Monosynaptic reflex arcs

- When a muscle is stretched, it responds by contracting. This is the stretch reflex.
- The stretch receptor is a small fusiform object in the muscle; it is an encapsulated organ inside the muscle tissue.
- The impulses it produces travel via fast neurons directly to the motor neurons which supply the same muscle.
- The neurotransmitter at that synapse is glutamate.
- A typical monosynaptic reflex is the KNEE JERK REFLEX.
  - **Muscle spindles:**
    - Three essential elements:
      - A group of specialized INTRAFUSAL MUSCLE FIBERS which contractile polar ends and a noncontractile center.
      - Large diameter myelinated nerve fiber, types Ia and II originating from the central portion of the intrafusal muscle fibers.
      - Small diameter myelinated efferent nerves innervating the polar contractile regions of the intrafusal fibers.
      - The intrafusal fibres are positioned in parallel with the normal muscle fibres; the ends of the spindle capsule are attached to the tendons at either end of the muscle. They don’t contribute to contractility- they have a purely sensory role.
      - There are two types of intrafusal fibres: nuclear bag and nuclear chain.
      - Nuclear bag fibers have a central portion full of nuclei, the nuclear chain fibers have a bunch of nuclei strewn along its length.
      - There are two types of nuclear bag fibers, the DYNAMIC and the STATIC.

NERVE FIBERS IN THE MUSCLE SPINDLE: type Ia and type II

- Each spindle just has 1 type Ia and up to 8 type II fibers.
- They type Ia wraps around the centre of the intrafusal muscle fibers.
- Type II innervate the centre as well, but they DO NOT innervate dynamic nuclear bag fibers.
- Ia fibers are sensitive to the velocity of muscle length change (the “dynamic response”) they inform the CNS regarding the speed of movements, and allow for rapid corrections.
- The steady-state “tonic” activity of type Ia and type II fibers provides the CNS with information about the steady state length of the muscles – the “static response”.

- The spindles have a nerve supply of their own: the nerves are 3-6 micrometres in diameter and they occupy 30% of the total diameter of the ventral root.
- These efferent neurons are called GAMMA-MOTOR-NEURONS.
- There are two types: dynamic and static.
- The dynamic ones supply the nuclear chain fibers and the dynamic nuclear bag fibers; the static efferent neurons supply static nuclear bag fibers only.
  - Activation of dynamic gamma-motor neurons increases the dynamic activity of type Ia endings.
  - Activation of the static gamma-motor-neurons increases the levels of tonic activity in both group Ia and group II afferents, and decreases the dynamic sensitivity of Ia afferents.

- When the muscle spindle is stretched, the sensory endings are distorted, and they produce a signal with a frequency which is proportional to the degree of stretching.
- Thus, the spindle and the reflex arc operate in a way which maintains muscle resting length.

**PHYSIOLOGICAL TREMOR:**

- Normally a small tremor occurs in the feedback loop because of conduction delays.
- This is a fine 10Hz tremor.

**Central connections:**

- The time between the application of stimulus and the muscle contraction response is the reaction time.
- In humans, it’s about 19-24 milliseconds.
- The central delay time taken to traverse the spinal cord – in humans is about 0.6-0.9 milliseconds.
- This means only one synapse is being traversed.