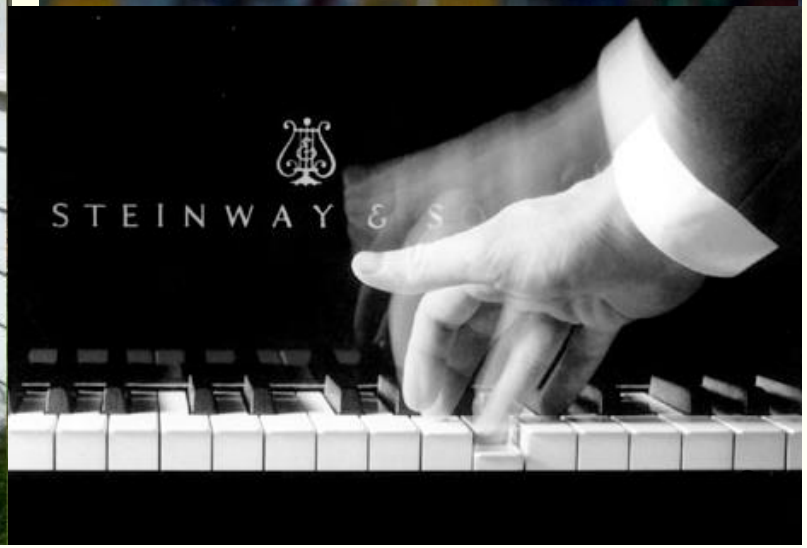
Peripheral control of posture & movement

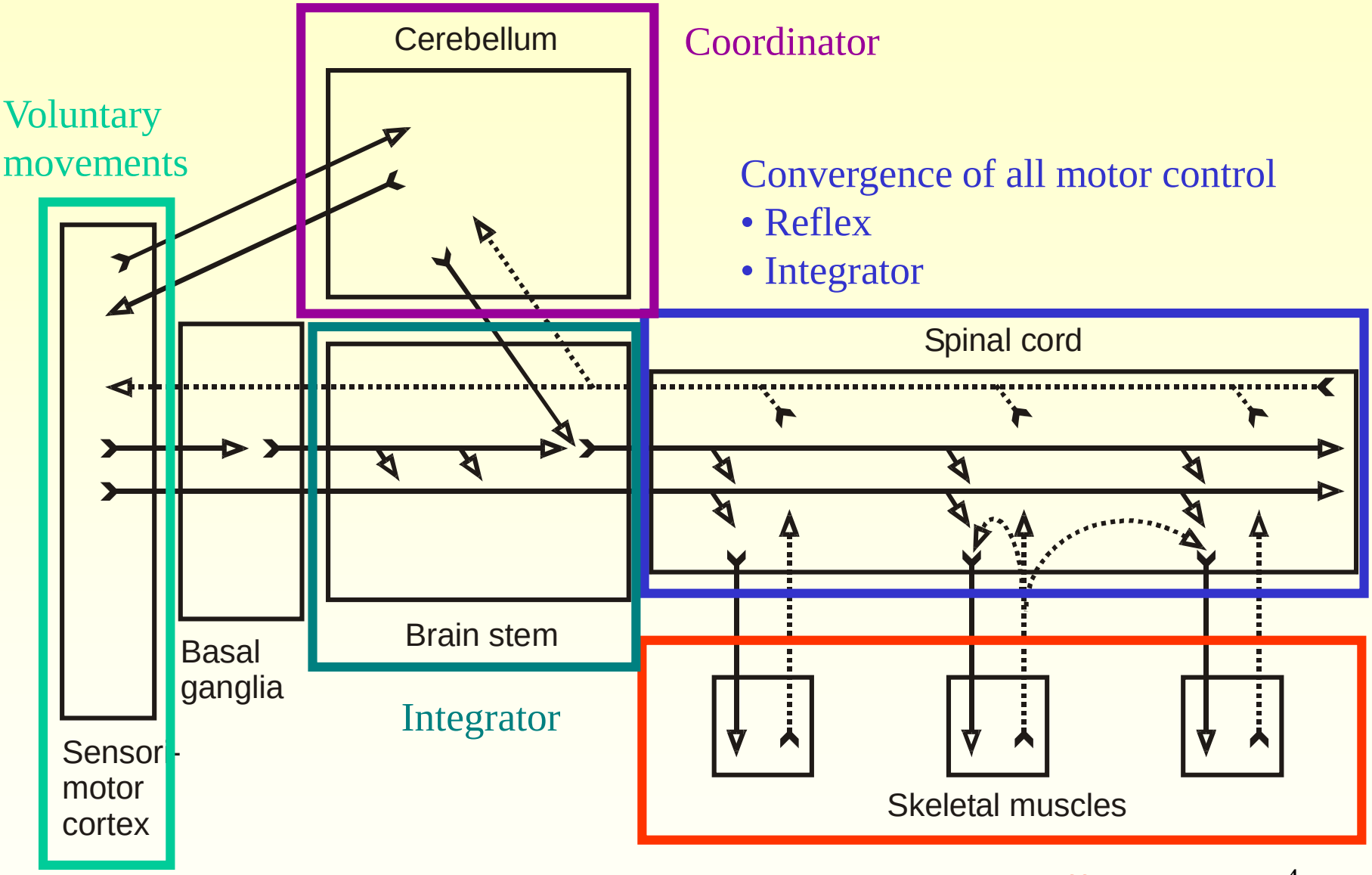
The control of posture and movement



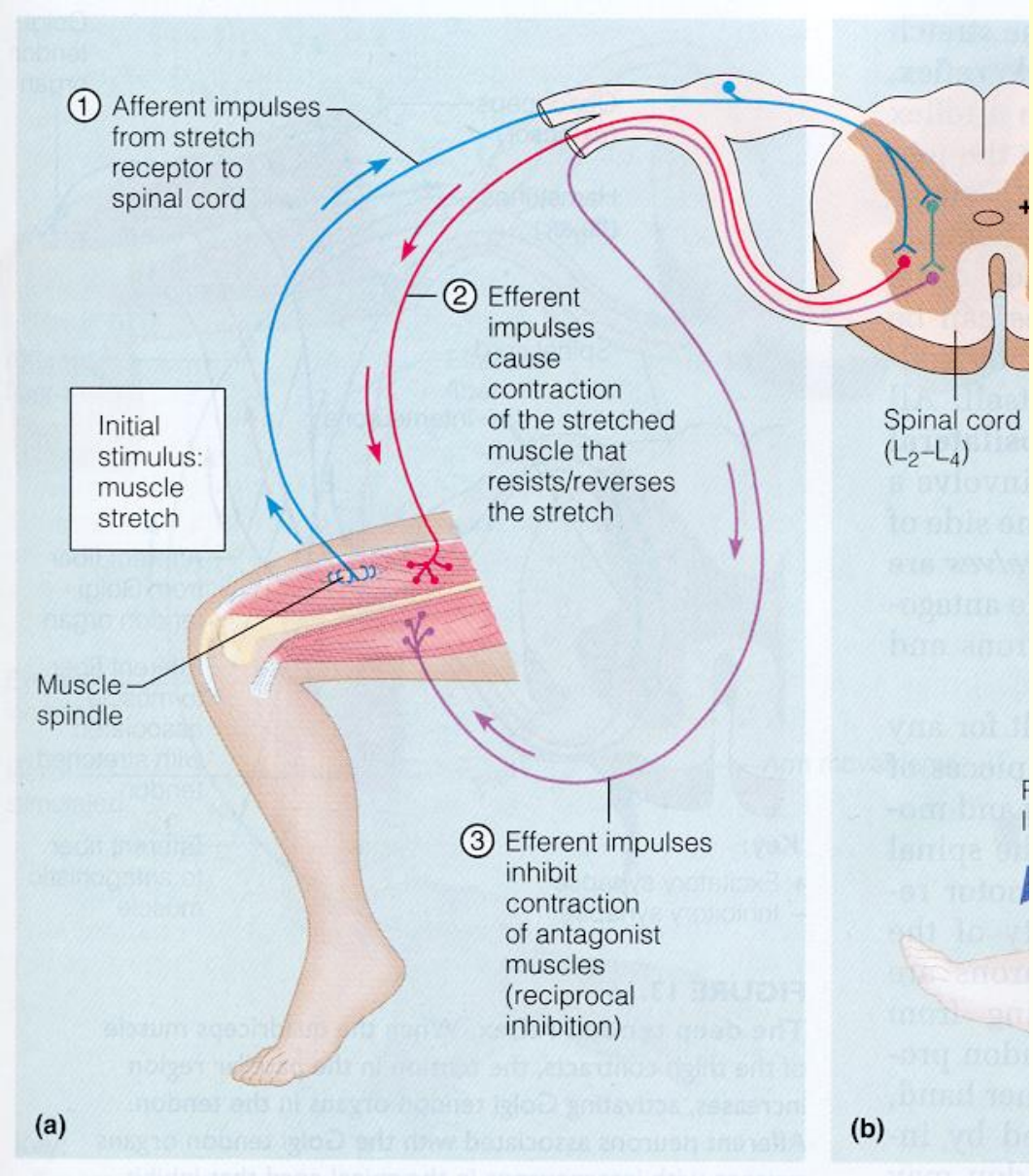
The control of posture and movement

Ludwig van Beethoven - Moonlight Sonata (3rd Movement)
Tina S, Cover

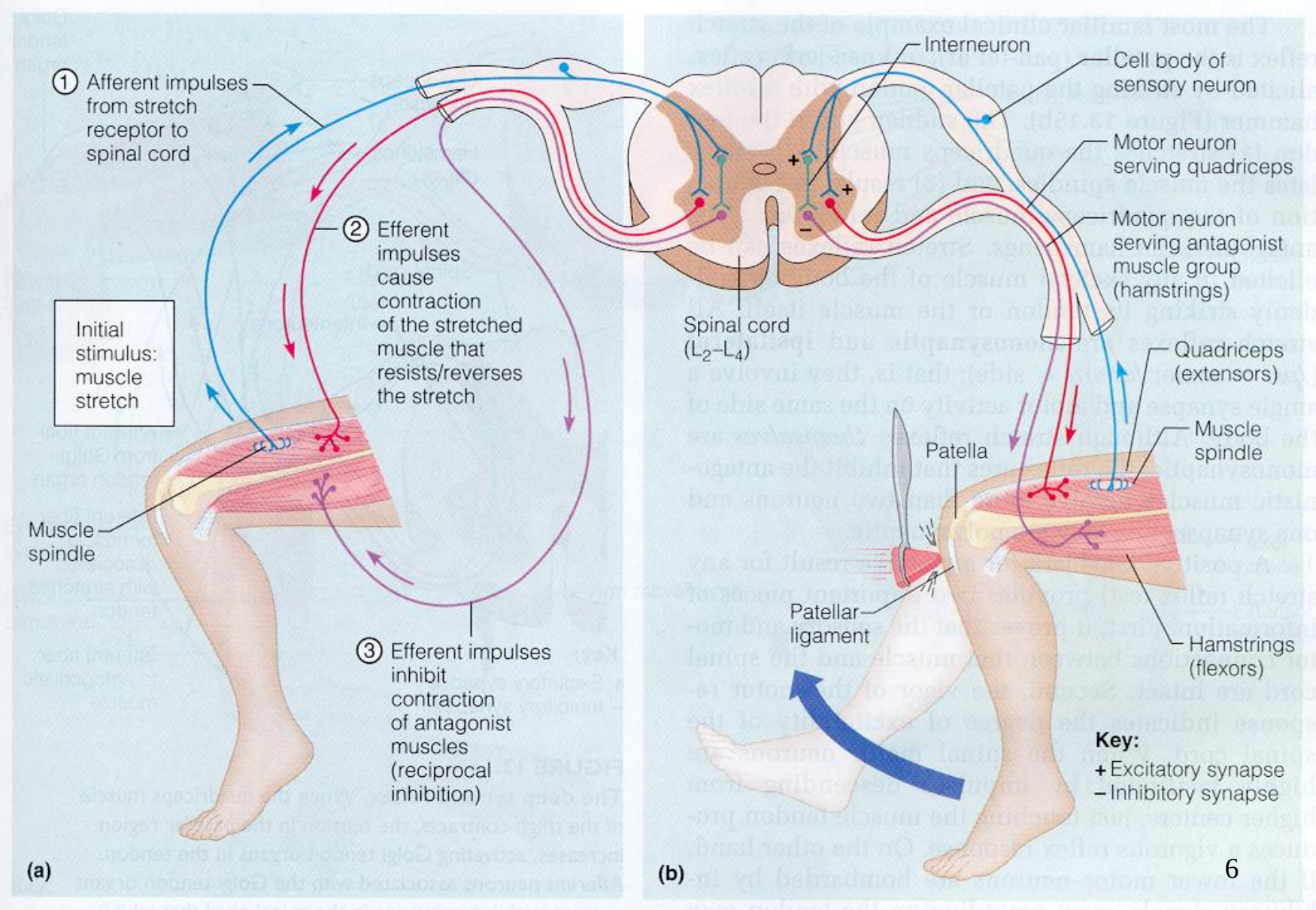
Simple diagram of the control of posture and movement



