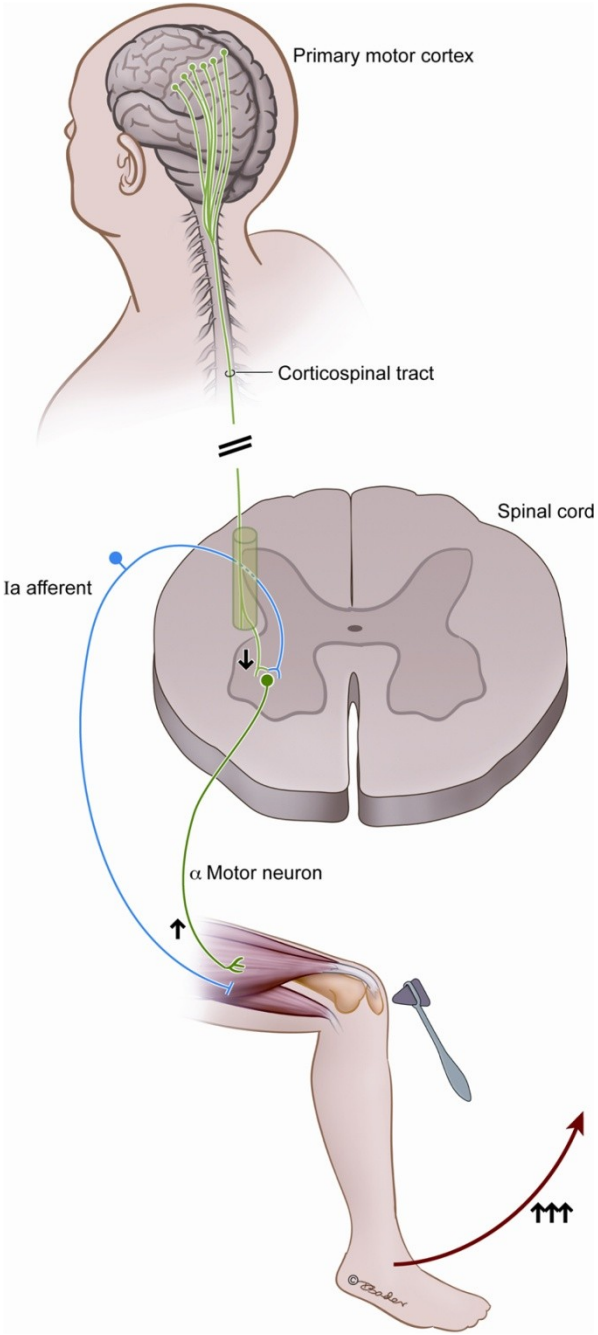
12
Motor system I

Introduction

- Skeletal muscle contraction is initiated by lower motor neuron



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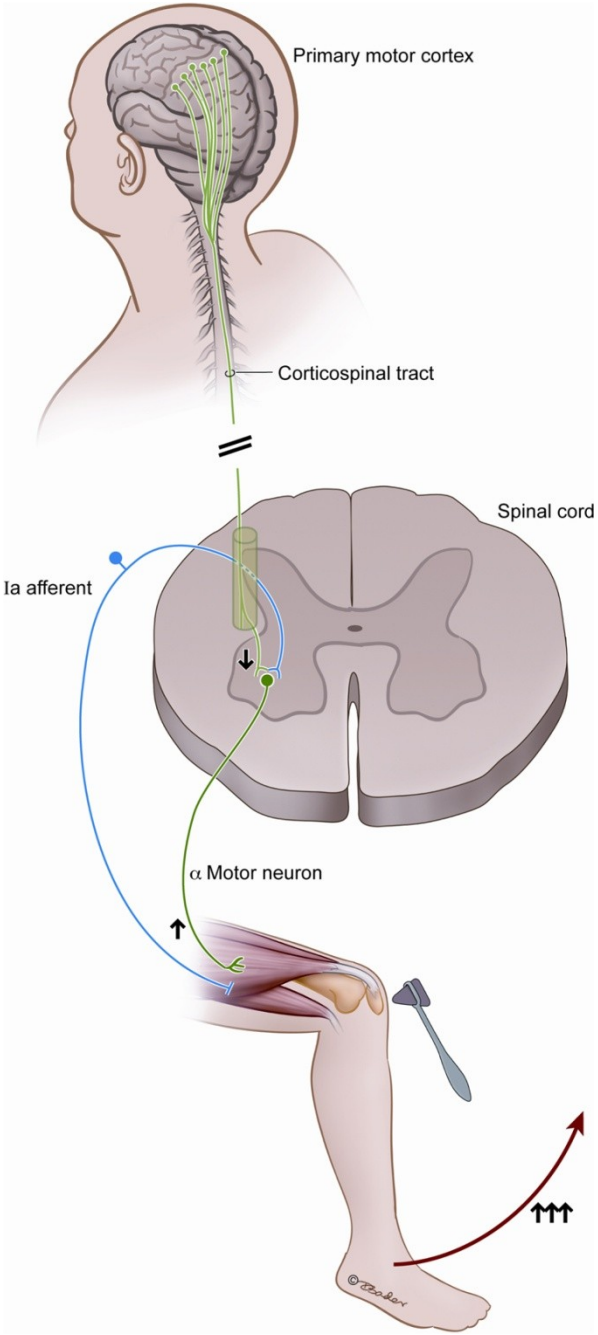
Introduction

- Skeletal muscle contraction is initiated by lower motor neuron
- Lower motor neuron is a part of local reflex circuits



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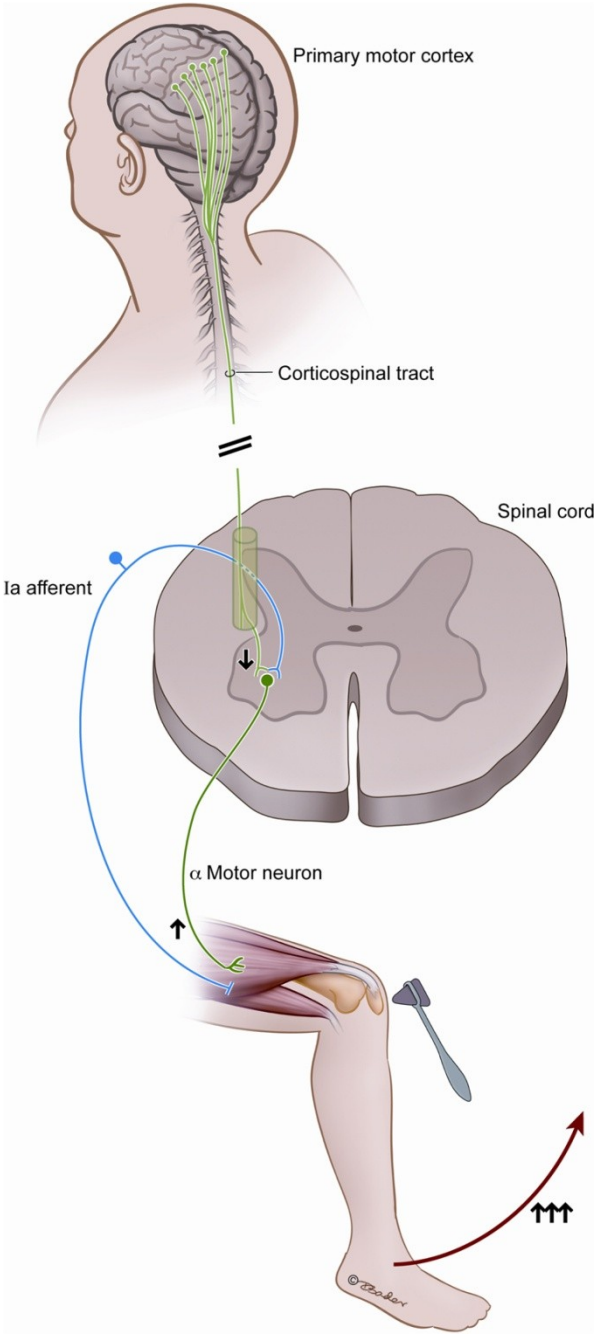
Introduction

- Skeletal muscle contraction is initiated by lower motor neuron
- Lower motor neuron is a part of local reflex circuits
- The information from several sources is integrated in the lower motor neuron
  - Higher levels of CNS
    - ➢Upper motor neuron, tectum, n. ruber, brain stem
  - Proprioception



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Introduction

- Skeletal muscle contraction is initiat
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Lower motor neuron regulates the activity of local reflex circuits, according to the demands of the higher regions of the CNS

– ption

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Introduction

- Skeletal muscle contraction is initiat
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  ref

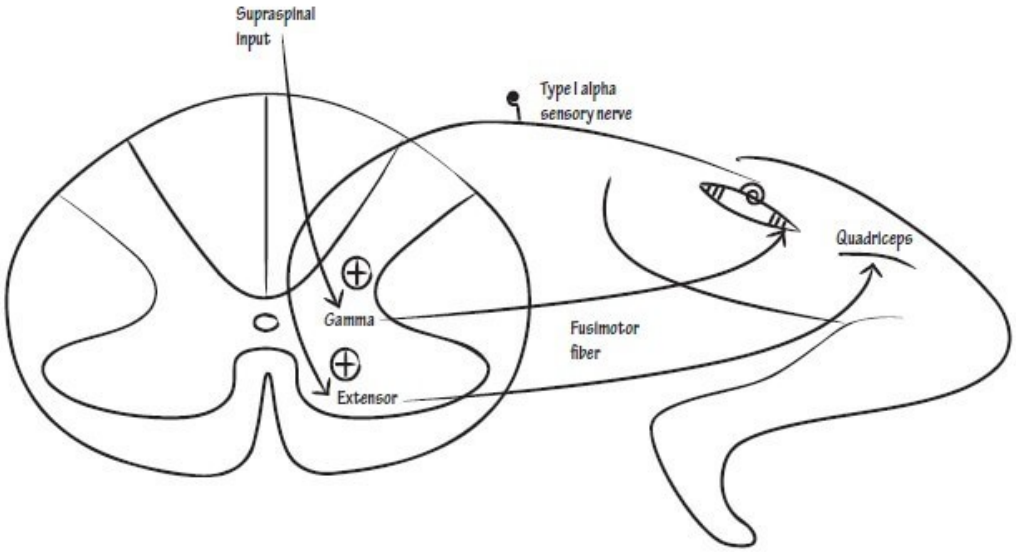
Lower motor neuron regulates the activity of local reflex circuits, according to the demands of the higher regions of the CNS

Proprioception is crucial for the regulation of local circuit activity

http://www.frontiersin.org/files/Articles/42416/fnhum-07-00085-HTML/image_m/fnhum-07-00085-g001.jpg

