
بسم الله الرحمن الرحيم

PHYSIOLOGY OF POSTURAL REFLEXES

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OBJECTIVES

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

- Describe the importance of postural reflexes and their types
- Identify the role of different brain areas in control of postural reflexes
- Describe the components of various postural reflexes
- Differentiate between decerebrate, decorticate and spinal animals/lesions.

WHAT IS POSTURE?

- Posture is the **attitude taken by the body in any particular situation** like standing posture, sitting posture, etc. even during movement, there is a continuously changing posture

- The basis of posture is the **ability to keep certain group of muscles in sustained contraction for long periods**. Variation in the degree of contraction and tone in different groups of muscle decides the posture of the individual.

MECHANISM

- Posture-maintaining muscles contain more of **red muscle fibres**, which are slowly contracting and not easily fatigued. All muscles in the body are a mixture of red and pale(white) muscles. Muscles of hand, eye etc., has a preponderance of white muscle fibres which are easily fatigued.
- Only a fraction of the muscle fibres are active at any given time due to **asynchronous contraction.**

Significance of Postural Reflexes

- Postural reflexes help to maintain the body in upright and balanced position
- They also provide adjustments necessary to maintain a stable posture during voluntary activity

The deficits in motor control seen after various lesions mimic those seen in humans with damage in the same structures.

Reflex Arc Of Postural Reflexes

- Afferent Pathway- comes from the eyes, the vestibular apparatus and the proprioceptors
- Integrating Centres- are formed by neuronal network in the brain stem and spinal cord
- Efferent Pathway- α-motor neurons supplying the various skeletal muscles i.e. the effector organ

Types Of Postural Reflexes

Postural reflexes are of two types-

(A) Static Reflexes

(B) Statokinetic Reflexes

Static reflexes are involved in adjustments to displacements produced by gravity

It is of three types-

(1) Local static reflexes
- (i) Stretch reflex
- (ii) Positive supporting reaction
- (iii) Negative supporting reaction

(2) Segmental static reflexes

(3) General static reflexes

Types Of Postural Reflexes

Static

- (1) Local
  - •Stretch reflex
  - •Positive supp r
  - •Negative supp r
- (2) Segmental
- (3) General
  - a) Attitudinal reflexes
    - 1) Tonic labyrinthine r
    - 2) Tonic neck r
  - b) Long loop stretch r
  - c) Righting reflexes
    1. Head or Labyrinthine
    2. Body
    3. Neck
    4. Limbs
    5. Optical

Statokinetic

1. Vestibular placing
2. Visual placing
3. Hopping

(1) Local static reflexes

- They exert their effect on the same limb from which the stimulus was initiated
- The centre of local static reflex are located in spinal cord
- Some important local static reflexes include:

i) Stretch reflex

ii) Positive supporting reaction

iii) Negative supporting reaction

i) Stretch reflex

- This is the most important local static reflex which controls the tone in those extensor muscles which keep the body upright (antigravity muscles)

ii) Positive supporting reaction

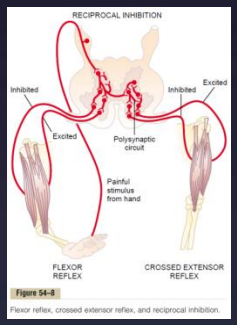
- It is characterized by simultaneous reflex contraction of both extensors and flexors of a limb
- Pressure on the footpad initiates a reflex that stiffens the limbs sufficiently to support the weight of the body. It plays an important role of steadying the ankle joint in standing position

iii) Negative supporting reaction

- It refers to disappearance of positive supporting reaction
- It is initiated by stretch of the extensor muscles

(2) Segmental static reflexes

- It is characterized by a **bilateral reflex response** when stimulus is applied to one limb
- The best example of segmental static reflex is **crossed extensor reflex** response component of withdrawal reflex
- The centre of this reflex is in spinal cord



