

# Stretch Reflex and Tendon jerks

# Objectives:

- ❖ . Describe the components of stretch reflex and its function.
- ❖ . Describe the structure , innervations and function of the muscle spindle.
- ❖ . Explain the roles of alpha and gamma motor neurons in the stretch reflex.
- ❖ . Describe and explain muscle tone.
- ❖ . Discuss the spinal and supraspinal regulation of stretch reflex.
- ❖ . Describe the inverse stretch reflex and its function.
- ❖ . Differentiate between primary and secondary afferent fibres of muscle spindle.
- ❖ . Describe the components of the inverse stretch reflex (golgi - tendon reflex)and its function.

As males doctor said: **Dr.faten** will write the questions for mid-exam

سو يانبهيين هل بتسحبون عالكلام الوردى والنوت الأصفر ؟

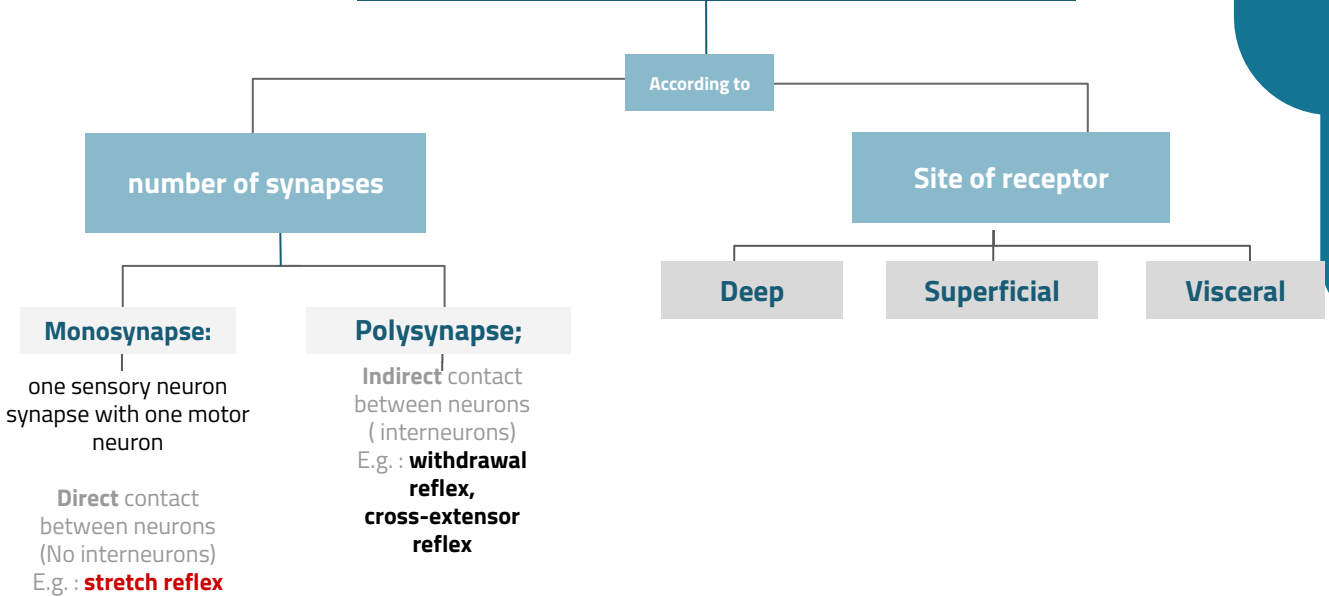
## Color index:

- ❖ Important.
- ❖ Girls slide only.
- ❖ Boys slide only.
- ❖ Dr's note.
- ❖ Extra information.



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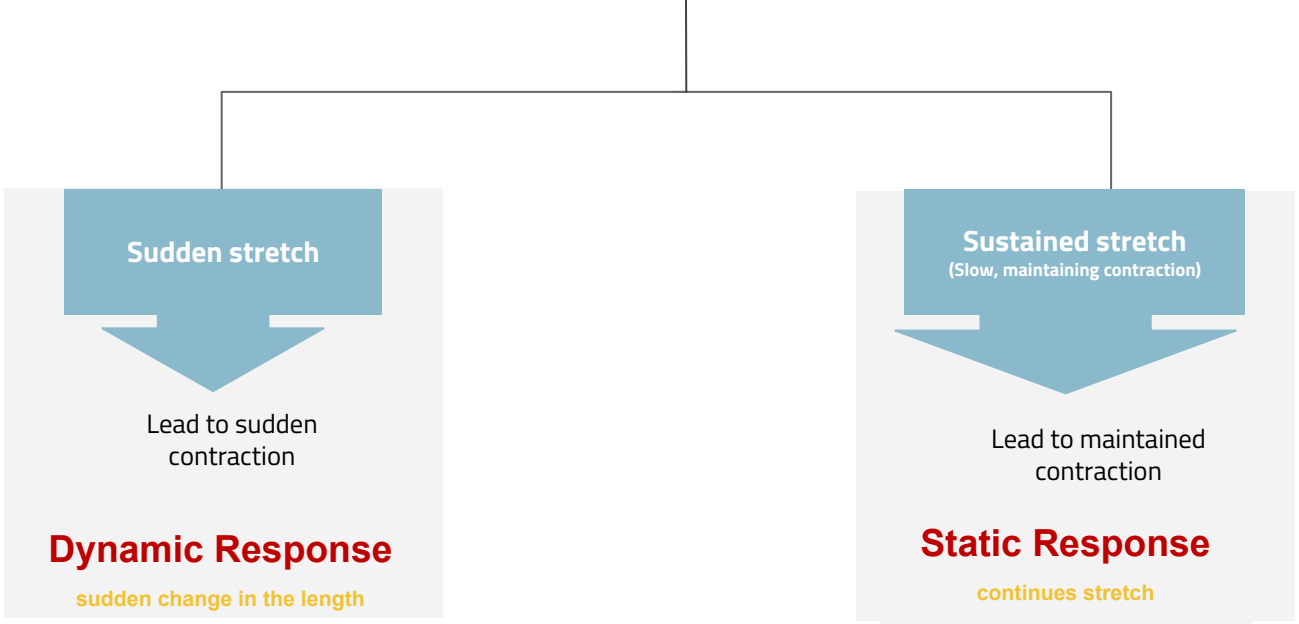
# Classification Spinal cord reflexes



