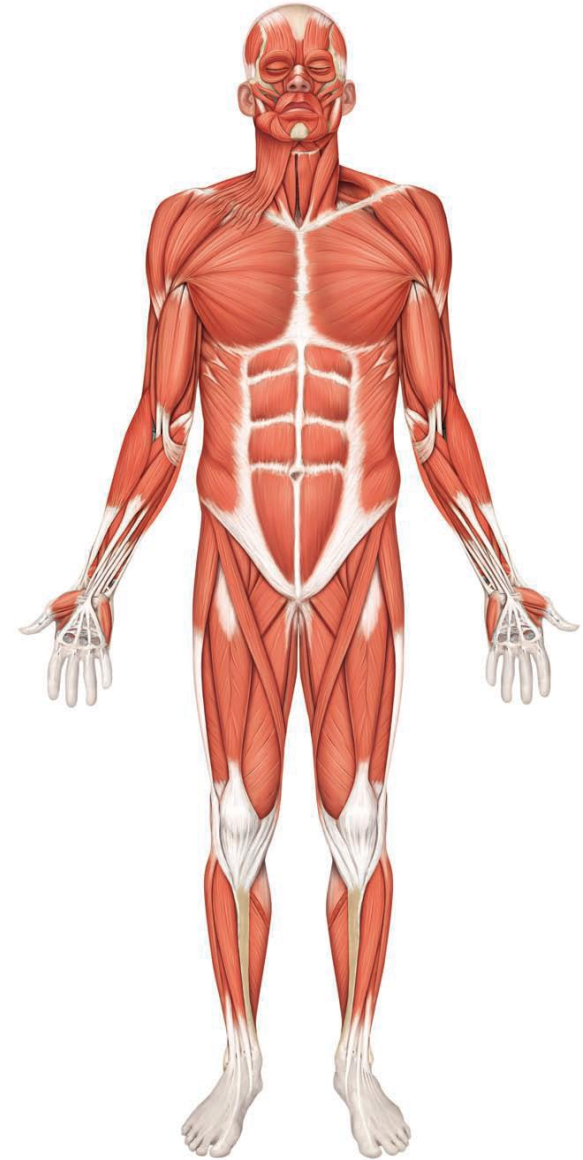


The Muscular System

Dr. Mustafa Saad
(2021)



Muscular Tissue

Muscular tissue is the type of tissue whose cells are differentiated to optimally use the contractile ability of the cells.

الوظيفة هي الانقباضات

بس غيرنا الاسماء

Cell membrane = Sarcolemma

Cytoplasm = Sarcoplasm

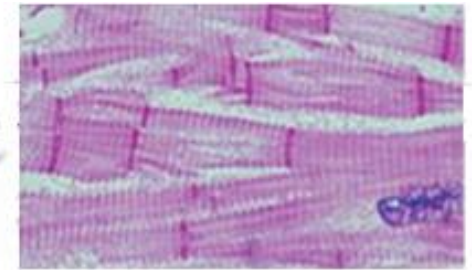
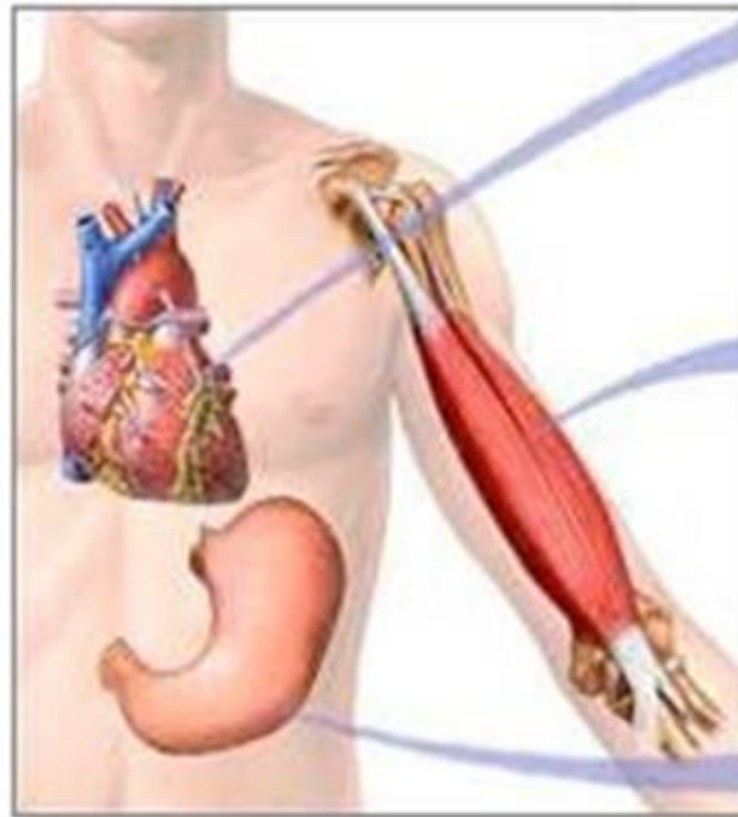
Smooth endoplasmic reticulum = Sarcoplasmic reticulum