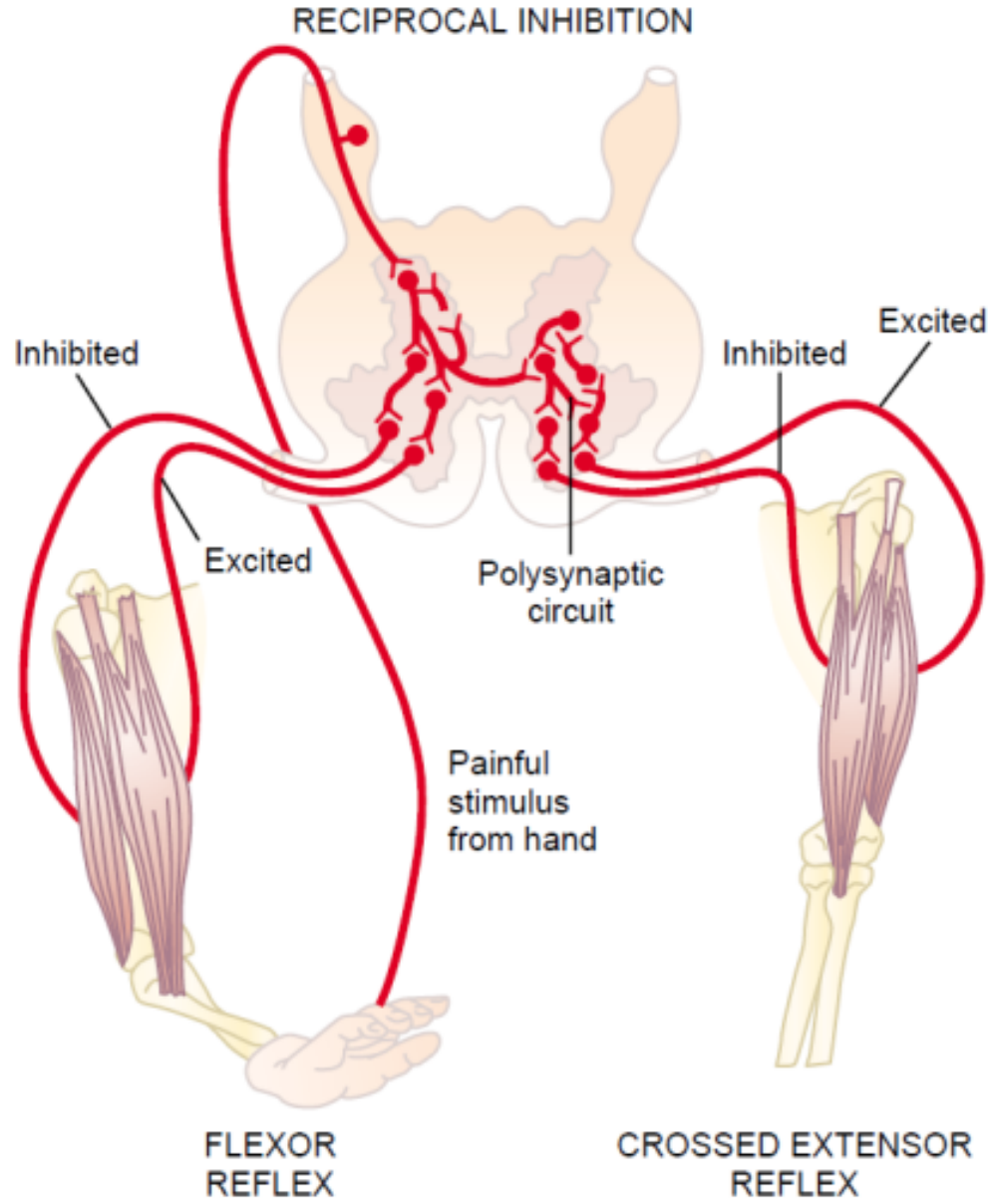
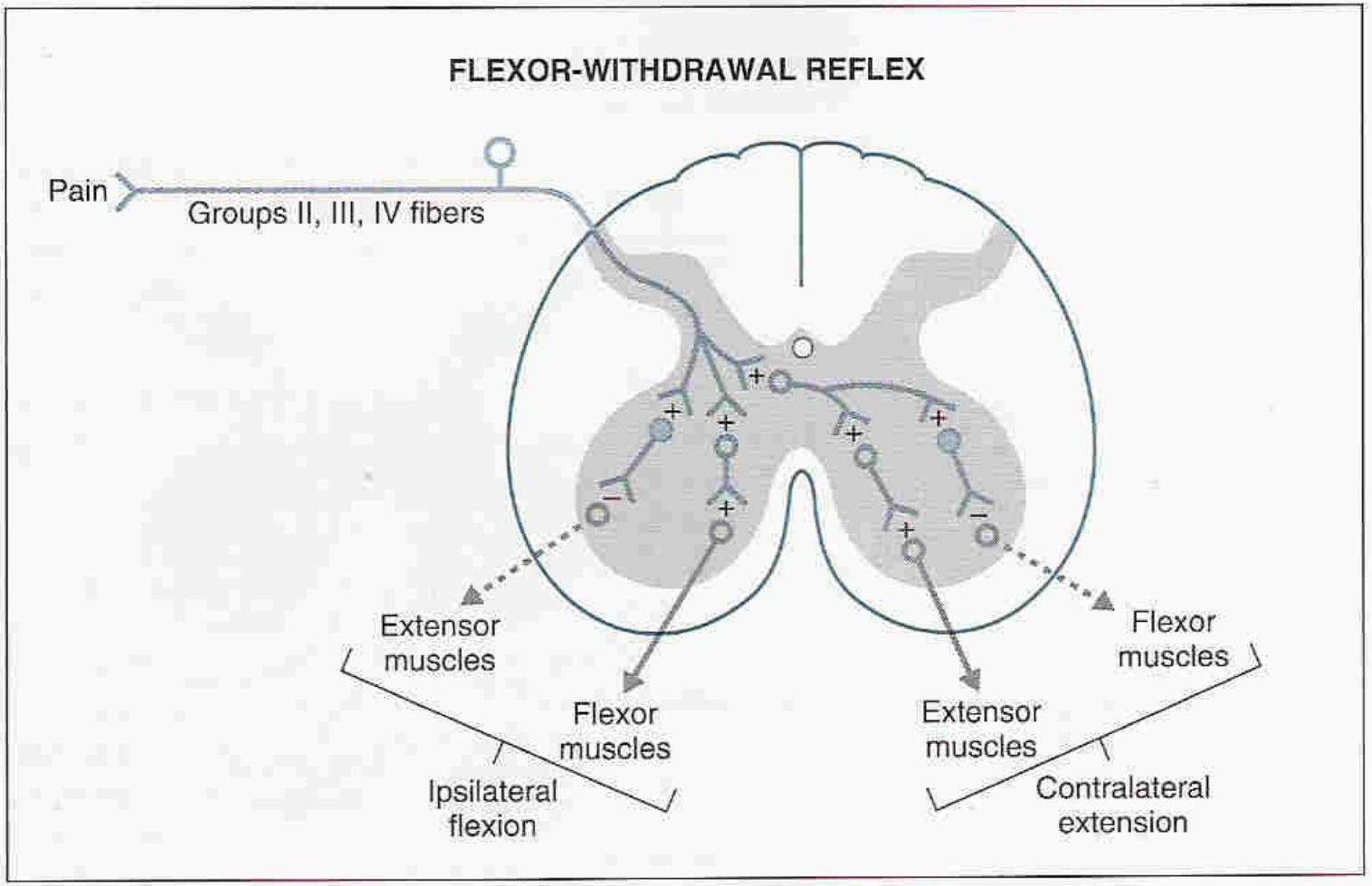


Figure 54–8

Flexor reflex, crossed extensor reflex, and reciprocal inhibition.



POLYSYNAPTIC REFLEX

(3) General static reflexes

- It is characterized by a generalized effect from many muscle groups in the body in response to a stimulus that arises at one side of the body

- General static reflexes can be divided into three groups:

a) Attitudinal reflexes

b) Long loop stretch reflexes

c) Righting reflexes

a) Attitudinal reflexes (Statotonic)

- These reflexes are initiated when the attitude of the body is changed i.e. while standing on an inclined plane

- These reflexes are of two types

1) Tonic labyrinthine reflex
2) Tonic neck reflex

1) Tonic labyrinthine reflex

- These reflexes are produced in response to alternation in position of head relative to horizontal plane e.g. while standing on an inclined plane

Pathway of reflex arc-

- Stimulus- is gravity
- Receptors- otolith organ (utricle and saccule of labyrinth)
- Afferents- from receptors travel along the vestibular nerve
- Centre- vestibular and reticular nuclei present in spinal cord
- Efferents- vestibulospinal and reticulospinal tracts which end on α-motor neurons of spinal cord
- Reflex response- contraction of extensor muscles of limb

