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لجان الرِّفعات



تفريغ فسيولوجي



موضوع المحاضرة: Muscular system lec7

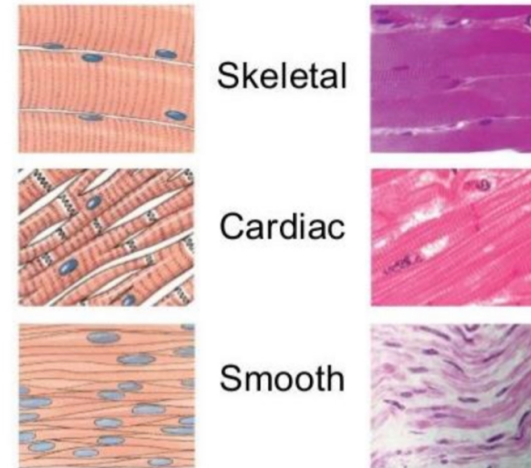
رقم المحاضرة: Part 1

إعداد الصيدلانية: Jeneen Alhasan

Muscle Tissue Types

General Overview

The three types of muscular tissue are skeletal, cardiac, and smooth.



٣ انواع muscles :-
skeletal
cardiac
smooth

هناك filaments وهي عبارة عن
الياف تنقسم إلى قسمين
thick
thin
هذه ال filaments تعملوا
sliding

SKELETAL MUSCLE TISSUE

- **Skeletal muscle tissue** is so named because most skeletal muscles move the bones of the skeleton. **Alternating light and dark protein bands** (striations) are seen when the tissue is examined with a microscope.
- Skeletal muscle tissue works **mainly in a voluntary manner**. Its activity can be **consciously** controlled by neurons (nerve cells) that are part of the somatic (voluntary) division of the nervous system.
- Most skeletal muscles also are **controlled subconsciously** to some extent. For example, your diaphragm continues to alternately contract and relax without conscious control so that you don't stop breathing. Also, you do not need to consciously think about contracting the skeletal muscles that maintain your posture or stabilize body positions.

لو بدنا نشوف skeletal muscle
تحت المجهر فنشوف filaments
اللي دائما تكون separate منفصلة
وعندما تبدأ عملية contraction
بتبليش عملية sliding و يخلط
يبين عندي under the microscope
عملية alternation و تعني التبديل

امثلة انه ليس skeletal muscle لكن يكون
subconsciously controlled

- skeletal muscle is not consciously controlled 100% , it is subconsciously controlled

• مثال ، في respiratory system لا يصير في relaxation أو contraction بلو يتحكم فيها أحيانا ال autonomic

• تعتبر effector لـ
autonomic nervous system

يعني ليستغل لحاله

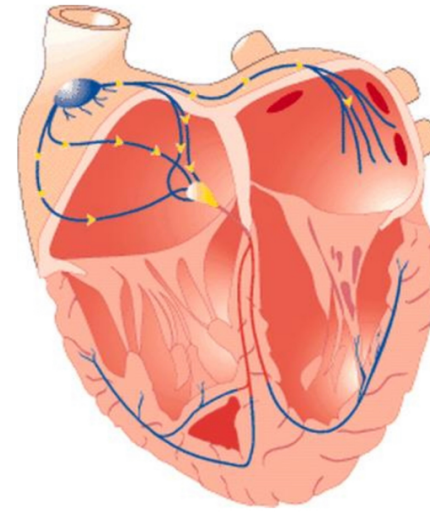
rythm يعني تناغم ، لحالها
تعمل تناغم بين contraction و
relaxation

ع إذا الشخص ضغطه stable بتظلها
موازنة بين contraction و
relaxation

أما إذا شخص عنده ضغط مرتفع
فسيبطل غير توازن بين العمليتين

CARDIAC MUSCLE TISSUE

- The alternating contraction and relaxation of the **heart is not consciously controlled**. Rather, the heart beats because it has a natural **pacemaker** that initiates each contraction.
- This built-in rhythm is termed **autorhythmicity**. Several hormones and neurotransmitters can adjust heart rate by speeding or slowing the pacemaker.