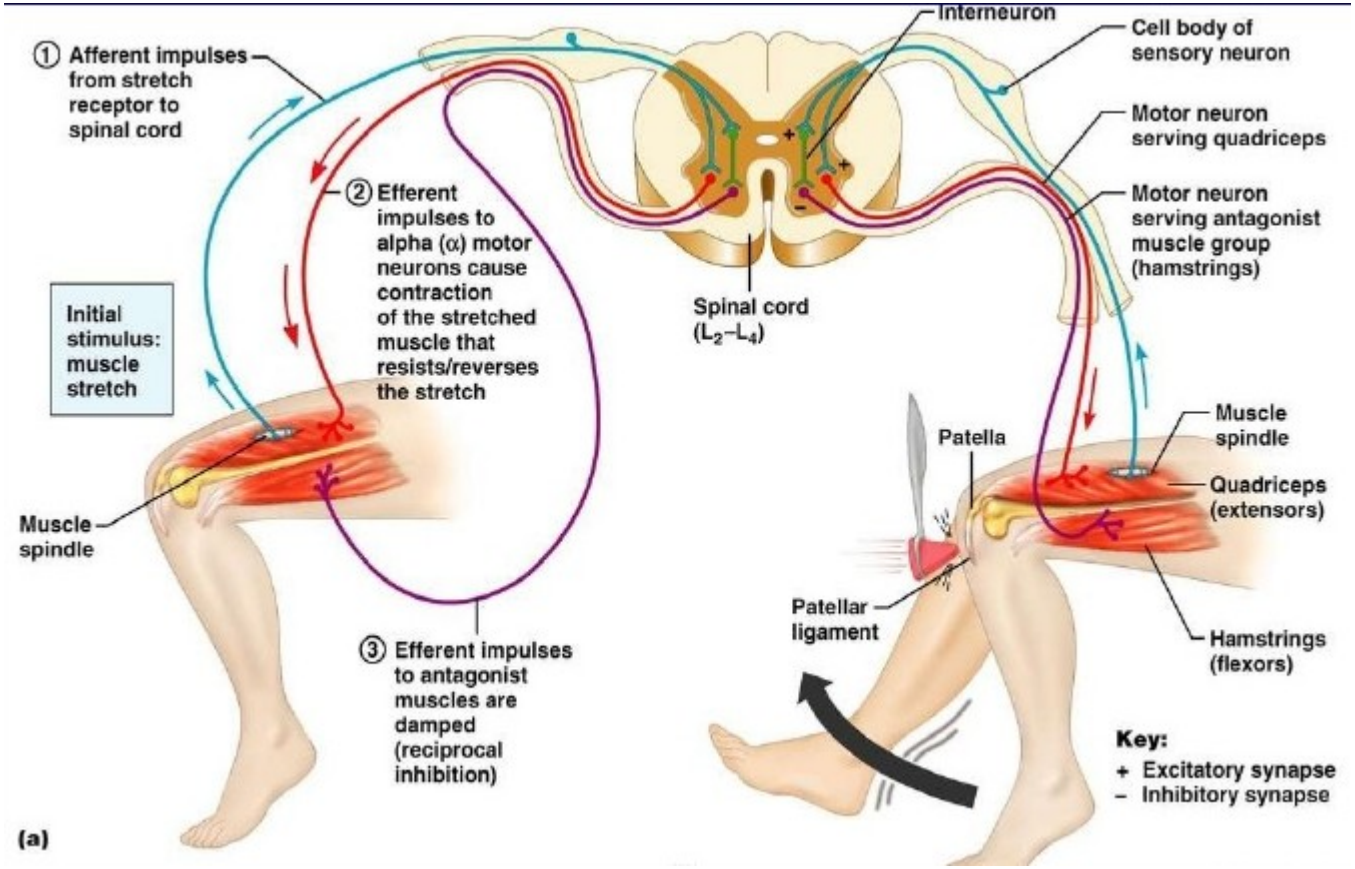
Lower motor neuron

- **α motoneuron**
  - Innervation of contractile elements
  - Extrafusal fibers
  - Muscle contraction
- **γ motoneuron**
  - Innervation of muscle spindles
  - Intrafusal fibers
  - Alignment of muscle spindles
  - Gamma loop
- **β motoneuron**



