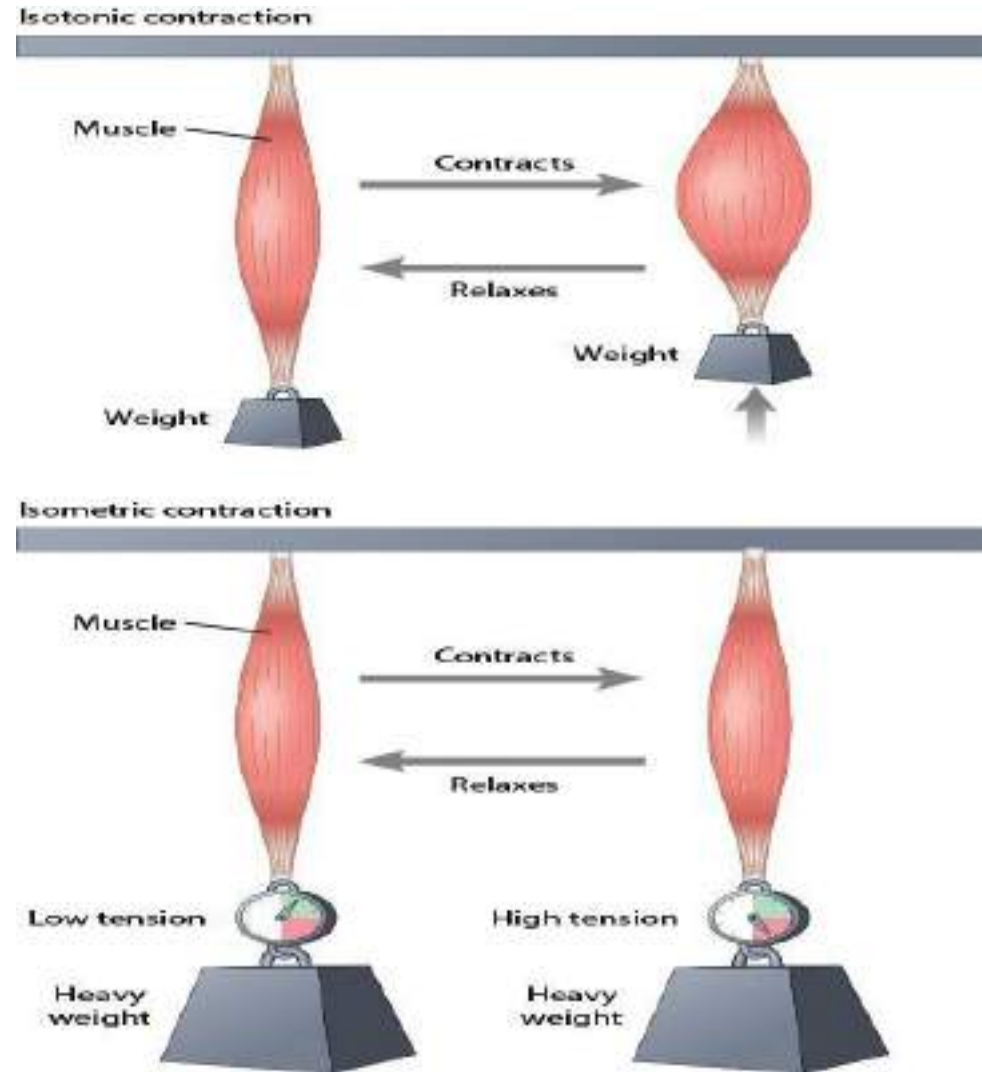


Isometric and isotonic contractions

Isotonic contraction occurs when the force of the muscle contraction is greater than the load and the tension on the muscle remains constant during the contraction; when the muscle contracts, it shortens and moves the load.