2) Tonic neck reflex

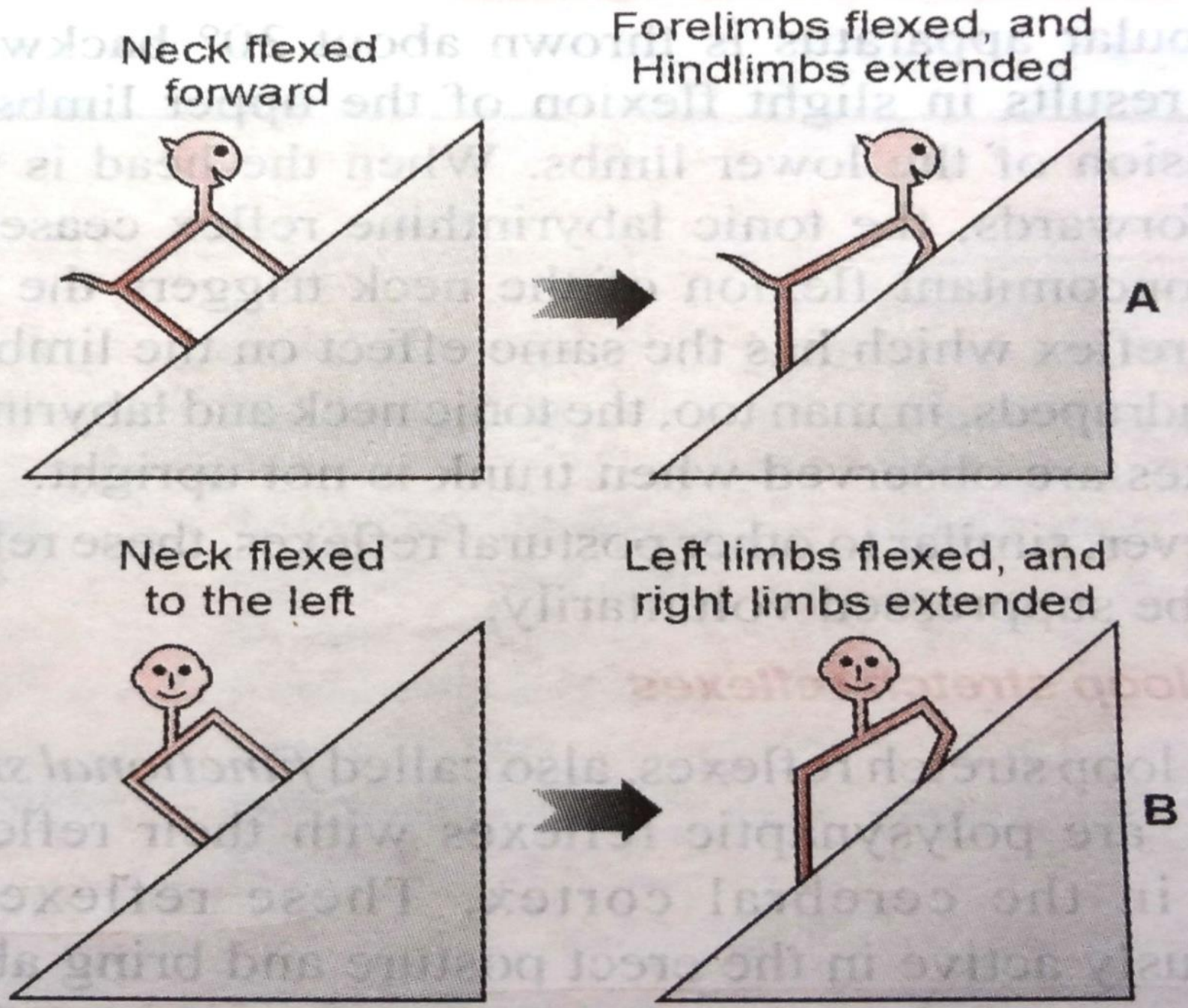
- **These reflexes are produced in response to alternation in the position of head relative to the body**

Pathway of reflex arc-

- Stimulus- stretch of neck muscles
- Receptors- Pacinian corpuscles in the ligaments of the cervical joint and muscle spindle of neck muscles
- Centre- in the medulla oblongata
- Efferent- corticospinal tracts

2) Tonic neck reflex Cont.

- **Reflex response- depends on the position of the head in relation to the body:**
- ***Turning down of head*** **causes flexion of the forelimb and extension of the hind limb**
- ***Turning up of head*** **causes reverse of the above**
- ***Turning the head sideways*** **produces flexion of the ipsilateral limbs and extension of contralateral limbs**


Neck flexed
forward
Forelimbs flexed, and
Hindlimbs extended
A
Neck flexed
to the left
Left limbs flexed, and
right limbs extended
B

b) Long loop stretch reflexes

- They are also called Functional stretch reflex
- These are polysynaptic reflexes with the centre of reflex arc in cerebral cortex
- These reflexes are continuously active in erect posture
- They bring about continuous correction of the sways that occur from moment to moment during standing

c) Righting reflexes

- Righting reflexes help to correct the position of the body when it goes off balance and falls down

- These reflexes consists of a chain of reactions following one another in an orderly sequence

- For example, if an animal is laid on it's side or back, head rights itself followed by body and animal finally resumes upright posture. The sequence of righting reflexes will be as follows :

1. Head righting reflex or Labyrinthine righting reflex

- It is initiated when animal's head is in lateral position
- Impulses arising from the saccules reflexly stimulate the appropriate muscles to bring head back to upright position

2. Body righting reflex

- When the animal lies on the ground, the side in contact with the ground is constantly stimulated while the other side is not
- This differential stimulation of the deep structures in the body wall reflexly rights the head

3. Neck righting reflex

- The head is righted by above two reflexes but the body still remains in lateral position
- This leads to twisting of neck and this brings thorax and lumbar region successively into upright posture
- If the righting of head is prevented , impulses from the body surface may cause righting of the body directly **(Body on body righting reflex)**

4. Limbs righting reflex

- Impulses arising from the limb muscles leads to attainment of appropriate posture of limbs.