http://epomedicine.com/wp-content/uploads/2016/07/gamma-loop.jpg

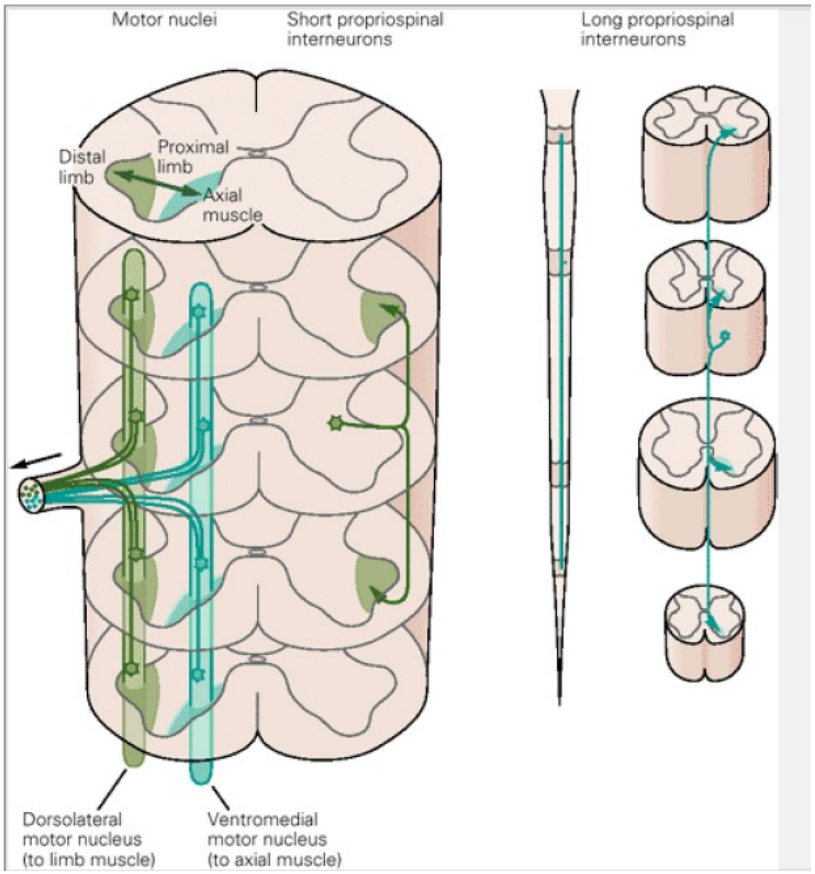
Stretch reflex

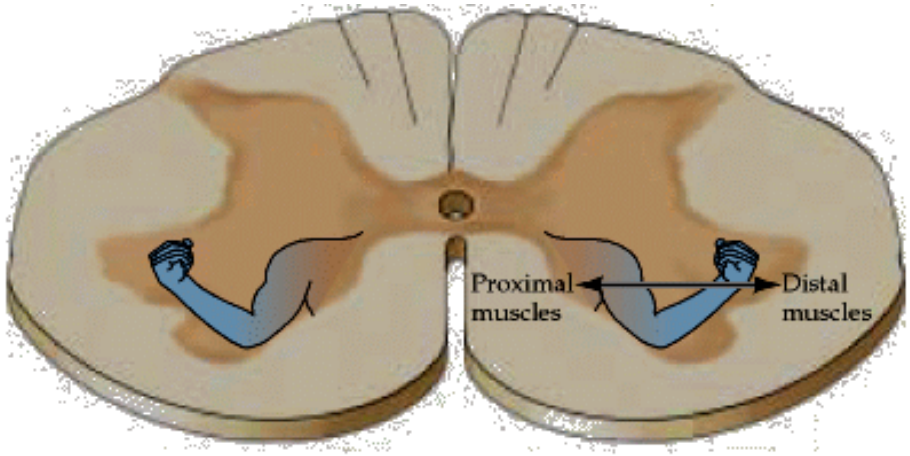


http://www.slideshare.net/ananthatiger/cns-4

Lower motor neuron

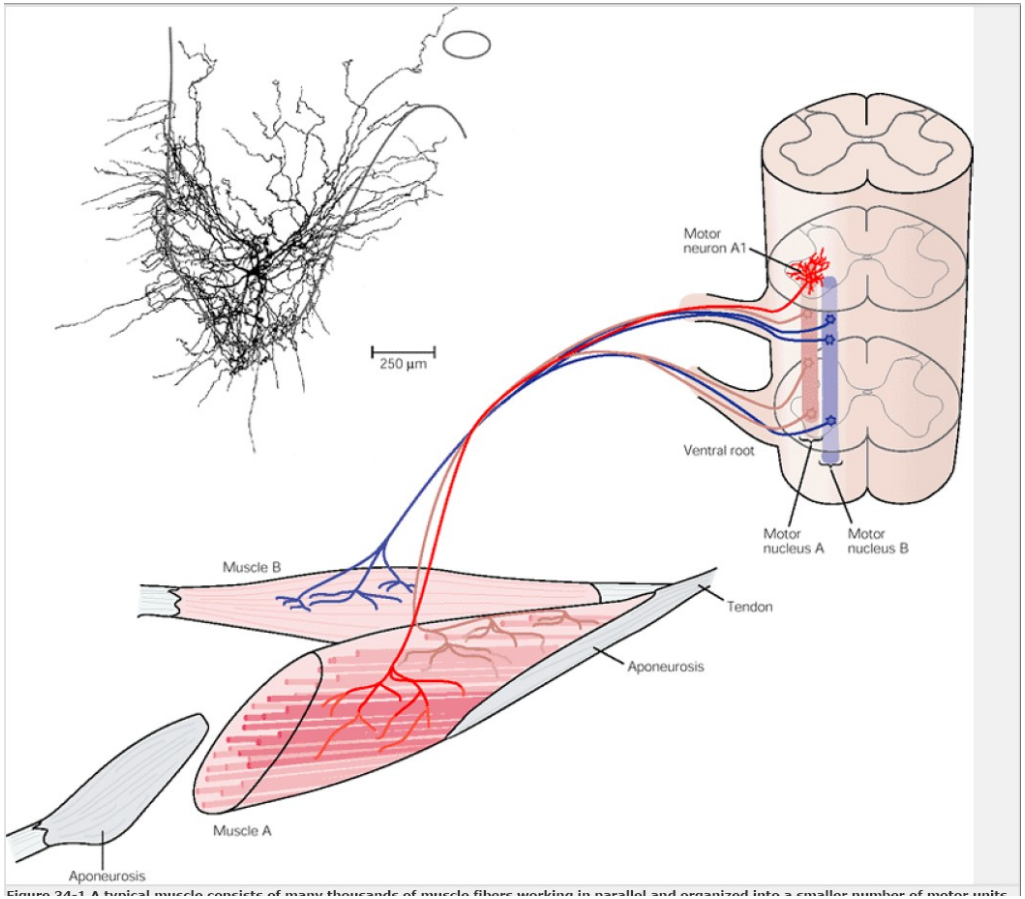
Topography





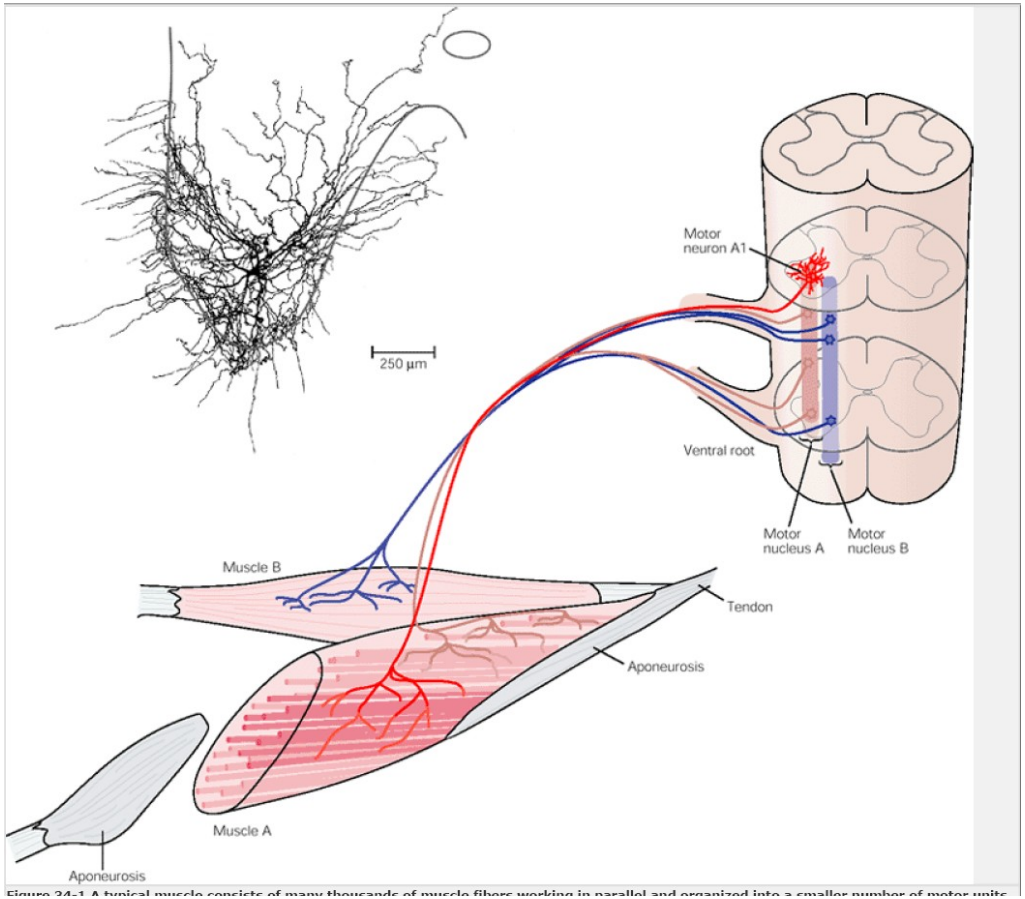
Motor unit

- A typical muscle is innervated by about 100 motoneurons which are localized in motor nucleus



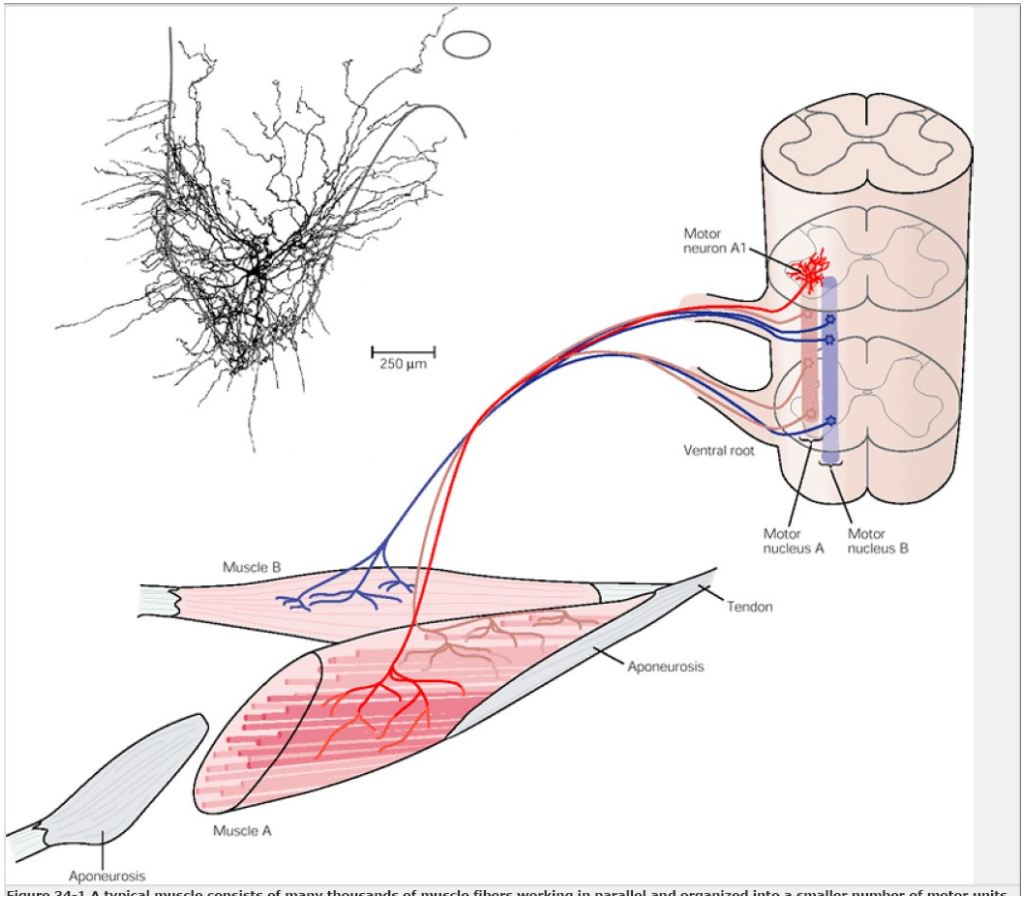
Motor unit

- A typical muscle is innervated by about 100 motoneurons which are localized in motor nucleus
- Each motoneuron innervate from 100 to 1000 muscle fibers and one muscle fiber is innervated by a single motoneuron

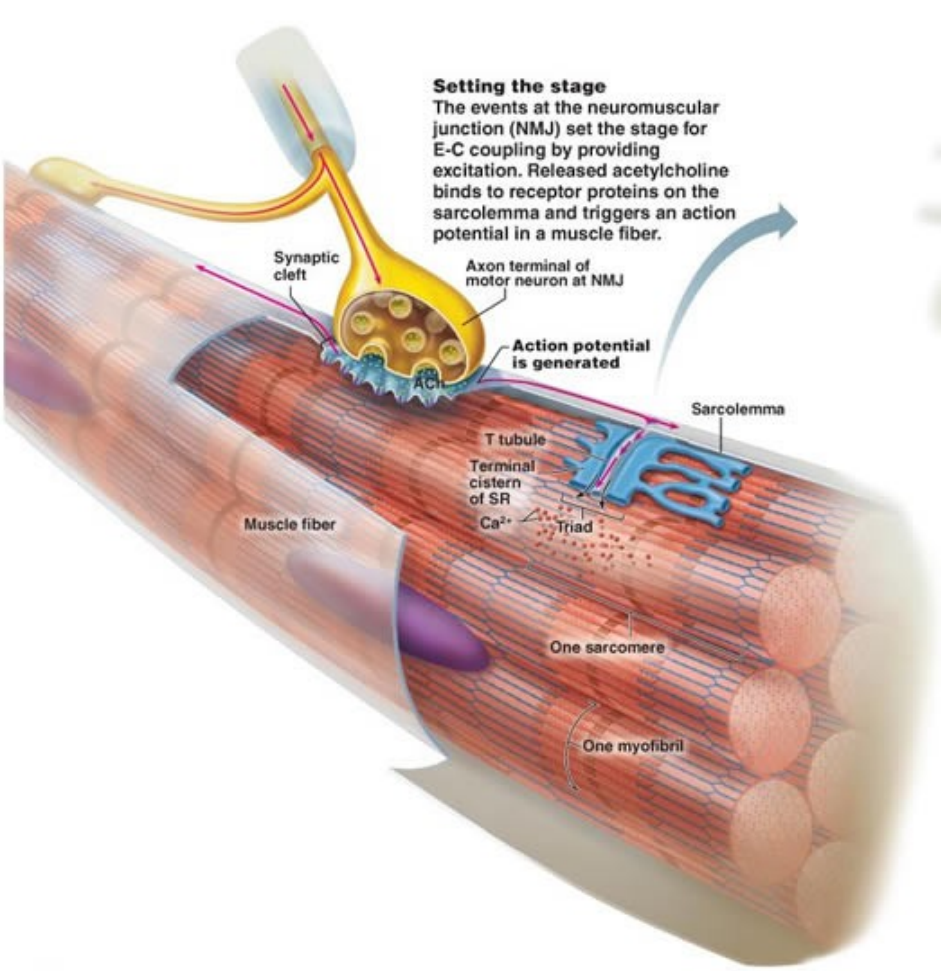


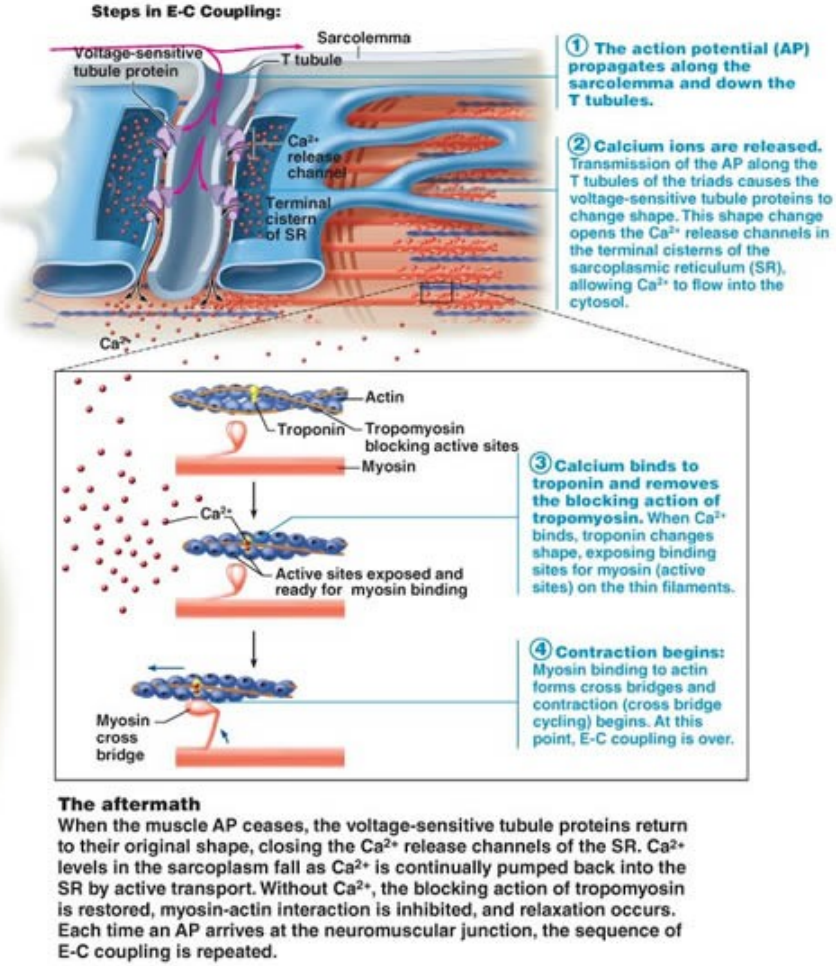
Motor unit

- A typical muscle is innervated by about 100 motoneurons which are localized in motor nucleus
- Each motoneuron innervate from 100 to 1000 muscle fibers and one muscle fiber is innervated by a single motoneuron
- The ensemble of muscle fibers innervated by a single neuron and corresponding motoneuron constitutes the motor unit



