Reflexes

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Contents

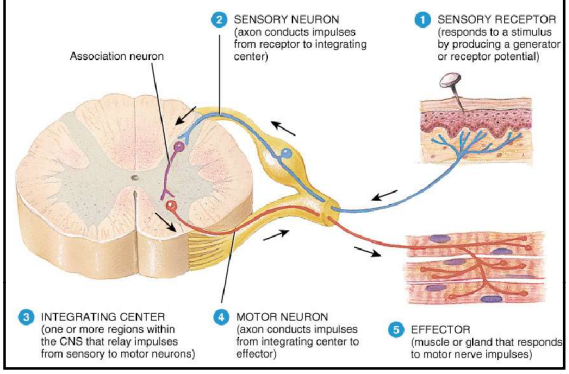
Introduction

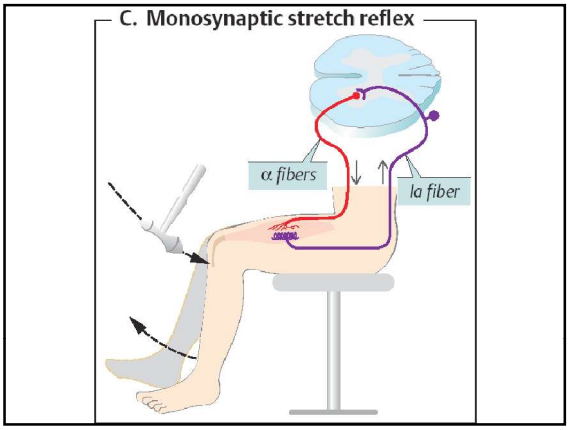
- **Reflexes**
- A reflex is an immediate sequence of actions in response to a particular stimulus.
- Spinal reflexes are integrated through the gray matter of the spinal cord. (patellar reflex)
- Cranial reflexes are integrated through the brain stem. (moving eyes to read)

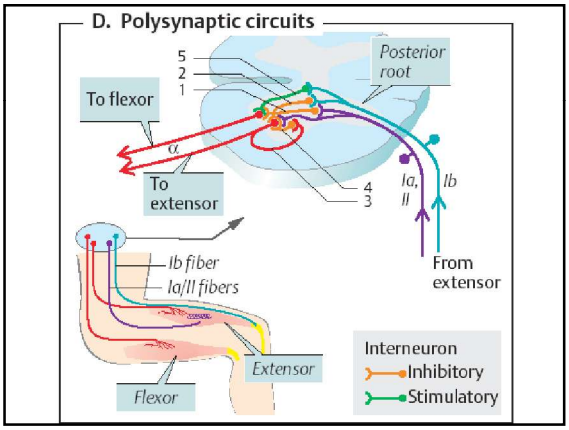
Reflex Arc

- A *reflex arc* is the simplest type of pathway - specific neuronal circuits and include at least one synapse.
- Reflexes help to maintain homeostasis by rapid adjustments
- 5 components of reflex arc
  - receptor
  - sensory neuron
  - integrating center
  - motor neuron
  - effecter
- Law of Bell & Magendie :- In spinal cord dorsal root is always sensory & ventral root is always motor

Reflex Arc components







Classification of reflexes

- **Inborn / Acquired :- Unconditioned & Conditioned e.g. salivation**
- **Anatomical :-**
  - **Segmental – knee jerk**
  - **Intersegmental – withdrawl**
  - **Suprasegmental – postural**

- **Physiological :- Functional**
  - **Extensor – antigravity**
  - **Righting**
  - **Flexor – protective**
  - **Sexual**
  - **Locomotor**
- **Clinical**
  - **Superficial – skin, mucus memb. – abdominal**
  - **Deep – muscle spindle – stretch reflex**
  - **Visceral – baro & chemoreceptors**
  - **Pathological – Babinski's sign**

Other Classifications

- Receptors involved – (Sherrington's)
  - **Exteroceptive, interoceptive, telereceptive**
- Effecter organ –
  - **Somatic, visceral, somatovisceral**
- Parts of CNS involved –
  - **Spinal, bulbar, mesencephalic, diencephalic, cortical.**
- Character of response –
  - **Motor, secretory, vasomotor**
- Modern –
  - **Asynaptic, monosynaptic, polysynaptic**

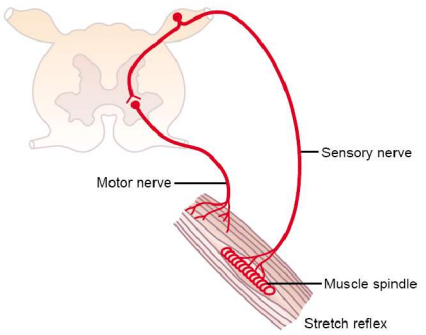
Important reflexes

- Somatic spinal reflexes include
  - *stretch reflex,*
  - *flexor (withdrawal) reflex*,
  - *crossed extensor reflex* - all exhibit reciprocal innervation.
  - *tendon reflex,*

