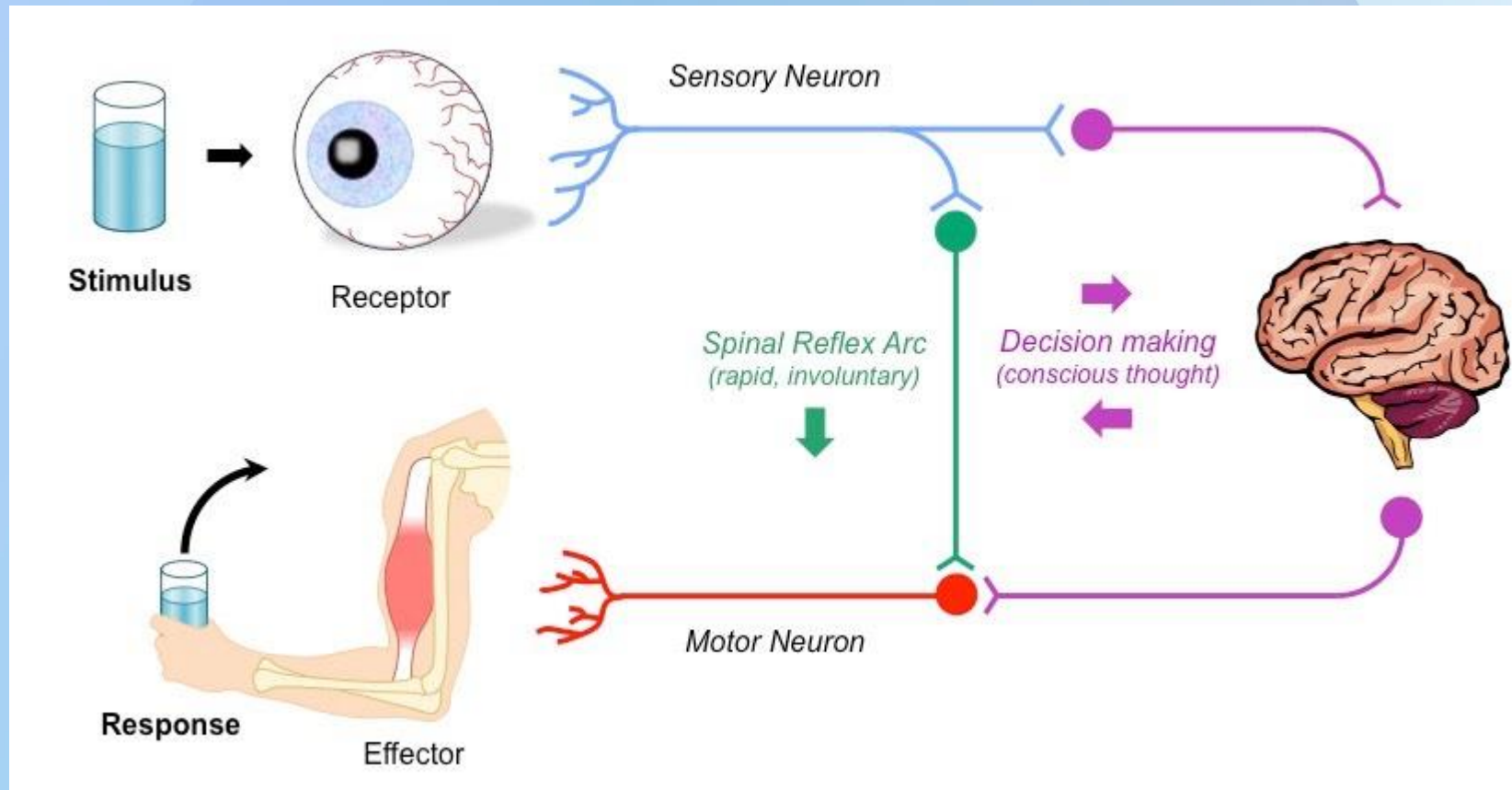


Spinal reflexes

Marte Rydland

A reflex is a protective response to stimulus that does not require consciousness

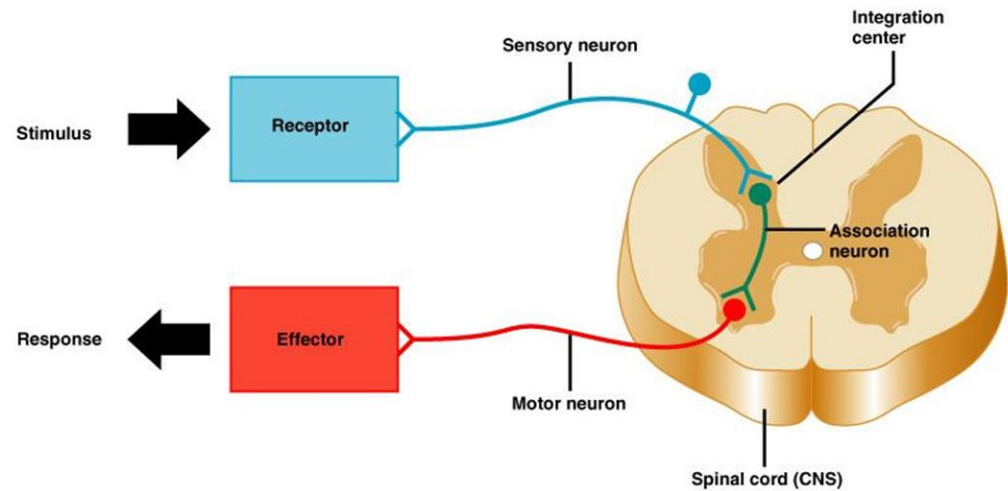


Reflexes

Elements of a reflex arc:

