REFLEXES

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REFLEX

- DEFINITION:

  INVOLUNTARY RSPONSE TO A SENSORY STIMULUS WITH OR WITHOUT INVOLVEMENT OF CNS.

  E.G. WITHDRAWAL REFLEXS

REFLEX ARC

- ANATOMICAL NERVOUS PATHWAY OF REFLEX IS CALLED REFLEX ARC.

RECEPTOR

SENSORY / AFFERENT NERVE

CENTER

EFFERENT / MOTOR NERVE

EFFECTOR ORGAN

* BELL-MAGENDIE LAW: DORSAL ROOTS ARE SENSORY & VENTRAL ROOTS ARE MOTOR.

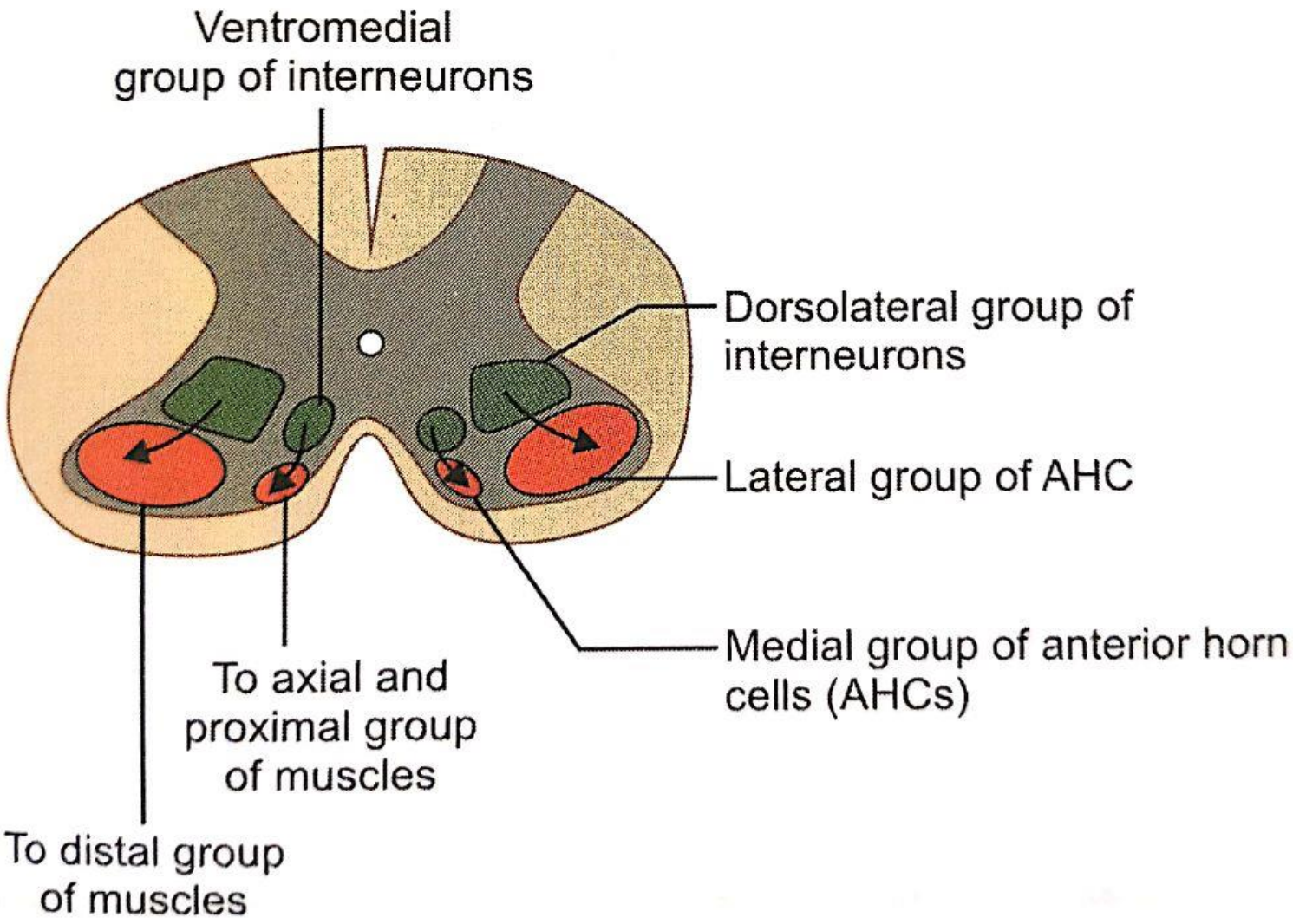


Fig. 126.5: Topographic organization of interneurons and motoneuronal pool. Arrows indicate the projection of interneuronal group to motoneuronal pool.

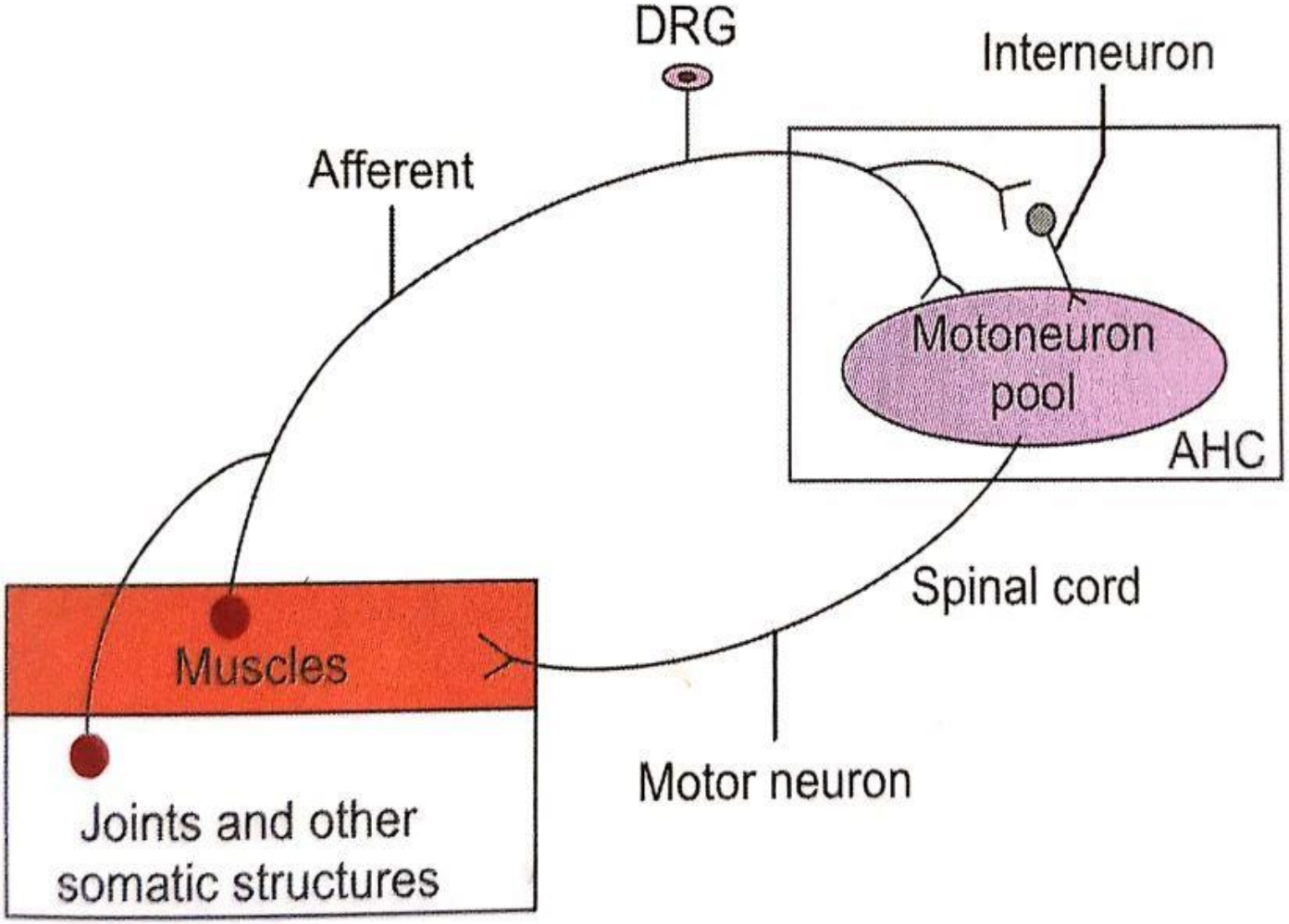


Fig. 126.2: Segmental (spinal) organization of motor control. (AHC: Anterior horn cell. Segmental (spinal) organization of motor control).

