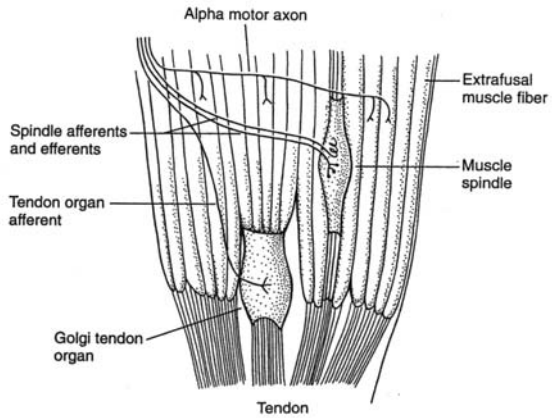
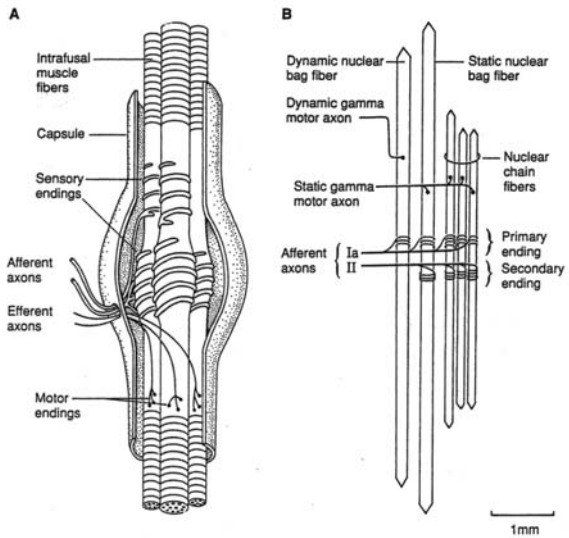
MUSCLE RECEPTORS

Muscle receptors

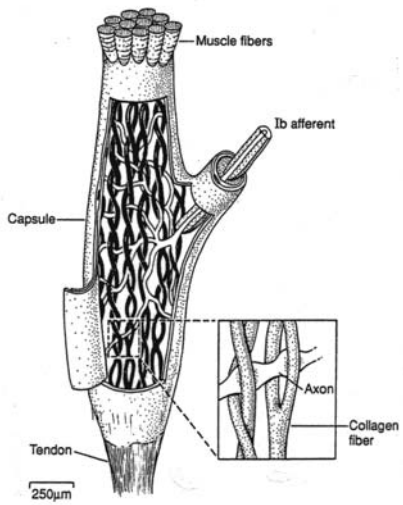
Muscle spindles and Golgi tendon organs



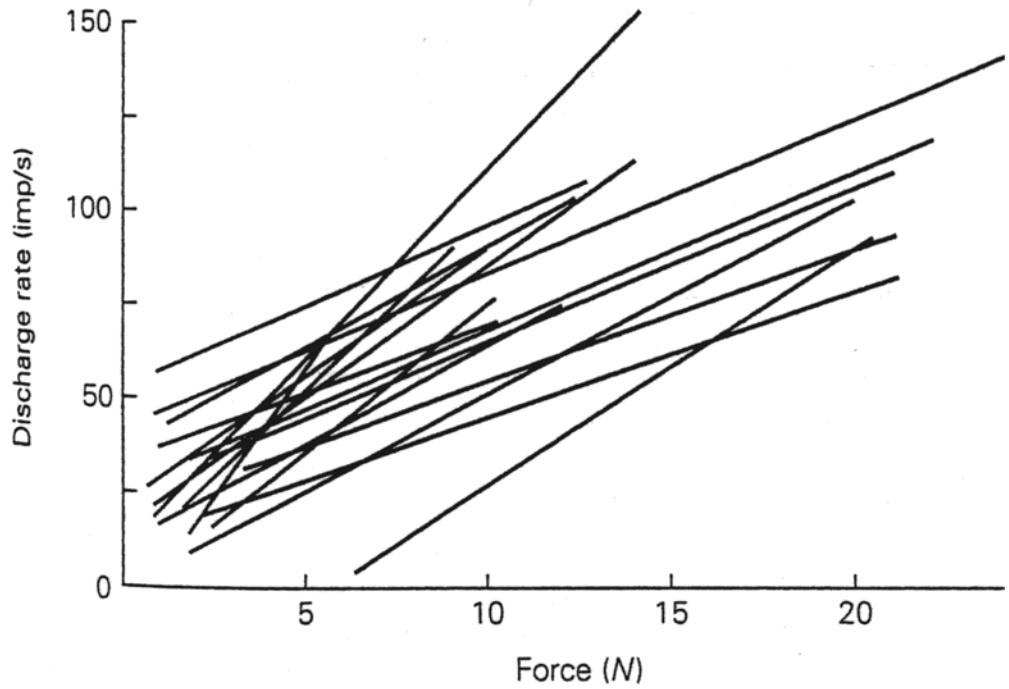
Muscle spindles respond to stretch of specialized muscle fibers



