النادي الطبي

CENTRAL NERVOUS SYSTEM

اذكروا
اصواتكم
بالدعاء

SUBJECT : physiology

LEC NO. : 4&5 : Reflexes

DONE BY : Nehaya

وَقُل رَّبِّ زِدْنِي عِلْمًا

O follow numbers

① Stretch: cotraction → لتحافظ على ثقل الجسم ثابت على الموكن

aim: keep constant length of muscle

يعني لو ملت يمين عضلاتي اليمين بت cont.

- centere: Spinal Cord
- site: Deep (muscles)
- synepses: monosynaps ③

② لازم يكون سريع ؟ ⇐ #

صراحتو stimulus

1A ① receptor afferent

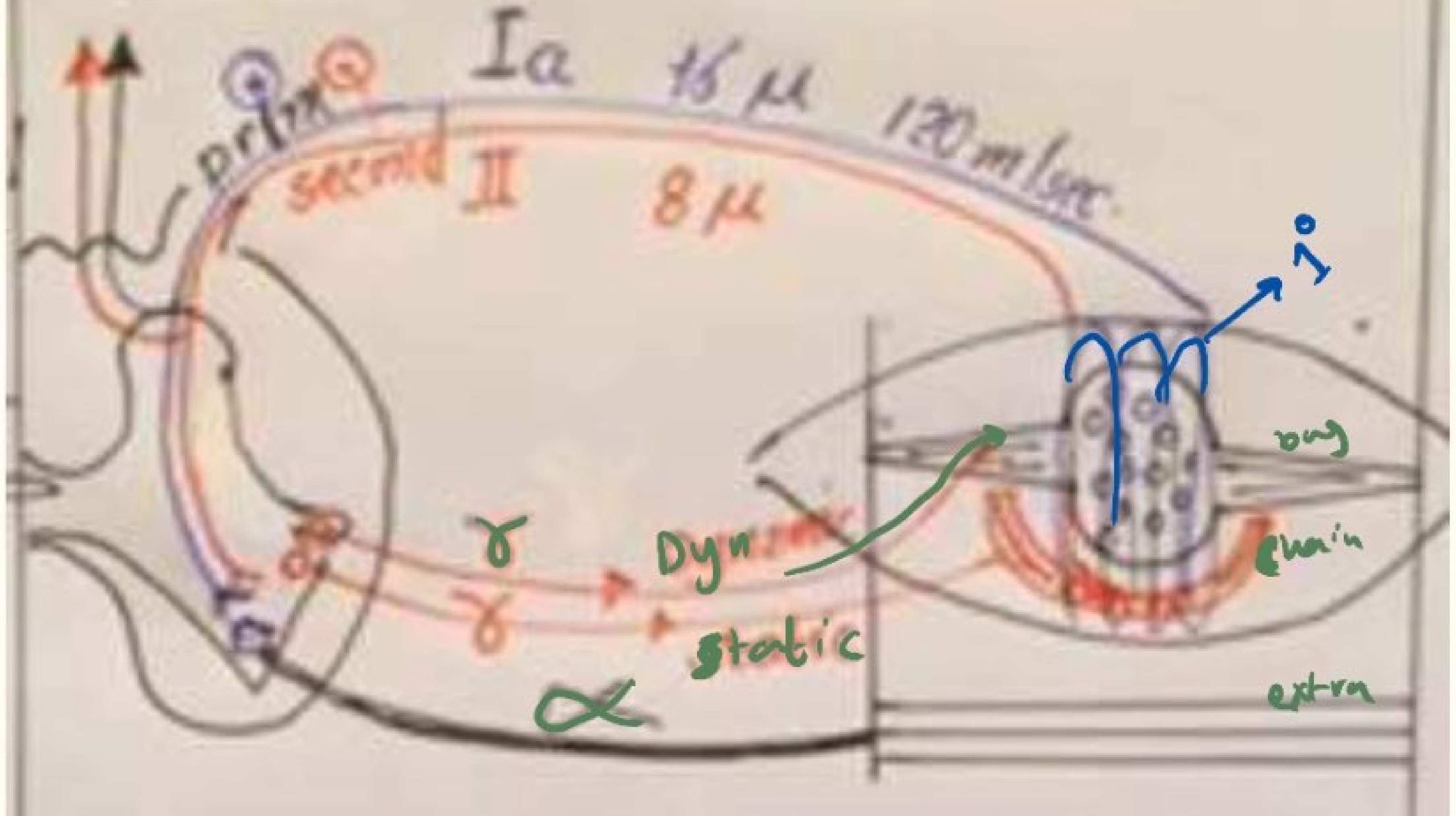
(عندو myelin = سريع جداً)

center

Aα ② efferent

response

Structure of Muscle Spindle



- Each spindle 8-10 intrafusal mf
- 2 types:

Nuclear bag	Nuclear chain
Dynamic	Static
Rapidly	Slowly adap

مع ال stretch going (وهي تتشد) — Dynamic

وهي مستمرة (while it's stretched) — Static

- 2 Afferents: primary — Secondary
- 2 Efferents: γ Dynamic — γ static

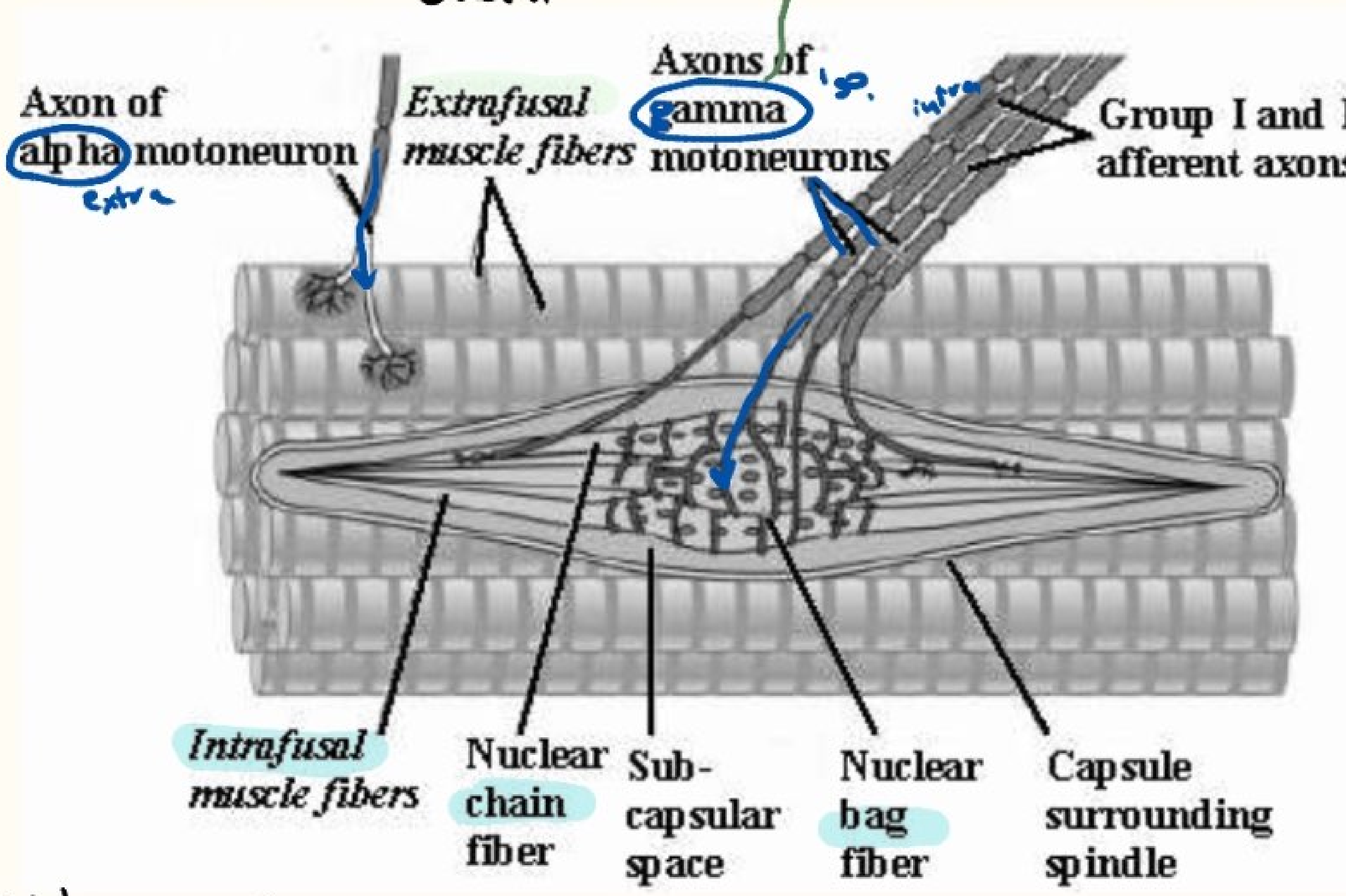
Note Dynamic R discharge less with sustained stretch (ما بتوقف تماما)

③ Muscle fiber

- Intrafusal (chain, bag) fib جوا muscle spindle
  - periphery → cont. ↑↑ 2 efferent
  - centre → Receptor ↑↑ ② afferent → bag & chain للنوعين
- extrafusal برا muscle spindle → contractile

Intrafusal

⑤ remember anatomy
تحت + motor grey anterior horn
nuclei (alpha & gamma)



④

Static SR (m. tone)	Dynamic SR (tendon jerk)
Maintained stretch	Sudden brief stretch
Maintained cont.	Sudden cont followed by sudden
Nuclear chain	Nuclear bag
* Nuclear bag [2]	
Secondary [2]	
Primary	Primary

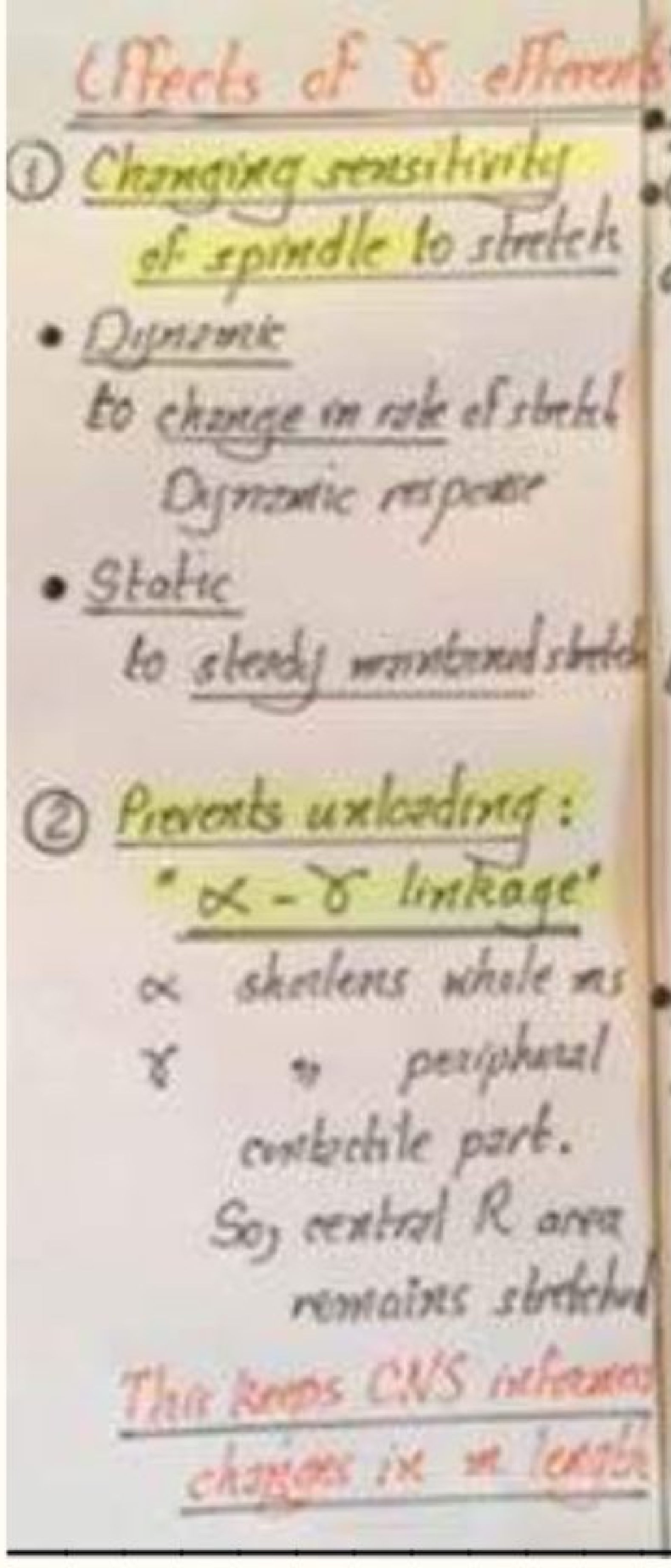
Higher center ⊕

⑤ gamma efferent → cont. peripheral intrafusal = stretch central receptor (⊕) = sensory ↑

لانه Stretch receptor

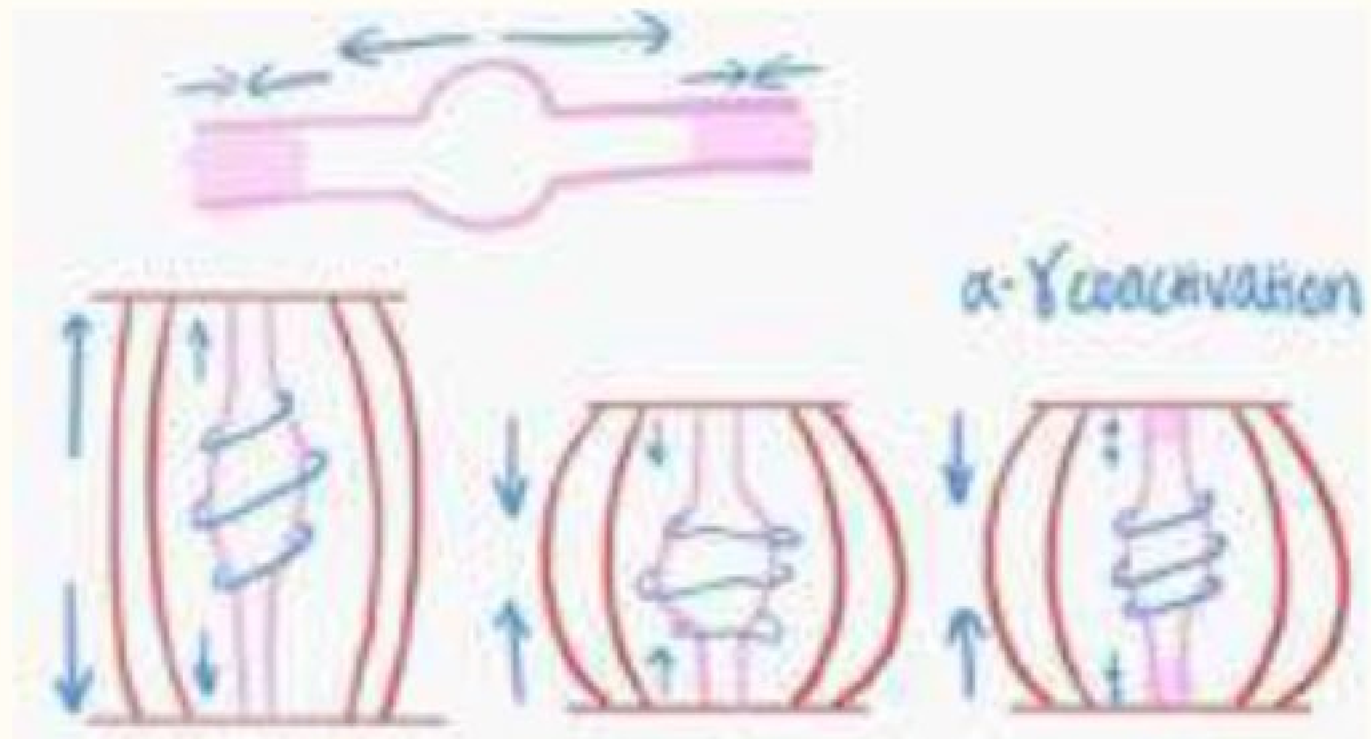
⊖ فلع العكس صار → relax peripheral = central ما انفعط

مثلا بدخل خيط بإبرة مركزة ← بيدي احافظ عالوضع لوحد كتير عطول بتوجع: stretch reflex لانه ال gamma ⊕



→ هاي
⑤ تقطة

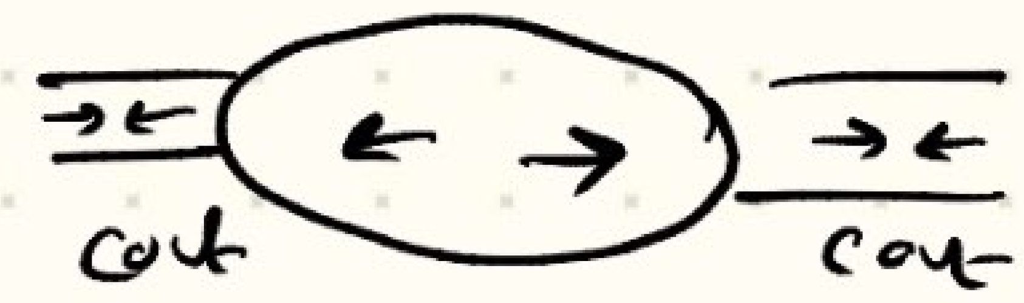
⑥ control يدي افل عنري معلومات عن العضلة من ال



[المشكلة] عند ال cont.
of extrafusal intrafusal contract too
بالتالي فش stretch واصل
لل stretch receptor (in center of intra)

I want to keep center stretched by cont. [الحل]
the peripheral (? How): gama efferent ⊕ عند تقلص ال extra