Isometric contraction occurs when the load is greater than the force of the muscle contraction; the muscle creates tension when it contracts, but the overall length of the muscle does not change.

iso
same → metric = length
 → tonic = pressure



Isotonic and isometric systems for recording muscle contractions

Isometric and isotonic contractions

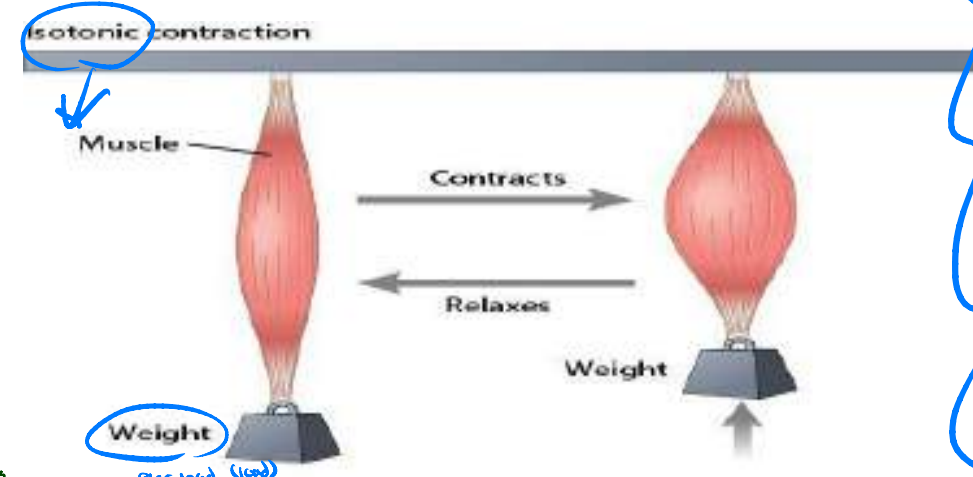
tension ← ثابت
length ← يثقل

② Isotonic: muscle shortens.

Important for:

1. For body movements
2. Moving external objects

يحدث بعد ال isometric
يحدث أولاً
يحدث عندما القوة من انقباض العضلة أكبر من الوزن الذي يرفع + التوتر يبقى ثابتاً
↓
الوزن يرفع



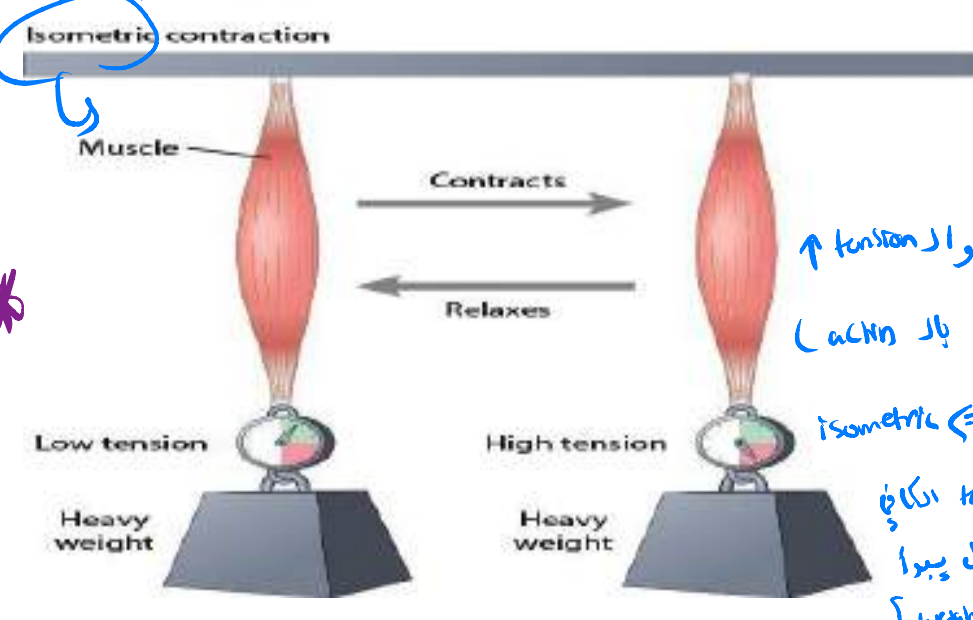
length ← ثابتة
tension ← يزيد

① Isometric: no muscle shortening.

Important for:

1. Maintaining posture (keep legs stiff while standing)
2. Supporting objects in a fixed place

load is greater than the force of muscle contraction, creating tension + no length changes.