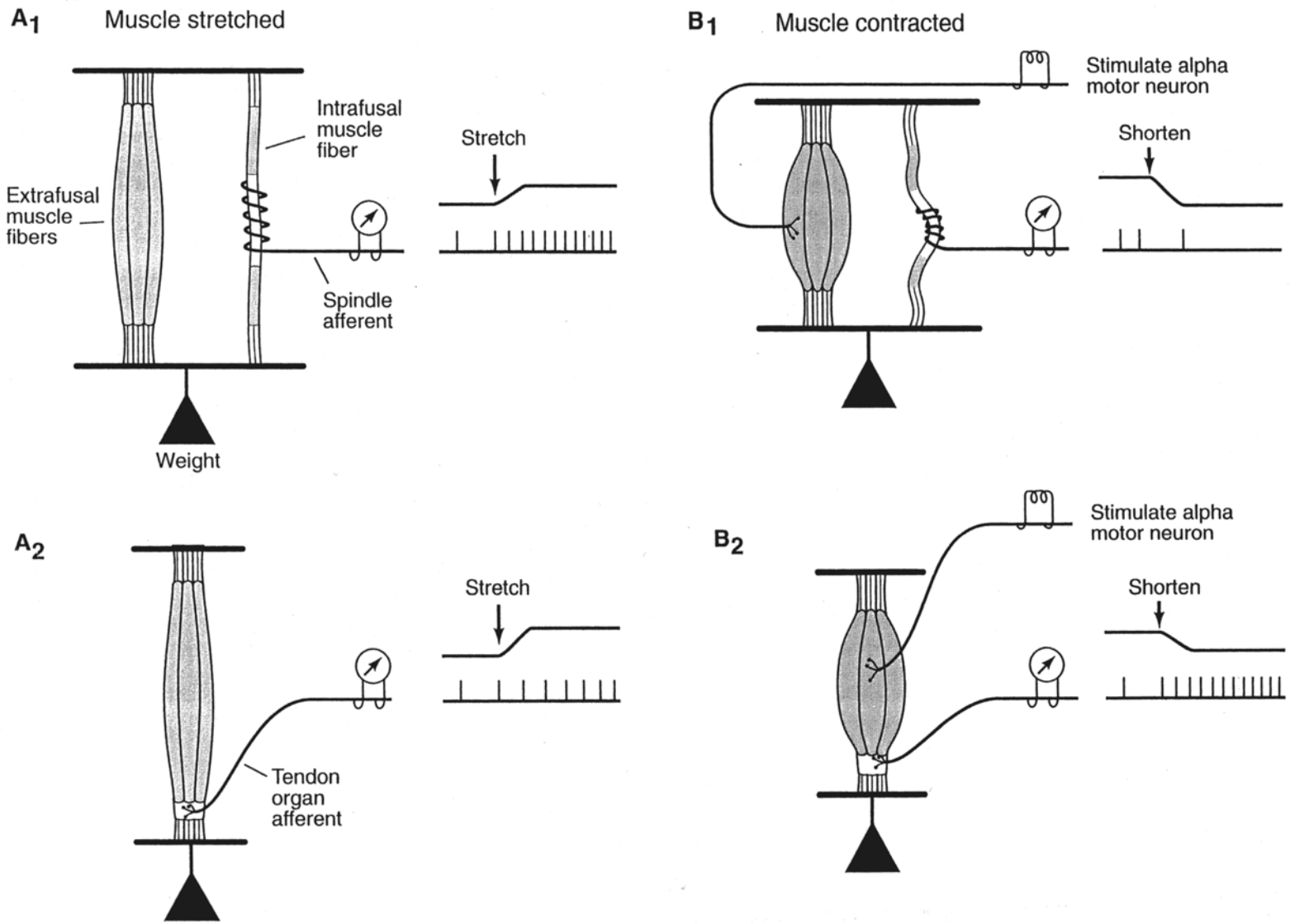
Golgi tendon organs are sensitive to change in tension



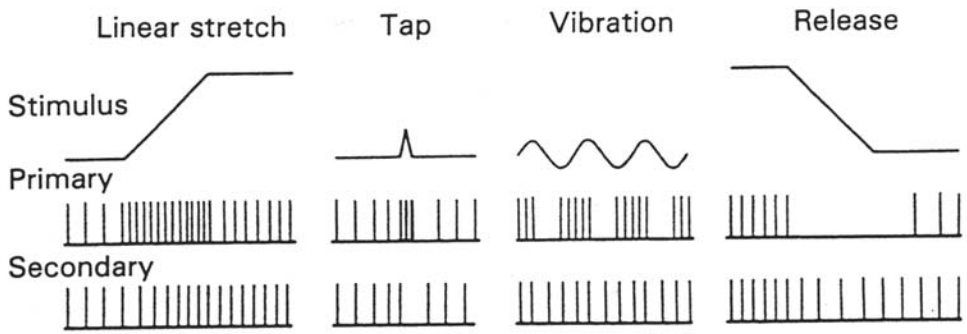
Discharge rate of 1b afferent fibers from Golgi tendon organs signals the force in a muscle



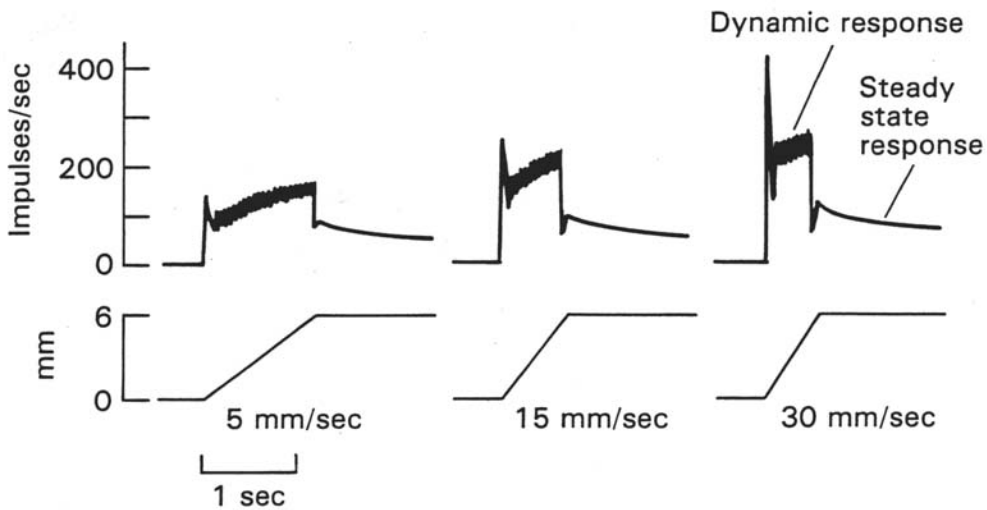
Functional differences between spindles and tendon organs derive from their different anatomical arrangements within muscle