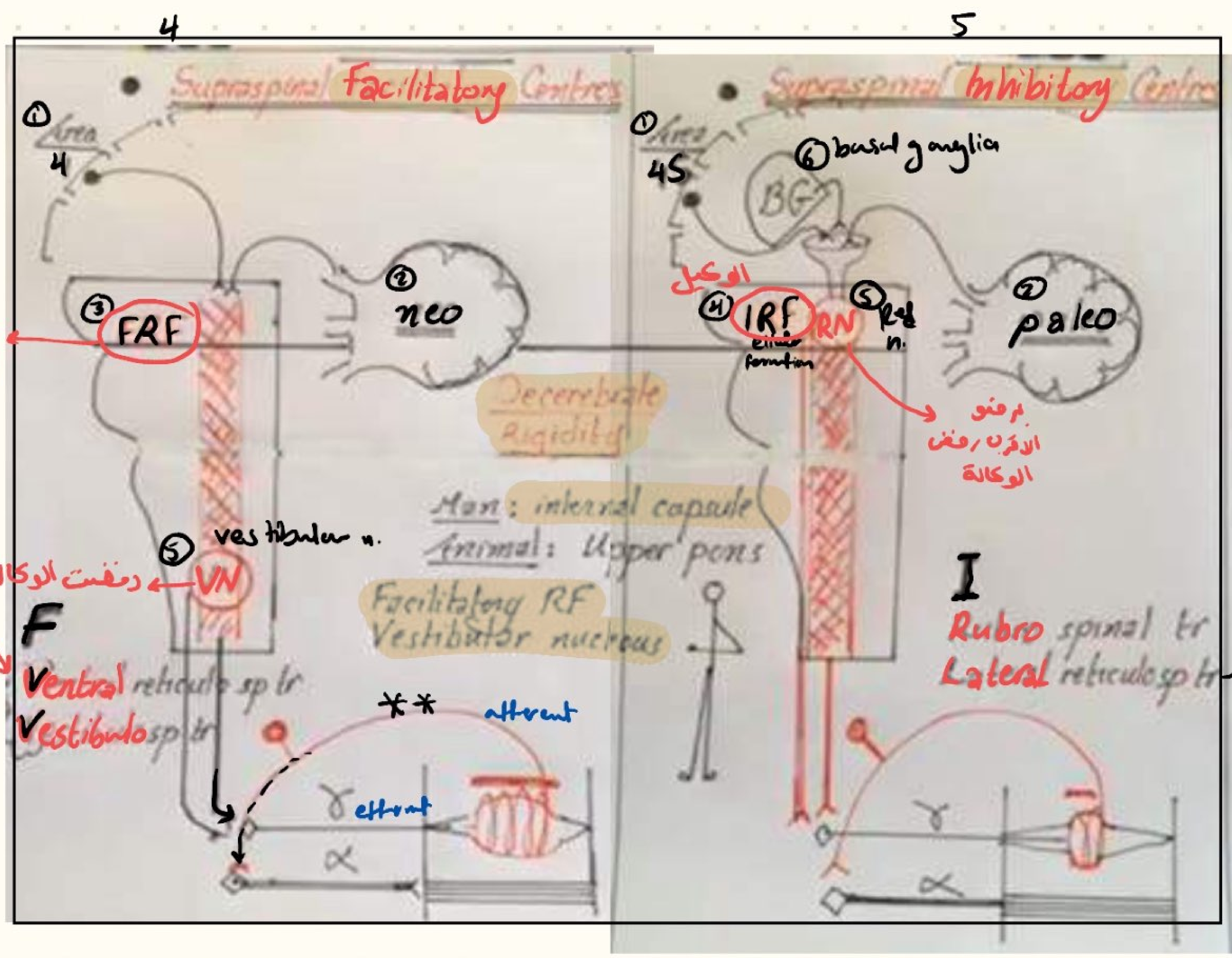
stretch receptor stretching
=
sensory is sensing



lect 5

Higher centers that control gamma

التفكير بال balance بين inhibitory & fascilitation



①
وكيل: يبعث ال fascilitation
البقية من خلاله لكن
رفضه الاقرب له VN
(الخيانة من الأقرب)

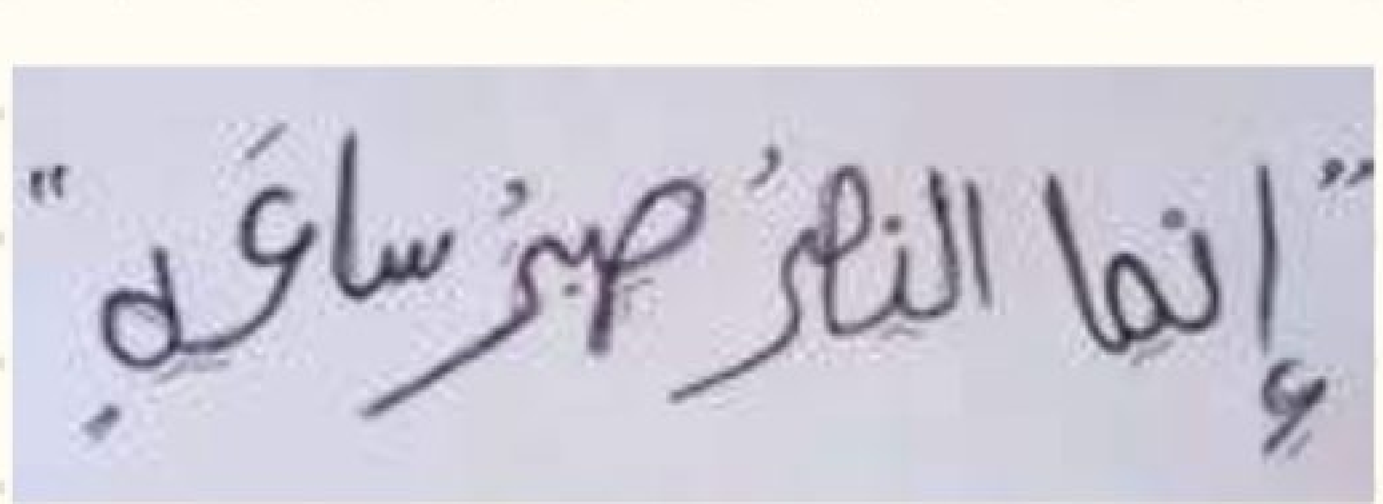
رفضت الوكالة ← VN

②
** يبعث ل γ فقط
يلي بتحكم ب peripheral muscle
ول α بتحكمها ال central
(not direct)
↓
السؤال عنا:
هل hemiplasia
الشلل النصفي γ Reflex
or Direct nature?
راجع لل α
طبعا الجواب Reflex لانه
يرجع لل γ بالاول

*IRF doesnt inhibit by itself
هو فقط funnel

③
lateral column تتقطع
=
inhibition فقط
↑ fascilitation
(بتحرك متخشب)
↑ tone بسبب
التحكم ال fascilitation
=
⊕ gamma = cont. peripheral
=
⊕ stretch center
=
تبعث ل α → extrafusal control
⇓
rigidity
⇓
antigravity
limbs
neck
&
Back

ماضي غير تأثير fascilitatory = فوق ال Internal capsule = Capsule
FRF ^ VN
مشتغل
السبب: تحت Internal Capsule في → VN
↓
FRF
فيه كان IRF
لكنها ما بشتغل بلا البقية




شلل نصفي

Physiological significance of SR i.e m. spindle
- Helps to maintain muscle length ① (discuss).
- Controls of voluntary movements ②

a Servo-assist function during m. contraction:
During vol. contraction, impulses from higher centres s…
α motor neurones → direct cont. of extrafusal m.fs.
γ motor neurone → reflex cont. of extrafusal m.fs.
So, α - γ linkage potentiates vol. contraction.

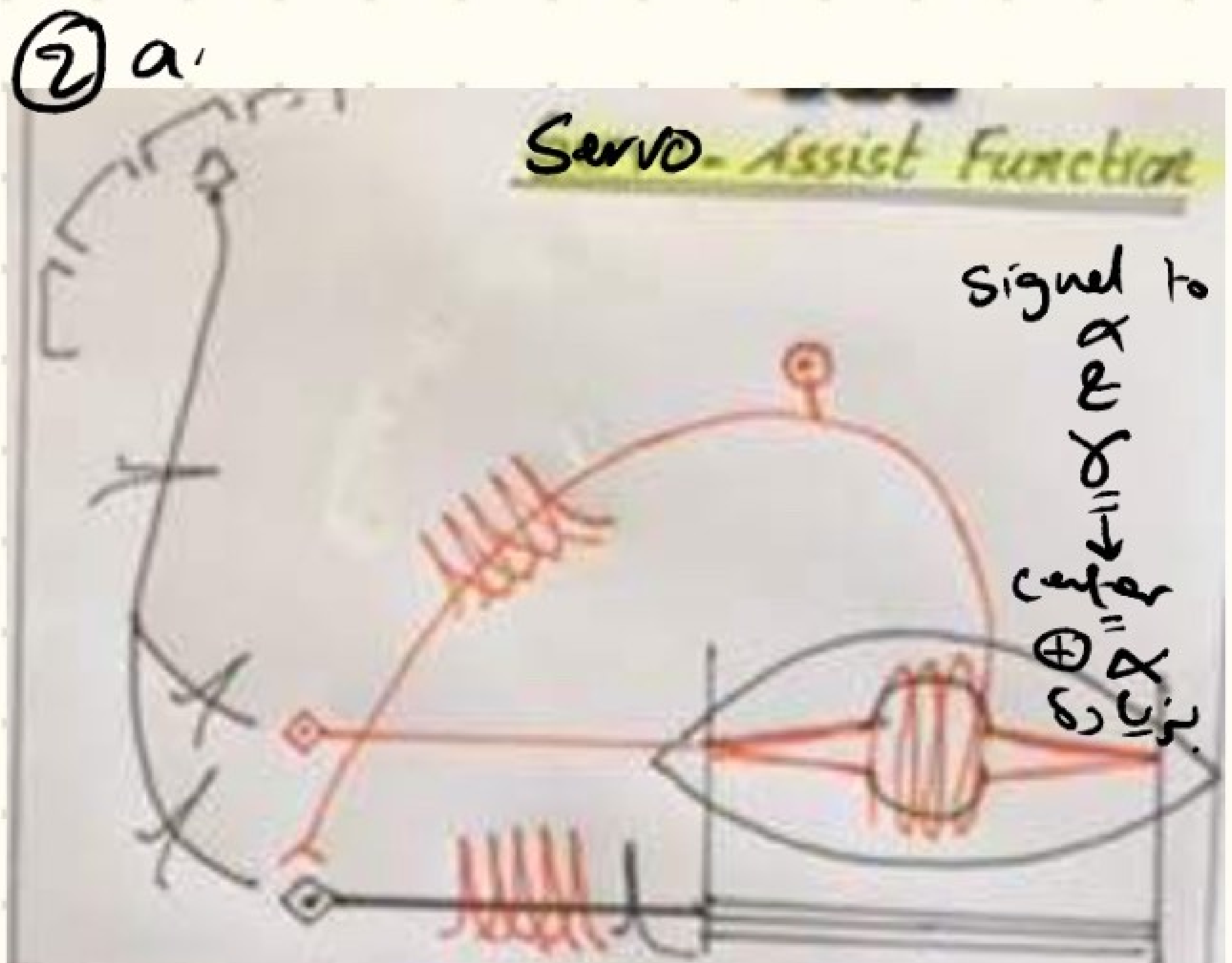
b Damping function smoothen muscle contraction:
During vol. cont., Δtr sends irregular signals to AHCs…
SR prevents oscillation & smoothens muscle contracti…
Prove: Deafferentation i.e no SR → jerky musc…

- Muscle tone i.e static SR is the basis of muscle to…
- Definition Reflex subtetanic alternating … cont.
- During rest, m. spindle is continuously stretche…
  a m. length < distance between origin & insertio…
  b force of gravity, i.e m. tone is more in antigrav…
    - Flexors of UL
    - extensors of LL, back & neck
    - elevator of lower jaw.
  c continuous γ efferent discharge

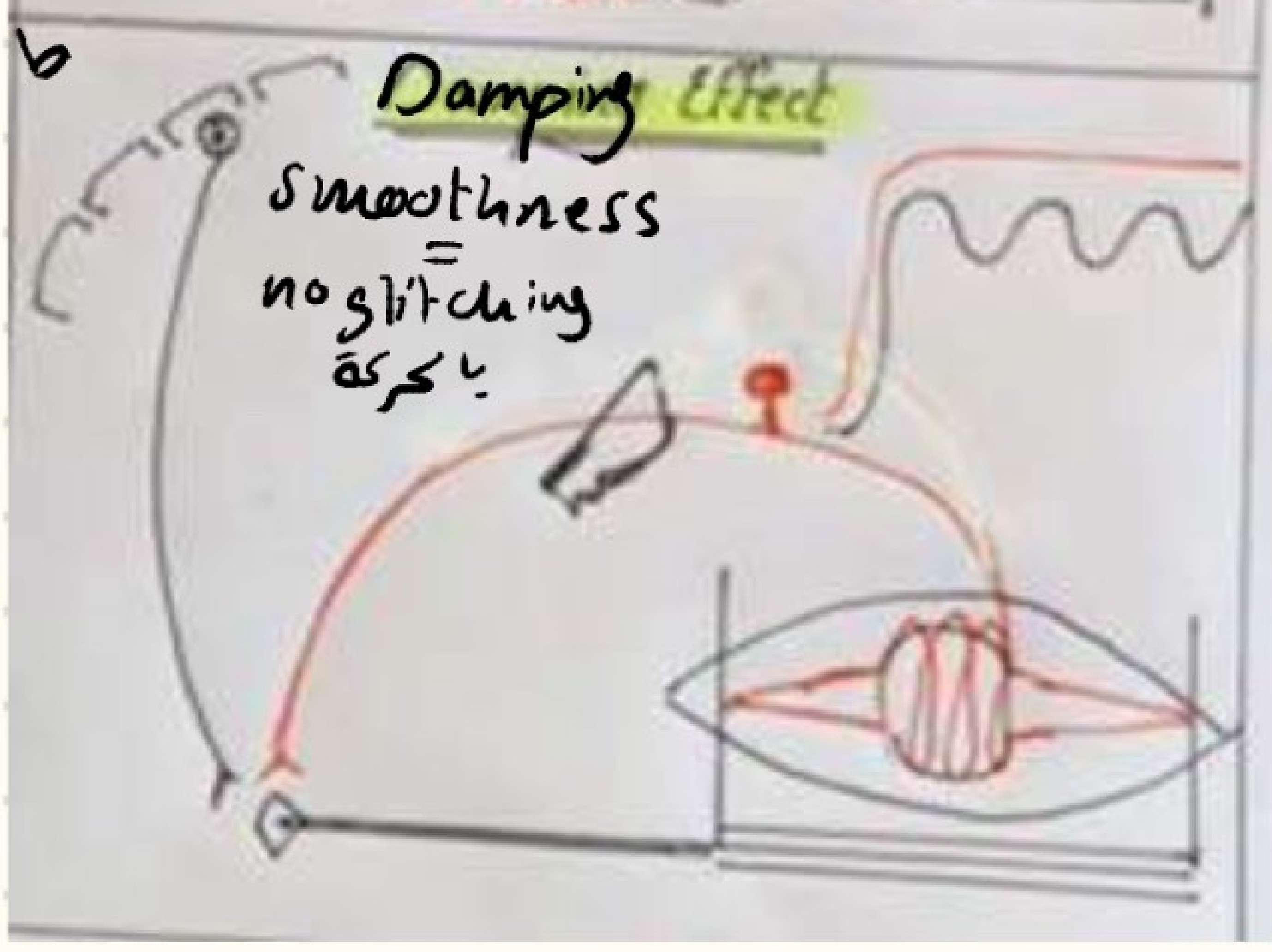
Skeletal m. tone doesn't show fatigue
a Subtetetanic
b Alternating
c Slow red m. fibres

★ Functions of m. tone
1 Maintains body posture
2 " " temp
3 Background for vol. movements
4 Helps VR & Lymph.R

② a.



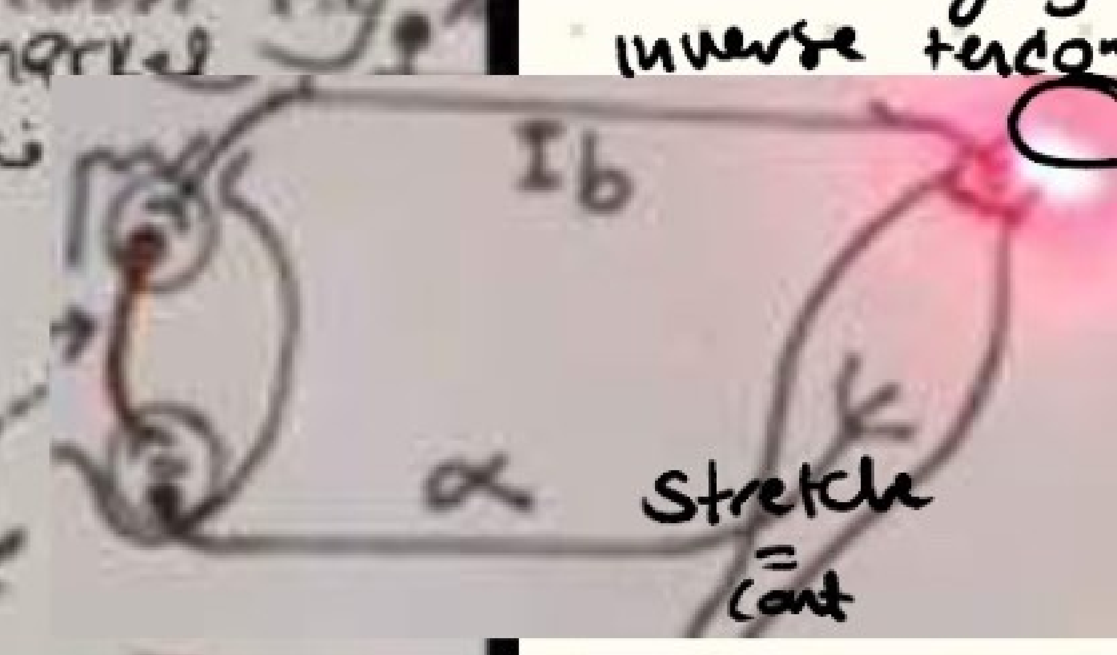
b

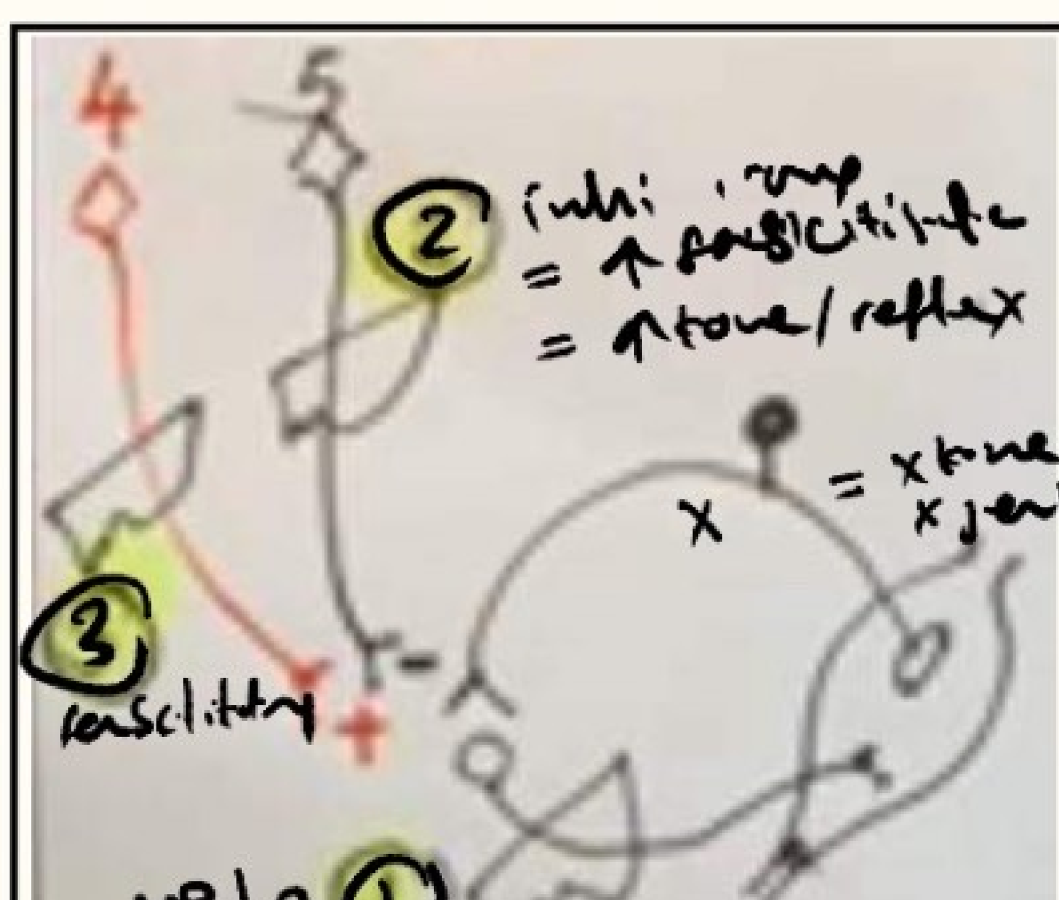


pyramid sends irriguler signals
stretch = تطول = relax فيه حركة متقطعة
= center ⊕ = + alph = cont extrafusal

inverse stretch

Stimulus	++ tension in muscle or tendon e.g. …
Receptor	Golgi tendon organ. ف تتقطع marked
Afferent	I_b (myelinated).
Centre	Bisynaptic. one inhibitory interneurone
Efferent	A alpha.
Response	Relaxation.
Aim	To maintain muscle TENSION const.