5. Optical righting reflexes

- Optical impulses also cause righting of the head in animals with intact visual cortex

Centers Of Righting Reflexes

- Chief center for all righting reflexes, except the optical righting reflex is red nucleus lying in the mid brain

- The center for optical righting reflex is in the visual cortex

(B) Statokinetic Reflexes

•These reflexes, also called phasic reflexes, are elicited by acceleratory displacement of the body. They maintain a stable postural background for voluntary activity.

These include:

1. Vestibular placing reaction

- Stimulus- linear acceleration
- Receptors- in utricle and saccule
- Center- cerebral cortex
- Response- as soon as foot comes in contact of any firm surface, it is reflexly placed on surface in position to support the body

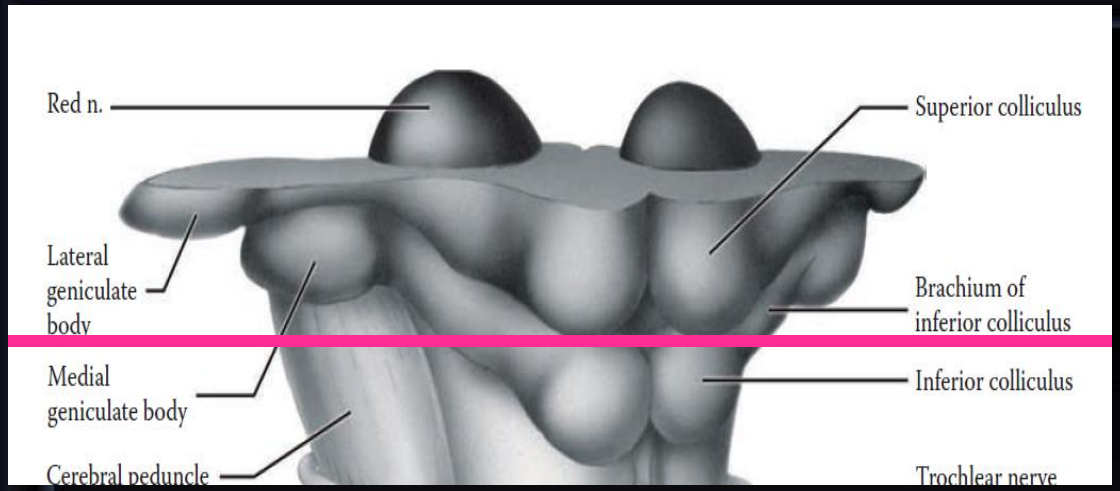
2. Visual placing reaction

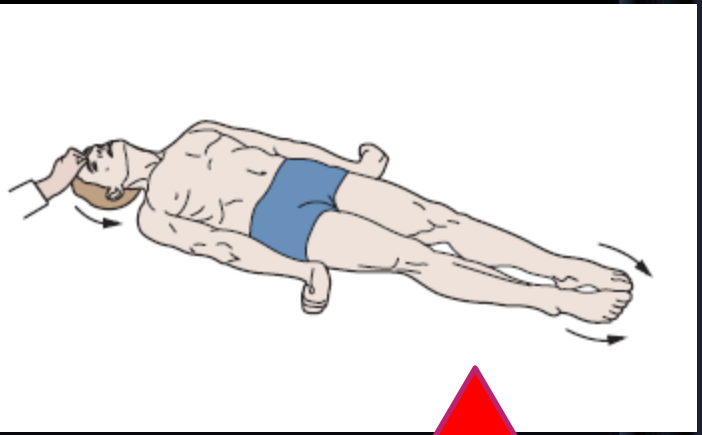
- Stimulus- visual cues
- Receptors- eyes
- Center- cerebral cortex
- Response – as in above

3. Hopping reaction

- Stimulus- lateral displacement while standing
- Receptors- muscle spindle
- Center- cerebral cortex
- Response- hopping movement that keeps the limb in position to support the body when standing animal is pushed laterally

Decerebrate posturing

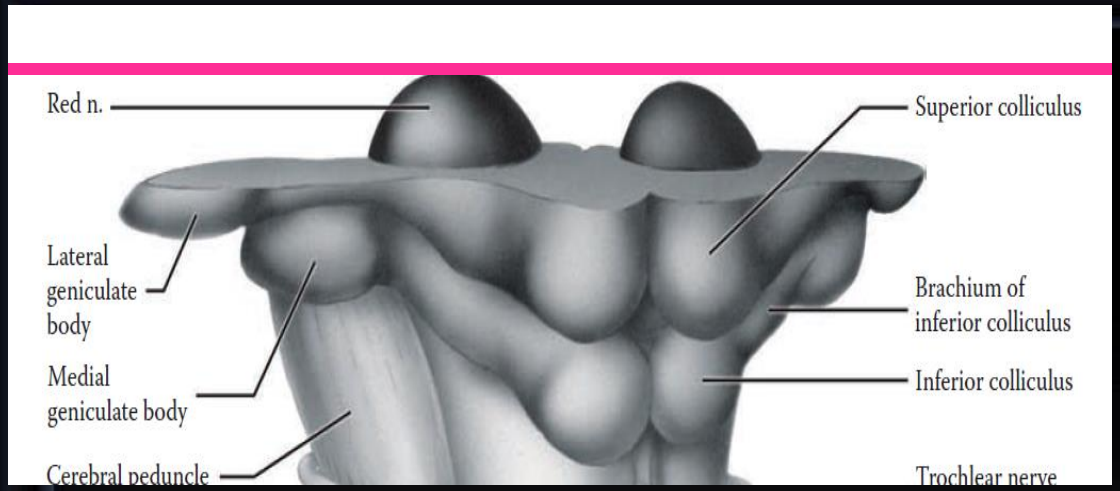




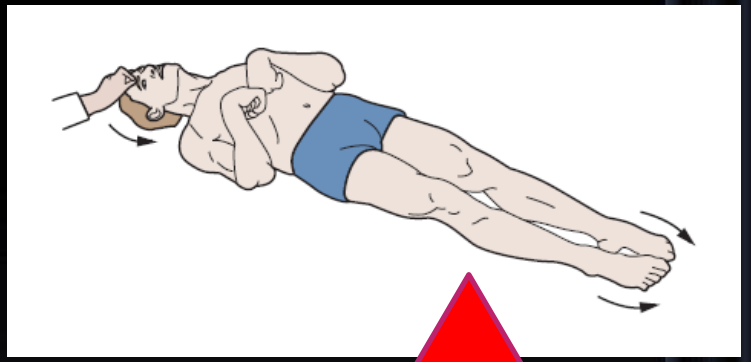
- midcollicular decerebration ➔decerebrate rigidity
- Clinical Example: Uncal herniation due to a supratentorial lesion (tumors, hemorrhages, strokes, or abscesses in the cerebral hemisphere)
- Signs:
  - compressing the ipsilateral cranial nerve III
  - hyperactive reflexes
  - bilateral Babinski sign

After brain herniates: the patients are decerebrate and comatose, have fixed and dilated pupils, and eye movements are Absent. Once damage extends to the midbrain, a Cheyne–Stokes respiratory pattern starts. Decerebrate posture occurs

Lower extremities are extended with toes pointed inward and upper extremities extended with fingers flexed and forearms pronate. Neck and head are extended.



