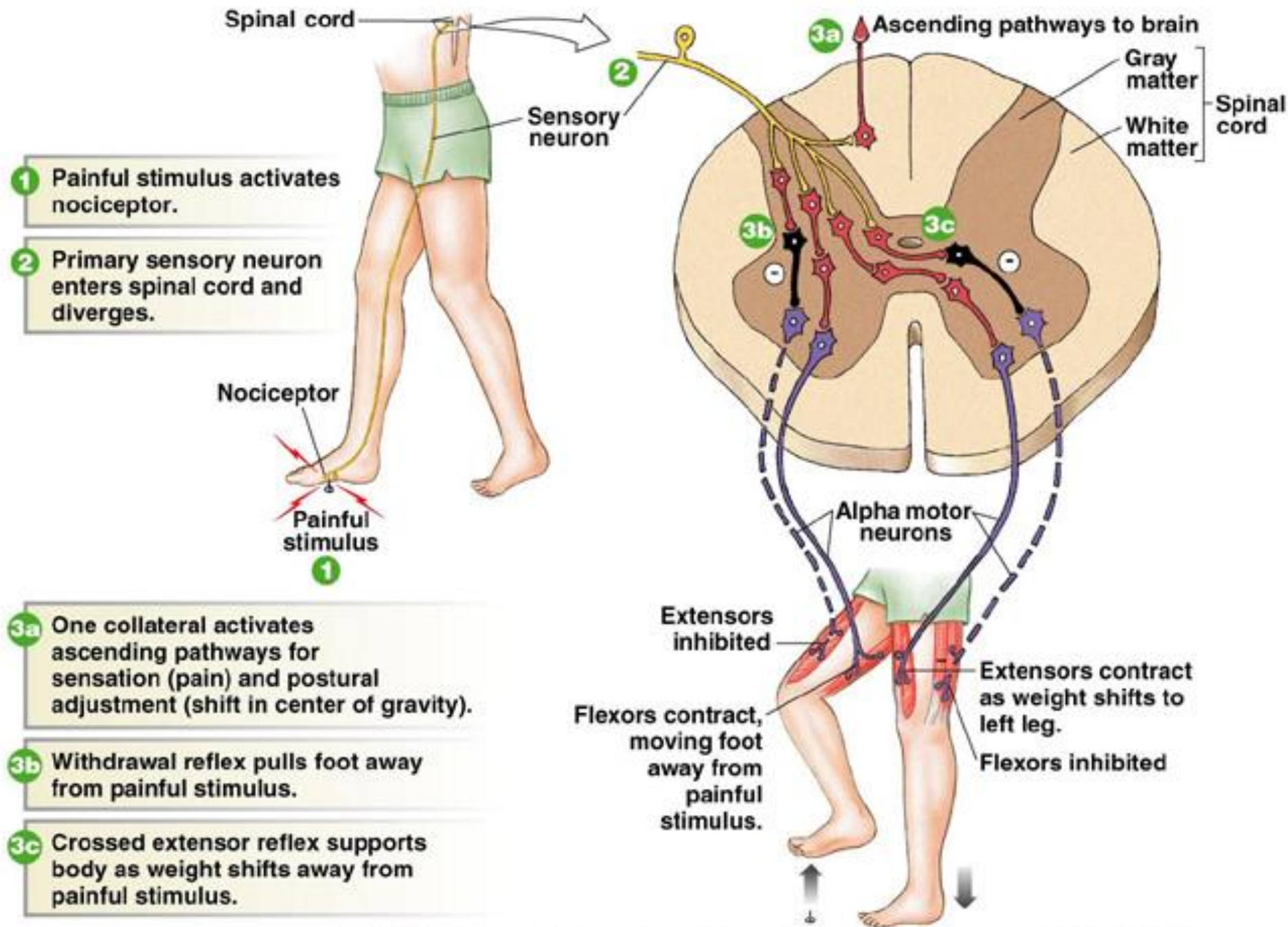
- The flexor reflex is produced by stimulation of skin or by stretch of muscle .but strong flexor reflex along with withdrawal of limb is produced only by stimuli that is noxious or potentially harmful to the animal.
- Such stimuli are called as “*nociceptive stimuli.*”
- Reflex is called as “*nociceptive reflex.*”

Withdrawal reflex



Crossed extensor reflex

- When the stimulus is strong enough, the response includes not only flexion and withdrawal of that limb but also extension of opposite limb. This is known as “***crossed extensor reflex***”.
- Extension of opposite limb obviously pushes the entire body away from the object causing the painful stimulus.