1. Receptor
2. Afferent pathway
3. Integration center
4. Efferent pathway
5. Effector

REFLEKS ARKI



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Types of reflexes

1. Stretch reflex

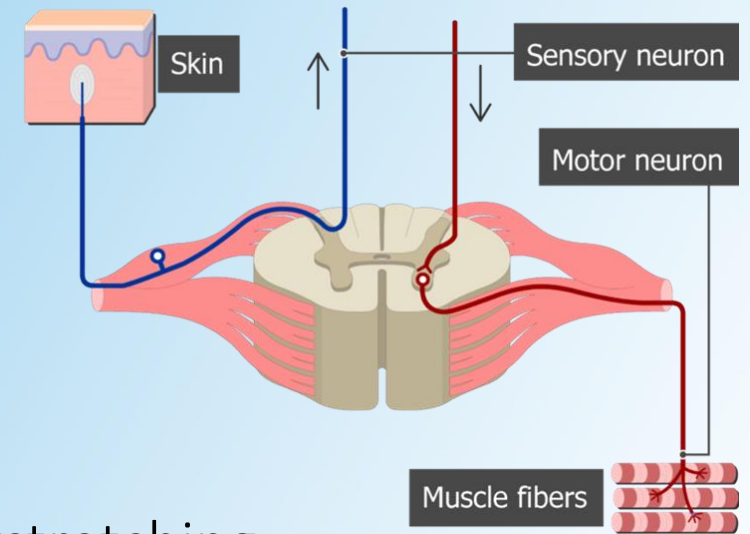
→ Protects from overstretching

2. Golgi tendon reflex

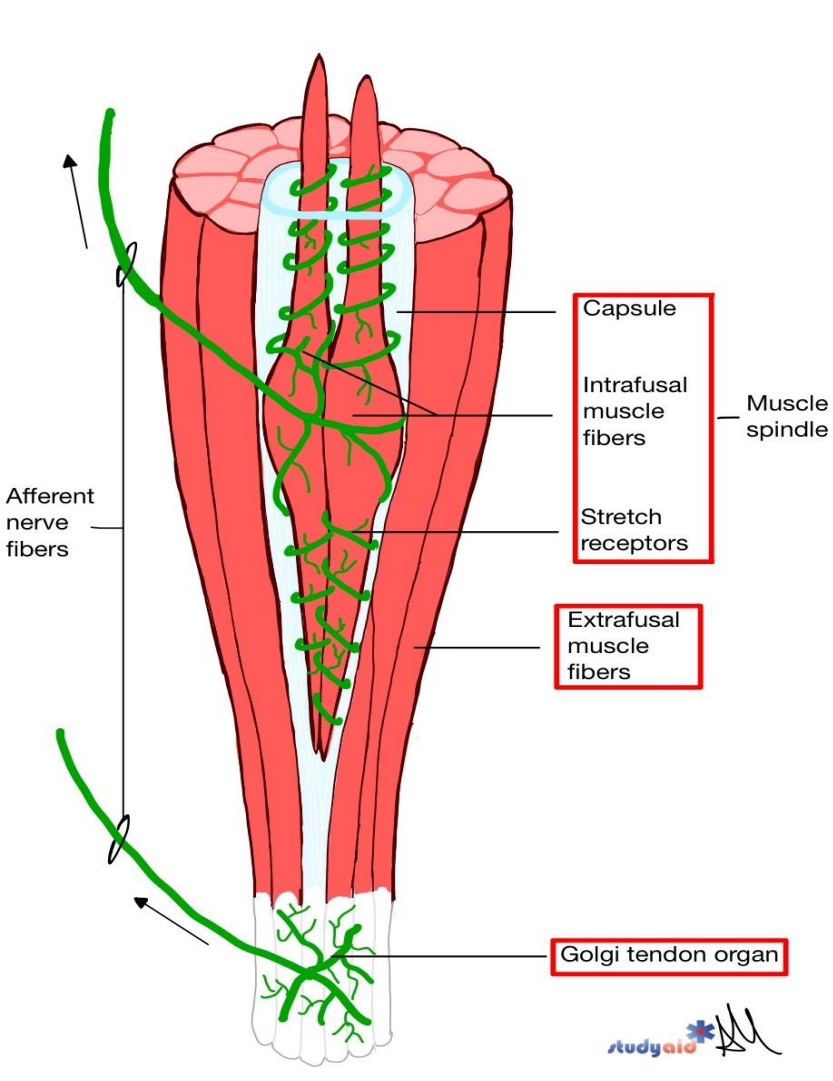
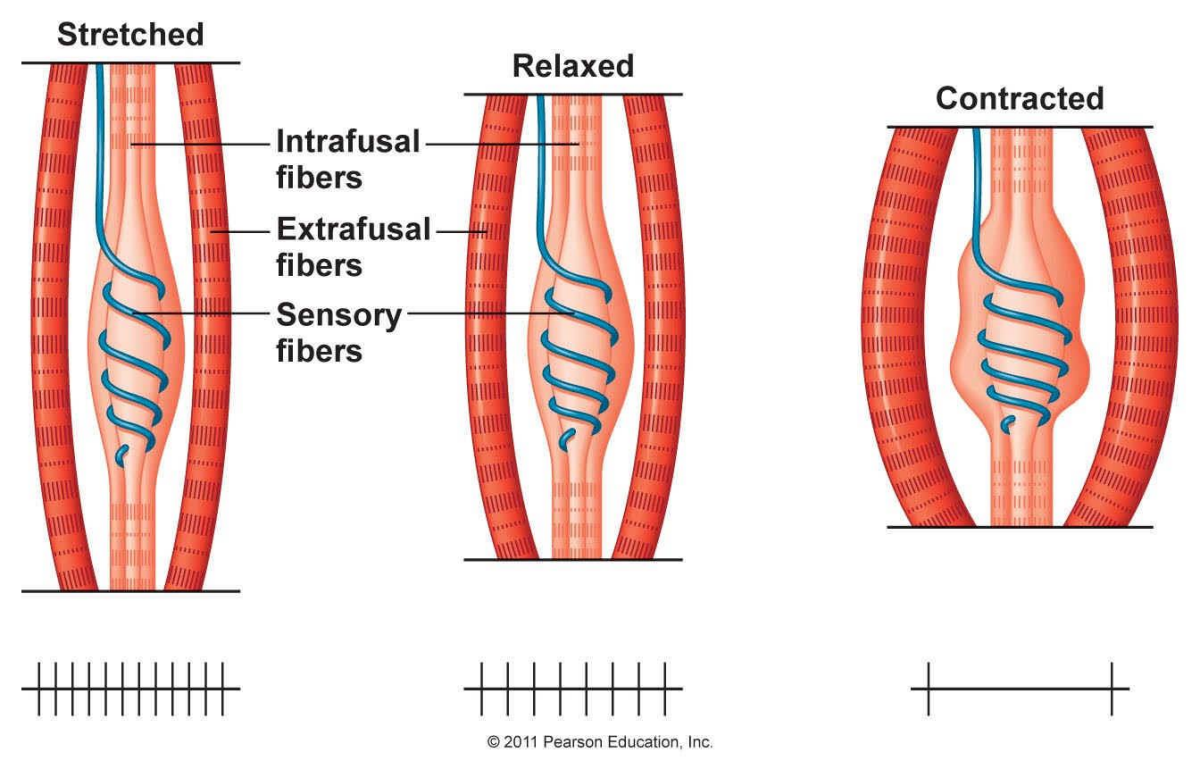
→ Protects from over contracting