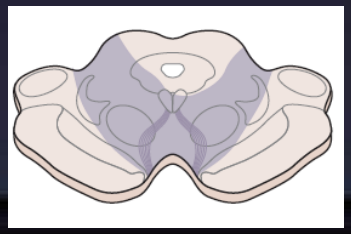
Decorticate posturing



Removal of the cerebral cortex (decortication)

- **Flexion can be explained by rubrospinal excitation of flexor muscles in the upper extremities; the**
- **hyperextension of lower extremities is due to the same changes that occur after midcollicular decerebration.**
- **because of their anatomy, the small arteries in the internal capsule (60% lesions) are especially prone to rupture or thrombotic obstruction, so this type of decorticate rigidity is fairly common**

Upper limbs are Flexed, lower limbs are extended with toes pointed slightly inward, and head is extended.



DECEREBRATE ANIMAL

- Decerebrate animal is one in whom the brain stem is transected at intercollicular level i.e. between superior and inferior colliculi

- Characteristic features-

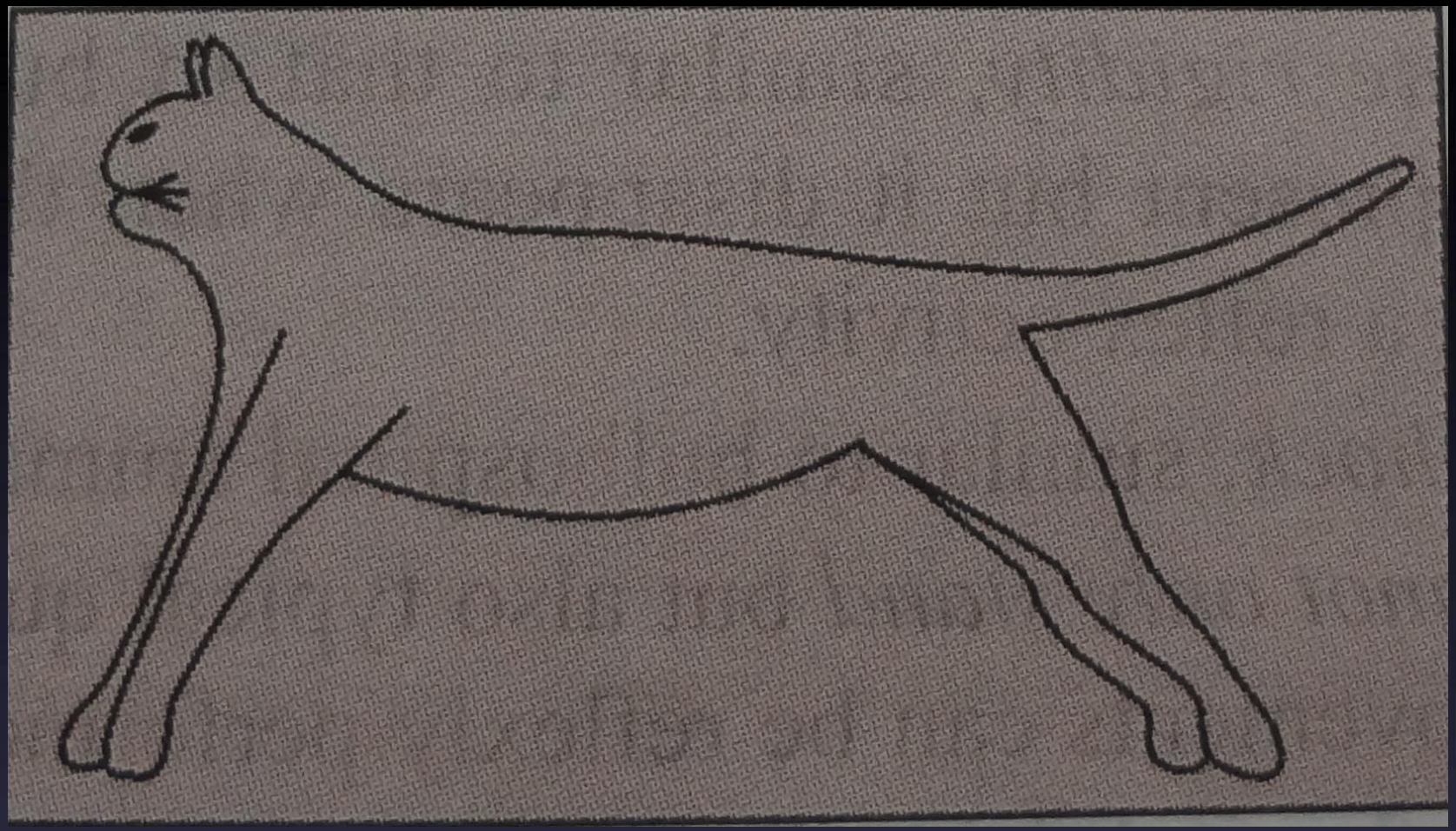
(i) Decerebrate rigidity

- It refers to marked increase in tone of extensors i.e. antigravity muscles
- Occurs immediately after decerebration

- **Features of decerebrate rigidity**

- hyperextension of all four limbs
- dorsiflexion (hyperextension) of tail and head
- extreme hyperextension of the spine(opisthotonus) produces concave configuration of the back
- the animal can be made to stand on four limbs but is easily toppled by slight push

Characteristic feature of decerebrate rigidity



Mechanism of Decerebrate Rigidity

- Rigidity occurs due to increased activity of motor neurons that facilitate stretch reflex
- Facilitation of stretch reflexes occur due to increased rate of γ motor neuron discharge