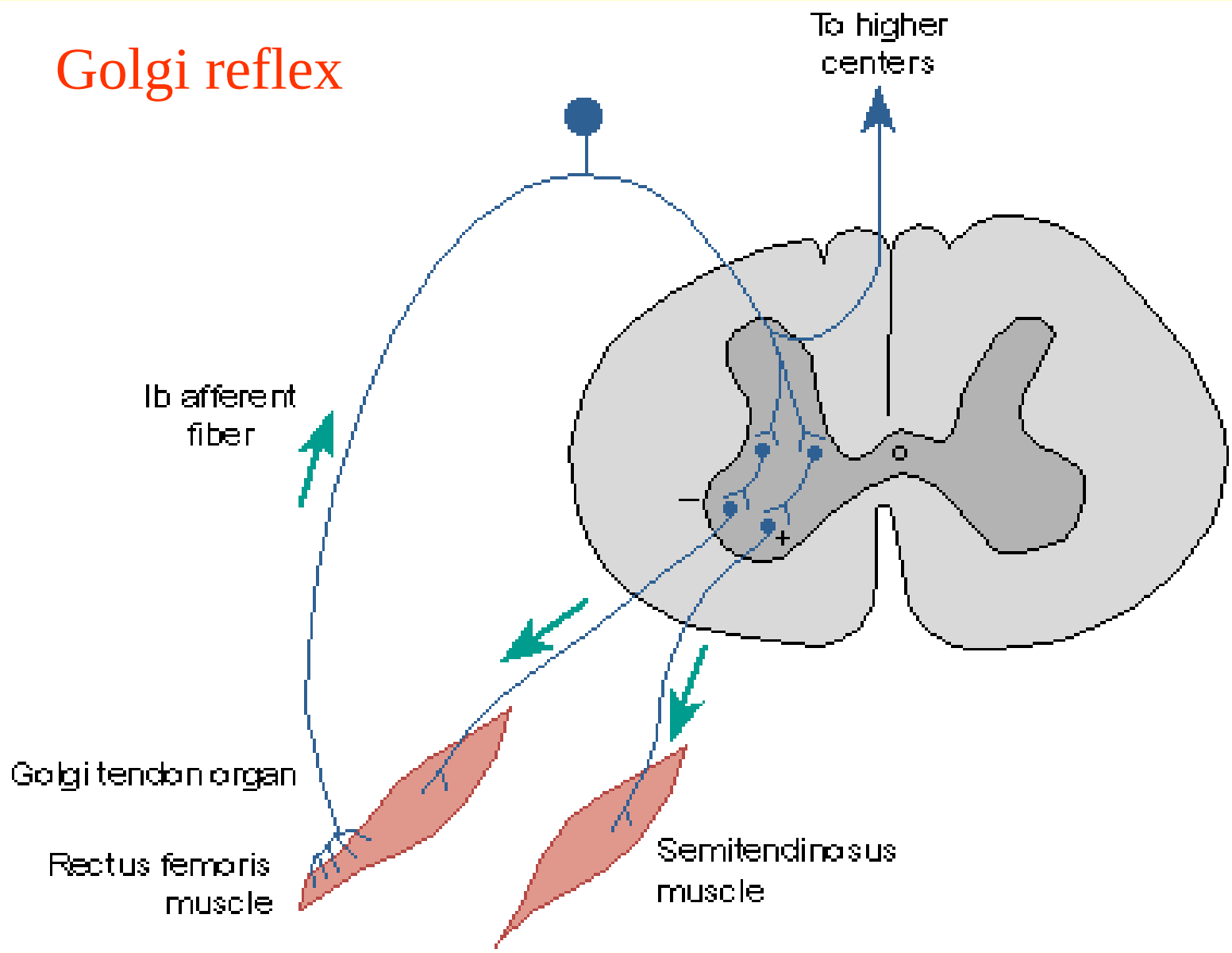
Stretch reflex



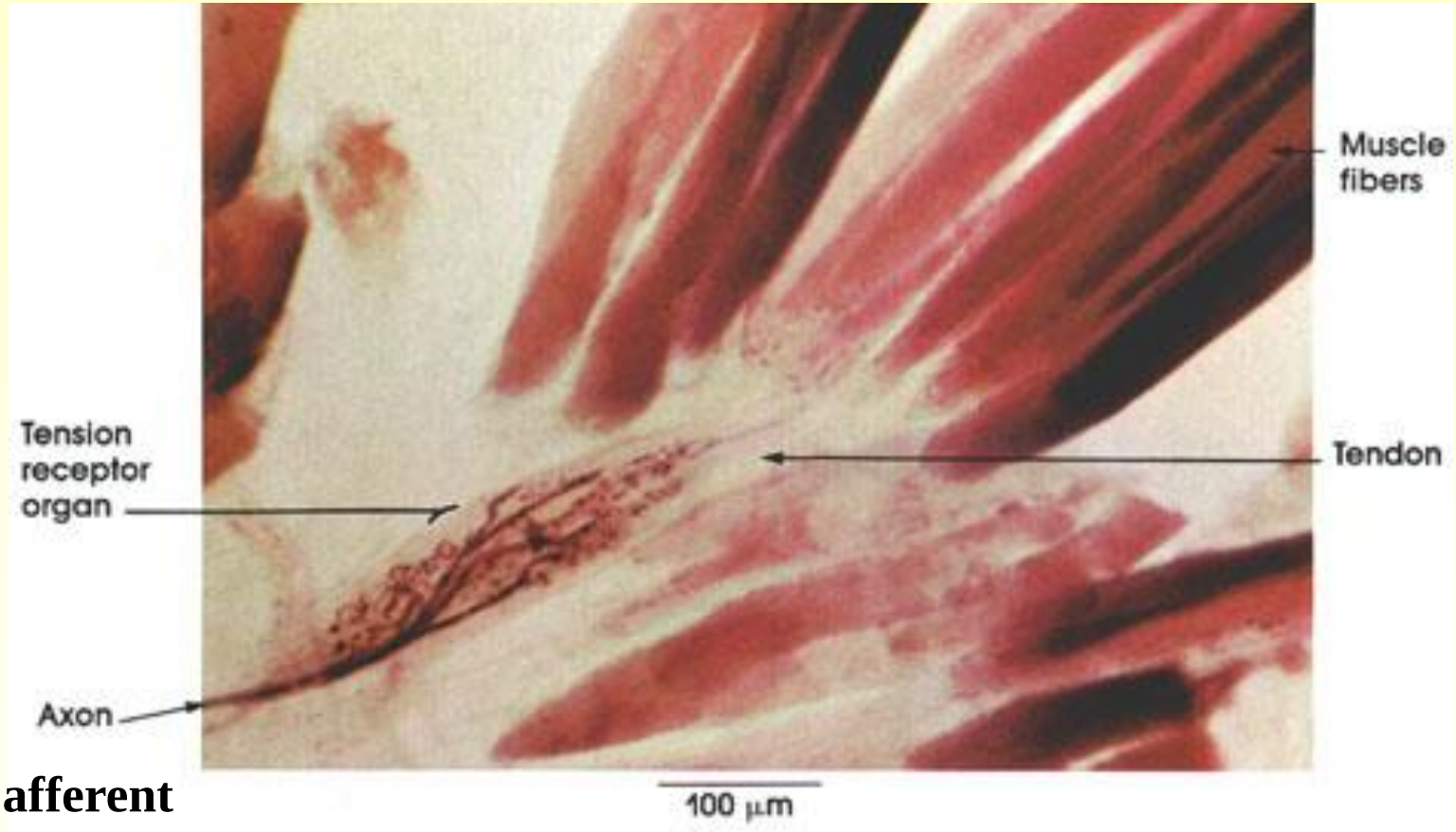
Stretch reflex



Golgi reflex

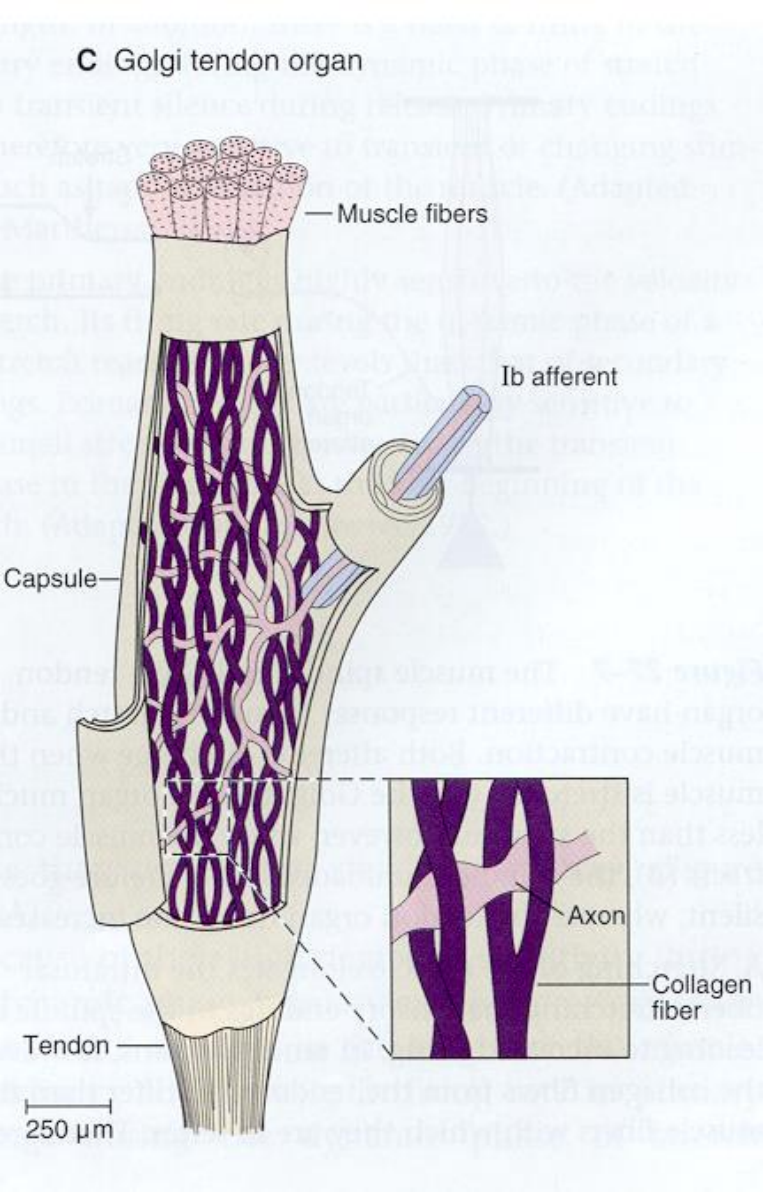


Golgi structure



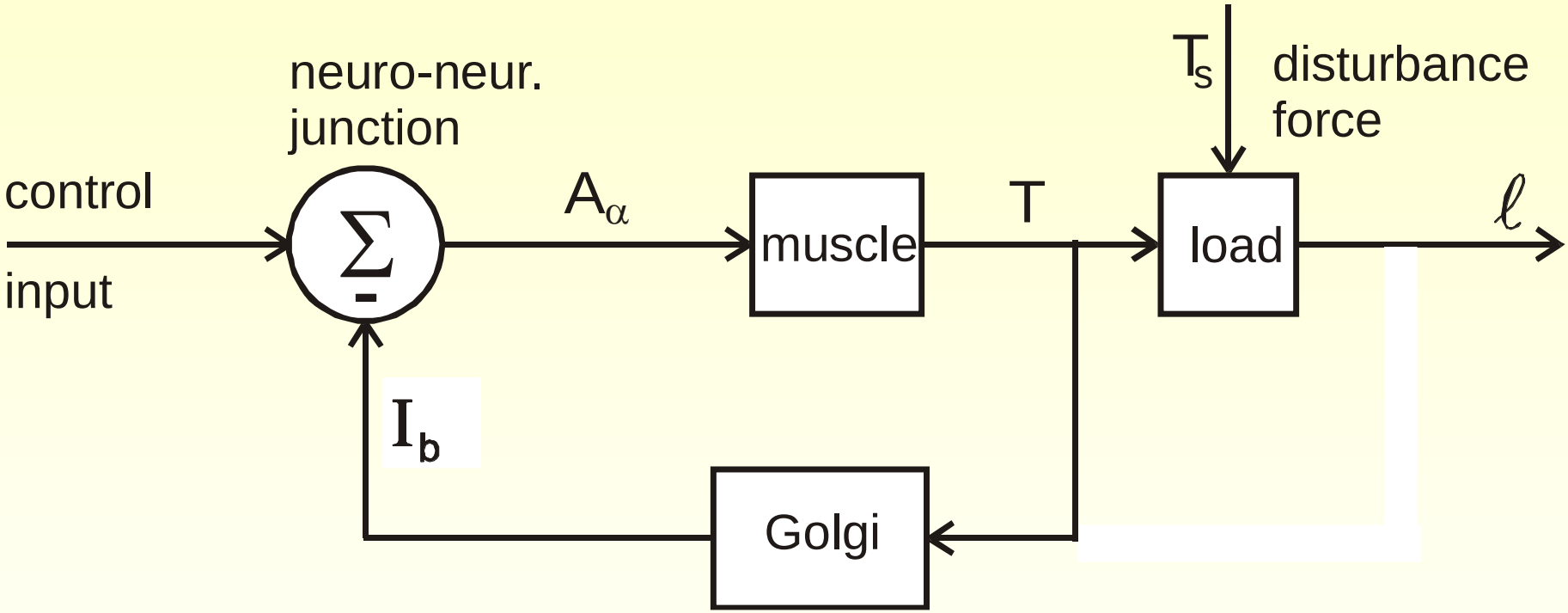
Ib afferent

Golgi structure



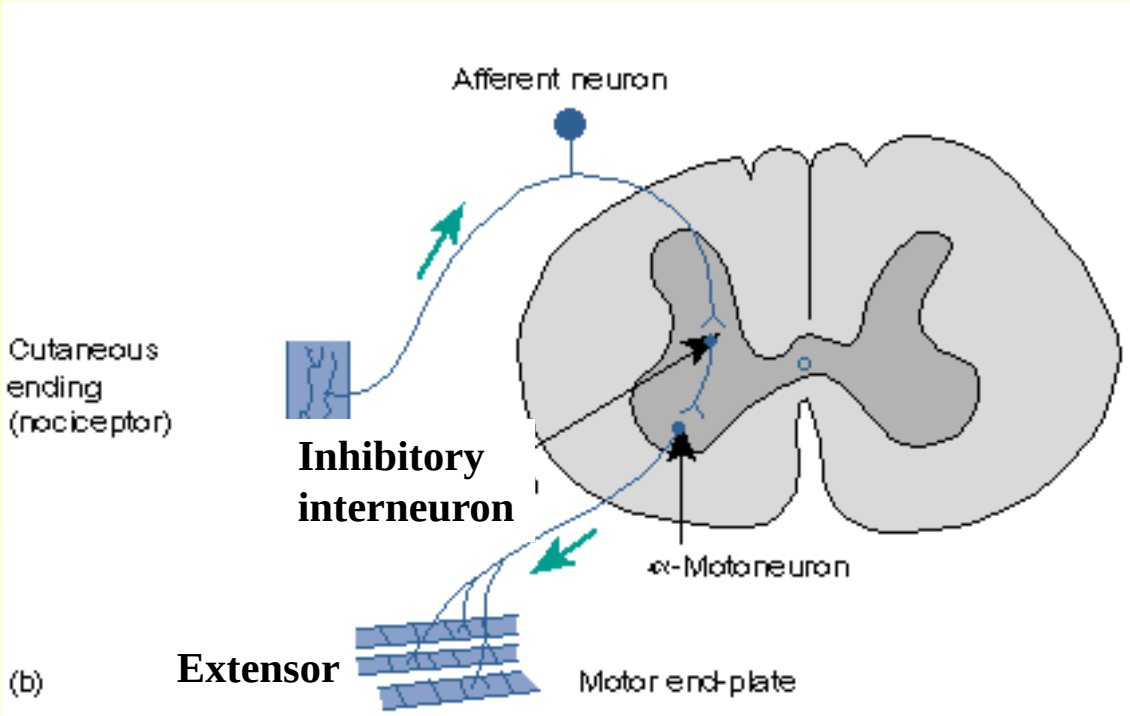
Golgi reflex

The Golgi organ measures the tension of the muscle



Pain reflex and stretch reflex:

- Subconscious movement control
- Protective role



Pain reflex and stretch reflex:

- Subconscious movement control
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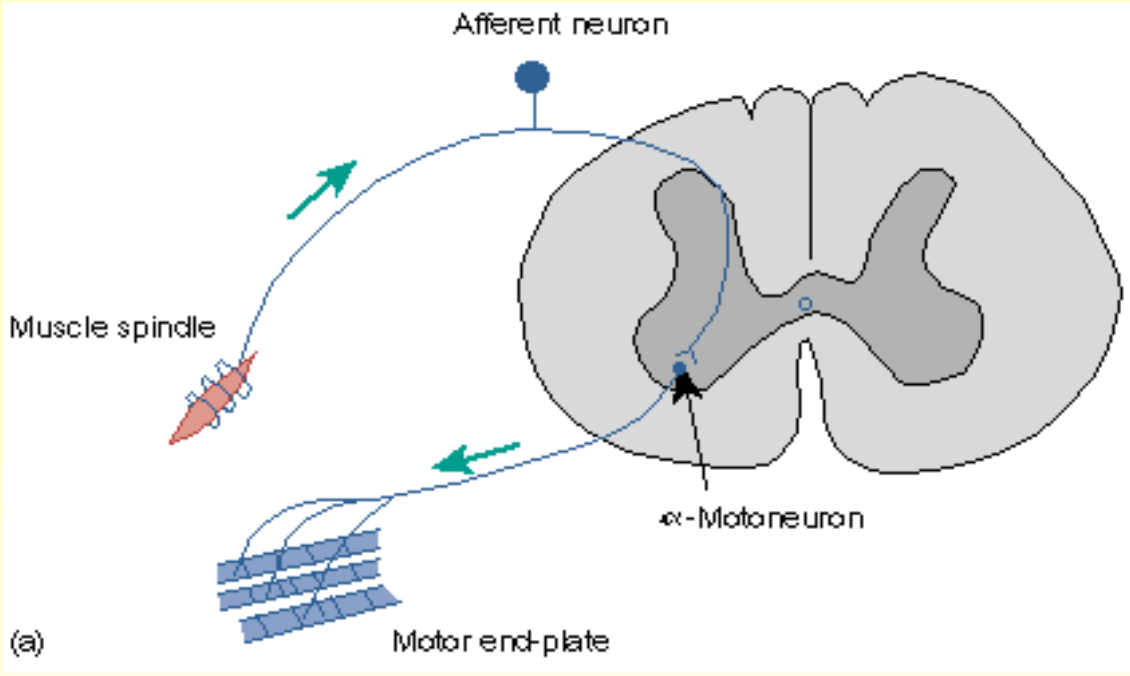
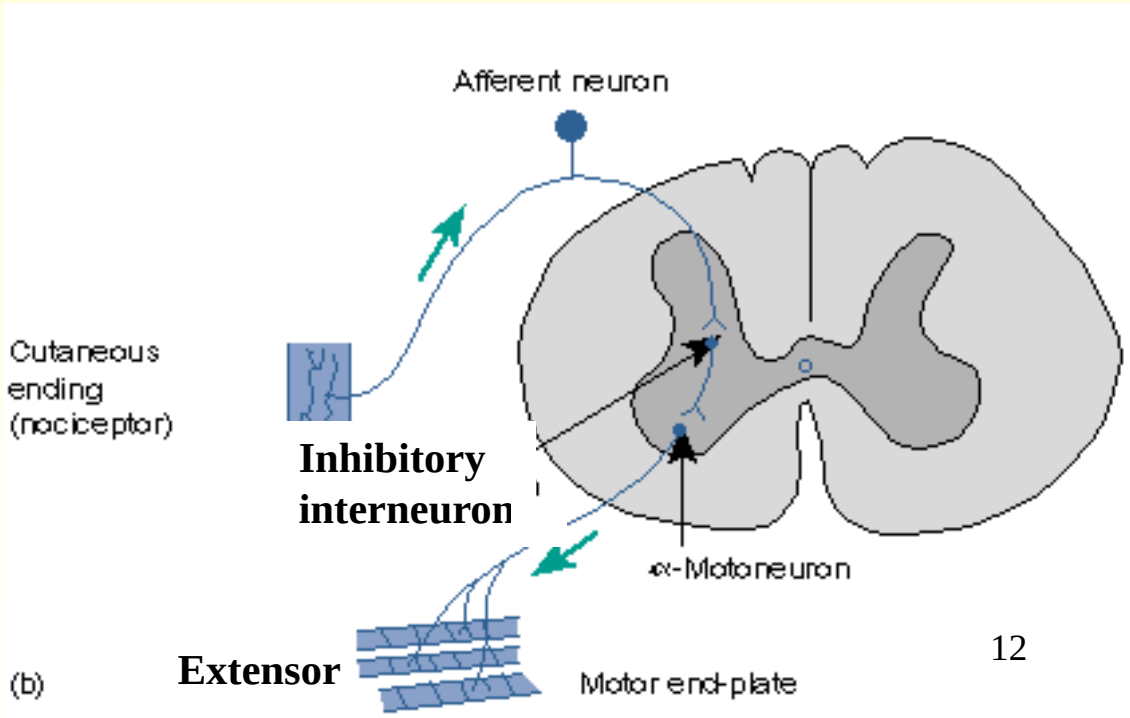
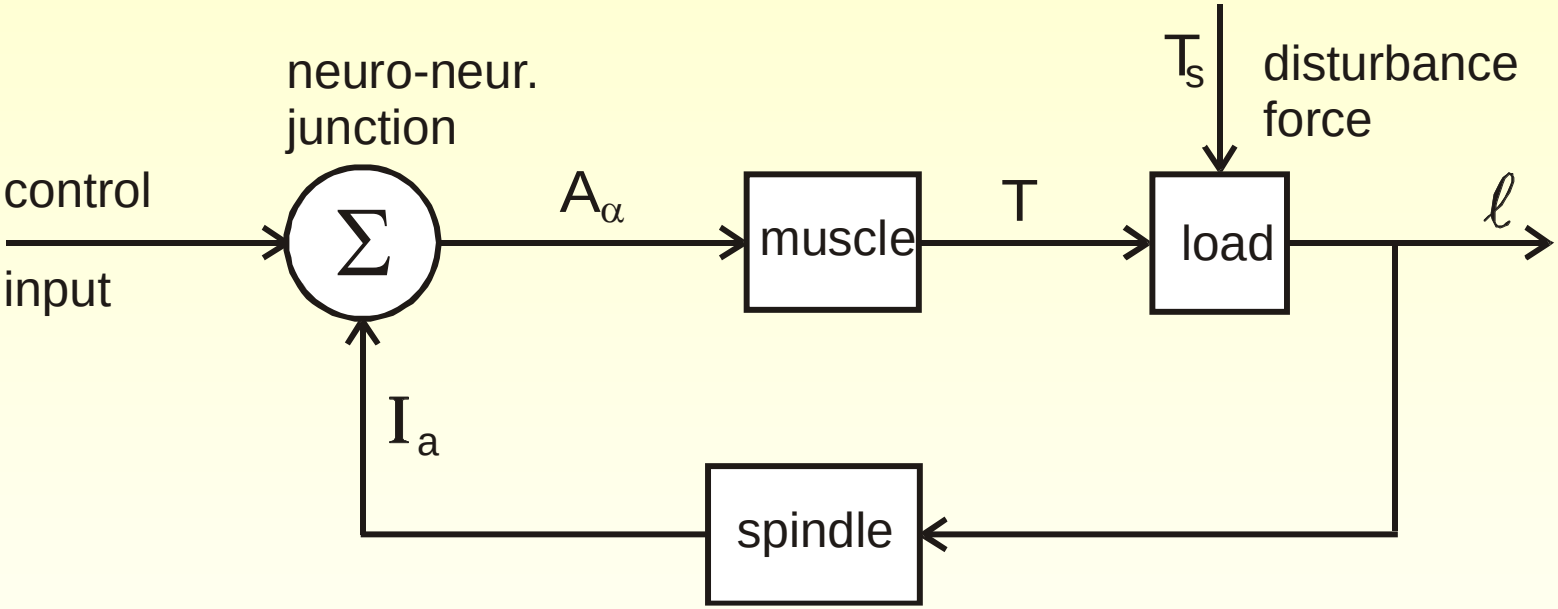