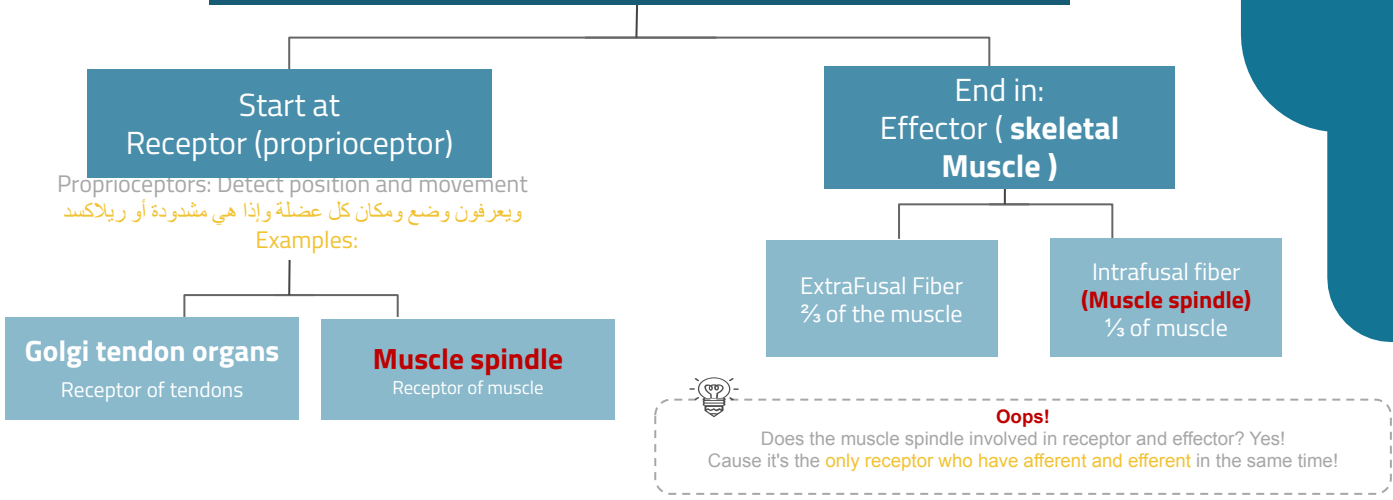
When a **skeletal muscle** is **stretched**, it **contracts**. This response is called the **stretch reflex** or myotatic reflex. ;It results from stimulation of the muscle spindle by stretching the whole muscle  
Its **monosynaptic** and **Deep** reflex

Vaule: Aids in maintaining posture, avoid muscle rupture

## Stretch Reflex (Myotatic Reflex)



# Where the Reflex start and end?



## Muscle spindle

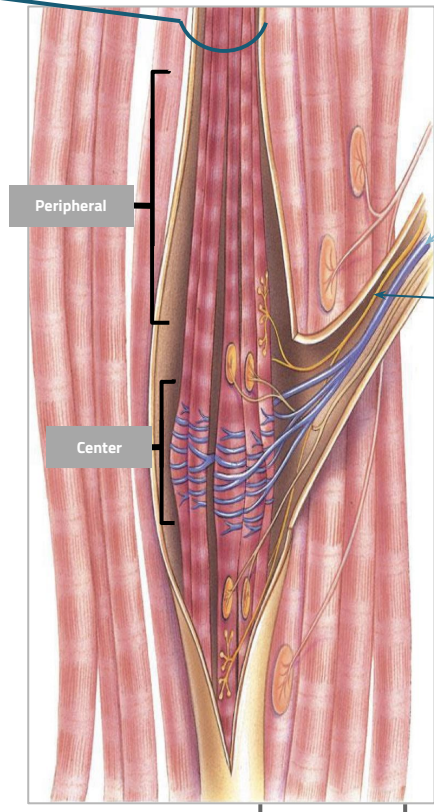
### Muscle spindle: Intrafusal fibers.

- 1-the receptor located inside muscle & detects changes in muscle length (its the sensory receptor)
2. consist of 3-12 small muscle fibers (intrafusal fibers) within the CT capsule.
- 3-each intrafusal fiber has:
  - central non-contractile** area (receptor)
  - peripheral contractile** area
 on each side of central zone, it has actin & myosin.
4. There are two types of **intrafusal fibers**:

1-Nuclear **bag** fibers (2/spindle)\*  
Central area is dilated with group (bag) of nuclei.

Nuclei  
تكون متجمعة في الوسط

2-Nuclear **chain** fibers (4+/spindle)  
One line of nuclei in a chain in the receptor zone



Extrafusal fibers. Note that its Not a part of muscle spindle

### Overview of innervation (Afferent, efferent)

1	Primary (Ia) aka: <b>annulospiral</b> The purple one.	2 types of <b>Afferent</b> nerves:
2	Secondary (II) aka: <b>flower spray*</b> The orange one.	

The difference between these two afferent is related to the two types of intrafusal fibers, how?