3. Withdrawal reflex

→ Protects from potentially harmful stimuli



Muscle fibers



Types of muscle fibers

Extrafusal fibers

- Outer layer
- Provide the **force** for muscle contraction
- Most of skeletal muscle
- Innervated by α -motoneurons
- Attach to tendons


Intrafusal fibers

- Encapsulated in sheaths to form **muscle spindle**
- Innervated by γ -motoneurons
- Smaller than extrafusal fibers
- Too small to generate force
- Sensory receptors: Detect the **stretch** of a muscle



Intrafusal fibers – Muscle spindle

Nuclear bag fibers

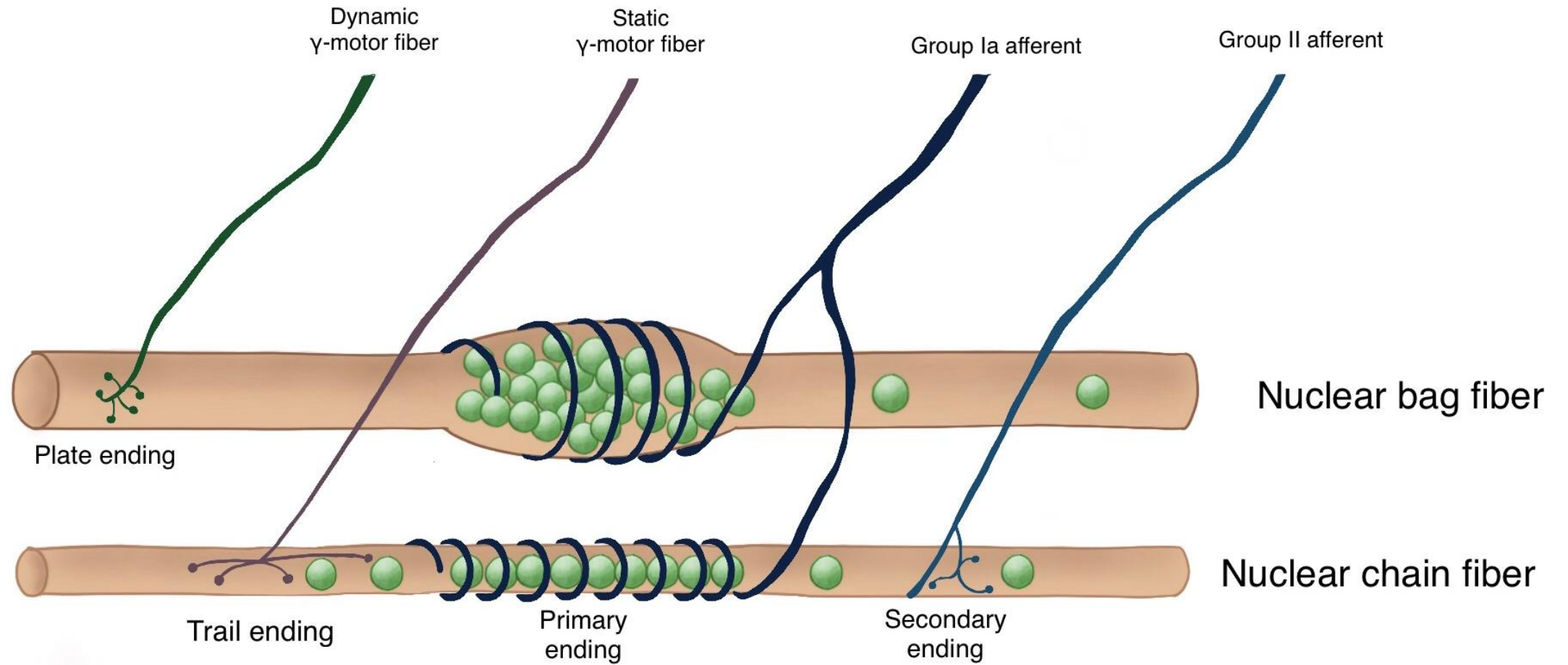
- Have nuclei collected in a "bag" region
- Onset of stretch
- Dynamic changes = LENGTH & VELOCITY
- Annulospiraling endings
- Innervated by group Ia afferents