Primary and secondary ending in muscle spindles have different firing properties

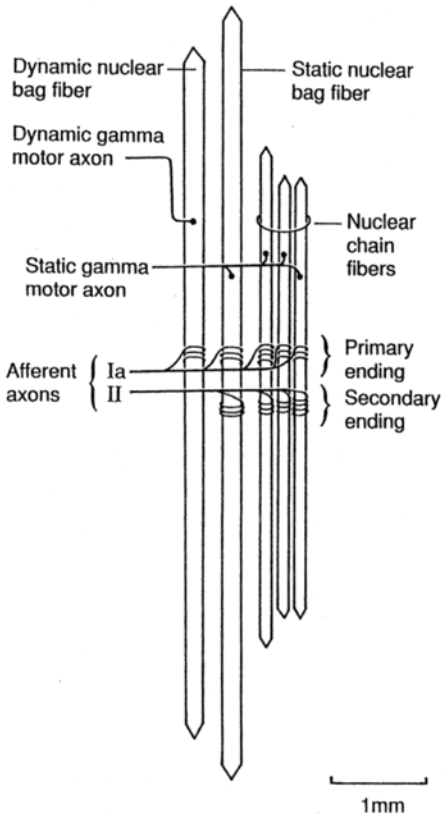


The primary ending is highly sensitive to the velocity of stretch

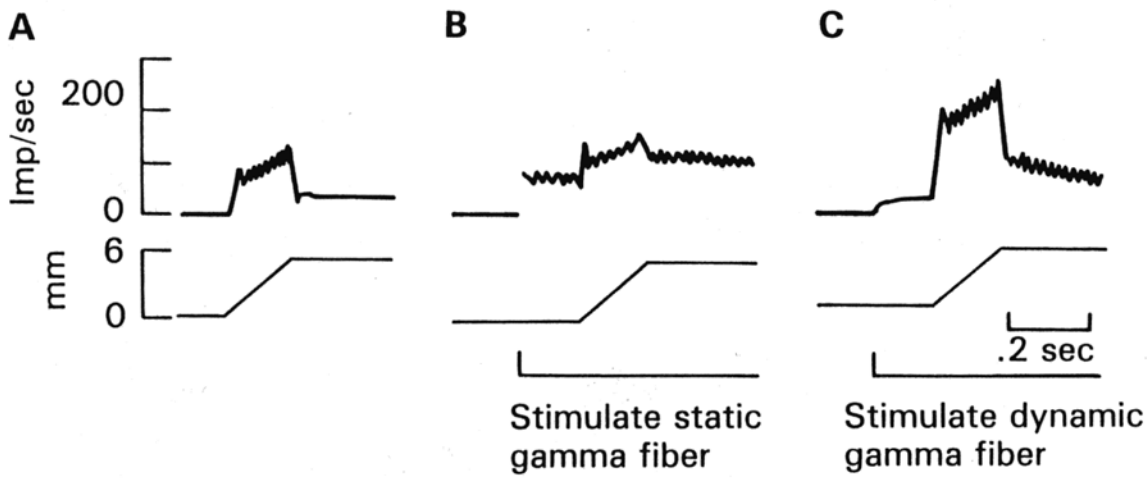


Two types of gamma motor neurons alter the responsiveness of spindles

Dynamic and static gamma motor neurons innervate different intrafusal fibers

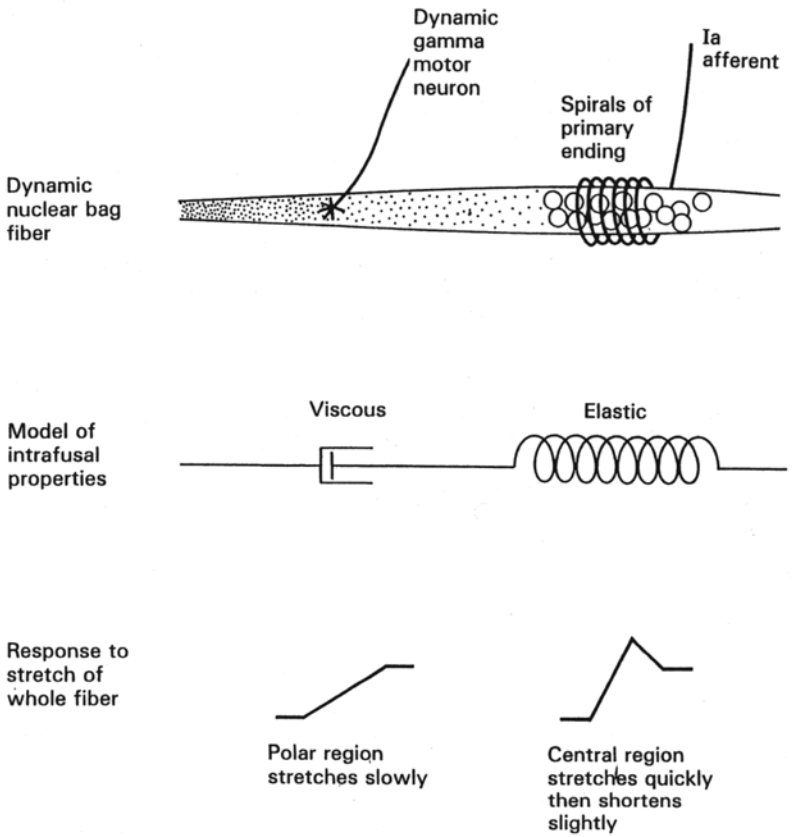


Effects of selective stimulation of dynamic and static gamma motor neurons on firing of spindle endings