Properties of Reflex

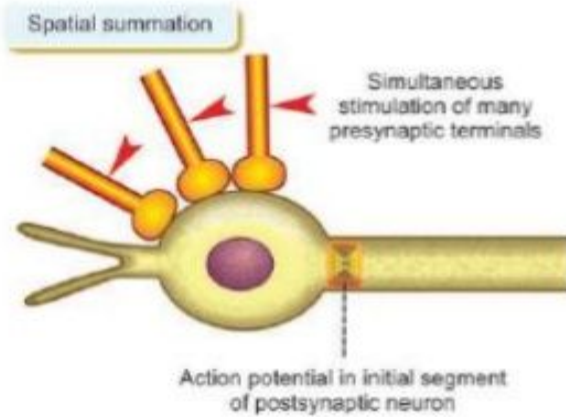
Reaction time: The time between the application of stimulus and the response is known as “*reaction time*”

Central delay: If the conduction velocities of afferent and efferent fibers are known and the distance from the muscle to the spinal cord is measured, it is possible to calculate how much of reaction time is taken up by conduction to and from the spinal cord. When this value is subtracted from the reaction time, the remainder is called “*central delay*.” it is time taken for the reflex activity to traverse the spinal cord.

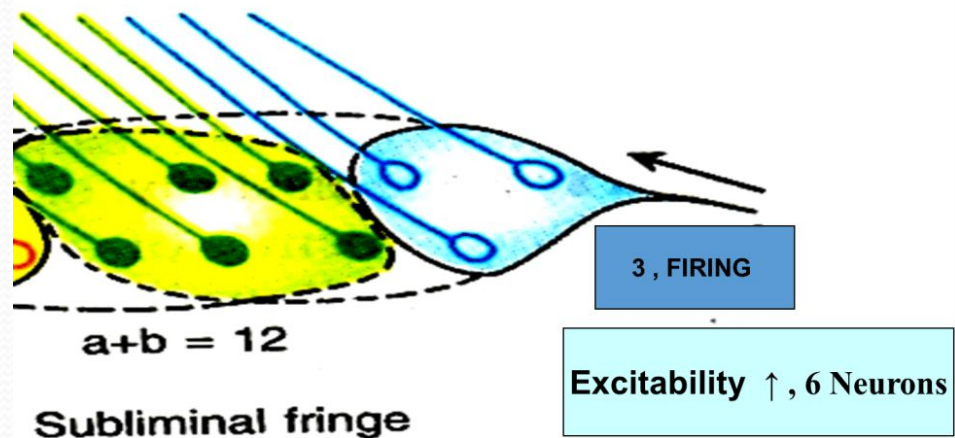
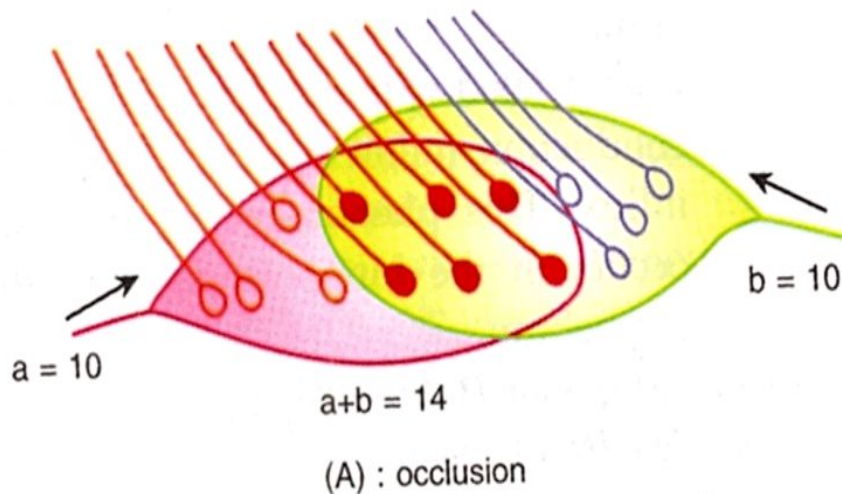
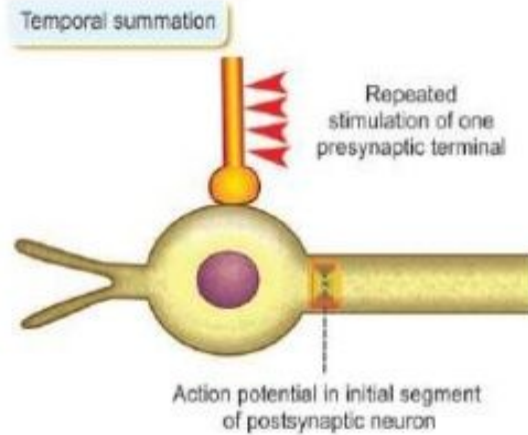
properties includes-