Neuromuscular junction





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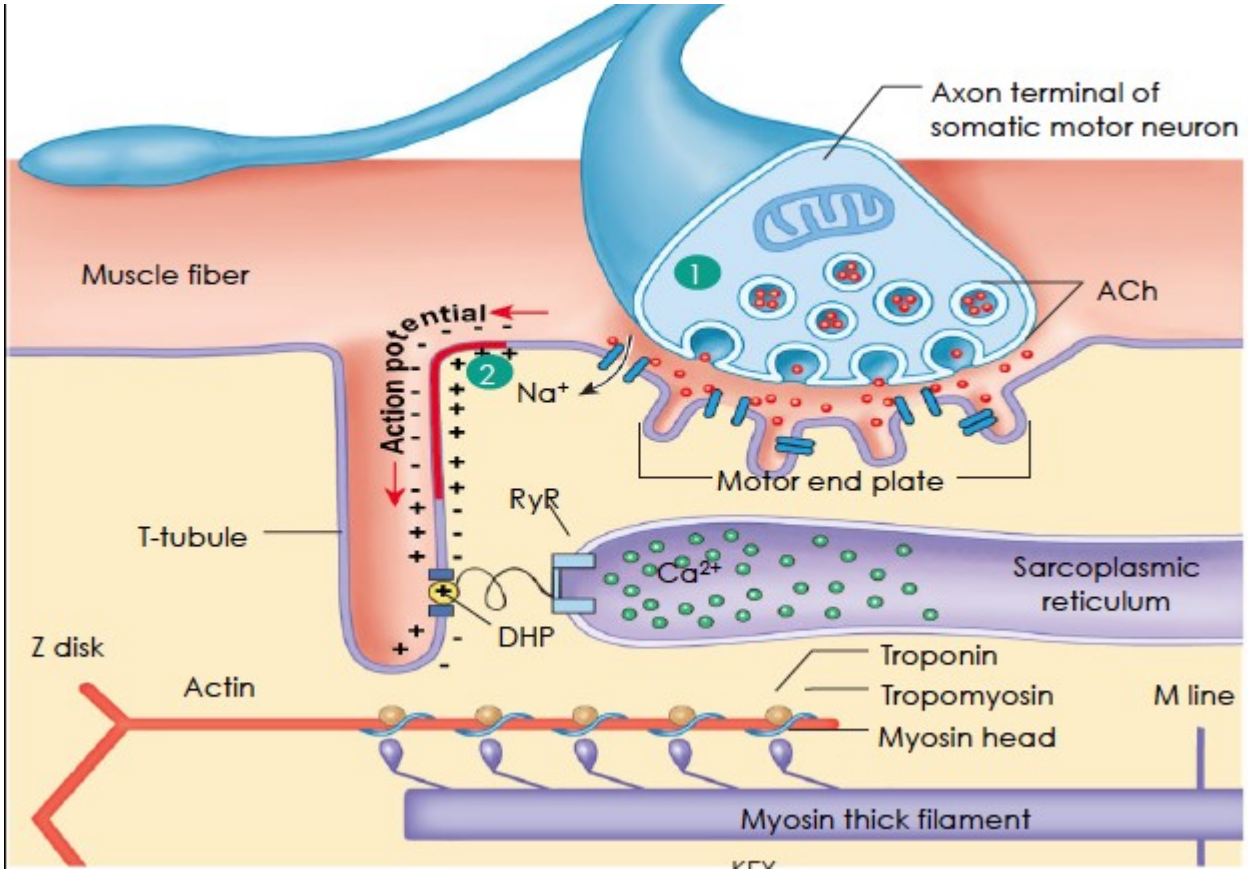
Neuromuscular junction



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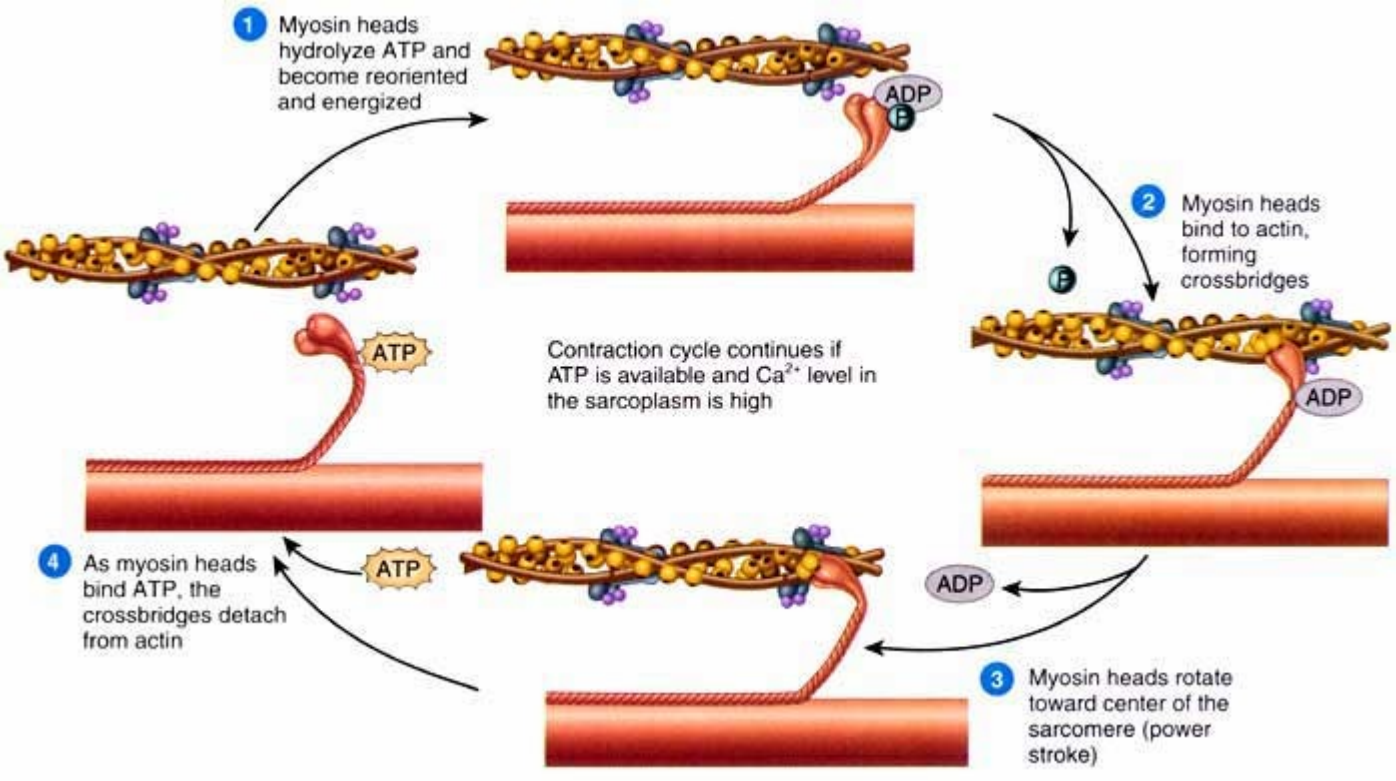
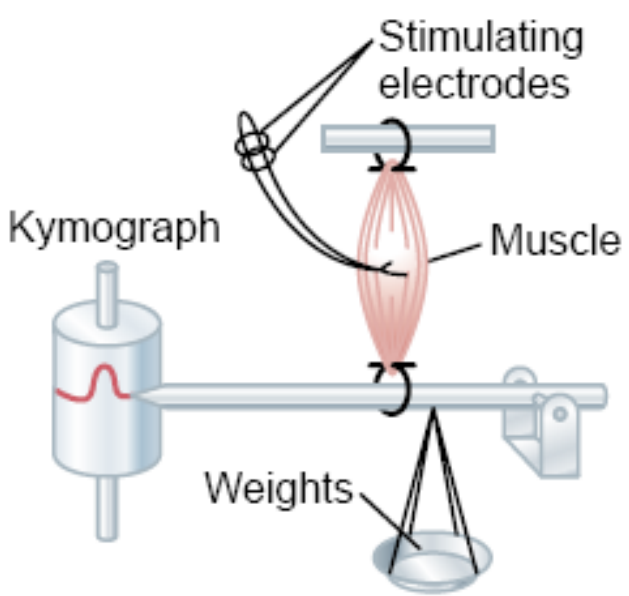
Muscle fibers



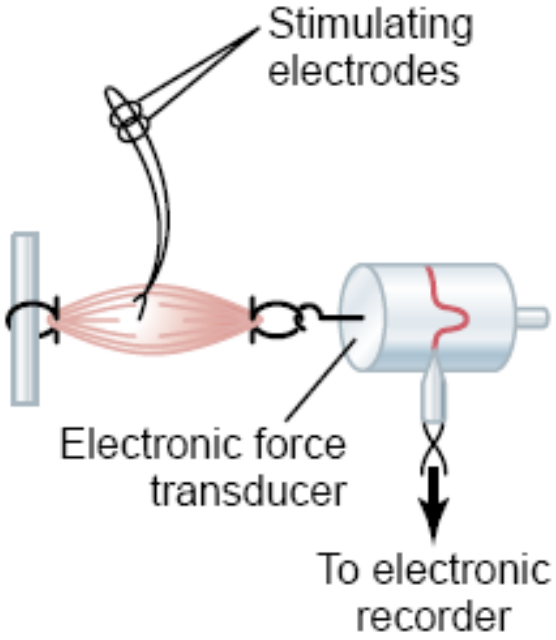
http://www.sivabio.50webs.com/mus019.jpg

Types of muscle contraction

- Isotonic contraction
  - Constant tension
  - The muscle shortens during contraction
- Isometric contraction
  - Muscle does not shorten during contraction