ثم ممكن يتأثر يؤثر عال Reflex

next slide بس

① عضلة بوضع stretch
② exposed
③ avoid gama inhibit
ابعد تركيزه = ... / ...
④ sudden tap
→ sudden cont
golgi > relaxation
motor units مرة وحدة ليشتغل بتوقف
1. tone على alternating (5/5

فحص tone passively
احرك العضلة

Clinical

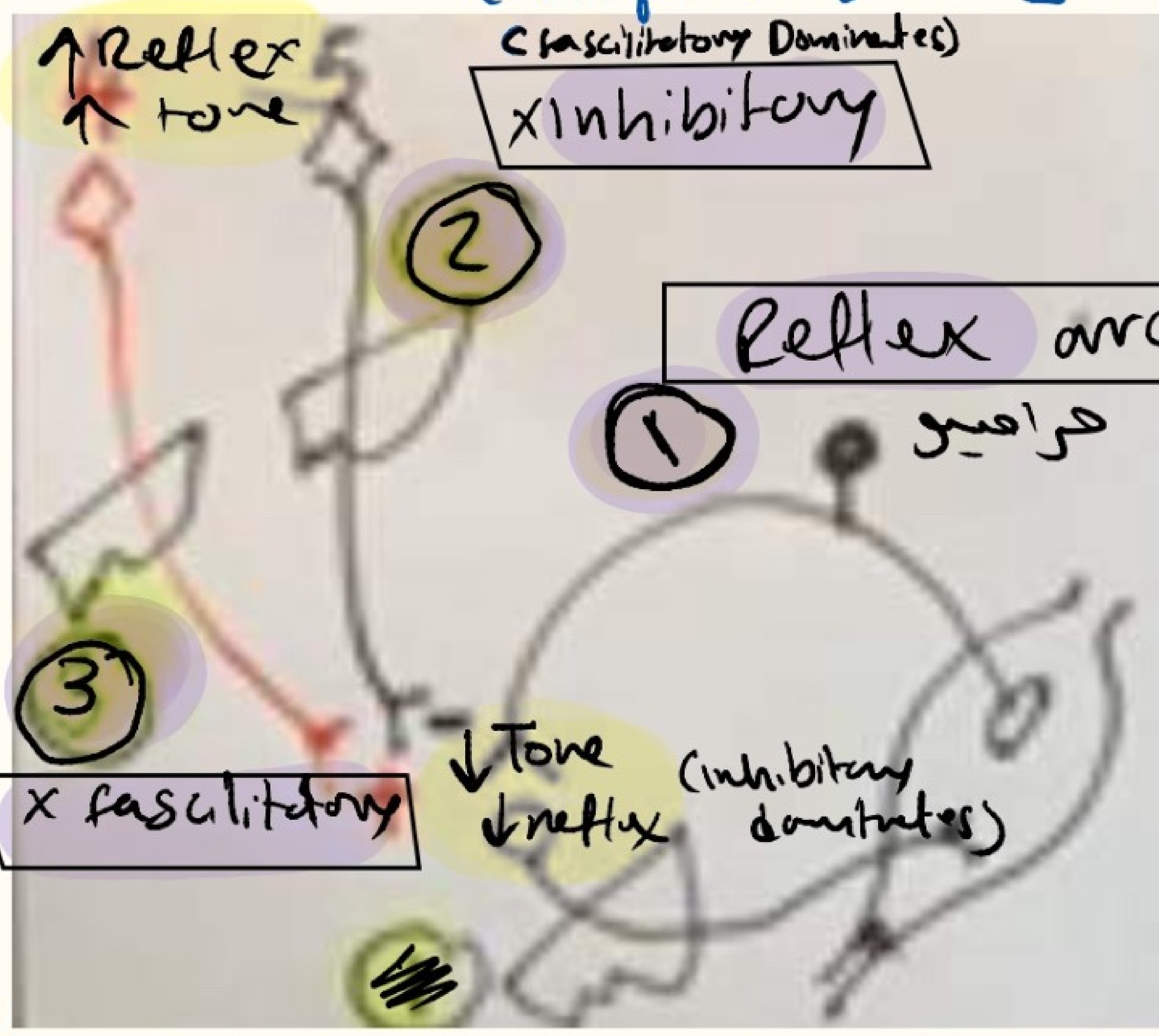
Ankle	: 1 - 2 S
Knee	: 3 - 4 L
Biceps	: 5 - 6 C
Triceps	: 6 - 7 C

فحص ال Jen King

(fellow numbers) reflexes مشاكل ال

الاسباب ²* anxiety ³* hyper thyroidism

¹* hemiplasia [UMNL] (internal capsule) upper motor neuron lesion
فخشب : شلل نصفي



upper upper
lower lower
motor neuron lesion (قطع)
* upper = ↑up = ↑ Tone & Reflex
* lower = قطع neurons = x arch = x Tone, x Reflex

*nerves → peripheral neuropathy
① DM ② ↓vit b12
tabes (damage) dorsalis
dorsal root

*center → polyomyelitis شلل الاطفال
↓
x Reflex
x tone

* severe hypothyroid (myxedema)

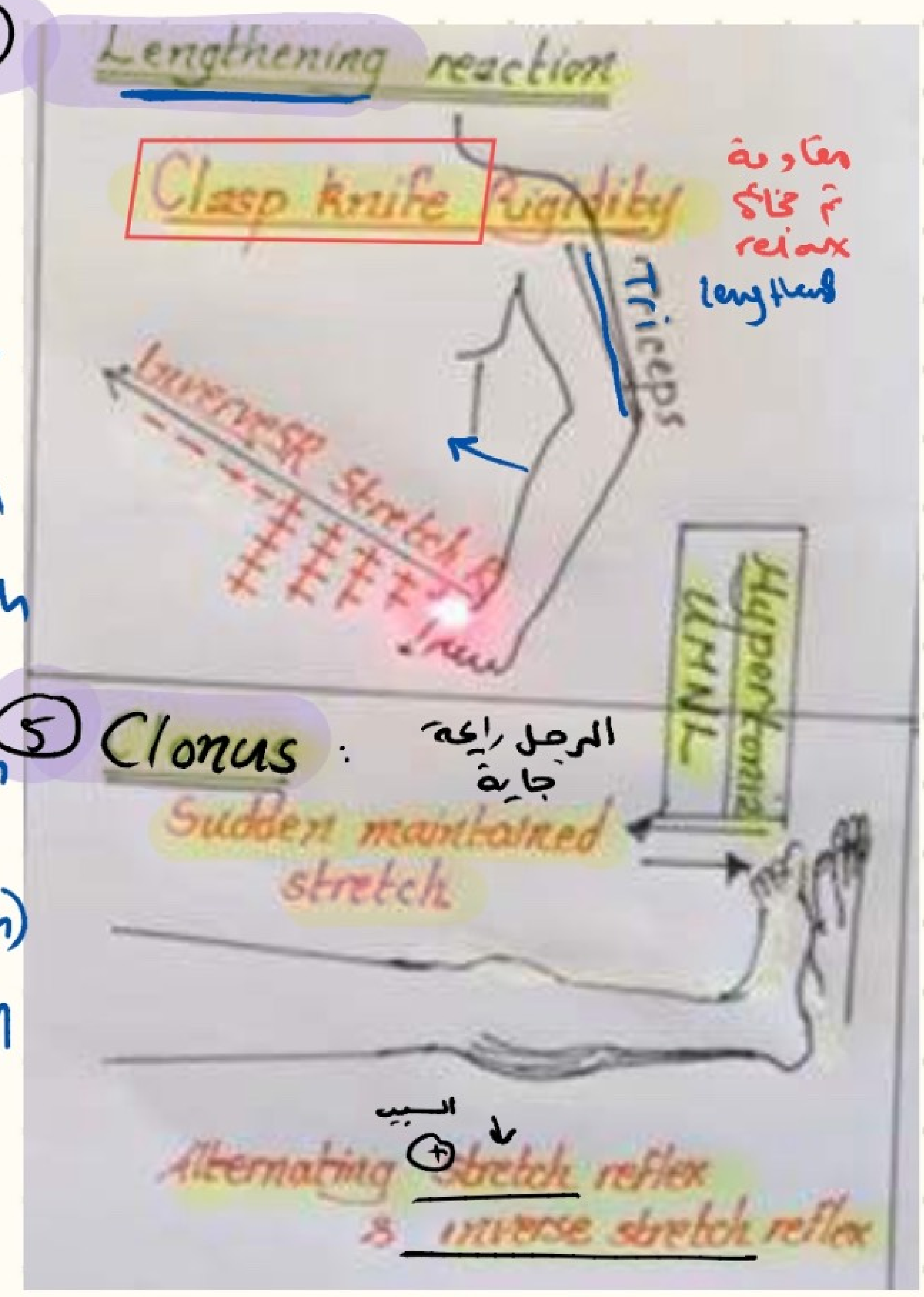
*ايم neo cerebellum lesion ← x fascilitatory

cerebellum الـ عيان ⟶ وسو خالص = سايب
*↓ tone (مايع)
↓ reflex

*الرجل رايحة جاية = tone لا نهائي

Knee jerk → normal / absent / hyper

[Pendular knee jerk] مثل البندول



لو حاولت تحرك elbow مريض شلل بالاول مقاومة ثم فجأة بتسحب انك ونة سيب كدة

moderate stretch = contraction
ثم
marked stretch = ⊕ golgi tendon (inverse stretch) = Relaxation

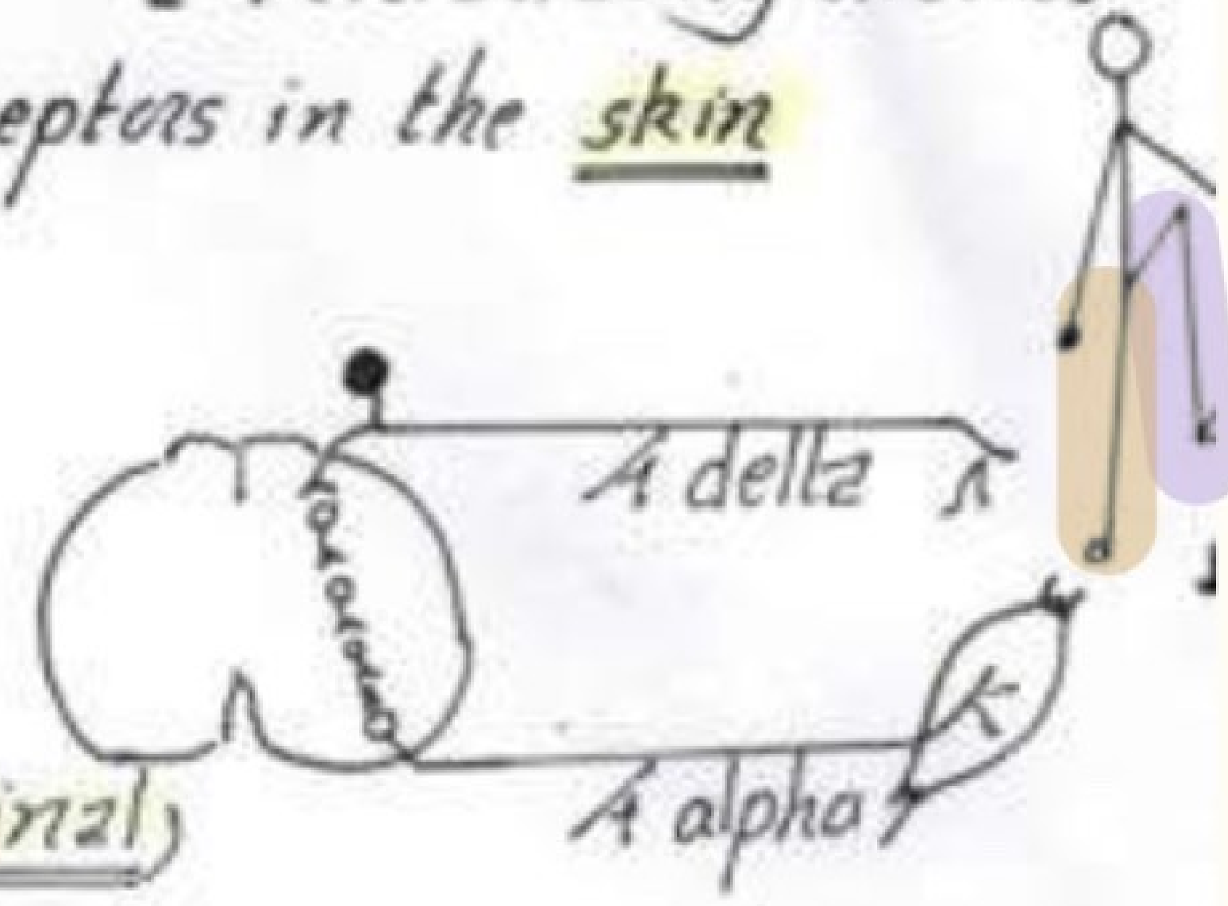
مقاومة ثم فجأة relax lengthens

Hemiplasia patients

Polysynaptic Reflexes

Prolonged response (after discharge) in polysynaptic R. is due to:
- Parallel chain circuits &
- reverberating circuits

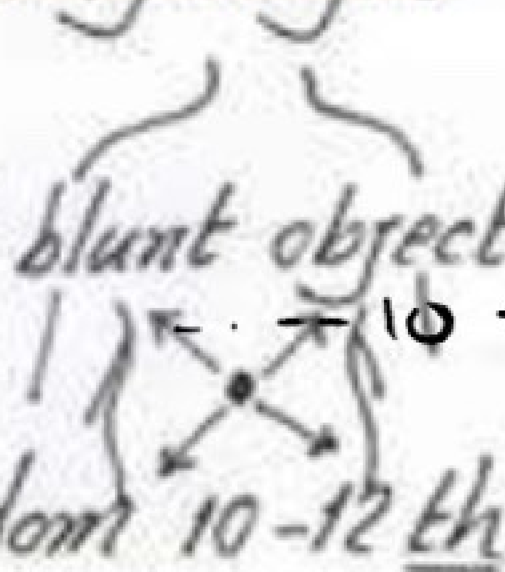
A) **Superficial reflexes** 7 i.e receptors in the skin



[1] **Flexor withdrawal reflex**:
- Stimulus: Injurious (painful)
- Receptors: Free n. ending
- Afferent: A delta (mainly)
- Center: Polysynaptic (spinal)
- Efferent: A alpha
- Response: Flexion & withdrawal of limb away from injurious S

Properties of flexor withdrawal reflex
- a Reciprocal innervation: cont. of flexors & relax. of extensors
- b Crossed extensor reflex: Stronger stimulus produces extension of the opposite limb to support body weight

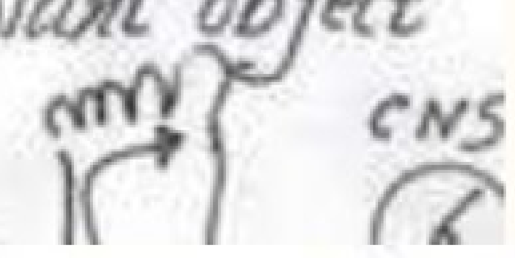
[2] **Abdominal reflex**:
- Stimulus: Stroking the skin of abdomen with blunt object.
- Response: Contraction of abdominal muscles
- Centre: Upper abdom. 7-10 th. Lower abdom 10-12 th



→ قطع عند (10): upper ✓ reflex, lower ✗ reflex

[3] **Cremasteric reflex**
- Stimulus: Scratching skin of upper inner aspect of thigh.
- Response: Cont. of cremasteric m. → elevation of testis
- Centre: 1st & 2nd lumbar segments

[4] **Planter reflex**
- Stimulus: Scratching outer aspect of sole by a blunt object
- Response: Planter flexion of all toes



sacral 1,2

[5] **+ve supporting reaction** — no reciprocal innervation
- Stimulus: Deep pressure on sole of foot
- Response: Cont. of flexors & extensors → limb is rigid column.

[6] **Scratch reflex**
- Stimulus: Tickling or itching e.g moving insect.
- Response: Too & fro scratching movements.

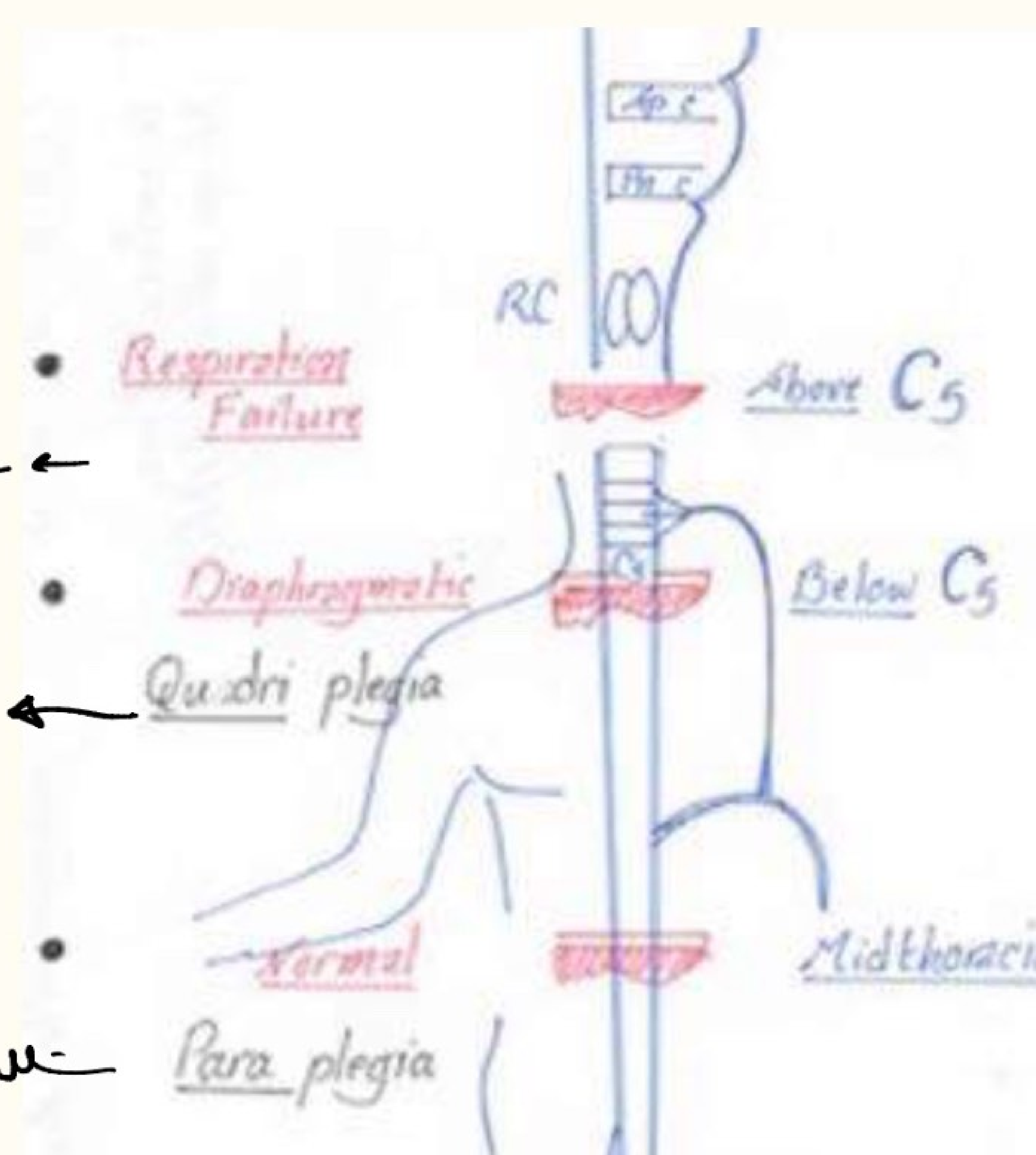
[7] **Local skin reflexes**: Local skin cold → VC
Local skin heat → VD and sweating

B) **Visceral reflexes** e.g Micturition, defecation & erection.