① ال طول ثابت و ال tension ↑
(ارتباط ال myosin heads بال actin)

لماي اول مرحلة isometric

② بعد ما بعد توغمر ال tension ال كافي
بعث ال tension ثابتاً و ال طول يبرأ
بالنقصان [بغير ال weight lifting]

Skeletal muscle contraction
* أثناء ال contraction بتغير كل من:

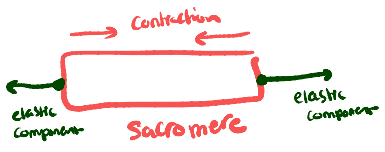
- ① Tension (↑)
- ② length of muscle (↓)

التغير ال يحدث ال في نفس الوقت، عشان ليهك عند ال نوعين ال contraction

tension ← يولد
بخطيتنا نحافظ
كل ال posture

No movement

* سؤال، كيف حكينا انه ال length لا يتغير في ال isometric مع انه بغير ال ال طول ال sarcomere بغير عند تولد ال tension نتيجة ارتباط ال actin ب ال myosin heads ؟



ل الجواب انه مع ال sarcomere بغير لكن
يعني هذا التقابل في ال طول ال elastic component
يشير ال في ال isometric طول ال elastic component
يقل و ال sarcomere اول Contracted
فيغير عند ال shortening of muscle length

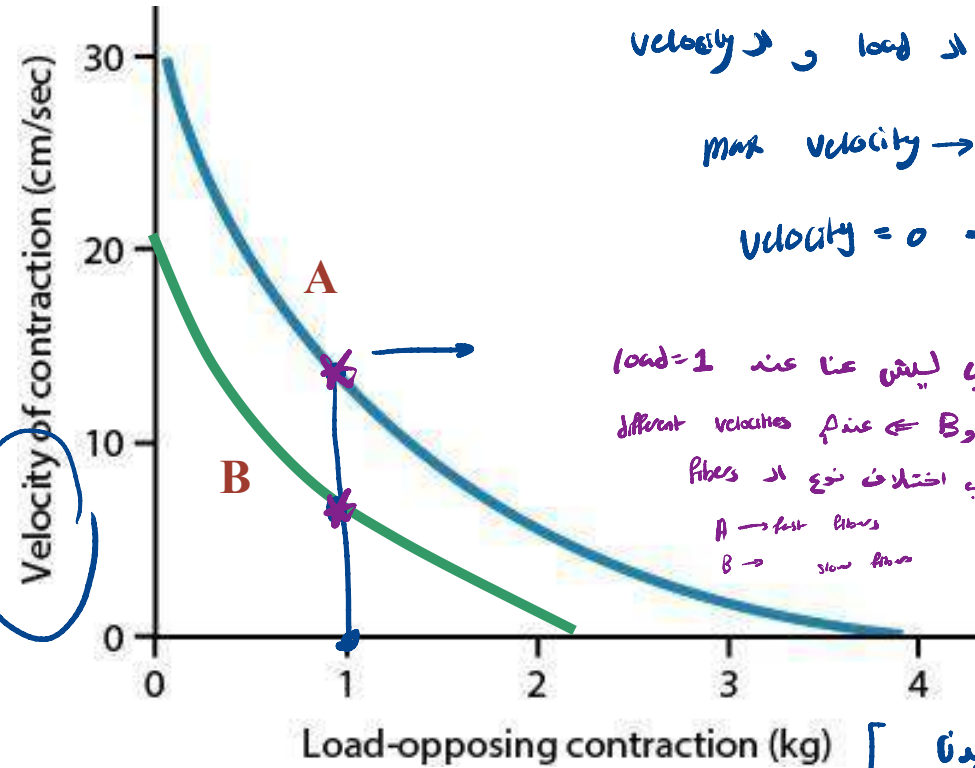
Relationship of Contraction Velocity to Load

The force-velocity curve is generated from the study of isolated muscle during isotonic contractions

no afterload: →
 load = 0
 • maximum velocity at minimum load

increased afterload: →
 • contraction velocity decreases
 سرعة انقباض

contraction velocity is zero when afterload = max force of contraction (∞)



* العلاقة عكسية بين الـ load و الـ velocity
 max velocity → load = 0
 velocity = 0 → load maximum

لا يوجد عتبات عند load = 1
 A و B عند مختلف velocities
 السبب اختلاف نوع الـ fibers
 A → fast fibers
 B → slow fibers

A: larger, faster muscle (white muscle)
 B: smaller, slower muscle (red muscle)

[الوزن إلي بدن]
 تشبيه
 * جاي بالامتحان هاي الحركة

ہا کون عم بنفان لا ^{twitter} ^{purus} بینہ
 مختلف عہدات سے الجیم ۶ عم نشیہ اینہ
 duration of contraction of AP و LP قسم