• **cardiac muscles** are
involuntary controlled
يعني انت كشخص ما بتقدر
تتحكم بعملية
contraction و relaxation لـ
cardiac muscle

SMOOTH MUSCLE TISSUE

It is located in the walls of hollow internal structures, such as blood vessels, airways, and most organs in the abdominopelvic cavity.

The action of smooth muscle is usually **involuntary**, and some smooth muscle tissue, such as the muscles that propel food through your gastrointestinal tract, has autorhythmicity.

• عملية الهمم نتيجة عملية
contraction and relaxation
في smooth muscles اللي بتكون
موجودة في GI لالكن التحكم
فيها

⇒ **skeletal muscle** : subconsciously
controlled

smooth and cardiac muscles :
unconsciously controlled

• effector of
autonomic nervous
system

• Involuntary controlled

FUNCTIONS OF MUSCULAR TISSUE

Skeletal
Smooth
Cardiac

1. Producing body movements (movements of the whole body, and localized movements).
2. Stabilizing body positions (such as standing or sitting, neck muscles hold your head upright).
3. Storing and moving substances within the body (storage is accomplished by sustained contractions of ringlike bands of smooth muscle called sphincters (i.e., gastrointestinal tract). Contraction and relaxation of smooth muscle in the walls of blood vessels help adjust blood vessel diameter and thus regulate the rate of blood flow).
4. Generating heat (As muscular tissue contracts, it produces heat, a process known as thermogenesis (maintaining normal body temperature)).

↓
انتاج الحرارة

← حركة جزء معين من الجسم
أو حركة الجسم كامل
← عدم الحركة
← تخزين ونقل المواد
خلال الجسم مثل
smooth muscle
بتعمل Digestion للأكل
وبالتالي عملية relaxation
بتخزين الأكل في المعدة

PROPERTIES OF MUSCULAR TISSUE

• skeletal muscle

1. Electrical excitability respond to certain stimuli by producing electrical signals called action potentials (impulses) (i.e., autorhythmic electrical signals arising in the muscular tissue itself, as in the heart's pacemaker or chemical stimuli, such as neurotransmitters released by neurons, hormones distributed by the blood, or even local changes in pH).
2. Contractility (ability of muscular tissue to contract forcefully when stimulated by an action potential).
3. Extensibility (ability of muscular tissue to stretch, within limits, without being damaged (i.e., smooth muscle in the stomach and cardiac muscle)).
4. Elasticity (ability of muscular tissue to return to its original length and shape after contraction or extension).

• خصائص النسيج العضلي

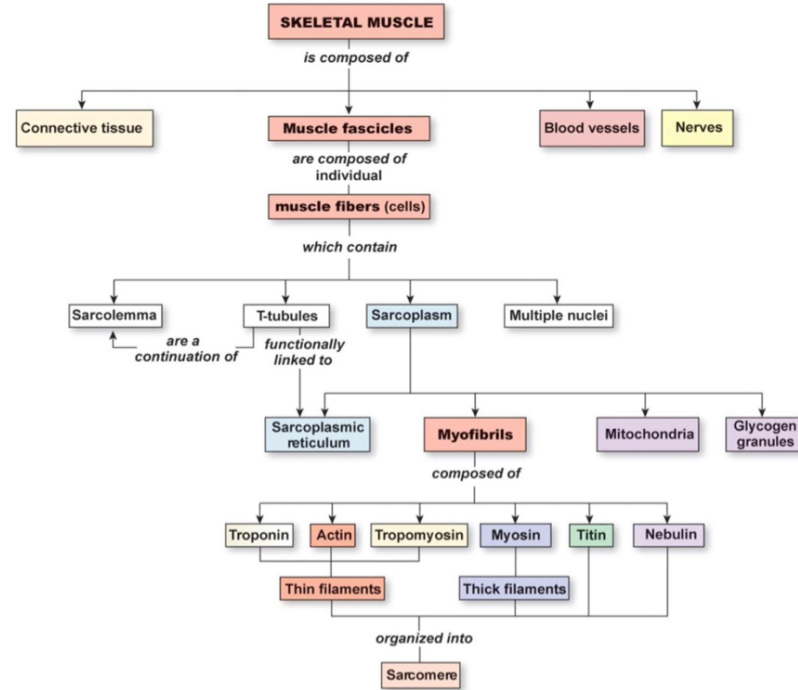
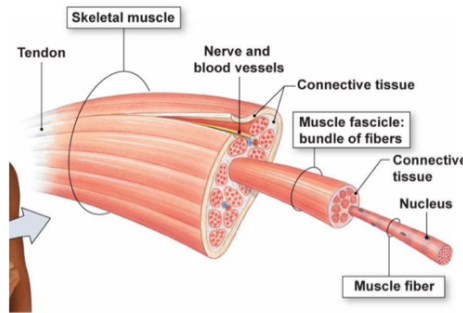
← مستحيل يستغل النسيج
العضلي بدون ما يوصله
action potential