- 1) CLINICAL:

SUPERFICIAL
DEEP
VISCERAL
PATHOLOGICAL

SUPERFICIAL REFLEXES

- CORNEAL AND CONJUNCTIVAL REFLEX
- PHARYNGEAL REFLEX
- PALATAL REFLEX
- ABDOMINAL RELEX
- PLANTAR REFLEX: Scratch over the outer edge of sole cause plantar flexion and adduction of all toes and dorsiflexion and inversion of foot.(L5,S1)
- ANAL REFLEX

DEEP REFLEXES

- JAW JERK: 5TH CRANIAL NV NUCLEI
- BICEPS JERK: C5,6
- TRICEPS JERK: C6,7
- SUPINATOR JERK: C5,6
- KNEE JERK: L2,3,4
- ANKLE JERK: S1,2

VISCERAL REFLEXES

- PUPILLARY REFLEXES:
  DIRECT LIGHT REFLEX
  INDIRECT OR CONSENSUAL LIGHT REFLEX
- ACCOMODATION REFLEX: Constriction of pupil, convergence of eye balls, increase in anterior curvature of lens
- CILIOSPINAL REFLEX: Stimulation of skin in neck –dilatation of pupils
- OCULOCARDIAC REFLEX: pressure over eyeballs – bradycardia

PATHOLOGICAL REFLEXES

- BABINSKI'S SIGN +
  Dorsiflexion of great toe and fanning of other toes.
- CLONUS
- PENDULAR MOVEMENTS

2) ACCORDING TO THE NUMBER OF SYNAPSES INVOLVED:

- i) Monosynaptic reflexes: Reflexes in which only one synapse is present between afferent and efferent neuron. E.g. All stretch reflexes like biceps, triceps, knee jerk etc.

- ii) Bisynapic reflex: Reciprocal innervation to antagonistic muscle.

- iii) Polysynaptic reflexes: Reflexes in which one or more interneurons are present between afferent and efferent neurons. E.g. withdrawal reflexes.

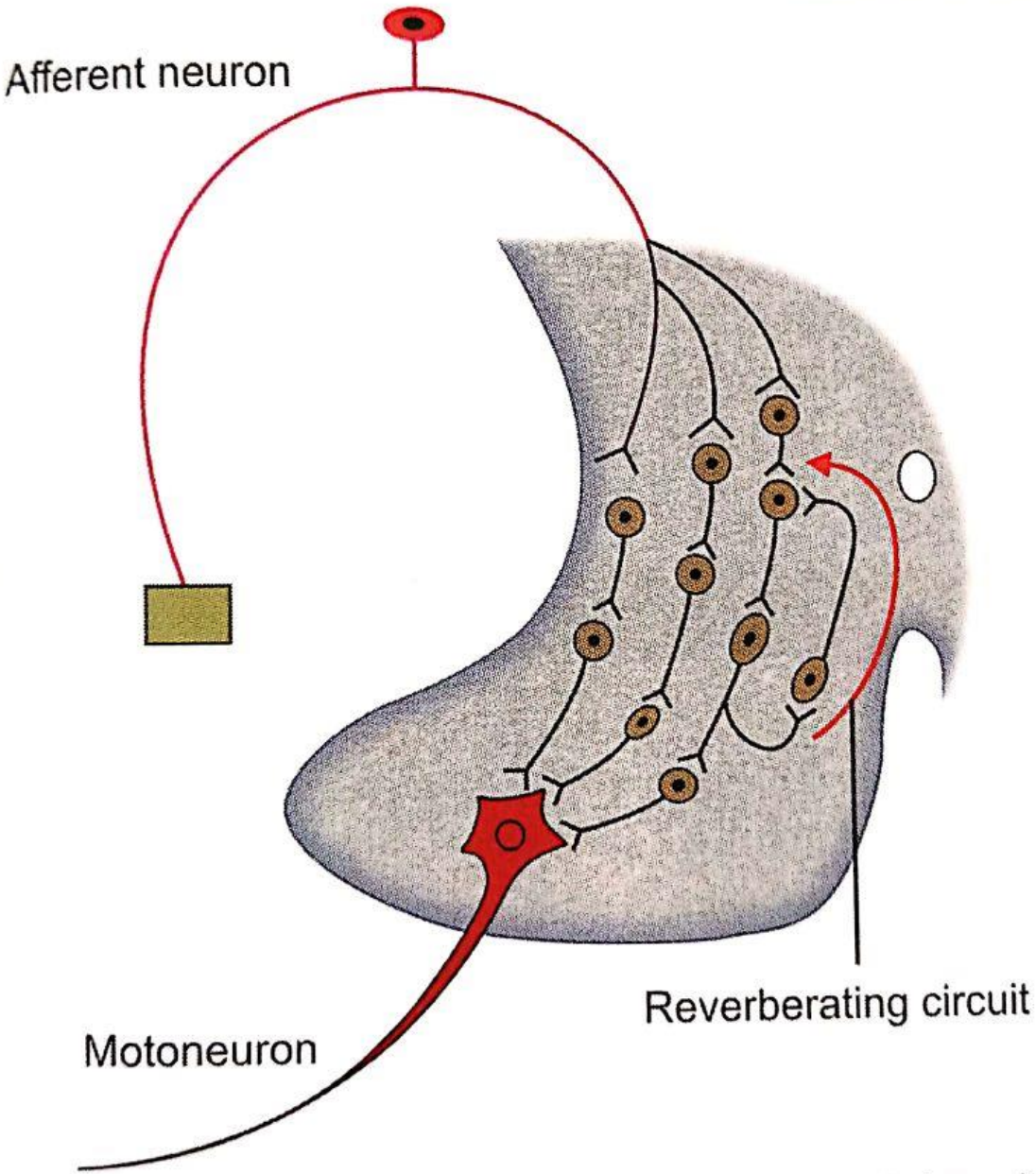


Fig. 128.5: Mechanism of afterdischarge in withdrawal reflex. Note the presence of many interneuronal pathways & reverberating circuits between afferent and efferent neurons.

- 3) DEPENDING ON SEGMENTS OF SPINAL CORD INVOLVED IN INTEGRATION OF REFLEX FUNCTION:
- i) Segmental: Only one spinal segment is involved e.g. Deep reflexes.
- ii) Inter segmental: Involving ascending or descending pathways. E.g. crossed extensor reflex.
- iii) Supra segmental: Reflexes involving nuclei above the spinal cord and the segments of the spinal cord themselves.

- **4)** i) Unconditioned (inborn, since birth): Reflex present since birth e.g. reflex salivation when any object is kept in mouth.

  ii) Conditioned (acquired): Reflex developed during life based on learning, training etc.

e.g. reflex salivation by sight, smell of food.

- 5) According to the center:

  Cerebellar, cortical, midbrain and spinal.

- 6) According to origin:

  Somatic: Flexor reflex and extensor reflex.

  Visceral reflexes.

- 7) Depending on the function (Physiological class.):

  * Flexor or protective reflexes: Protect the body from harmful stimuli. E.g. withdrawal reflex.

  * Extensor or antigravity reflexes: Protect the body from gravitational force and help us in standing.

MONOSYNAPTIC REFLEX: STRETCH REFLEX

- WHEN A SKELETAL MUSCLE IS STRETCHED, IT CONTRACTS.