ISOTONIC SYSTEM



ISOMETRIC SYSTEM

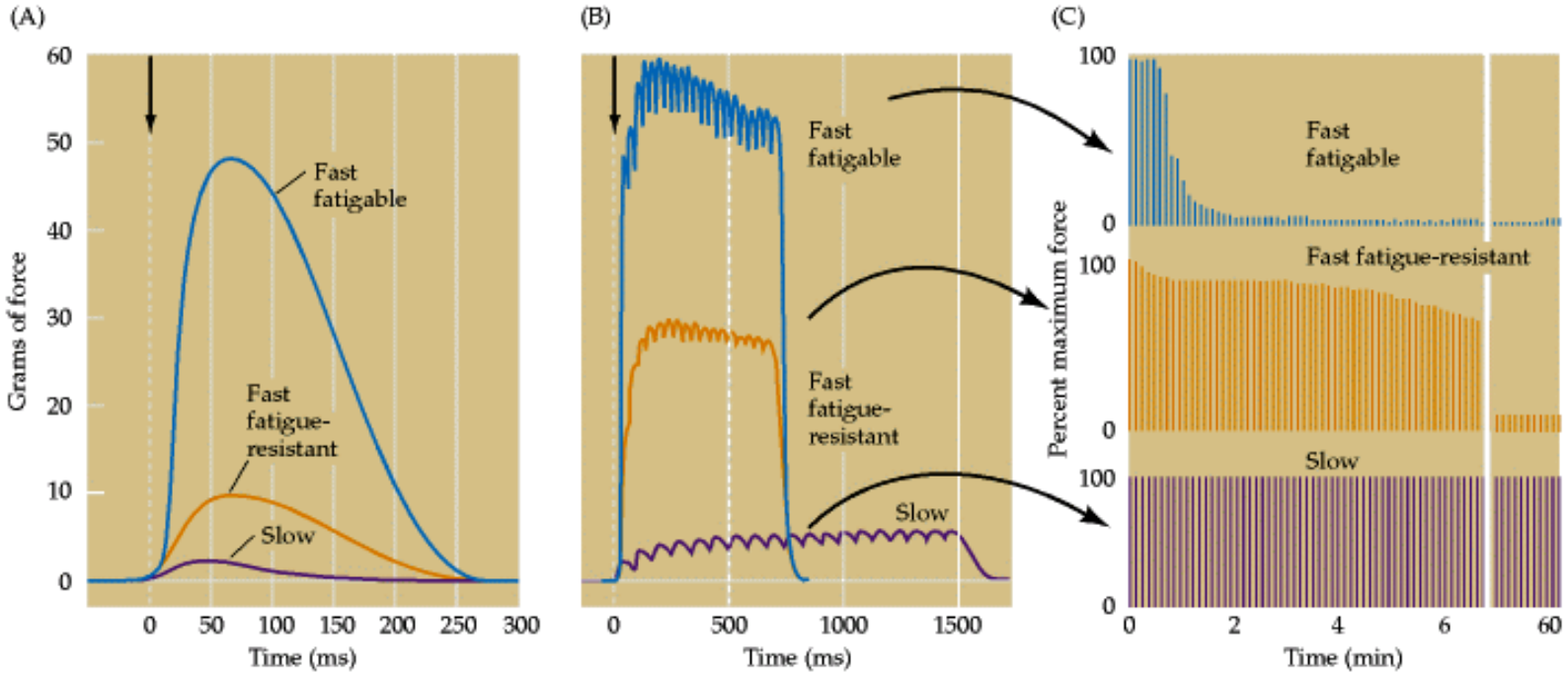
Types of muscle fibers

Fast fibers

- Performance
- Fast fatigue-resistant – normal performance
- Fast fatigable – high performance

Slow fibers

- Endurance
- Fatigue resistant



Types of muscle fibers

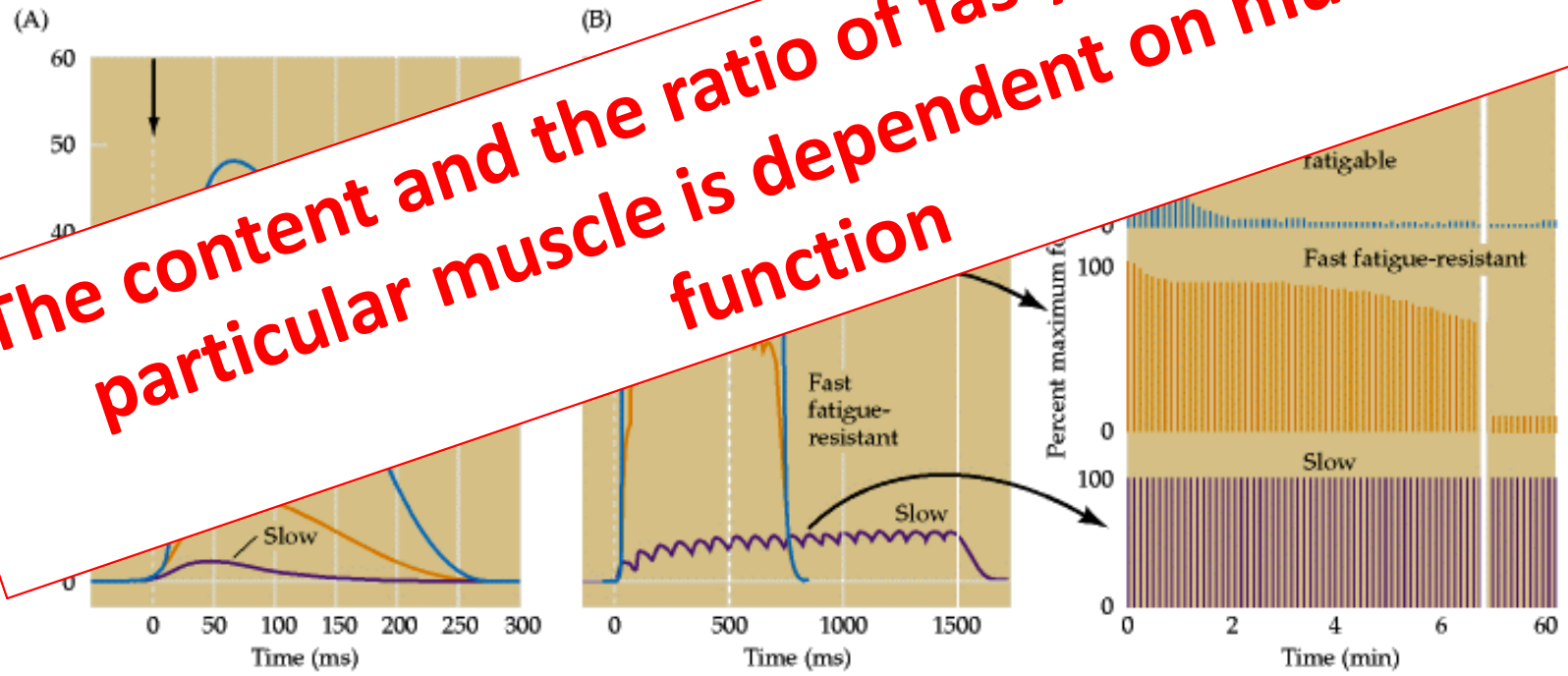
Fast fibers

- Performance
- Fast fatigue-resistant – normal performance
- Fast fatigable – high performance

Slow fibers

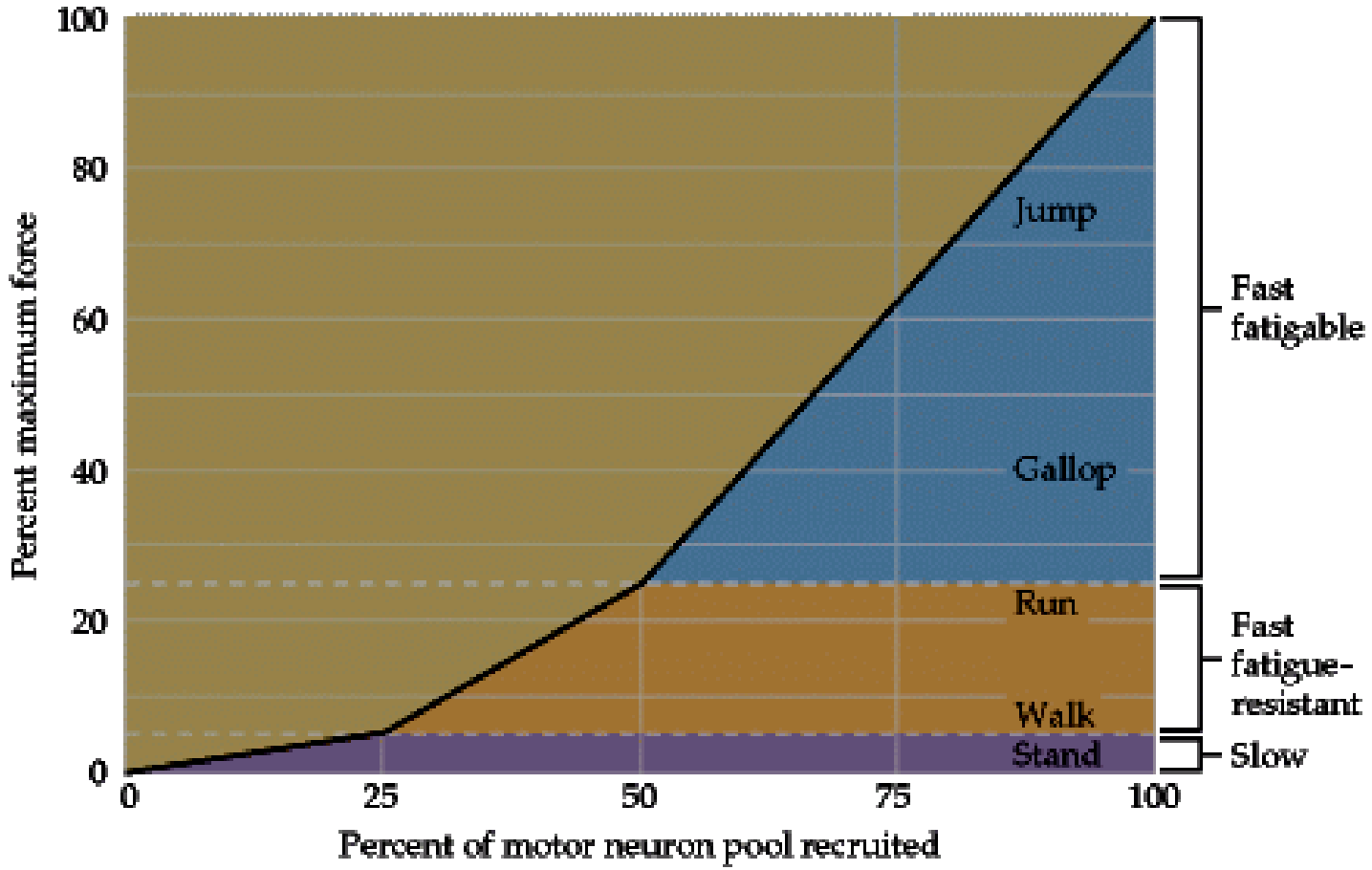
- End

The content and the ratio of fast/slow fibers in particular muscle is dependent on muscle function