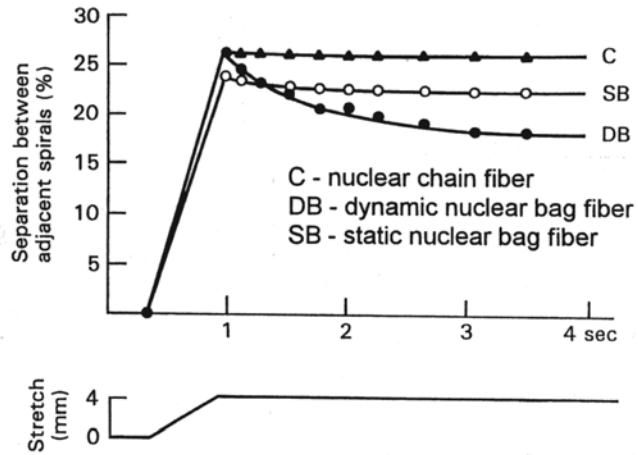


The dynamic sensitivity of primary endings results from unusual mechanical properties of the dynamic nuclear bag fibers of the muscle spindle

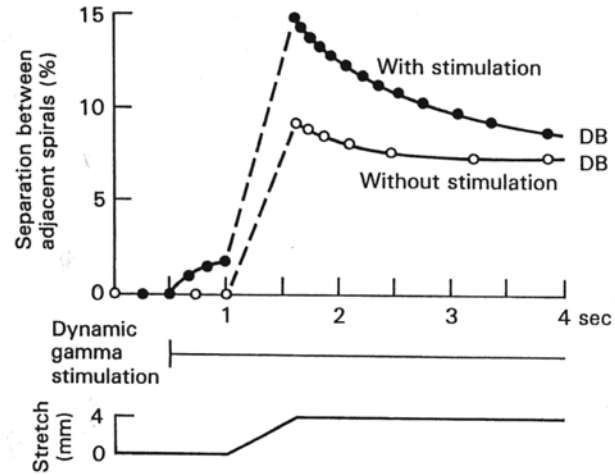
The dynamic bag fiber has an elastic response to stretch in its central region and viscous response in its polar regions