Bi: inverse
mono: stretch reflex

* تحت lesion عمر ال sensation
ما صيرجع تاني لانه
tracts can't regenerate

x phrenic = تنفس ←
x diaphragm
x respiration



تحت C5 شلل رباعي لكن ← Quadri plegia
ال phrenic شغال لانه
فوق C5 ما انقطع = ✓ diph ✓ resp

شلل القدمين ← Para plegia

THE REFLEXES & THEIR PROPERTIES

A reflex can be defined as an involuntary response to a stimulus, and various reflexes are essential for homeostasis. Reflex actions are performed through pathways called reflex arcs. A reflex arc consists of (a) An afferent (or input) neuron which starts at a receptor, (b) One or more (and sometimes no) interneurons, (c) A nerve center, (d) An efferent (or output) neuron, which terminates at an effector organ.

The nerve cell bodies of afferent neurons are located in the dorsal root ganglia. Inter-neurons are present in all reflexes, so they are polysynaptic except the stretch reflex, which is thus monosynaptic, and it is probably the only monosynaptic reflex in the body.

The nerve centers of somatic reflexes are the anterior horn cells (= spinal motor neurons), while the nerve centers of visceral reflexes are the lateral horn cells. Some cranial nerve nuclei are also centers in certain reflexes.

TYPES OF REFLEXES: Reflexes are generally classified into peripheral and central reflexes.

(A) PERIPHERAL REFLEXES

(1) Local axon reflexes (e.g., producing flare of the triple response).

(2) Local enteric reflexes, e.g., those involved in gastrin secretion and intestinal peristaltic movements.

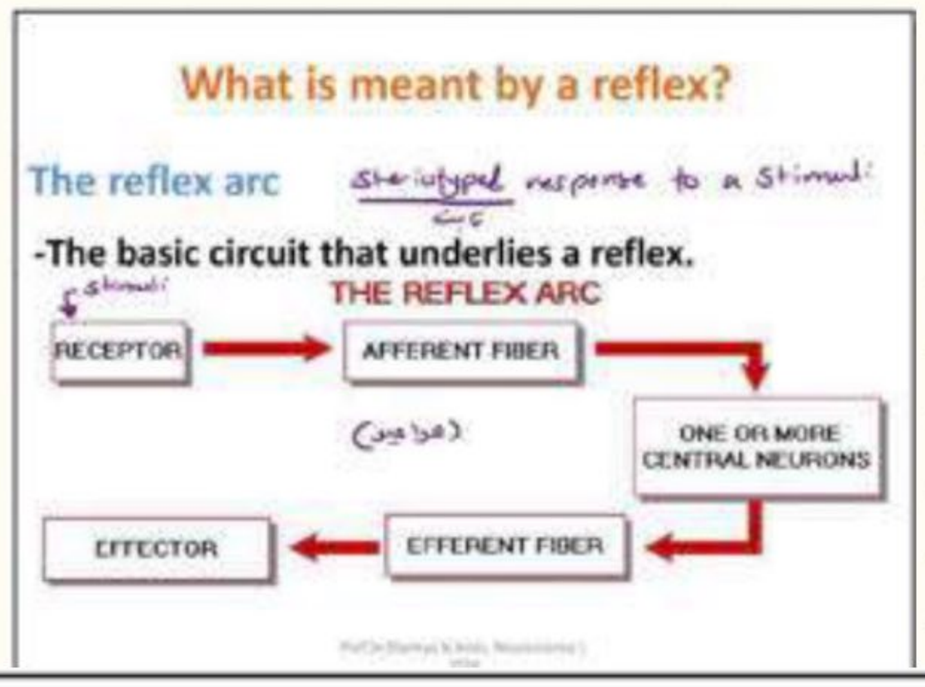
(B) CENTRAL REFLEXES

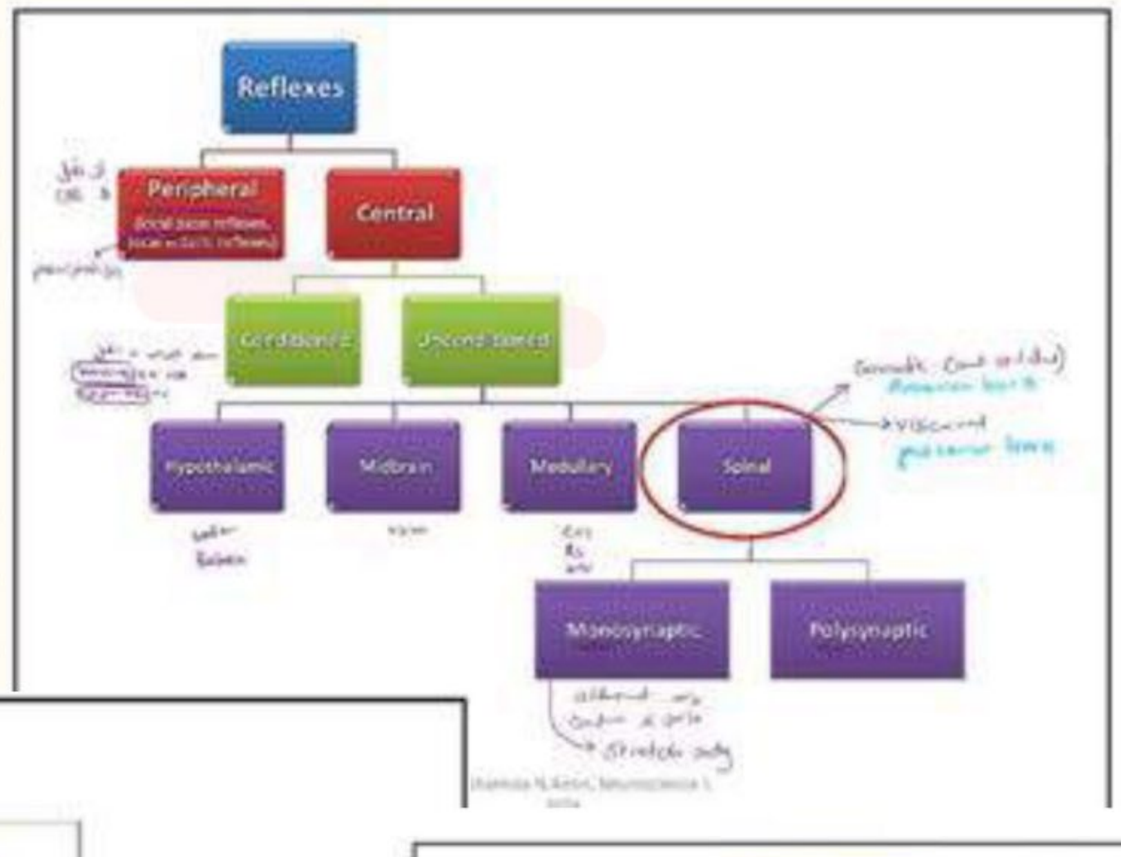
(l) Conditioned reflexes: These are acquired (i.e., develop by learning) and are integrated in the cerebral cortex.

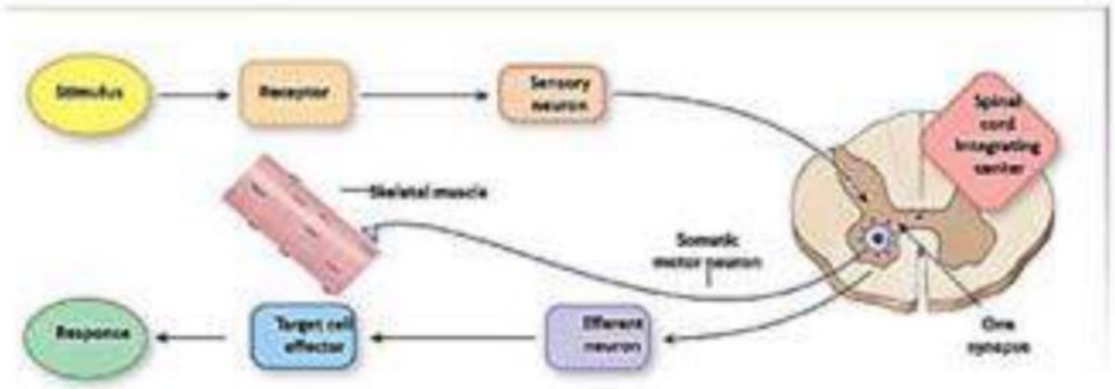
(2) Unconditioned reflexes: These are inherent (or inborn) i.e. occur without learning, and include (a) Hypothalamic reflexes (regulate many functions e.g. body temperature and water balance) (b) Midbrain reflexes (mediate postural reflexes and most visual reflexes) (c) Medullary reflexes (mediate cardiovascular, respiratory and digestive reflexes) (d) Spinal reflexes which include superficial, deep and visceral reflexes or monosynaptic and polysynaptic.

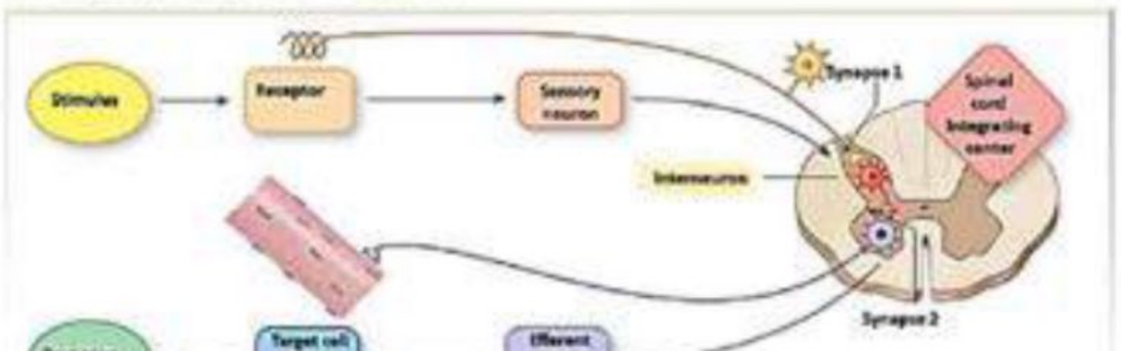
THE STRETCH REFLEX AND SKELETAL MUSCLE TONE

The stretch reflex is the contraction of a skeletal muscle in response to passive stretch. It is also called the myotatic or muscle spindle reflex (MSR)









no interneurons

Structure of the muscle spindle

Muscle spindles are fusiform stretch receptors present in the fleshy parts of skeletal muscles parallel to the muscle fibers called extrafusal fibers. Each spindle consists of several small muscle fibers called intrafusal fibers enclosed in a connective tissue capsule attached to the sides of the extrafusal fibers. The central parts of these fibers are noncontractile and constitute the receptor areas ol' the spindles. On the other hand, their peripheral parts are contractile, and when they contract, they stretch the central receptor areas. There are 2 types of intrafusal muscle fibers (based on morphology), which are the following:

(I) Nuclear bag fibers: These have a dilated central area filled with nuclei, and there are typically 2 of these fibers per spindle. Functionally there are 2 types of nuclear bag fibers: dynamic that respond to dynamic pattern of stretch and rapidly adapting and static nuclear bag fibers that respond to sustained stretch and are slowly adapting.

(2) Nuclear chain fibers: These also have multiple nuclei, but they are arranged as a chain in the receptor area. They are attached to the sides of the other type, and there are 4-8 of these fibers per spindle.

Innervation (nerve supply) of the muscle spindles

(A) Afferent nerves arising from the spindles:

(1) Type la nerve fibers: These type A alpha fibers are thick (average diameter 17 microns) and rapidly conducting (velocity of conduction meters/second). They arise from the receptor areas of both the nuclear bag and nuclear chain muscle fibers, where their endings wrap around the fibers forming primary endings.

(2) Type Il nerve fibers: These type A-beta fibers are thinner and slower in conduction than the la fibers (average diameter of 8 microns). They arise from secondary endings at the sides of the nuclear chain fibers' primary endings and static nuclear bag fibers.

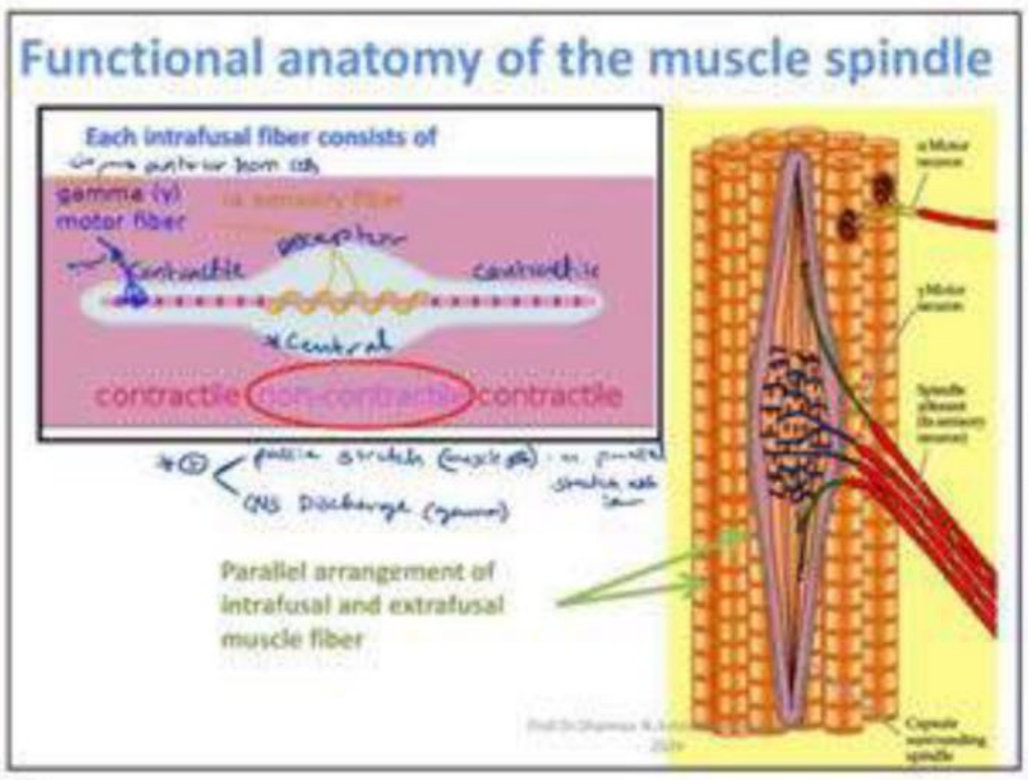
(B) Efferent nerves supplying the spindles (gamma efferent):

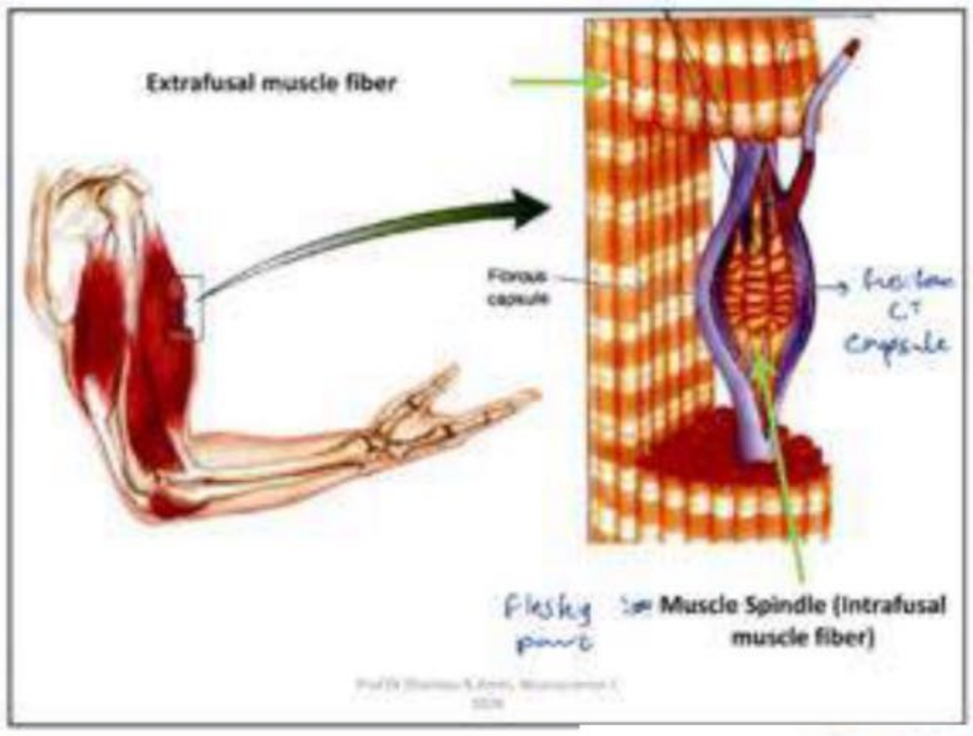
The intrafusal fibbers' peripheral (contractile) parts are supplied by thin myelinated motor nerve fibers called gamma-efferent nerves. These are the axons of small anterior horn cells called the gamma motor neurons, and are 2 types:

(1) Gamma-d (dynamic) fibers supply the dynamic nuclear bag fibers.

(2) Gamma-s (static) fibers supply the nuclear chain fibers and static nuclear bag fibers.

Mechanism of stimulation of the muscle spindles: The adequate stimulus for excitation of the muscle spindles is stretch, and this can be produced by either passive stretch of the whole muscle or stimulation of the gamma efferent fibers. The latter causes contraction of the peripheral parts of the intrafusal fibers, which stretches their central parts, and the resulting muscle contraction is said to occur via **a gamma-spindle loop**.

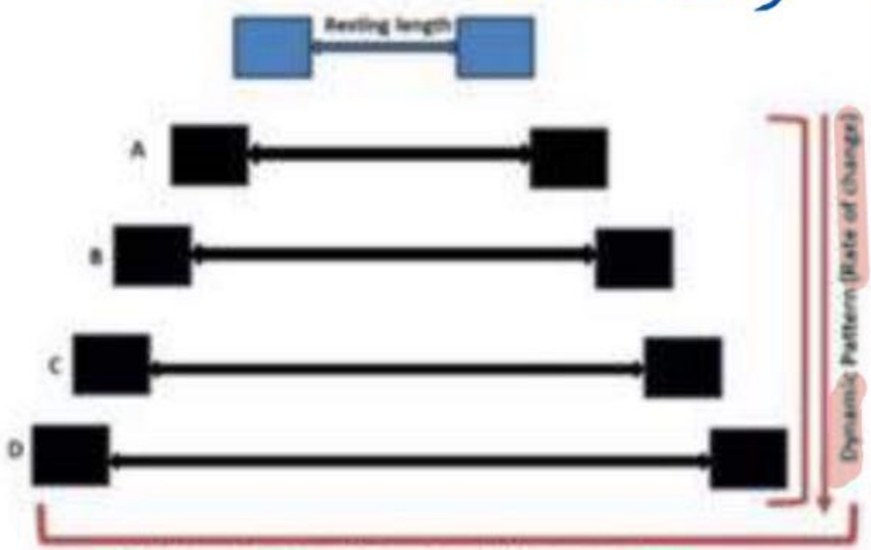




- Dynamic stretch sen
- ✓ static stretch sen & maintaining

Table 36-1 Classification of Sensory Fibers from Muscle

Type	Receptor	Axon	Sensitive to
Ia	Primary spindle endings	12-20 μm myelinated	Muscle length and rate of change of length
Ib	Golgi tendon organs	12-20 μm myelinated	Muscle tension
II	Secondary spindle endings	6-12 μm myelinated	Muscle length (little rate sensitivity)
II	Nonspindle endings	6-12 μm myelinated	Deep pressure
III	Free nerve endings	2-6 μm myelinated	Pain, chemical stimuli, and temperature (important for physiological response to exercise)
IV	Free nerve endings	0.5-2 μm nonmyelinated	Pain, chemical stimuli, and temperature



-Nervous pathway of the stretch reflex

Its fast-conducting afferent nerve fibers transmit impulses from the muscle spindles to the CNS. These proceed directly without intervening interneurons to the ventral horns, where they excite the alpha motor neurons that supply the stretched muscle (by releasing glutamate). The alpha motor neurons then transmit impulses to the stretched muscle leading to contraction of its extrafusal fibers.

