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INNERVATION/CONTRACTION

- Striated muscle fibers do not show graded contraction---all or none.
- To vary the force of contraction--- fibers within a muscle fascicle do not all contract at the same time.
- large muscles with many motor units---firing of a single motor axon -----tension proportional to the number of muscle fibers it innervates.



Notes:

All or none contraction: All the sacromerese in single muscle fiber cotracts.

However, groups of muscle fibers are relaxed where other are stretched, then they switch.example:postural muscles : العضلات الخلفية للجسم التي تمكننا من الوقوف لفترات طويلة دون تعب

The muscle fibers that are innervated with one axon will contract while the other fibers will be relaxed. This can be observed , in the postural muscles that have different types of muscle fibers from qudercips.this point will be explained in the next slides.

4This slide is important.

CONTRACTIO

RELAXATION VERSUS

Check the black and white pictures, you should differentiate between the contracted and the relaxed sacromere

How to differentiate between them?



TYPES OF MUSCLE FIBERS (skeletal)

· Slow oxidative: Type I (SO) dark or red in Color

Slow contractions over long periods without fatigue, having many mitochondria, many surrounding capillaries, and much myoglobin $\longrightarrow Sou(CC) OS OXOCC$ $<math>\searrow Source OS Sugar$

· Fast glycolytic: Type IIb (FG) the lighter one

Rapid, short-term contraction, few mitochondria/capillaries and depending on anaerobic metabolism, fibers appear white. Rapid contractions – rapid fatigue due to lactic acid production, energy from glucose (glycogen).

- Fast oxidative-glycolytic: Type IIa (FOG)

Physiological and histological features intermediate between those of the other two types.

Myosin ATPase



<u>Notes</u>: Check the figure:

6

myosin ATPase protien is stained by immunohistochemistry

The darker ones have high intensity of the label; which means they have alot of ATPase protein attached to the myosin which makes their contraction more efficient.

Fatigue: sore, tiredness, it is reffers to the lactic acid. Sparse: قليل

	Slow, Oxidative Fibers (Type I)	Fast, Oxidative-Glycolytic Fibers (Type IIa)	Fast, Glycolytic Fibers (Type 11b)
Mitochondria	Numerous	Numerous	Sparse
Capillaries	Numerous	Numerous	Sparse
Fiber diameter	Small	Intermediate	Large
Size of motor unit	Small	Intermediate	Large
Myoglobin content	High (red fibers)	High (red fibers)	Low (white fibers)
Glycogen content	Low	Intermediate	High its sacroplazm so there's
Major source of ATP	Oxidative phosphorylation	Oxidative phosphorylation	Anaerobic glycolysis
Glycolytic enzyme	Low	Intermediate	High
activity Produce Luckin	acid		
Rate of fatigue	Slow	Intermediate	Fast
Myosin-ATPase activity	Low	High	High
Speed of contraction	Slow	Fast	Fast
Typical major locations	Postural muscles of back	Major muscles of legs	عصلات العن

Myoglobin: globular sarcoplasmic protein similar to hemoglobin which contains iron atoms and allows for O_2 storage. Gives (SO) the (ed color

Rigor mortis

When the neural impulse stops and levels of free Ca2+ ions diminish, tropomyosin again covers the myosin-binding sites on actin and the filaments passively slide back and sarcomeres return to their relaxed length . In the absence of ATP, the actin-myosin crossbridges become stable, which accounts for the rigidity of skeletal muscles (**rigor mortis**) that occurs as mitochondrial activity stops <u>after death</u>.

اقرؤوا عنه اكثر . الموضوع اله علاقة بالجرائم و تحديد وقت موت الجثة.

Cardiac muscles

- Cells align into chain-like arrays.
- Form complex junctions between interdigitating processes
- Cells within one fiber often branch..
- Mature cardiac muscle cells are 15-30 μ1 in diameter and 85-120 μm long, They are wider than
- · Striated due to the Z-disc
- One centrally nucleus located.
- Each muscle cells is a surrounded by endomysium with a rich capillary network.



Cardiac muscle.

10<u>Notes</u>:

Has one nucleus---->Single cell only

The cardio myocytes are highly vascularised. they need constant blood supply, because the don't have enough amount of glycogen so they rely on the nutrients in the blood.

The perimesium in the skeletl mucles surounds the fascicles .

While The Perimesium in the cardiac muscles

...forms "the skeleton of the heart",

...it is acondensation of connective tissue that seprates the atrials and the ventricles from each other.

..It is quitly an electrical isoltion so th artials contraxt before ventricals wich depends on the thuckening of the perimesium



Intercalated discs



H&E , light microscope I: interlacated disc .S: more closely spaced striations. N: nucleus



D: desmosomes F:Facia adherentes M: mitochondria

Notes :

Cardiac muscle development:

mesenchymal myoblast have developed(increased in size) but don't form a fiber like the skeletal muscles so they decide to branch. cardiac muscle cells are large branched myoblasts. branched المهم انهم

Cardiac muscle tissue has less **myofibrils** than the skeletal

z disc=Striation ,esonophilic,demarcates the connection between cells side by side or in the branching.

Cardiac muscles

- 2 regions
 - Intercalated discs: transverse lines that cross the fibers at irregular intervals where the myocardial cells join (junctional complexes). Connect between cells
 - Transverse regions: many desmosomes and fascia adherens junctions--- strong intercellular adhesion. binding the cells to ght by bogether; they prevent detachment.
 Longitudinally: run parallel to the myofibrils and are filled with gap junctions
 - (ionic continuity between the cells).