Effect of muscle stretch on intrafusal fibers

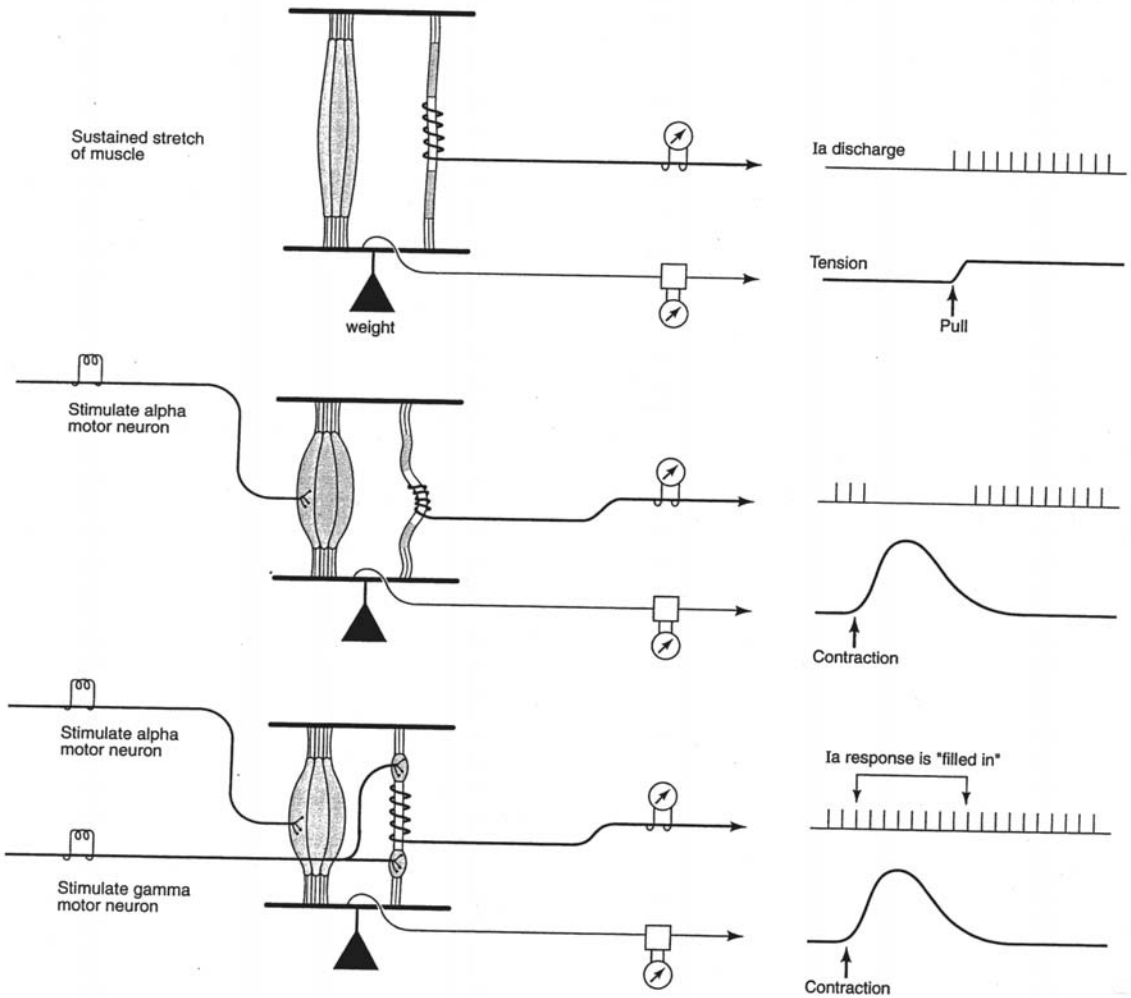


Effect of stimulation of dynamic gamma motor neuron



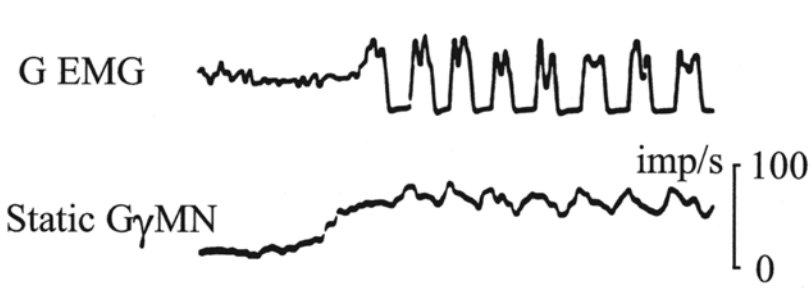
The CNS can control sensitivity of muscle spindles through the gamma motor neurons

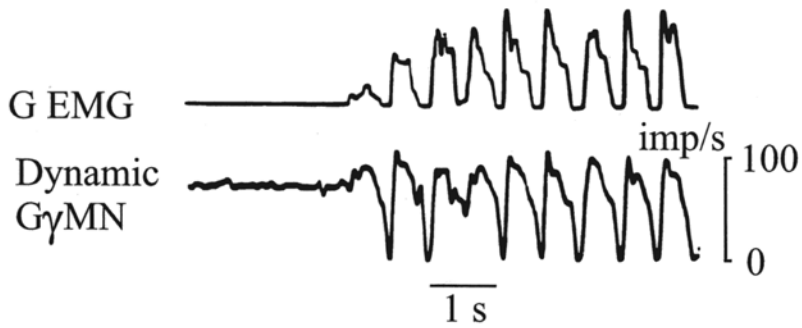
During active muscle contractions the ability of the spindles to sense length changes is maintained by activation of gamma motor neurons