← الانقباضات التي تهب
بوساطة action potential

← مثل المطاط يعني muscle قادرة على
انها أثناء عملية relaxation تتمدد
ولكن إلى حد معين وتبرجع إلى
وضعها الطبيعي لأنه عندها خاصية
elasticity (المرونة)

- تحتوي على **Fibers**
- تحتوي على **connective tissue**

SKELETAL MUSCLE FUNCTIONAL ANATOMY



- تحتوي على **herves** عنان يوصلها **action potential**
- تحتوي على **Blood vessels** عنان يوصلها **oxygen** الذي يساعدها انها تقوم بعملية **contraction**

- مكونات **connective tissue**

CONNECTIVE TISSUE COMPONENTS

1. **Subcutaneous layer or hypodermis** (which separates muscle from skin, is a pathway for nerves, blood vessels, and lymphatic vessels to enter and exit muscles).
2. **Adipose tissue of the subcutaneous layer** (stores most of the body's triglycerides, serves as an insulating layer that reduces heat loss, and protects muscles from physical trauma).
3. **Fascia** (is a dense sheet or broad band of irregular connective tissue that lines the body wall and limbs and supports and surrounds muscles and other organs of the body.).

- **connective tissue** هي طبقة خارجية تعمل **protection** يعني اذا صار في توتر على **skeletal muscles** فهناك الطبقة بتحميها من **damage** الضرر

- ترتيب الطبقات من الداخل إلى الخارج

الطبقة التي بتدخلها
الأعصاب و **Blood vessels**

الطبقة الوسطى وهي عبارة عن **Fats** دهون والتي يتم تخزينها على شكل **triglycerides**

والتي وظيفتها الاساسية هي الحماية ضد التوتر

آخر طبقة تعمل **protection** ، يعني الطبقات التي يعملوا
1) **Fascia**
2) **adipose tissue**

NERVE AND BLOOD SUPPLY

- Skeletal muscles are well supplied with nerves and blood vessels.
- Generally, an artery and one or two veins accompany each nerve that penetrates a skeletal muscle.
- The neurons that **stimulate skeletal muscle to contract** are **somatic motor neurons**. Each somatic motor neuron has a threadlike axon that extends from the brain or spinal cord to a group of skeletal muscle fibers.
- The axon of a somatic motor neuron typically branches many times, each branch extending to a different skeletal muscle fiber.
- The blood capillaries bring in oxygen and nutrients and remove heat and the waste products of muscle metabolism.

• نحن بحاجة إلى أعصاب
توصل skeletal muscles
عشان يوصل action potential

• ولحاجة إلى Blood supply
عشان الأكسجين

MICROSCOPIC ANATOMY OF A SKELETAL MUSCLE FIBER

- Because each skeletal muscle fiber **arises during embryonic development from the fusion** of a hundred or more small mesodermal cells called **myoblasts**, each mature skeletal muscle fiber has a hundred or more nuclei.
- Once fusion has occurred, **the muscle fiber loses its ability to undergo cell division**. Thus, **the number of skeletal muscle fibers is set** before you are born, and most of these cells last a lifetime.