Types of Muscle Cells

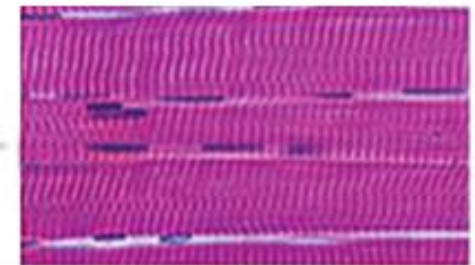
➤ Muscle cells are relatively long, therefore, they're called muscle fibers

➤ There are three types of muscle cells:

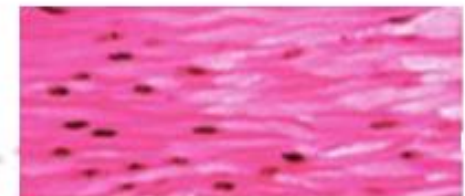
→ في ثلاث انواع



Cardiac muscle cell



Skeletal muscle cell

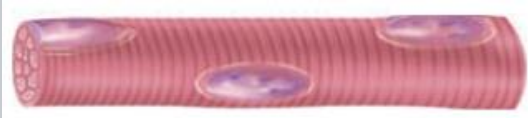
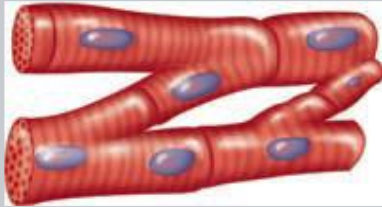



Smooth muscle cell

Fig.1: Types of muscle cells.

Comparison between the three types of muscle cells:

مهم حفظ هذا
الجدول

	<i>Skeletal</i>	<i>Cardiac</i>	<i>Smooth</i>
<i>Location</i>	<u>Attached to bones</u>	<u>The heart</u>	<u>Internal organs</u> <u>and skin</u>
<i>Shape</i>	<p>مستطيل Elongated and cylindrical أسطواني</p> 	<p>متفرع <u>Branched</u></p> 	<p>مغزلي <u>Spindle</u></p> 
<i>Nucleus</i>	Several peripherally located nuclei	Single centrally located nucleus	Single centrally located nucleus
<i>Striation</i>	Striated	Striated	Non-striated
<i>Function</i>	<ul style="list-style-type: none"> Movement of bone Heat production 	Beating of the heart	Movement of the viscera الاحشاء
<i>Control</i>	Voluntary — ارادي	Involuntary	Involuntary

غير ارادي

Notes

- Smooth muscle cells are held together by **desmosomes**. Also, **gap junctions** are present between the cells to allow the spread of Ca^{2+} (and thus contraction) rapidly between them.
- The branches of cardiac muscle cells meet each other at specialized structures called the **intercalated discs** which also contain desmosomes and gap junctions.

