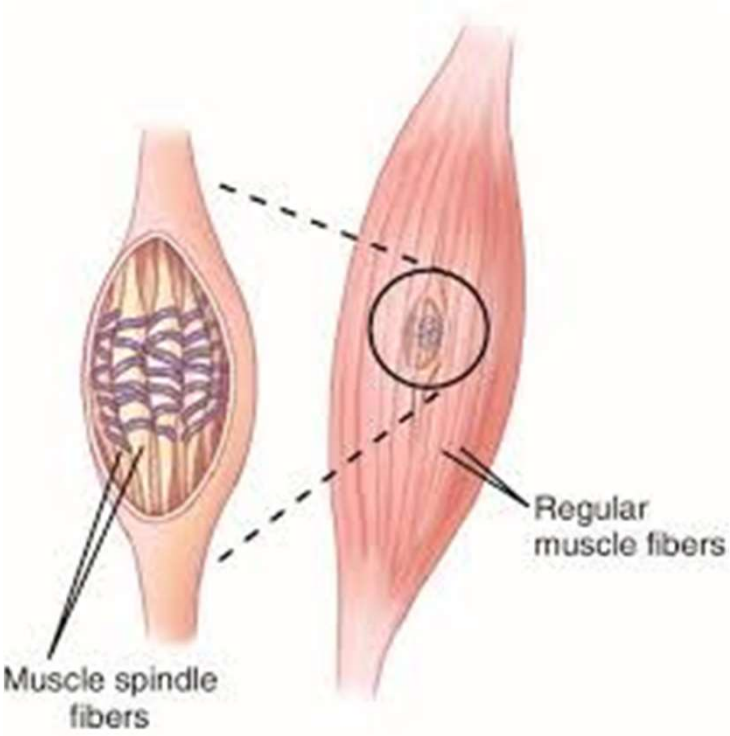

Muscle spindle

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