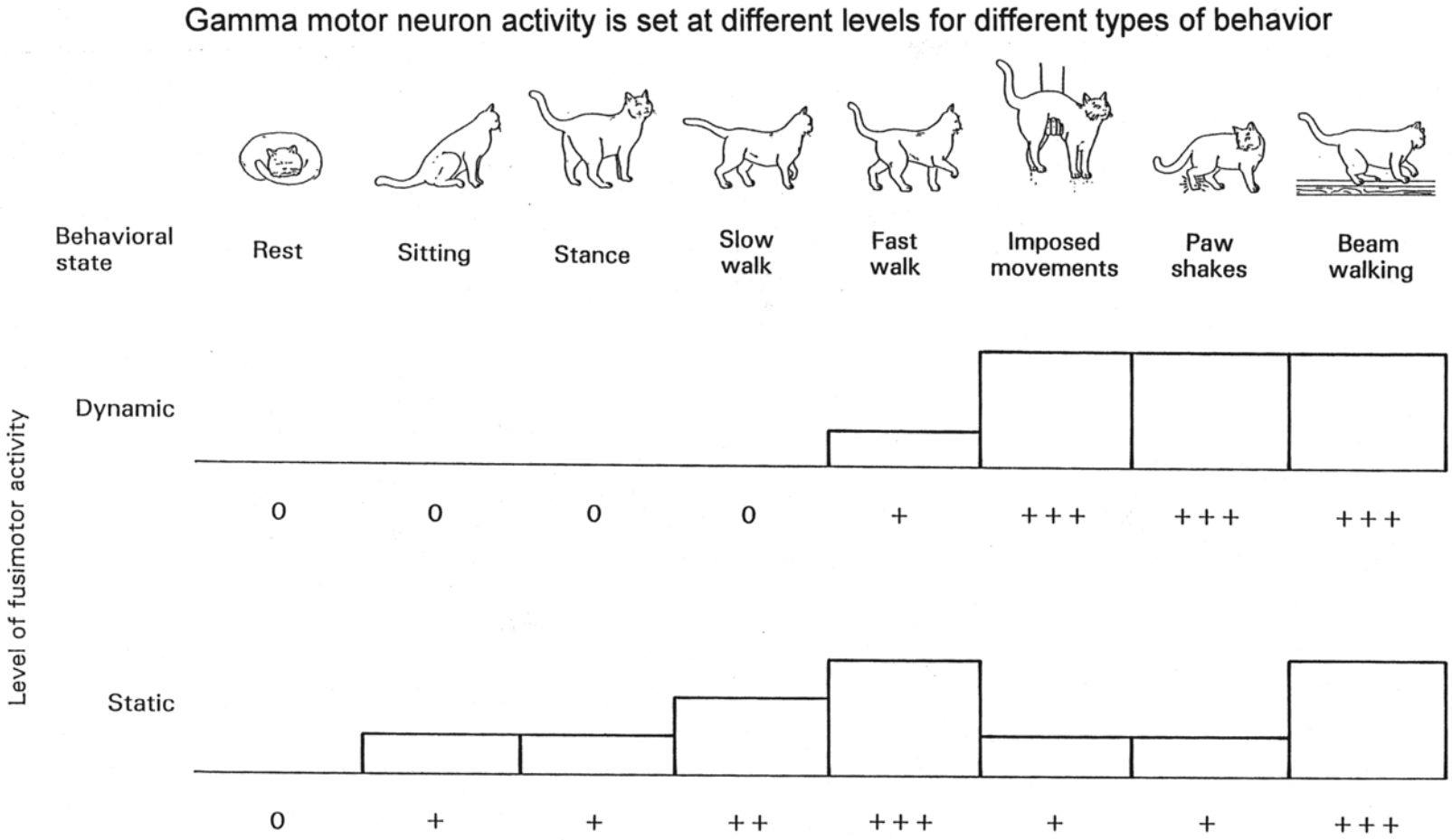
Alpha-gamma coactivation

Activity of static and dynamic gamma motor neurons during locomotion

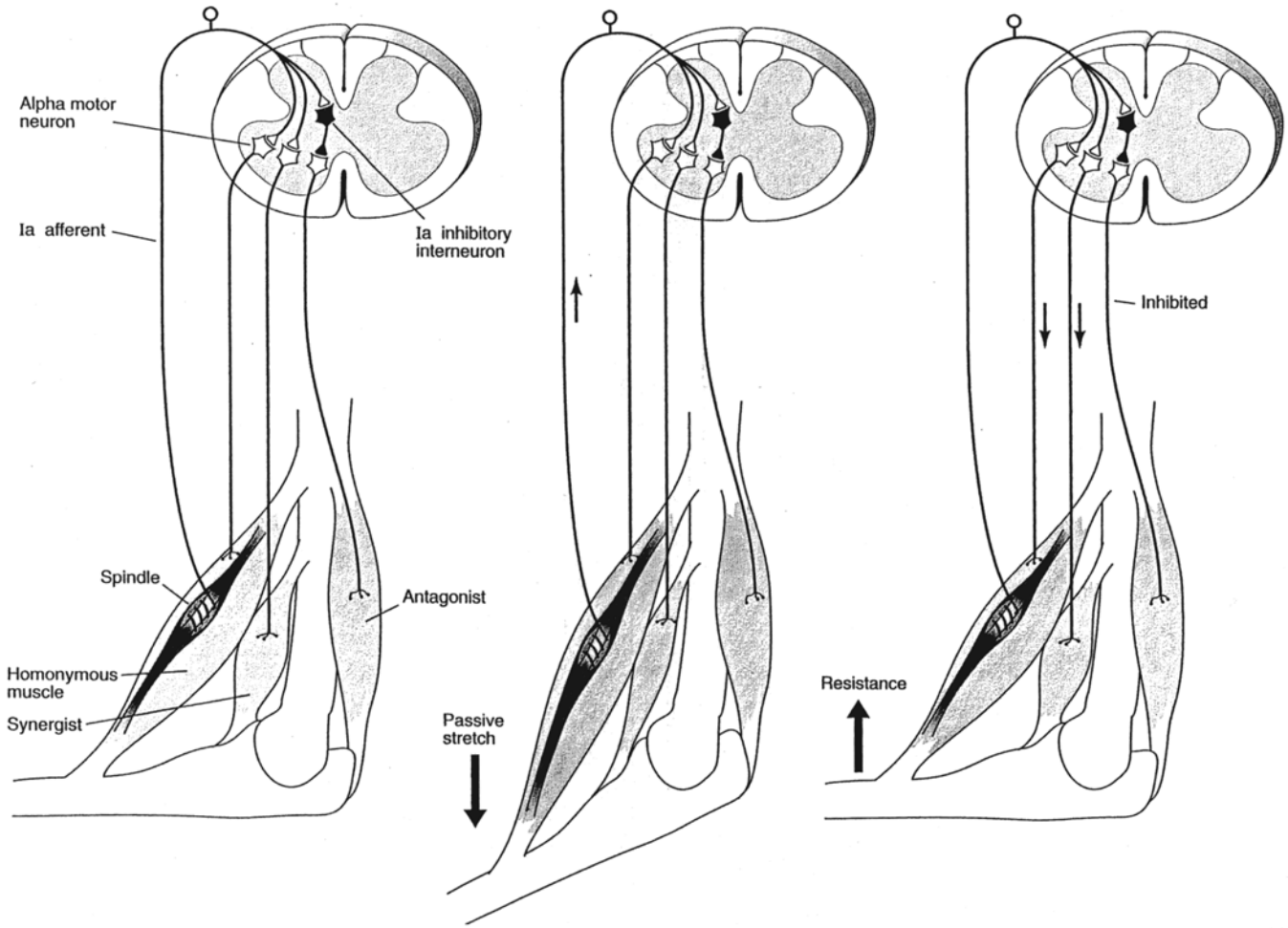




Gamma motor neuron activity can be adjusted independently of alpha motor neuron activity