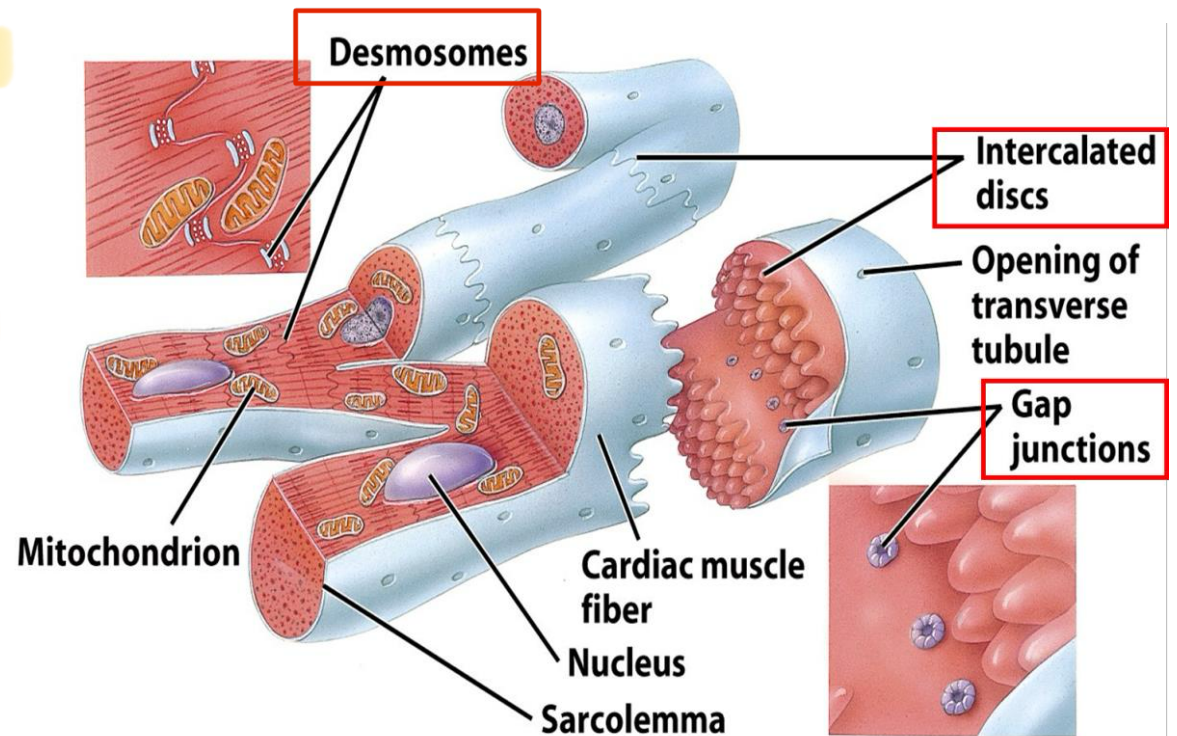


Fig.2: Cardiac muscle cells.

تتكون من

- **Skeletal muscles** are formed of several bundles of skeletal muscle cells. They are attached by tendons to bones.
- When a skeletal muscle contracts, the tendon will be pulled and this will pull the bone resulting in Movement.
- The **belly** of the muscle is the fleshy (wide) part between the tendons.
- Muscles have more than one bony attachment:
 - the attachment of a tendon to the relatively stationary bone is called the **origin**. هو المكان الي طلعت منه العضلة وما بتحرك يعني عبارة عن نقطة البداية
 - the attachment of the muscle's other tendon to the relatively movable bone is called the **insertion**. وهي عبارة عن نقطة النهاية الي بتحرك العضلة
 - the **action/s** of a muscle are the main movements that occur during contraction (e.g., flexion or extension).

هي عبارة انه نجيب insertion الى origin

ورح نتعرف في كل عضلة على origin و insertion لها

Organization of Skeletal muscles:

- Skeletal muscles are formed of several bundles of muscle fibers.

- Each fiber is surrounded by Endomysium: a loose areolar connective tissue layer. Each bundle is surrounded by ^{dense} connective tissue Perimysium. The whole muscle is surrounded by Epimysium: a dense connective tissue layer.



في شكلين لل tendon

- The collagen fibers in these three connective tissue layers will extend beyond the fleshy part of the muscle to form the cord-like tendons or the broad aponeuroses that attach muscles to bones.