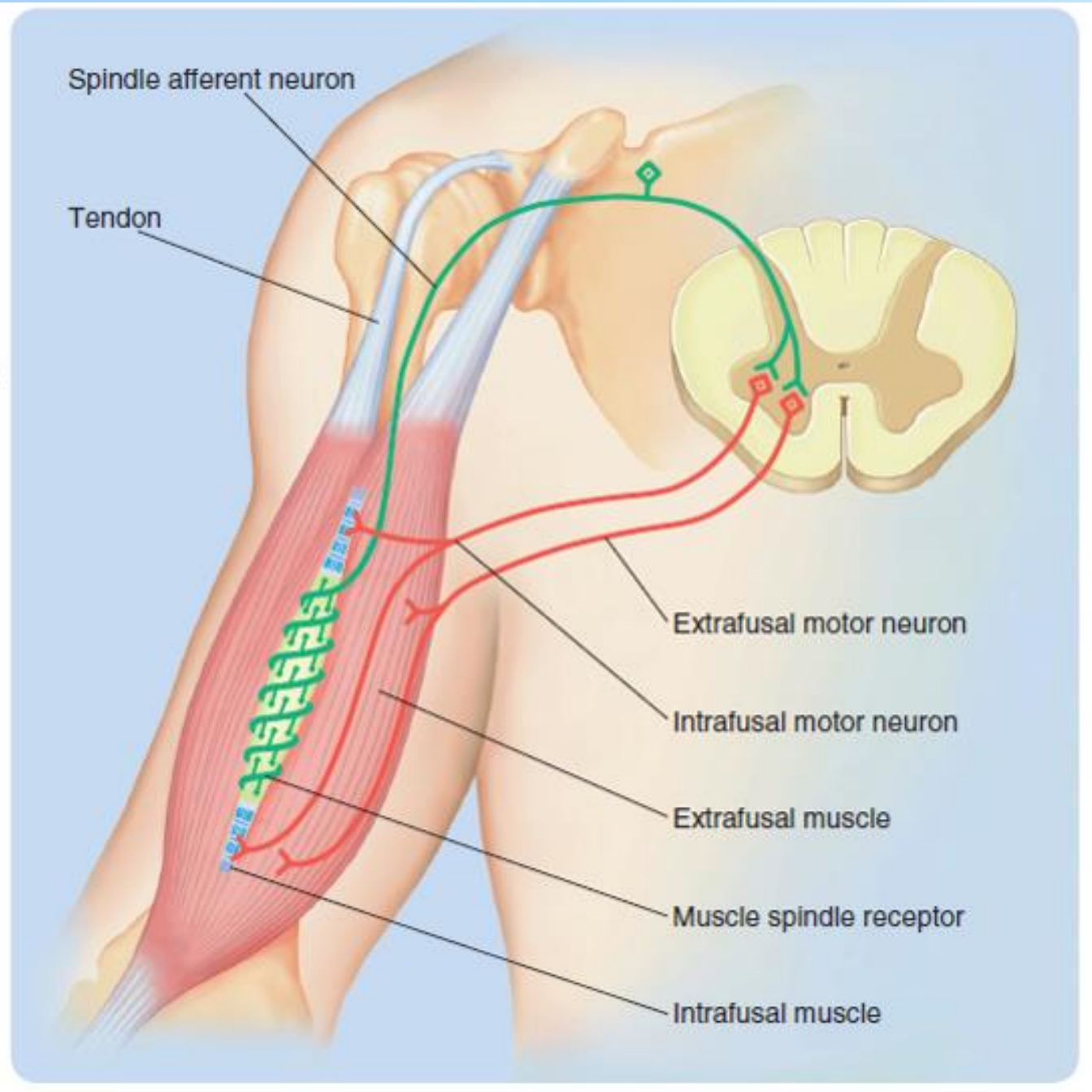
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RAPID

Nuclear chain fibers

- Have nuclei arranged in series
- Are more numerous than nuclear bag fibers
- Sustained stretch
- Static changes = LENGTH
- Flower spray endings
- Innervated by group Ia + II  SLOW 