- STIMULUS: STRETCH
- RESPONSE: CONTRACTION OF MUSCLE
- RECEPTOR: MUSCLE SPINDLE
- NEUROTRANSMITTER: GLUTAMIC ACID

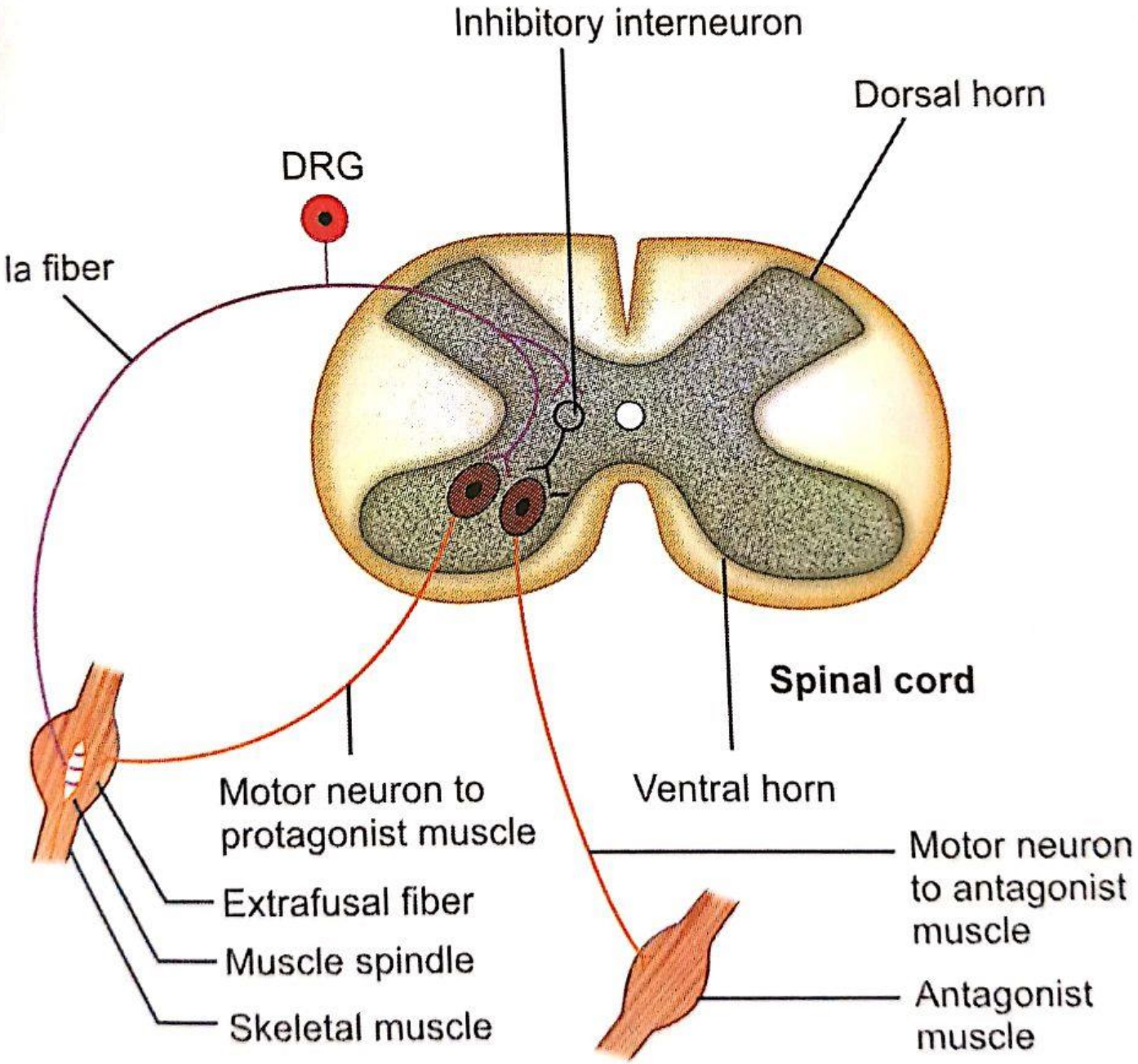
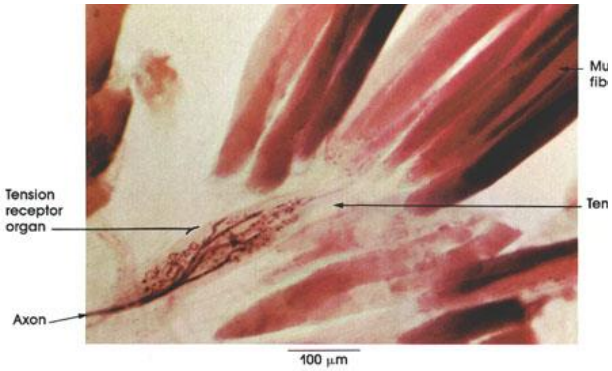
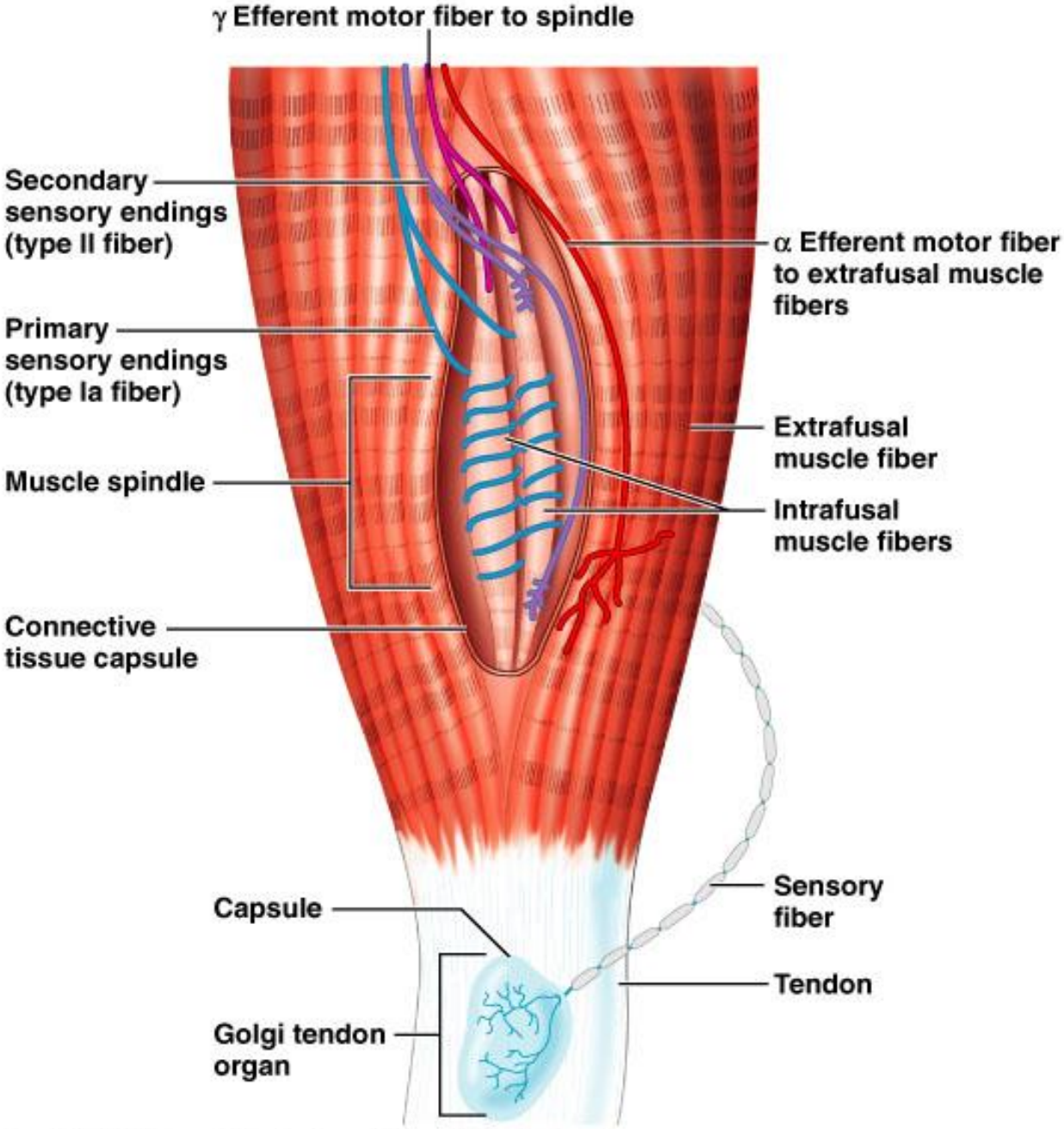


Fig. 128.2: Schematic representation of a stretch reflex.