شكله زي الورقة

انا مش فاهم
شو قصة
الصورة مع
السلاید !!
بس مش مهم
احلى
مشاوي
لعيونكم

شكله
زي
الحبل

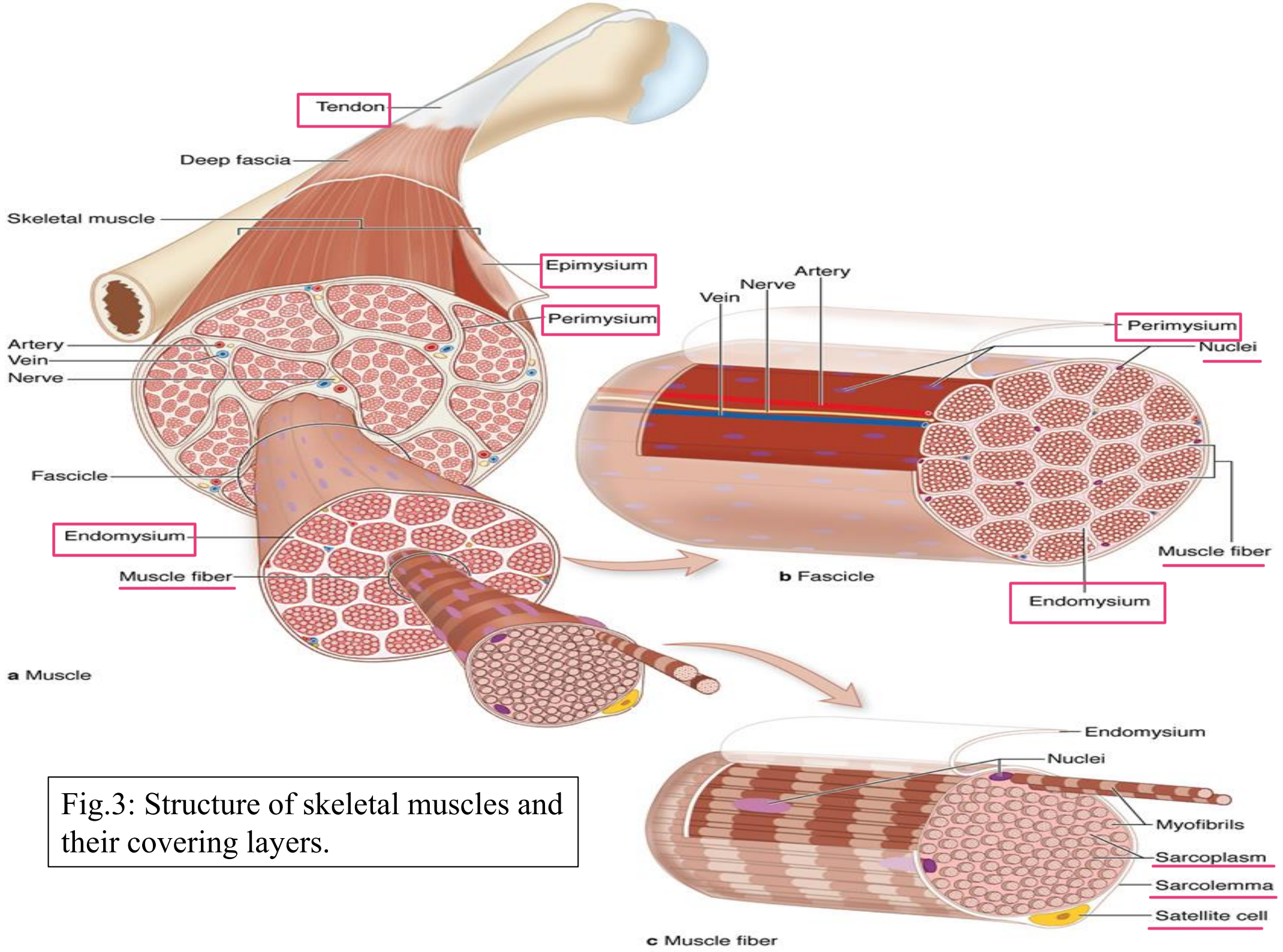


Fig.3: Structure of skeletal muscles and their covering layers.

Cross-Striation of skeletal and cardiac muscle cells:

- ✓ Skeletal and cardiac muscle fibers, under the LM, appear to have alternating dark and light areas. These are called the A and I bands respectively. The banding is due to the regular arrangement of the thin myofilament Actin and the thick myofilament Myosin.



Fig.4: Striation under light microscope.

- ✓ Under the EM, this arrangement proves to be more complex.

