II. REFLEX ANATOMY & ACTIVITY

- One category of STIMULUS-RESPONSE SEQUENCES.

- REFLEX - rapid, predictable motor response to a stimulus.
  * Unlearned or learned, involuntary

- Most happen with no awareness (e.g.: visceral activities controlled by spinal cord, brain stem & basal nuclei - no cortex intervention = no awareness).

- LEARNED REFLEXES - acquired reflexes; result from practice & repetition.
  * Car driving, playing a sport, walking, writing, etc.

A) REFLEX ARCS

- Specific neural pathways.
- RECALL: All have 5 components:
  1. Receptor--stimulus action
  2. Sensory neuron--afferent impulses to CNS.
  3. Integration area--always centered in CNS.
  4. Motor neuron--go from integration center to the effector.
  5. Effector--muscle or gland cell that responds by contracting, secreting, etc. Usually have an excitable membrane & are stimulated by neurotransmitter.

B) TYPES OF REFLEXES - Classified based on:

  1. Amount of integration. Simplest = MONOSYNAPTIC = direct synapse between an afferent & efferent neuron. POLYSYNAPTIC = interconnections of interneuron leads to a cascade effect.

  2. Location of reflex relative to the stimulus. Contralateral (a reflex that occurs on the opposite side of the body as the stimulus) vs Ipsilateral (reflex occurs on the same side as the stimulus)

  3. Functional classification: SOMATIC (activate skeletal muscle tissue) vs. AUTONOMIC or VISCERAL (activate cardiac muscles or glands).

(I). Somatic Reflexes – further subdivided by which part of the CNS is controlling the reflex:

  1. Spinal reflexes
     i. Stretch: Patellar, Biceps, Triceps & Achilles’
     ii. Superficial: Plantar & Babinski’s sign

  2. Cranial
     i. Corneal
     ii. Gag

(II). Autonomic Reflexes: We will study many in A&P2. Pupillary reflex is example in A&P1.

* Here, we will mostly concern ourselves with SOMATIC.
1) SPINAL REFLEXES - mediated by the spinal cord (not cranial nerves!).

* Many occur w/out higher brain centers.
**pithing a frog.
* However, the brain is usually advised & has some means to either facilitate or inhibit these reflexes.

(a) STRETCH & GOLGI TENDON REFLEXES – Maintaining muscle tone or length while preventing “over-stretching”

- Proprioceptors maintain TONE = resistance to active or passive stretch at rest.

* Muscle spindles & Golgi tendon organs are always sending info to cerebellum & cerebrum about amount of stretch of tendons, ligaments and muscles, so you know where your limbs are, and movements can be coordinated. However, normal muscle tone depends on stretch reflexes initiated by spindles monitoring changes in muscle length, and is mediated by the spinal cord.

* INTRAFUSAL (“within the tube”) muscle fiber = specialized muscle fiber.

Stretch reflexes initiated by muscle spindles must maintain healthy muscle tone, while The Golgi Tendon organs (proprioceptors) must prevent overstretching and tearing of the tendons.

1. STRETCH REFLEX (SR)

- The stretch reflex is a muscle contraction in response to stretching within the muscle.

* It is often a monosynaptic reflex which provides automatic regulation of skeletal muscle length.

- When a muscle lengthens, the muscle spindle is stretched and its nerve activity increases.

* This increases motor neuron activity, causing the muscle fibers to contract and thus resist the stretching.

* A secondary set of neurons also causes the antagonist muscle to relax (= RECIPROCAL INHIBITION). The reflex functions to maintain the muscle at a constant length.

* IPSILATERAL (synapse on same side of body) & MONOSYMPATIC (often).
- “Deep Tendon Reflex”: mimic this by tapping on tendon. Stretches muscle.
  