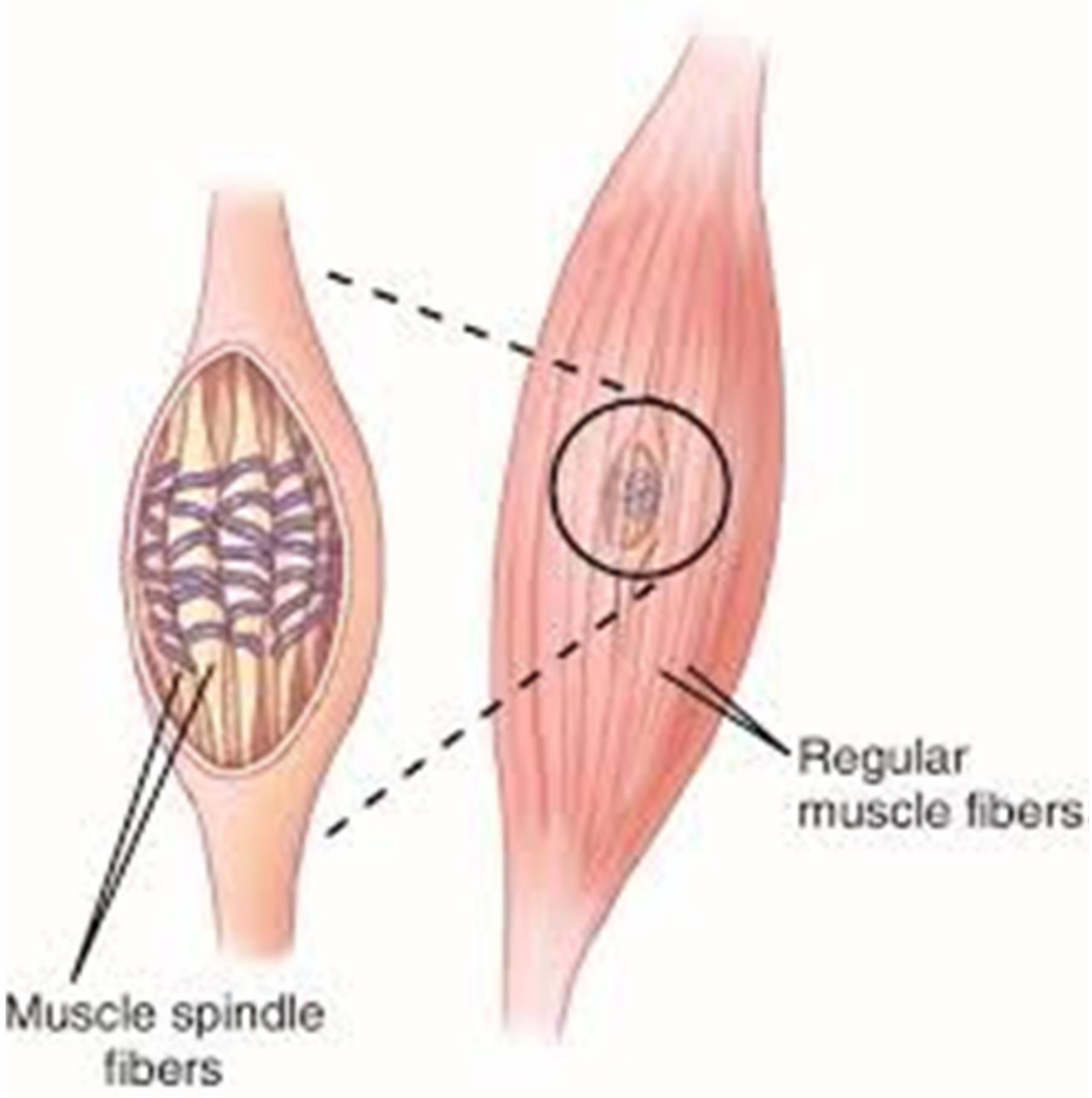
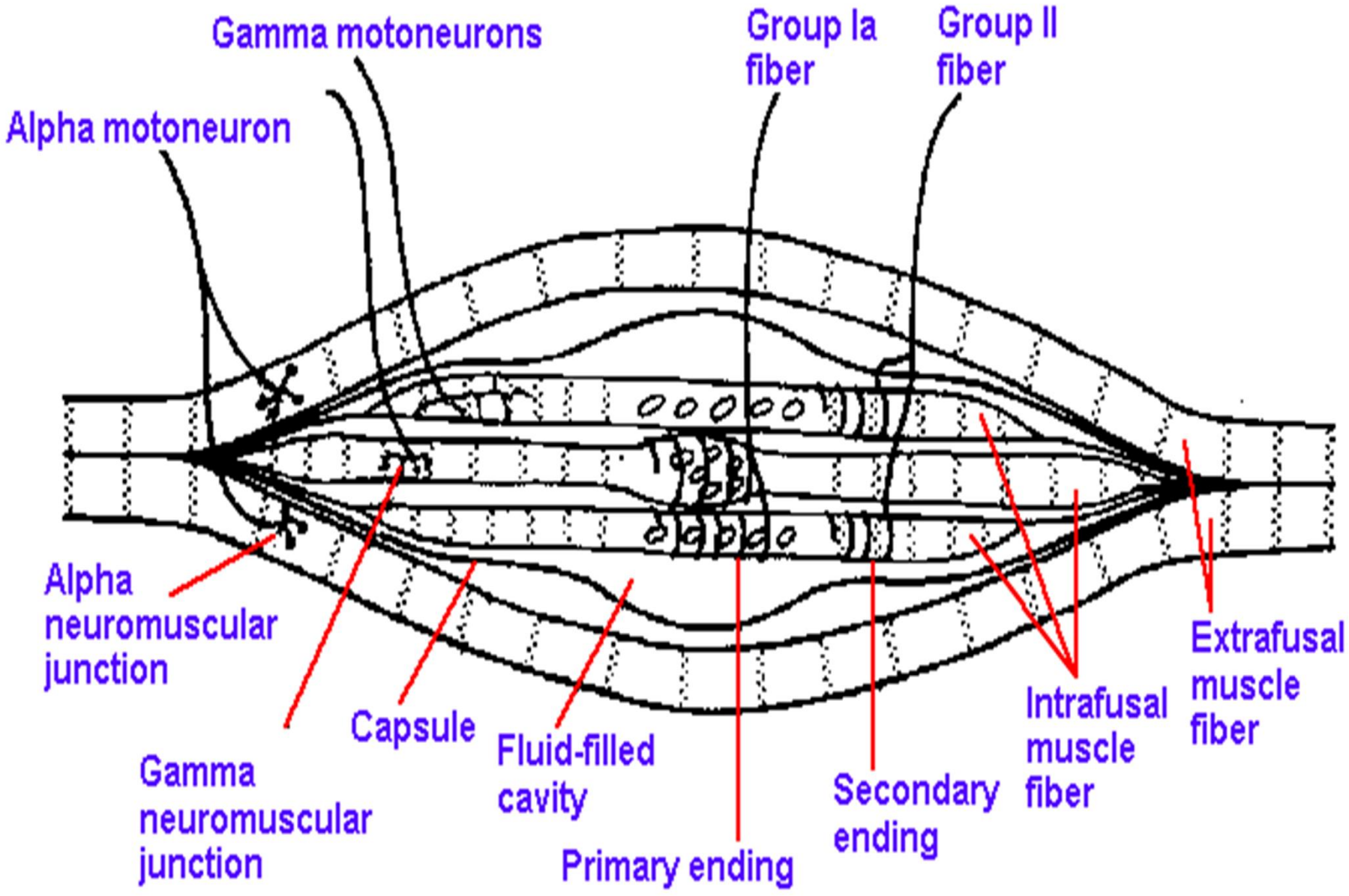
Where is muscle spindle?