MUSCLE TONE

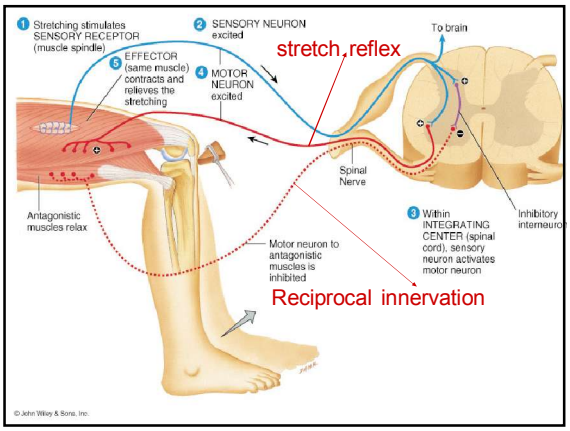
It is a state of partial tetanus of muscle maintained by asynchronous discharge of impulses in motor neurons supplying the muscle. It is reflexly engendered by impulse activity of afferent nerves whose nerve endings lie in muscle spindles.

Stretch reflex



Stretch reflex

•Stretch reflex arc is monosynaptic and consists of afferent and efferent limb.
•Destruction of any of the limbs of the arc abolishes tone.
•Sherrington showed that when an innervated muscle is stretched it responds by contracting. This is called stretch reflex.
- **•Here stretch is stimulus**
- **•Contraction is response**
- **•Muscle spindle is receptor**

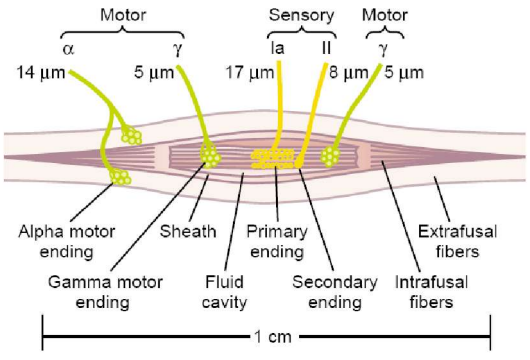


Stretch reflex

- Stretch Reflex (patellar reflex)
  - Monosynaptic,ipsilateral reflex arc
  - feedback mechanism to control muscle length
  - Prevents injury from over stretching

- Events of stretch reflex
  - muscle spindle signals stretch of muscle
  - motor neuron activated & muscle contracts
  - Brain sets muscle spindle sensitivity as it sets **muscle tone** (degree of muscle contraction at rest)
- Reciprocal innervation (interneuron) – antagonistic muscles relax as part of reflex

MUSCLE SPINDLE



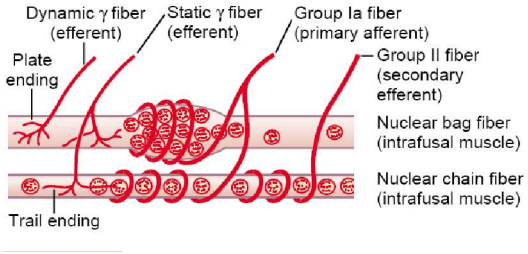
MUSCLE SPINDLE

•Macroscopic structure
- 4 mm long
- Spindle shaped
- Parallel to skeletal muscle fibres
- Attached to endomysium of extrafusal fibres at both ends.

- Intrafusal ms fibres – 2-12 muscle fibres enclosed in connective tissue capsule.They are more embryonal and have less striations.

•2 types of intrafusal fibers
nuclear bag fibres
Nuclear chain fibres.

INNERVATION



INNERVATION

SENSORY SUPPLY –

i) Primary (annulospiral) endings.

Ending of Ia or A α (12-20 µm in diameter)
Dynamic response – Nuclear Bag responds rapidly during initiation of stretch.
Static response – Nuclear Chain discharge throughout sustained stretch.

ii) Secondary (flower spray) ending

Termination of group II-A or A β afferent fibres (6-9 µm)
Near polar ends of nu. Chain fibres only.
They respond to sustained stretch.

MOTOR SUPPLY –

α efferent – (12-20µm in diameter)
Supply extrafusal fibres
Low threshold for excitation.

γ-efferent – group A γ – (3-6µm).
High threshold for excitation
γ 1 – supply ends of nu. Bag fibres plate endings.
γ 2 – supply ends of nu. Chain fibres trail endings.
They cause reflex contraction of muscle.
Their stimulation produces shortening of contractile ends of intrafusal fibres.
↓
Initiates impulses in sensory nerve.
↓
Reflex contraction of muscle.