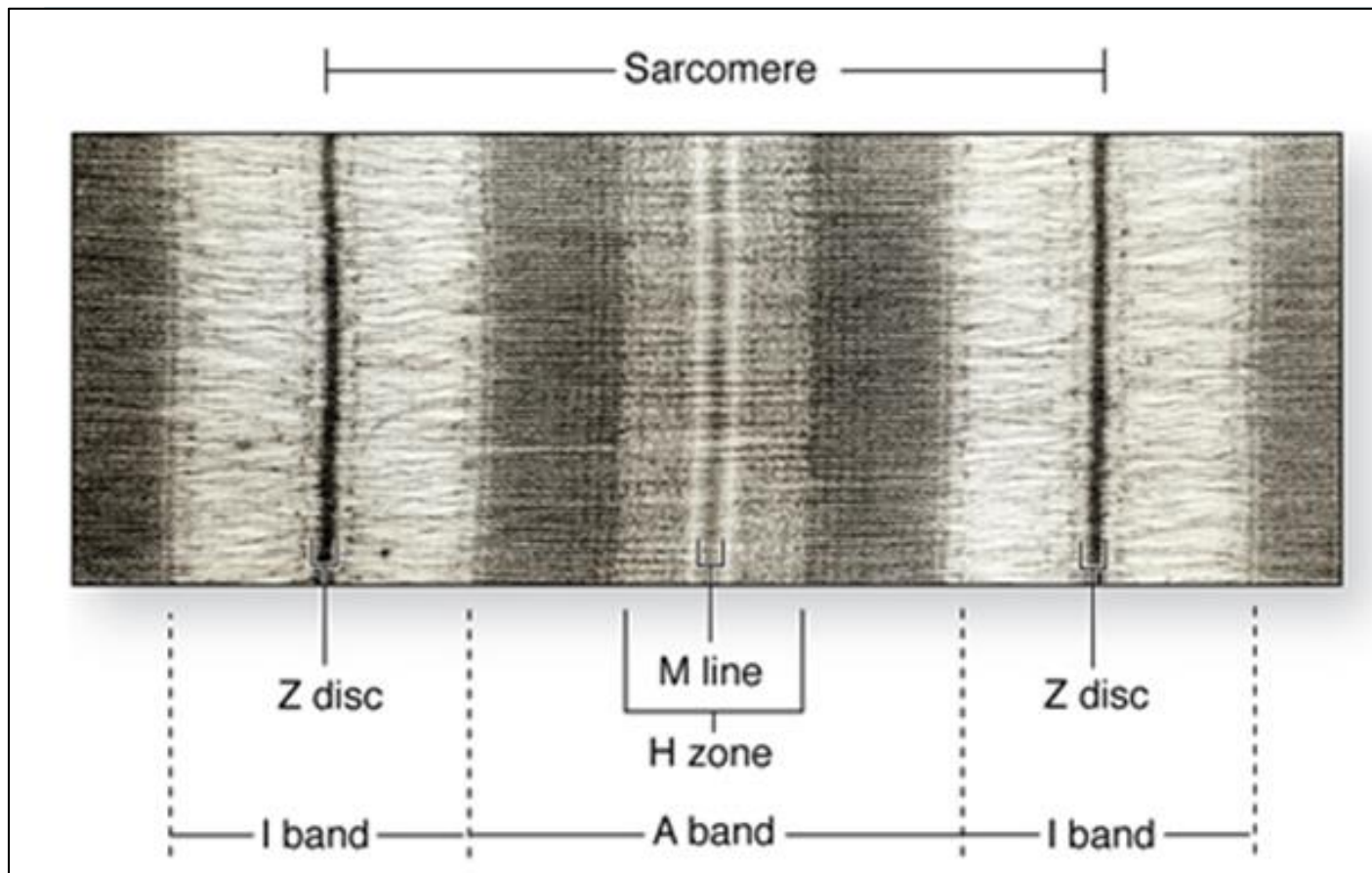
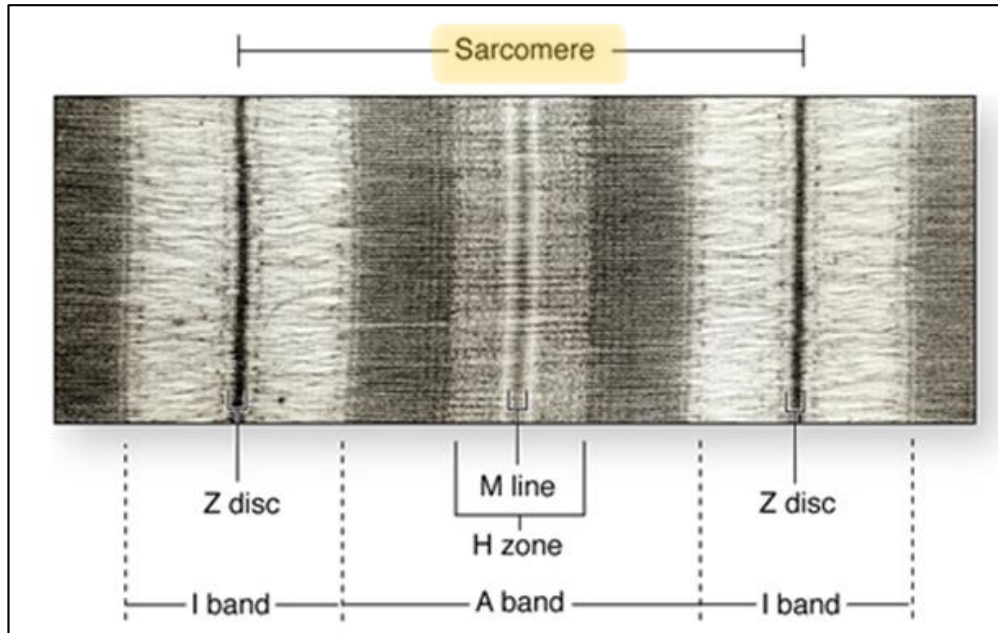