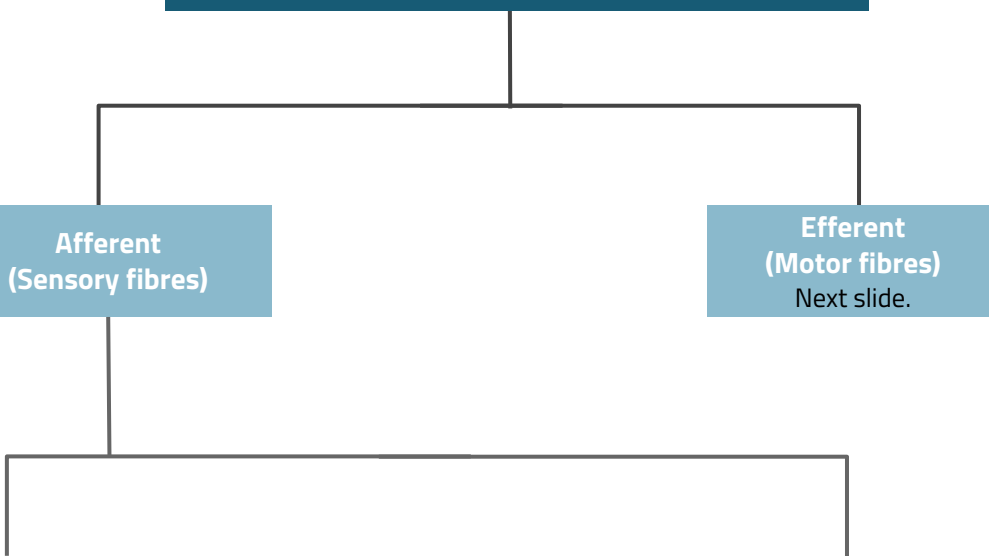
Primary afferent will carry sensation from  
1-Nuclear **bag** fibers  
2-Nuclear **chain** fibers  
whereas the secondary afferent will carry information from:  
1-Nuclear **chain** muscle **-only-**

**Names of afferent is important**

<b>Gamma</b> 1-Plate endings 2-Trial ending	Intrafusal	Efferent Motor
<b>Alpha</b> Alpha motor neurons synapse with the afferent sensory neurones in the spinal cord ( secrete glutamate)	Extrafusal	

Where is the Integrating center?  
(spinal cord) AHC  
What is the Effect?  
Muscle contraction & Reciprocal Inhibition of antagonist

## Innervation of the muscle spindle



### 1- Primary (annulospiral) Ia

- **Fast**, transmits sensory signals to the spinal cord at a velocity of 70 - 120 m/sec
- encircle receptor areas of **nuclear bag fibers** mainly, but also nuclear chain fibres
  - 17 micrometers diameter
- Discharge most rapidly if the muscle is suddenly stretched (**dynamic response**) & less rapidly (or not) during sustained stretch (static response)
- Measure the rate & or velocity of change in muscle length of nuclear bag fibres

### 2- Secondary (flower spray) II

- innervate the receptor area of the nuclear chain fibres ONLY
- 8 micrometers in diameter
- Discharge throughout the period of muscle stretch, (sustained stretch) measure mainly muscle length (**static response**)
- **directly proportional to the degree of stretch**

### N.B: important

	Supplied by Which afferent	Responsible for
Nuclear bag Fibres	<b>primary</b> endings only	the <b>dynamic response</b>
Nuclear chain fibres	both <b>primary</b> and <b>secondary</b> endings	the <b>static response</b>

## Innervation of the muscle spindle

### Afferent (Sensory fibres)

Previous slide

### Efferent (Motor fibres)

Gamma ( $\gamma$ ) efferent endings terminate on the peripheral contractile parts of the intrafusal muscle fibres

#### 1-Plate endings

End mainly on the nuclear **bag** fibres called (dynamic gamma efferent)

Dynamic? وش دخل

Because it's found in nuclear **bag** fiber  
Which have which type of afferent?

**Primary**

Primary is responsible for which response?

**DYNAMIC !**

شغيفنا نهاوش؟

**Basis of tendon jerk (knee, biceps, triceps)**

**Role of Dynamic gamma efferent (plate endings):**

-Tapping the tendon, stretch the muscle, so it contracts and shorten, nuclear bag fibres relax during muscle contraction, its sensitivity to stretch decreases  
تحسن بالشدة والان ارتخت أكيد ينقل بالعقل

-Plate gamma endings which end mainly on the nuclear bag fibres periphery, enhances the dynamic response<sup>1</sup>

#### 2-Trail endings

end mainly on nuclear chain fibres called ( static gamma efferent)

static? وش دخل

Because it's found in nuclear **chain** fiber  
Which have which type of afferent?

**Secondary** mainly.

Secondary is responsible for which response?

**Static**

معد هاوشنا

**The function of the  $\gamma$  motoneurons (either static or dynamic) is to regulate the sensitivity of the intrafusal muscle fibres.**

-Activation of  $\gamma$  motoneurons will cause contraction of peripheral parts of the muscle spindle which increase muscle spindle sensitivity to stretch.

- When  $\gamma$ -d (D donated to dynamic) fibers excite the nuclear **bag** fibers, the dynamic response of the muscle spindle become enhanced.

- Conversely, stimulation of the  $\gamma$ -s (S donated to static) fibers, which excite the nuclear **chain** fibers enhances the static response.<sup>1</sup>

1

اذا عارفين ان السنتر ما ينقبض ايدا فلما ترسل  
motor efferent > peripheral

طيب وش الفائدة من الاطراف؟

اذا شدت الاطراف بيشتد الوسط بعد، زي الخيط شديه من الطرفين بيشتد اوسطه! واذا صار الوسط مشدود، واذا عارفين انه مليون من

Afferent sensory fibers

فكانه بيحسن عمل السنتر ويعصير يعلم الافرننت عن الشد اول باول

-المكان يحس بالشدة، فلزام تخليه على طول مشدود عشان يوصل المعلومات للباينل كورد-

reflex:يحسن ال

#### ❖ Alpha- gamma COACTIVATION: to avoid opposition

Signals from the motor cortex to the alpha motorneurons, mostly transmitted to the gamma motorneurons simultaneously, an effect called coactivation.

it's the maximum stimulation

#### ❖ The purpose of Coactivation:

First, it keeps the length of the receptor portion of the muscle constant.

Otherwise receptor portion of the spindle would sometimes be flail and sometimes be overstretched, causing unsmooth muscle contractions.