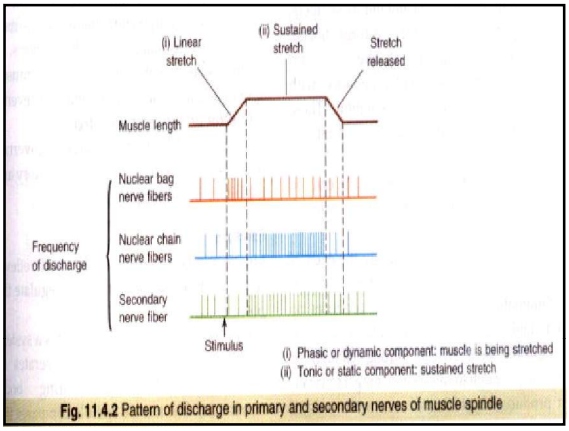


Fig. 11.4.2 Pattern of discharge in primary and secondary nerves of muscle spindle

The role of Y efferents in inducing muscle contraction

• Direct recording of activity in Y fibers are made by dissecting filament from the ventral root
• Discharge in such fibers is tonic in an anesthetized intact animal.
• Spinal transections above the segmental level depresses such discharge.
• Intercollicular transection of an anesthetized animal (sherrigtonian decerebration) markedly increases both Y discharge and muscle tone

Y Discharge

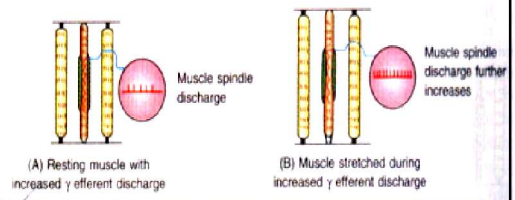


Fig. 11.4.5 Effect of stretching of muscle with increased γ-efferent activity on muscle spindle discharge (compare with Fig. 11.4.3)

Y Discharge

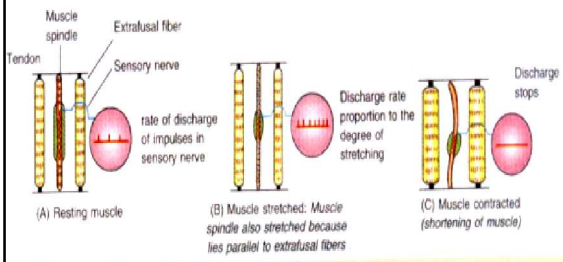
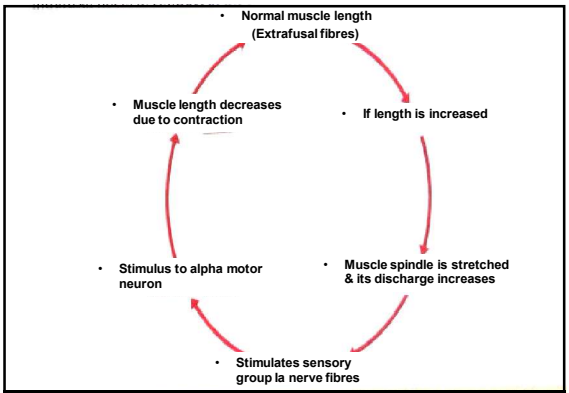


Fig. 11.4.3 Variation in muscle spindle discharge



Length Servo Mechanism

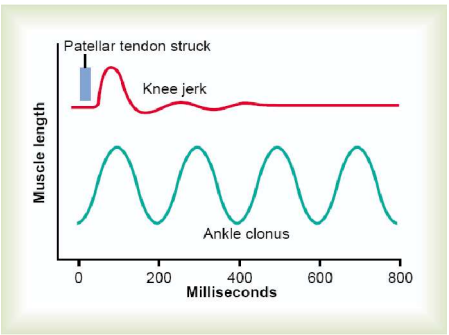
Reflexes

Part II

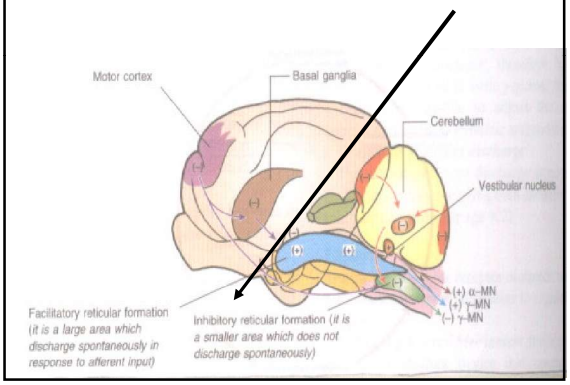
Contents

- Knee jerk
- Higher control of stretch reflex
- Flexor reflex
- Crossed extensor reflex
- Golgi tendon reflex
- Properties of reflex action
- Mass reflex