• الحنين أول ما ينولد
أو أول ما بينمو بصير
differentiation
واللي بصير بـ skeletal muscles

• تكون بالبداية عبارة عن
precursor cells
وبعدين لبصير mature cells

• ولوقف نموها و عشان هيك
عددتها ثابت بعد ما ينولد
الحنين

• مصدر الخلايا الموجودة
في skeletal muscles
هو نوع من الخلايا اسمها
mesodermal cells or myoblasts

• تندمج خلايا myoblast
معًا وتكوّن الخلايا الموجودة
في skeletal muscles
وبعدين بتوقف و هسب تنقسم
مع الوقت و هسب أنها تتجدد
أو يزيد عددها ولكن هكن
أنها تكبر growth

MICROSCOPIC ANATOMY OF A SKELETAL MUSCLE FIBER

- **Sarcolemma** is the plasma membrane of a muscle cell.
- **Transverse (T) tubules** which are tunnels in from the surface toward the center of each muscle fiber.
- Muscle action potentials travel along the sarcolemma and through the T tubules, quickly spreading throughout the muscle fiber.
- **Sarcoplasm** is the cytoplasm of a muscle fiber which includes a substantial amount of **glycogen**, which is a large molecule composed of many glucose molecules. In addition, the sarcoplasm contains a red-colored protein called **myoglobin**. It binds oxygen molecules that diffuse into muscle fibers and releases oxygen when it is needed by the mitochondria for ATP production.

الجزء السائل عبارة عن
glycogen و myoglobin
الغلايكوجين عبارة عن سكر
مخزن في العضلات زي اللي
موجود في liver أما
myoglobin فهو يرتبط مع الأكسجين

لماذا نحتاج إلى جلوكوز (سكر) وأكسجين؟
لأنه عملية انقباض العضلات في skeletal muscles
مستحيل تحدث بدون كالسيوم ووجود ATP
لأنه في مكان عال myosin يرتبط مع ATP
ولا يتم تحلل ATP إلى جزيئات فوسفات و ADP
و بدون ADP و الأكسجين و الكالسيوم
ولا كبتين و الميوسين ما يصير contraction
فيتم تحصيل الطاقة إما عن طريق الجلوكوز الذي
يخزن على شكل glycogen أو عن طريق جزيء
الأكسجين الذي يرتبط مع الميوسين الموجود في sarcoplasm
والذي يسمى myoglobin

• مكونات skeletal muscle fiber
النسيج عبارة عن cells + fiber

• حتى تدخل المواد من surface
إلى center الخاص ب fiber
يعني ما بين plasma membrane
و nucleus في tubules قنوات
اسمها transverse tubules
والتي تساعد action potential
التي على plasma membrane
أنه ينتقل من خلالها إلى الداخل

MICROSCOPIC ANATOMY OF A SKELETAL MUSCLE FIBER

- **Myofibrils**, the contractile organelles of skeletal muscle.
- Fluid-filled system of membranous sacs **called the sarcoplasmic reticulum (SR)** encircles each myofibril.
- In a relaxed muscle fiber, the sarcoplasmic reticulum **stores calcium ions**. Release of calcium ions from the sarcoplasmic reticulum triggers muscle contraction.

هناك **organelles** تكون موجودة داخل **skeletal muscle fibers** وما يتكون موجودة في أي خلية وتكون مسؤولة عن **contraction** اسمها: **myofibrils** تكون فيها بروتينات وهذه البروتينات تعمل تنظيم لعملية **contraction** وبعضها تعمل بيئة مناسبة عشان تعمل فيها **contraction**

- دائما المصطلحات التي لها علاقة بـ **skeletal muscles** تبدأ بكلمة **sarco**

- الأجزاء التي تساهم في عملية **contraction** (1) **sarcoplasm** يحتوي على ATP على شكل جليكوز أو أكسجين (2) **sarcoplasmic reticulum** يعمل على تخزين الكالسيوم