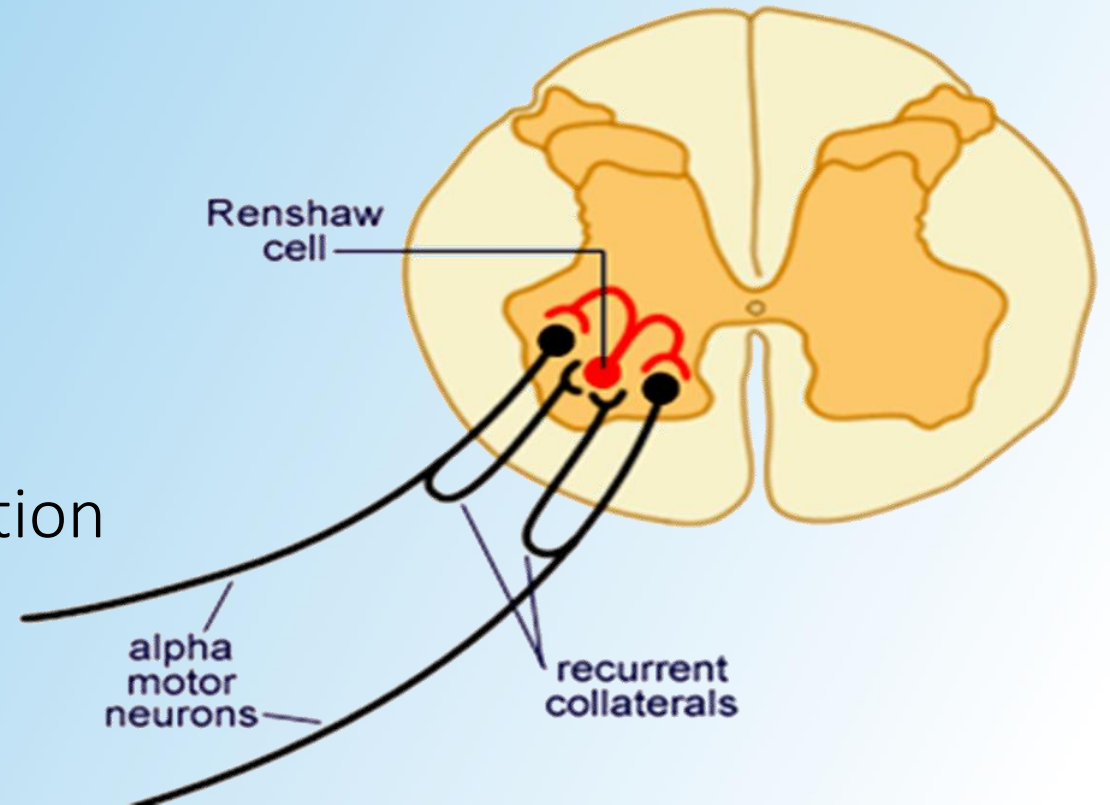
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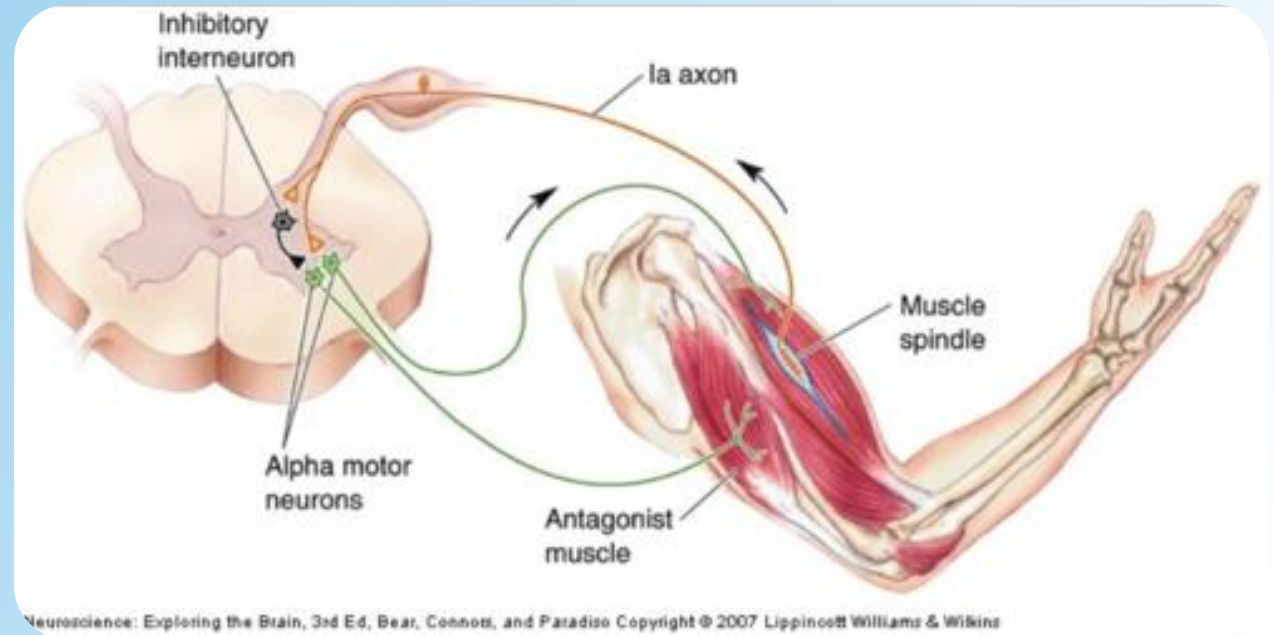
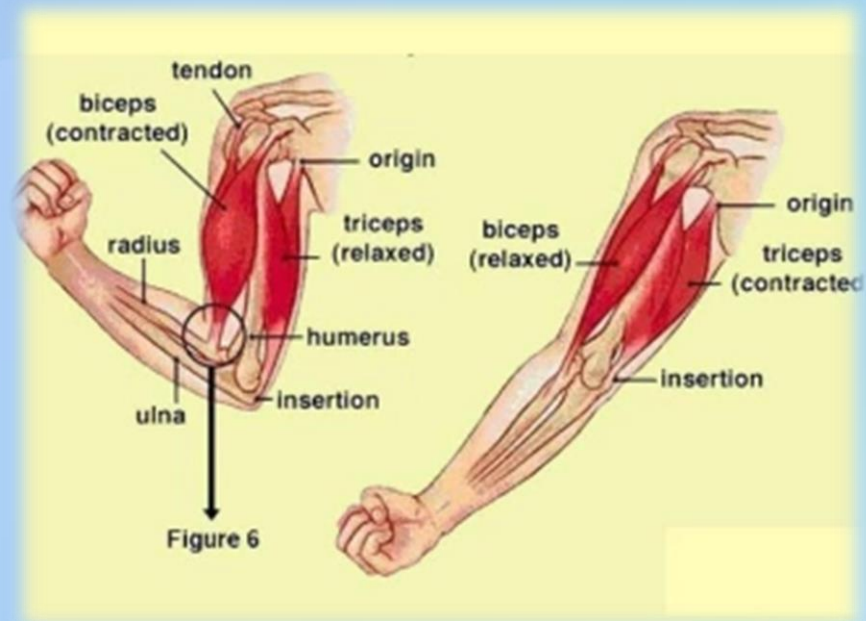
Renshaw inhibition

- Inhibitory interneurons
- Between LMN/AMN's
- Negative feedback loop
- Removes "noise"
- Prevents hyperactive muscle contraction



How to move a limb?