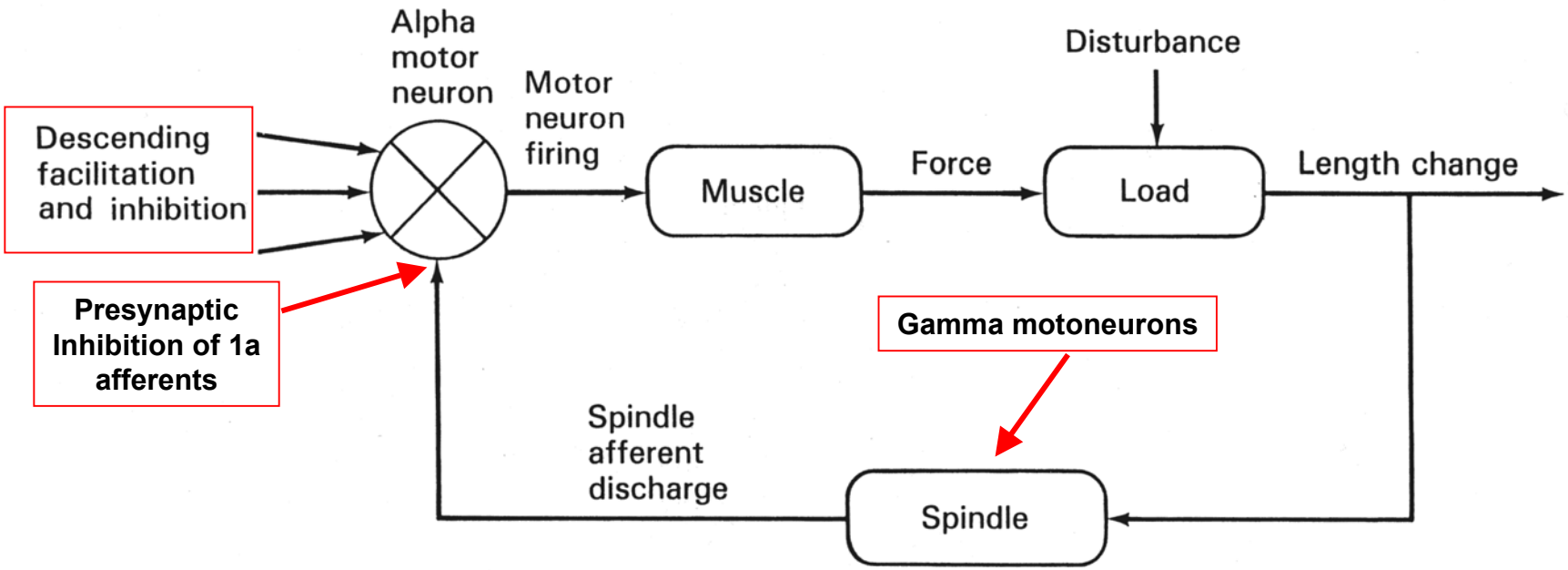


Discharge of muscle spindle afferents produces stretch reflex



The stretch reflex acts like a negative feedback loop

The stretch reflex participates in stabilization of the muscle tone throught stabilization of the muscle length

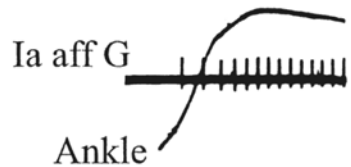


CNS can regulate the effectiveness of the stretch reflex through:

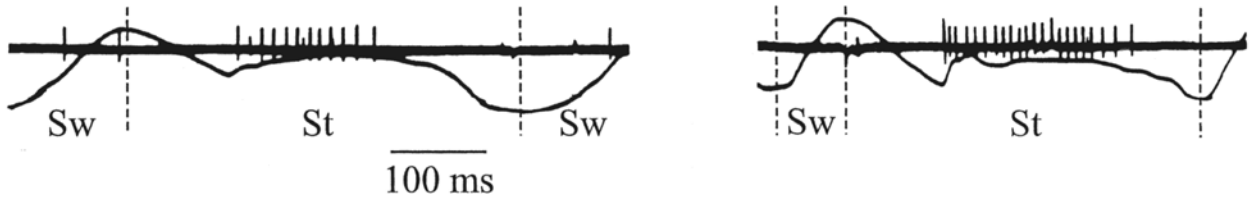
(i) Gamma motoneurons;
(ii) Presynaptic inhibition of 1a afferents;
(iii) Inputs affecting alpha motoneurons

Modulation of effectiveness of the stretch reflex during locomotor cycle

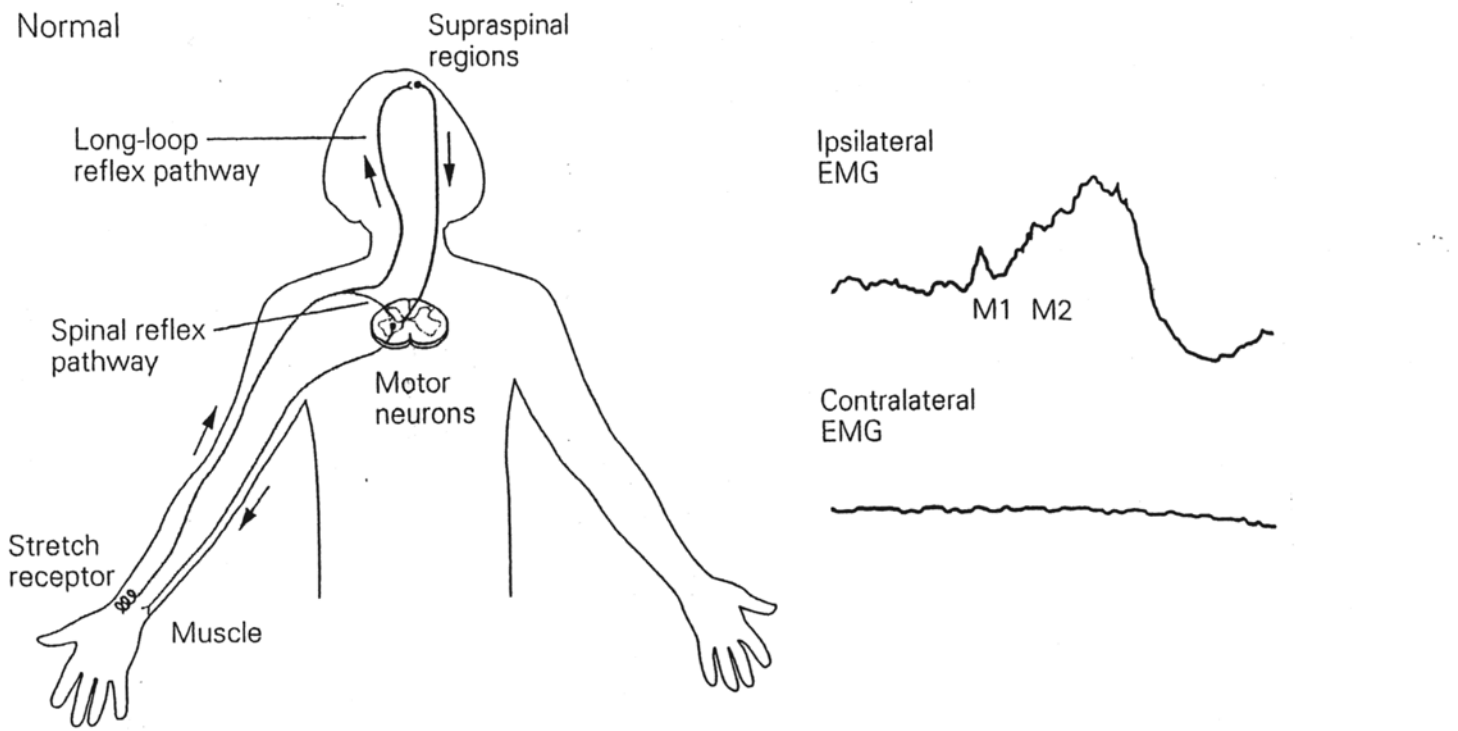
A response of Ia afferent to passive stretching