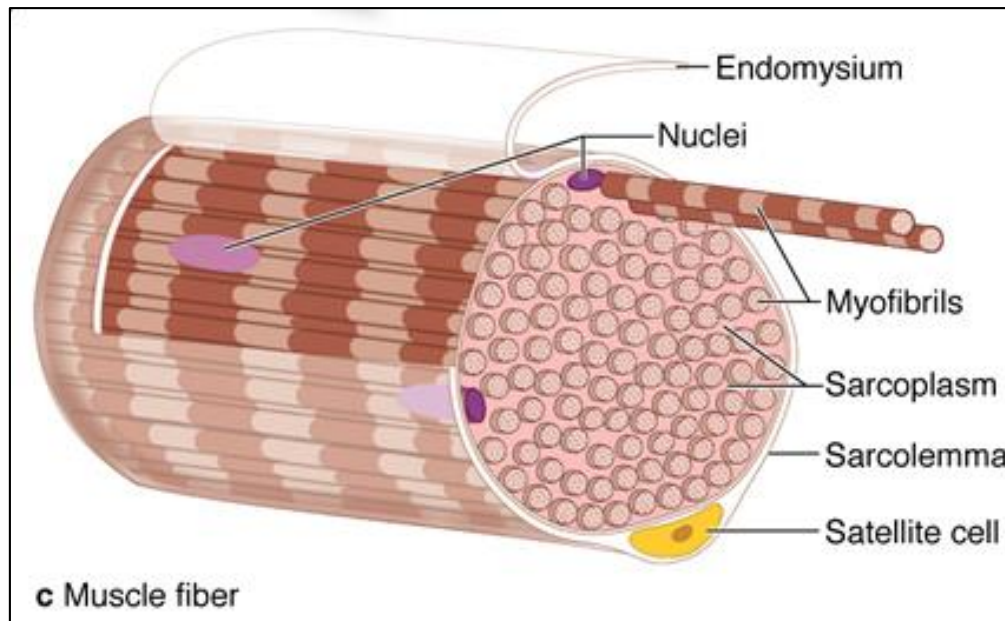
Fig.5: Striation under electron microscope.



- ✓ **H Zone**: a lighter colored area within the A band.
- ✓ **M Line**: darker colored line in the middle of the H zone.
- ✓ **Z Disc (Line)**: a dark line in the middle of the light I band.



- ✓ ***The Sarcomere:*** is the repetitive functional subunit of the contraction apparatus. It extends from one Z-line to the next Z-line.



- ✓ Several sarcomeres arranged end-to-end form the cylindrical myofibrils. Each muscle fiber contains several myofibrils.

Fig.6: Sarcomeres and myofibrils.

Muscle Regeneration

- ❖ **Skeletal muscle** cells cannot divide. Inactive *Satellite cells* ^{اصابات} are present close to the muscle fibers. When injury occurs, the satellite cells become active, divide and form new skeletal muscle fibers. This is also thought to be the mechanism by which skeletal muscles **hypertrophy** after **exercise**.



زي اخوانا الشباب لما يلعبوا في الجيم هم زي بقطعوا
العضلة عشان تتنشط Satellite cells وتبني مكانها ووهيك
بتكبر hypertrophy وتتضخم

- ❖ **Cardiac muscles** cannot divide and they lack satellite cells. After injury, the damaged muscles are replaced by a connective tissue scar.
- ❖ **Smooth muscle** cells can divide, and, therefore, can easily replace damaged cells.

Muscles Of The Head

Muscles Of Facial Expression

- Muscles of facial expression:
 - Lie within the subcutaneous layer. يعني بتشد الجلد الى العظام ويطلع عنا تعابير الوجه
 - Usually originate from **skull bones** & insert into the **skin.** origin insertion
 - Are all supplied by the **Facial nerve.** الي اخذناهم كان رقمه 7
- Because of their insertions, the muscles of facial expression move the skin rather than a joint when they contract. Because of this, these muscle produce the wide variety of facial expressions that humans have.