Therefore, the stretch reflex arc contains only one synapse, and it is probably the only monosynaptic reflex in the body.

-Function of the muscle spindles

The muscle spindles constitute a feedback mechanism that maintains the muscle length constant. Elongation (stretch) of the muscle excites the muscle spindles, which leads to contraction and shortening of the muscle.

-Responses of the muscle spindles to stretch

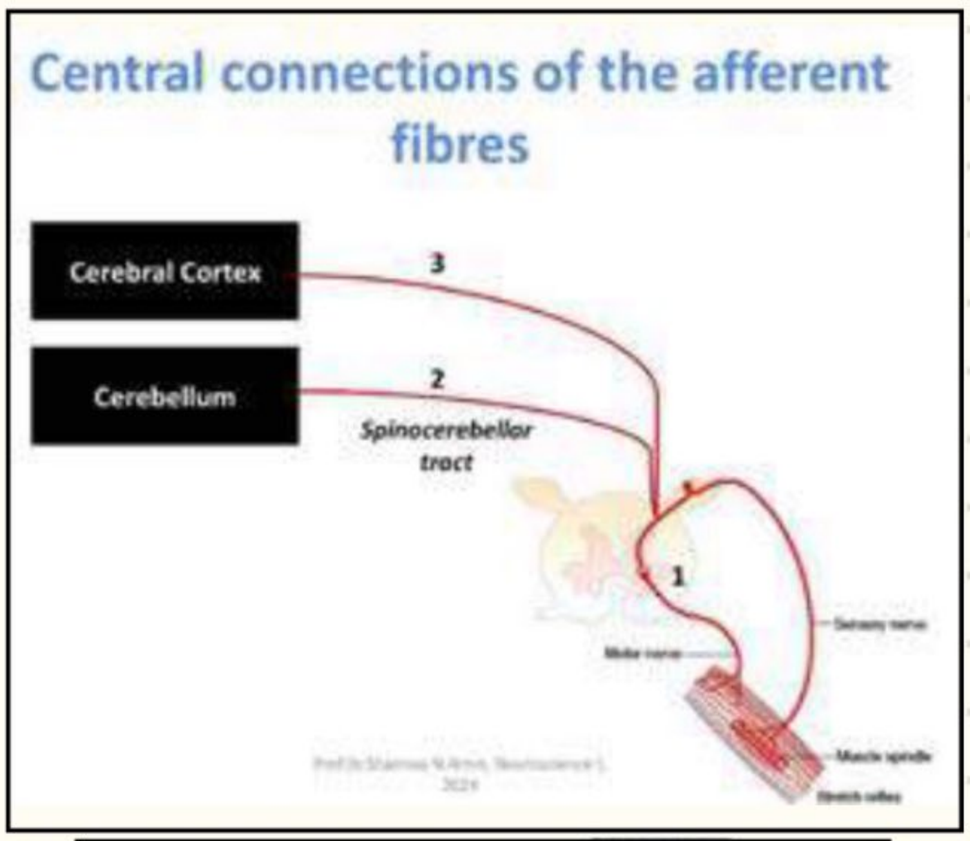
(I) Dynamic response: This occurs while the muscle length increases, and it informs the CNS about the rate of muscle length change. It is produced mainly due to a stretch of the dynamic nuclear bag fibers. The response is an increase in the discharge rate from the primary endings in these fibers, followed by a marked decrease when the new length is maintained (because these receptors are rapidly adapting).

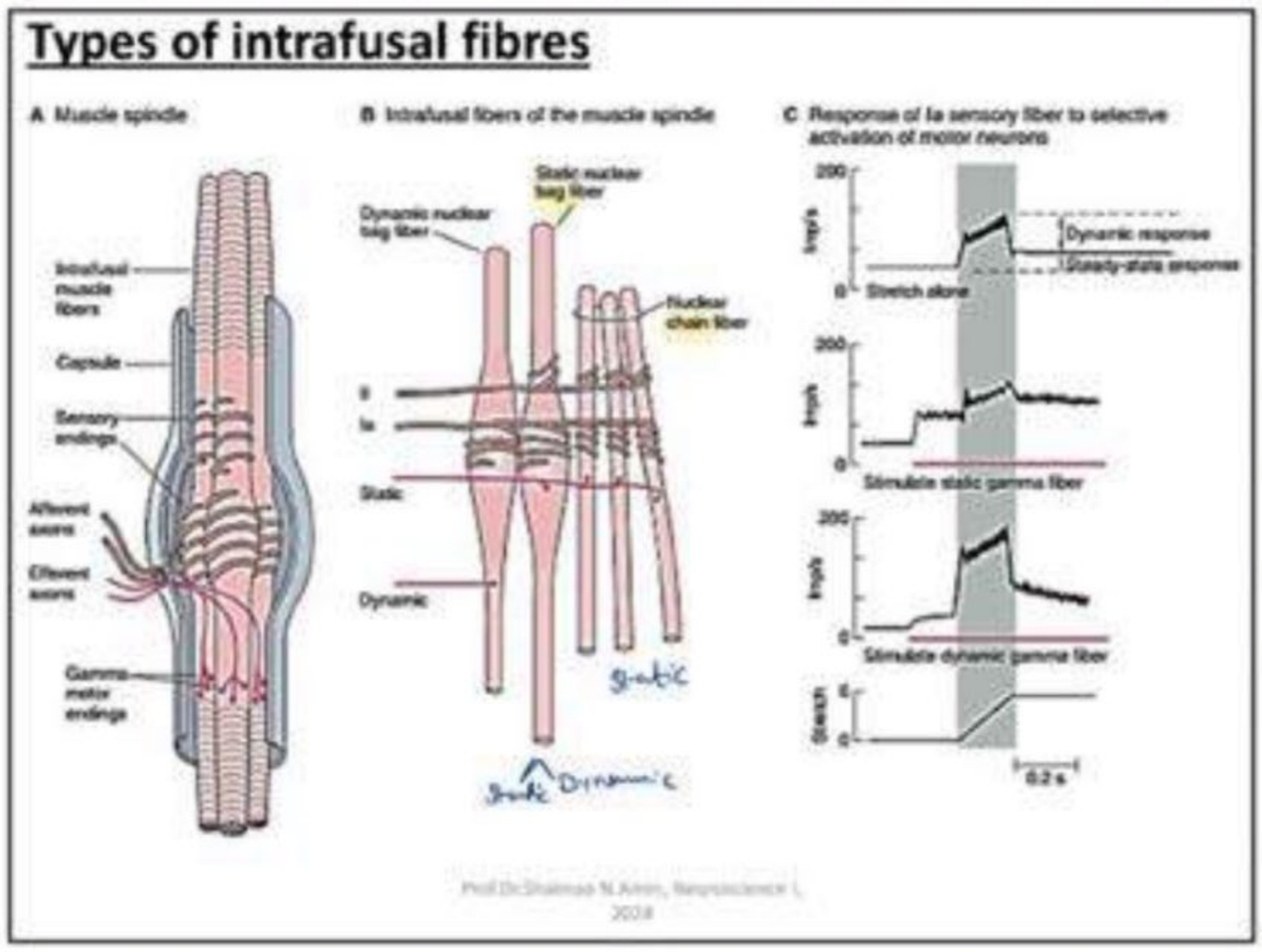
(2) Static response: This occurs while muscle stretch is maintained, and it informs the CNS about muscle length changes. It is produced mainly as a result of a stretch of the nuclear chain fibers and static nuclear chain fibers, and the response is an increase in the rate of discharge from the primary and secondary endings in these fibers, which continues as long as the new muscle length is maintained (because these receptors are almost non-adapting).

TYPES OF THE STRETCH REFLEX

(1) Dynamic stretch reflex: This is initiated by a sudden stretch of the muscle, and the response is a brief strong contraction that ends rapidly because it occurs as a result of the dynamic response of the muscle spindles. It is the basis of the tendon jerks.

(2) Static stretch reflex: This is initiated by a steady stretch of the muscle, and the response is a continuous contraction as long as the stretch is maintained because it occurs as a result of the static response of the muscle spindles. It is the basis of skeletal muscle tone.





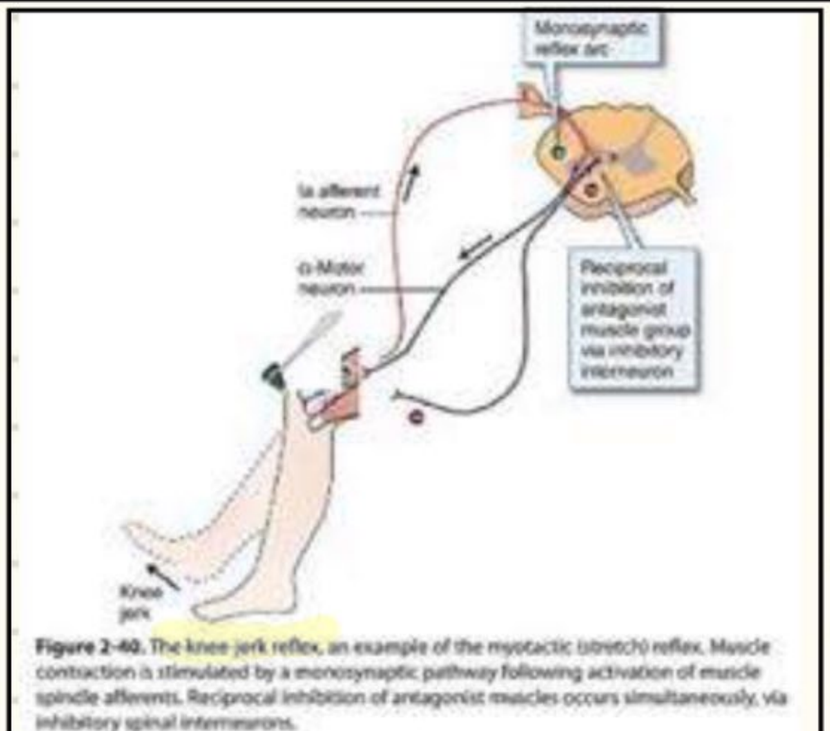


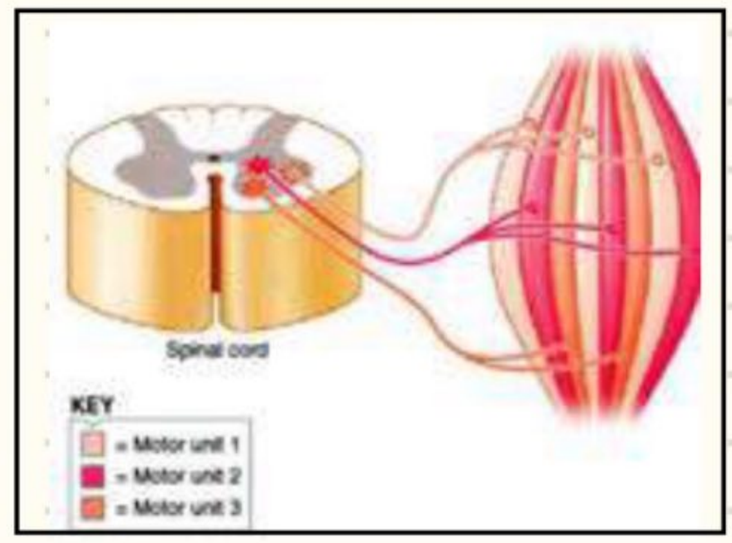
Figure 2-40. The knee-jerk reflex, an example of the myotactic (stretch) reflex. Muscle contraction is stimulated by a monosynaptic pathway following activation of muscle spindle afferents. Reciprocal inhibition of antagonist muscles occurs simultaneously, via inhibitory spinal interneurons.