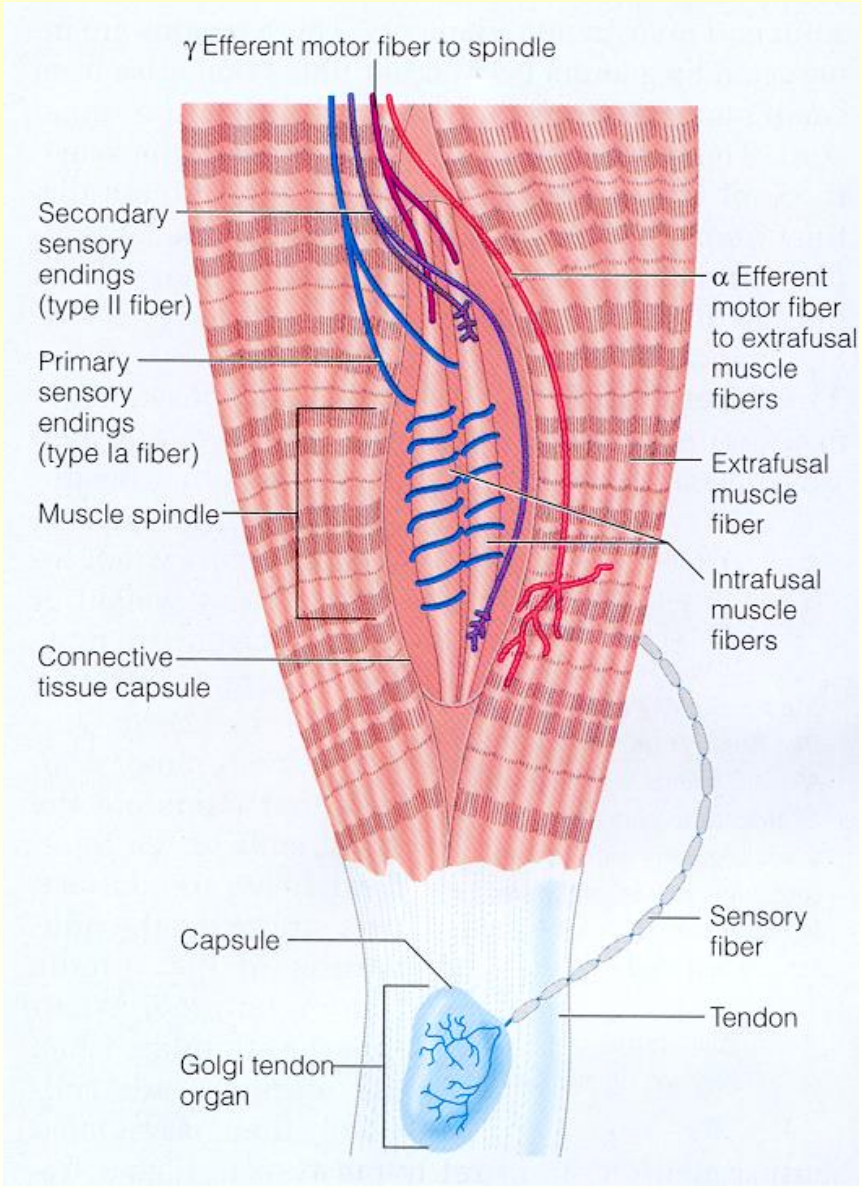


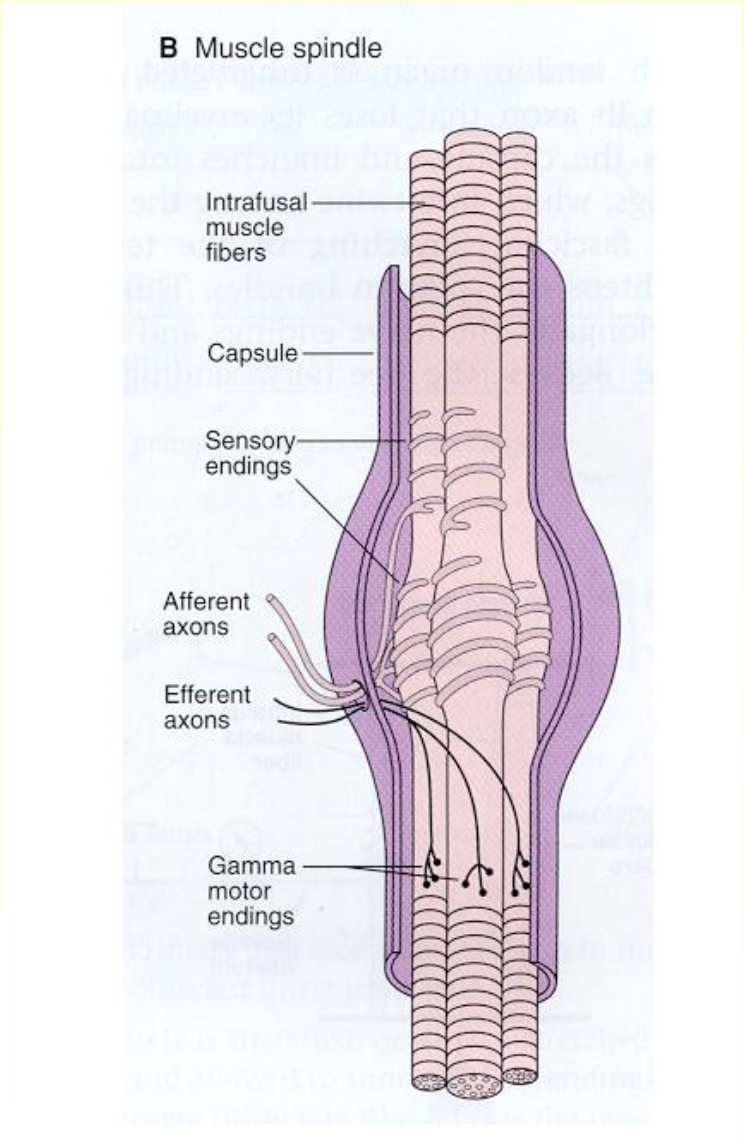
Muscle spindle reflex

The muscle spindle measures the length of the muscle



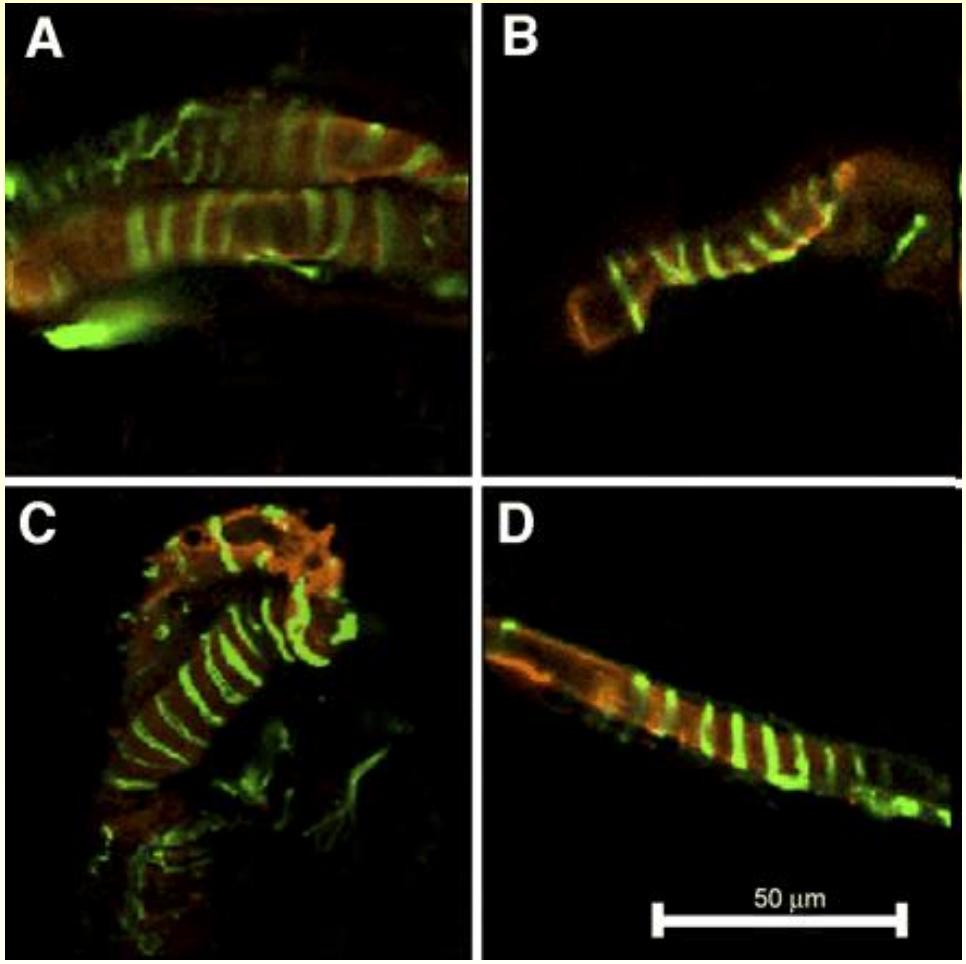
Morphology of the muscle spindle





Morphology of the muscle spindle

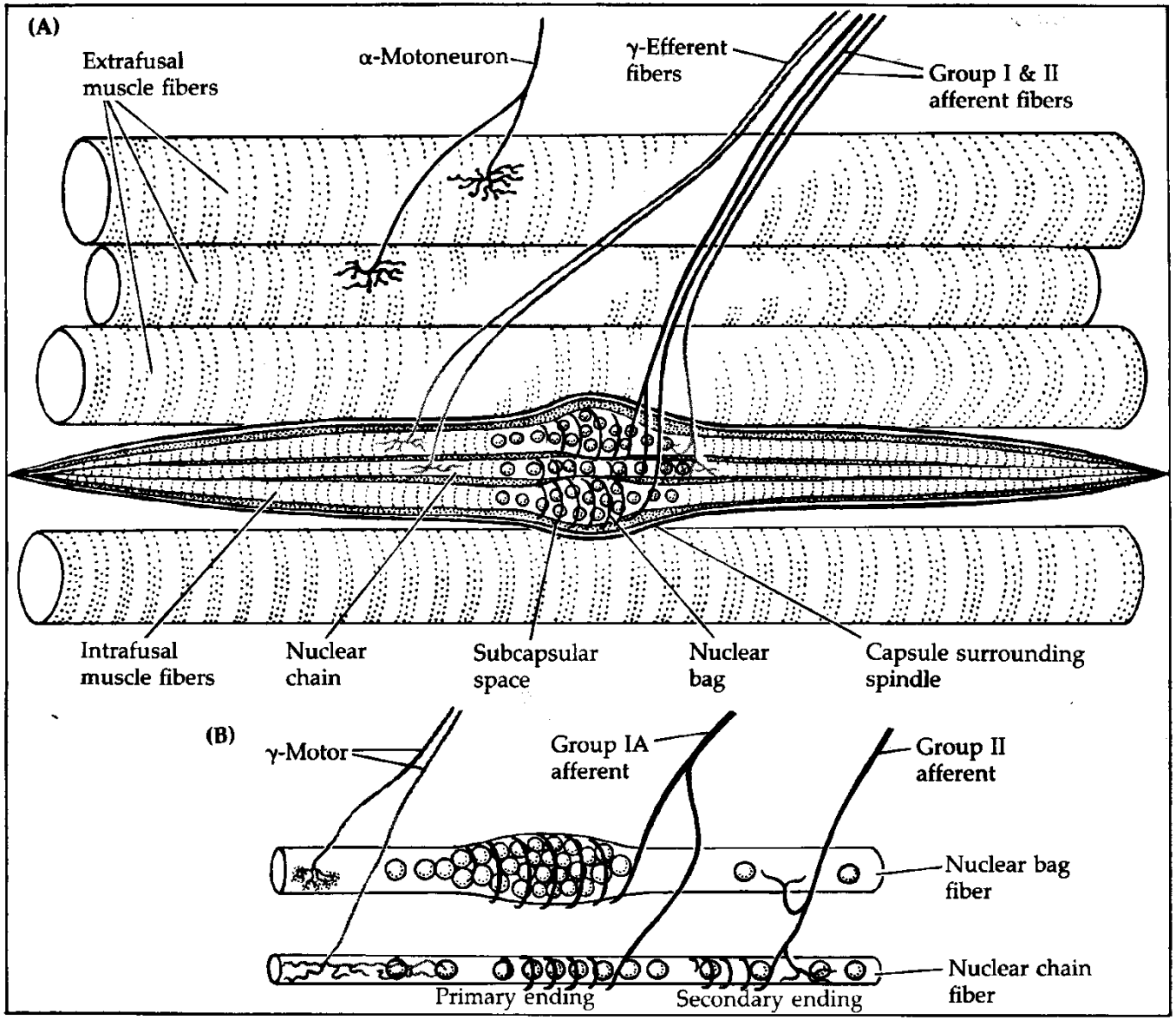
Sensory Ia nerve fibers



Red: Slow tonic myosin heavy chain marking the muscle

Green: NF-H, anulospiral marker of nerve fibres

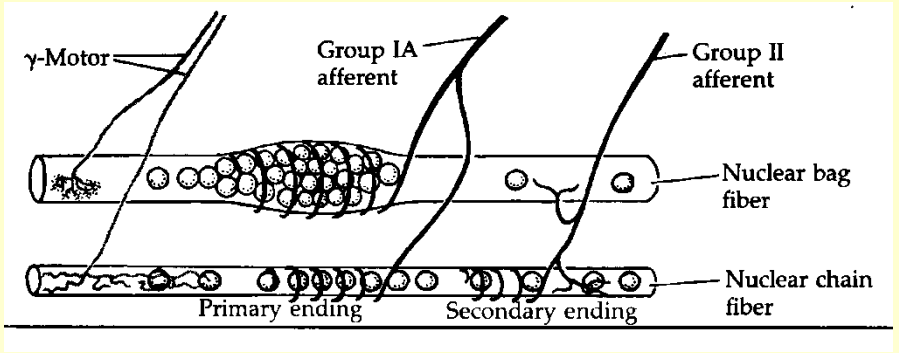
Morphology of the muscle spindle

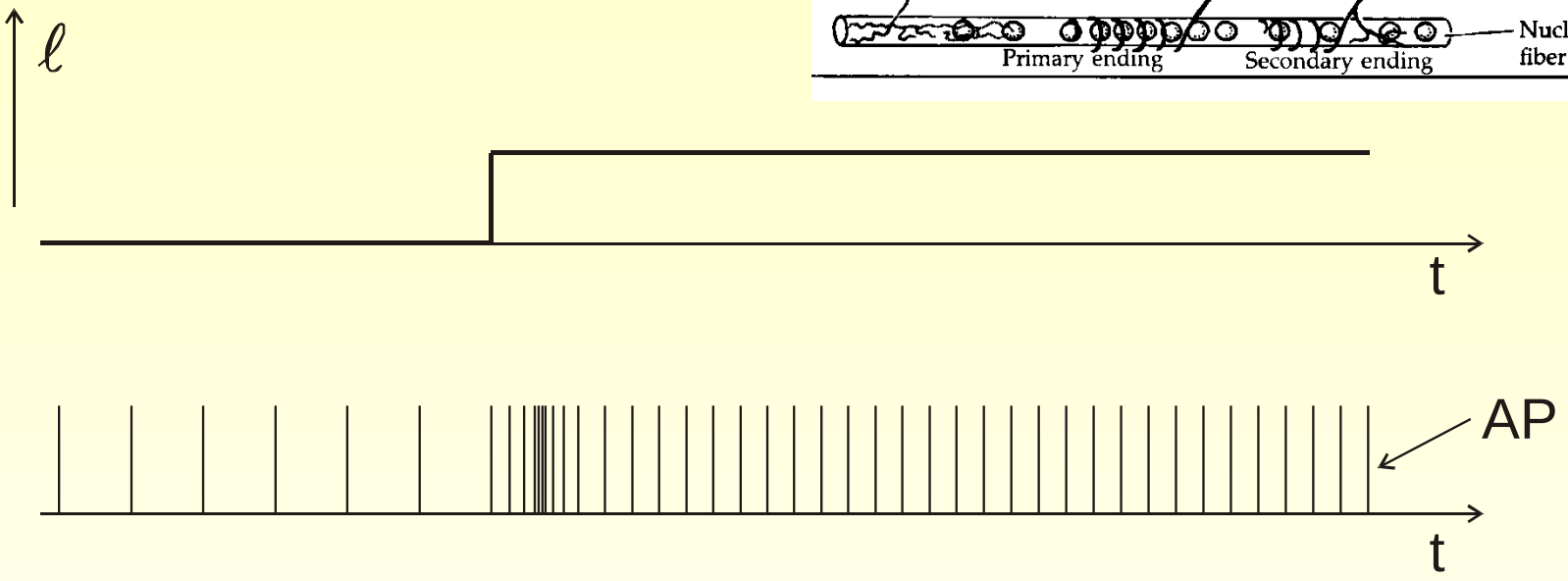


Nerves in the muscle spindle: type and structure

Type	Subtype	Afferents	Endings	Efferents	Endings
Nuclear Chain Fibers					
	Ia	Ia	Annulo-spiral	γ_s	Trail
	II	II	Annulo-spiral Flower spray	γ_s	Trail
Nuclear Bag Fibers					
	Bag1				
		Ia	Annulo-spiral	γ_d	Plate
		II	Flower spray	γ_d	Plate
	Bag2				
		Ia	Annulo-spiral	γ_s γ_d	Trail Plate
		II	Flower spray	γ_s	Trail

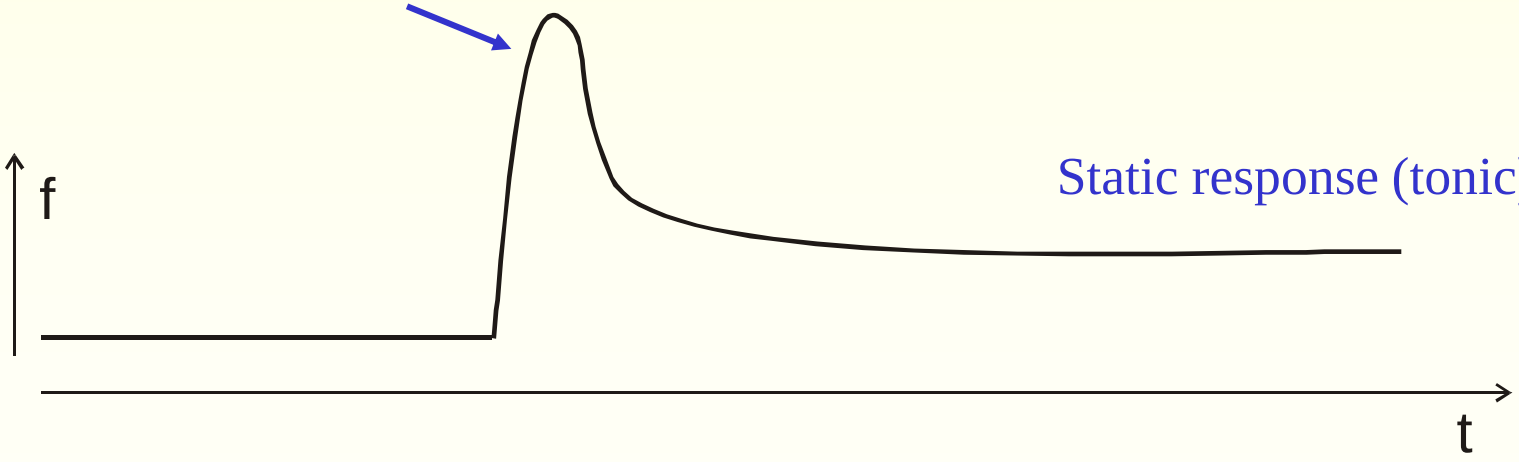
Response of spindle: Ia afferent nerve fiber to step input



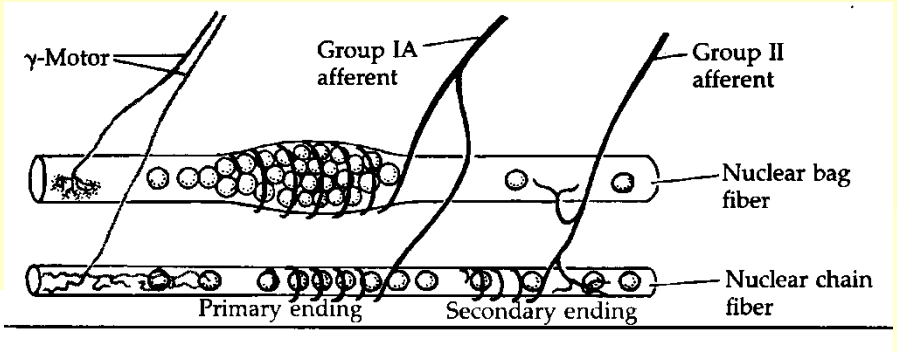


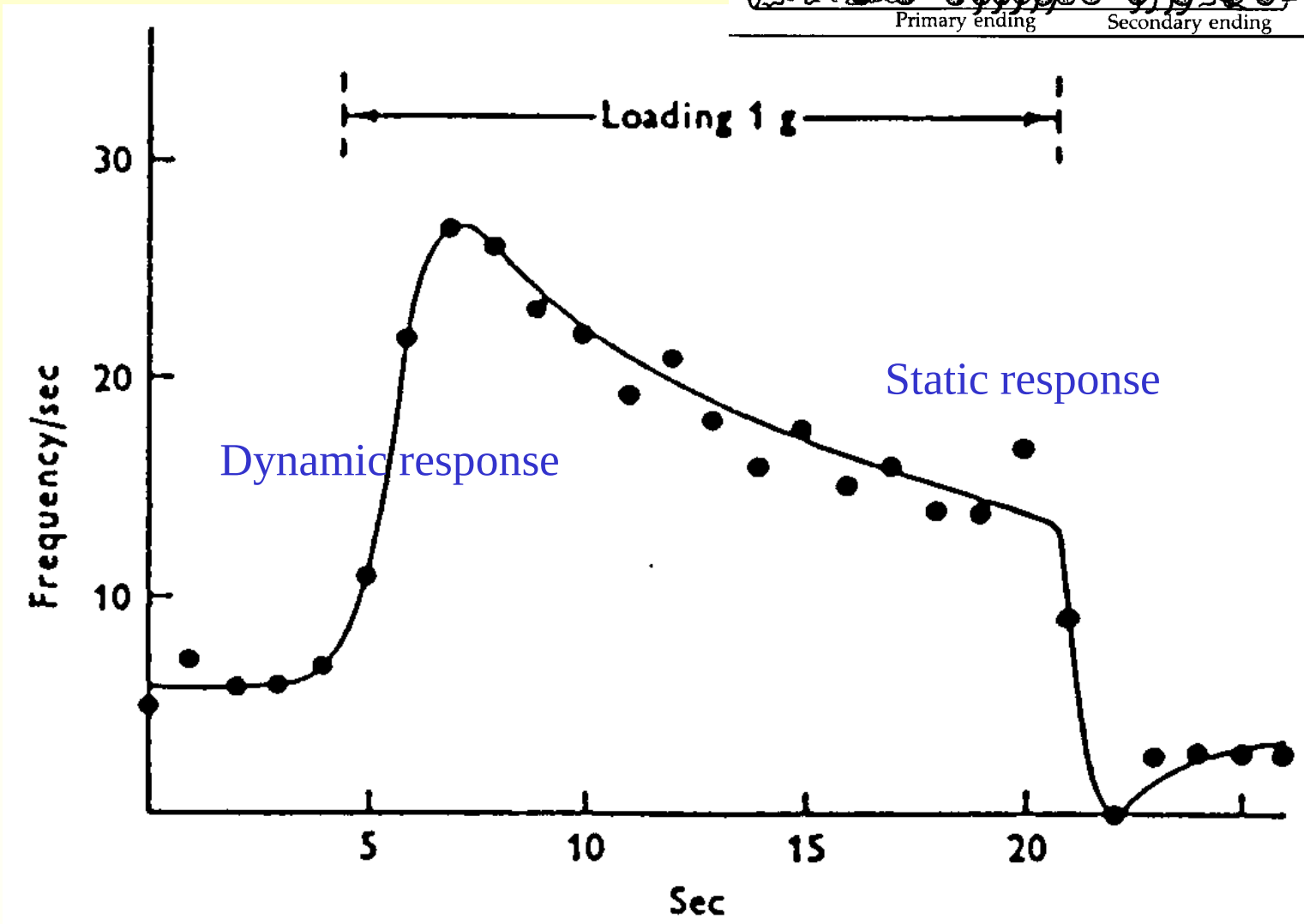
Dynamic response (phasic)

Static response (tonic)



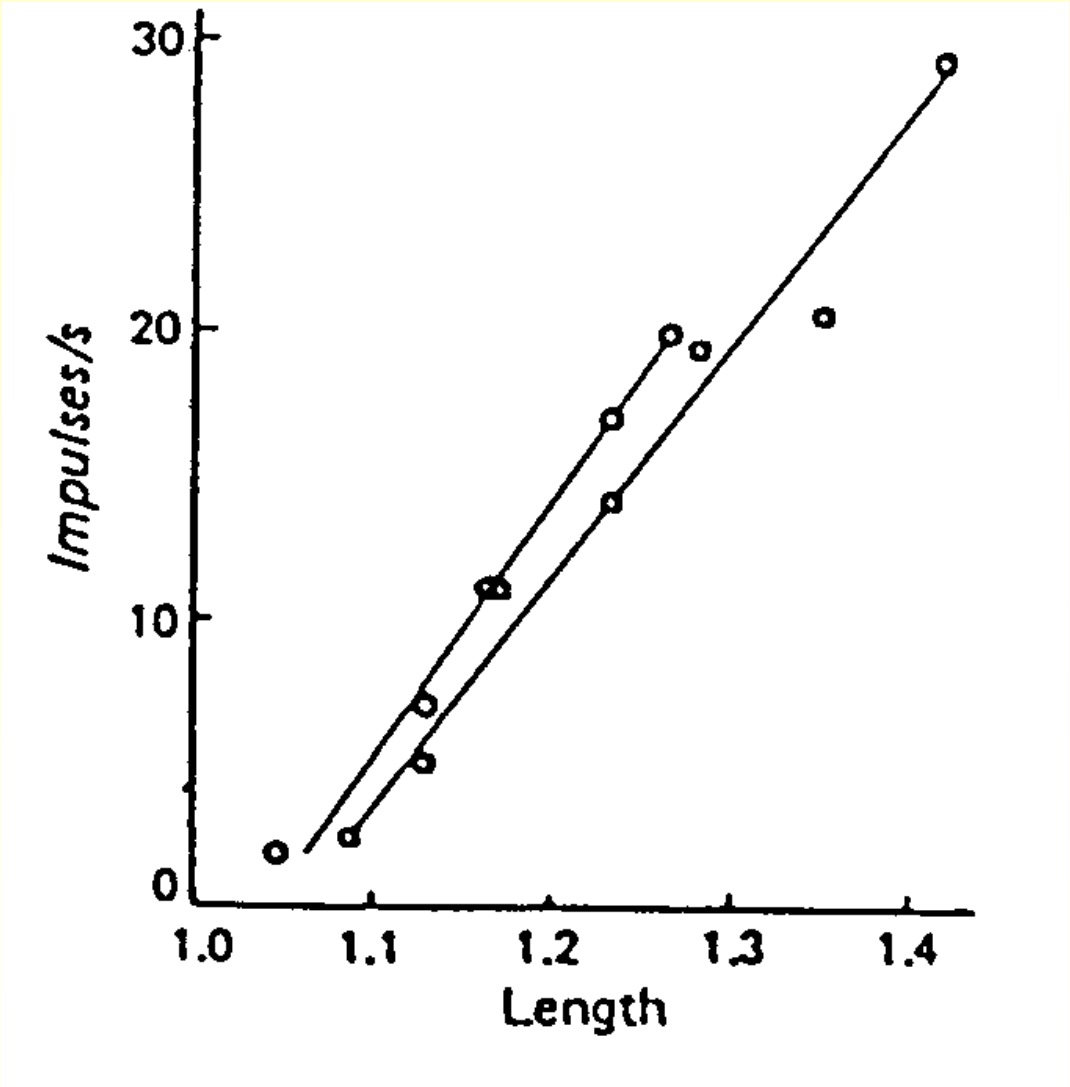
Action potential freq of spindle Ia afferent nerve fiber to step input





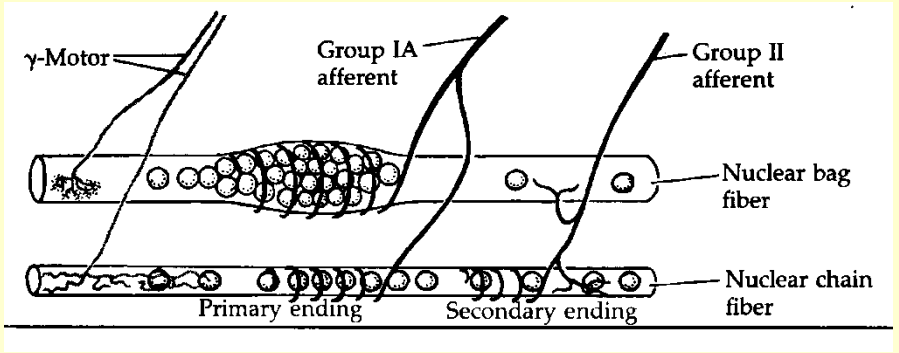
Static response of the spindle to stretch

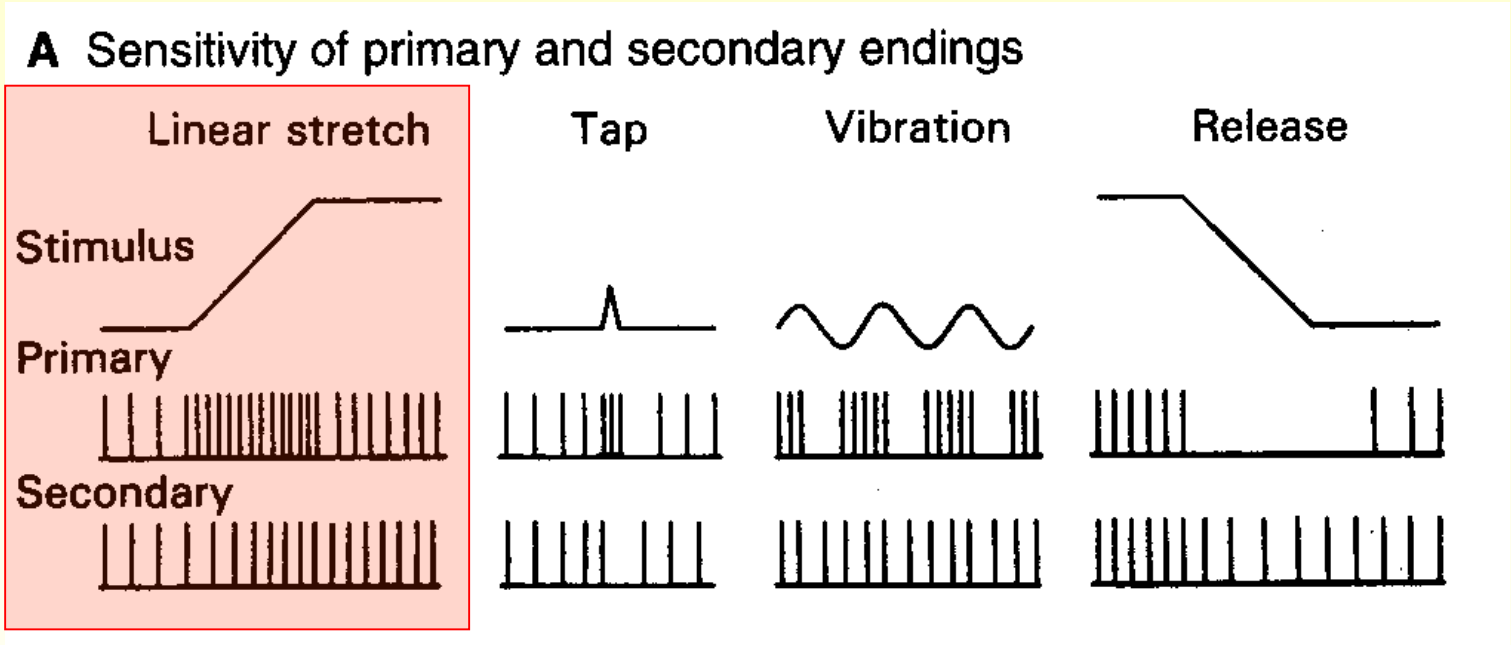
Action potential frequency of spindle Ia afferent nerve fiber to steady-state stretch