(ii) No spinal shock

(iii) Postural reflexes are those which have their centre in spinal cord, medulla or pons. These include-

- stretch reflexes, positive and negative supporting reaction, crossed extensor reflex, tonic neck and tonic labyrinthine reflex

(iv) Righting reflexes are absent

DECORTICATE ANIMAL

- Decorticate animal is one in whom the whole cerebral cortex is removed but the basal ganglia and brain stem are left intact

- **Characteristic features:**

  (i) Moderate rigidity is present
- Cortex inhibit medullary reticulospinal tract

- Therefore, removal of cortex results in facilitation of γ motor neuron discharge

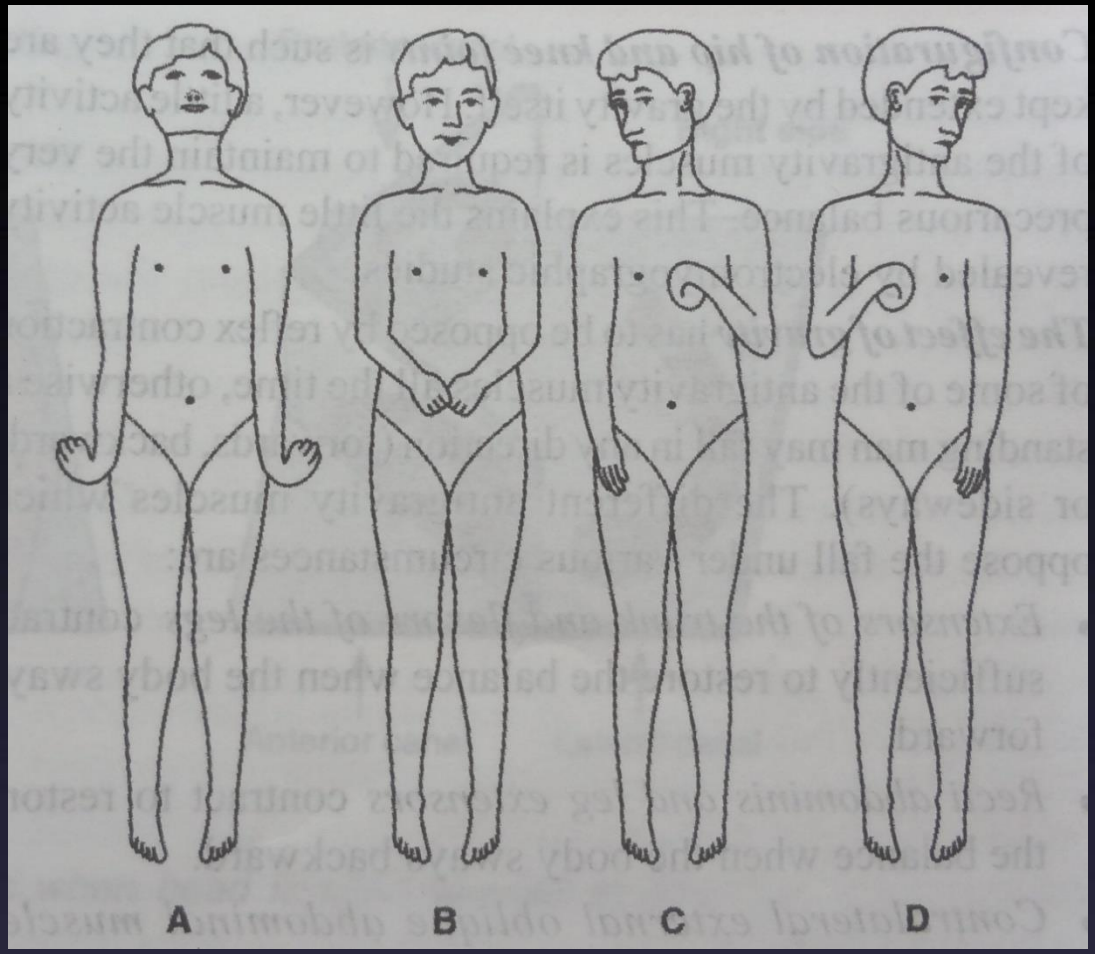
- Seen only when the animal is at rest

(ii) Typical posture in decorticate man consists of

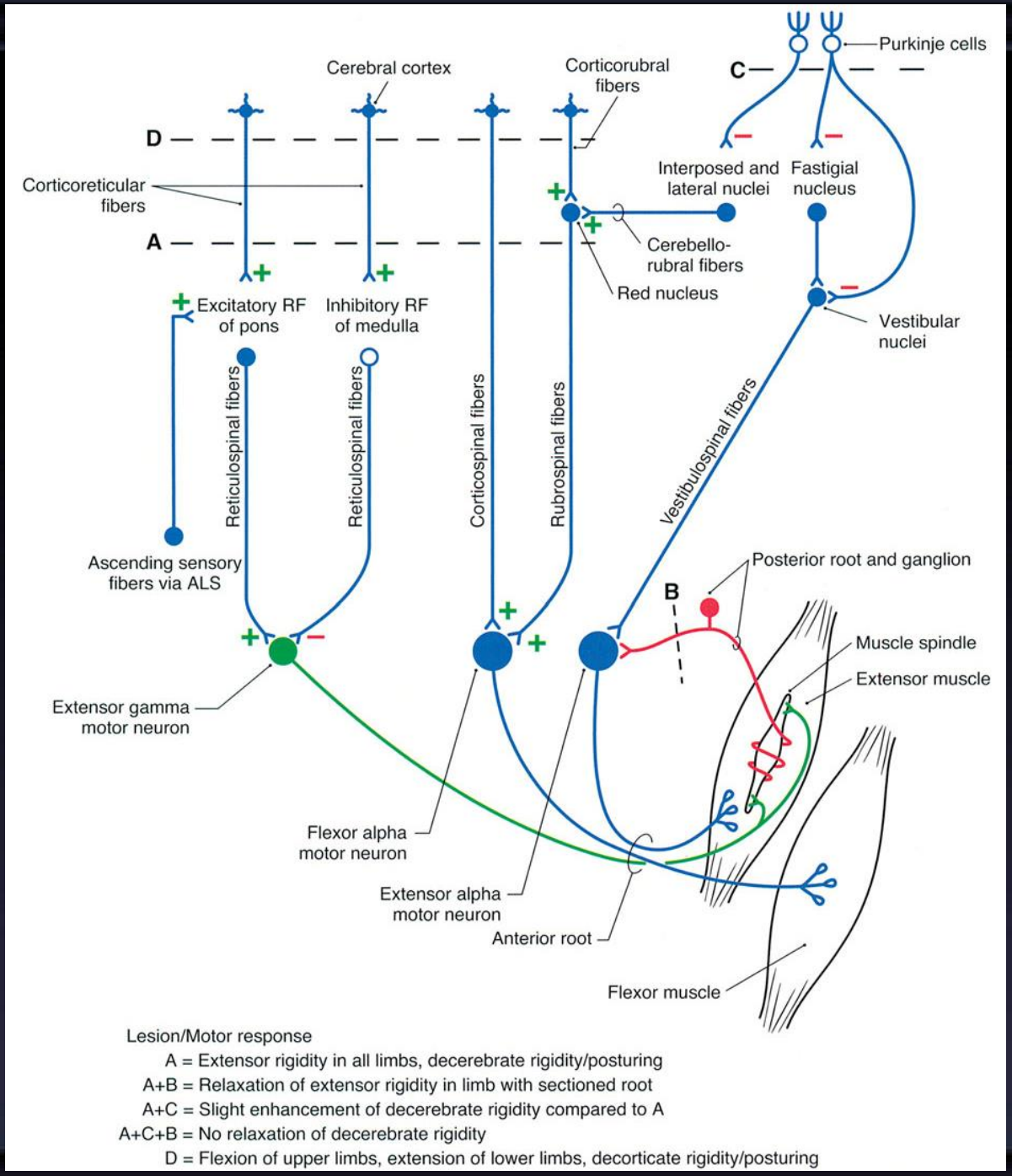
- full extension of legs
- arms lying across the chest
- semiflexion at elbow
- slight pronation of forearm
- flexion of wrist and fingers