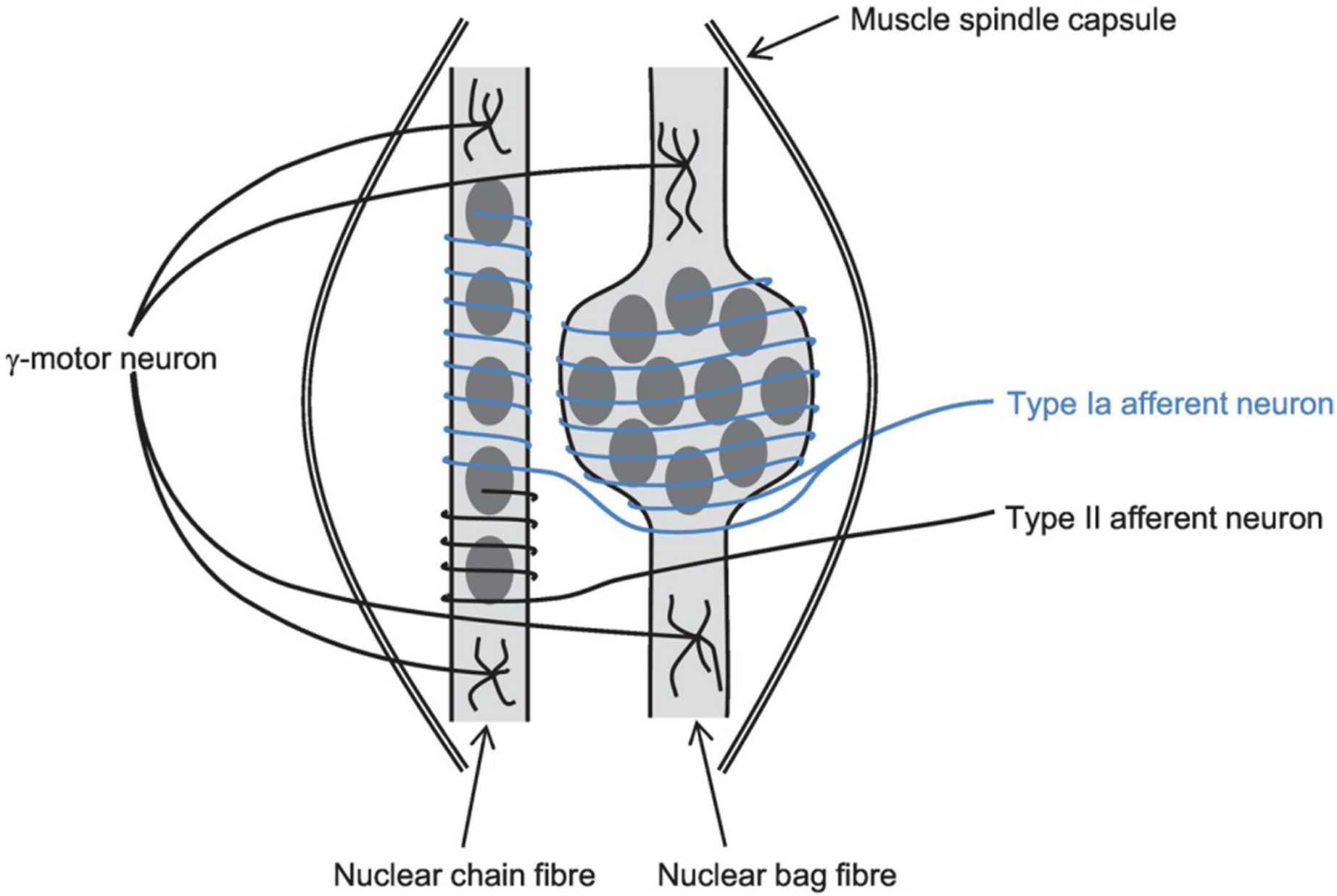
Dedicated sensory receptors found **within the belly of a skeletal muscle**.