MUSCLE SPINDLE

- INTRAFUSAL FIBERS
- NUCLEAR BAG FIBER
- NUCLEAR CHAIN FIBER





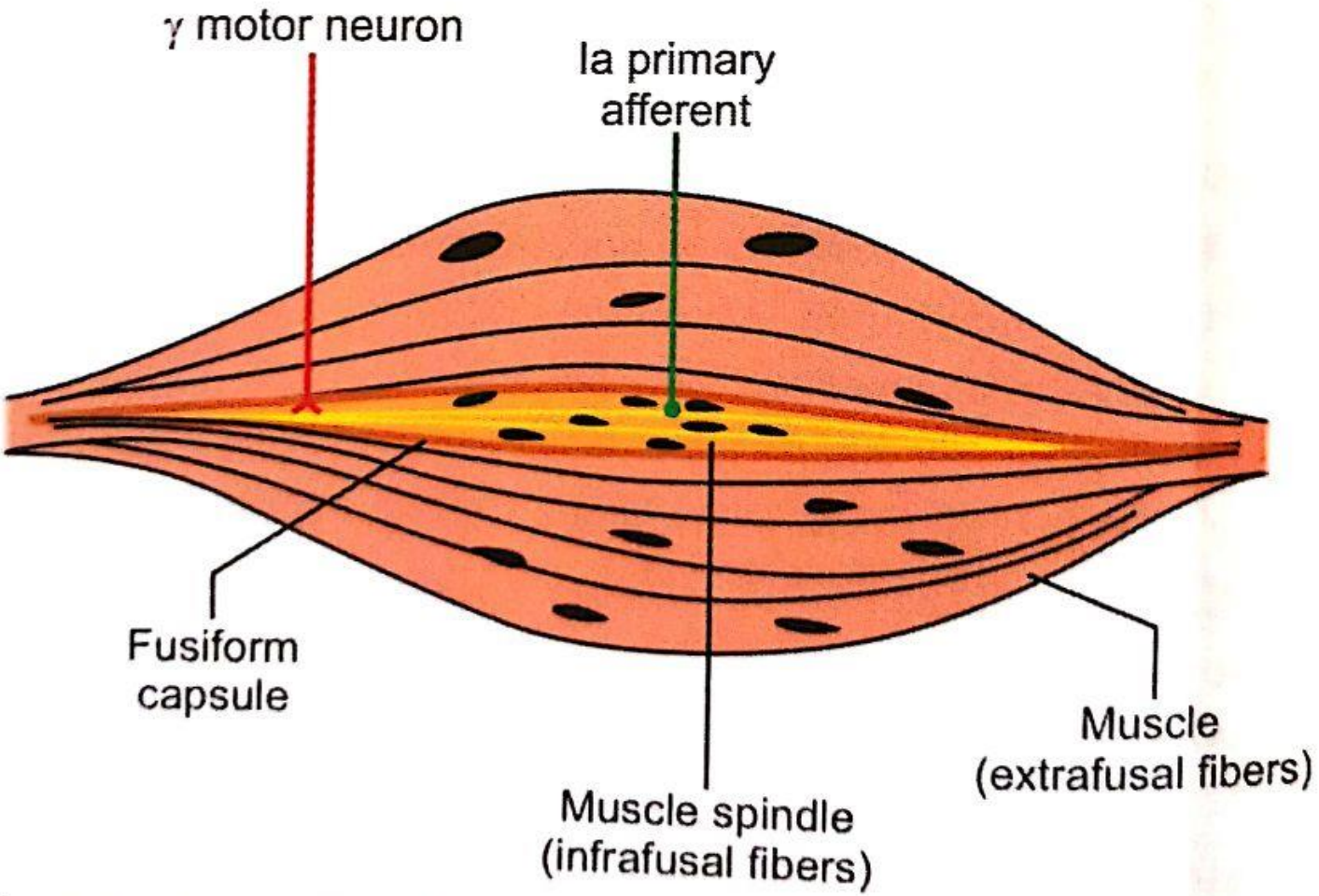


Fig. 127.1: Location of muscle spindle. Note, in the muscle, spindle is surrounded by a fusiform capsule. The peripheral part of muscle spindle is innervated by γ motor neuron and central part receives Ia afferent fiber.

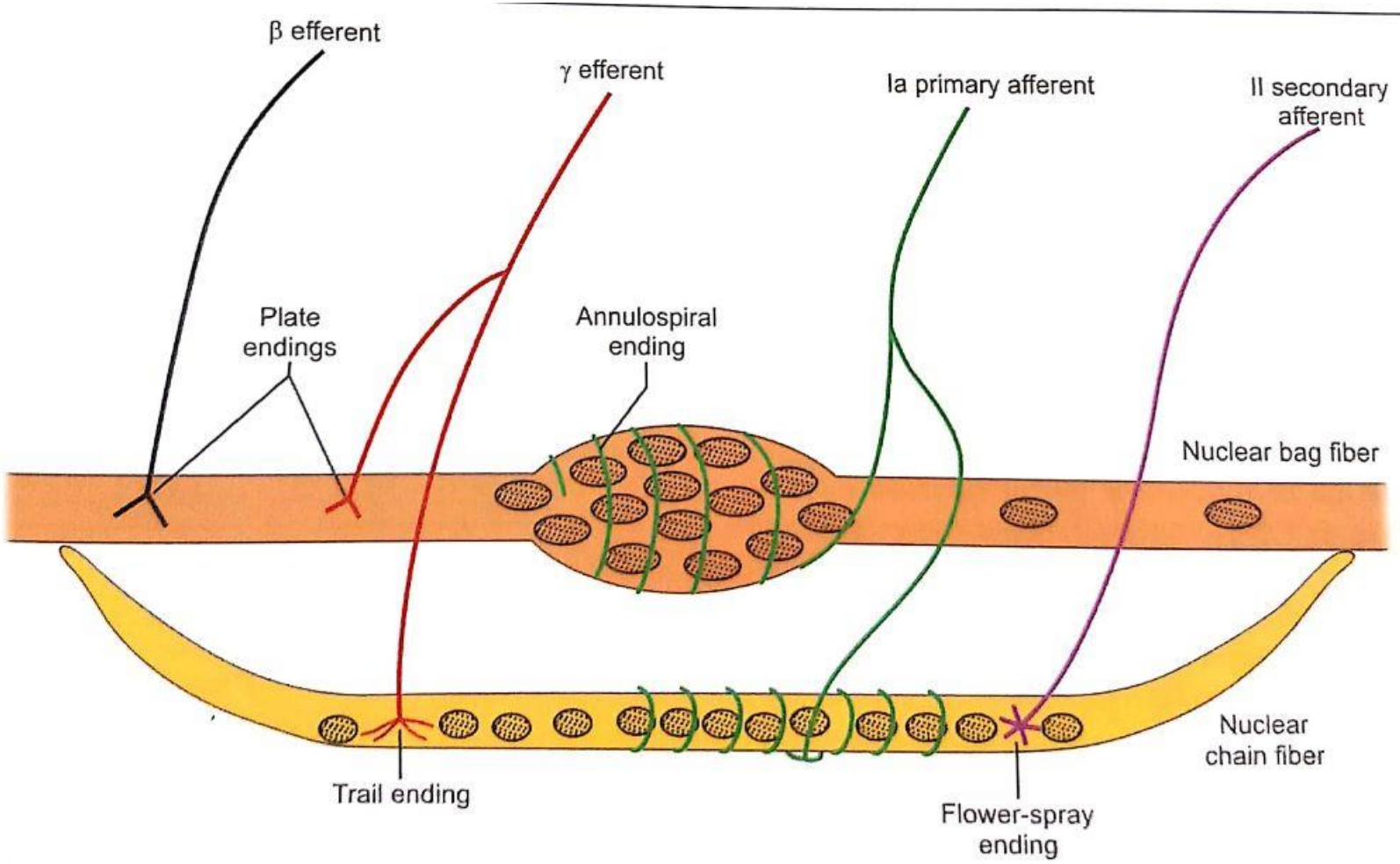
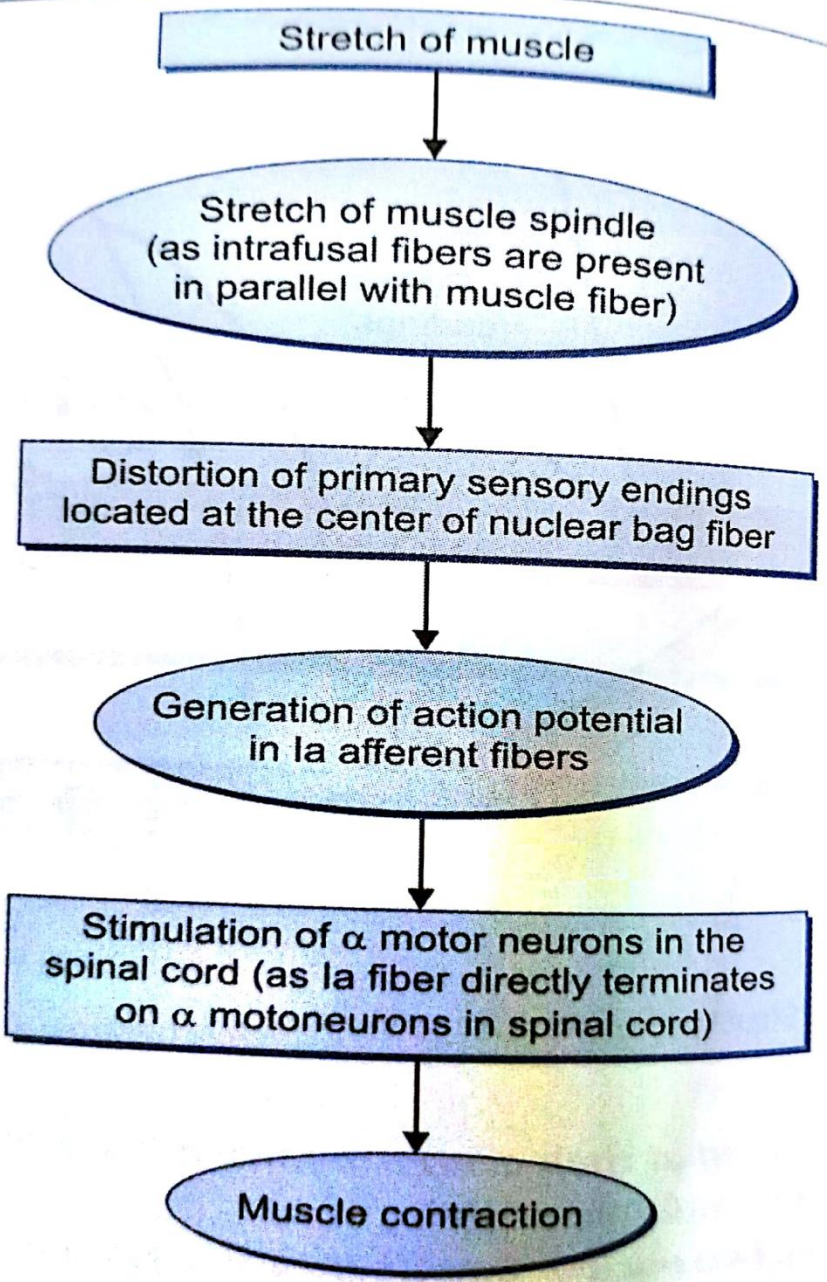


Fig. 127.2: Structure of muscle spindle.