Jenndrassik maneuver

طا بدى اعمل tendon jerk بحكي للمريض يشبك اصابعه و يشد هم ار يشد علشانه ليه؟

① اصرف انتباهه

② gamma ↑

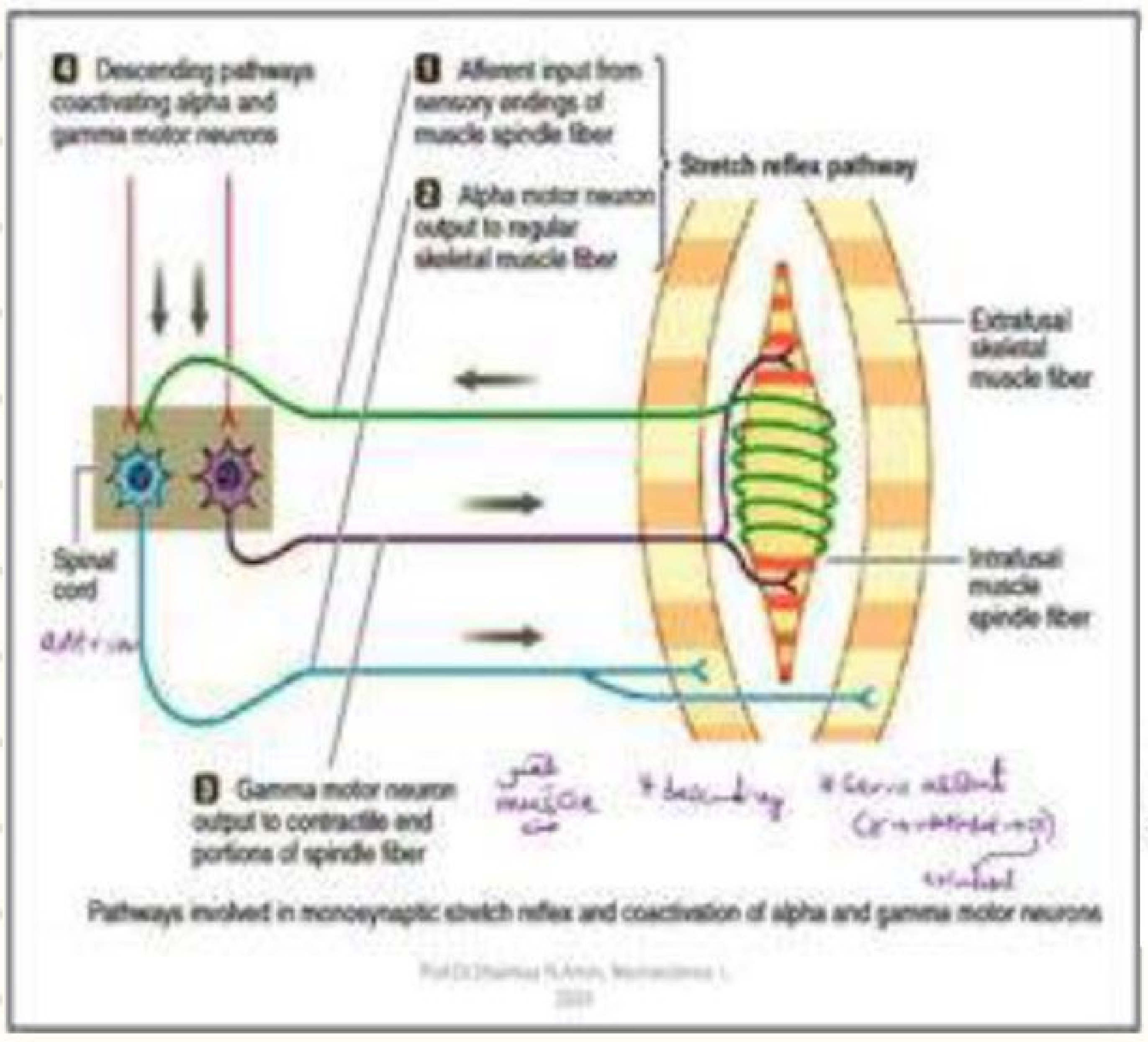


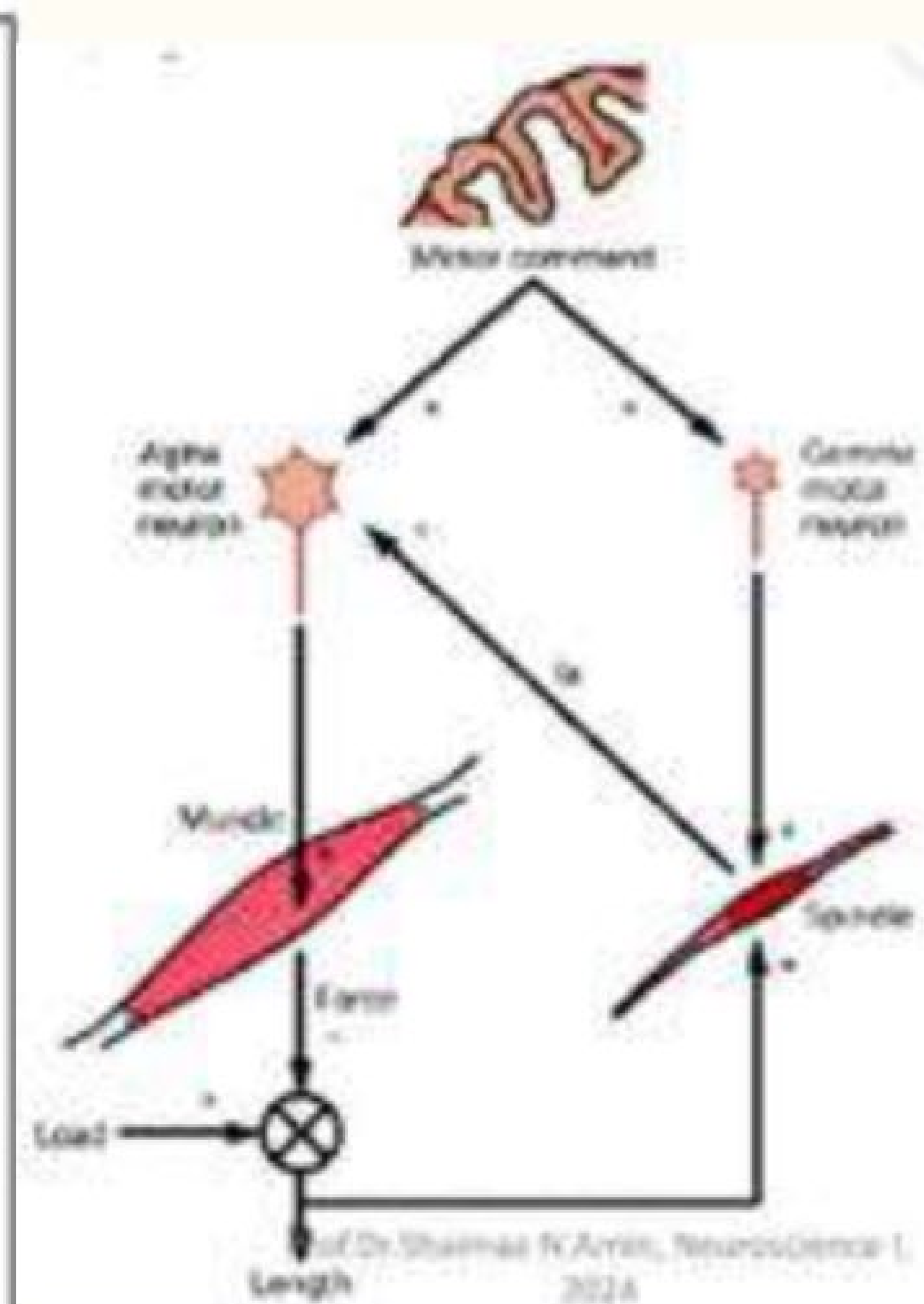
FUNCTIONS OF THE STRETCH REFLEX

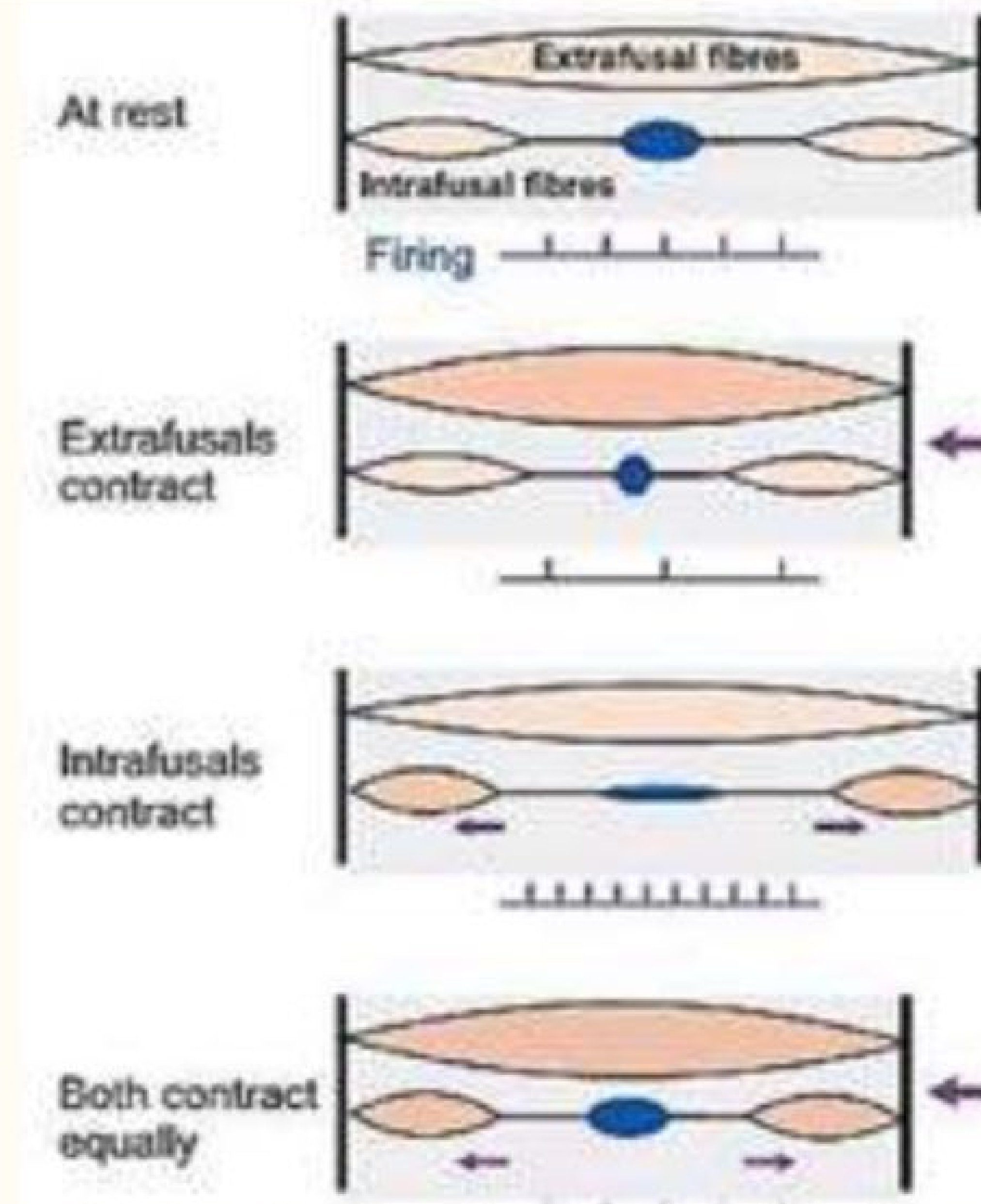
① Maintenance of the erect posture against the force of gravity: This occurs through producing a strong muscle tone in the antigravity muscles.

② Damping (smoothing) function: The signals discharged to a muscle usually have varying intensities, resulting in uncoordinated movements. However, the signals are adjusted through the alpha-gamma linkage to produce smooth movements (= signal averaging).

③ Increasing muscle contraction power: Due to the alpha-gamma linkage, both the extrafusal and intrafusal fibers contract when a muscle is stimulated. The intrafusal fibers elicit a stretch reflex by the gamma-spindle loop mechanism, which results in a more powerful contraction of the extrafusal fibers (= ***servo-assistant function***).







uncommon =

contract = alpha (+) = loop

THE SKELETAL MUSCLE TONE

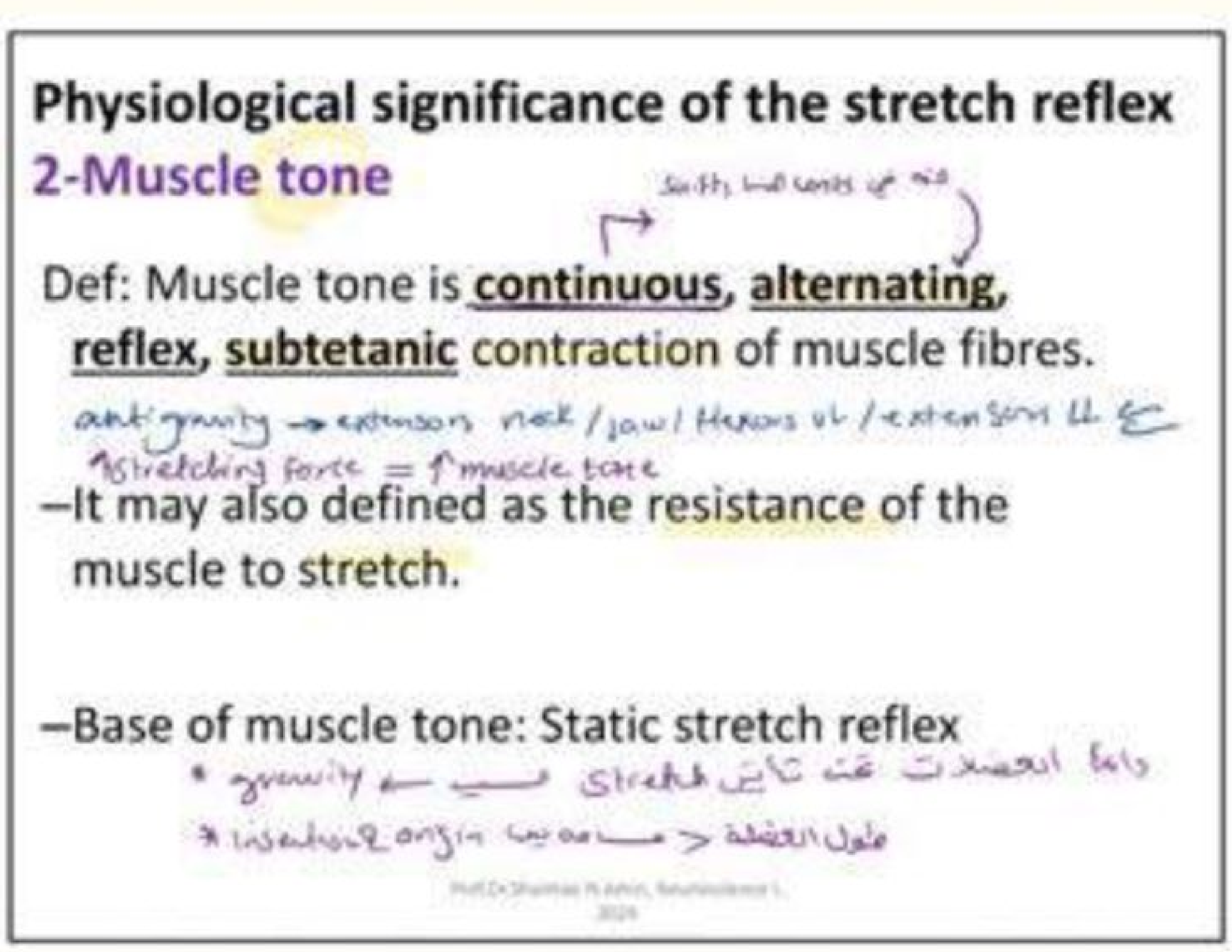
DEFINITION: The skeletal muscle tone is a state of continuous mild or partial (or subtetanic) contraction of skeletal muscles during rest.

MECHANISM: It is a static type of stretch reflex produced due to a continuous mild stretch of skeletal muscles during rest by the series of elastic elements present in the tendons.

DISTRIBUTION: It is present in all skeletal muscles but especially in the antigravity muscles (because they are subjected to more stretch by the force of gravity). These muscles include (1) Extensors of the lower limbs (2) Flexors of the upper limbs (3) The muscles of the back and back of the neck (4) The elevators of the lower jaw.

FUNCTIONS OF THE SKELETAL MUSCLE TONE

(I) It is essential for the maintenance of an erect posture.
(2) It helps both the venous and lymph return.
(3) The abdominal muscles' tone prevents visceral ptosis.
(4) It is an important source of heat production, so it is markedly increased on exposure to cold.



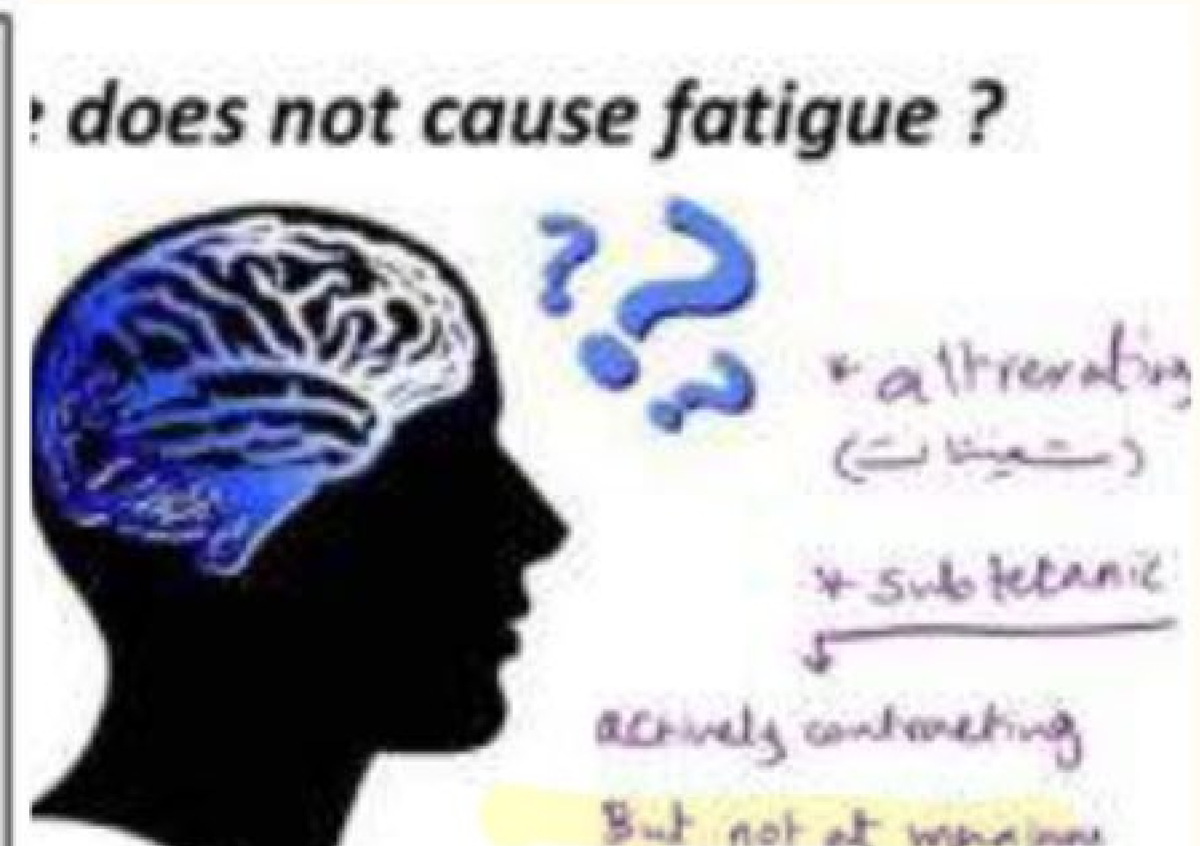
Physiological significance of the stretch reflex

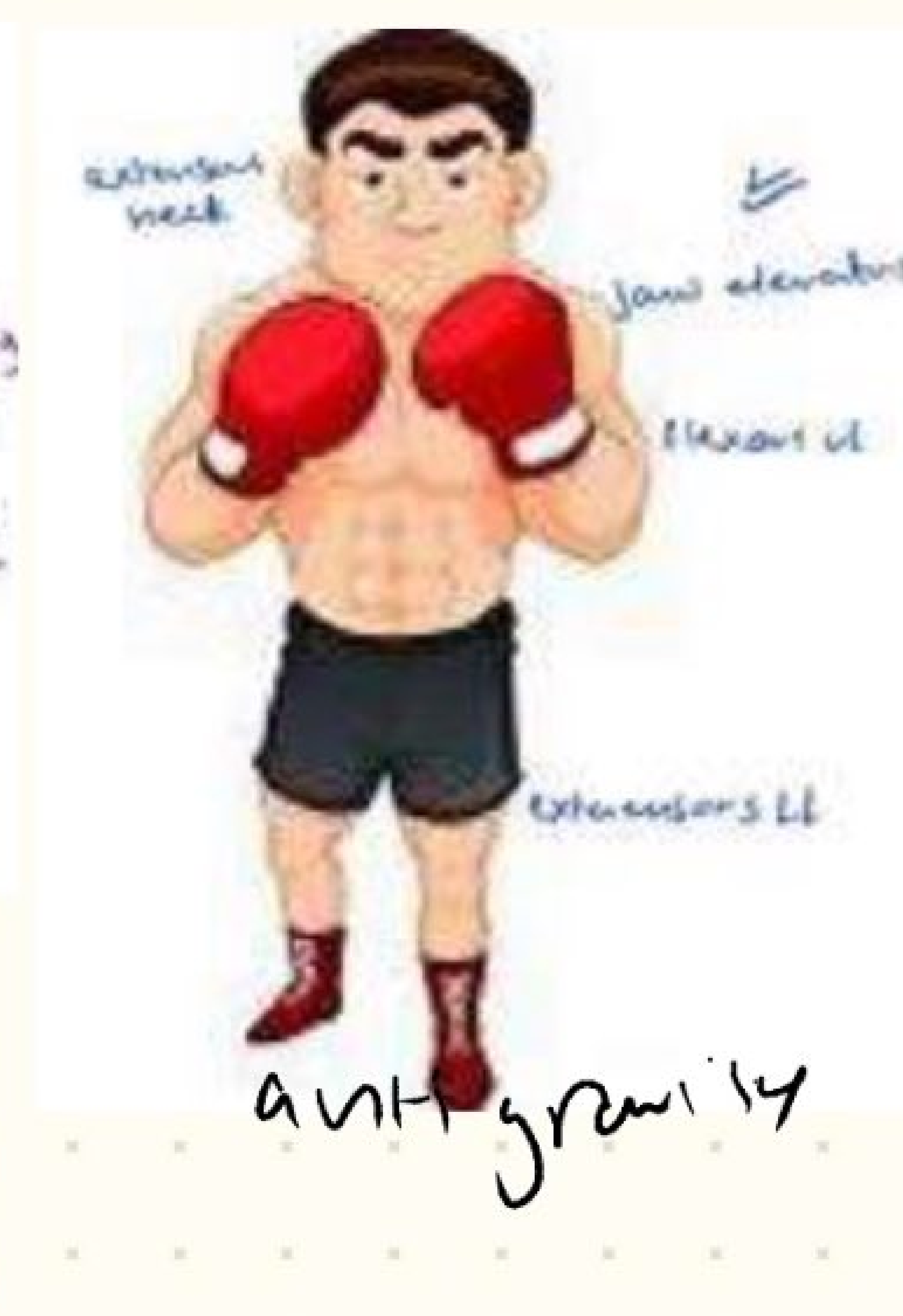
2-Muscle tone

Def: Muscle tone is **continuous**, **alternating**, **reflex**, **subtetanic** contraction of muscle fibres.

–It may also defined as the resistance of the muscle to stretch.

–Base of muscle tone: Static stretch reflex





FUNCTIONS OF THE GAMMA EFFERENT NERVES

Stimulation of these nerves leads to the stretch of the central parts of the muscle spindles, which increases the sensitivity of the muscles to stretch and may result in reflex muscle contraction.(↑ α)

CONTROL OF GAMMA EFFERENT DISCHARGE

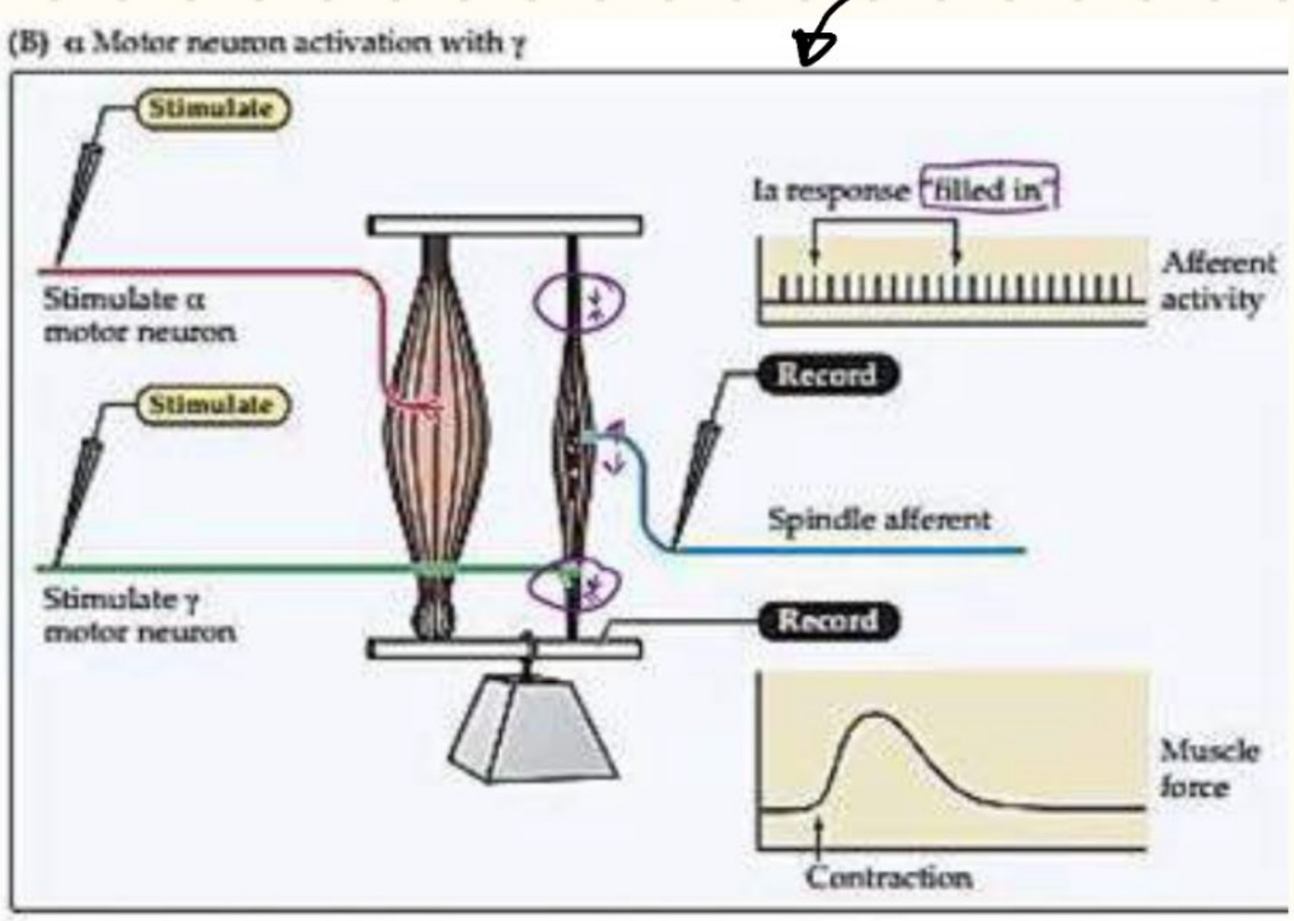
The gamma motor neurons are controlled by signals discharged from

(1) Certain supraspinal areas

(2) The skin: Noxious stimulation of the skin increases the gamma efferent discharge to the flexor muscles, which potentiates the withdrawal reflex.