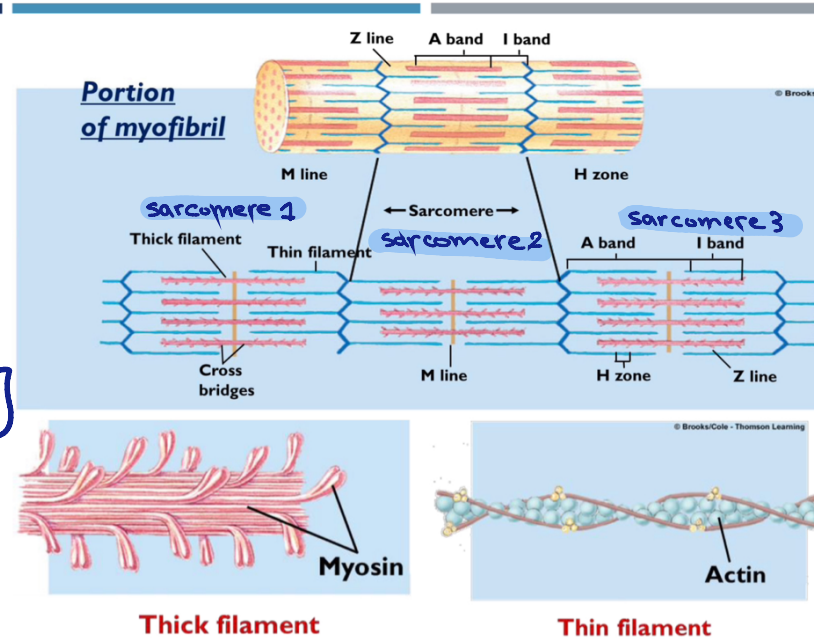
MICROSCOPIC ANATOMY OF A SKELETAL MUSCLE FIBER

- Within myofibrils are smaller protein structures called **filaments or myofilaments**. They are arranged in compartments called **sarcomeres**. The plate-shaped regions of dense protein material called **Z discs** separate one sarcomere from the next. Thus, a sarcomere extends from one Z disc to the next Z disc
- **Thin filaments** are 8 nm in diameter and 1–2 μm long and composed mostly of the **protein actin**, while **thick filaments** are 16 nm in diameter and 1–2 μm long and composed mostly of the **protein myosin**.

• **myofibrils** فيها **filaments**

thin filament $\Rightarrow$ **actin**
thick filament $\Rightarrow$ **myosin**

- The myofibrils are organized into a repetitive pattern, the sarcomere.
- Myosin: thick filament.
- Actin: thin filament.
- Bands formed by pattern. A and I and H bands.
- Z line: area of attachment of the actin fibers.
- M line: Myosin fiber centers.



دائماً يجيوا بالامتحان

اللي بالأخضر myosin
اللي بالأحمر actin

كل مجموعة من
thick and thin filaments
اسمها sarcomere

عملية contraction بغير sliding
و sarcomere بغير و muscle
و diameter بغير

MUSCLE PROTEINS

1-Contractile proteins generate force during muscle contractions. actin, myosin

2-Regulatory proteins help switch the contraction process on and off.

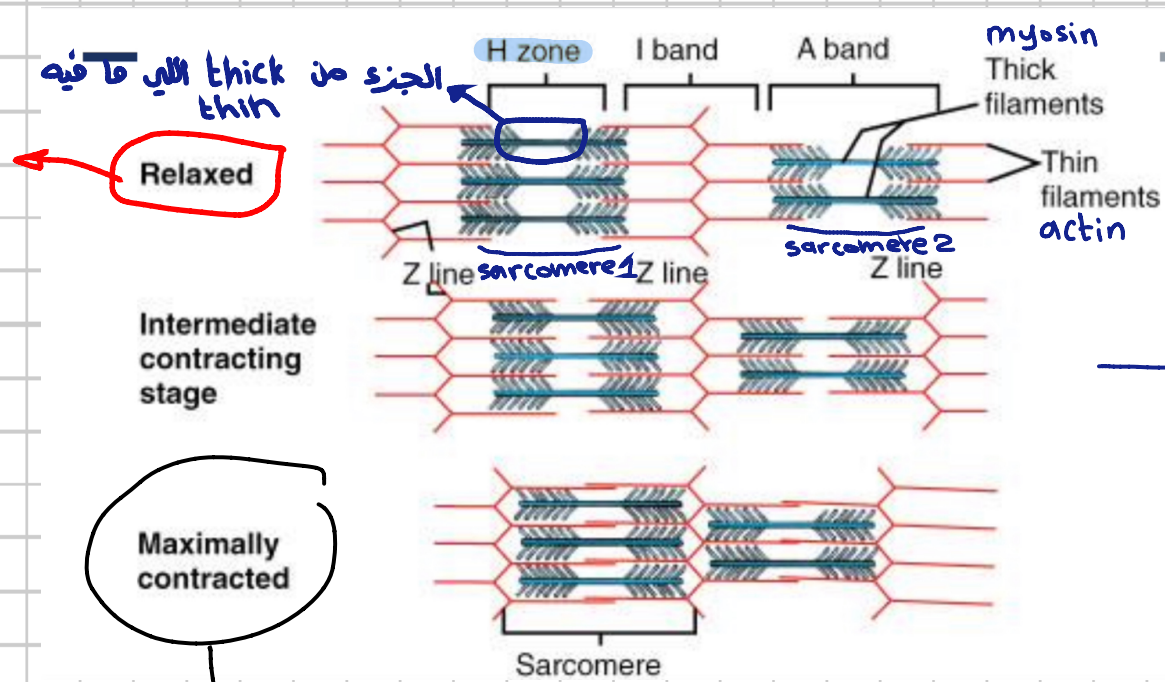
3-Structural proteins keep the thick and thin filaments in the proper alignment, give the myofibril elasticity and extensibility.