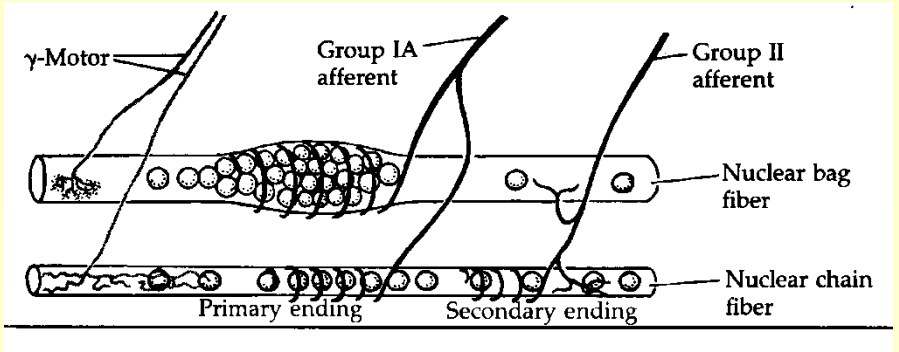
Dynamic response of the spindle to linear stretch

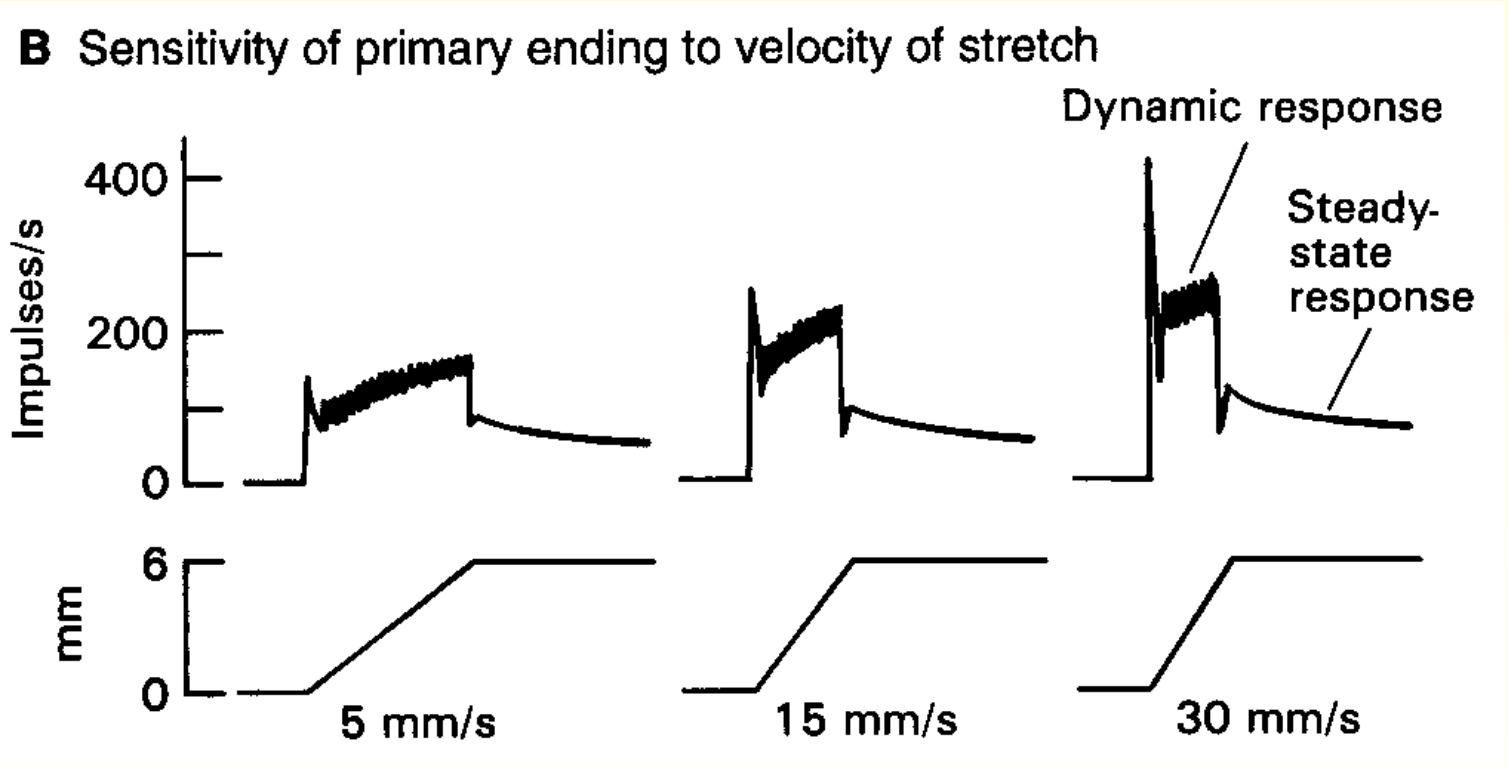
Dynamic response of the spindle to linear stretch

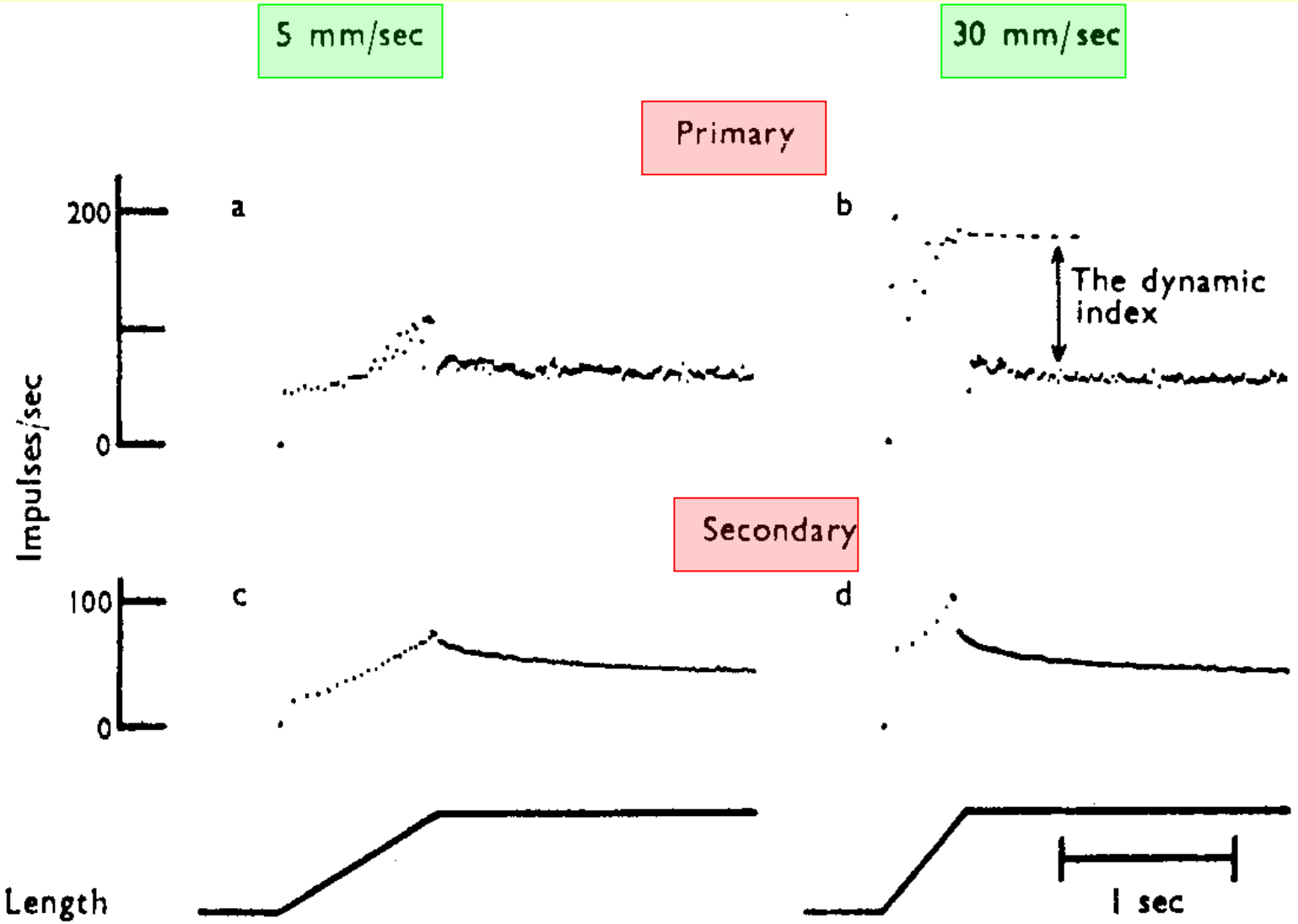




Dynamic response of the spindle to linear stretch

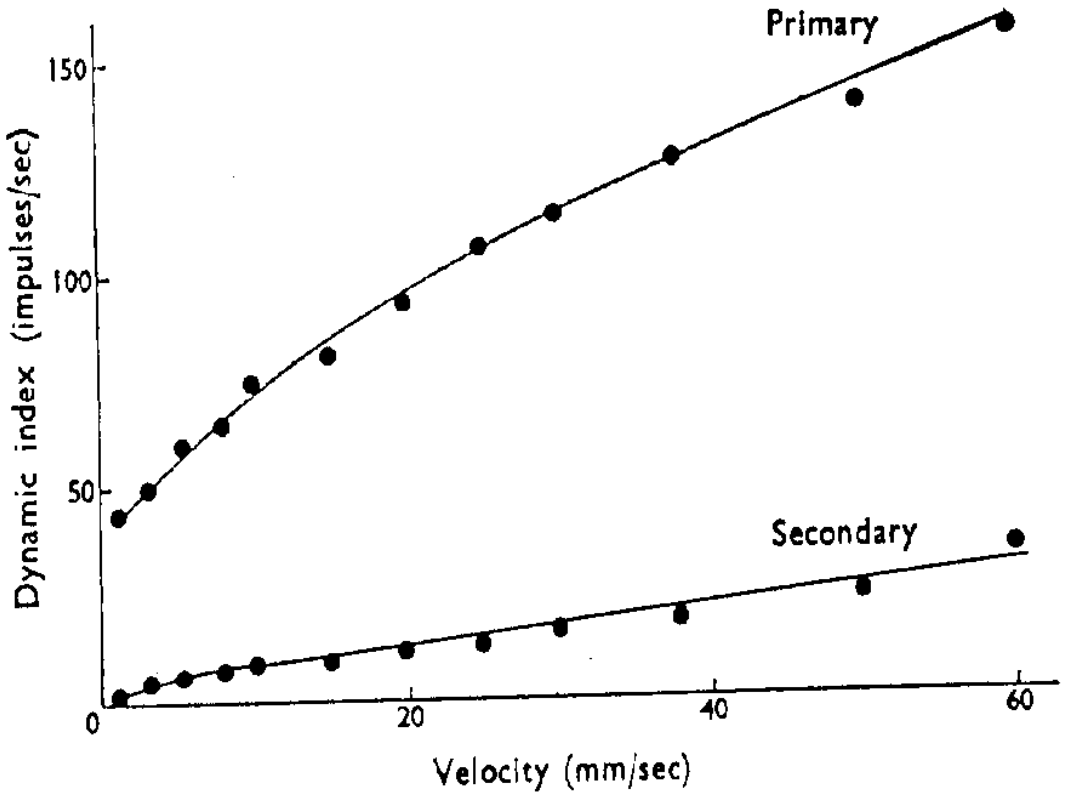






Comparison of the responses of de-efferented primary and secondary endings to a ramp stretch by means of a direct display of their 'instantaneous' frequency of firing.

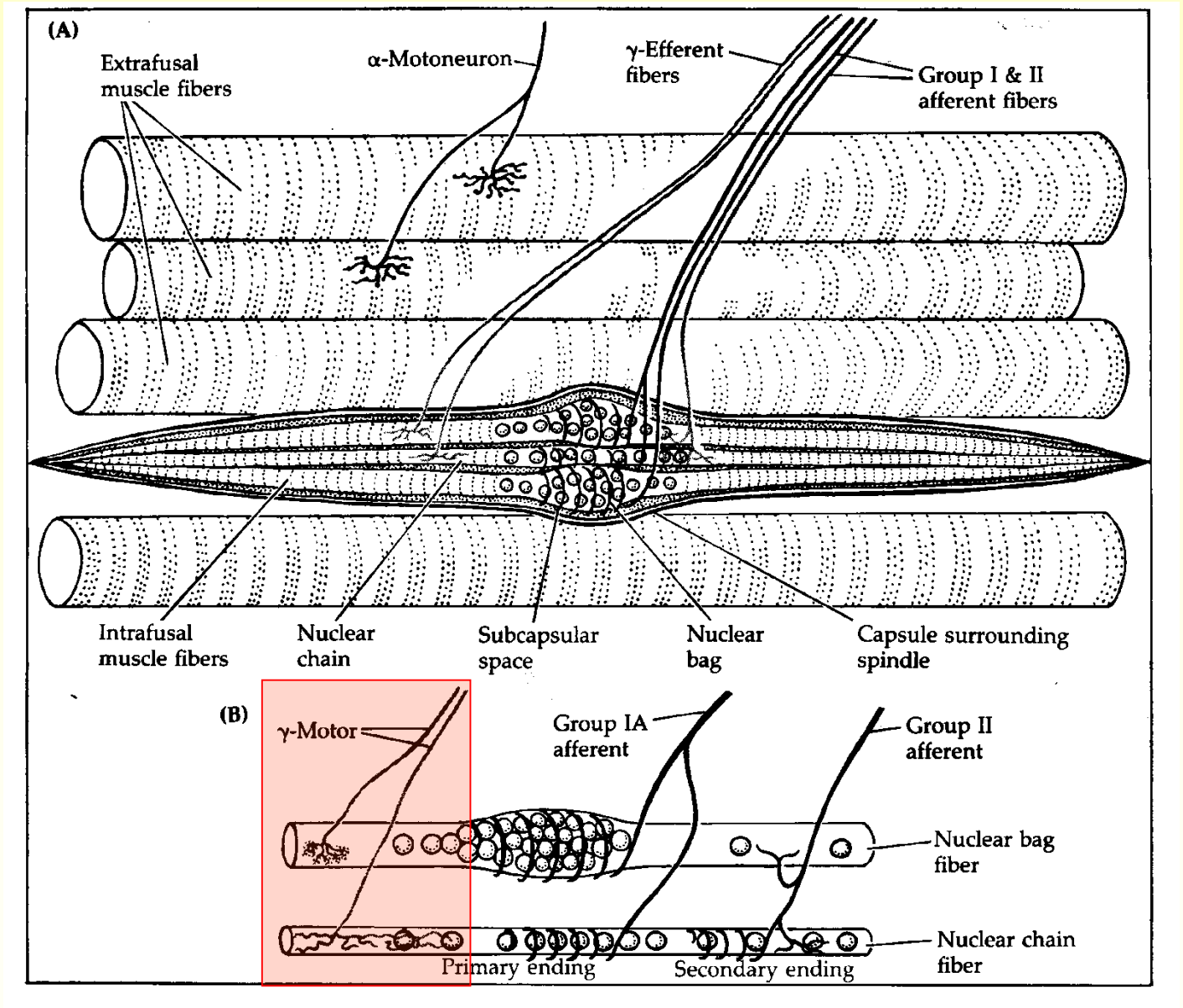
Dynamic response of the spindle to linear stretch



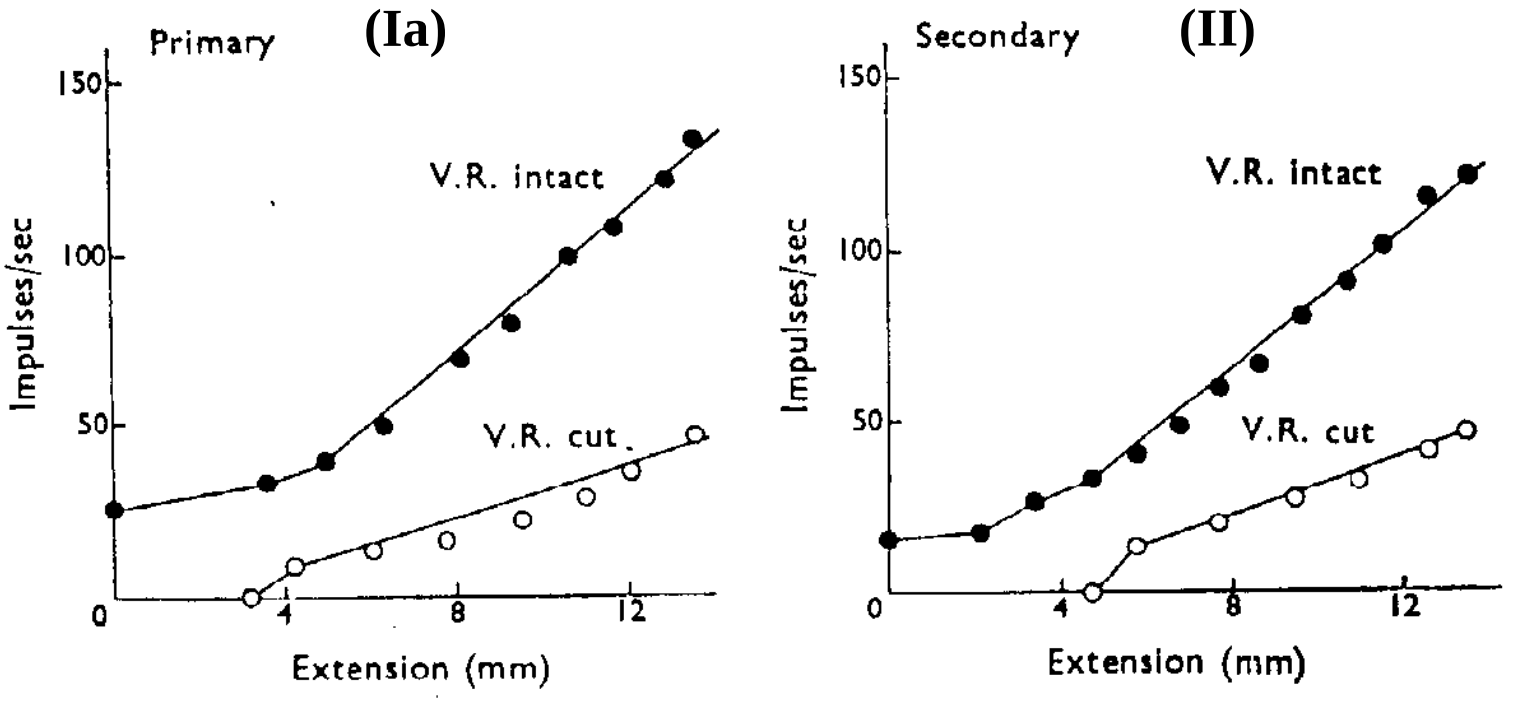
The relation between the dynamic index and the velocity of stretching for a primary and a secondary ending in the same soleus muscle.

Effect of gamma fiber stimulation on the response of the spindle to linear stretch

Morphology of the muscle spindle

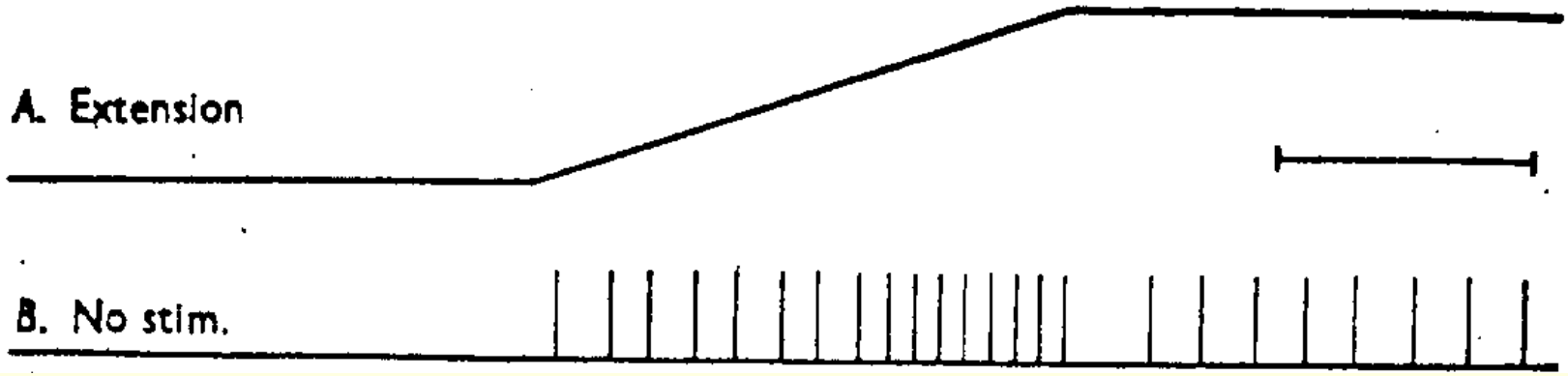


Effect of γ denervation on static firing

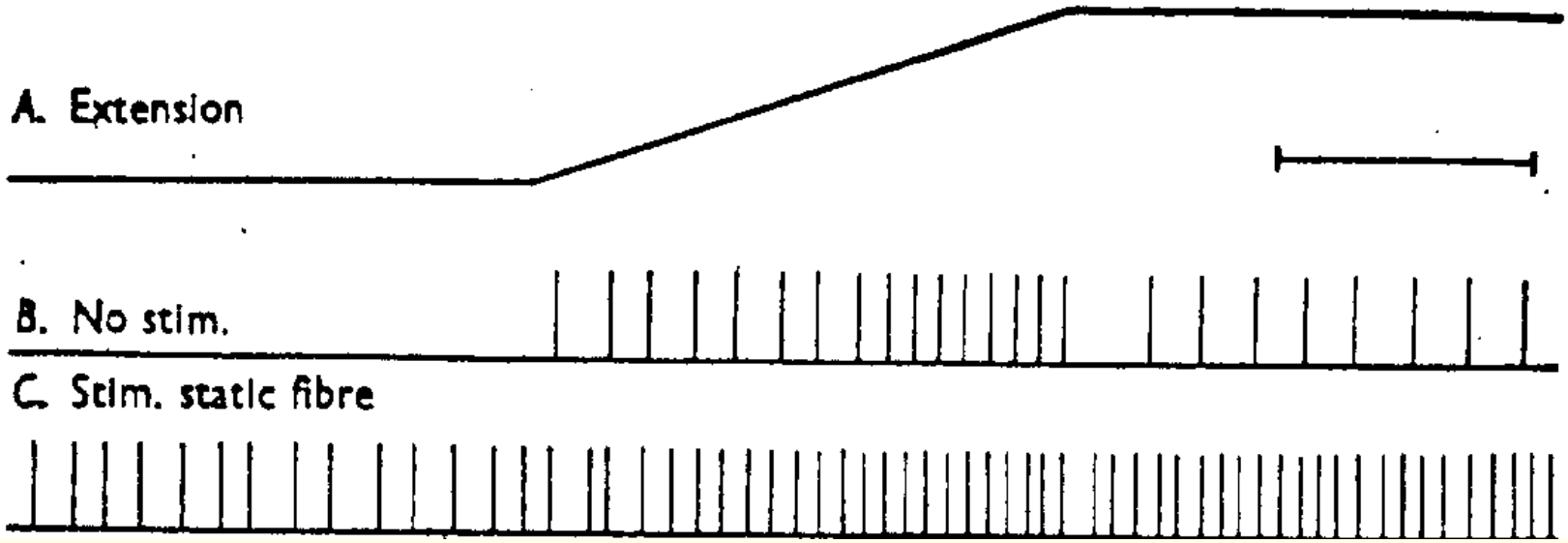


The relation between the frequency of static firing and the extension, determined on stretching the muscle to a series of different lengths. This was done for a pair of endings in the soleus muscle of the same decerebrate cat both in the presence of spontaneous fusimotor activity (V.R. intact) and after its abolition by ventral root section (V.R. cut).