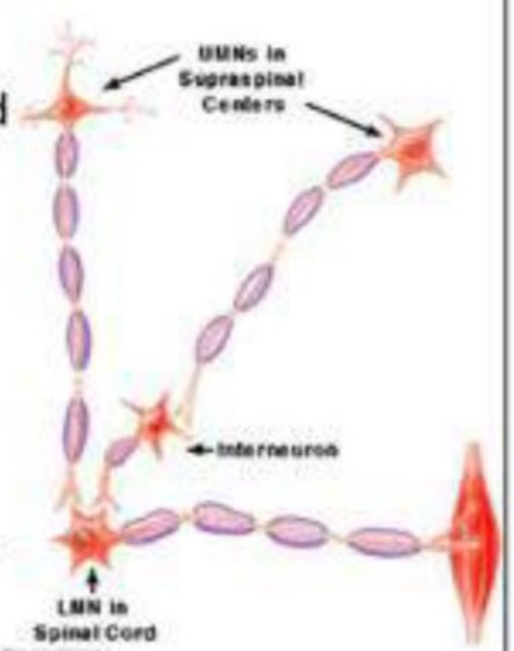
(3) The skeletal muscles: Signals from skeletal muscles also increase the gamma efferent discharge, as shown in the Jendrassik maneuver. (go back to slide 9)

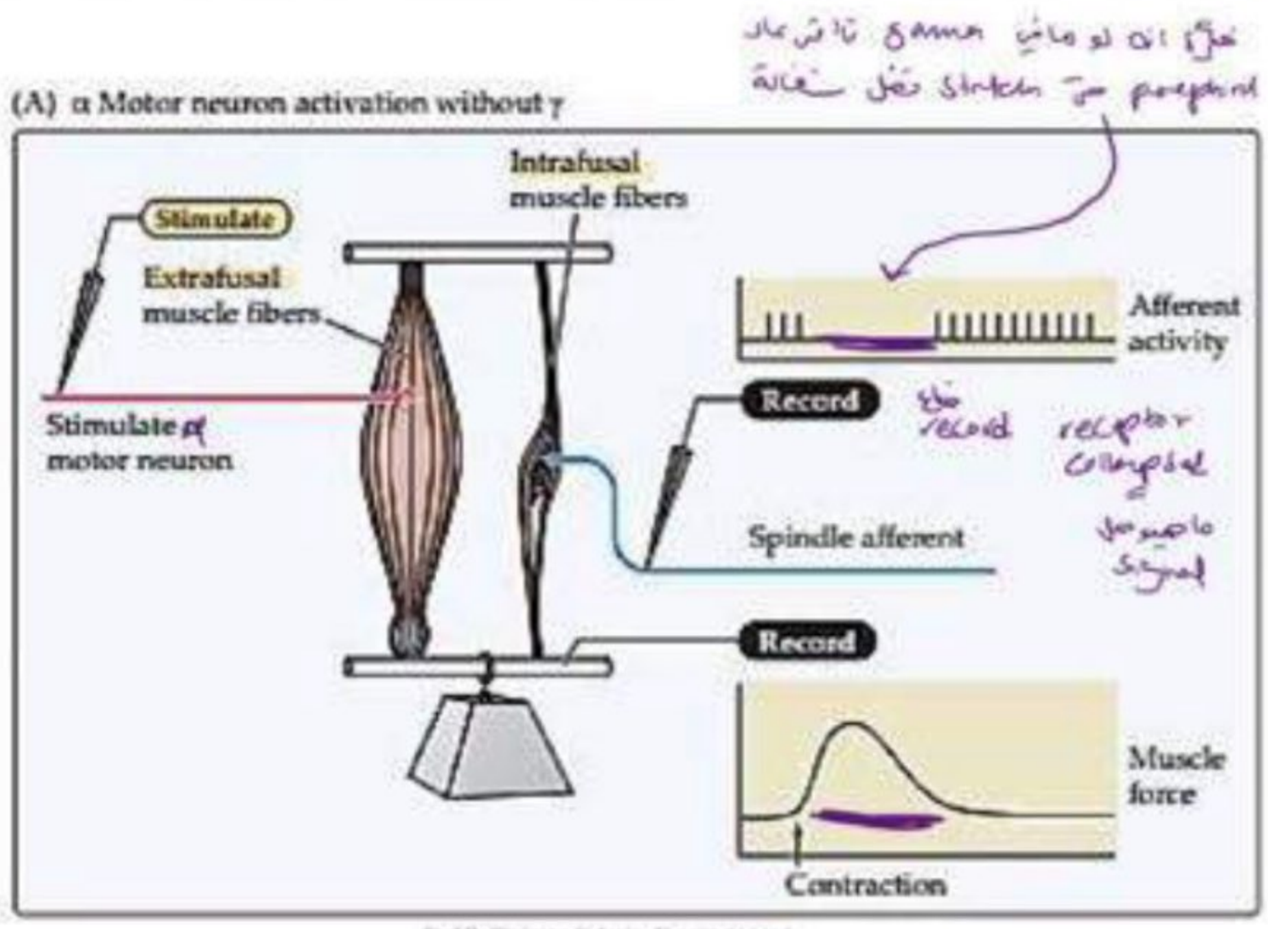
Alpha gamma linkage (or coactivation): Whenever the alpha motor neurons are activated (whether by supraspinal signals or by impulses discharged from skeletal muscles), the gamma motor neurons are activated simultaneously. The role of gamma efferent coactivation is to prevent relaxation of the muscle spindles during extrafusal muscle contraction and maintain them capable of adjusting the alpha motor neuron discharge throughout the movement.

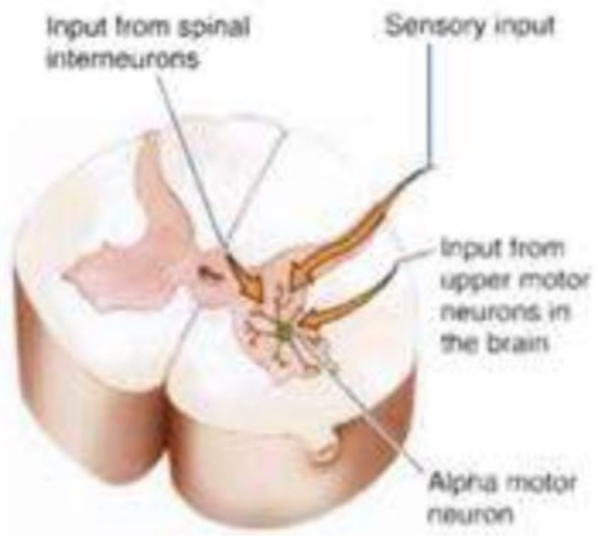


- Cells that carry signals from supraspinal centers to LMNs of the spinal cord are **the Upper Motor Neurons (UMNs)**.

-**UMNs** carry **motor commands** to the LMNs, which **execute them** by causing muscle contraction.

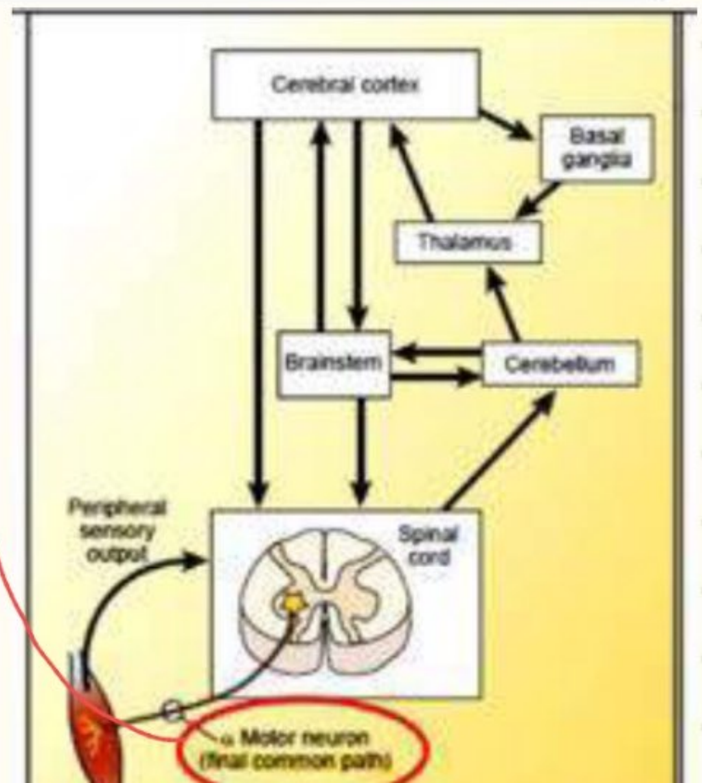






Alpha motor neuron and its three sources of input

Final common path : LMN lower motor neurons of spinal cord



اللَّهُمَّ صلِّ وسلِّم على نَبينا مُحمد

عدد ما ذكره الذاكرون وعدد ما غفل عن ذكره الغافلون.

HIGHER CONTROL OF THE STRETCH REFLEX

(A) SUPRASPINAL FACILITATORY AREAS

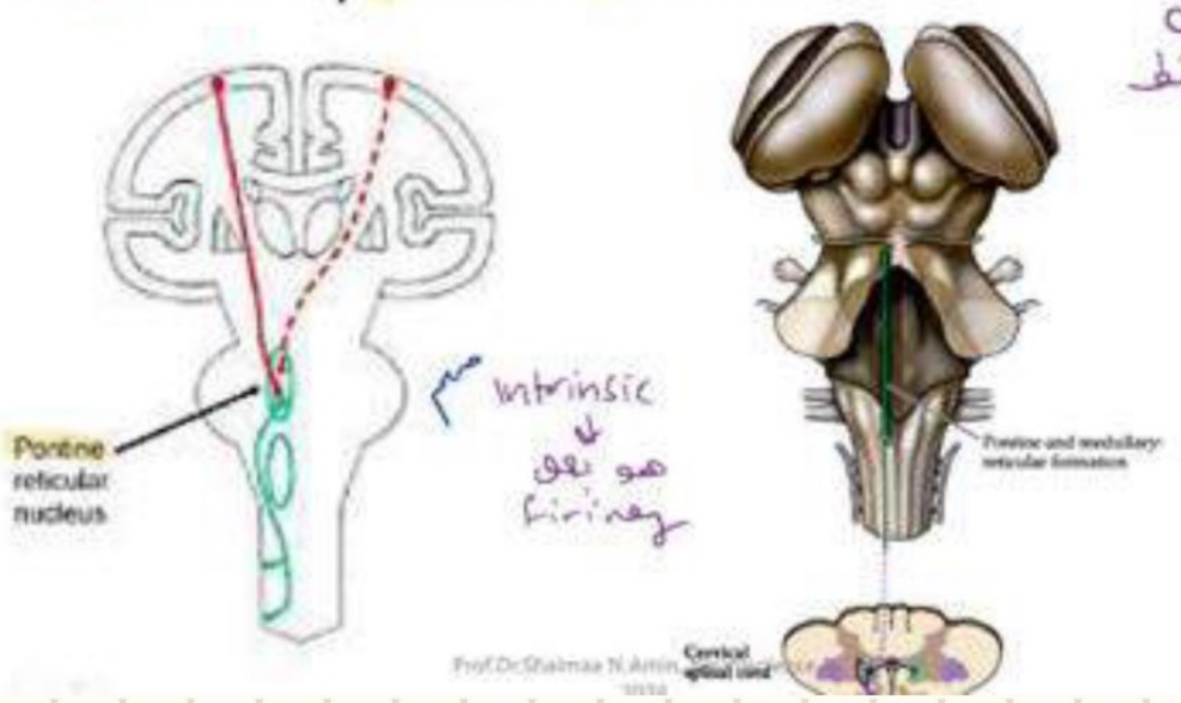
(1) The facilitatorv reticular formation: This is a wide active area that discharges spontaneously by intrinsic activity. It is present mainly in the pons, and its signals reach the spinal cord through the ventral reticulospinal tract. It facilitates the stretch reflex mainly by activating the gamma motor neurons, and almost all other facilitatorv areas stimulate it.

(2)The primary cortical motor area (area 4): This discharges facilitatory signals to the alpha motor neurons through the corticospinal tract.

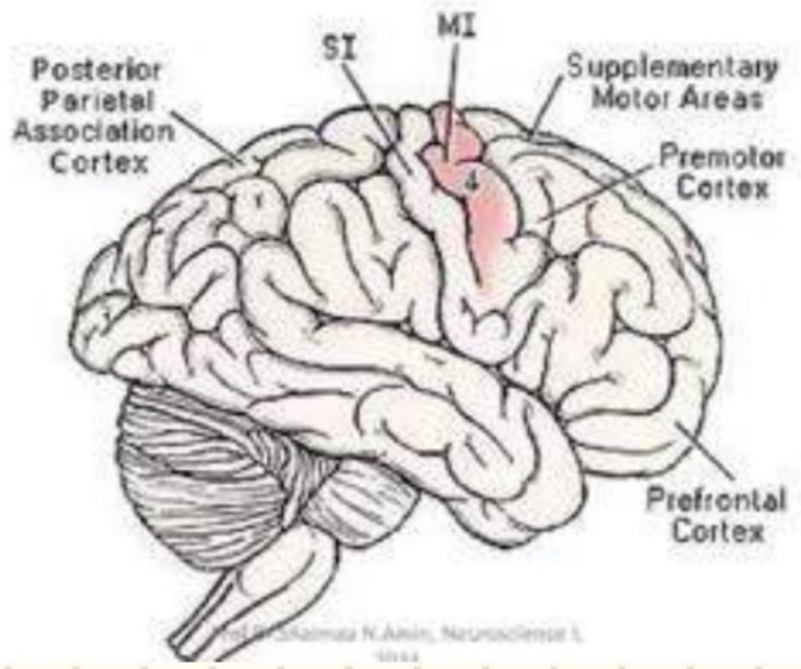
(3)The vestibular and inferior olivary nuclei: stimulate the facilitatory reticular formation and discharge direct facilitatory signals to the alpha motor neurons through the vestibulospinal and olivospinal tracts.

(4)The caudate nucleus and neocerebellum stimulate the Facilitatory reticular formation and the vestibular and inferior olivary nuclei.

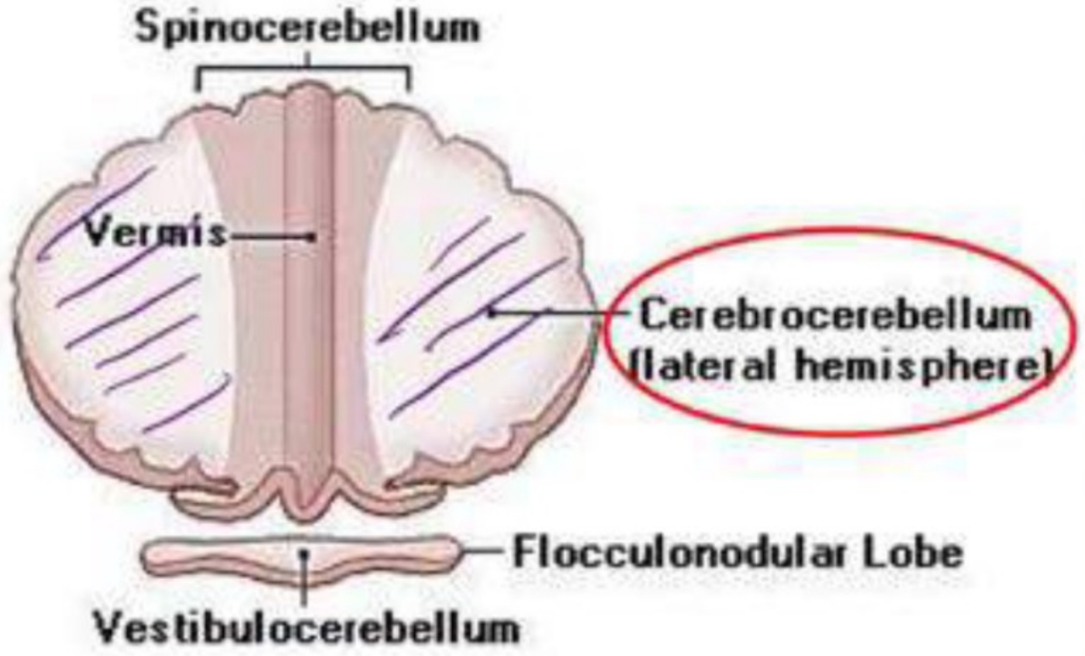
1-Facilitatory reticular formation



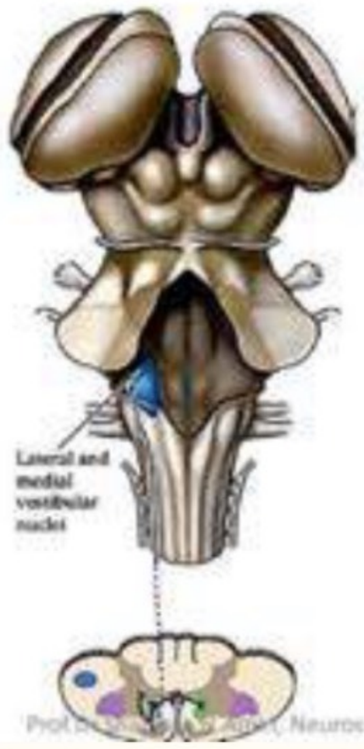
2-Primary motor area 4



3-Neocerebellum



4-The lateral Vestibular nucleus



(B)SUPRASPWAL INHIBITORY AREAS

(1)The inhibitory reticular formation: A small inactive area (i.e., no intrinsic activity) is present mainly in the medulla oblongata. Signals from the other inhibitorv areas activate it, and its signals reach the spinal cord through the lateral reticulospinal tract, where they inhibit mainly the gamma motor neurons.