Flowchart 127.1: Mechanism of muscle contraction in response to muscle stretch



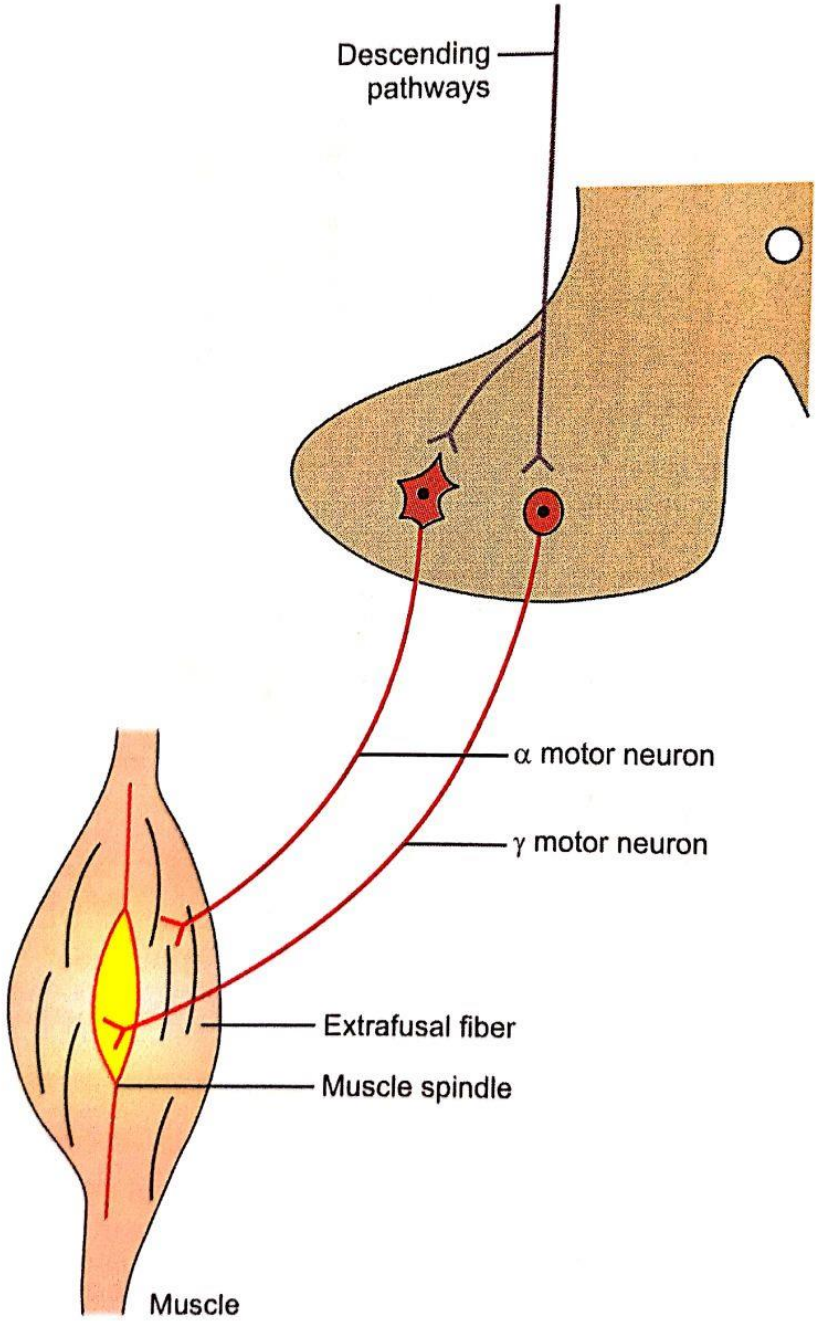
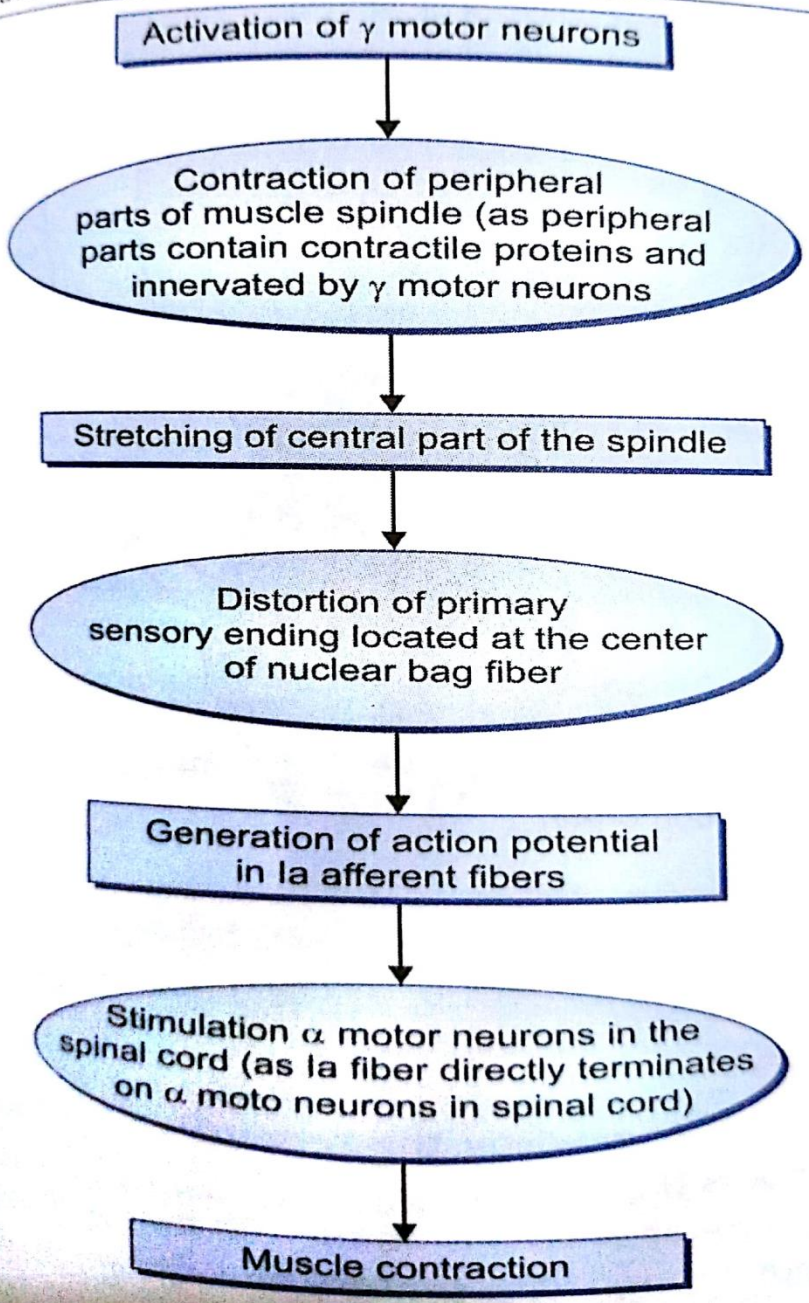


Fig. 127.5: Mechanism of α–γ coactivation.

Flowchart 127.2: Mechanism of muscle contraction in response to stimulation of γ motor neuron.