- Antagonizing muscles must do the opposite
- Flexors vs. extensors
- **Reciprocal innervation**
- Inhibiting interneurons

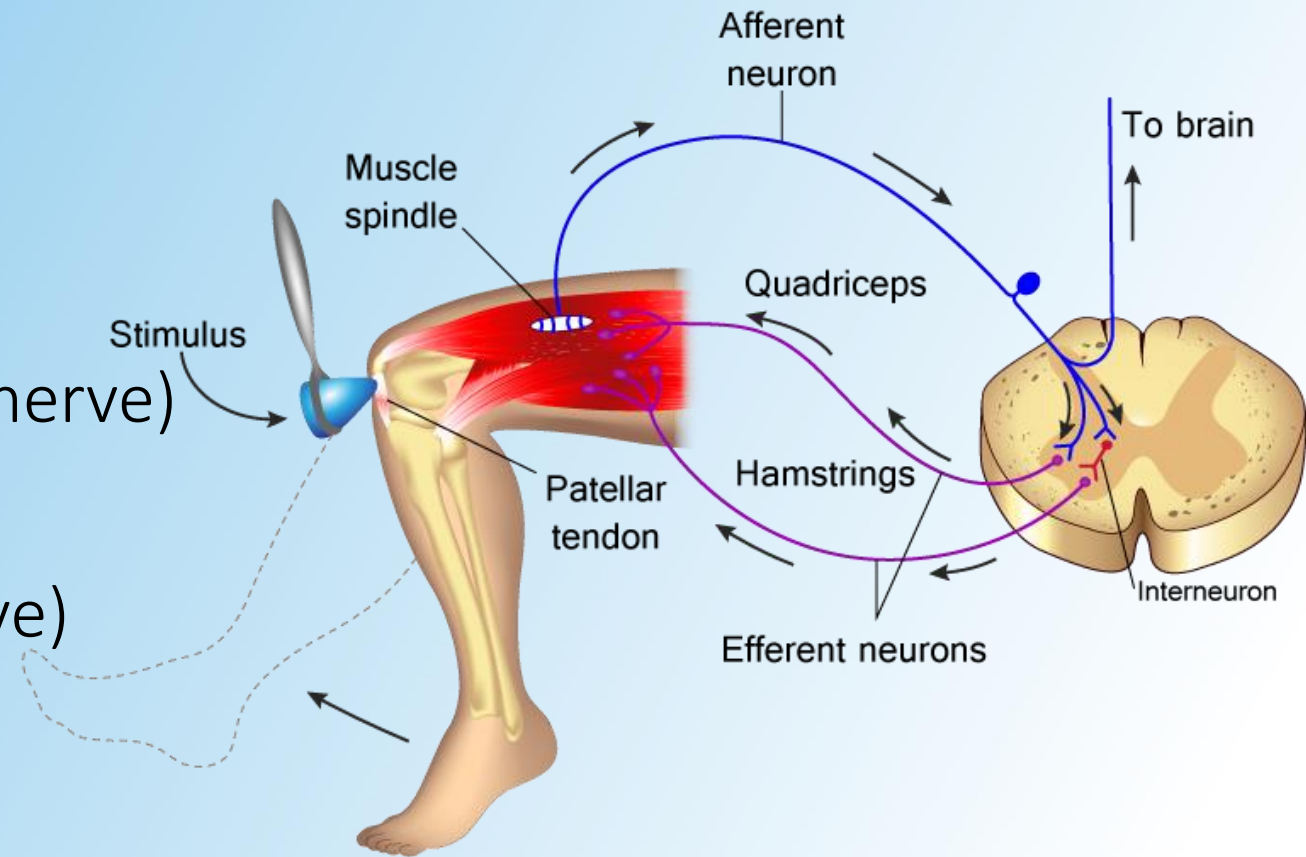


Neuroscience: Exploring the Brain, 3rd Ed, Bear, Connors, and Paradiso Copyright © 2007 Lippincott Williams & Wilkins