(2)Certain cortical areas: These include mainly the premotor area (= area 6) and area 4 S (= main cortical suppressor area). These areas activate the inhibitory reticular lòrmation both directly and by stimulating the lenticular nucleus of the basal ganglia (see below).

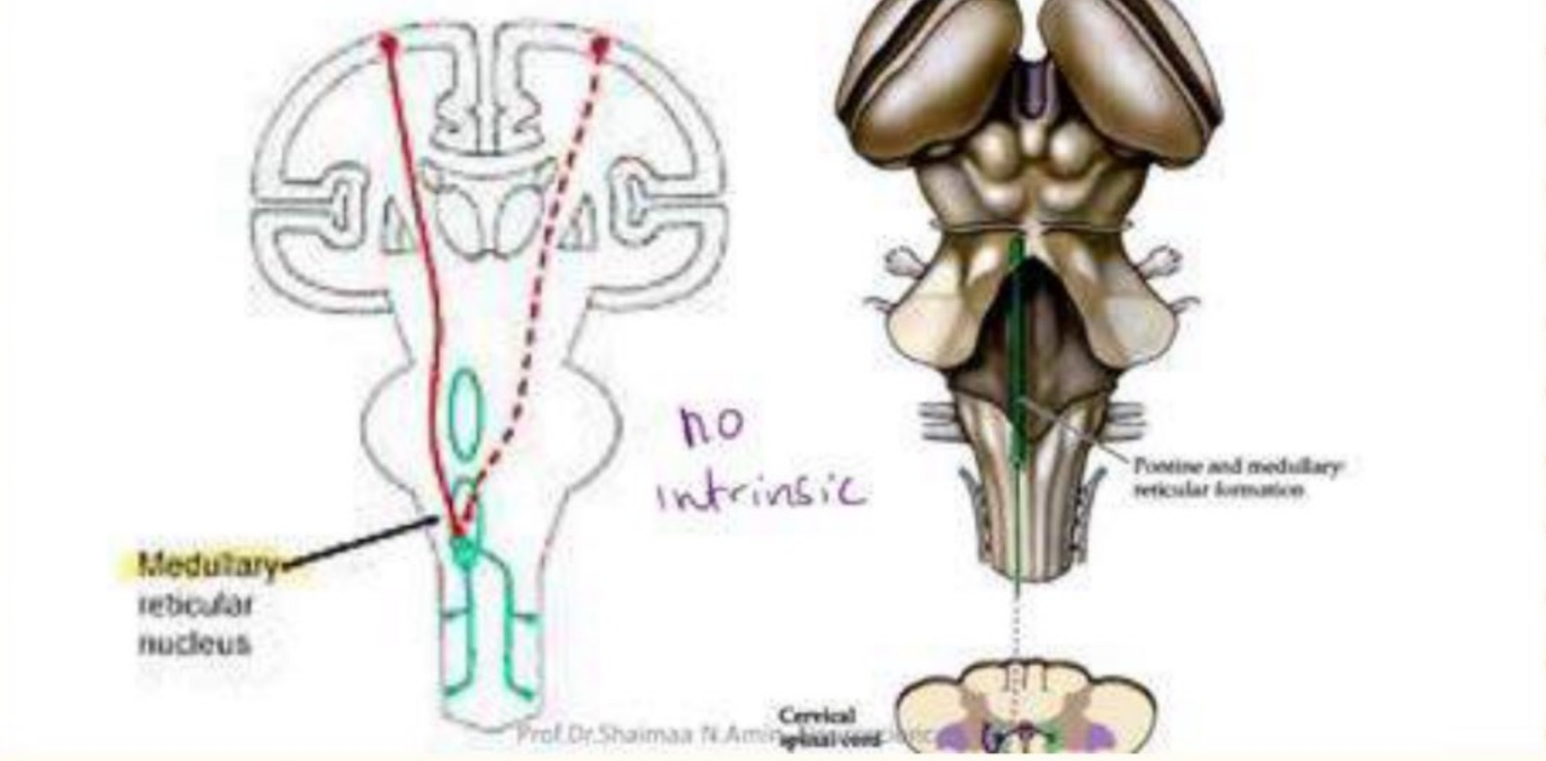
(3)The red nucleus (in the midbrain): This nucleus discharges inhibitory signals to the alpha motor neurons through the rubrospinal tract.

(4)The lenticular (or lentiform) nucleus and paleocerebellum: These activate the inhibitory reticular formation and inhibit the vestibular nucleus.

The main facilitatory tracts are the ventral reticulospinal, the vestibulospinal, and the corticospinal tracts, while the main inhibitory tracts are the lateral reticulospinal and the rubrospinal tracts. The reticulospinal tracts terminate at the gamma motor neurons, while the other tracts terminate at the alpha motor neurons.

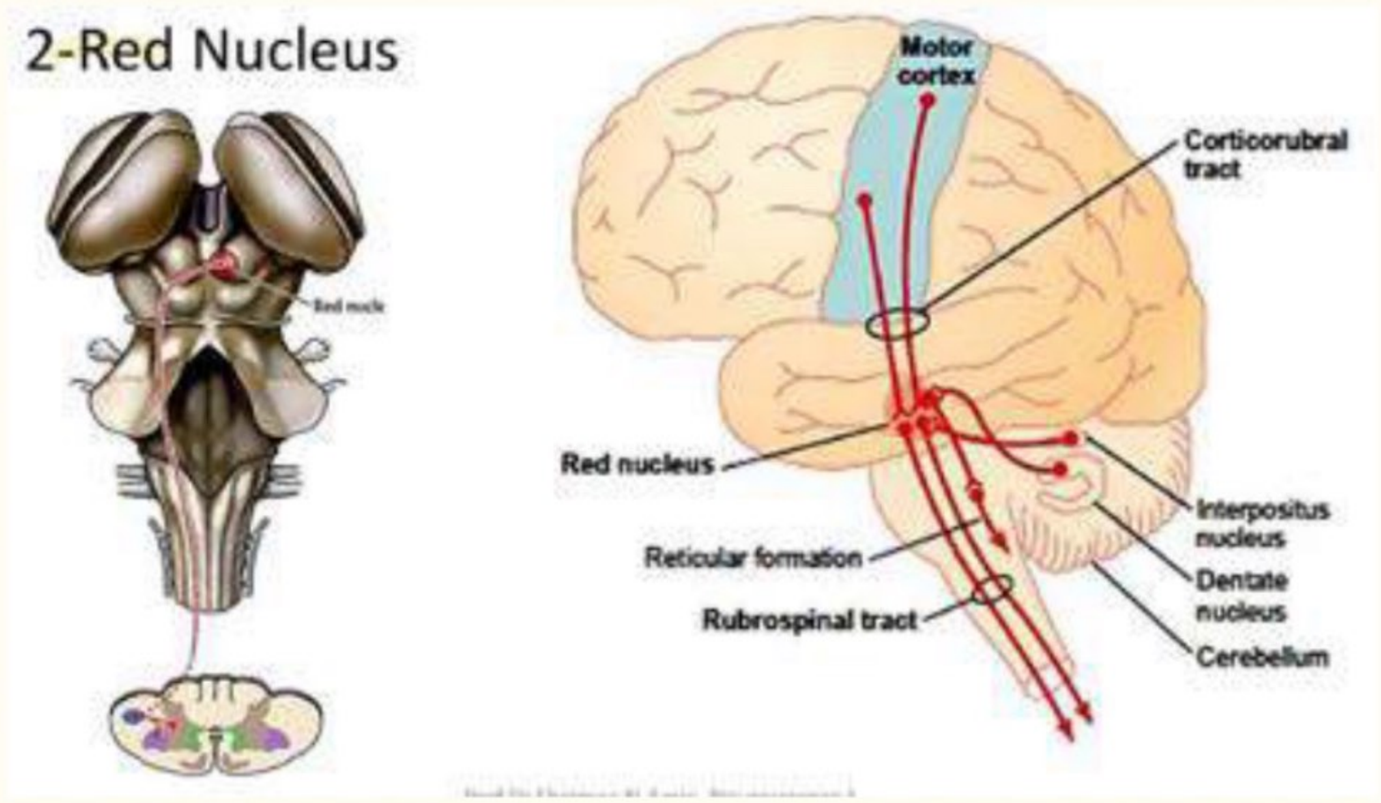
X cortical
facilitating ↑ = X inhibiting = VMNL ← inhibition of cortical

1-Inhibitory reticular formation

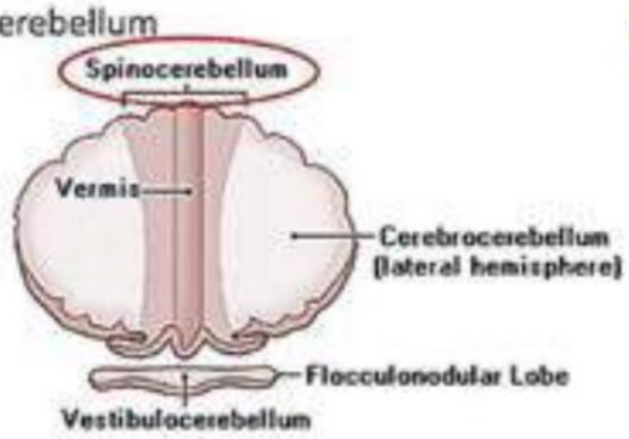


no intrinsic

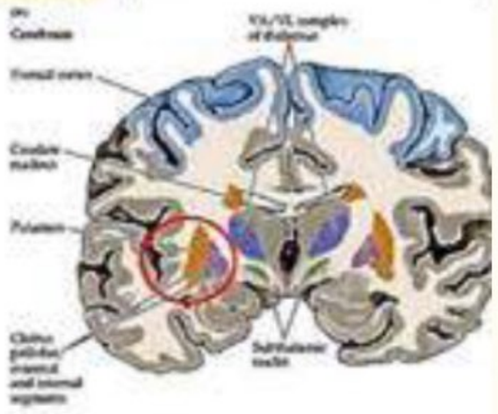
2-Red Nucleus



3-Paleocerebellum



4-Basal ganglia (lentiform neucleus)



5-Cortical suppressor area (4S)

تقارن

FRF	IRF
intrinsic	inactive
⊕	⊖
pons	medulla
Ventral spinothalmic	lateral spinothalmic

gamma motor neurons

THE GOLGI TENDON ORGANS (GTOs)

These are the receptors present in the tendons of skeletal muscles. Each GTO consists of a netlike collection of knobby nerve endings that give rise to thick myelinated type 1b afferent nerve fibers (A type of A alpha fibers).

The GTOs are tension receptors (i.e., they detect muscle tension), and they are stimulated by both passive stretch and active contraction of skeletal muscles. They are slowly adapting and are not under nervous control because they do not receive efferent nerve supply.

Effect of stimulation of the GTOs:

Signals from the GTOs excite inhibitory interneurons called Golgi bottle neurons which produce IPSPs at both the alpha and gamma motor neurons. Therefore, such Golgi tendon reflex is disynaptic and leads to relaxation of the muscle from which it originates.

The main function of the GTOs is the maintenance of constant muscle **tension** by a negative feedback mechanism (i.e., if the muscle tension increases. the GTOs are stimulated, resulting in muscle relaxation and reduction of its tension, and vice versa).

The inverse stretch reflex (autogenic inhibition): This is the reflex relaxation of a muscle in response to excessive stretch. It is an inhibitory reflex that occurs if the muscle tension markedly increases. It is initiated by the excitation of the GTOs and is a protective reaction against the tearing of the muscle or avulsion.

The lengthening reaction (= clasp knife effect)

This reaction is obtained in spastic (or hypertonic) muscles, e.g., in upper motor neuron lesions. It is demonstrated by flexion of a patient's limb at its main joint by means of the examiner e.g., the lower limb at the knee joint. The reaction consists of muscle contraction upon moderate stretch of the quadriceps muscle followed by sudden muscle relaxation upon overstretch, and it occurs as follows: As the limb is flexed, the quadriceps femoris muscle is lengthened (so it is called the lengthening reaction), and resistance is encountered due to contraction of this muscle as a result of the stretch reflex. However, with sustained flexion, the inverse stretch reflex is initiated, so the initial resistance suddenly disappears, and the limb gives up and flexes easily, as occurs during closing a pocket knife (so it is also called the clasp knife effect).

** When the examiner tries to extend the limb after its flexion, he will also initially find resistance, then the limb suddenly gives up and extends easily. This is due to a sequence of stretch and inverse stretch reflexes in the hamstring (flexor) muscles. This effect is sometimes called the shortening reaction (referring to the shortening of the extensor muscles).

	STRETCH REFLEX	INVERSE STRETCH REFLEX
synapses	Monosynaptic	Disynaptic
Receptor	spindles	Golgi tendon organs
Stimulus	Muscle stretch (increased muscle length)	Excessive muscle stretch (increased muscle tension)
Effect	Muscle contraction	Muscle relaxation
Function	Maintenance of erect posture and smoothing movements	It prevents the tearing of tendons during strong muscle contraction

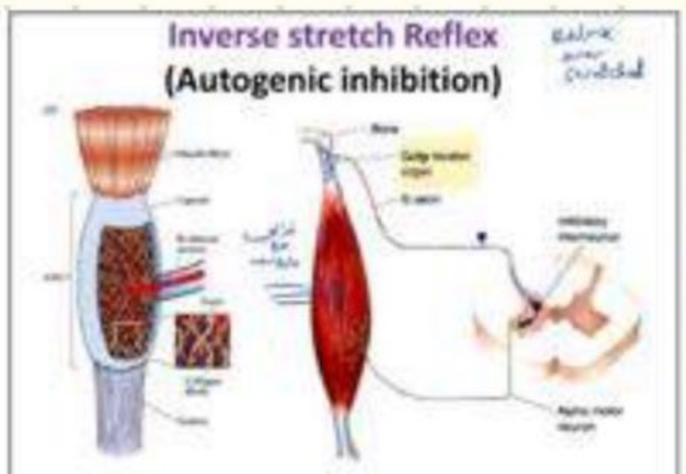


Table 36-1 Classification of Sensory Fibers from Mus

Type	Receptor	Axon	
Ia	Primary spindle endings	12-20 μm myelinated	Muscle length and rate of change of
Ib	Golgi tendon organs	12-20 μm myelinated	Muscle tension
II	Secondary spindle endings	6-12 μm myelinated	Muscle length (little rate sensitivity)
II	Nonspindle endings	6-12 μm myelinated	Deep pressure
III	Free nerve endings	2-6 μm myelinated	Pain, chemical stimuli, and temperat exercise)
IV	Free nerve endings	0.5-2 μm nonmyelinated	Pain, chemical stimuli, and temperat

THE TENDON JERKS (TENDON REFLEXES)

A tendon jerk is the response of a skeletal muscle to a sudden stretch produced by tapping its tendon sharply and strongly with a medical hammer. It is a dynamic type of stretch reflex, and it consists of rapid muscle contraction followed by rapid relaxation.

CLONUS

This is alternating rhythmic contractions and relaxations of a muscle in response to sudden maintained stretch. It occurs when the spinal motor neurons are facilitated (particularly in upper motor neuron lesions), which can be demonstrated at both the knee and ankle.

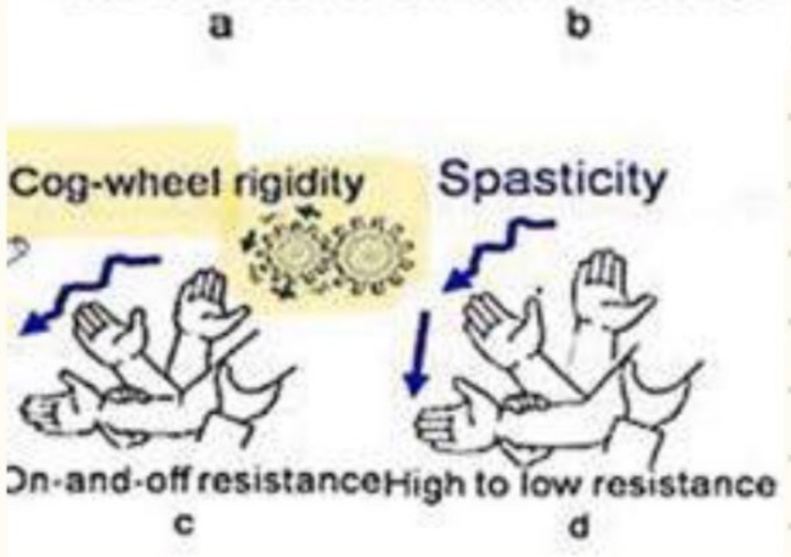
GAMMA RIGIDITY AND ALPHA RIGIDITY

	Gamma rigidity (Spasticity)	Alpha rigidity
Cause	Increased gamma discharge	Increased alpha discharge
Muscles affected	Antigravity muscles	All muscles
Resistance to movement	Uni-directional	Bi-directional
Type of rigidity	Clasp -knife	Lead- Pipe or cogwheel
Effect of velocity	Increases with velocity	Not velocity-dependent
Tendon jerks	Exaggerated and clonus may also be present	Not necessarily exaggerated
Common diseases	Upper motor neuron lesion	Parkinsonism

عكس clasp knife لايوجد sudden release بتقل resistant (tremor cont.) مع smooth

CLONUS
This is alternating rhythmic contractions and relaxations of a muscle in response to sudden maintained stretch.

UMNL = ↑ facilitatory ⇒ stretch maintained → stretch & inverse stretch
= ↑ tension
cycles + cont. stretch



The Polysynaptic Reflexes: They include the following reflexes:

(1)The plantar reflex: Scratching the outer (lateral) edge of the sole by a blunt object (e.g. a key) causes plantar flexion of all toes in normal awake adults and infants more than one year of age. Such response is changed in many conditions into the Babinski's sign, and its centre lies in L5, Sl, and S2 segments of the spinal cord.

(2)The abdominal reflexes Striking the abdominal skin lightly (e.g. by a pin) leads to contraction of the underlying muscles, as indicated by the movement of the umbilicus. They are a type of withdrawal reflex (see below), and their centres lie in the 7th to the 12th thoracic segments of the spinal cord (depending on the stimulation site).

(3)The cremasteric reflex: Striking the skin at the medial side of the upper part of the thigh in males causes contraction of the cremasteric muscle and upward retraction of the testis on the same side. It is a type of withdrawal reflex, and its centre lies in the spinal cord's first and second lumbar segments.

(4)The withdrawal (flexor) reflex: This is a protective, powerful reflex (because it inhibits other reflexes occurring at the same time). Noxious stimulation of the skin (e.g. at a limb) leads to contraction of the flexor muscles of that limb and its withdrawal away from the stimulus.

(5)The crossed extensor reflex This is the reflex extension of a limb during flexion of the other limb due to a withdrawal reflex. It occurs with strong noxious stimuli and is supportive in function. → postural reflex

(6)The positive supporting reflex (reaction): Applying pressure to the sole (e.g. the pressure exerted by the body weight during standing) leads to contraction of both the flexor and extensor muscles of the lower limbs. It is the only reflex that does not obey the principle of reciprocal innervation. Its center extends from the first lumbar segment to the first sacral segment of the spinal cord, and during standing, it renders the lower limbs to act as 2 solid pillars that support the body against gravity.

(7)The scratch reflex: This is initiated by the sensation of itching, particularly caused by multiple tactile stimuli (e.g. the reflex initiated by a crawling insect). It can also be produced experimentally by stimulating the skin with a weak faradic current, and it results in rhythmic scratching movements to remove the irritant stimulus (and sometimes the production of pain, which also relieves the effect of the irritant stimulus).