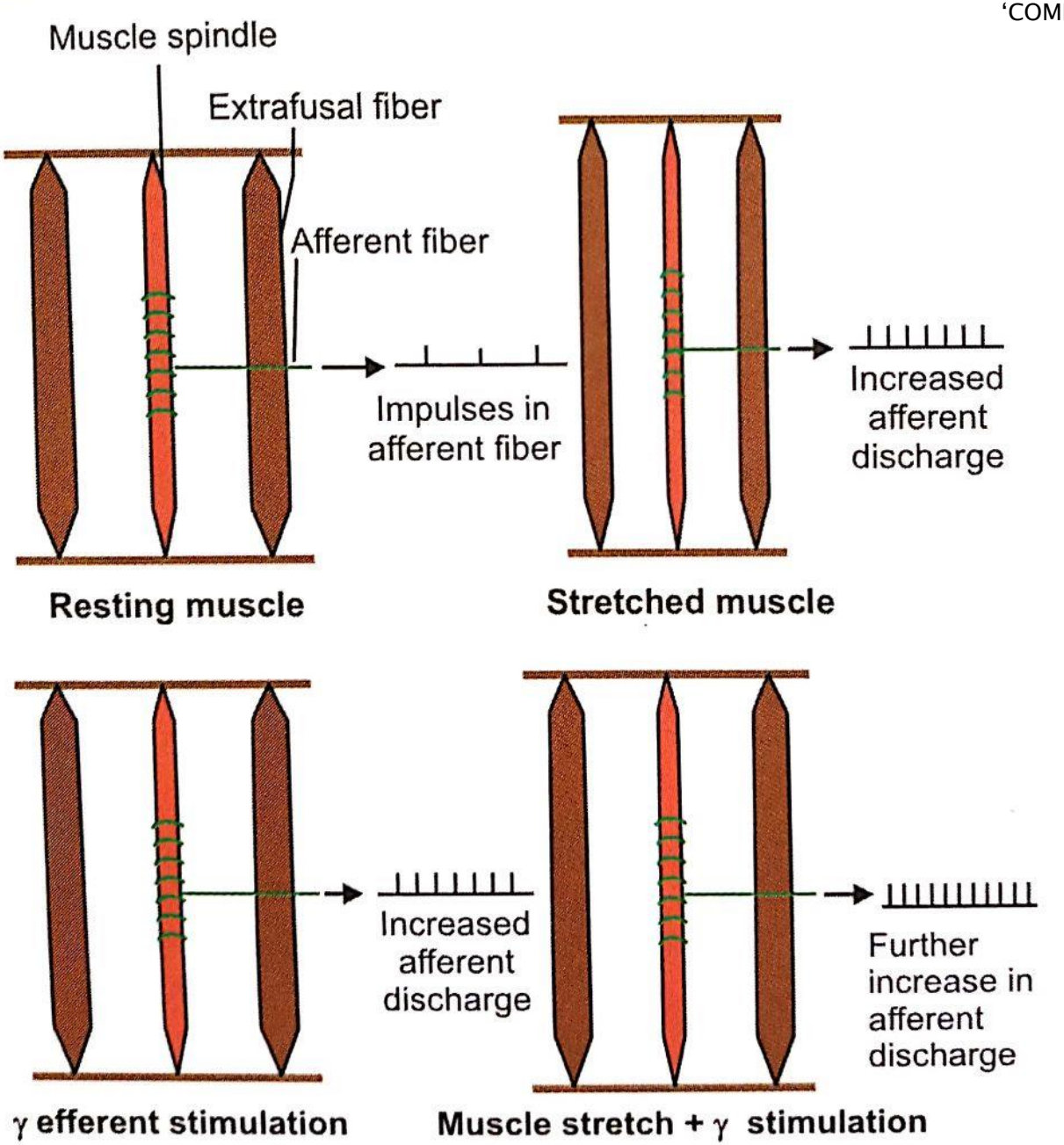


Fig. 127.3: Effects of stretch and stimulation of γ motor neuron on spindle activity.

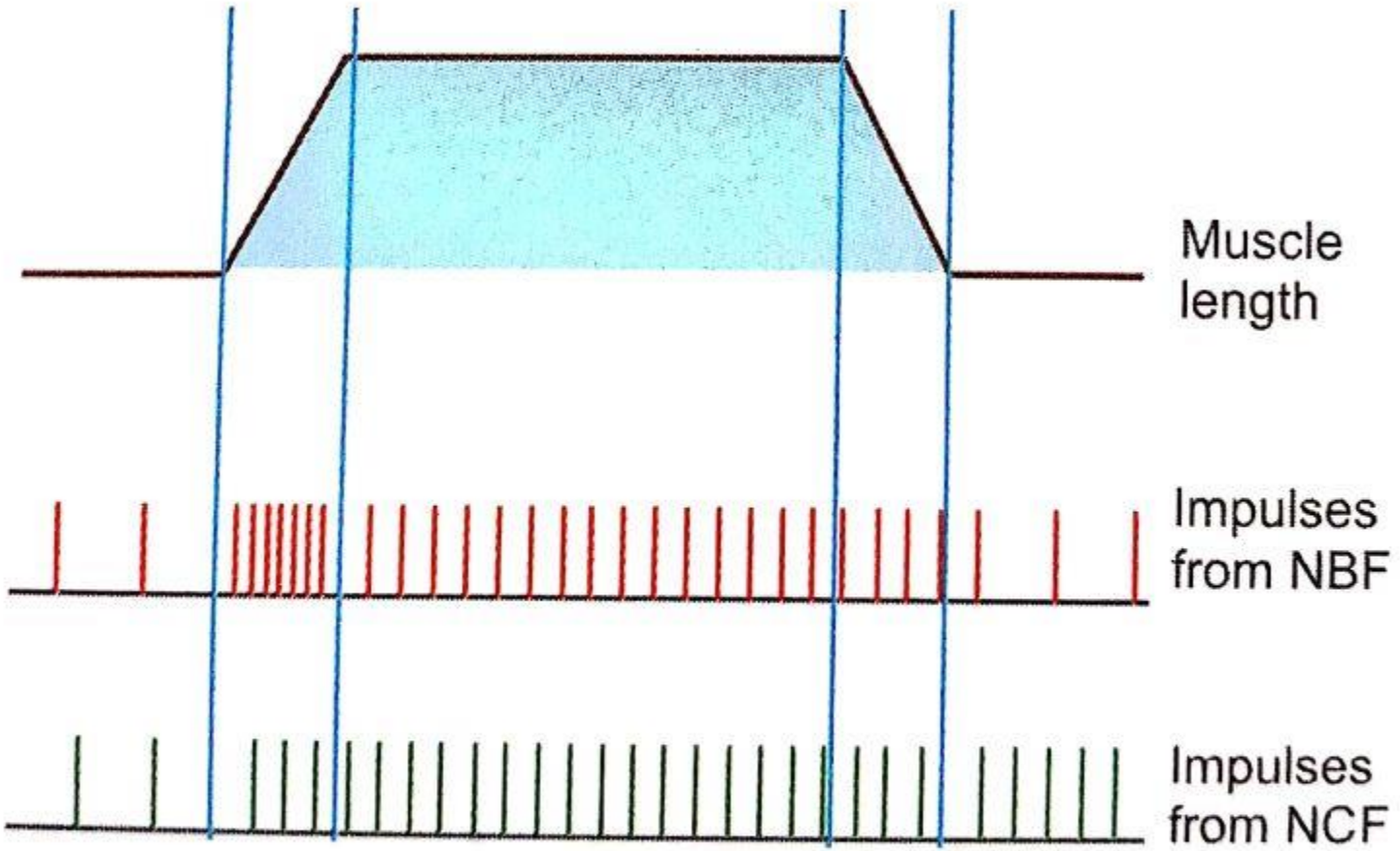


Fig. 127.4: Dynamic and static spindle responses. Nuclear bag fiber (NBF) exhibits dynamic responses (increased rate of impulse) during the act of stretch, whereas nuclear chain fiber (NCF) shows static responses (same impulse rate) throughout the stretch.

INVERSE STRETCH REFLEX/ AUTOGENIC INHIBITION

- WHEN A MUSCLE IS STRETCHED, IT CONTRACTS BUT IF THE STRETCH IS MAINTAINED (CONTINUED), THE MUSCLE RELAXES.