Types of skeletal muscle

- speed of twitch contraction -

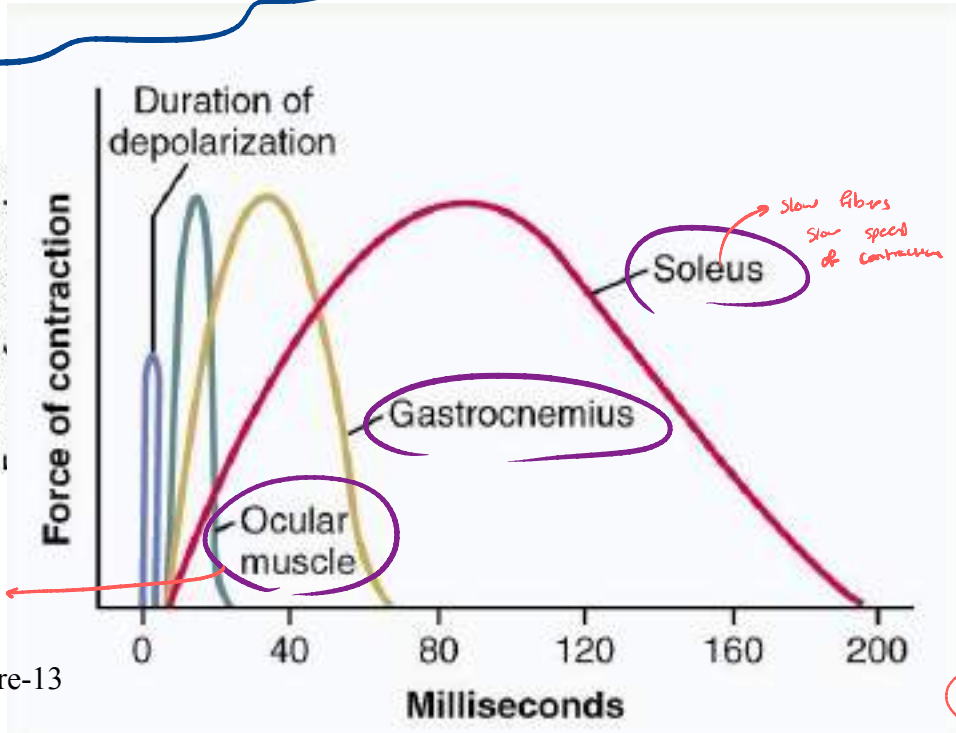


Figure-13

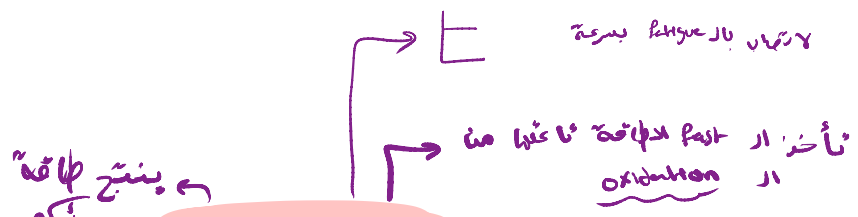
The duration of isometric contractions for different types of mammalian skeletal muscles, showing a latent period between the action potential (depolarization) and muscle

- **velocity**
Speed of contraction determined by V_{max} of myosin ATPase.
 - **High V_{max} (fast, white)**
 - rapid cross bridge cycling
 - rapid rate of shortening (fast fiber)
 - **Low V_{max} (slow, red)**
 - slow cross bridge cycling
 - slow rate of shortening (slow fiber)
- **Most muscles contain both types of fiber, but proportions differ**
- All fibers in a particular motor unit will be of the same type, i.e., fast or slow.