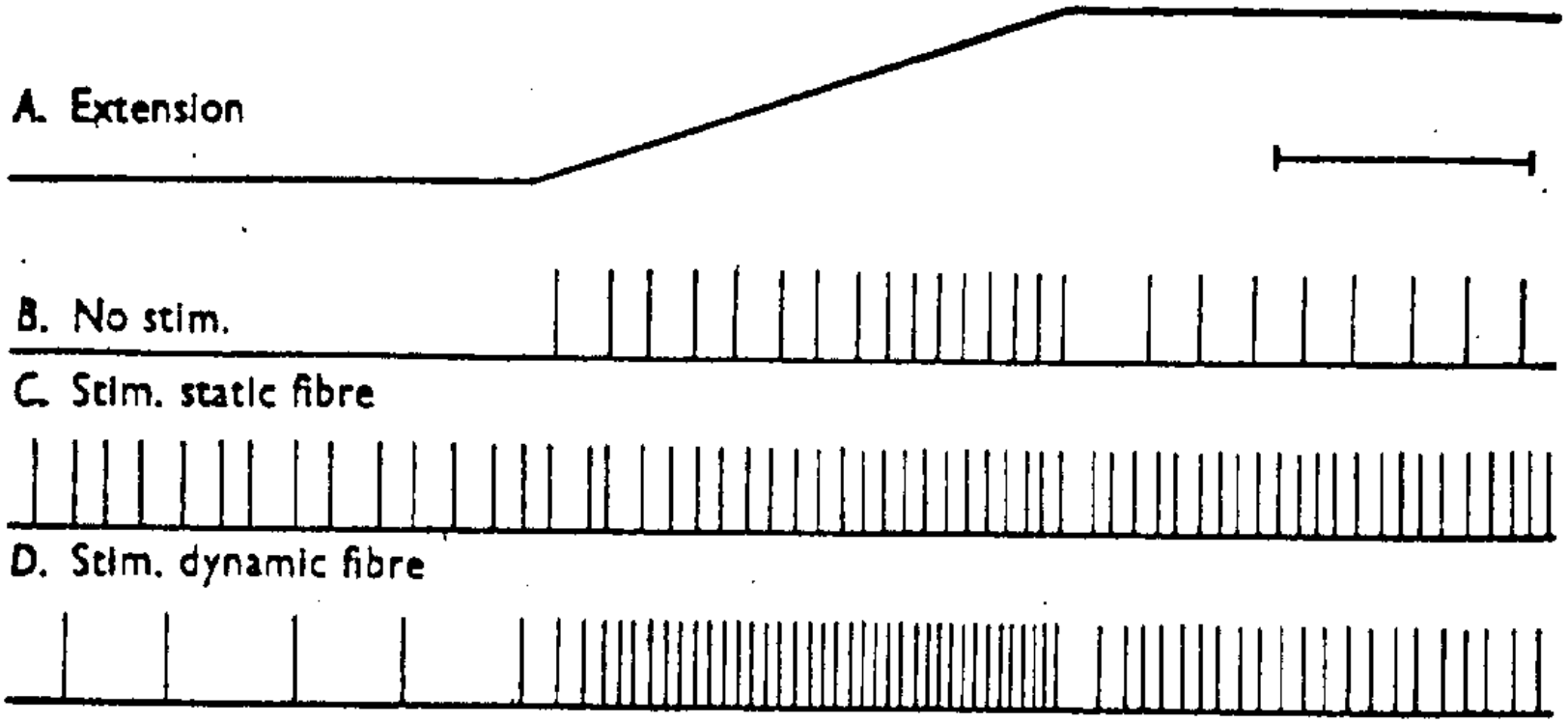
Effect of gamma fiber stimulation on the response of the Ia afferent nerve fiber to linear stretch



Effect of gamma fiber stimulation on the response of the Ia afferent nerve fiber to linear stretch



Effect of gamma fiber stimulation on the response of the Ia afferent nerve fiber to linear stretch

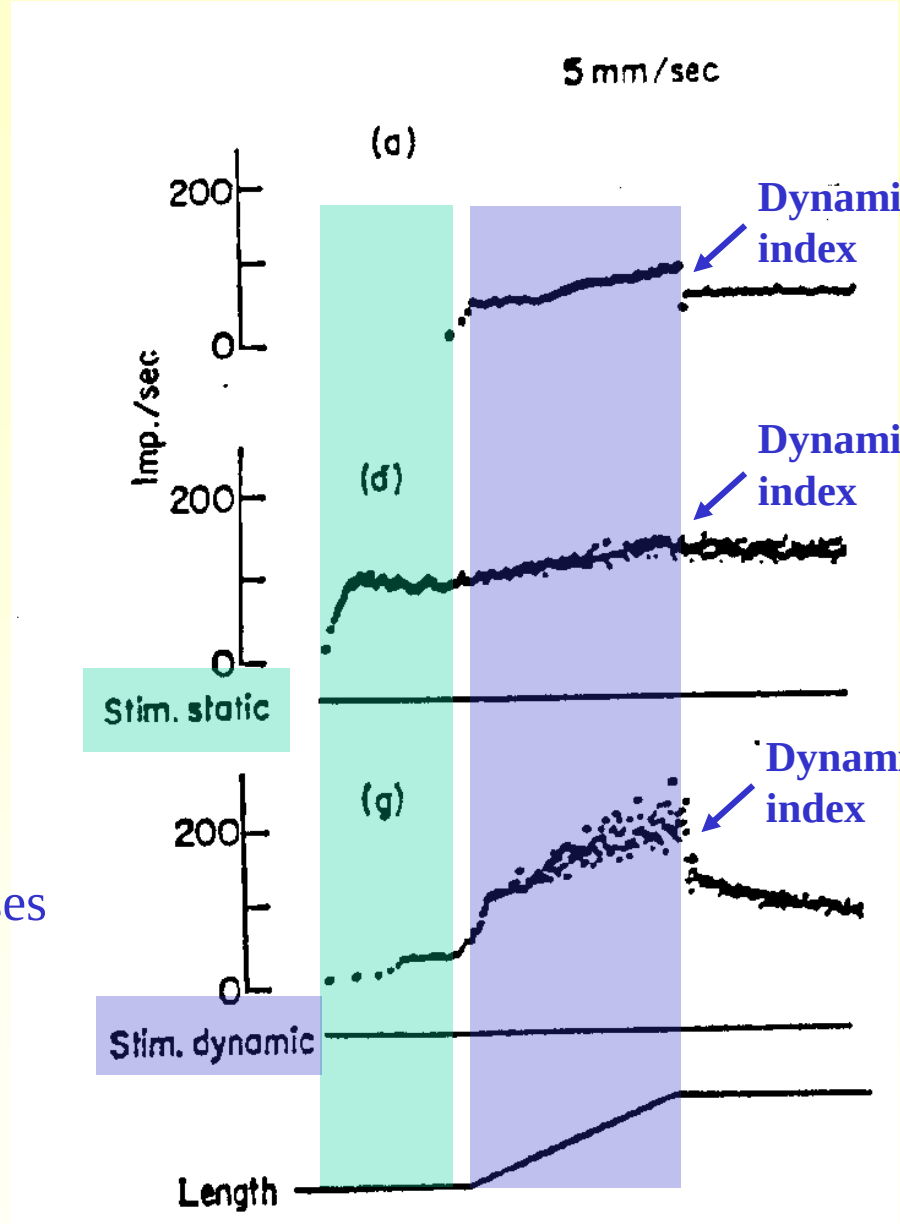


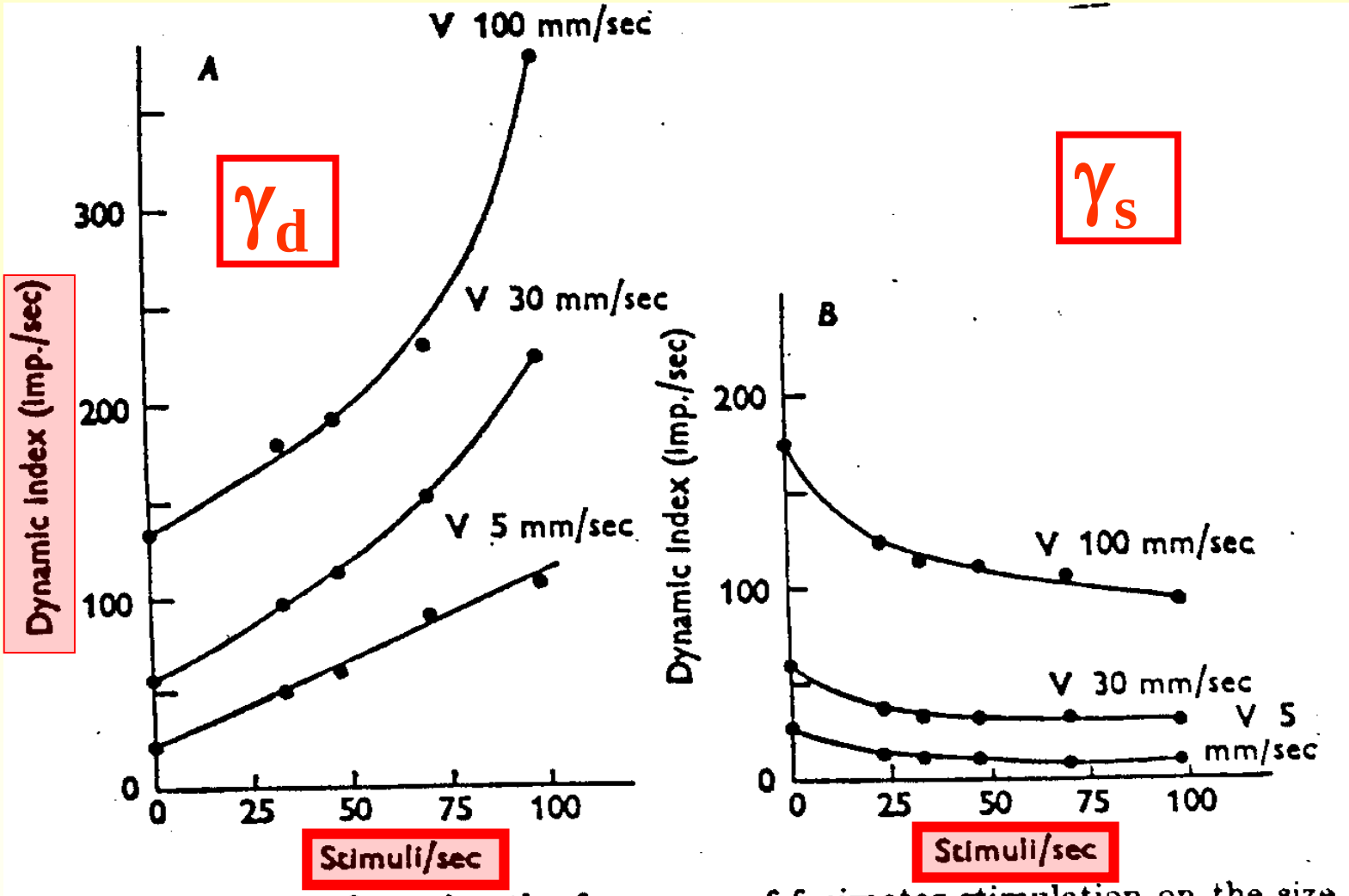
Effect of gamma fiber stimulation on the response of the Ia afferent nerve fiber to linear stretch

Stimulation of static and dynamic gammas increases static discharge of the Ia and II afferent fibers

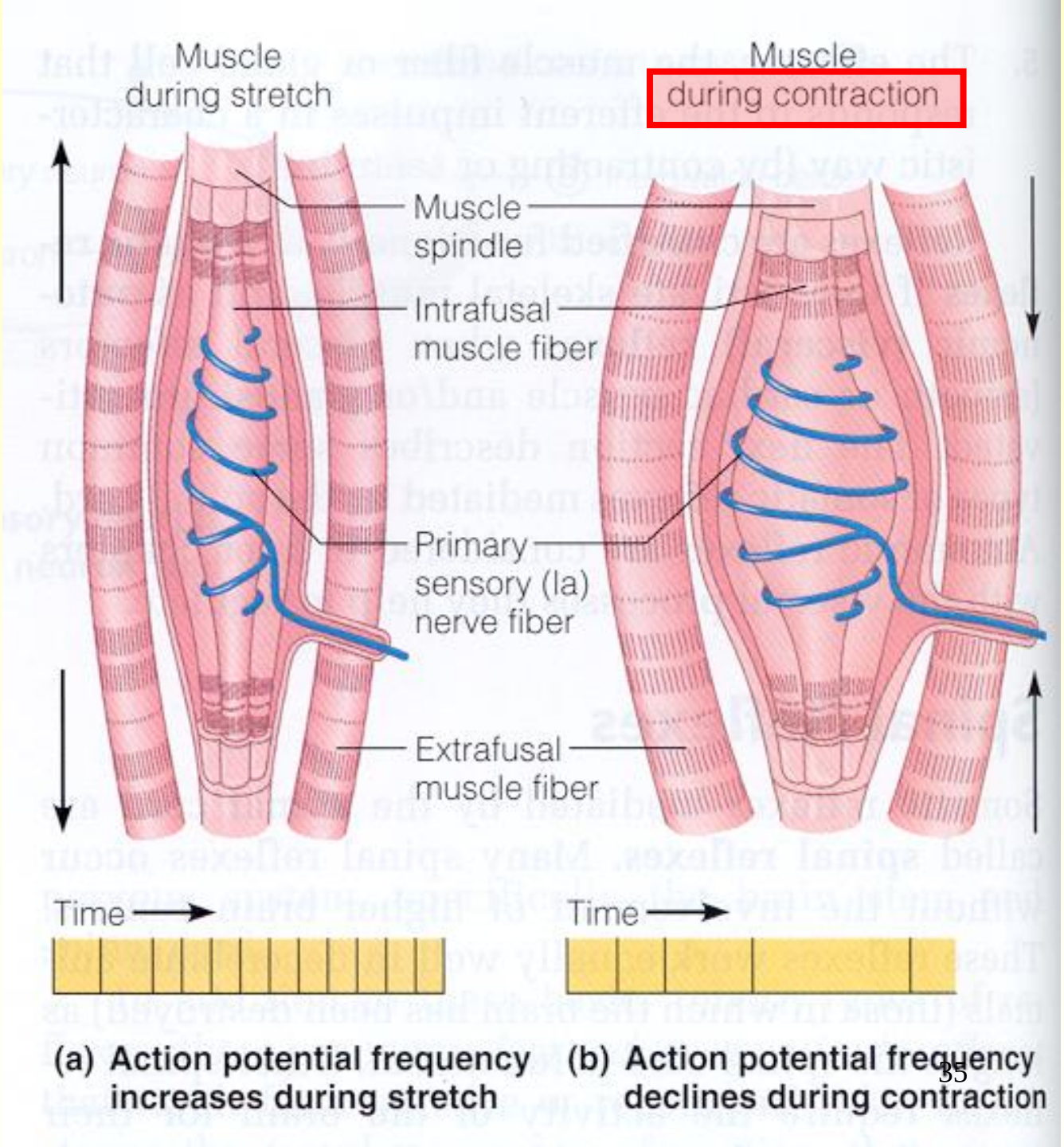
Stimulation of static gammas decreases the dynamic discharge

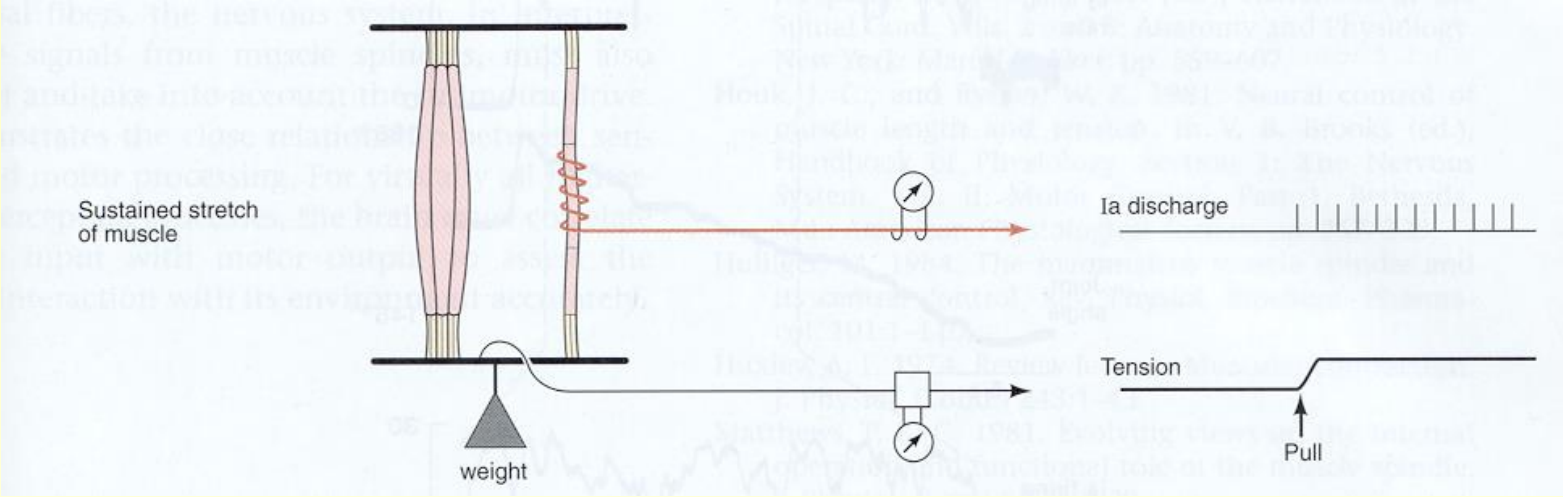
Stimulation of dynamic gammas increases de dynamic discharge