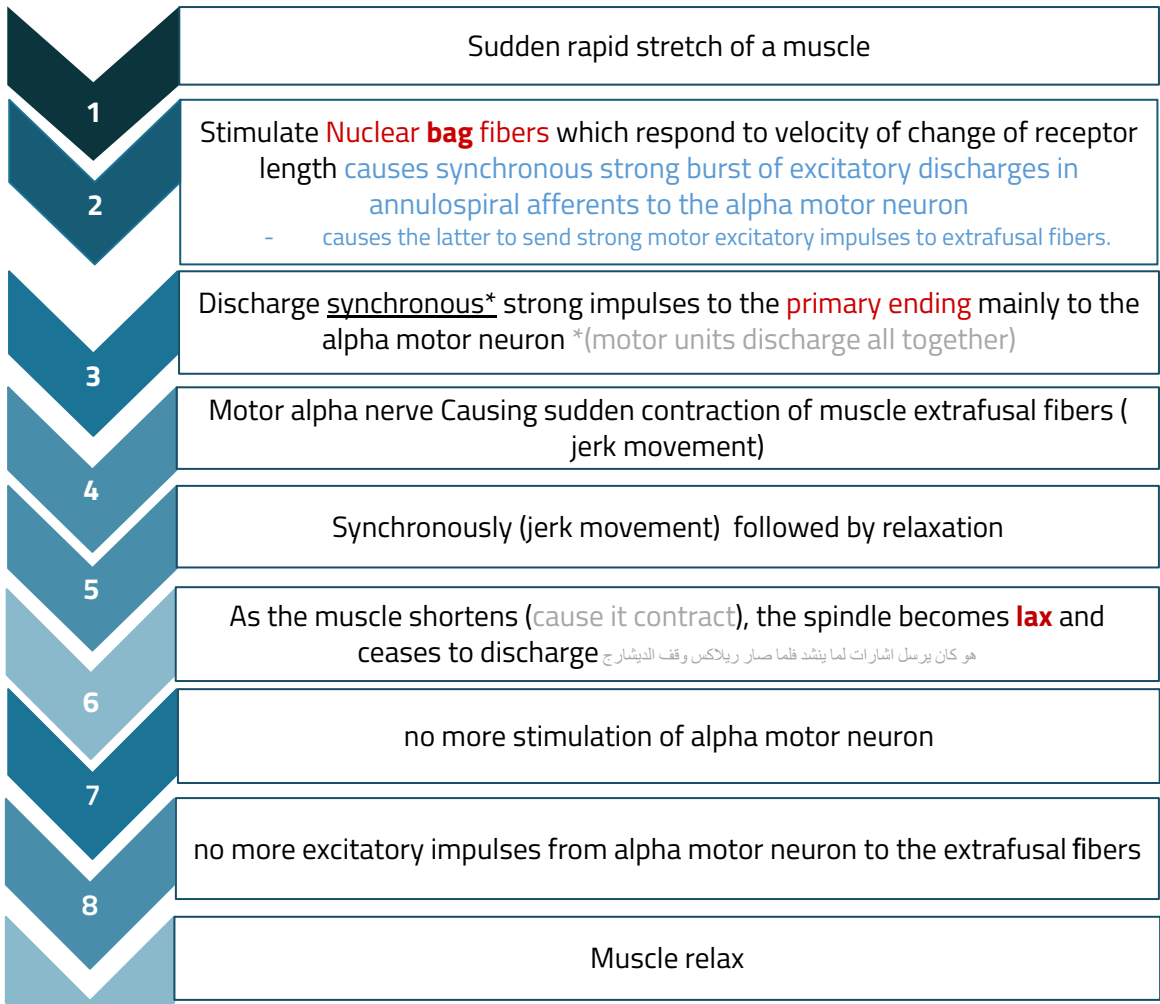
1- central of reception portion of the muscle constant.

2- Oppose sudden changes in muscle length.



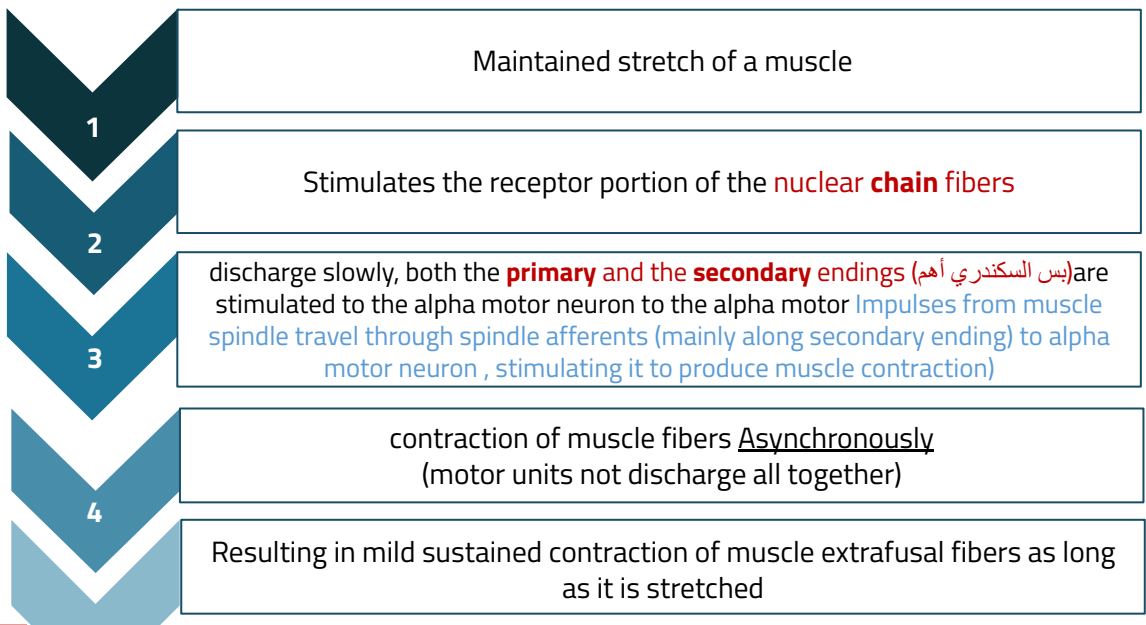
# Dynamic stretch reflex ( dynamic or phasic Response )

**Sudden stretch**  
 sudden contraction This is the basis of Tendon Jerks ( dynamic stretch reflexes )



# Static stretch reflex ( static Response )

**Sustained stretch**  
 Sustained/maintained contraction



## Application of Static stretch reflex: Muscle tone

### Definition

the stimulus for muscle tone is sustained Stretch of skeletal muscle between origin and insertion / resistance of muscle to stretch./a state of continuous partial contraction of skeletal ms during rest.