  * “Knee Jerk” is an example.
  ** Polysynaptic. At same time, interneurons excite antagonists = RECIPROCAL ACTIVATION.
  
  \[\text{stretch patellar tendon} \rightarrow \text{stretch quads} \rightarrow \text{increase AP on muscle spindle} \rightarrow \text{incr. AP on afferent} \rightarrow \text{contract quad, relax hamstrings.}\]
  
  **HYPOACTIVE KNEE-JERK: peripheral nerve or ventral horn damage.
  **ABSENT KNEE-JERK: advanced diabetes mellitus & neuro-syphilis.
  **HYPERACTIVE KNEE-JERK: lesions on tract (lessens inhibition of antagonist); polio & stroke patients.

2. **GOLGI TENDON REFLEX** – protect the tendon from tearing. Supersedes the stretch reflex (PREPOTENT).

*Opposite effect of SR; muscle relaxes in response to stretching. Skeletal muscle contraction causes the agonist muscle to simultaneously lengthen and relax. Acts to protect muscle against over-stretching; get to a point and it “shuts-off” the muscle. So, you drop a heavy weight.

*IPSILATERAL (synapse on same side of body) & MONOSYNAPTIC.

Unfortunately, fast actions, such as in some sports and accidents, may happen too fast for this reflex, and damage to tendons occurs.

Used to believe that these organs were responsible for “weightlifting failure” – lifting weights until muscle “fails”, but shown not to be true (despite what you read in weight-lifting and massage magazines).

We use a reflex test called “clasped-knife response” to check for lesions on motor neuron.
2) FLEXOR & CROSS-EXTENSION REFLEXES – avoiding pain or perceived damage. Polysynaptic. 
* common, everyday reflexes; very complicated. Mixing of ipsilateral withdrawal & contralateral (opposite side) extensor reflexes.

1. FLEXOR REFLEX (FR) : the “WITHDRAWAL REFLEX”
The withdrawal reflex (nociceptive or flexor withdrawal reflex) is a spinal reflex intended to protect the body from damaging stimuli. It is polysynaptic; causing stimulation of sensory-, association-, and motor neurons.

   * a response to painful stimulus (actual OR perceived), where stimulus causes an automatic withdrawal of body part.

   ** e.g.: moving hand of hot stove.

   * Polysynaptic & ipsilateral

   * FRs are PREPOTENT (override spinal pathways, preventing other pathways from getting in the way of the action. Bet you can’t NOT do them!!).

**Done in conjunction with:**

2. CROSSED EXTENSOR REFLEX

Once a nociceptor has been stimulated, the signal travels via the sensory nerve to the dorsal (posterior) horn of the spinal cord.

The nerve synapses with ipsilateral motor neurons that exit the ventral (anterior) horn of the spinal cord and work to pull the soon-to-be injured body part away from danger within 0.5 seconds. (the Flexor reflex).

At the same time, the sensory neuron synapses with the ipsilateral motor neuron, as well as the motor neuron in the contralateral anterior horn.

This motor neuron stabilizes the uninjured side of the body (for instance; preparing the other leg to support the entire body weight when the other foot has stepped on a tack).

At the same time as these two synapses, the sensory neuron also sends signals along the spinal cord to get motor neurons to contract muscles that shift the center of gravity of the body to maintain balance.

![Crossed-extensor reflex](image-url)
3) SUPERFICIAL REFLEXES – any withdrawal reflex elicited by noxious or tactile stimulation of the skin, cornea, or mucous membrane, including the corneal, pharyngeal, and cremasteric reflexes. swallowing reflex palatal reflex.

PLANTAR REFLEX -very complex; draw a blunt object along plantar surface (sole of foot) = downward flexion of toes.

**BABINSKI’S SIGN: infants, with same stimulation, exhibit a lateral movement of toes until 1 yr old.

III. CLINICAL TERMS

- NEURALGIA - sharp, spam-like pain along the course of 1 or more nerves.

- NEURITIS - inflammation of nerve; many different effects.

- SHINGLES / HERPES / COLD SORE/ CHICKENPOX - virus (Herpes spp., Herpes zoster = chicken pox); invades dorsal root of spinal nerves, forming blister-like lesions on the skin. Is not curable; present for life. during periods of weakened immune system, re-activated virus migrates along sensory nerve associated with the infected dorsal root ganglion. SHINGLES = above the waist dermatome, HERPES = below the waist dermatome.