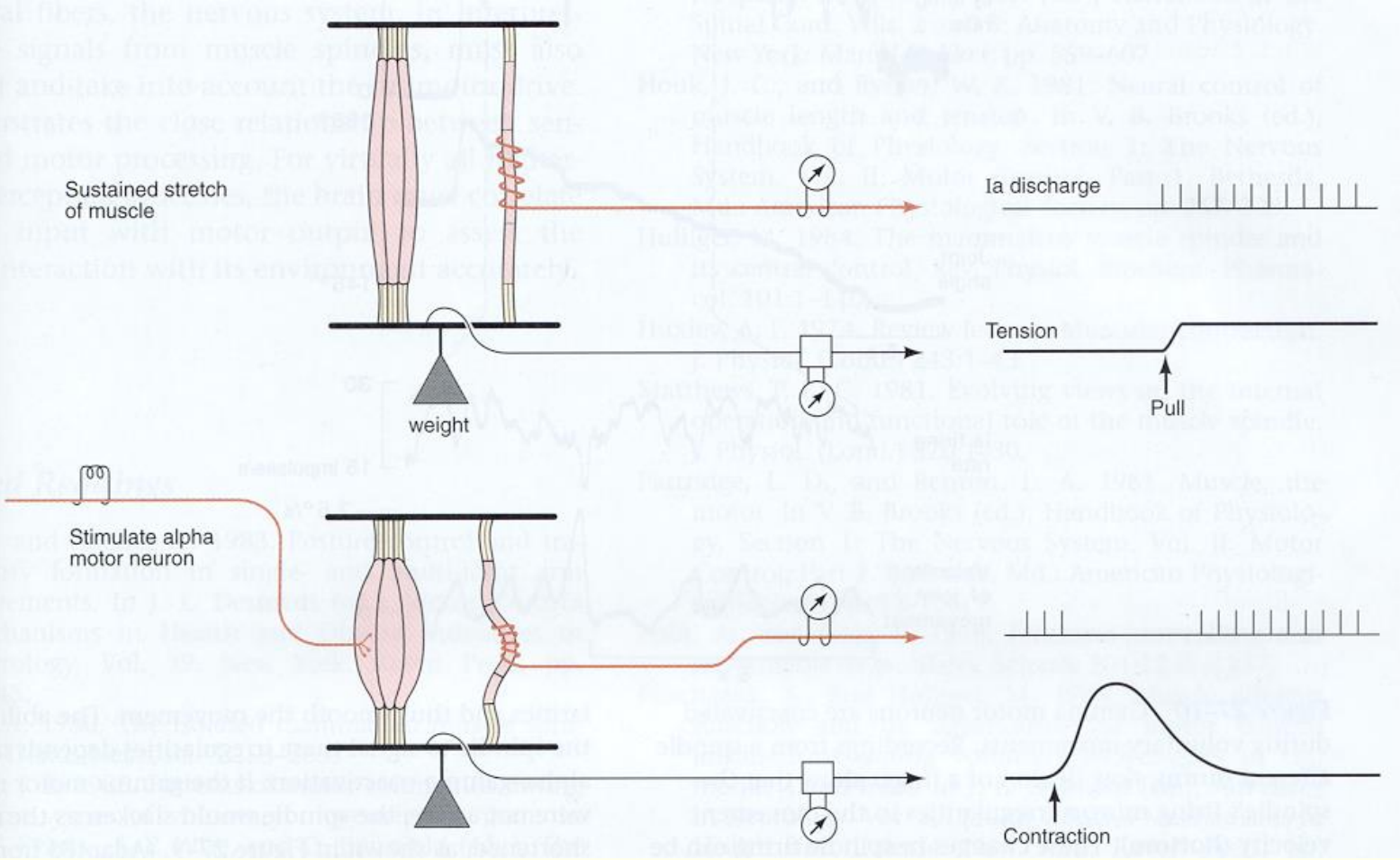


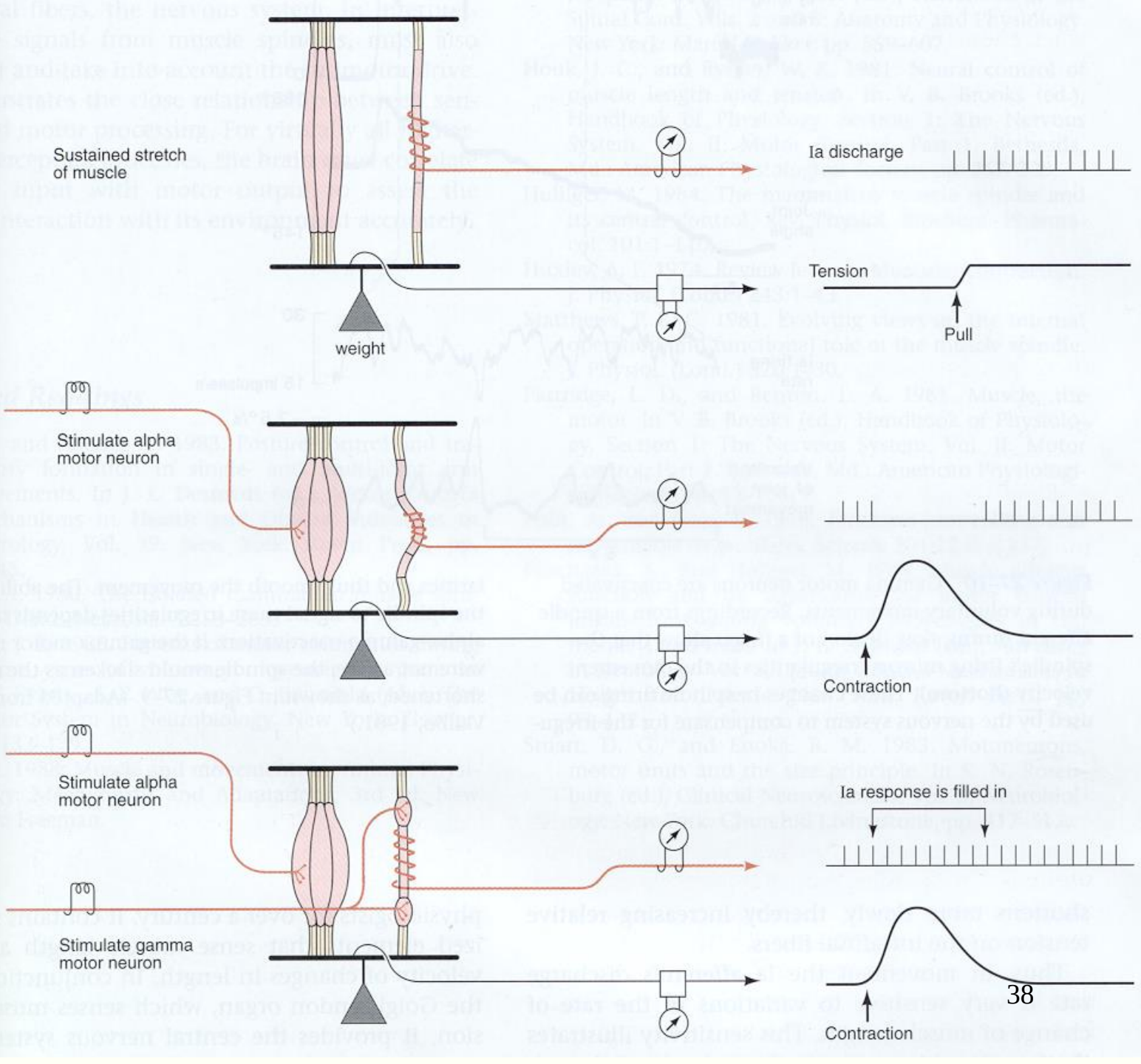


The effect of varying the frequency of fusimotor stimulation on the size of the 'dynamic index' found for particular velocities of stretching. *A*, stimulation of dynamic fusimotor fibre. *B*, stimulation of static fibre.

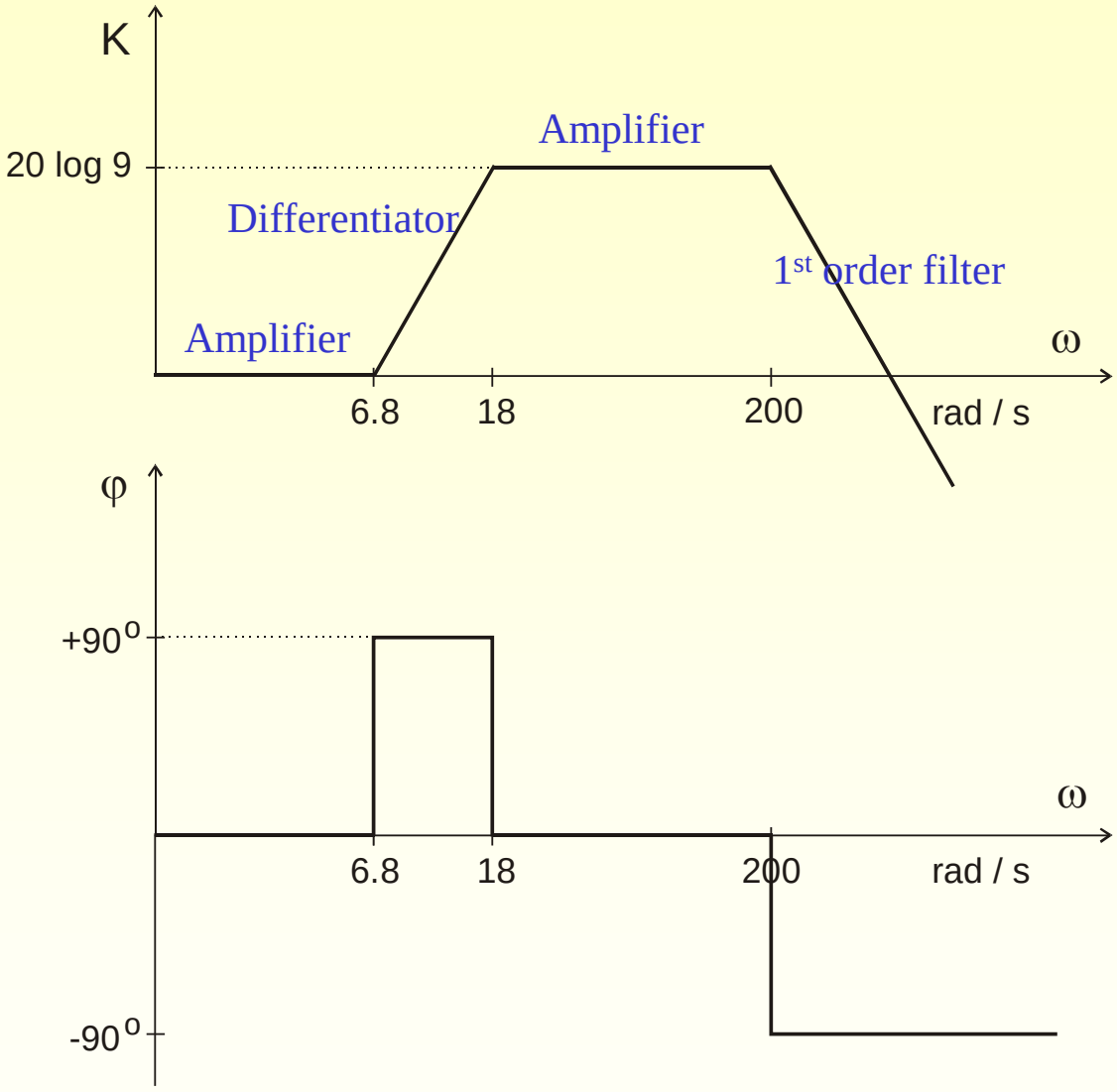

Muscle during stretch
Muscle during contraction
Muscle spindle
Intrafusal muscle fiber
Primary sensory (Ia) nerve fiber
Extrafusal muscle fiber
Time
Time
(a) Action potential frequency increases during stretch
(b) Action potential frequency declines during contraction


Sustained stretch
of muscle
Ia discharge
Tension
Pull
weight

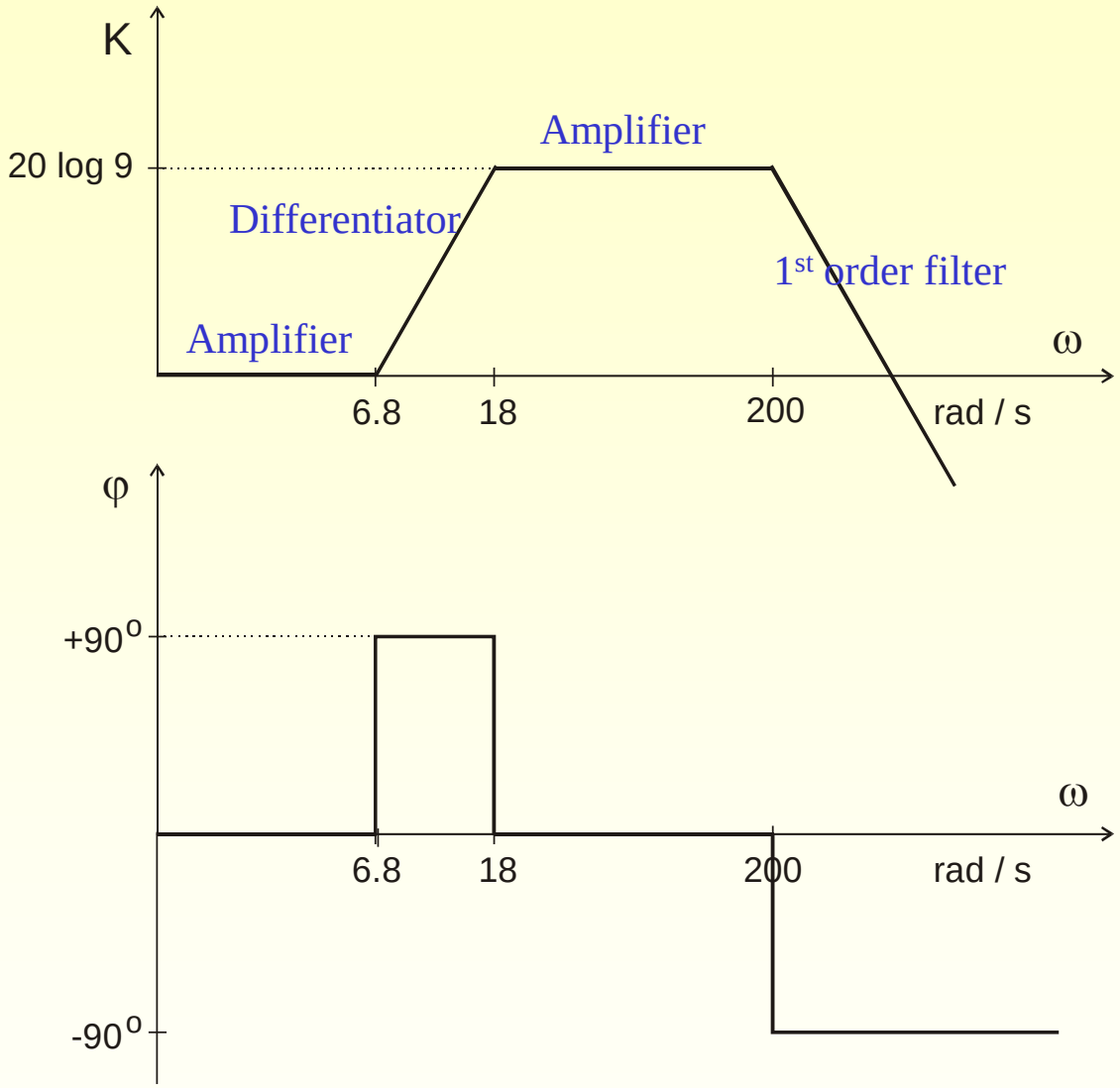

Sustained stretch
of muscle
weight
Ia discharge
Tension
Pull
Stimulate alpha
motor neuron
Contraction

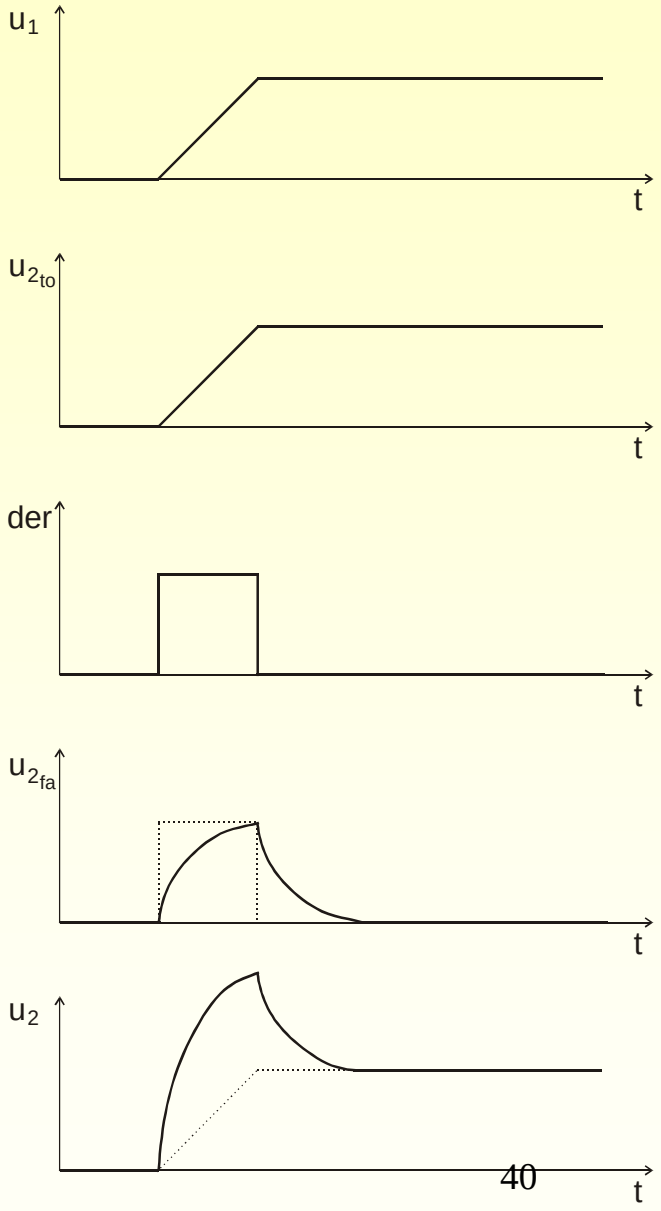

Sustained stretch
of muscle
weight
Ia discharge
Tension
Pull
Stimulate alpha
motor neuron
Contraction
Stimulate alpha
motor neuron
Stimulate gamma
motor neuron
Ia response is filled in
Contraction

Bode diagram of the response of spindle Ia afferent

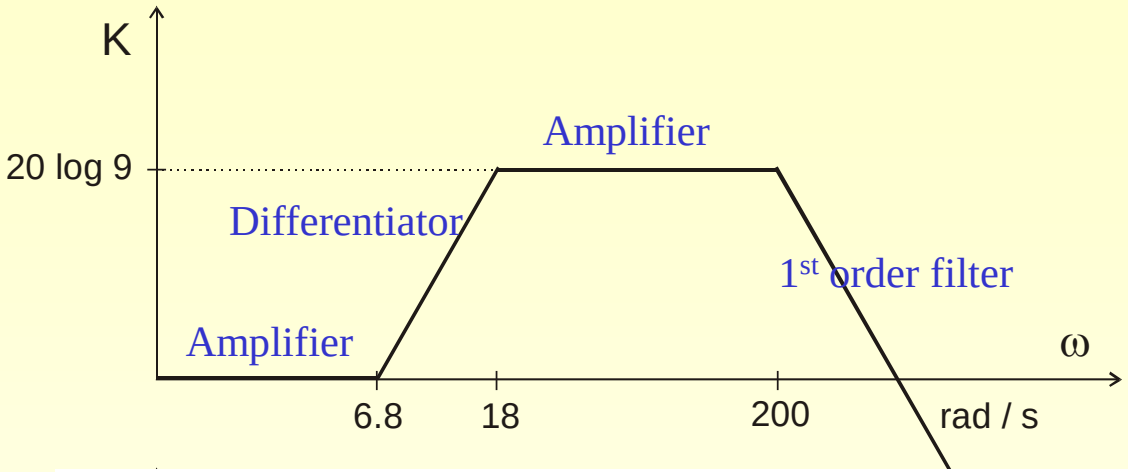


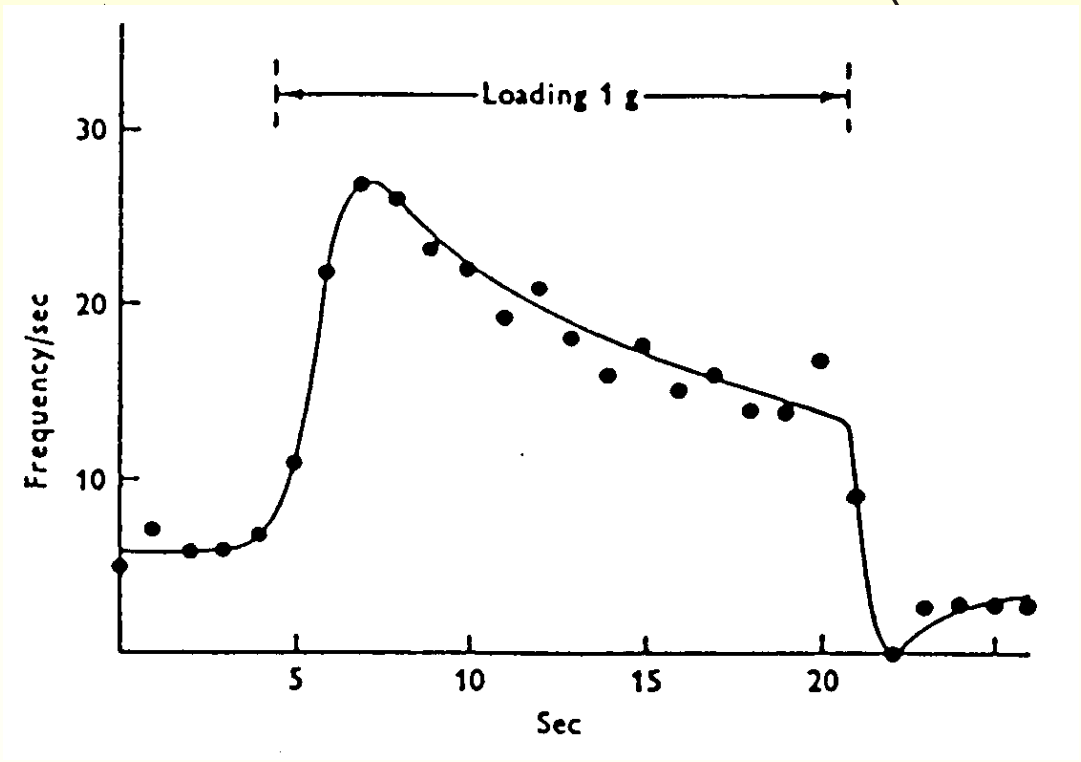
Bode diagram of the response of spindle Ia afferent