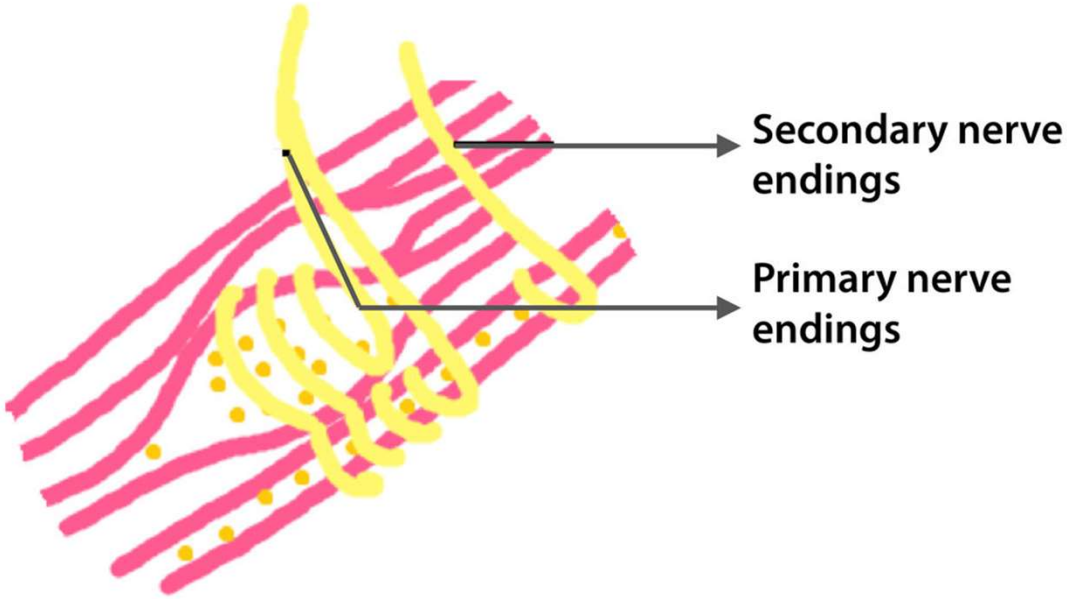
Muscle spindles are fusiform (spindle-shaped), and the specialized fibers that make up the muscle spindle are called **intrafusal muscle fibers**.