(iii) Righting reflexes are present

A-Decerebrate and B,C,D-Decorticate rigidity in man




THANKS



Lesion/Motor response

A = Extensor rigidity in all limbs, decerebrate rigidity/posturing

A+B = Relaxation of extensor rigidity in limb with sectioned root

A+C = Slight enhancement of decerebrate rigidity compared to A

A+C+B = No relaxation of decerebrate rigidity

D = Flexion of upper limbs, extension of lower limbs, decorticate rigidity/posturing

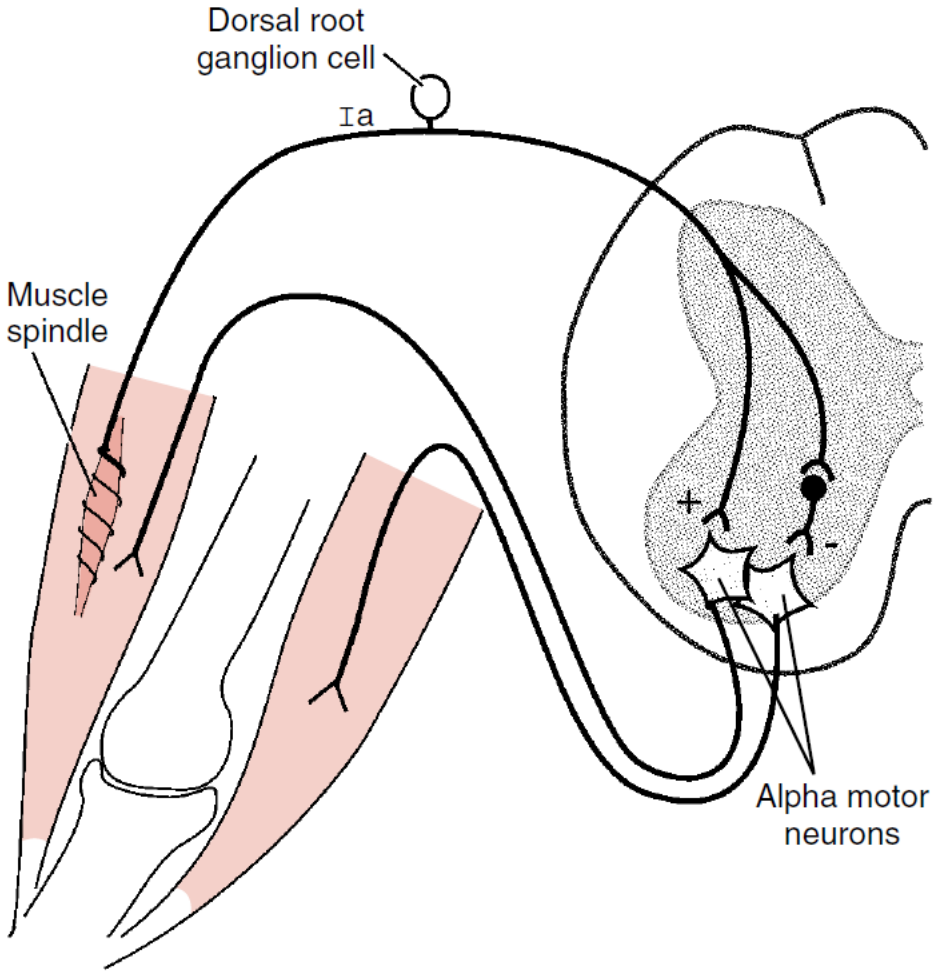


FIGURE 5.8 **Myotatic reflex circuitry.** Ia afferent axons from the muscle spindle make excitatory monosynaptic contact with homonymous motor neurons and with inhibitory interneurons that synapse on motor neurons of antagonist muscles. The plus sign indicates excitation; the minus sign indicates inhibition.