### In which muscle

all skeletal ms but specially in the **antigravity muscle** (extensors of LL, back, neck, flexor of UL, muscle of abdominal wall and elevator of mandible).

### Abnormalities

**-if lost by low gamma efferent discharge to muscle:**

hypotonic muscle or flaccidity.

**-if increased by high gamma efferent discharge to muscle:**

hypertonic muscle , spastic muscle.



Gamma is **عَبْدُ مَأْمُور**

Because signals to gamma come from the brain, so brain abnormalities cause gamma overstimulated (hypertonic)  
Or down stimulated (hypotonic).

To be more specific, signals comes from brain we mean **supraspinal** signals

So, the muscle tone is important cuz it can indicate the brainstem disease.

## Basis of muscle tone

❖ The Static Stretch Reflex is the basis of muscle tone, which is defined clinically as resistance to muscle stretch.

❖ Static gamma efferent (trail endings): increase sensitivity of muscle spindle to steady maintained stretch & enhances the static response.

muscle tone helps to maintain the posture

## Value (function) of stretch reflex

They help maintain a normal posture

They function to oppose sudden changes in muscle length

Damping or smoothing of muscle contraction

Generation of muscle tone



# Damping (tone down) function of muscle spindle

بإختصار: لو كل إشارة من  
Brain+ Spinal cord > سببت contraction  
راح تكون الانقباضات غير منتظمة ويسبب  
jerk movement  
الريفكلس ينظمها من خلال انه مازيرسل جميع الاشارات لذلك  
damping(down)

Signals from Spinal cord transmitted to a muscle in an **Unsmooth** form ( increasing in intensity for a few milliseconds, then decreasing in intensity, then changing to another intensity level) **increase for few sec and decrease in another sec**

Which lead to oscillation or jerkiness of movement.

In contrast, muscle spindle reflexes make the contraction **smooth**, because the motor nerve to the muscle is excited at a **slow frequency\*** than the incoming signals from S.C

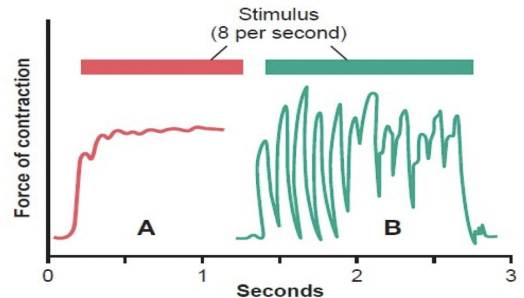
The signals discharged from the ms spindles cause partial activity of  $\alpha$ MNs of the ms.

So, the motor signals find  $\alpha$ MNs in state of partial activity, so they cause continuous activation of them → cause smooth ms contraction.

So, the proper damping function of the muscle spindle, it is the stretch reflex ability to prevent oscillation or jerkiness of movements.



\*That's why we called it  
Damping function, tone  
down function



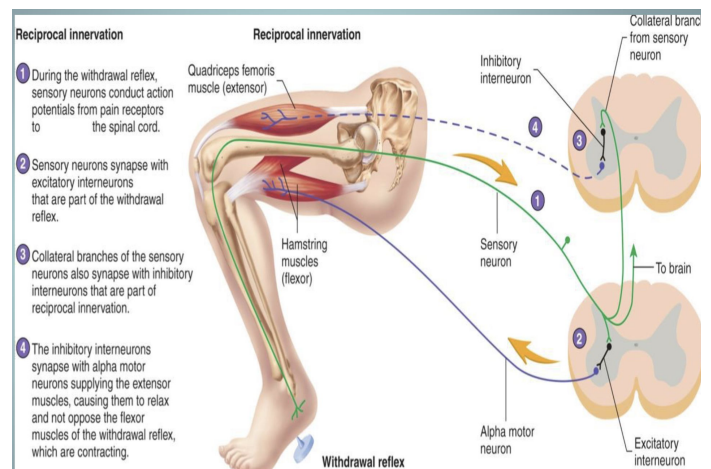
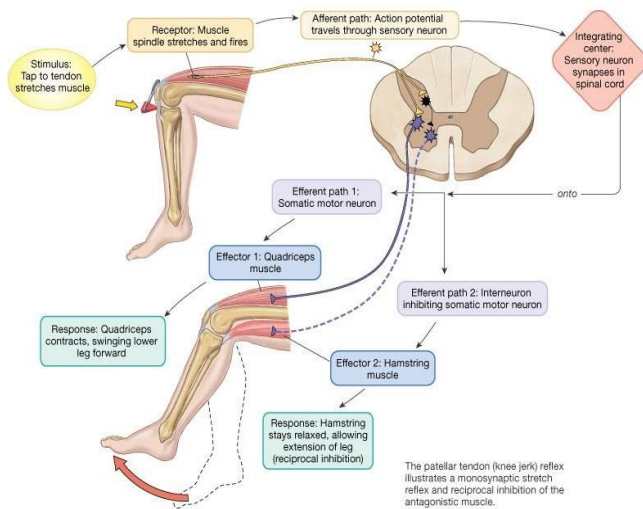
**Figure 55-6.** Muscle contraction caused by a spinal cord signal under two conditions: *curve A*, in a normal muscle, and *curve B*, in a muscle whose muscle spindles were denervated by section of the posterior roots of the cord 82 days previously. Note the smoothing effect of the muscle spindle reflex in *curve A*. (Modified from Creed RS, Denney-Brown D, Eccles JC, et al: *Reflex Activity of the Spinal Cord*. New York: Oxford University Press, 1932.)