The recruitment of motor neurons

m. gastrocnemius in a cat



Proprioception

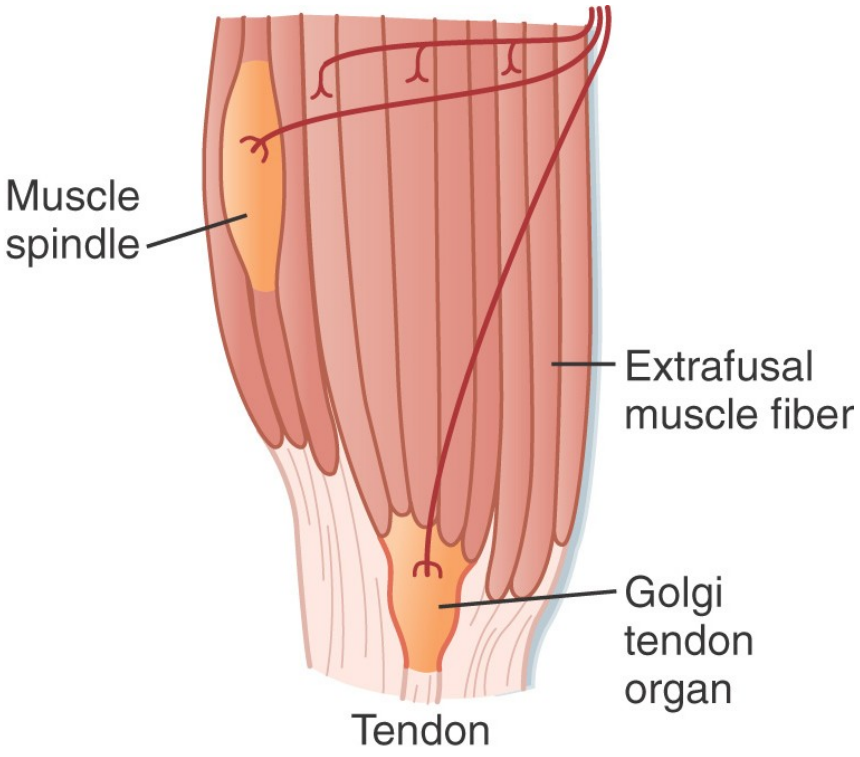
- Information about the position of body parts in relation to each other

  (The sum of information about lengths of particular muscles)

- Information about movement

  (The force and speed of muscle contraction)

- Reflex regulation of muscle activity



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Proprioception

- Information about the position of body parts in relation to each other

  (The sum of information about lengths of particular muscles)

- Information about movement

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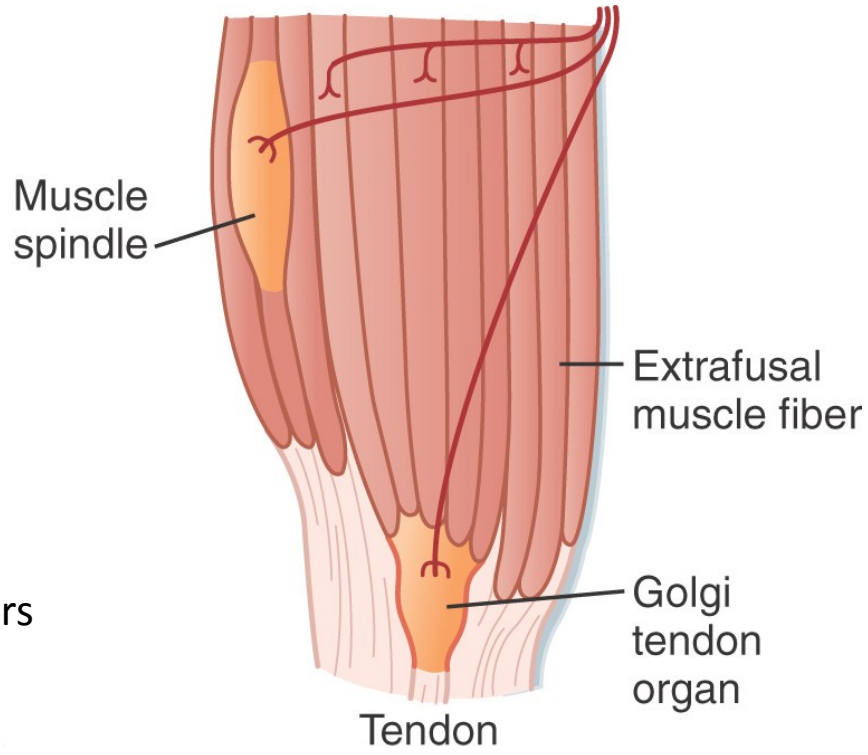
- Reflex regulation of muscle activity

- Muscle spindles
  - Lie in parallel with extrafusal muscle fibers

- Golgi tendon organ
  - Arranged in series with extrafusal muscles



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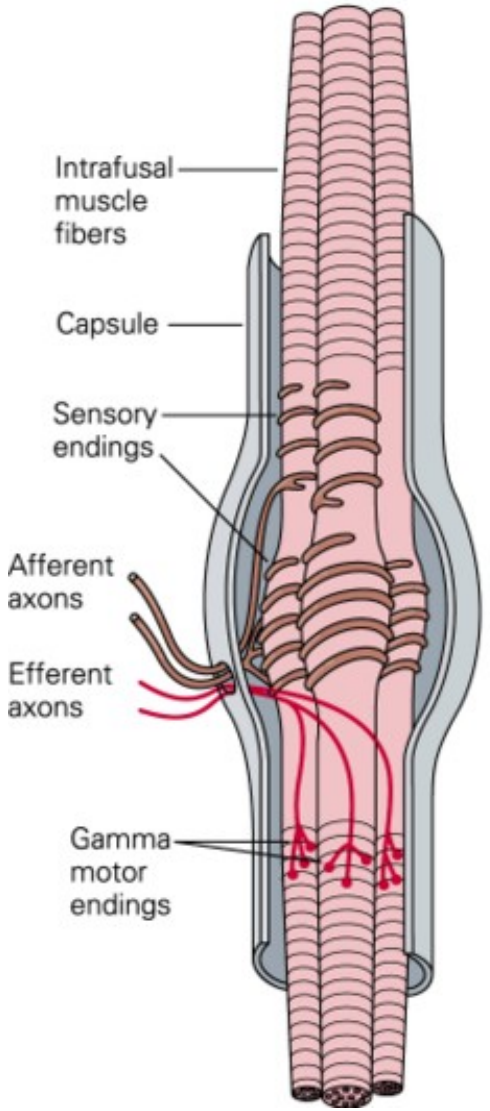
Muscle spindles

- Nno-force generating contractile structures
- The contractility is for spindle length adjustment



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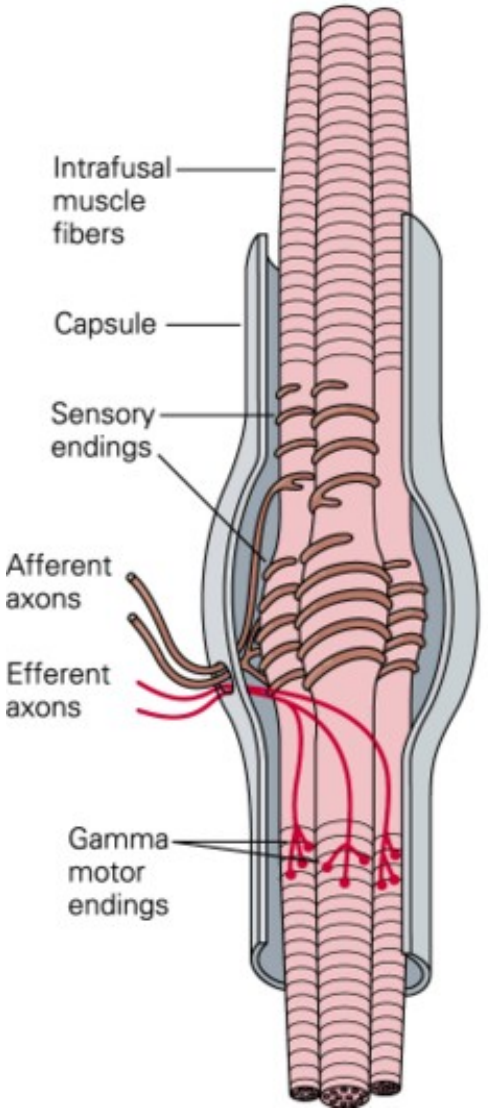
Muscle spindles

- Nno-force generating contractile structures
- The contractility is for spindle length adjustment
- Encapsulated structure filled with a fluid
- Intrafusal fibers



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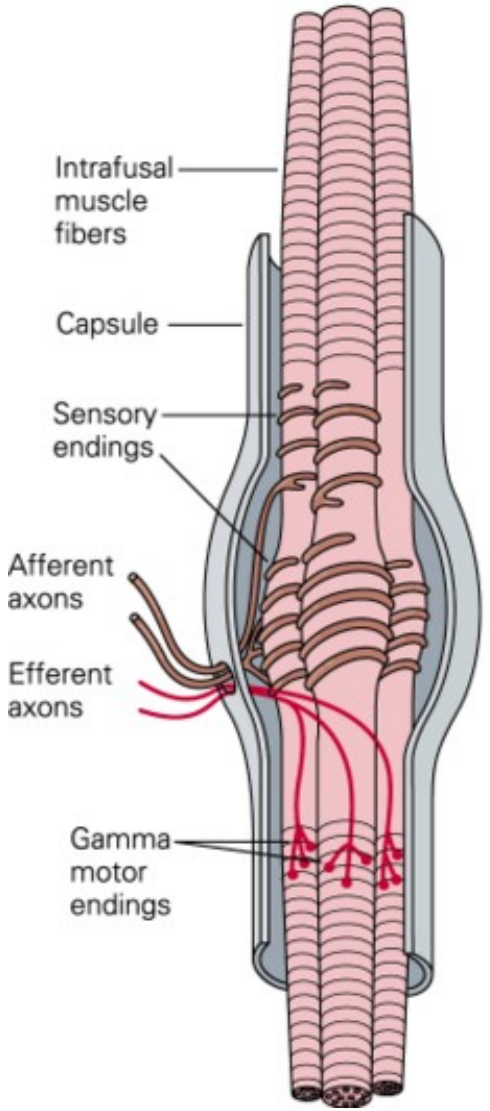
Muscle spindles

- Nno-force generating contractile structures
- The contractility is for spindle length adjustment
- Encapsulated structure filled with a fluid
- Intrafusal fibers
  - Lie in parallel with extrafusal muscle fibers (Stretch/shorten along with extrafusal fibers)
  - Efferent connections (into muscle spindle)
    - γ motoneuron
  - Afferent connections (from muscle spindle)
    - Information about change in muscle length
    - Reflex regulation of the α motoneuron activity



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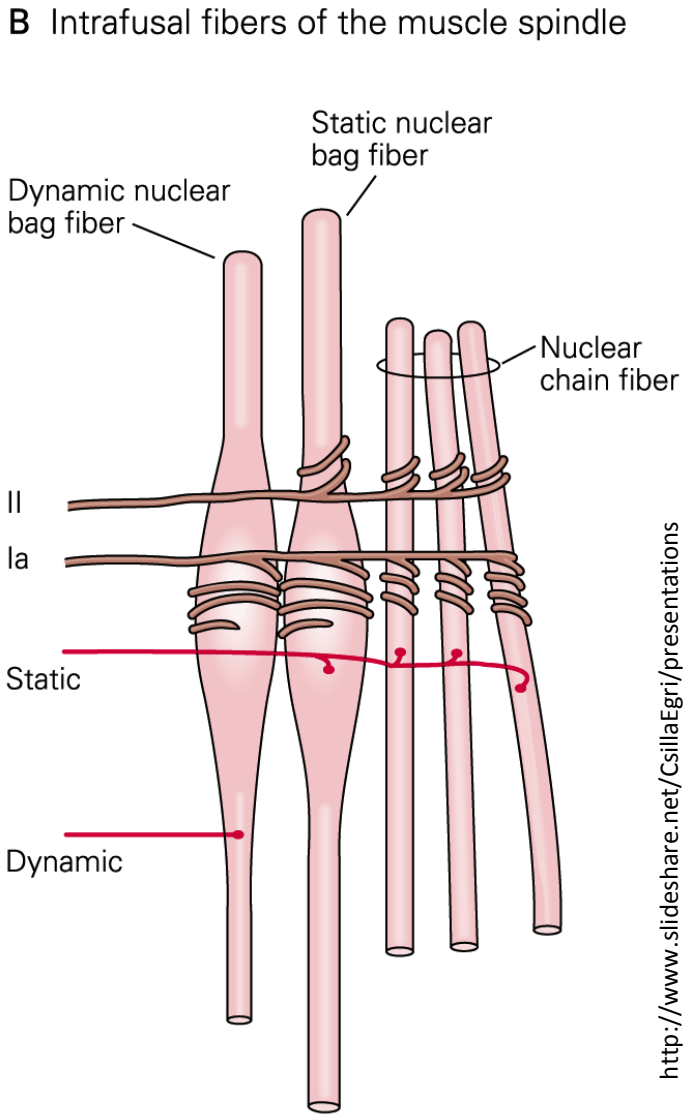
Muscle spindle