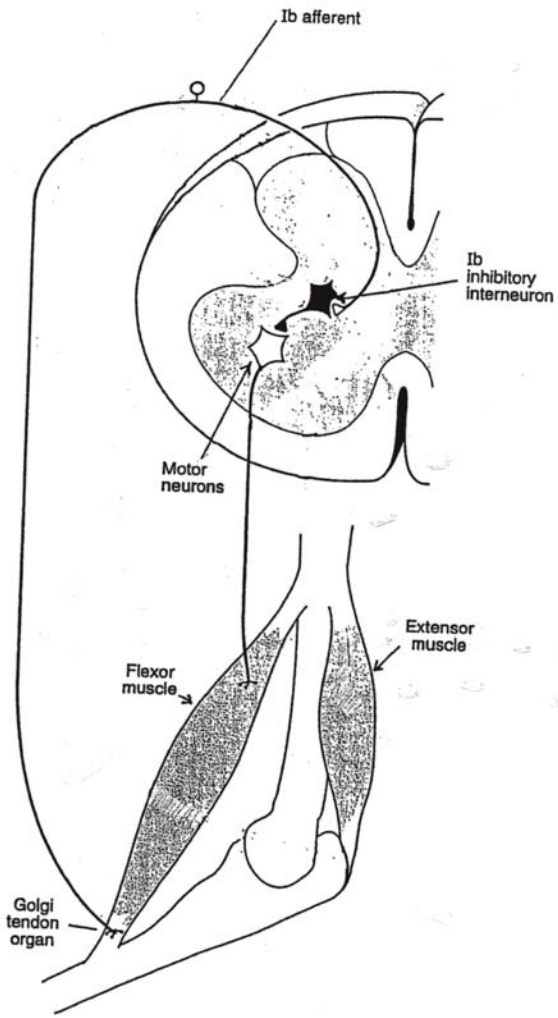
The response to stretching disappeared during locomotion

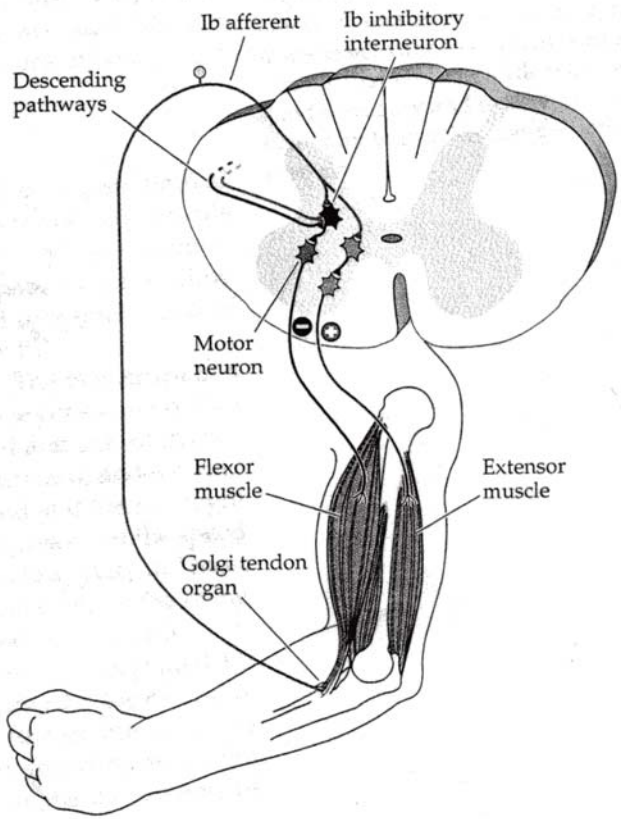


Sensory signals from muscle spindles produce reflex responses through spinal reflex pathways and long-loop reflex pathways that involve supraspinal regions



1b afferent fibers from Golgi tendon organs provide a negative feedback system for regulating muscle tension




Ib afferent
Ib inhibitory interneuron
Descending pathways
Motor neuron
Flexor muscle
Extensor muscle
Golgi tendon organ

Conclusions

1. Specialized sensory receptors (spindles and tendon organs) in the muscle provide feedback to the CNS regarding the amount the muscle stretch and tension.

2. Muscle spindles are located within the muscle and provide signals on the muscle length. The length of the muscle and changes in length are coded by the pattern and frequency of action potentials in the primary or Ia afferents and secondary or Group II afferents. Gamma motor neurons innervate the spindle fibers and can adjust the sensitivity of the spindle.

3. Golgi tendon organs lie within the musculotendinous junctions and are activated when tension is produced by nearly active motor units.

4. Muscle spindles and tendon organs provide the CNS with continuous information about the mechanical state of the muscle. Sensory signals from muscle receptors are transmitted to the spinal cord as well as to the higher levels of the central nervous system.

5. Discharge of muscle spindle afferents evokes stretch reflex. It is a monosynaptic spinal reflex, which allows muscle tone to be regulated quickly and efficiently without direct intervention by higher centers. Descending control signals adjust the gain of the reflex loops, adapting them to the requirements of specific motor acts.

6. Discharge of Golgi tendon organ Ib afferents disynaptically inhibits the discharge of homonymous alpha motor neurons, thus providing a negative feedback mechanism for regulation of muscle tension.