1. Stretch reflex (myotatic reflex)

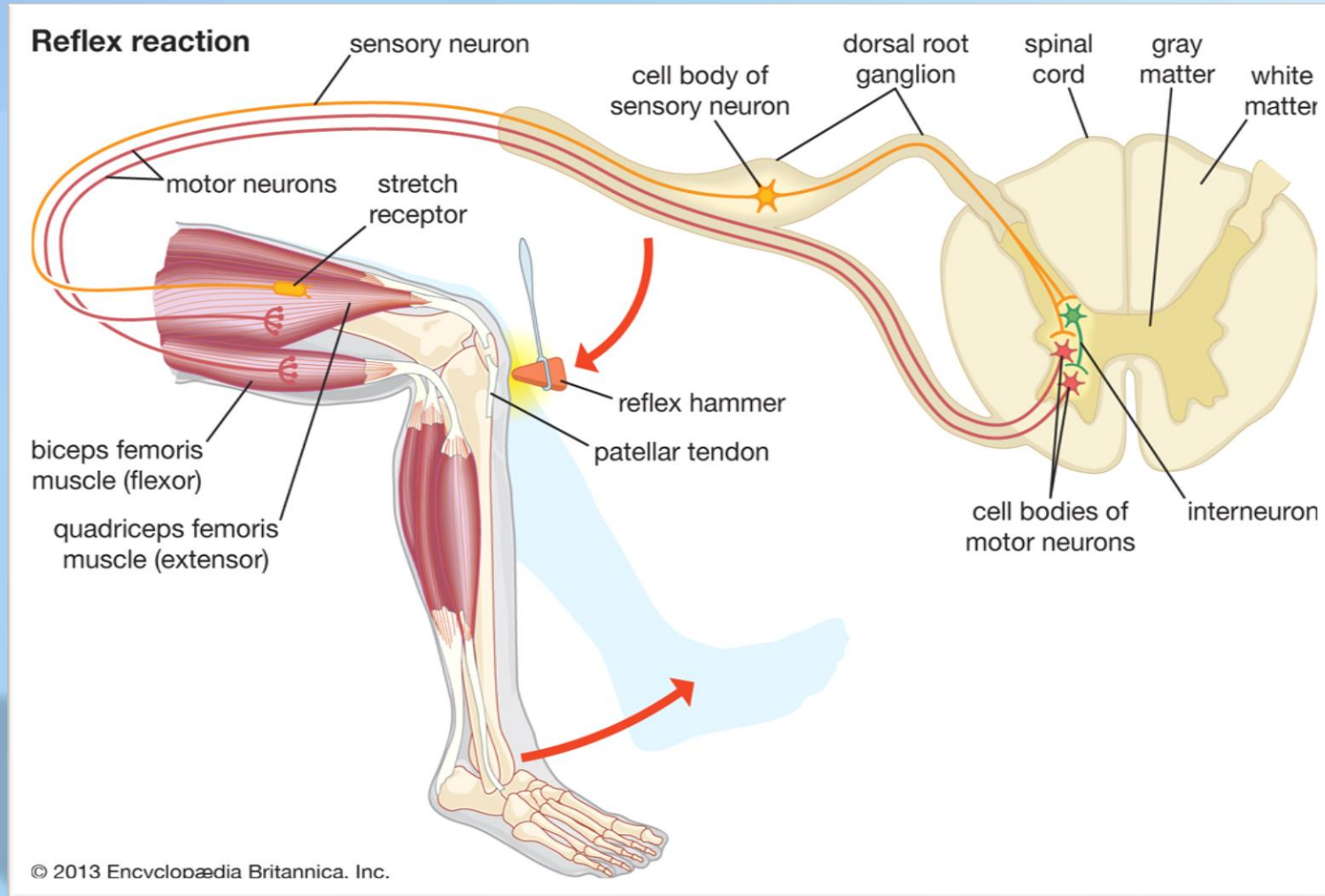
Stimulus: stretching of the muscle

1. Intrafusal fiber
2. Type Ia sensory fiber (afferent nerve)
3. Monosynaptic
4. α motor neurons (efferent nerve)
5. Extrafusal muscle fibers
= Agonist muscle contracts
= Antagonist relaxes



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Knee jerk reflex



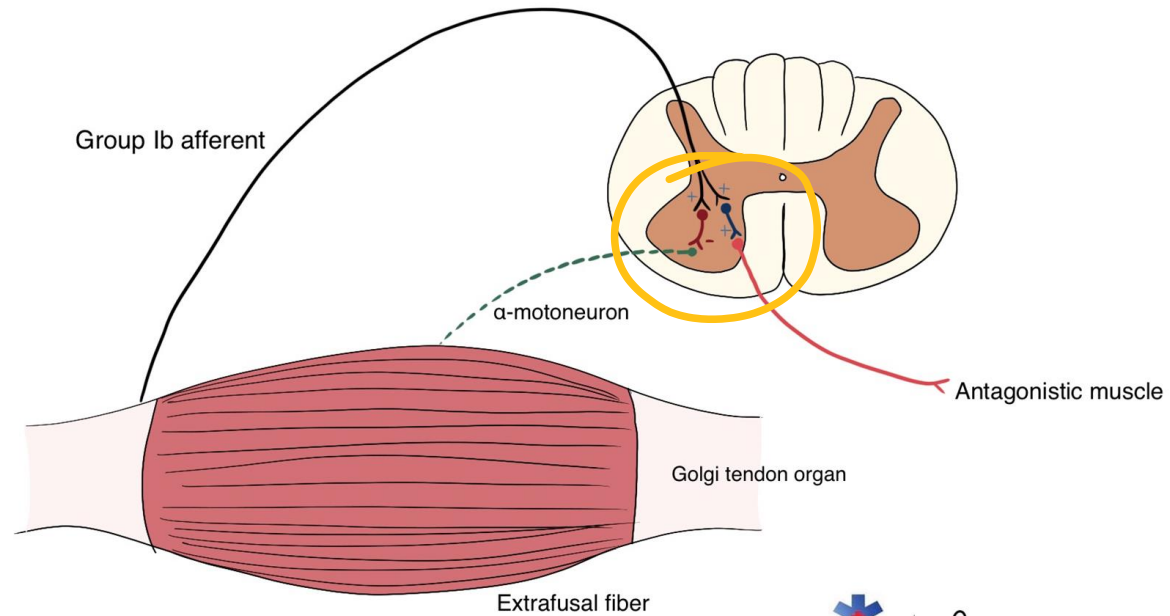


2. Golgi tendon reflex (inverse stretch)

Stimulus: contraction of the muscle

1. Golgi tendon organ
 2. Type Ib afferent fiber
 3. Polysynaptic/ disynaptic (2 synapses)
 4. α motor neurons (AMN)
 5. Agonist muscle relaxes + antagonist contracts
- Physiological significance:
 - Prevention of direct muscle damage
 - separation of the tendon from the bone