- Static fibers
- Dynamic fibers



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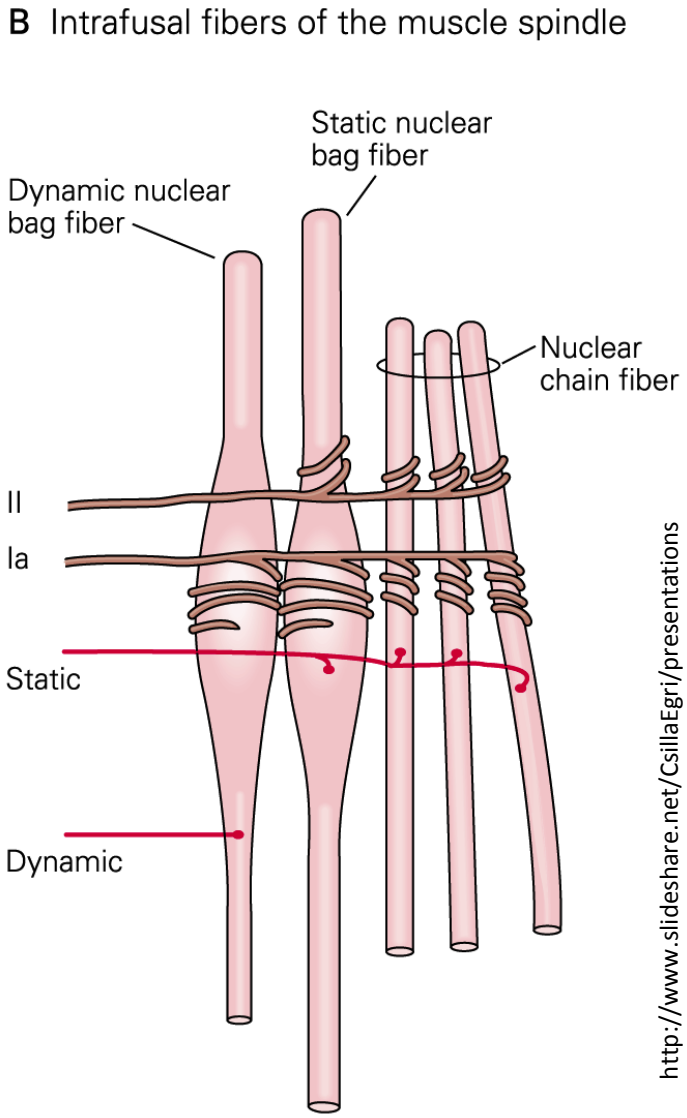
  - Spindle length adjustment

Muscle spindle

- Static fibers
- Dynamic fibers
- Afferent connections (from spindle)
  - II – static fibers
    - Information about muscle length (position)
    - Ia – static and dynamic fibers
    - Information about muscle length and contraction (movement)
  - Reflex regulation of the α motoneuron activity



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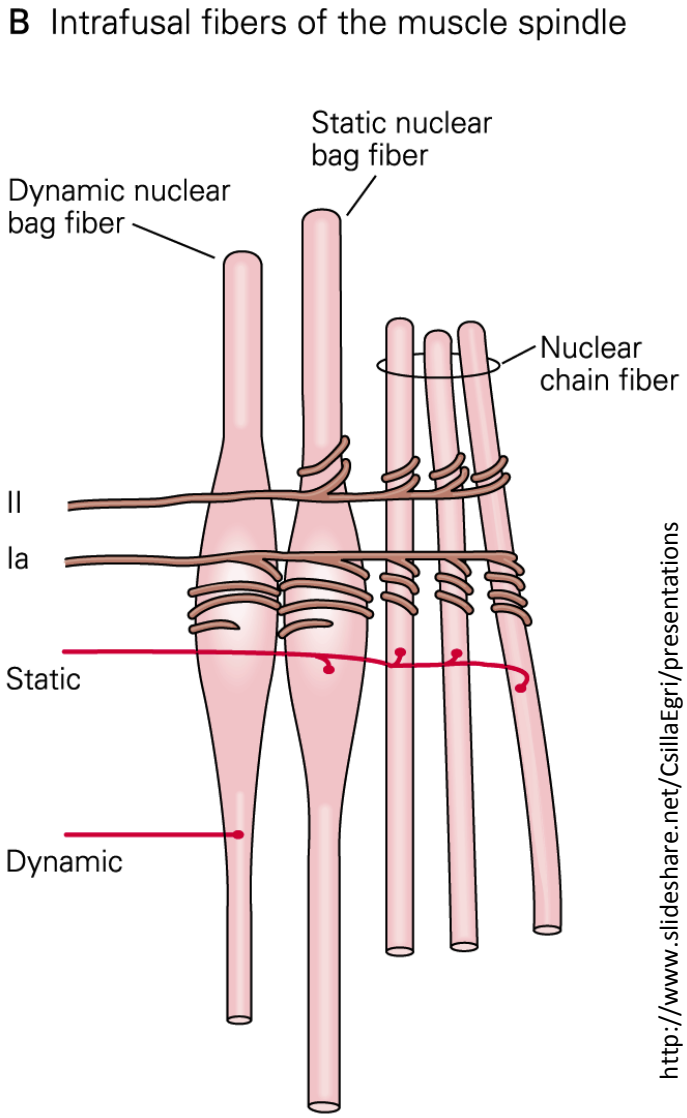
Muscle spindle

- Static fibers
- Dynamic fibers
- Afferent connections (from spindle)
  - II – static fibers
    - Information about muscle length (position)
    - Ia – static and dynamic fibers
    - Information about muscle length and contraction (movement)
  - Reflex regulation of the α motoneuron activity
- Efferent connections (from spindle)
  - Static γ motoneurons
  - Dynamic γ motoneurons
  - Spindle length adjustment



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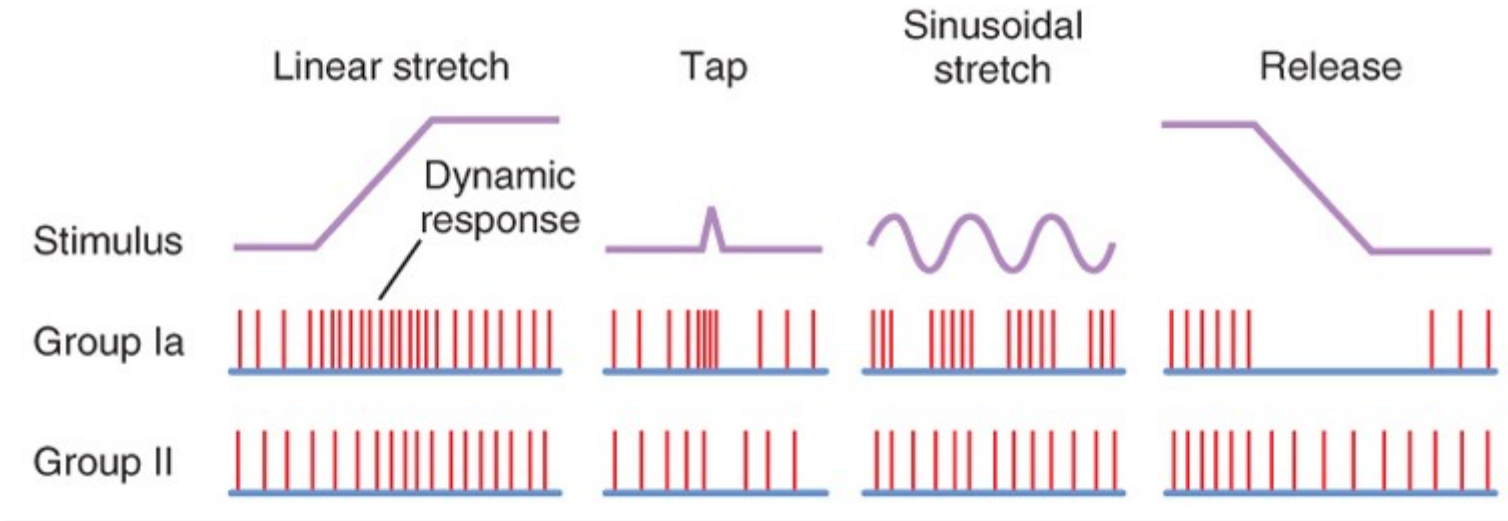
Afferent signaling from muscle spindles