## Proper control of muscle function requires:

- 1-excitation of the muscle by spinal cord anterior motor neurons
- 2-continuous feedback of sensory information from muscle to the spinal cord, indicating
  - 1.what is the length of the muscle
  - 2.what is its tension?

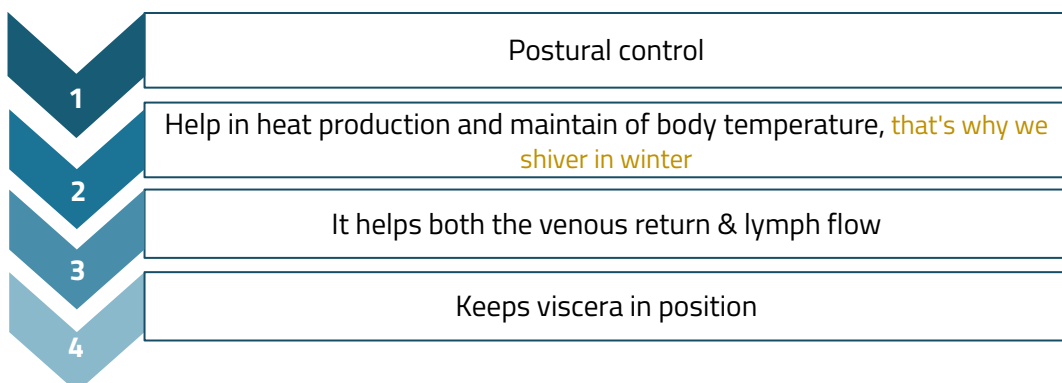
# Reciprocal inhibition with stretch reflex (Reciprocal innervation)

- ❖ Reflex contraction of an agonistic muscle is accompanied by inhibition of the antagonist. as in knee jerk : **Contraction of Extensors** of thigh (e.g. quadriceps) cause **Relaxation of Flexors** (hamstring).
- ❖ Contraction of the muscle being stretched (quadriceps)
- ❖ Reciprocal innervation **prevents conflict** between opposing muscles and is **vital in coordinating body movements**.
- ❖ Reciprocal inhibition of the antagonistic muscle (hamstring) through (reciprocal innervation)
- ❖ Impulses from stretched muscle reach the spinal cord to cause:
  - 1- stimulate the motor neurons of the stimulated muscle to contract (by **glutamate**).
  - 2- send collaterals to the inhibitory interneurons synapse on the AHCs of the antagonistic muscle & inhibit them (by **GABA**).



## Function of Muscle Tone

Founds in male slides only



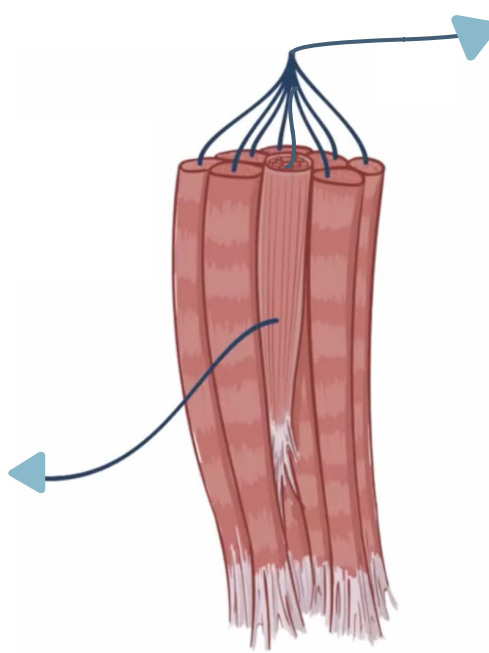
## Activation of muscle spindle

We already know that muscle spindle gets stimulated by stretch of the center point (mid portion)

There are **two ways** to stretch the mid-portion:

### 1. Intrafusal's peripheral portion contract.

Contraction of the peripheral contractile portions by **supraspinal centers** to the spindle's intrafusal fibers which stretches the mid-portions (**receptor area**) of the spindle & excites the receptor during  $\gamma$ -efferent discharge



### 2. Whole muscle contract.

The passive stretch of the whole muscle  
Lengthening of the whole muscle which stretches the mid-portion of the spindle which lies parallel to muscle fibers and, therefore excites the receptor.

Extrafusal +intrafusal  
Contraction

If the **whole muscle** is stretched during stimulation of the  **$\gamma$ -motor** neurons, the rate of discharge in sensory fibers is further **increased**.

After activation, by which the muscle **contract** ?

- ❖ Stimulation of **alpha motor neurons**, therefore excites the receptor.
- ❖ Stimulation of **gamma motor neurons** by supraspinal signals
- ❖ **Co-activation** of  $\alpha$ -and  $\gamma$ -Motor Neurons. هذا اللي يصير بأجسامنا. أما الستيموليشن الخاص بالقاما مثلاً هذا نسويه بالمعمل

## Clinical Significance of Tendon Reflexes

- They are carried out clinically to test the integrity of reflex arc.
- **A-reflexia** or **hypo-reflexia (hypo-tonia)** indicates that the reflex arc is interrupted at one of its components by:
  - Lesions of lower motor neuron, e.g. **poliomyelitis**
  - Peripheral nerve lesions e.g. **peripheral neuropathy**.
  - Neuromuscular junction disorder e.g. **myasthenia gravis**.
  - Primary muscle disorder e.g. **myopathy** .
- **Hyper-reflexia (hyper-tonia)**: exaggerated deep reflexes.
  - Upper motor neuron lesion.
  - Anxiety.