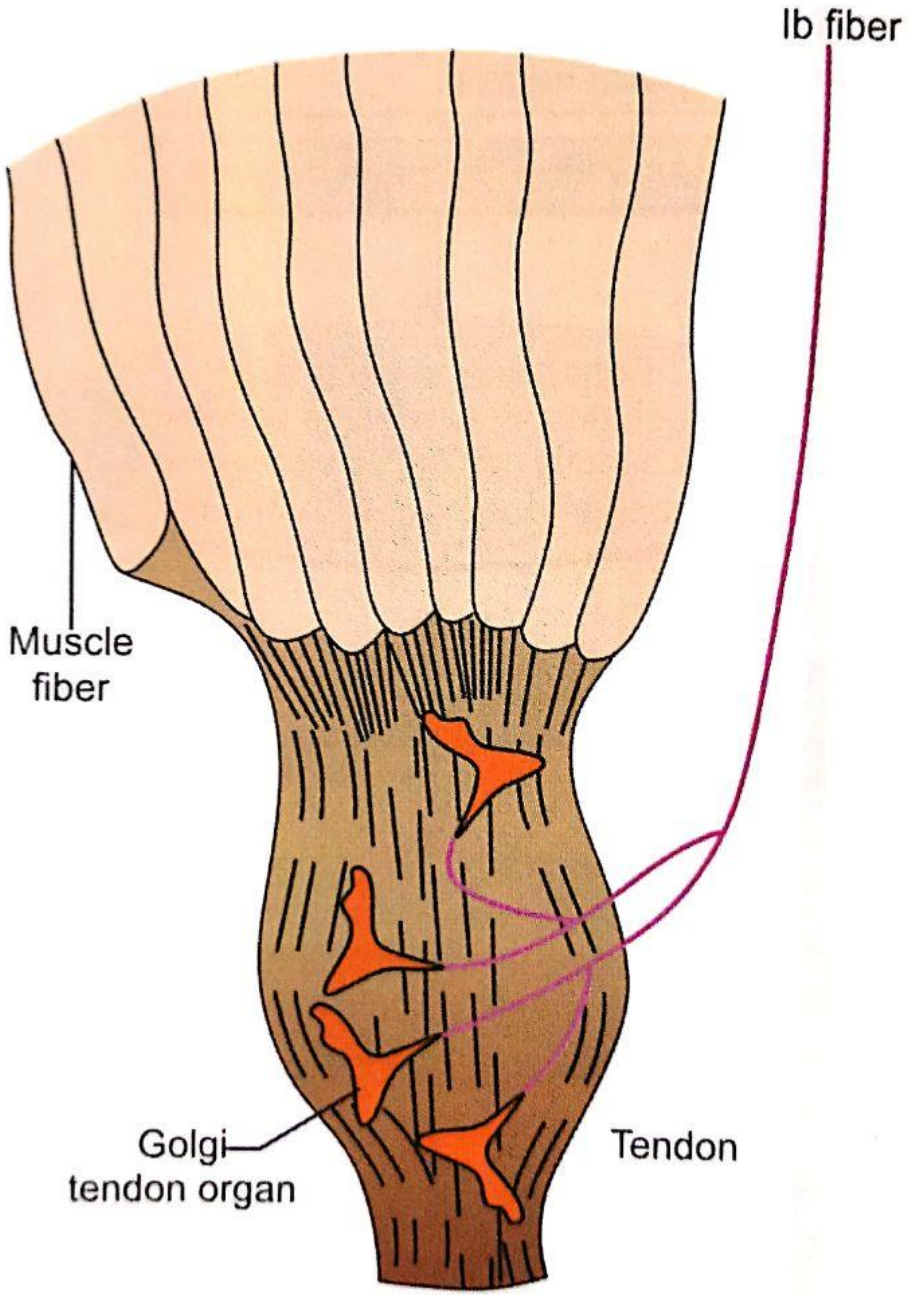


Fig. 127.6: Structure of Golgi tendon organ (GTO).

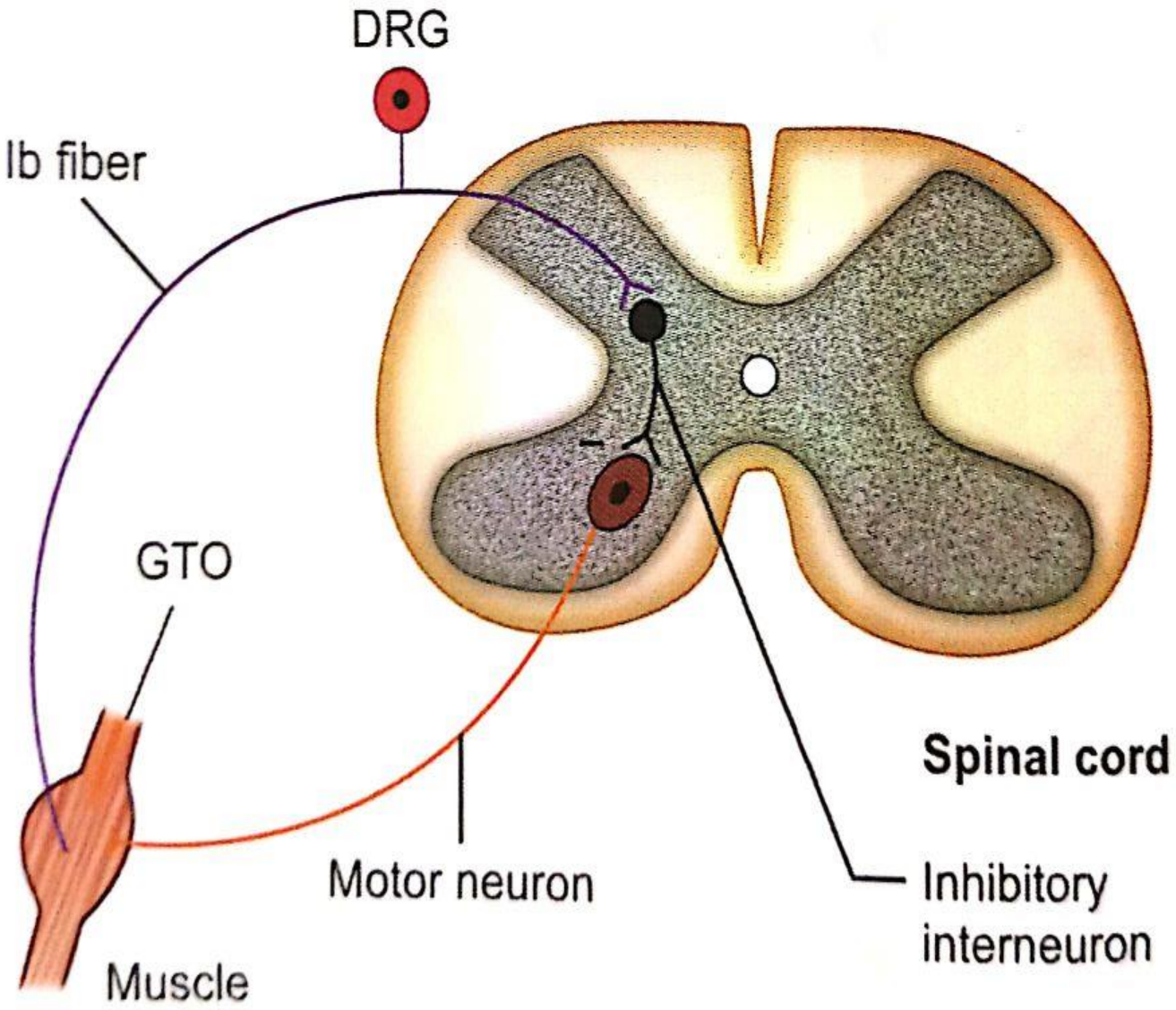


Fig. 128.3: Schematic representation of an inverse stretch reflex.

Alpha motor neurons

- FINAL COMMON PATHWAY

APPLIED

- TONE
  hypotonia
  hypertonia

* CLONUS: exaggerated reflexes

CROSSED EXTENSOR REFLEX

- **Painful stimuli:**
- SAME SIDE: Flexion
- OPPOSITE SIDE: Extension
- POLYSYNAPTIC: Withdrawal reflex

CLINICAL SIGNIFICANCE OF REFLEX

- TYPE OF NEUROLOGICAL LESION
- ASSESSING THE LEVEL OF NEUROLOGICAL LESION

A) RECEPTORS: LEPROSY
B) AFFERENT: PERIPHERAL NEURITIS
C) CENTRE: SYRINGOMYELIA
D) EFFERENT: POLIOMYELITIS
E) EFFECTOR ORGAN: MYASTHENIA GRAVIS

PROPERTIES OF REFLEX

- ADEQUATE STIMULUS
- DELAY
- ONE WAY CONDUCTION
- SUMMATION: SPATIAL, TEMPORAL
- OCCLUSION
- SUBLIMINAL FRINGE
- RECRUITMENT
- AFTERDISCHARGE
- REBOUND PHENOMENON
- FATIGUE

- RECIPROCAL INNERVATION AND RECIPROCAL INHIBITION

ADEQUATE STIMULUS

- Reflex activity is fixed in terms of stimulus and the response.
- The receptors respond maximally to a particular stimulus only.
- This minimal stimulus is called as adequate stimulus.

