Reflex: Conducted through the spinal cord and brainstem

Two types of reflex: protective and regulatory

Protective examples: eye blink, gag reflex, limb withdrawl reflex.

Regulatory examples: oculomotor reflex (maintaining gaze), muscle stretch reflex (maintaining position).

Arrangement of α-motor neurons in the spinal cord:

- Neurons proximal to the body are located at the medial part of the ventral horn
- Neurons distal to the body are located at the lateral part of the ventral horn
- Extensors (e.g. triceps) neurons located closer to the central canal
- Flexors (e.g. biceps) neurons are located further away from the central canal, closer to the periphery grey matter.

Motor Unit and the size principle:

- Small motor unit contains arouns 20 muscle fibres, while large motor unit can contain up to 1000 muscle fibres.
- Smaller motor units have a smaller diameter, ions more likely to collide with cell membranes, greater resistance.
- Ohm's law: V=IR, higher resistance, produce greater voltage change at any current. Smaller motor units easier to reach action potential, small motor units are recruited first.
- Once recruited, increase in signalling strength leads to higher frequency of motor unit firing, increasing tension until reaching a maximum.

Muscle unit structures:

- Extrafusal spindles: Involved in contraction, innervated by α-motor neurons
- Intrafusa spindles: Sensing changes in length of the muscle fibre, innervated by
    - Type 1a-affarent (larger diameter, faster conucting, sensing dynamic changes)
    - Type II affarent (smaller diameter, slower conduction, sensing static changes). Also innervated by gamma-motor neurons.
- Golgi Tendon Organs (GTOs), located within the tendon, innervated by type 1b-affarent, axon of 1b affarent located within the collagen network, compression allow sensing muscle tension.

Reflex

- When the tendon is stretched, the stretch is detected by the intrafusal fibre, 1a affarent neuron transmit signal up to the spinal cord and down the α-motor neuron triggering contraction in agonist
- Reciprocal inhibition of antagonist via 1a inhibitory interneurons.
- Sometimes the agonist and antagonist co-contract to allow stiffening of the joints, bracing for sudden loads or changes in direction (e.g. catching load / going down the stairs)

Cross-extension reflex

- Aδ nociception neuron transmit signal to the spinal cord, causes contraction of flexor and relaxation of extensor via monosynaptic reflex.
- Inhibitory commissural neurons inhibit contralateral flexor and contract contralateral extensor, via trisynaptic pathway.
- Monosynaptic neuron withdrawl the limb while contralateral reflex strengthen the opposite length.

α/γ co-contraction: stimulation signal from the brain stimulate both alpha and gamma motor neurons, contraction of intrafusal and extrafusal fibres occur simultaneously, allow maintainence of tension during contraction.

Hoffmann's reflex and M-wave

- Artificial stimulation leads to both orthodromic and antidromic electric stimulation waves.
- Stimulation first excites larger diameter 1a affarent fibre, trigger monosynaptic reflex (H-reflex).
- Stronger stimulation excites α-motor neuron, produce contraction with shorter latency
- Stronger stimulation further excites α-motor neuron, antidromic wave cancels out orthrodromic wave from monosynaptic reflex.

Inverse myostatic reflex

- When under high tension, the 1b affarent fibre stimulate the 1b inhibitory interneuron to strongly inhibiti α-motor neuron contraction. Relaxes agonist muscle induce “clasp knife” reflex.
- Aδ nociception integrate signal to the 1b inhibitory interneuron, pain from cutaneous surface and joints inhibit contraction of agonist muscle. Protective reflex when injured

Approximate position of α-motor neurons in the spinal cord

Motor unit recruitment principle, number of motor fibres.

Motor unit structures: innervation, sensors.

Stretch reflex

Cross extension reflex

Inverse myostatic reflex

H-reflex and M wave