The regular muscle fibers outside of the spindle are called **extrafusal muscle fibers.**

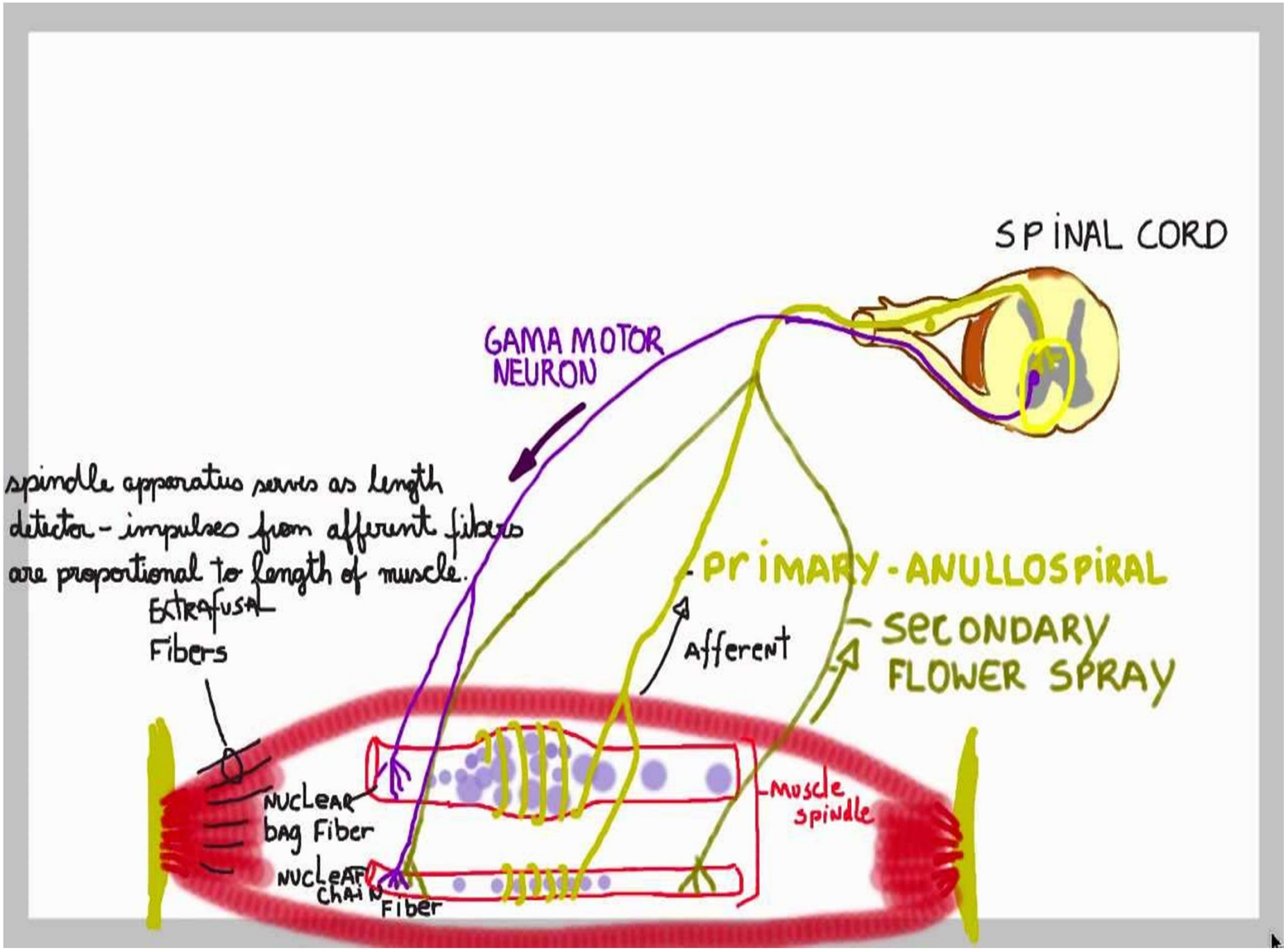

Regular
muscle fibers
Muscle spindle
fibers


Gamma motoneurons
Group Ia fiber
Group II fiber
Alpha motoneuron
Alpha neuromuscular junction
Gamma neuromuscular junction
Capsule
Fluid-filled cavity
Primary ending
Secondary ending
Intrafusal muscle fiber
Extrafusal muscle fiber