Zygomaticus major –

The muscle of true
smile

Risorius –

The muscle of false
smile (probably
present only in
humans and gorillas)

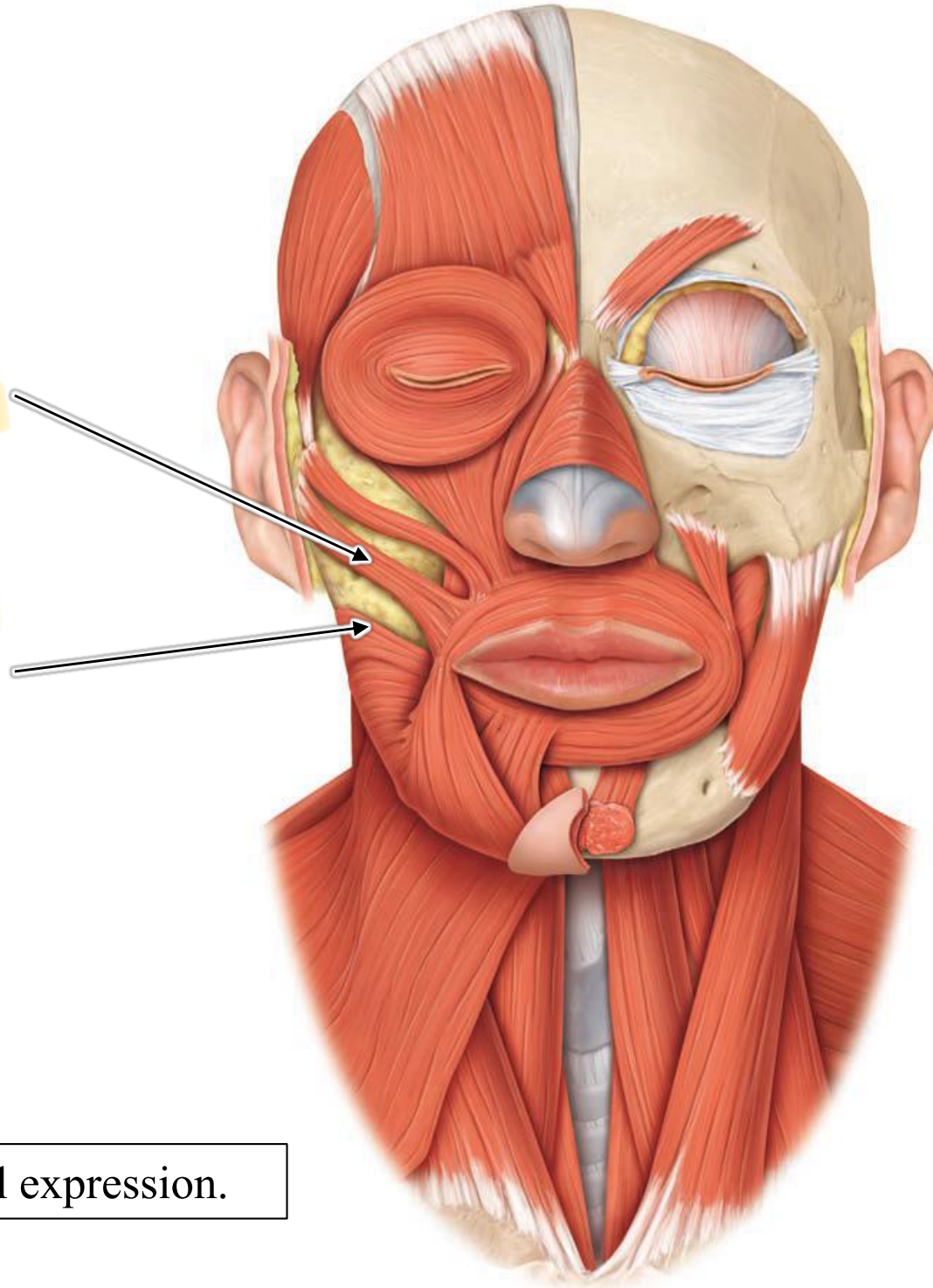
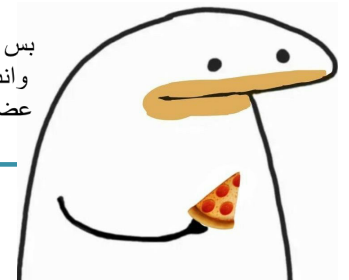


Fig.7: Muscles of facial expression.

Muscles of Mastication (Chewing)

- Four pairs of muscles move the mandible, and are known as 'muscles of mastication'. ^{الفك} المضغ.
- They are all supplied by the **mandibular branch of the trigeminal nerve**. ^{الي اخذناه كان رقمه 5}
- The **masseter**, **temporalis**, and **medial pterygoid** ^{اغلاق الفم} close the mouth and account for the strength of the bite.
- The **lateral pterygoid** is also the main depresser of the mandible as in ^{خفض الفك} opening the mouth. Note that **Gravity** ^{والجاذبية بتساعد على اخفاض الفك كمان} assists in depressing the mandible (plus other muscles).
- The **medial** and **lateral pterygoid** muscles help to chew by moving the mandible from side to side.