DELAY

- TIME BETWEEN APPLICATION OF STIMULUS AND THE RESPONSE OF REFLEX.
- SYNAPTIC DELAY: 0.5 ms. + CONDUCTION ACROSS NERVE

- IMPORTANCE:

  * ONE OF CAUSES OF LATENT PERIOD OF REFLEX ACTIVITY.

  * NO. OF SYNAPSES CAN BE ESTIMATED

(WHETHER MONOSYNAPTIC OR POLYSYNAPTIC)

ONE WAY CONDUCTION

- THE IMPULSES ARE TRANSMITTED IN ONLY ONE DIRECTION THROUGH THE REFLEX ARC.
- DORSAL ROOTS ARE SENSORY AND VENTRAL ROOTS ARE MOTOR IN SP. CORD.
- THE IMPULSES PASS FROM RECEPTORS TO SENSORY NERVE, CENTER, MOTOR NERVE, EFFECTOR ORGAN
- BELL AND MAGENDIE LAW

SUMMATION

When more than one sensory nerves are simultaneously their effects are summed and muscle contracts.

spatial summation.

when a single sensory nerve is repetitively and rapidly stimulated, the effects produced by impulses are added.

temporal summation.

subliminal fringe/occlusion

When the sensory nerves are separately stimulated, sum of their effects is less than the effect, which is produce when they are simultaneously stimulated. This property is called

Subliminal fringe

when the sensory nerves are separately stimulated, sum of their effects is more than the effect, which is produce when they are simultaneously stimulated. This property is called

Occlusion

RECRUITMENT

- When an excitatory nerve is stimulated with a stimulus of constant strength for a long time, there is progressive increase in response of reflex activities.
- due to more and more activation of motor units.
- (like temporal summation).
- Beyond a certain limit, more stimulation does not increase the response because all the motor units have already contracted (quantal summation).

AFTER DISCHARGE

- When a sensory nerve is continuously stimulated with high frequency the corresponding motor neuron responds.
- But if the stimulation is suddenly removed, the response in the motor neuron continues in spite of stoppage of stimulus.
- It occurs due to presence of reverberating circuits.

REVERBERATION

- Passage of impulse from sensory neuron and again back to same sensory neuron leading to continuous stimulation of motor neuron.
- REBERVERATING CIRCUIT
- Reverberation of impulse through the same circuit again and again.
- This is prevented to some extent in the form of fatigue.

REBOUND PHENOMENON

Reflex activity can be inhibited by some methods.

But when the inhibition is suddenly removed, the reflex activity becomes more forceful than the force before inhibition.

Cause is unknown.

FATIGUE

- REPEATED STIMULUS OF SENSORY NEURON, DECREASES REFLEX ACTIVITY THEN DISAPPEARANCE.
- TEMPORARY.
- CAUSE: DEPLETION OF NT, INACTIVATION OF Ca++ CHANNELS, ACCUMULATION OF WASTE.
- FIRST SEAT OF FATIGUE IN INTACT AND EXPERIMENTAL PREPARATION ???

FINAL COMMON PATHWAY

- alpha motor neurons which supply the extrafusal fibers in the skeletal muscles
- All the neuronal influences either excitatory or inhibitory ultimately converge on the alpha motor neurons.
- The resultant effect causes the stimulation or inhibition of the alpha motor neuron leading to contraction or relaxation of the skeletal muscles.

- **CENTRAL EXCITATORY AND INHIBITORY STATES**

- E.g. mass reflex: occurs as a result of complete transection of spinal cord

- due to central excitatory state of the spinal cord.

- (If the spinal cord is cut into two halves, even a small noxious stimulus on the lower limb produces withdrawal reflex, urination, defecation, sweating etc.)

- HABITUATION

- Reflexes can be modified by experience.

- If the stimulus is weak and benign, and if it is repeated at intervals, the response decreases and finally disappears.

SENSITIZATION

- If repeated noxious stimuli are given along with a normal stimulus, the reflexes become hyperactive (increased) and the response goes on increasing.

- 15) Facilitation: When a reflex is elicited repeatedly, the response becomes progressively higher for first few occasions. i.e. each subsequent stimulus exerts a better effect than the previous one.

RECIPROCAL INNERVATION AND INHIBITION

- During reflex activity, impulses through sensory fibres from protagonist muscles inhibit the action of antagonistic muscles. E.g. when flexor group of muscles of a joint are stimulated, extensor muscles are inhibited.

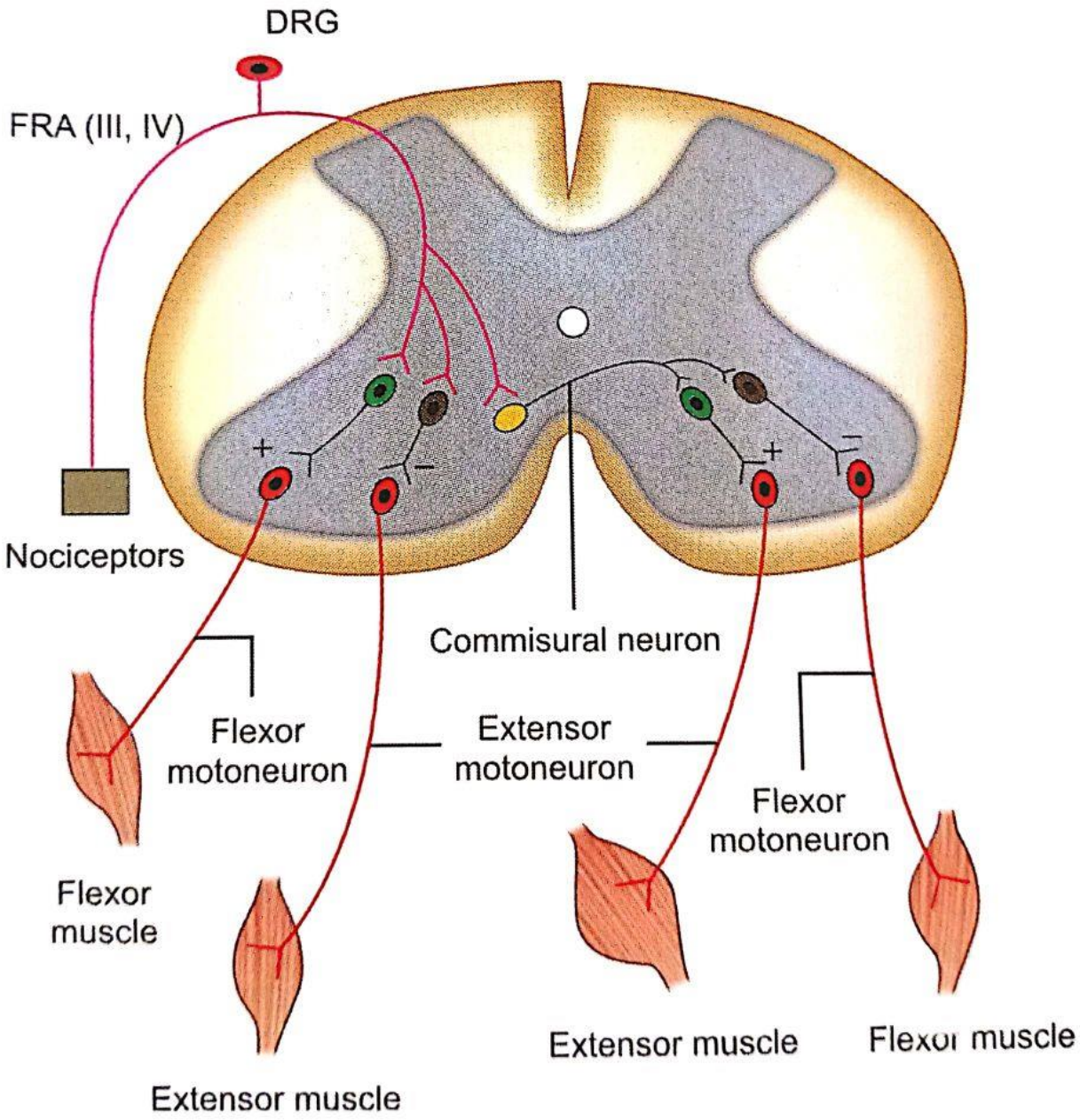


Fig. 128.4: Schematic representation of a withdrawal reflex. (FRA: Flexion reflex afferents).

FRACTIONATION

- The force of contraction is higher when it is stimulated directly through motor nerve as compared to when it is stimulated reflexly through sensory nerve.

- This is due to phenomenon of occlusion of motor neurons when sensory nerve is stimulated. Due to occlusion, number of motor neurons stimulated is lesser.

- CONVERGENCE: COMING TOGETHER IN SPINAL CORD

DIVERGENCE: DISTRIBUTING

THANK YOU