Lab Activity 14

Reflexes
Reflexes

- A reflex is a rapid, predictable motor response to a stimulus
- Reflexes may:
  - Be inborn (intrinsic) or learned (acquired)
  - Involve only peripheral nerves and the spinal cord (aka: spinal reflexes)
  - Involve higher brain centers as well
Reflex Arc

- There are five components of a reflex arc
  1. **Receptor** – site of stimulus
  2. **Sensory neuron** – transmits the afferent impulse to the CNS
  3. **Integration center** – either monosynaptic or polysynaptic region within the CNS
  4. **Motor neuron** – conducts efferent impulses from the integration center to an effector
  5. **Effector** – muscle fiber or gland that responds to the efferent impulse
Reflex Arc

STEP 1: Arrival of stimulus and activation of receptor

STEP 2: Activation of a sensory neuron

Dorsal root

Sensation relayed to the brain by collateral

Ventral root

STEP 3: Information processing in CNS

KEY
- Sensory neuron (stimulated)
- Excitatory interneuron
- Motor neuron (stimulated)

STEP 4: Activation of a motor neuron

EFFERENT PATHWAY

STEP 5: Response by effector

Stimulus

Receptor

REFLEX ARC

Effector
Innate Reflexes

- **Innate reflexes**: Reflexes you are born with.
- They are genetically or developmentally programmed.
- **Examples:**
  - Withdrawing from pain
  - Suckling
  - Chewing
  - Tracking objects with the eyes
Acquired Reflexes

- **Acquired reflexes** are learned motor patterns
- Generally more complex than innate reflexes
- **Examples:**
  - Slamming on the break when driving
  - Professional skier making quick adjustments in body position
Reflexes

- **Visceral** (Autonomic) reflexes regulate body functions
  - Digestion, blood pressure, sweating etc…

- **Somatic** reflexes involve skeletal muscles
  - Function to maintain posture, balance and locomotion
Reflexes

- **Spinal reflexes**: The important interconnections and processing events occur in the spinal cord.

- **Cranial reflexes**: The integration center is in the brain
Types of Reflexes

- **Monosynaptic reflexes**: The sensory neuron synapse directly on a motor neuron.
  - The delay between stimulus and the response is minimized.
  - The synapse is considered the integration center.

- **Polysynaptic reflexes**: There is at least one interneuron between the sensory and motor neuron.
  - More complex responses.
Upper Motor Neurons

- Upper motor neurons: Starts in the motor cortex of the brain and terminates within the medulla (another part of the brain) or within the spinal cord.
  - Damage to upper motor neurons can result in spasticity and exaggerated reflexes (because of the loss of inhibition) “Spastic Paralysis”
Lower Motor Neurons

- Lower motor neurons go from the spinal cord to a muscle.
- The cell body of a lower motor neuron is in the spinal cord and its termination is in a skeletal muscle.
- The loss of lower motor neurons leads to weakness, twitching of muscle (fasciculation), and loss of muscle mass (muscle atrophy). “Flaccid Paralysis”
Reflexes

• Intact reflexes require
  • Intact sensory afferent nerves (coming to the spinal cord)
  • Intact synapse within the spinal cord
  • Intact efferent motor nerves coming from the spinal column
  • Adequately functioning muscle.
Testing Reflexes

• Reflexes can also be modified by conditions higher in the cord than the relevant synapse including the brain itself.
• The purpose of testing reflexes is to check the integrity of the system as a whole.
• An absent reflex indicates a problem somewhere in the reflex arc but it does not tell you where.
Stretch Reflexes

1. Stretching of the muscle activates a muscle spindle
   - A muscle spindle is a bundle of specialized skeletal muscle fibers that act as sensory receptors

2. An impulse is transmitted by afferent fibers to the spinal cord

3. Motor neurons in the spinal cord cause the stretched muscle to contract

4. The integration area in the spinal cord causes the antagonist muscle to relax (reciprocal inhibition)
Stretch Reflex Example
Patellar Reflex (L2, L3, L4)