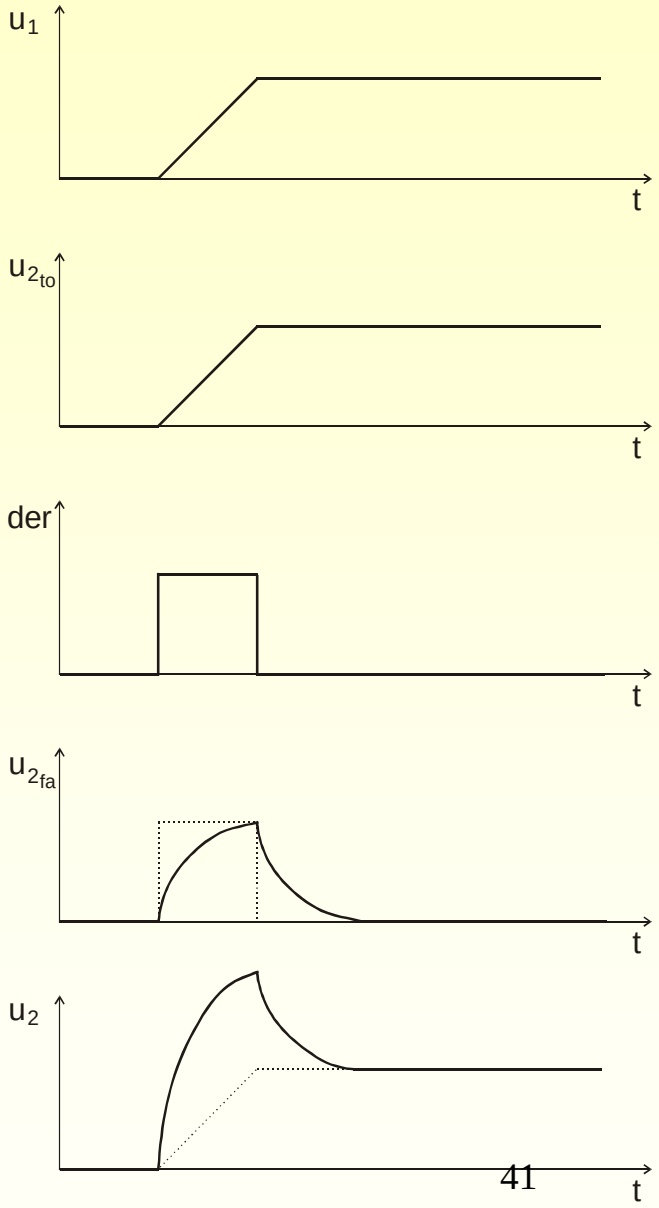




Bode diagram of the response of spindle Ia afferent

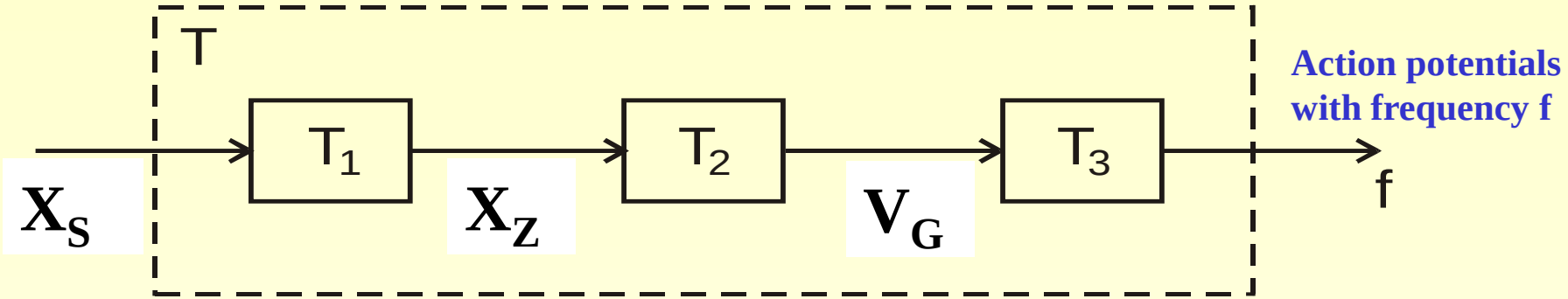






Model of the stretch reflex

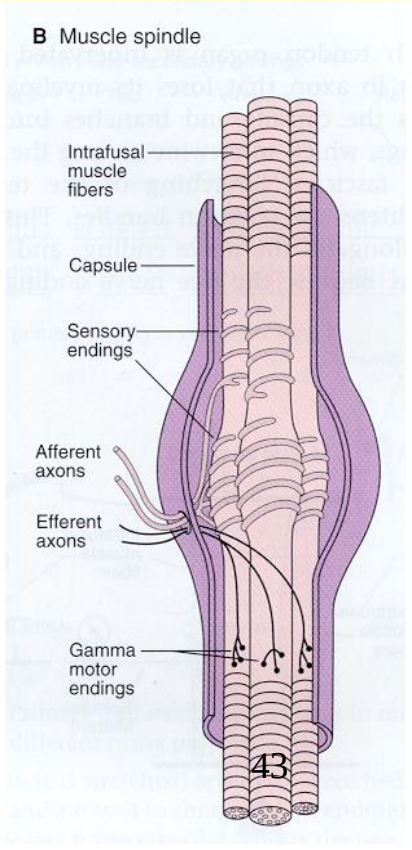
Classical representation of the spindle



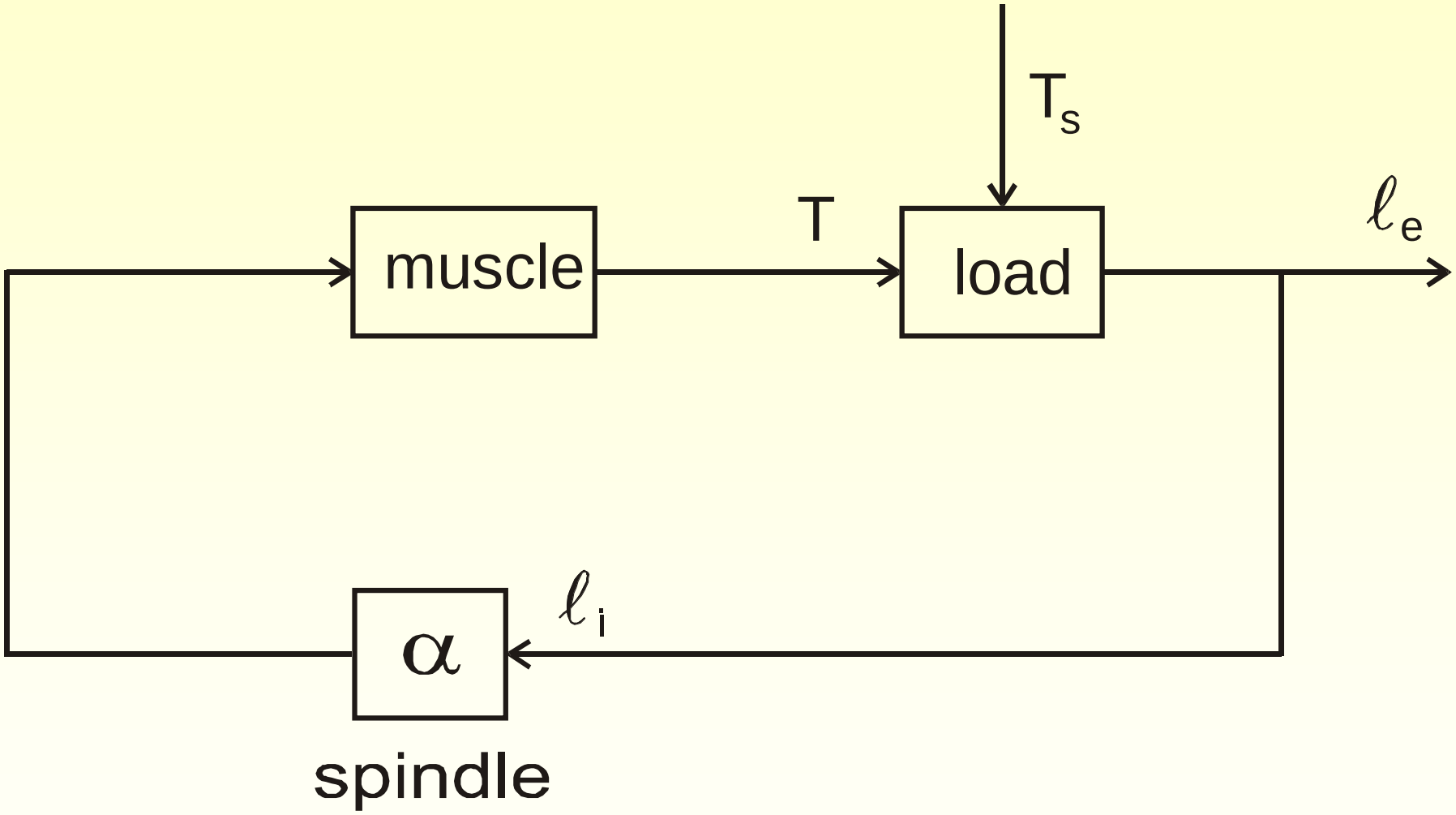
Extension of the spindle

Extension of the nuclear bag

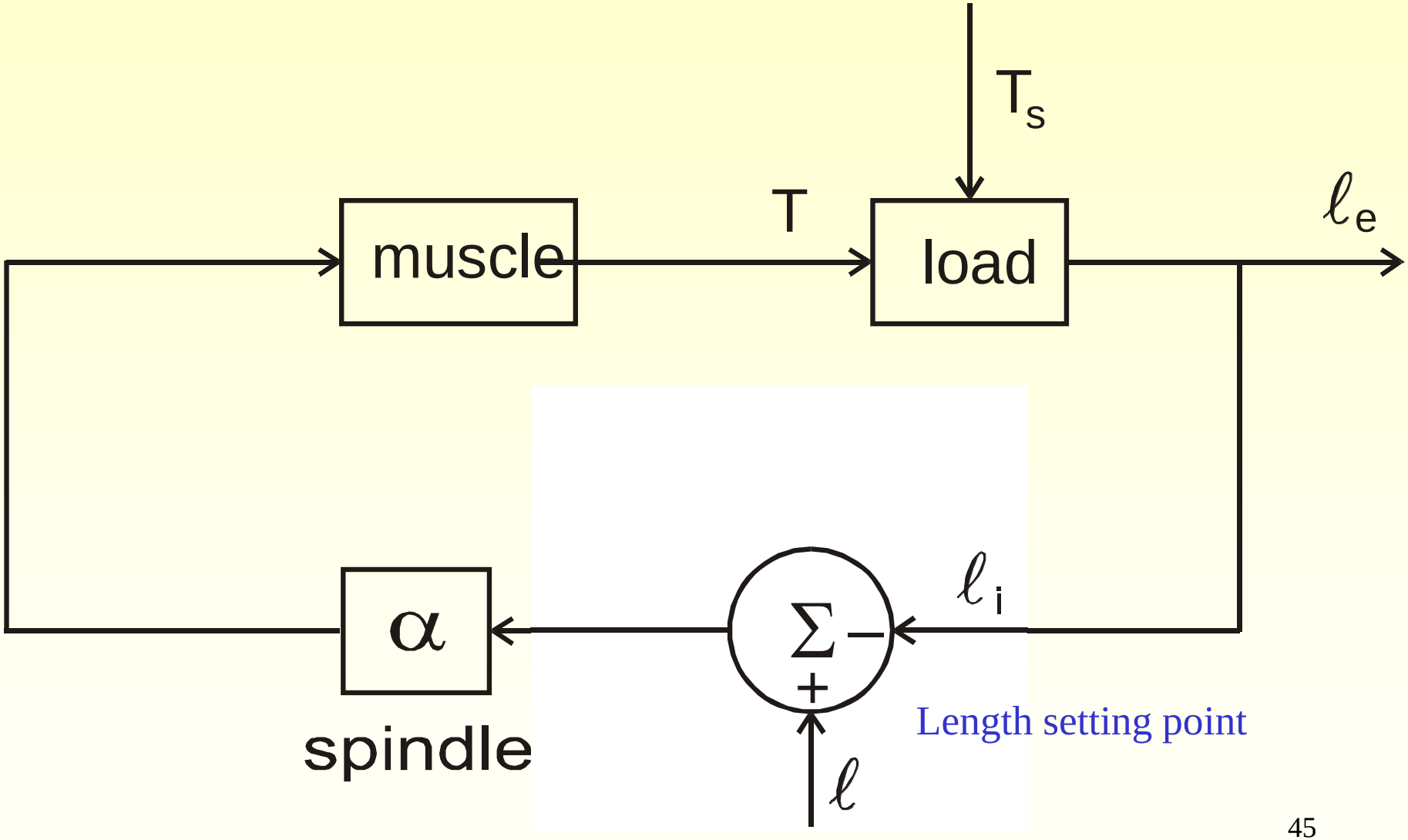
Generator potential in the Ia afferent fibers



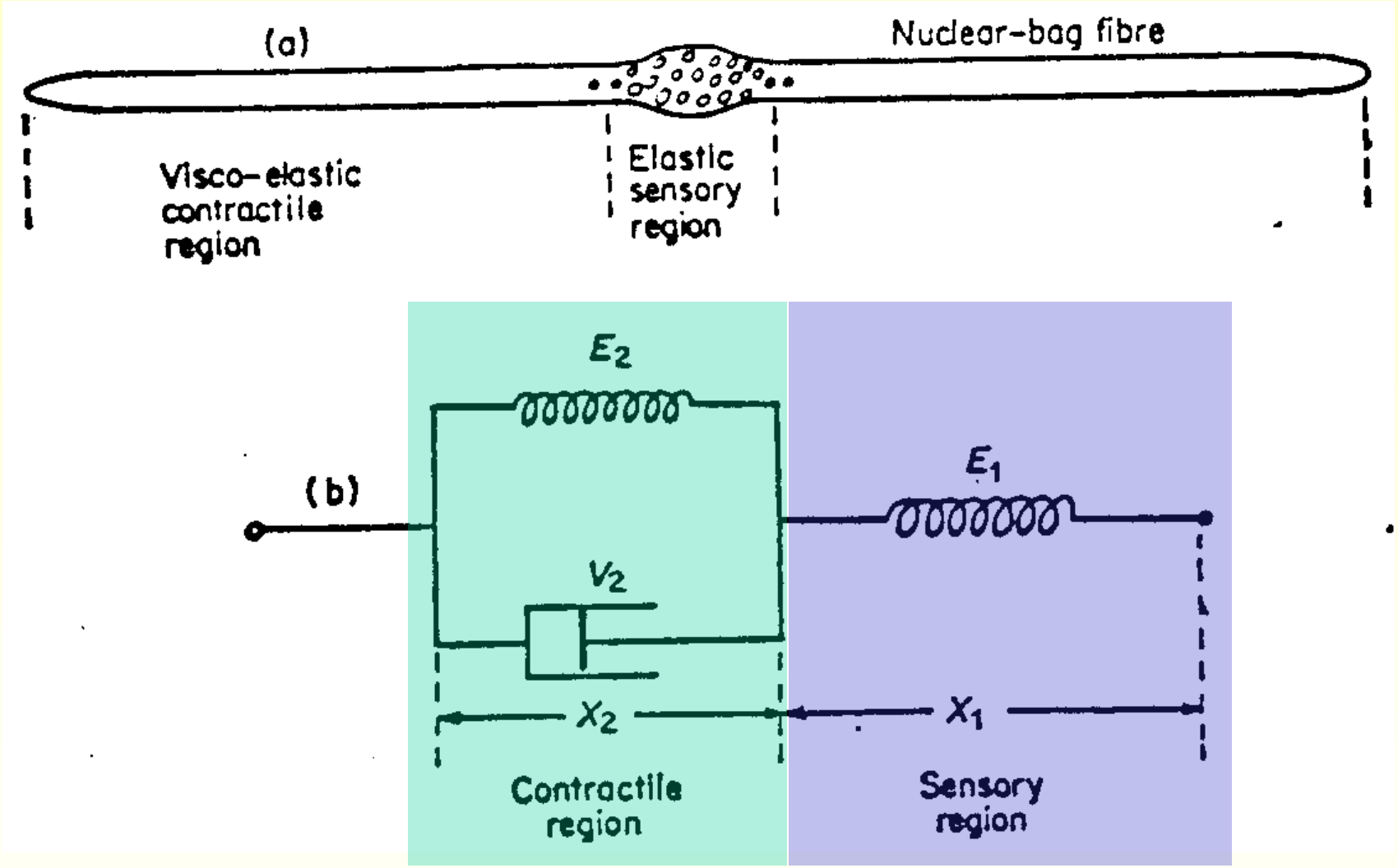
Simplified model of the muscle spindle reflex



Simplified model of the muscle spindle reflex

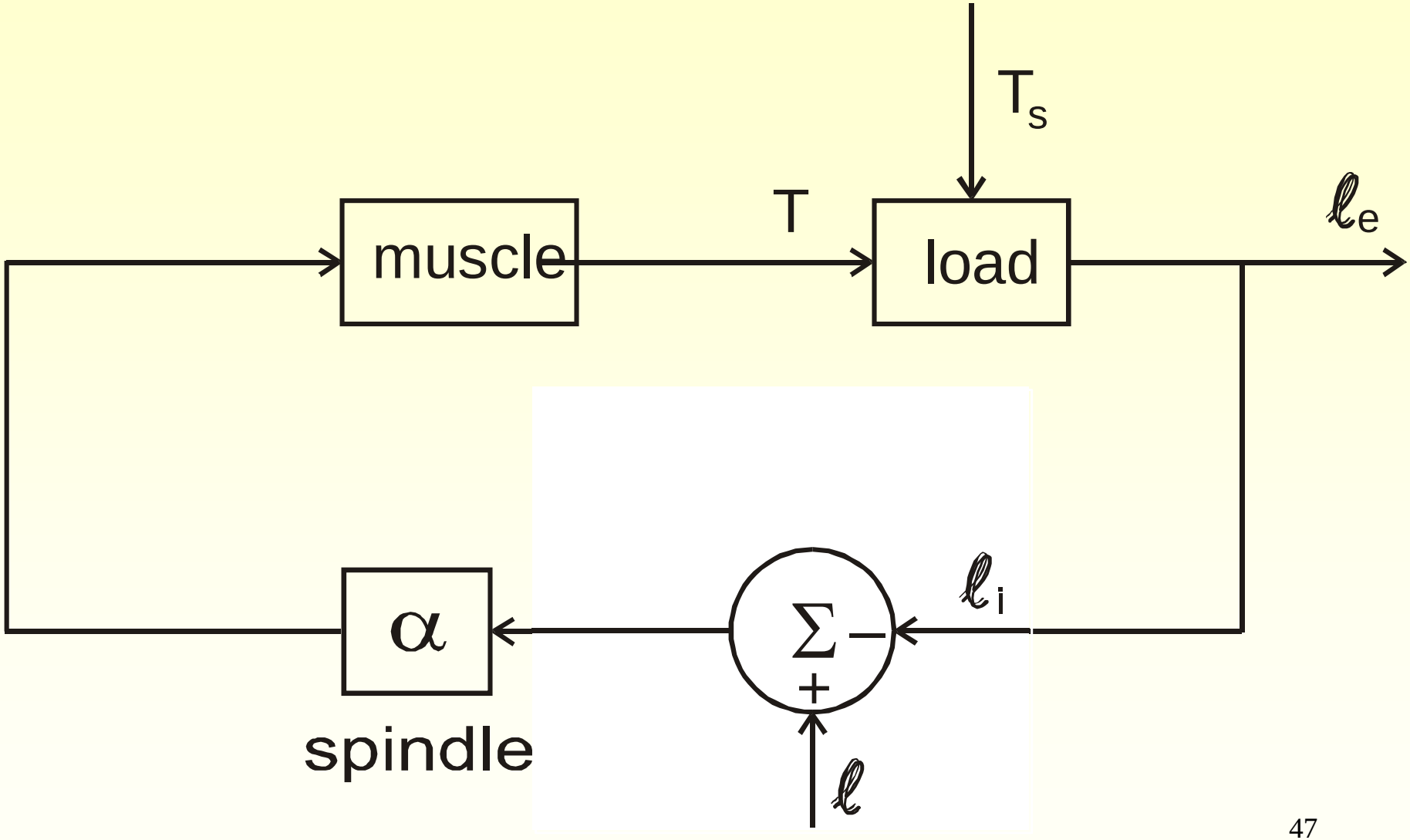


Mechanical model of the spindle

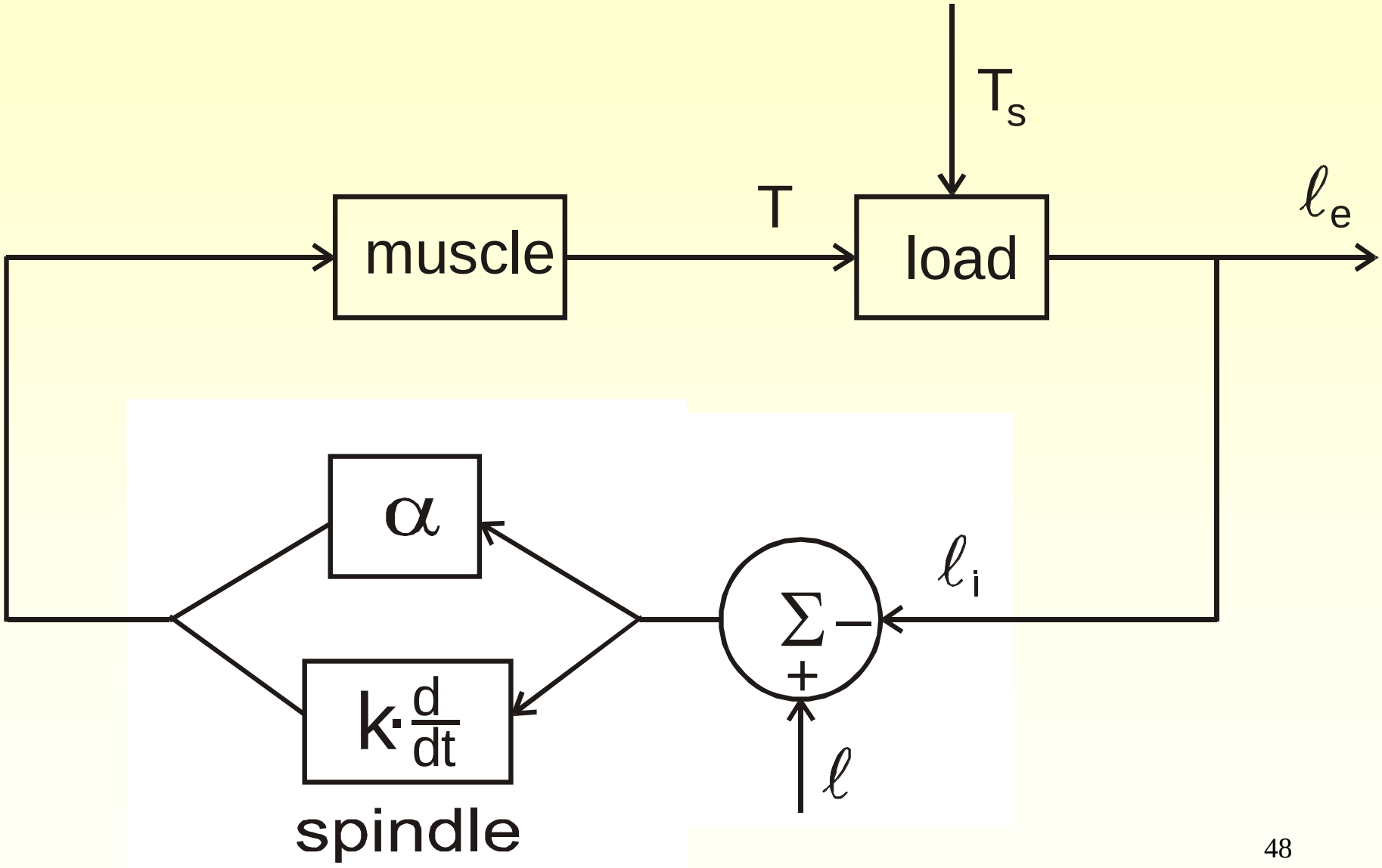


Differentiator: phasic Amplifier: tonic

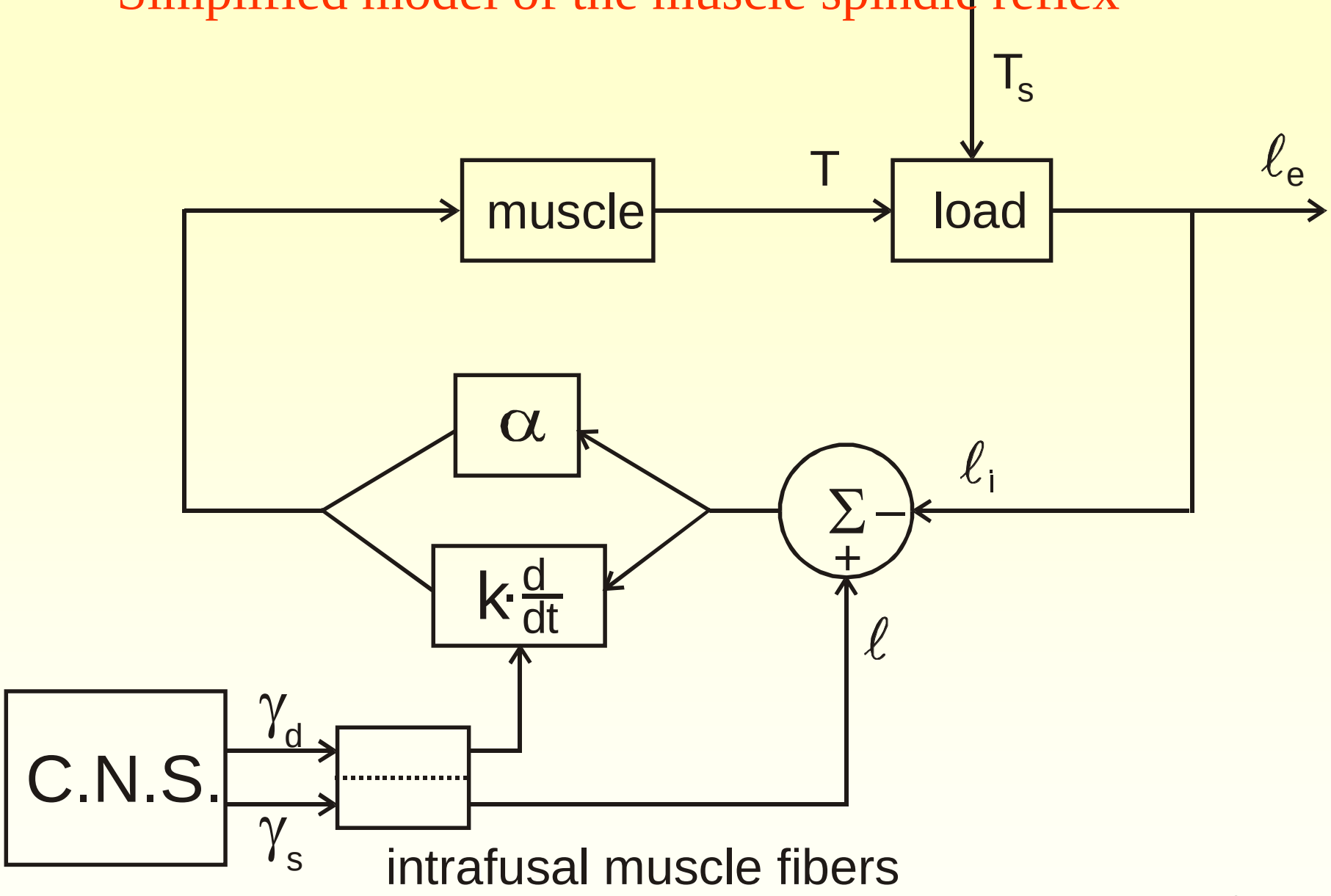
Simplified model of the muscle spindle reflex