myofibrils يحتوي على
بروتينات , بعضها مسؤول
عن contraction وبعضها
منظم وبعضها structural

الراحة ، ما تبعمل skeletal muscles contraction في حالة

• thin and thick and z line together are sarcomere

line من النهاء thick ل sarcomere الاول إلى منطقة بداية thick ل sarcomere الثاني اسمها I Band إذا هي الجزء اللي بتخوي فقط thin على



A-band طول thick كامل

مرحلة الانزعة ، بصيروا الاكثين يقتربوا كجف ف

- 1] H zone قلت
- 2] I band قلت
- 3] A band ثابت
- 4] z-line ثابت (كطول)
- 5] sarcomer قلت
- 6] whole fiber قل (كطول)

لما يجي بالامتحان انه Z-line كطول (length) لا يتغير لكن لو سأل عن المسافة بين z line الأول والثاني ← يقل

- 1] H-zone اختفت
- 2] I-band اختفت
- 3] A-band ثابت

ممكّن بالامتحان بدل كلمة diameter (طول) يجي radius (نصف القطر) وتكن تجيب عن المسافة بين منطقتين

اللي ما بتغير أبدًا ←

- length of z-line
- length of A-band

CONTRACTILE PROTEINS

- **Myosin** is the motor protein in all three types of muscle tissue and makes up thick filament, which consists of a tail and two myosin heads.
- **Motor proteins** pull various cellular structures to achieve movement (muscle contractions) by **converting the chemical energy in ATP to the mechanical energy of motion**, that is, the **production of force**.
- Thin filaments are anchored to Z discs. Their main component is the protein **actin**. **On each actin molecule is a myosin-binding site**, where a myosin head can attach during muscle contraction.

- مستحيل حدوث contraction بدون action potential

← يعني في مكان على الأكتين يرتبط عليه الميوسين

REGULATORY PROTEINS

- They are **tropomyosin** and **troponin**, that help switch muscle contraction process on and off.
- In **relaxed muscle**, myosin is blocked from binding to actin because strands of **tropomyosin** cover the myosin binding sites on actin. The tropomyosin strands in turn are held in place by troponin molecules.
- When **calcium ions bind to troponin**, it undergoes a change in shape; this change moves tropomyosin away from myosin-binding sites on actin and **muscle contraction** subsequently begins as myosin binds to actin.

سبب تسمية هذه البروتينات بهذا الاسم ؟ فاسب الحاجة إلى الكالسيوم و ATP ؟

- الكالسيوم الموجود داخل sarcoplasm يحتاجه في عملية contraction لأنه الموقع الموجود على الأكتين عندما تكون relaxed ← muscle

يكون مرتبط ب tropomyosin فتكون الخلية في حالة relaxation وعندما يصل action potential

وتخرج أيونات الكالسيوم من السيتروليزم ، يرتبط الكالسيوم مع troponin و ar troponin أي tropomyosin بالخروج من active site الموجود على الأكتين و بجبي يرتبط محله الميوسين

← طول ما الخلية relaxed بفضل tropomyosin مرتبط على الموقع active site على الأكتين وتبدأ عملية sliding

بدون troponin و tropomyosin لا يمكن حدوث عملية contraction

• سبب الحاجة إلى ATP :- في حال myosin وكان يرتبط عليه جزئ ATP

STRUCTURAL PROTEINS

- They contribute to the alignment, stability, elasticity, and extensibility of myofibrils.
- Several key structural proteins are **titin**, **α -actinin**, **myomesin**, **nebulin**, and **dystrophin**.
- **Titin** is the third most plentiful protein in skeletal muscle (after actin and myosin), it has a huge size. It accounts for much of the elasticity and extensibility of myofibrils.
- **Titin** probably helps the muscle return to its resting length after a muscle has contracted or been stretched, and it may help prevent overextension of muscles; thereby helping to stabilize thick filament position.