- Summation
- Occlusion
- Subliminal fringe
- Facilitation
- Inhibition
- Irradiation
- After-discharge
- Habituation and Sensitization

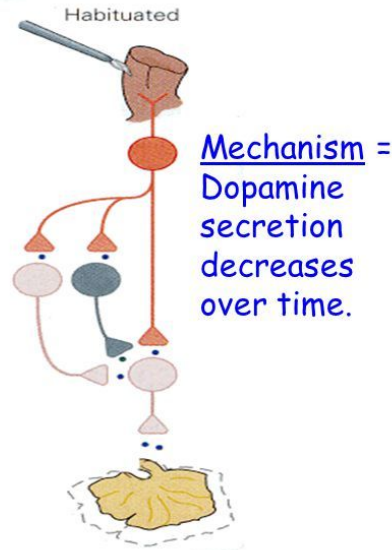
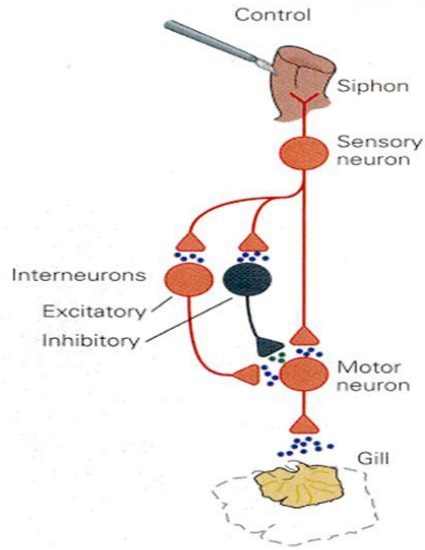
► SPATIAL SUMMATION



► TEMPORAL SUMMATION



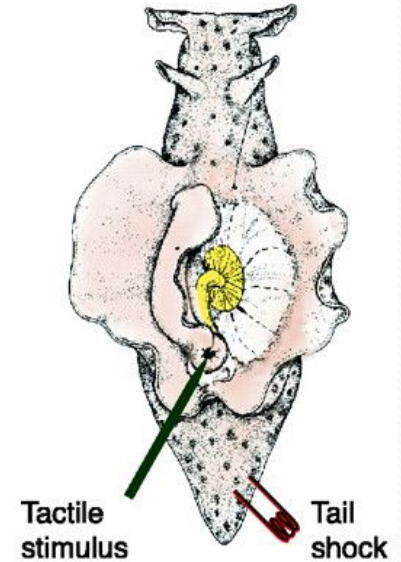
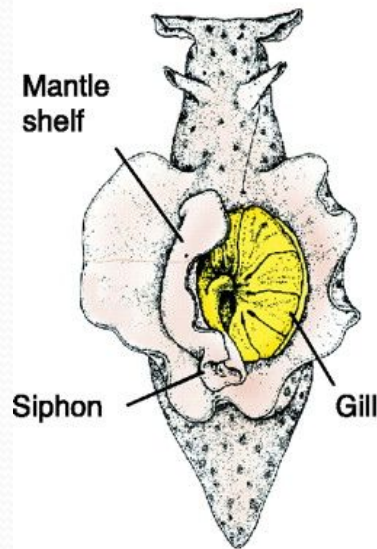
habituation in *Aplysia californica*, the sea slug