Muscle spindle capsule
γ-motor neuron
Type Ia afferent neuron
Type II afferent neuron
Nuclear chain fibre
Nuclear bag fibre



Primary nerve ending (I) (**Dynamic**) associated with change in **stretching** while secondary nerve ending (II) (**Static**) associated with change in **length .**


SPINAL CORD
GAMA MOTOR NEURON
spindle apparatus serves as length detector - impulses from afferent fibers are proportional to length of muscle.
EXTRAFUSAL Fibers
PRIMARY - ANULLOSPIRAL
SECONDARY FLOWER SPRAY
Afferent
NUCLEAR BAG Fiber
NUCLEAR CHAIN Fiber
Muscle spindle

Almost every muscle contains muscle spindles.
These **delicate sensory receptors** inform the central nervous system (CNS) about changes in the length of individual muscles and the speed of stretching. With this information, the CNS computes the position and movement of our extremities in space, which is a requirement for motor control, for maintaining posture and for a stable gait.

The responses of muscle spindles to c**hanges in length** also play an important role in regulating the **contraction of muscles**, by activating motor neurons via the stretch reflex to resist muscle stretch.

Muscle spindles are stretch receptors that signal the stretch and changes in length of muscles.

They are therefore stretched when the muscle lengthens but shorten when the muscle contracts.

Each spindle contains at least two nuclear bag and four nuclear chain intrafusal muscle fibers—

these can contract independently under the control of a γ-fiber motor supply to their intrafusal fibers.

They signal to the spinal cord via fast Ia afferents with annulospiral terminals and thinner, slower, group II fibers with flower-spray endings.

The **Ia fibers** respond to the rate of change of length (dynamic sensitivity), and the secondary endings signal the actual length (static sensitivity) of the muscle.

Muscle spindles also supply **stretch information** to the **cerebellum** for automatic adjustment and coordination of movements and to the **cerebral cortex** for conscious position sense.

Why are muscle spindles important?

Ultimately, the muscle spindle functions **to alert the brain that nearby joints and soft tissues are in danger of being stretched too far**.

These are important concepts in understanding body awareness (also known as proprioception and kinesthetic awareness).

- Muscle spindles are sensitive to changes in velocity and are innervated by **type 1a nerve fibers**.

- These afferent nerve fibers conduct the impulse directly to the spinal cord, where they are immediately conducted via interneurons to alpha motor neurons, which stimulate muscle contraction.

- **Gamma motor neurons** innervate intrafusal fibers and control their contraction.

- **When muscles lengthen, the spindles are stretched. This stretch activates the muscle spindle which in turn sends an impulse to the spinal cord**.

- This impulse results in the activation of more motor neurons at spinal level that send an impulse back to the muscle.

Withdrawal reflex –

Defined as **the automatic withdrawal of a limb from a painful stimulus.**

- Intended to protect the body from damaging stimuli.
- The reflex rapidly coordinates the contractions of all the flexor muscles and the relaxations of the extensors in that limb causing sudden withdrawal from the potentially damaging stimulus

- Spinal reflexes are often monosynaptic and are mediated by a simple reflex arc.

- A withdrawal reflex is mediated by a polysynaptic reflex resulting in the stimulation of many motor neurons in order to give a quick response

- What causes knee-jerk reflex?

- The normal knee-jerk or, "patellar jerk," reflex is elicited **when the knee is tapped below the knee cap (patella)**.

- Sensors that detect stretching of the tendon of this area send electrical impulses back to the spinal cord.

Alpha and gyama motor neurons activation through stretch reflex –

Gyama neurons – excited by descending tract pathway.

“Alpha – gyama motor neuron co-activation”

Jendrassik maneuver - Increases activity of **gyama motor neurons** – increases sensitivity

- During reflexes clinical exam – Clinical implications ?

JENDRASSIK'S MANEUVER OR reinfrorcement

- Voluntary muscle contraction any where in the body increases the sensitivity of the tendon reflex (stretch reflex)
- This is due to enchanced gamma efferent discharge to the muscle spindle. This procedure is termed Jendrassik;s maneuver