سبب اختلاف V_{max} اور
 myosin اور ATPase activity

در کھیپے اور ادا آکر پکون ادا

Fast and slow fibers types

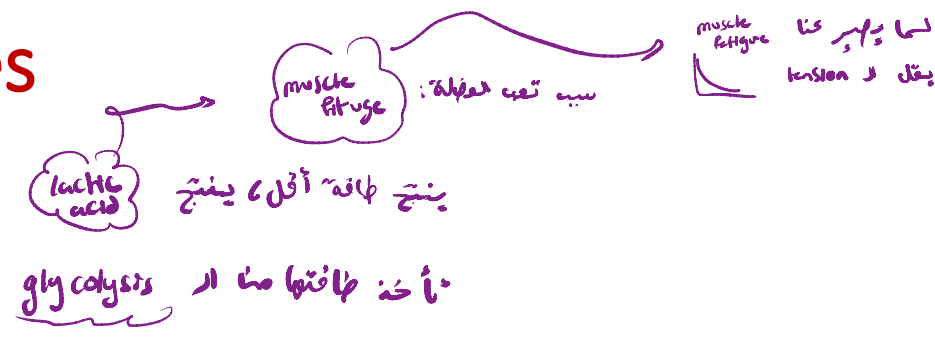


الاختلاف بين نوعي ال fibers
 لكن اختلاف ال velocity = speed of contraction

• Slow Fibers (Type 1, Red Muscle).

- Slow fibers are smaller than fast fibers.
- Slow fibers are also innervated by smaller nerve fibers.
- Compared with fast fibers, slow fibers have a more extensive blood vessel system and more capillaries to supply extra amounts of oxygen.
- Slow fibers have greatly increased numbers of mitochondria to support high levels of oxidative metabolism.
- Slow fibers contain large amounts of myoglobin

✳ Due to the ↑ myoglobin + ↑ vessels → slow fibers are called red fibers



Fast fibers Type II white muscles type 2

- Are large for great strength of contraction.
- have an extensive sarcoplasmic reticulum is present for rapid release of calcium ions to initiate contraction.
- Have Large amounts of glycolytic enzymes are present for rapid release of energy by the glycolytic process.
- Have less extensive blood supply than do slow fibers because oxidative metabolism is of secondary importance.
- have fewer mitochondria than do slow fibers, also because oxidative metabolism is secondary.
- A deficit of red myoglobin in fast muscle gives it the name *white muscle*.

✳ ↓ myoglobin → fast fibers are called white fibers

✳ fast fibers are less resistant to fatigue than slow fibers (ال fast بسرعة يتعب)

Motor Unit

مجموعه لا فبرس الي يتم تغذيتها من قبل motor neuron

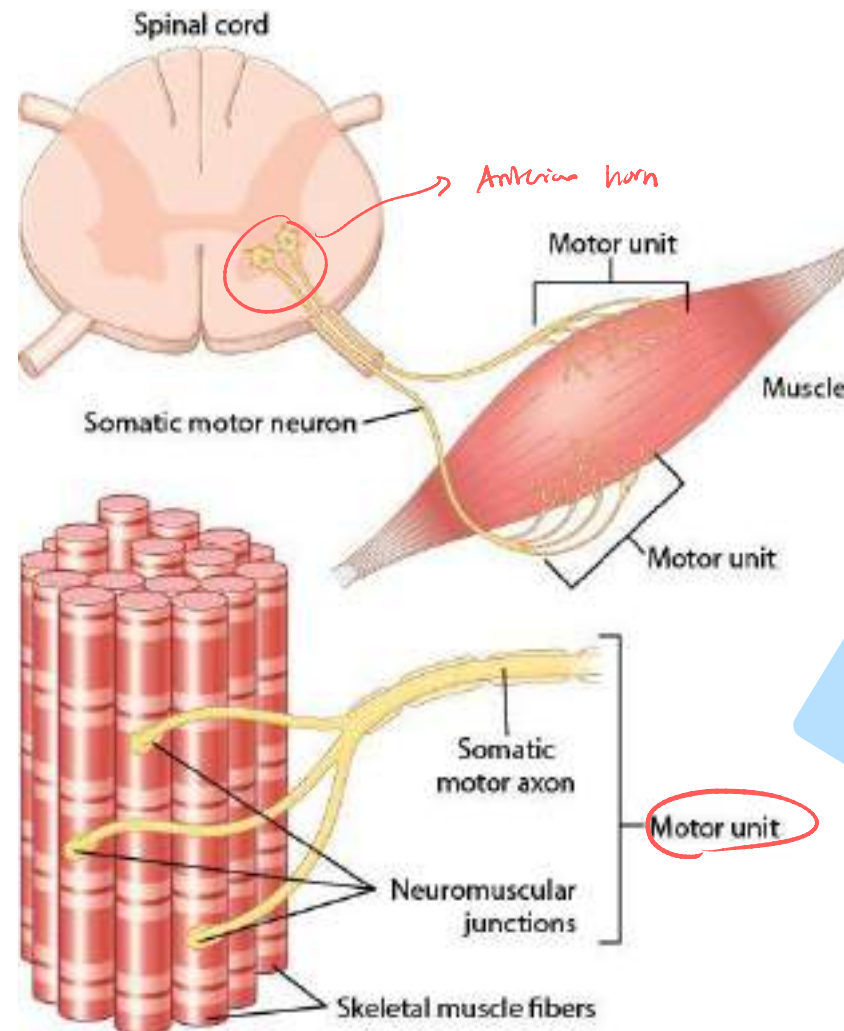
A collection of muscle fibers innervated by a single motor neuron