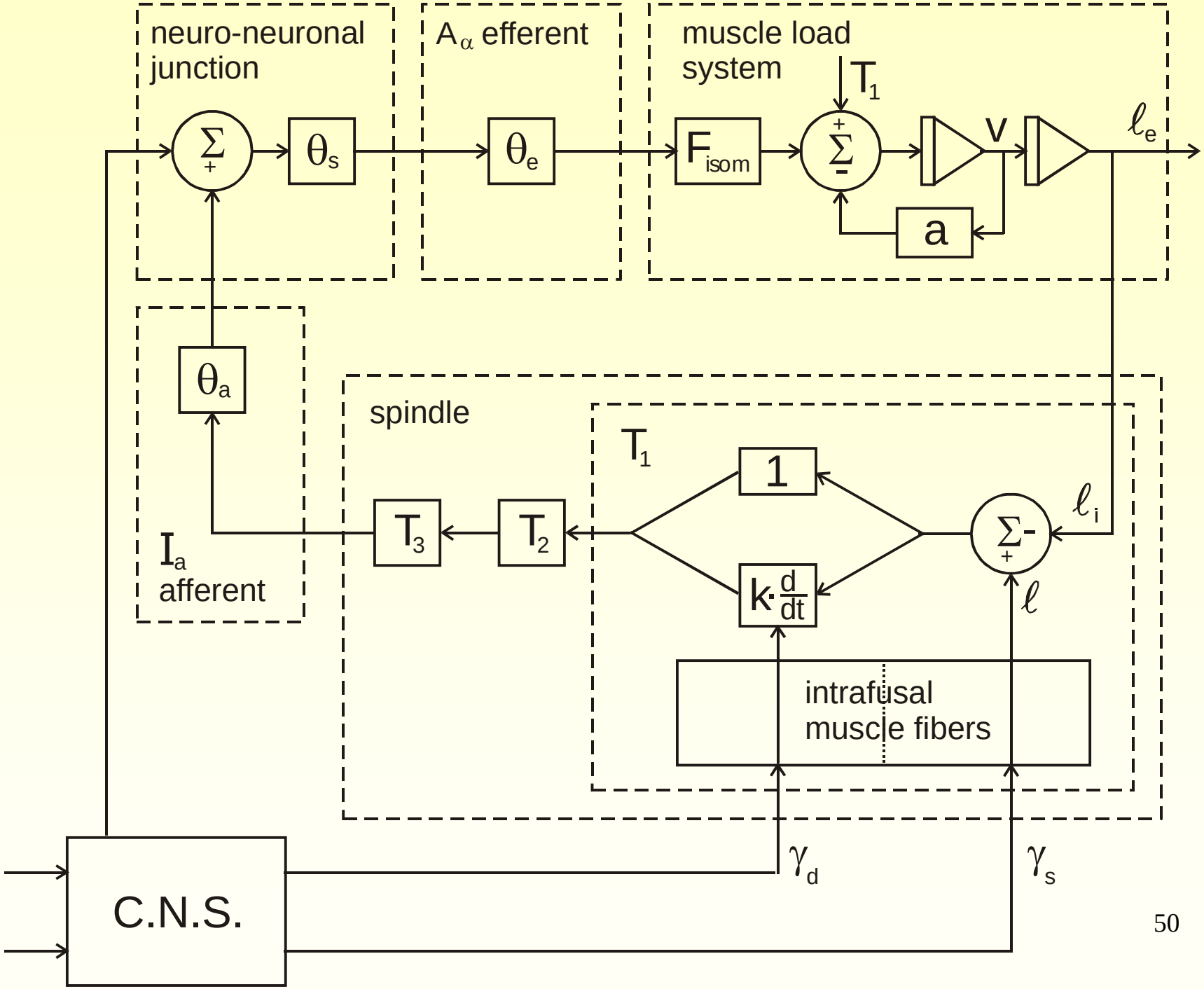


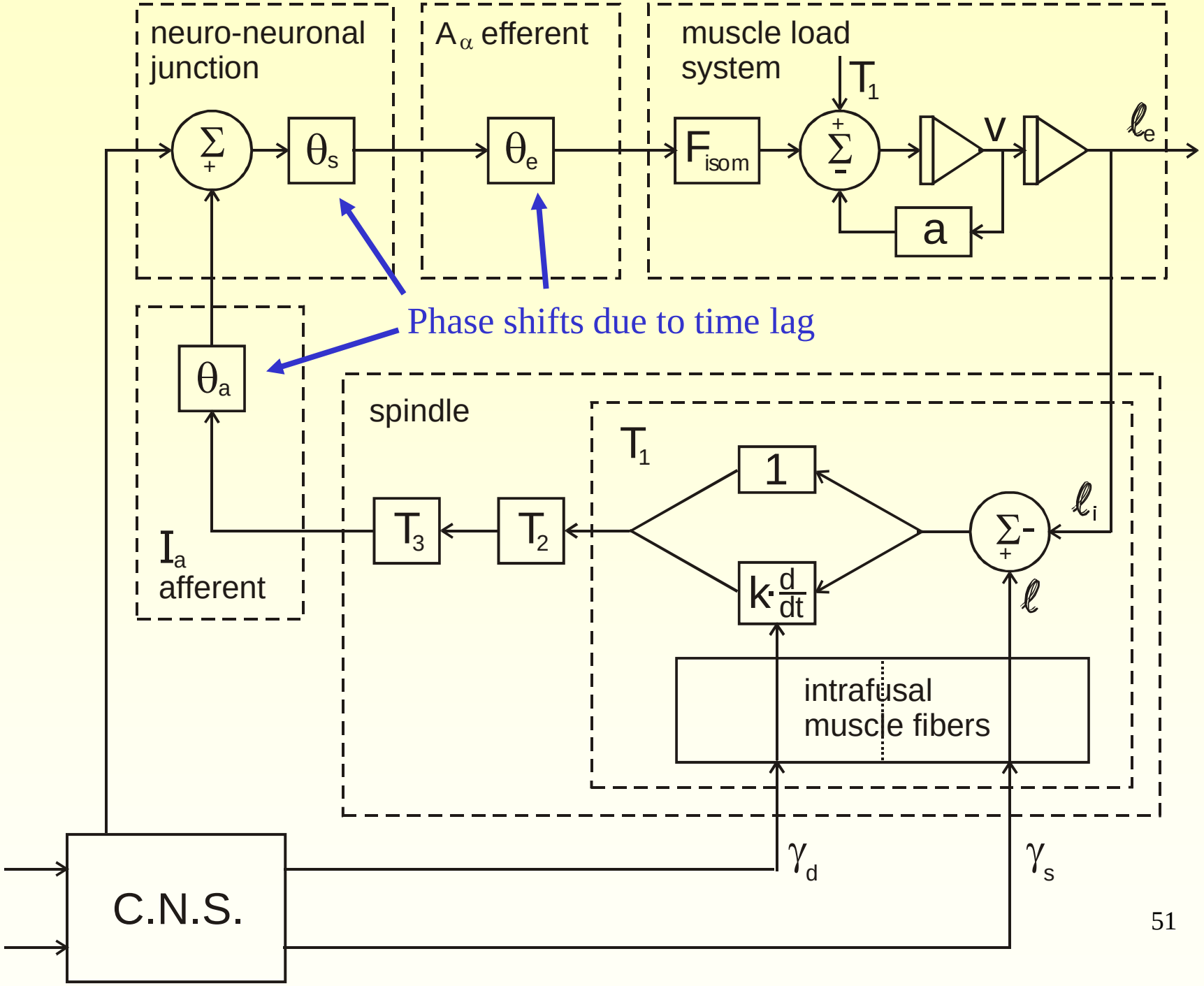
Simplified model of the muscle spindle reflex



Simplified model of the muscle spindle reflex

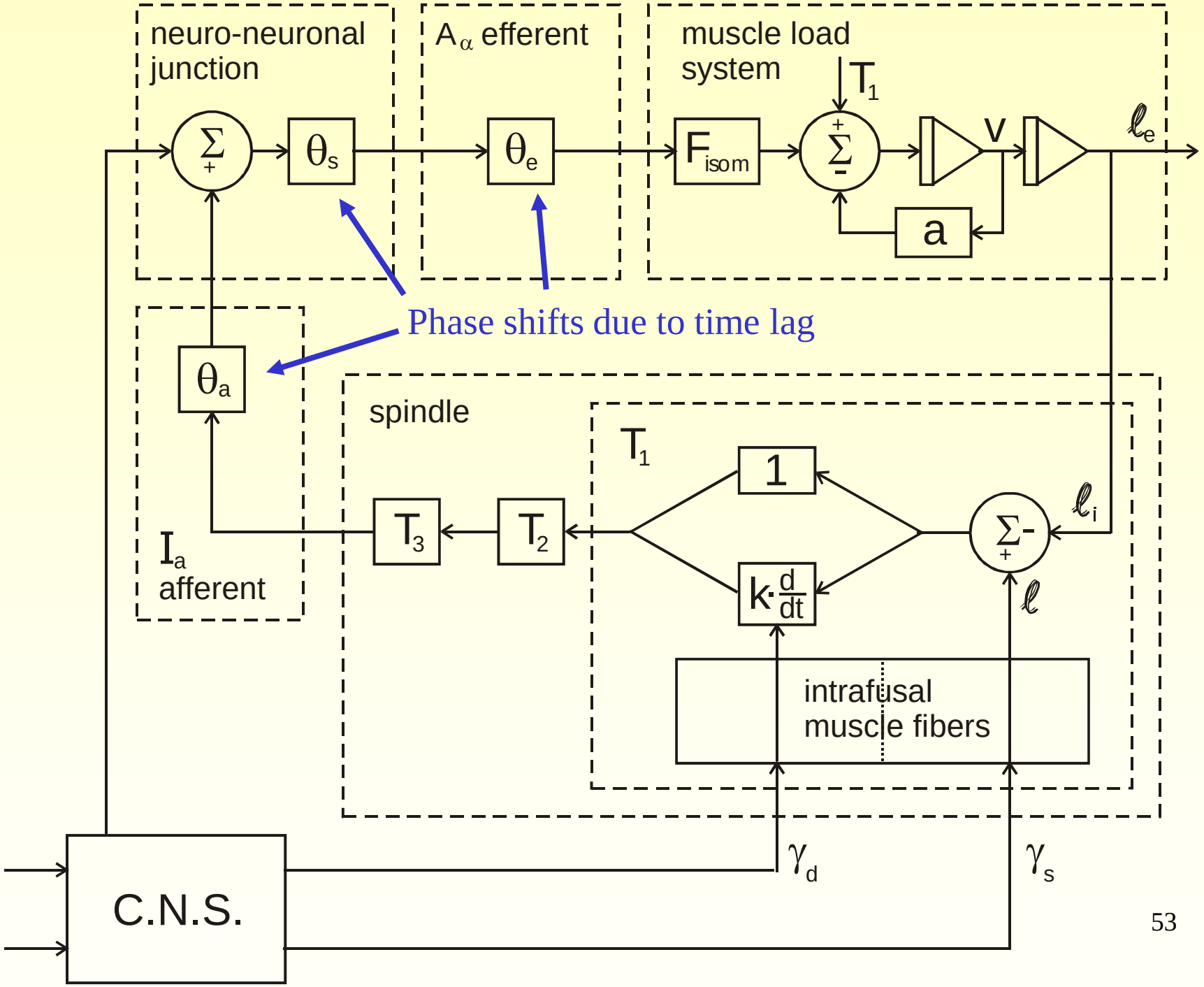



neuro-neuronal junction
A_α efferent
muscle load system
T_1
θ_s
θ_e
F_{isom}
v
ℓ_e
a
θ_a
spindle
T_1
1
T_3
T_2
ℓ_i
$k \cdot \frac{d}{dt}$
ℓ
I_a afferent
intrafusal muscle fibers
γ_d
γ_s
C.N.S.


neuro-neuronal junction
A_α efferent
muscle load system
T_1
θ_s
θ_e
F_{isom}
v
ℓ_e
a
Phase shifts due to time lag
θ_a
spindle
T_1
1
T_3
T_2
ℓ_i
$k \cdot \frac{d}{dt}$
ℓ
I_a afferent
intrafusal muscle fibers
γ_d
γ_s
C.N.S.

The control of posture and movement

Ludwig van Beethoven - Moonlight Sonata (3rd Movement)
Tina S, Cover


neuro-neuronal junction
A_α efferent
muscle load system
T_1
Σ_+
θ_s
θ_e
F_{isom}
Σ_+^-
v
ℓ_e
a
Phase shifts due to time lag
θ_a
spindle
T_1
1
T_3
T_2
Σ_+^-
ℓ_i
$k \cdot \frac{d}{dt}$
ℓ
I_a afferent
intrafusal muscle fibers
γ_d
γ_s
C.N.S.

The control of posture and movement

Motor learning (conscious and non-conscious) in sport & other activities | Prof Rich Masters, HKU

https://www.youtube.com/watch?v=jif6TMe_DcY

Motor Control, Motor Learning and Brain-Computer Interfaces

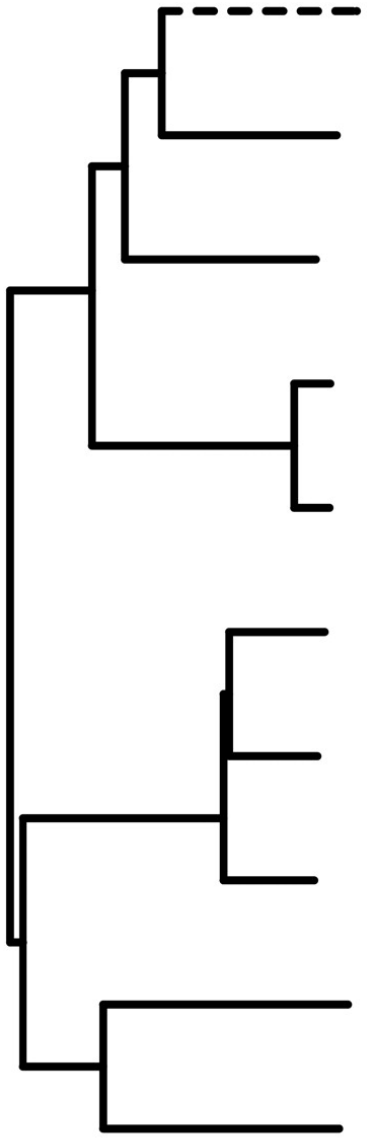
https://www.youtube.com/watch?v=O7Dlyplv7Sk

The control of posture and movement

Motor Control, Motor Learning and Brain-Computer Interfaces

https://www.youtube.com/watch?v=O7Dlyplv7Sk

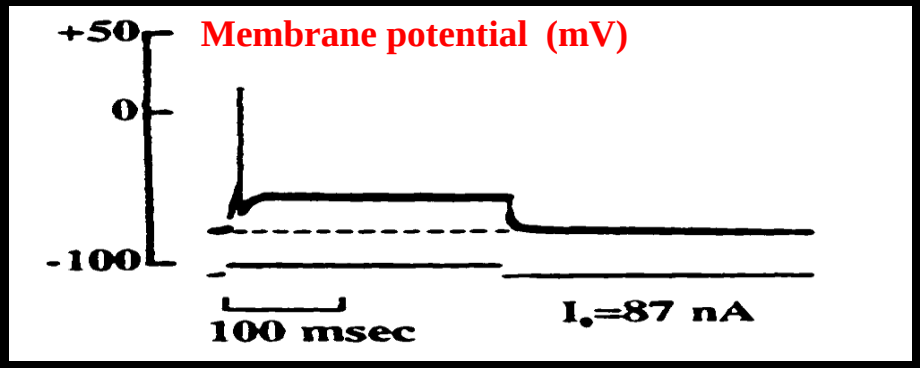
The ClC family of voltage-gated chloride channels



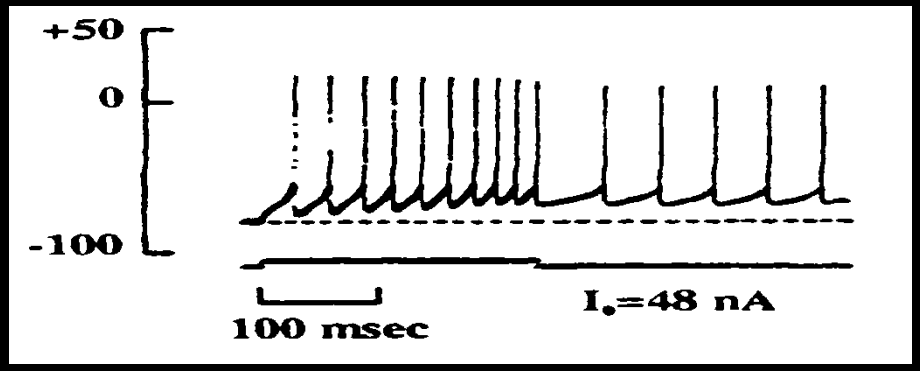
	expression	function	disease	KO mouse
ClC-0				
ClC-1 7q35	skeletal muscle	stabilization of plasma membrane V	myotonia congenita	myotonia congenita (adr mouse)
ClC-2 3q27	broad	transepithelial transport? pH,volume regulation?	?	degeneration: testes and retina
ClC-Ka 1p36	kidney, inner ear*	transepithelial transport	? (BSND)*	nephrogenic diabetes insipidus
ClC-Kb 1p36	kidney, inner ear*	transepithelial transport	Bartter's syndrome (BSND)*	-
ClC-3 4q33	broad (brain, kidney, liver ...)	acidification of endosomes, synaptic vesicles	?	degeneration: hippocampus and retina
ClC-4 Xp22.3	broad (brain, muscle...)	?	?	?
ClC-5 Xp11.22	kidney (intestine, liver...)	acidification of endosomes	Dent's disease	defect in renal endocytosis
ClC-6 1p36	broad	?	?	?
ClC-7 16p13	broad	acidification of lysosomes, resorption lacuna of osteoclasts	osteopetrosis	osteopetrosis

The myotonic goat

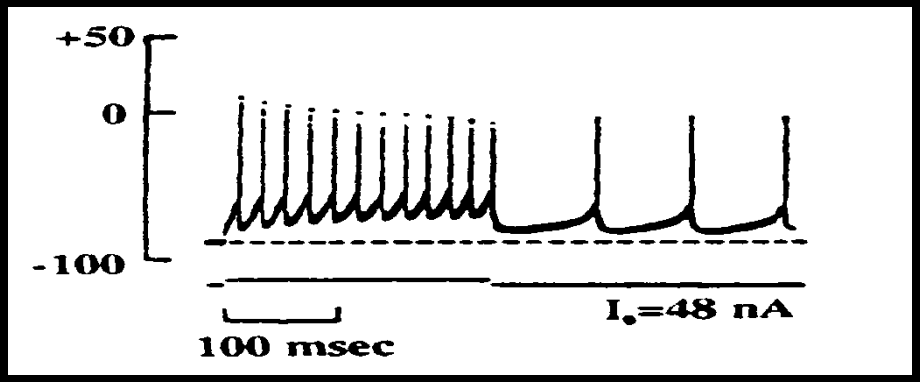
Cause: defect in ClC-1



Normal goat



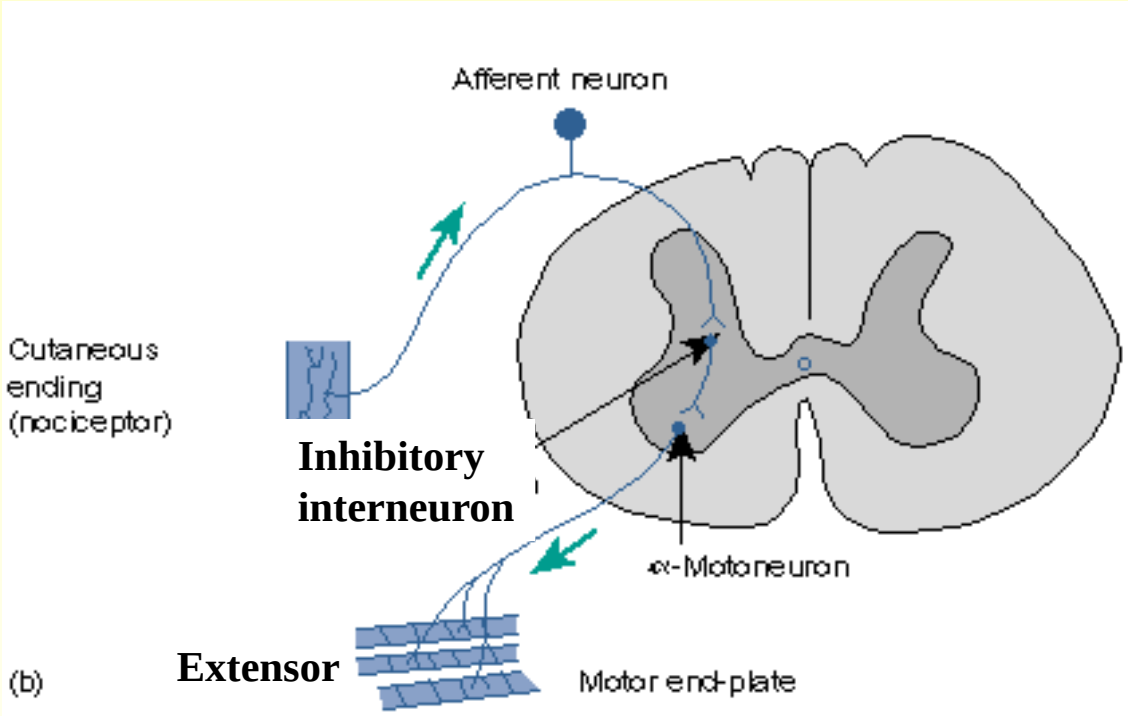
ClC-1 mutant goat



Normal goat, 9-AC

Pain reflex and stretch reflex:

- Subconscious movement control
- Protective role



TRPA1: a sensor of harmful cold