A

Gill Withdrawal Reflex

Sensitization



IRRADIATION

- Application of strong noxious stimulus to a limb, complex set of reflex responses including withdrawal of that limb, e.g., extension of opposite limb.
- Irradiation of impulses to contralateral neuronal pool (have long latency)

RECRUITMENT :

- ↑↑↑ muscle tension on continued stimulation, due to recruitment of more neurons

AFTER DISCHARGE :

- Persistence for a while & gradual decline in muscle tension even after cessation of stimulation
- Cause: Persistent interneuronal activity in a polysynaptic reflex arc

Note: Recruitment gives inertia & 'after discharge' provides momentum to reflex movements resulting in their smoother onset & termination

CLINICAL SIGNIFICANCE OF REFLEXES

- Muscle tone:
 - Resistance offered by the resting skeletal muscle to its passive movement
 - Tonic components contributes to muscle tone
 - Hypertonia: Spasticity, resistance offered is high
 - ❖ High motor discharge in the arc due to interruption of descending pathways
 - Hypotonia: Flaccidity, low resistance offered
 - ❖ When the reflex arc is interrupted

CLINICAL SIGNIFICANCE OF REFLEXES (2)

● Tendon Jerks

- Stretch reflex. Sharp tap on tendon by patellar hammer
- Contraction of muscle tapped
- Integrity of stretch reflex at particular spinal level is tested
- Alter reflexes by:
 - ❖ Decreased or hypoactive reflex or total absence
 - ❖ Increased or hyperactive reflex
 - ❖ Change in the pattern
- Anxiety and emotional stress exhibit hyperactivity
- Slackness in muscles and tendons exhibit hypoactive reflexes
- Jendrassik maneuver help clarify spurious results

CLINICAL SIGNIFICANCE OF REFLEXES (3)

Hyporeflexia

- Defect in reflex arc:
 - Afferent damage (Tabes dorsalis).
 - Efferent damage (LMN disease in poliomyelitis)
 - Damage to centre as in myelitis
 - Damage to effectors as in myasthenia gravis
- Old age/sleep.
- Endocrine deficiencies like myxoedema.
- Facilitatory inputs lack from higher centers, spinal shock, diseases of cerebrum or cerebellum

Hyperreflexia

- Temporary phenomenon as in:
 - Physiological causes like anxiety, nervousness
 - Irritative/inflammatory lesions involving the segmental reflex arc
- Persistent hyperreflexia :
 - Thyrotoxicosis
 - Upper motor neuron (UMN) diseases

CLINICAL SIGNIFICANCE OF REFLEXES (4)

Clonus:

- Abnormal clinical sign
- Some UMN disease
- Cyclical repetition of reflex action-oscillatory motion of foot

Spinal Shock:

- Complete or partial transection, e.g., automobile accidents, gunshot wounds and transverse myelitis
- Immediate loss of voluntary and reflex movements caudal to the level of injury
- Atonic muscles
- Bladder and rectum control lost.
- Fall in blood pressure
- Known as '**stage of spinal shock**'
- Cause: Transient reduction in excitability of spinal motoneurons
- Loss of supraspinal control
- Lasts days to months, depending on the severity of injury
- Recovery of muscle tone, visceral and flexor reflexes
- Paraplegia in flexion
- Mass reflexes are seen

Deep tendon reflexes

<https://www.youtube.com/watch?v=cC7uDy2DnQw>

Abdomen reflex

<https://www.youtube.com/watch?v=v4FyZydgHs0>

Plantar reflex/ Babinski sign

<https://www.youtube.com/watch?v=HnX4bH1WRHQ>