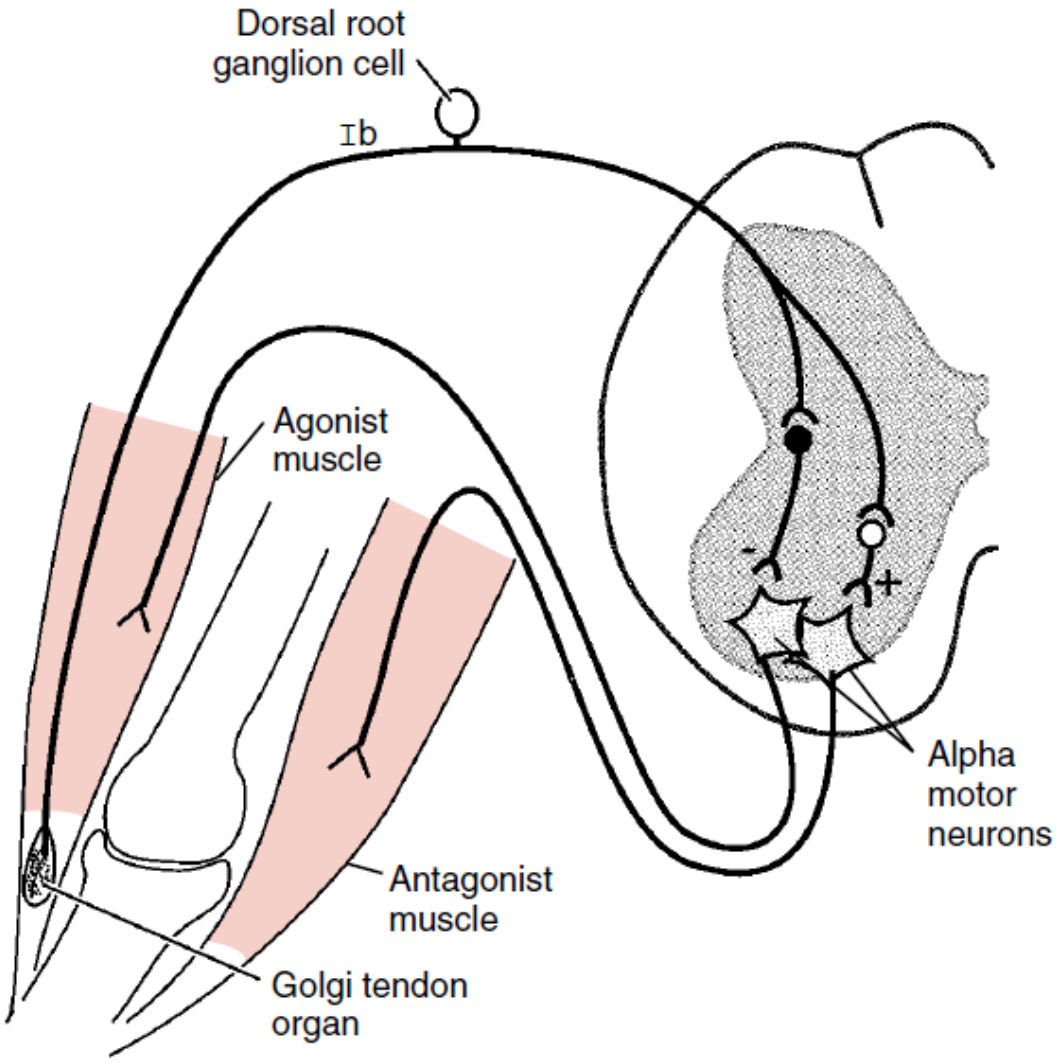


FIGURE 5.9 **Inverse myotatic reflex circuitry.** Contraction of the agonist muscle activates the Golgi tendon organ and Ib afferents, which synapse on interneurons that inhibit agonist motor neurons and excite the motor neurons of the antagonist muscle.

VARIOUS POSTURAL REFLEXES

REFLEX	STIMULUS	RESPONSE	RECEPTORS	INTEGRATING CENTRE IN CNS
A.Static reflexes				
1.Local static reflexes Stretch reflex	Stretch	Contraction of antigravity muscles	Muscles spindles	Spinal cord and mid brain
2.Positive Supporting reflex	Contact of skin of the sole of foot with ground	Contraction of flexors and extensors of the limb.	Touch and pressure receptors from skin of sole of foot.	Spinal cord
3.Negative supporting reaction	Stretch of extensor muscles	Disappearance of positive supporting reaction	Proprioceptors in extensors	Spinal cord

REFLEX	STIMULUS	RESPONSE	RECEPTORS	INTEGRATING CENTRE IN CNS
2.Segmental static reflexes Crossed extensor reflex	Painful stimulus	Contraction of flexors of the ipsilateral limb and extensors of contralateral limb to support the body. Extensor rigidity	Nociceptors	Spinal cord
3.General static reflexes Attitudinal reflexes 1. Tonic labyrinthine reflex 2. Tonic neck reflex	Gravity (alternation of position of head relative to horizontal plan) Stretch of neck muscles due to alternation of position of head relative to body.	Flexion of forelimbs and extension of hind limbs on ventroflexion of head .extension of fore limbs and flexion of hindlimbs.flexion of ipsilateral limbs and extension of contralateral limbs on turning the head side-ways.	Otolith organs Pacinian corpuscles in the ligaments of cervical joint and muscles spindles of neck muscles.	Vestibular and reticular nuclei present in the medulla oblongata. Medulla

REFLEX	STIMULUS	RESPONSE	RECEPTORS	INTEGRATING CENTRE IN CNS
2.Long loop stretch reflex	Stretch of the muscle due to swaying of body	Continuous moment to moment corrections of sways which occurs during standing.	Muscle spindles(monosynaptic reflex) visual receptor(long loon reflex)	Spinal cord Cerebral cortex
3.Righting reflexes				
• Labyrinthine righting reflex	Gravity	Brings the head in upright level	Otolith organs in saccules of labyrinth.exteroceptors	Mid brain
•Body righting reflex	Pressure on side of body	Righting of head.	Exteroceptors	Mid brain
•Neck righting reflex	Stretch of neck muscles	Righting of thorax and shoulders and then pelvis	Muscle spindles	Mid brain
•Body on body righting reflex	Pressure on side of the body	Righting of body even when righting of head is prevented.	Exteroceptors	Mid brain
•Limbs righting reflex	Stretch of limb muscles	Appropriate posture of limbs	Muscle spindles	Mid brain
• optical righting reflex	Visual cues	Righting of head	Eyes	Cerebral cortex

REFLEX	STIMULUS	RESPONSE	RECEPTORS	INTEGRATING CENTRE IN CNS
B.Statokinetic reflexes				
•Vestibular placing reaction	Linear acceleration	Foot placed on supporting surface in position to support body.	Receptors in utricle and saccule .	Cerebral cortex
•Visual placing reaction	Visual cues	Foot places on supporting surface.	Eyes	Cerebral cortex
•Hopping reactions	Lateral displacement while standing	Hops, maintains the limb in position to support the body	Muscle spindle	Cerebral cortex