- Tap the patellar tendon
  - muscle spindle signals stretch of muscle
  - motor neuron activated & muscle contracts
- Quadriceps muscle contracts
- Hamstring muscle is inhibited (relaxes)
  - Reciprocal innervation (polysynaptic- interneuron)
  - antagonistic muscles relax as part of reflex
- Lower leg kicks forward
- Demonstrates sensory and motor connections between muscle and spinal cord are intact.
1. Stretching stimulates SENSORY RECEPTOR (muscle spindle)
2. SENSORY NEURON excited
3. Within INTEGRATING CENTER (spinal cord), sensory neuron activates motor neuron
4. MOTOR NEURON excited
5. EFFECTOR (same muscle) contracts and relieves the stretching

Antagonistic muscles relax

To brain

Motor neuron to antagonistic muscles is inhibited

Inhibitory interneuron

Stretch Reflex
Stretch Reflex Example
Ankle Jerk (S1, S2)

• Stretch the Achilles tendon by pushing up with your left hand on the ball of the foot (extend the ankle)

• Swing the patellar hammer onto the tendon striking it sharply.

• Measure the response by feeling the push against your left hand and observing the contraction of the calf muscles
Stretch Reflex Example
Biceps jerk (C5, C6)

• Bend the patient’s arm at the elbow so it is lying relaxed across the lower part of the chest.

• Find the long head of biceps tendon in the antecubital fossa and stretch it by pushing down on it with your thumb.

• Swing the patellar hammer down and strike your thumb sharply.
Grading Reflexes

• Grading of reflexes:
  • 0+ = absent
  • 1+ = hyporeflexic (reduced reflex)
  • 2+ = normal
  • 3+ = hyperreflexia (exaggerated reflex)
  • 4+= clonus
  • Say “one plus”

• Conditions such as hypothyroidism and spinal shock diminish reflexes.

• Stimulant drugs, anxiety, and hyperthyroidism increase reflexes.
Tendon Reflexes

- Controls muscle tension by causing muscle relaxation that prevents tendon damage
- Golgi tendon organs in tendon
  - Activated by stretching of tendon
  - Inhibitory neuron is stimulated (polysynaptic)
  - Motor neuron is hyperpolarized and muscle relaxes
- Both tendon & muscle are protected
Tendon Reflex
Flexor Reflex

- Withdrawal reflex

- When pain receptors are activated it causes automatic withdrawal of the threatened body part.

- Reciprocal inhibition: Interneurons in the spinal cord prevent a stretch reflex in the antagonistic muscles
Flexor (Withdrawal) Reflex
Crossed Extensor Reflex

• Complex reflex that consists of an ipsilateral withdrawal reflex and a contralateral extensor reflex

• This keeps you from falling over, for example if you step on something painful. When you pull your foot back, the other leg responds to hold you up.
Crossed Extensor Reflex

1. Stepping on a tack stimulates SENSORY RECEPTOR (dendrites of pain-sensitive neuron) in right foot.
2. Sensory neuron activated.
3. Within INTEGRATING CENTER (spinal cord), sensory neuron activates several interneurons.
5. Effectors (extensor muscles) contract and extend left leg.

Withdrawal of right leg (flexor reflex).

Extension of left leg (crossed extensor reflex).
Cutaneous Reflexes

• Elicited by gentle cutaneous stimulation

• Important because they depend on upper motor pathways (Brain) and spinal cord reflex arcs
Cutaneous Reflexes
Plantar Reflex

• Tests spinal cord from L4 to S2
• Indirectly determines if the corticospinal tracts of the brain are working
• Draw a blunt object downward along the lateral aspect of the plantar surface (sole of foot)
• Normal: Downward flexion (curling) of toes
Abnormal Plantar Reflex
Babinski’s Sign

• Great toe dorsiflexes (points up) and the smaller toes fan laterally

• Happens if the primary motor cortex or corticospinal tract is damaged

• Normal in infants up to one year old because their nervous system is not completely myelinated.
Plantar Reflex

Normal

Abnormal (Babinski’s)
The End