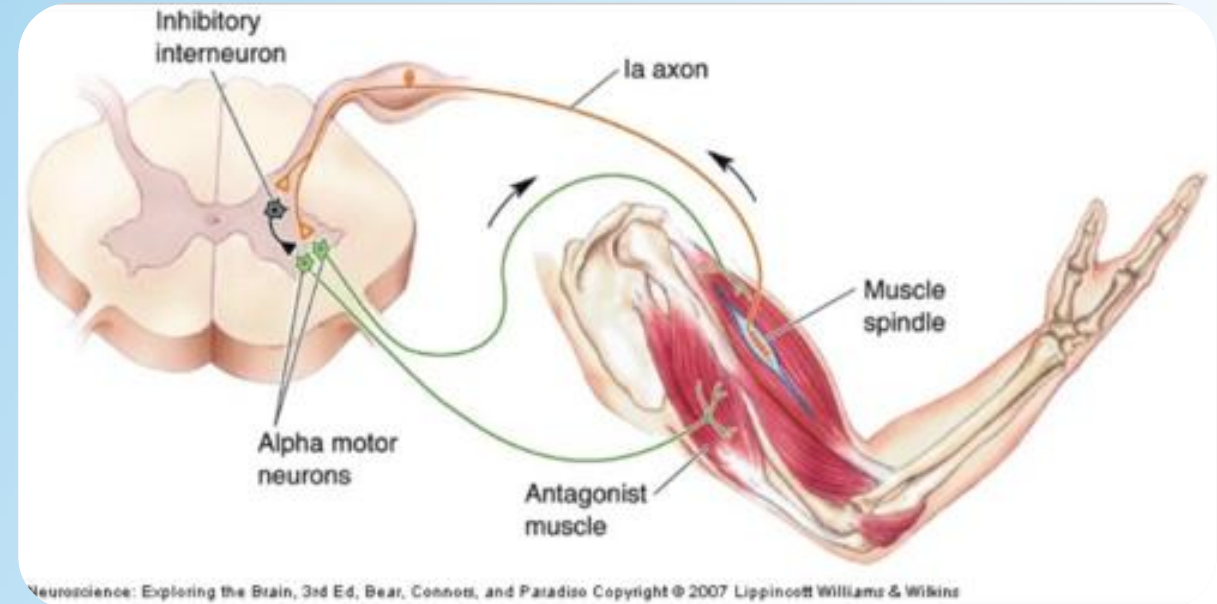
Disynaptic reflex



Clasp knife reflex



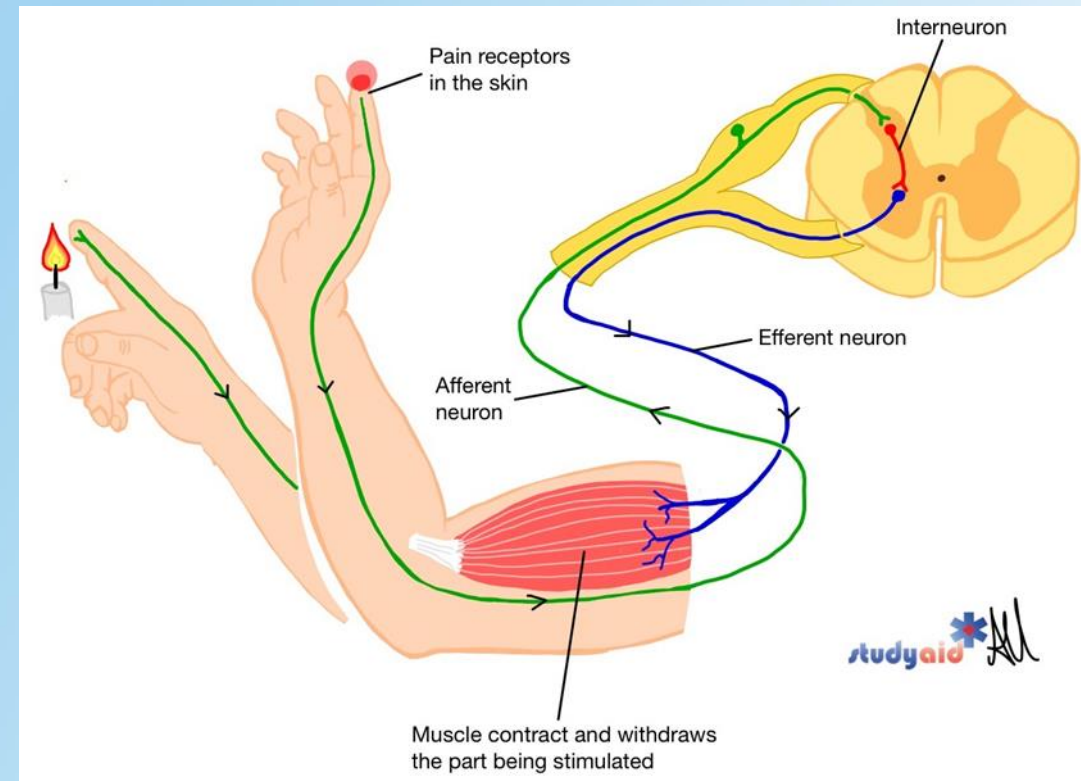
- UMN lesion
- Uncontrolled LMN
 1. Passive stretch reflex
 - Increased muscle tone
 - Increased stretch of muscle spindle
 2. Golgi tendon reflex
 - Loss of resistance
 - Relaxation of agonist muscle



3. Withdrawal reflex

Stimulus: noxious (pain)

1. Free nerve endings
2. Type III fibers ($A\gamma$)
3. Polysynaptic (many synapses)
4. α -motor neurons
5. Flexor muscle contracts + extensor relaxes



1. More than one joint
2. Crossed extensor response
= Opposite leg: flexor muscle relaxes, extensor contracts

- Prepotent reflex

	Stretch reflex	Inverse stretch reflex	Withdrawal reflex
Receptor	Muscle spindle	Golgi tendon organ	Free nerve endings
Afferent pathway	Type Ia fibers	Type Ib fibers	Type III fibers
Integration center	Monosynaptic	Poly-/disynaptic	Polysynaptic
Efferent pathway	α -motor neurons	α -motor neurons	α -motor neurons
Effector	Flexors relax Extensors contract	Agonists mm relax Antagonists mm contract	(Ipsilateral side) Flexors contract Extensors relax