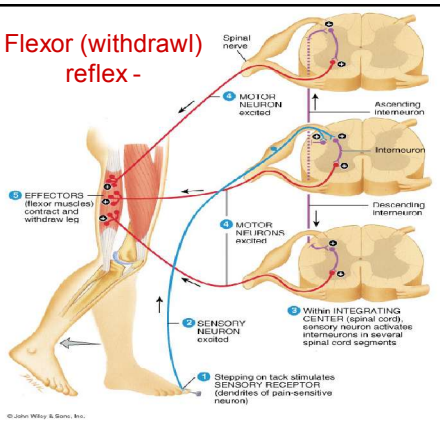
Knee jerk



HIGHER CONTROL OF STRETCH REFLEX



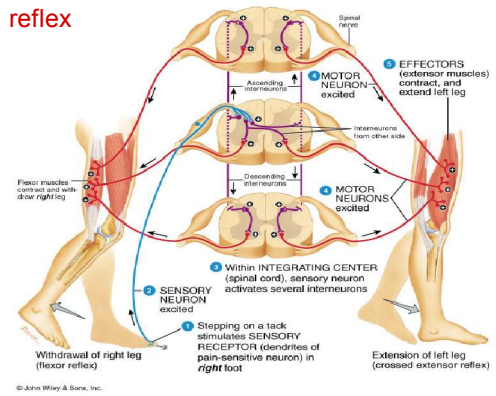
Flexor (withdrawl) reflex -



Flexor Reflex

- The *flexor (withdrawal) reflex* is ipsilateral
- Is protective :- contraction of flexor muscles to move a limb to avoid injury or pain.
  - Step on painful object
  - pain fibers send signal to spinal cord
  - Interneuron branch to different spinal cord segments
  - Motor fibers in several segments are activated
  - More than one muscle group activated to lift foot off of tack

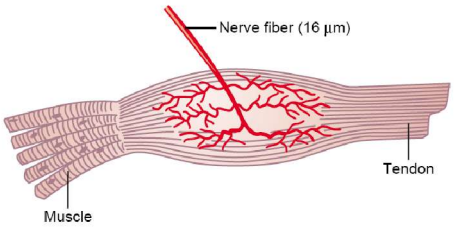
Crossed extensor reflex

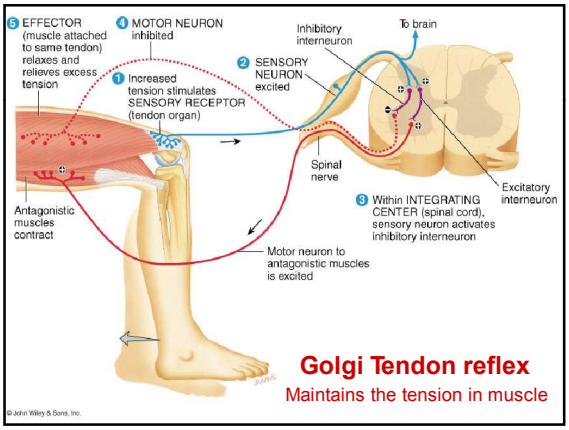


crossed extensor reflex

- It is contralateral, helps to maintain balance during the flexor reflex.
- synchronized flexion of one limb and extension in the opposite limb.
  - **Pain signals cross to opposite side of spinal cord**
  - **Contralateral extensor muscles are stimulated by interneurons**
- To hold up the body's weight Reciprocal innervation – when extensors contract flexors relax

Golgi Tendon





Golgi Tendon reflex

- Controls muscle tension by causing muscle relaxation when tension becomes too high
- Ipsilateral polysynaptic reflex
  - **Golgi tendon organs are activated by stretching of tendon**
  - **Inhibitory interneuron neuron is stimulated**
  - **Motor neuron is hyperpolarized and muscle relaxes**
- Both tendon & muscle are protected
- Reciprocal innervation causes contraction of ipsilateral opposite muscle group

Properties of reflex action

- Delay
- Reciprocal innervation – Withdrawl reflex
- Facilitation – Response gradually increases
- Habituation – Benign & frequent stimuli ↓ response
- Sensitization – Noxious stimulus prolong facilitation
- Subliminal fringe
- Occlusion

Cntd…

Summation – Temporal, Spatial
Irradiation – Spreads in neighboring areas
After discharge – Reverberating circuits
Fatigue – Exhaustion of NT
Recruitment –↑ strength → ↑magnitude
Inhibition - Presynaptic
Susceptibility to hypoxia -↓ Response

Mass Reflex

- When central excitatory state is marked excitatory impulses irradiate to autonomic areas along with somatic areas of spinal cord e.g. in paraplegic person noxious stimulus may cause urination, defecation, sweating, BP fluctuations in addition to prolonged withdrawl extension patterns