Muscles

How many skeletal muscles are present in our body?

-646 muscles

The functions of the muscles are:

* Movement
* Maintenance of posture
* Generation of heat
* Stabilization of joints : amount of muscle surrounding joint is very important

Muscles are *excitable* *& contractile*, *extensible* and *elastic* to some extent.

Muscle types

1- Skeletal; striated, voluntary

\*Some skeletal muscles are striated but not voluntary

\* Some are voluntary up to a limit like the diaphragm

2- Cardiac; striated & involuntary \*muscles of the pharynx \*

The heart muscle is striated and innervated by the autonomic nervous system

\*any structure innervated by autonomic nervous system is involuntary

3- Smooth; non-striated, involuntary

Fibre in a muscle means: a cell

E.g. cardiac muscle fibre = cardiac muscle cell

1) Skeletal Muscles

Myofilaments mainly contain actin (thin) & myosin (thick)

^not restricted to muscles only, other organs or part of body may contain them

**Sarcolemma** is the plasma membrane of the muscle

**Sarcoplasm** is the cytoplasm of the muscle

**Sarcoplasmic reticulum** is the endoplasmic reticulum

Skeletal muscle fibres e.g. deltoid muscle , its surrounded by dense connective tissue which contains the blood vessels and nerves entering the muscle, this is called **epimysium** (in anatomy it's called muscle fascia) - connective tissue surrounding whole muscle

Each muscle is an organ by itself, so we have 646 muscular organs in the body

Each muscle has many vesicles inside, each vesicle would be surrounded by a connective tissue that is continuous with the epimysium, and this is called **perimysium**

**Endomysium** - each muscle fibre is surrounded by this connective tissue, this is continuous with perimysium

\*Epimysium is continuous with dense regular connective tissue of the tendon of the muscle

Tendon is attached to **periosteum**; some fibres pass through the bone

Sarcolemma invaginates deep into the muscle - this is called **transverse tubule** -" T-tubule"

Inside the muscle, nuclei of the muscle is located *peripherally* immediately underneath the sarcolemma, no. of nuclei varies from one muscle fibre to another, sometimes 100nuclei - indication myoblast fused together to form one cell - skeletal muscle fibre

Amount of mitochondria is enormous; they are randomly disturbed they are adjacent to nuclei, underneath plasma membrane

Triad: 2 endoplasmic reticulum (intercommunicating with each other) surrounding one T-tubule

There is an alteration of dark and light areas under high magnification of muscle fibre.

\*structures having the ability to refract polarized light are called **anisotropic** and appear as dark areas (A-Band)

\*structures having low affinity to refract polarized light are called **isotropic** and appear as light areas (I-band)

Inside I-band there is a line called "Z-line"

2 Z-lines from 2 adjacent cells are called **sarcomere**; unit of contraction

1 sarcomere contains: 1 complete A-band and 2 halves of 2 adjacent I-bands

During relaxation, if you look at the light area, it contains actin, actin and actin

While if you look at the dark area it contains actin myosin, actin myosin... etc

In the middle of the A-band there is an area called "H-band" in the middle of the H-band there is an "M-line"

During contraction, 2 Z-lines approach each other as if we are closing the I-band, 2 actin filaments slide over the myosin, they come in contact with each other but they don't overlap. I band width reduced, A band width not affected

\*In each sarcomere there are 2 triads; 2 T-tubules and 4 endoplasmic reticulum arranged regularly in the A-I junction

Each muscle fibre has its own innervations, when a nerve reaches the epimysium it starts dividing into nerve fibres, if the muscle is performing a flexion action, the no. of nerves supplying it is large, if the muscle is performing a rough action, and the no. of nerves supplying it is small.

In between ends of the axon and the surface of skeletal fibre there is a synaptic cleft where ACH is released, axon terminal + muscle + cleft = **motor end plate**

In the terminal part of the axon, no. of mitochondria is great as this is an active process that needs energy

When T-tubules are excited, Ca is released from smooth ER, and in case of relaxation Ca is stored in smooth ER.

Once Ca is released contraction occurs

Muscle fibres have several types

Classified into **red and white**

-Classified into type 1, type 2a (red)

-and type 2b (white)

^without staining they all look the same as they have peripheral nuclei - t-tubules etc...

Type 1 and type 2a have rich vascularity compared with type 2b (that's why they are called RED fibres)

Type 2a is an intermediate between type 1 and 2b



Muscles of the back contract in a repetitive manner (for maintaining posture)

Sarcoplasmic reticulum *is very extensive* in type 2b as contraction is fast, liberation of calcium is needed

**Satellite cell**: outside muscle fibres, it fuses with muscle and stimulates growth of skeletal muscle fibres

Some satellite cells degenerate with old age, therefore muscle fibres don't regenerate as there isn't a stimulant

\*Smooth muscles fibres have *good regeneration*

\*Skeletal muscle fibres have *poor regeneration*

\*Cardiac muscle fibres have *no generation* (also no mitotic ability)

Type 2a are the most common muscle fibres found

There are no isolated skeletal muscles in the human body

Skeletal muscle fibres are generally strong muscles

2) Cardiac muscle fibre

Heart: modified blood vessel, lined internally by endothelium called endocardiam

Muscle of the heart is called myocardial

Pericardial couples the heart

Fibrous pericardium and serous pericardium (parietal and visceral(epicardium))

Heart muscle is *striated*

*No neuromuscular junction* in the heart

Contains gap junctions *unlike skeletal muscle fibres*

Muscle fibres divide and branch

Nuclei is **central**

Mono or bi nucleated unlike skeletal muscle fibres which are *multinucleated*

In between 2 muscle fibres there is a functional complex called **intercalated disc** (only found in the heart)

This disc contains desmosomes in focal points of adhesion

Desmosomes seen in cardiac muscle fibres contain **desmin** (intermediate type of filament)

Desmosomes seen in epithelium contain **cytokeratin**

No. Of mitochondria in cardiac muscle is *much larger* than in skeletal but no. of smooth ER is *much less* in cardiac than skeletal

**"Diad"** instead of triad as 1 ER associated with 1 t-tubule

Position of the diad is next to Z-line (peripheral)

Very old people 50+ have collateral circulation

**Purkinje fibres** (special fibres) have less myofibrils than other cardiac muscles

More glycogen, much faster than other cardiac muscles

Striations are less peripheral; area surrounding nucleus appears as empty.

3)Smooth Muscle fibres

Smooth muscle fibres: either isolated or in sheets (most of the time)

-Present in blood vessels

Under epithelium e.g. digestive tract: there are single smooth muscle fibres which function to support connective tissue and overlying epithelium

-Appears spindle shaped, contains only one nucleus, ends overlap each other

Spaces between them are filled with connective tissue

If a smooth muscle is contracting, nucleus's shape changes \*most important factor for identification\*

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