15 <u>Notes</u>:

There are no axsons attach to cardiac Cells and release neurotransmitters. instead they have S A node (specific cells) their membrane is instable produce action potential transported internalized (داخليا), where the Na+ flow through gap junctions in the Elongitudinal aspect of interlacated disc.

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However, the automic nervous system axons attached to the Sa node.controll the rate of Sa node action potentials.

So the axons control the heart rate butthey are not the reason of the heart bumping.

Cardiac muscles

- Mitochondria occupy up to 40% of the cell volume.
- Fatty acids, the major fuel of the heart, are stored as triglycerides.
- Glycogen granules are present.
- T-tubules in ventricular muscle fibers are well-developed, but much smaller atrial regions.
- Sarcoplasmic reticulum is less well-organized.
- **Dyads**: the junctions between terminal cisterns and T-tubules involve only one structure of each.

17<u>Notes:</u>

Have more mitochondria than the skeltal; which provide constant **source of energy** for the continuos contraction of the heart, they also have a constant source of nutrient due to the rich network of capillaries that surounds them.

T-tubules in ventricular muscle fibers are well-developed, with large lumens and penetrate the sarcoplasm in the vicinity of the myofibrils' Z discs. In atrial muscle T-tubules are much smaller or entirely absent.

Sarcoplasmic reticulum is **less well-organized in cardiac compared** to skeletal muscle fibers.

The junctions between its **terminal cisterns and T-tubules typically involve only one structure of each type (1 t tubule :1 sacroplasmic cisternae)**, forming profiles called **dyads** rather than triads ; the cardiac muscles are shorter.

The contraction in the vintricles(thicker) is much stronger than atrials

Cardiac muscles

- Cardiac muscle fiber contraction is intrinsic and spontaneous.
- Impulses for the rhythmic contraction initiated, regulated, and coordinated locally by nodes of unique myocardial fibers.
- Contraction of individual myocardial fibers is all-or-none.
- The rate of contraction is modified by autonomic innervation at the nodes of conducting cells.
- Sympathetic nerve supply accelerating and the parasympathetic supply decreasing it

19 Notes:

Intrinsic(ذاتي) contraction means that the heart has its own electrical circuits intiats in the Sa nodes and spreads by gap junjtions in artrials then it is slightly delayed when it is spreaded to the ventricles.

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There is no fatigue in the cardiac muscles ; they are oxidative so there is no lactic acid to cause fatigue.

The hypertrophy of cardiac muscle :

Cardio exercise strengthening the cardiac muscle by increasing the **size** of the cardiac muscles not the number of muscles, it increases the synthesis of <u>myofibrils</u>.

The hypertrophy of skeletal muscle :

Exercising increase the size of the muscle by increasing the nomber of SO fibers.

Exercise enlarges the skeletal musculature by stimulating formation of new **myofibrils** and growth in the diameter of individual muscle fibers. This process, characterized by increased cell **volume**, is called **hypertrophy**

Tissue growth by an **increase in the number of cells** is termed **hyperplasia** which takes place very readily in smooth muscle, whose cells have not lost the capacity to divide by **mitosis**.

21 Book questions

A 66-year-old man who lives alone has a severe myocardial infarc®tion and dies during the night. The medical examiner's office is called the following morning and describes the man's body as being in rigor mortis. This state of rigor mortis is due to which one of the following

a. Inhibition of Ca2+ leakage from the extracellular fluid and sarco@plasmic reticulum

b. Enhanced retrieval of Ca2+ by the sarcoplasmic reticulum

c. Failure to disengage tropomyosin and troponin from the myosin active sites

d. Absence of ATP preventing detachment of the myosin heads from actin

e. Increased lactic acid production

Answer is d

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In one type of muscle, numerous gap junctions, desmosomes, and adherens junctions are specifically localized in which structures?

- a. Myofilaments
- b. Dense bodies
- c. Sarcomeres
- d. Neuromuscular spindles
- e. Intercalated discs

Answer is e

Which characteristic is unique to cardiac muscle?

- a. Contain centrally located nuclei
- b. Striated
- c. Often branched
- d. Multinucleated
- e. Lack T-tubules

Answer is c

ملاحظة مهمة هناك محاضرة مخصصة smooth muscles الآتي مجرد مقدمة



SMOOTH MUSCLE

- Slow and steady contraction
- Under the control of autonomic nerves and various hormones.
- Present in blood vessels, digestive, respiratory, urinary, and reproductive tracts.
- Fibers of smooth muscle are elongated, tapering, and <u>unstriated cells</u>. → No Z-disc.
- Enclosed by an endomysium (a network of type I and type III).
- Length is 20 μm 500 $\mu m.$



Their contractoin is weaker than other muscle types.

They are single spindle like cells , found everywhere.

Hormonal regulation: eg. Oxytocin in the female uterus

Very long, wich is important feature when they are extremely stretched in the female uterus during pregnancy.

SMOOTH MUSCLE

- Lack well-defined neuromuscular junctions
- Axons of autonomic nerves have periodic swellings close to muscle fibers----synaptic vesicles-----acetylcholine o norepinephrine---binds receptors in many muscle cells.
- Stimulation is propagated via gap junctions-----contract synchronously
- Fibroblast activity!!!

لم يتم شرحها

27 <u>Notes</u>:

lack of bulbs that contact with the muscle, instead there are swelling in the axons release neurotransmitters. لتقريب الصورة مثل عملية الري بالتنقيط

Then the action potential is spreaded by the gap junction in the cell muscle to the other cells that haven't received neurotransmitters.

سبحانك اللهم و بحمدك، نشهد أن لا إله إلا أنت ، نستغفرك و نتوب إليك

V1 Slide 19

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