Stretch reflexes are subject to strong regulation by supraspinal centres, especially certain **motor centres** in the **brainstem** and **cerebral cortex**. These supraspinal centres send to gamma motor neurons through descending fibres

Factors that Influence Stretch Reflex (all act on gamma motor neurons)	
Inhibitory	Facilitatory
Supraspinal: <ol style="list-style-type: none"> <li>Cortical (suppressor area 4 &amp; Area 6)</li> <li>Basal ganglia</li> <li>Red Nucleus</li> <li>Medullary RF (Reticular formation)</li> <li><b>paleocerebellum</b></li> </ol>	Supraspinal: <ol style="list-style-type: none"> <li>Cortical (Primary motor area 4)</li> <li>Vestibular N (nucleus)</li> <li>Pontine RF (reticular formation) (bulboreticular)</li> <li><b>Neocerebellum</b></li> </ol>
Excessive stretch of muscle (golgi tendon reflex)	Anxiety: <u>Gamma motor neuron will be active</u>
Muscle contraction	Noxious painful stimuli طبعمًا الألم بيحفز الريفلكس E.g: appendicitis (muscle rigidity and gamma efferent is still stimulated which causes further muscle contraction.
مساحة فاضية ماعرفنا وش نقولكم فيها، نقولكم بالتوفيق بكم لغة ؟  <b>French:</b> Bonne chance. <b>German:</b> Viel Glück. <b>Italian:</b> In bocca al lupo.	Jendrassik-manuver هذا تكنيك يوصلنا لريفلكس واضح، كيف؟ يقولون للمريض عض على اسنانك مثلاً أو اضغط باصابعك ضد بعض -اي شيء مؤلم شوي للغاية منها نلهي The cortex from inhibitory impulses للمكان اللي قاعدين نختبره ونخليها ترسل مثبطات لألم الأسنان بدل المكان اللي نختبره وبكذا يصير الريفلكس واضح لنا



# The Golgi tendon reflex (Inverse Stretch Reflex)

## Definition

It is Deep & polysynaptic reflex - Opposite response to stretch reflex = Inverse Stretch Reflex).  
 It is a reflex in which there is a reflex relaxation (or lengthening) of a muscles in response to excessive stretch or contraction of that muscles.

## Mechanism

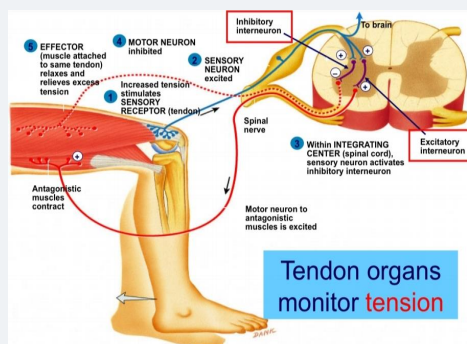
Excessive tension in the muscle ( by passive **over-stretch** of tendon or active muscle contraction) >>> cause muscle relaxation.

### Neural pathway:

- **Stimulus:** ↑increased muscle tension by; Overstretch or Severe contraction. About 10 to 15 muscle fibers are usually connected to each Golgi tendon organ, and the organ is stimulated when this small bundle of muscle fibers is "tensed" by severe contracting.
- **Receptors:** Golgi tendon organs.(Transmit information about tendon tension or rate of change of tension.)
- **Site:** Golgi tendon organs (3-25) present in tendons of skeletal muscle in series with muscle fibers, through which muscle tendon fibers pass.
- **Structure:** Are encapsulated sensory receptor 6-20 elastic fibers.
- **Innervations:** Type fast Ib afferent fibres.large, rapidly conducting fibers (16 micrometers in diameter).
- **Center (spinal cord) :**
  - increase in muscle tension if the muscle overstretch >impulses via fast Ib fibers > SC > The local cord signal excites inhibitory interneurons (secrete Glycine)→ inhibit the α-MNs supplying the same muscle > negative feedback mechanism>muscle relaxation
  - stim excitatory interneurons→ excite the α-MNs supplying the antagonistic (reciprocal innervation).
- **Response:**
  - Relaxation of the same muscle(**lengthening reaction** )
  - Contraction of antagonistic group of muscles.
- **Significance:** This reflex protects muscle from rupture & tendon from avulsion and tear.

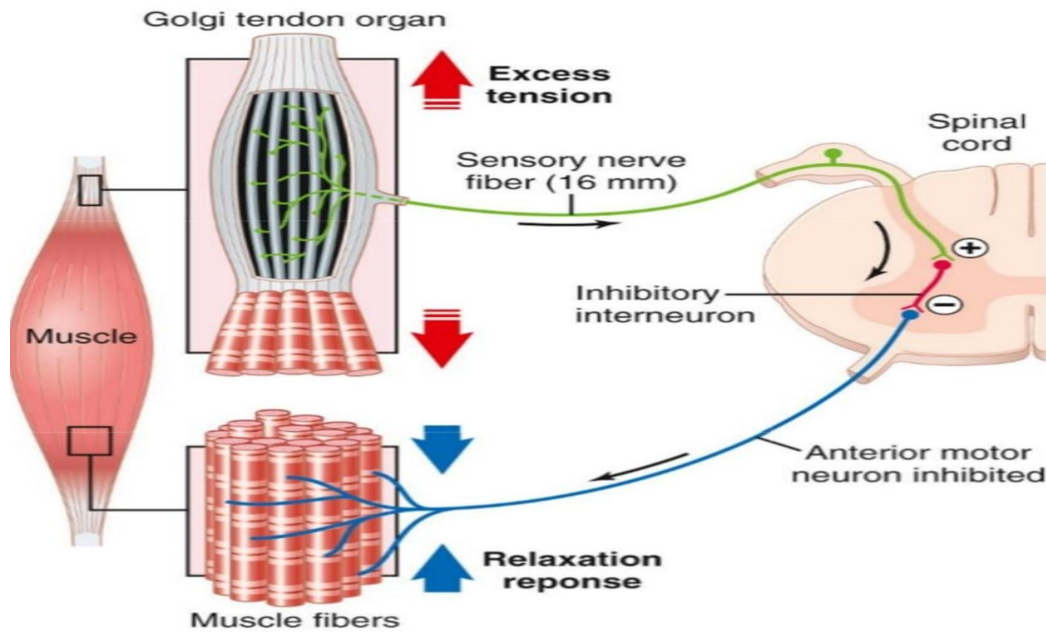


In muscle > the receptor is muscle spindle.  
 In tendon > the receptor is Golgi tendon organs