motor unit

A motor unit consists of a motor neuron and the group of skeletal muscle fibers it innervates. A single motor axon may branch to innervate several muscle fibers that function together as a group. Although each muscle fiber is innervated by a single motor neuron, an entire muscle may receive input from hundreds of different motor neurons.

* Muscle fibers in the motor unit act as one unit

لو كان لوحده contraction
كل لا فبرس اللي بتتغذى الي من
الموتور نيرون contraction
يتم بها



نشكر انه كل :
a group of muscle fibers ← innervated by motor neuron
← innervated by fiber by one motor neuron only.

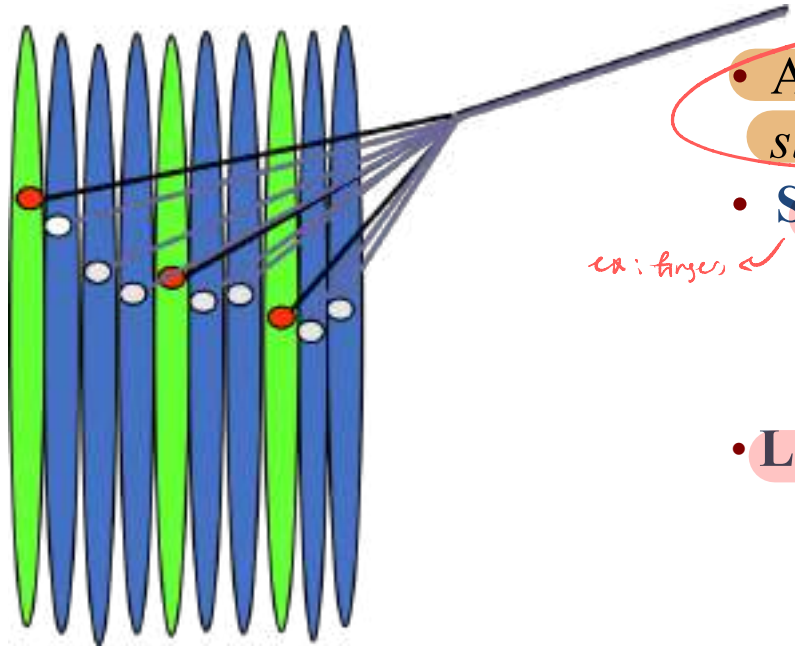
* The whole skeletal muscle might be innervated by many motor neurons.

* muscle fibers in the same motor unit are of the same type (either fast or slow)

Motor Unit (cont.)

↳ might be of 2 sizes → small motor units / large motor units

نوع الـ fibers في كل motor neuron هو نفسه



All fibers are same type (fast or slow) in a given motor unit

• **Small motor units** (e.g., larynx, extraocular)

ex: fingers

- as few as 10 fibers/unit
- precise control
- rapid reacting

↑↑ accuracy (دقة عالية)

• **Large motor units** (e.g., quadriceps muscles)

- as many as 1000 fibers/unit
- coarse control
- slower reacting

↑ motor unit size → ↑ fibers ↓ accuracy

• Motor units overlap, which provides coordination

Muscle Contractions of Different Force.

Force Summation.

تدقيق أكثر من contraction فوق
بعداً

تension أي نسبة ال contraction

- *Summation* means the adding together of individual twitch contractions to

increase the intensity of overall muscle contraction.

تعريف

tensity

- Summation occurs in two ways:

زبي ال temporal و ال space ال EPSP

- (1) Recruitment of motor units by : increasing the number of motor units

↑ tension contracting simultaneously, which is called *multiple fiber summation*

زيادة ال motor units

- 2) by increasing the frequency of contraction, which is called *frequency summation* and can lead to *tetanization*

بالتزايد عدد ال contractions

peak of tension