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II – Static fibers

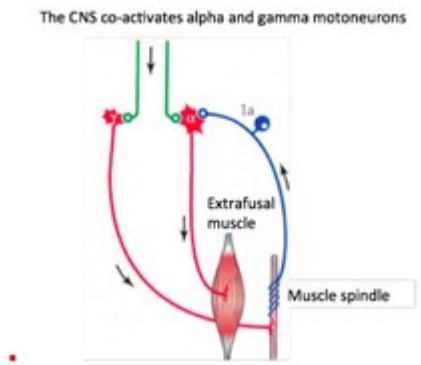
- Static response

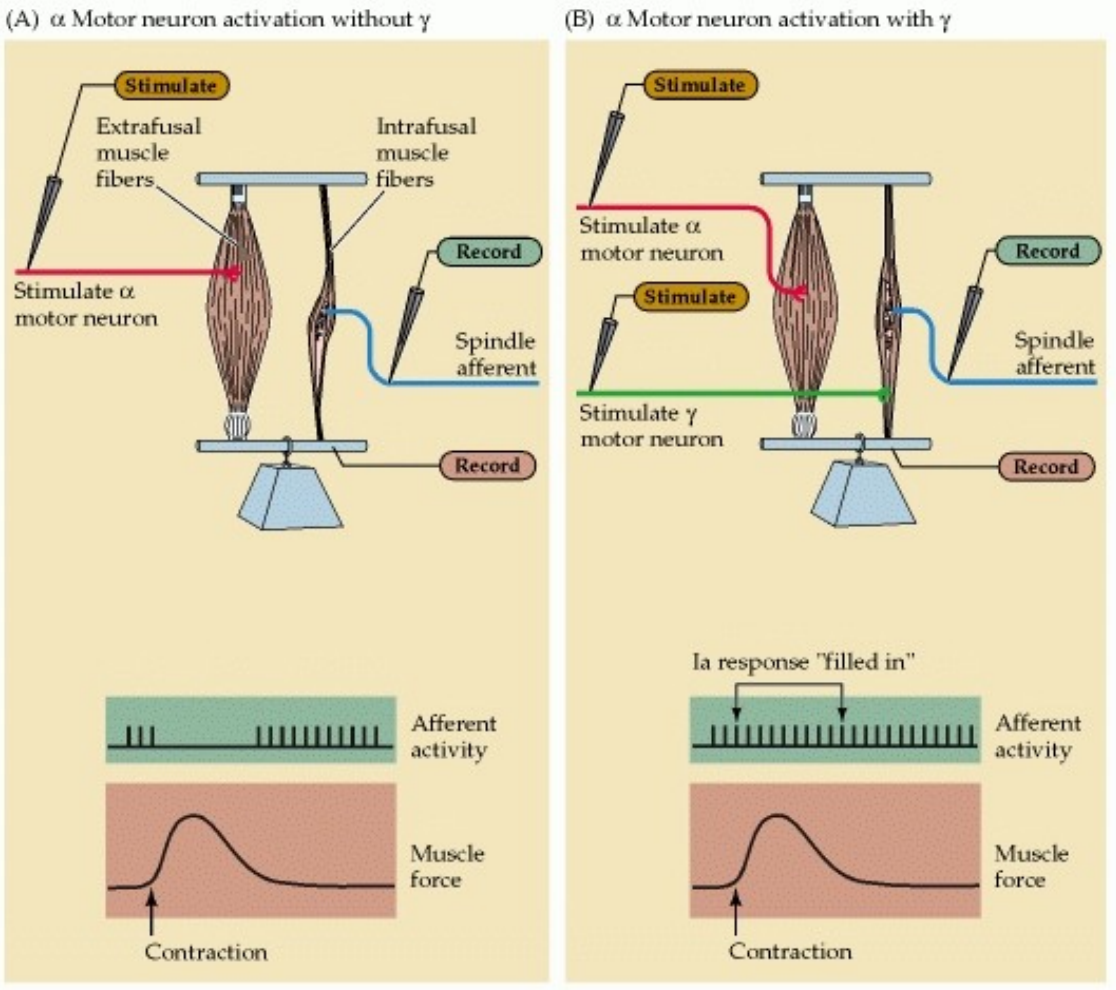
Ia – Static and dynamic fibers

- Static and dynamic response

Efferent signaling into the muscle spindle

- γ motoneurons adjust the length of intrafusla fibers
- Regulation of sensitivity
- α and γ coactivation
-





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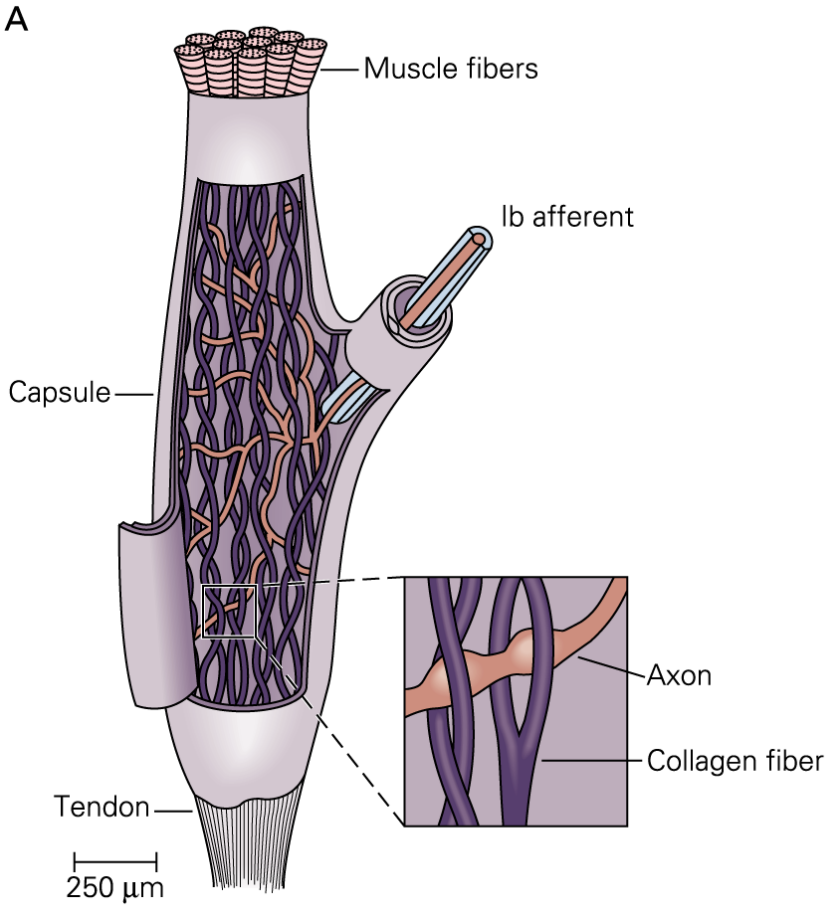
Golgi tendon organs

- Non-contractile encapsulated structures
- Collagen fibers
- Ia fibers
- Mechanoreception
- Arranged in series with extrafusal muscles
- Information about changes in tendon tension/force
- Reflex regulation of the α motoneuron activity



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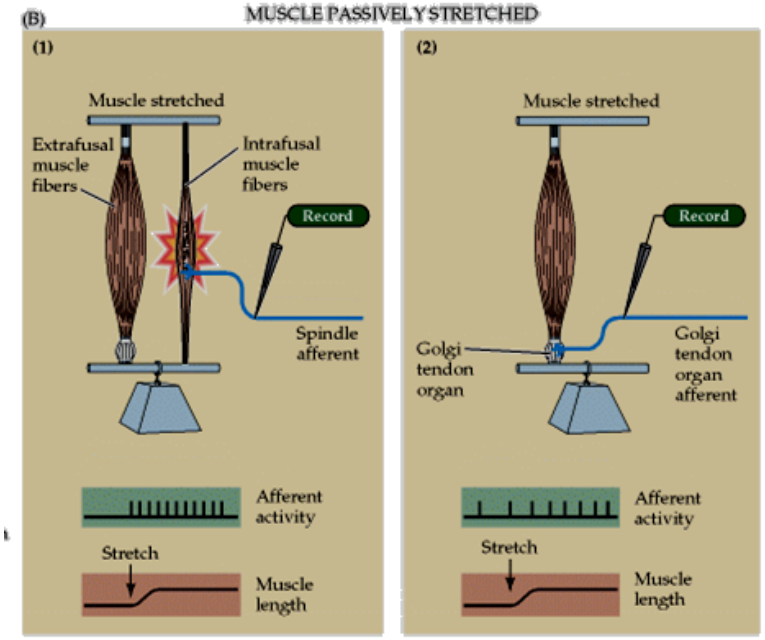
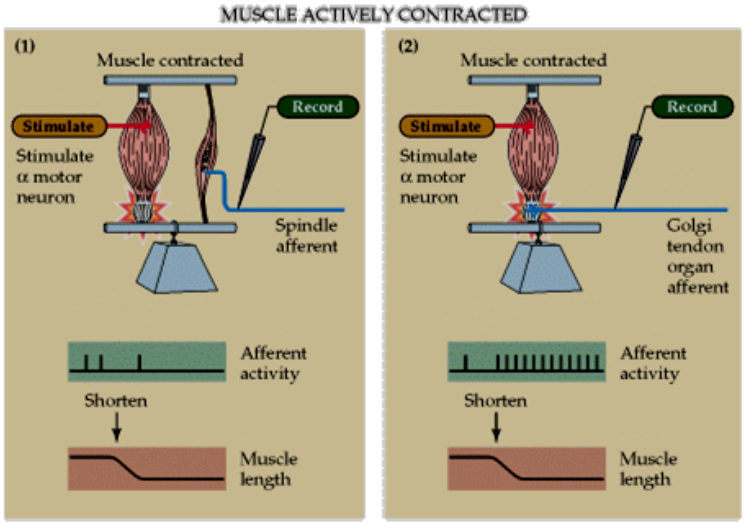
Reaction of muscle spindles and the Golgi tendon organs to muscle fiber stretch/contraction



Stretch (passive)

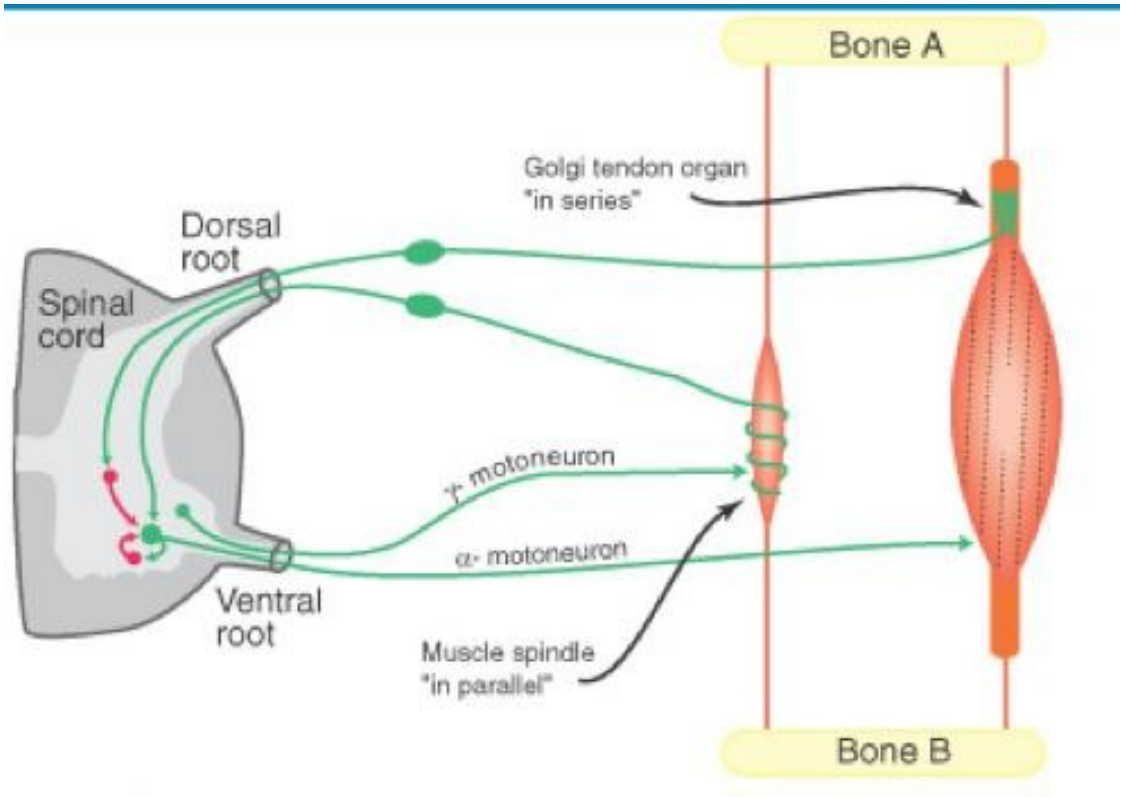
Muscle spindles reaction



Contraction (active)

Golgi tendon organ reaction

Recapitulation



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