Tendon organs monitor tension

# (Inverse Stretch Reflex)- The Golgi tendon reflex



## Comparison Between Stretch & Inverse Reflexes

	Stretch reflex	Inverse stretch reflex
<b>Stimulus</b>	Increased muscle length	Increased muscle tension
<b>Receptor</b>	Muscle spindles	Golgi tendon organs
<b>Afferents</b>	Type Ia & II fibers	Type Ib fibers
<b>Response</b>	Muscle contraction	Muscle relaxation
<b>Synapses</b>	Monosynaptic	Polysynaptic
<b>RECIPROCAL INNERVATION Regulation</b>	Inhibit antagonists through inhibitory interneurons	Excites antagonistic muscles through excitatory interneurons
<b>PHYSIOLOGICAL SIGNIFICANCE</b>	Regulate muscle length	Regulate muscle tension to prevent excessive tension increase & tendon avulsion
<b>CLINICAL ASSESSMENT</b>	Sudden tap of muscle causes brisk contraction muscle jerk	Overstretch of muscle sudden muscle relaxation (lengthening reaction)



# MCQ & SAQ:

L5

**Q1: which one of the following describe Primary afferent fibers?**

- A. Fast
- B. Slow
- C. Static response
- D. 8 micrometer in diameter

**Q3: Which of the following is not a function of muscle tone?**

- A. Postural control
- B. Helps both the venous return & lymph flow
- C. Depression of mandible
- D. Help in heat production and maintain of body temperature

**Q5: Which reflex is correctly paired with the sensory structure that mediates the reflex?**

- A) Autogenic inhibition—muscle spindle
- B) Reciprocal inhibition—Golgi tendon organ
- C) Reciprocal inhibition—Pacinian corpuscle
- D) Stretch reflex—muscle spindle
- E) Golgi tendon reflex—Meissner corpuscle

**Q2: Nuclear bag fibers supplied by :**

- A. Both primary & secondary endings
- B. Primary endings only
- C. Secondary endings only
- D. None

**Q4 :Which cells receive direct synaptic input from Golgi tendon organs?**

- A) Type Ia inhibitory interneurons
- B) Dynamic gamma motor neurons
- C) Alpha motor neurons
- D) Type Ib inhibitory interneurons

**Q6: What's the efferent of plate endings?**

- A. Dynamic alpha efferent
- B. Dynamic gamma efferent
- C. Static gamma efferent
- D. Static alpha efferent

answ  
key:  
1: A  
2: B  
3: C  
4: D  
5: D  
6: B

**1- What's the type of fibers in plate endings/ trail endings ?**

**2- What's the result of static stretch reflex ?**

**3- What are the factors that influence Stretch Reflex?**

**4- Compare between Stretch and Inverse Stretch reflexes?**

**A1:** nuclear bag fibers / nuclear chain fibers

**A2:** Mild sustained contraction of muscle extrafusal fibers as long as it is stretched

**A3:** Refer to the table (slide 12)

**A4:** Refer to the table (slide 14)

## Leaders:

- **Abdulaziz Alsuhaim.**
- Ghada Aljedaie.
- Homoud Algadheb.
- Raghad Albarrak.
- Samar Almohammedi.

## Organizers:

- Basel Fakeeha.
- Fatimah Saad.
- **Hessah Alalyan.**
- Majed Alaskar.
- Mayasem Alhazmi.
- Mohamed Alquhidan.
- Sadeem Al Zayed.

## Note takers:

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- **Fahad Alajmi.**
- **Hessah Alalyan.**
- Reem Aldosari
- Shuaa Khdary.

## Revisers:

- Abeer Awwad.
- Saud Alrsheed.
- **Teif Almutiri.**

## MEMBERS:

- Abdulaziz Alrabiah.
- Abdulaziz Alderaywsh.
- Abdulaziz Alamri.
- Abdulaziz Alomar.
- Abdullah Alburikan.
- Abdullah Binjadou.
- Abdullah Alanzan.
- Abdullah Alhumimidi.
- Abdulrahman Almegbel.
- **Abdulrahman Barashid.**
- Abdulrhman Alsuhaibany.
- Abeer Awwad.
- Ahmad Alkhayatt.
- Aljoharah Albnyan.
- Aljoud Algazlan.
- Almaha Alshathri.
- Arwa Al-Qahtani.
- Bader Arayes.
- Bassam Alasmari.
- Bushra Alotaibi.

- Faisal Jazzar.
- Feras Alqaidi.
- Ghaida Alassiry.
- **Ghaida Alshehri.**
- Hamad Almousa.
- Haya Alanazi.
- Hind Almotywea.
- Ibraheem Altamimi.
- Ibrahim Alnamlah.
- Joud Alarifi.
- Khalid Altowajjeri.
- Khalid Almutlaq.
- Leen AlMadhyani.
- May Barakah.
- Mohamed Alquhidan.
- Mohammed Alkathiri.
- Murshed Alharby.
- Nada Bin Obied.
- Norah Alsalem.
- Norah Aldakhil.

- Nouf Alsubaie.
- Noura Alshathri.
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- Shaden Alobaid.
- Shahd Almezel.
- Shatha Aldossary.
- Shayma Alghanoum.
- Tarfah Alkaltham.
- Yara Alasmari.
- Yara Alomar.
- Yara Alzahrani.
- Yazeed Alqahtani.
- ziyad Alhosan.