• تتجاذب على environment و structure of actin and myosin

• تحافظ على Binding site

• الحفاظ على elasticity و extension

• الحفاظ على normal function

THE CONTRACTION CYCLE

Contraction cycle consists of four steps:

1. ATP hydrolysis.
2. Attachment of myosin to actin to form **cross-bridges**.
3. **Power stroke**.
4. **Detachment** of myosin from actin.

cross bridge:-

عملية ارتباط الميوسين مع الأكتين

power stroke

نتيجة Cross bridge بين الأكتين والميوسين المتكثرة والتي تكون عددها عالية جدًا والتي تعمل على الأكتين على الميوسين لجهة المنتصف M-line

THE CONTRACTION CYCLE

Each of the 600 cross-bridges in one thick filament attaches and detaches about five times per second.

EXCITATION-CONTRACTION COUPLING

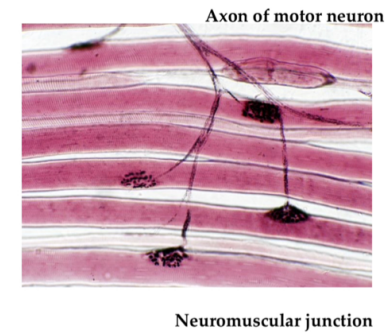
The events just described are referred to collectively as **excitation-contraction coupling**, as they are the steps that connect **excitation** (a muscle action potential propagating along the sarcolemma and into the T tubules) to **contraction** (sliding of the filaments).

excitation $\Rightarrow$ action potential

❖ **Synapse:** A functional connection between a neuron and another cell.

❖ **Two types of synapses:**

1. **Electrical synapse.**
2. **Chemical synapse**, i.e., neuromuscular junction.



synapse في muscles ← chemical ونوع الناقل Ach ا سليل كولين

NEUROMUSCULAR JUNCTION

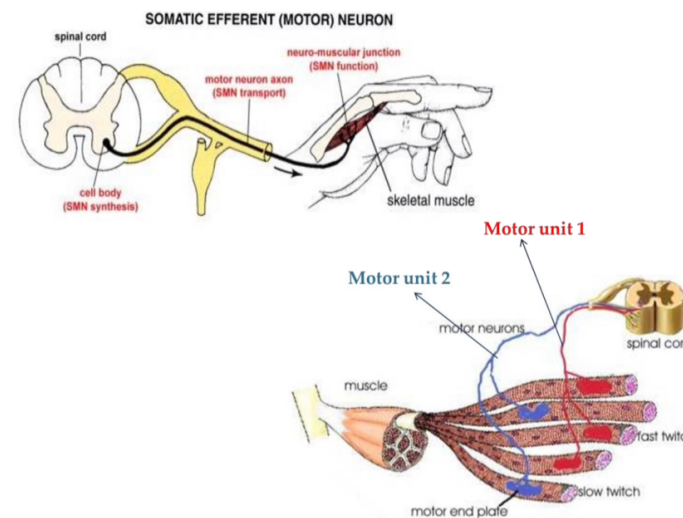
- Is the junction (**synapse**) between a nerve (**motor neuron**) and a muscle cell (**muscle fiber**).

- **Motor neuron** is the neuron that innervates a muscle fiber.

- **Motor unit** : single motor neuron and the muscle fibers it innervate.

- As axon approaches muscle , it divides into many terminal branches and loses its myelin sheath.

- Each of these axon terminal forms special junction, a **neuromuscular junction** with one of the many cells that form the whole muscle.



الفاصل ما بين **Sarcomere** الاول
عن الثاني عن الثالث ...
اسمه **neuromuscular junction**