بس لما نحكيك تسكر فمك
وانت بتأكل شكلها بتكون
عضلات اغلاق الفم فلتانه
عندك



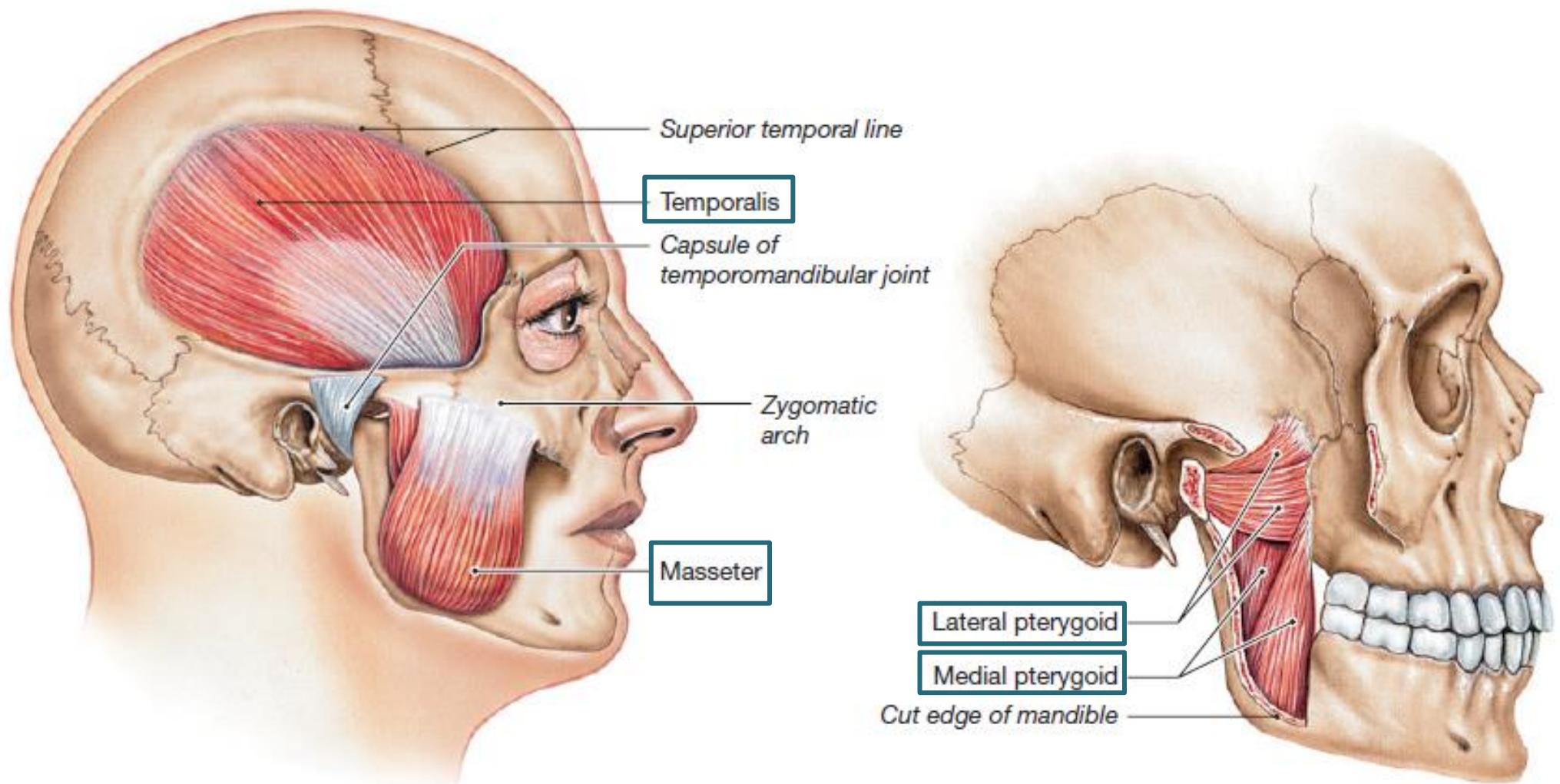


Fig.8: Muscles of mastication.

Muscles Of The Tongue

- Muscle of the tongue include:

- Intrinsic muscles (originate ^{داخل} and insert within tongue). These are responsible for changing the shape of the tongue. يعني بتعج اللسان
- Extrinsic muscles (originate ^{خارج} outside the tongue, insert into tongue). These are responsible for moving the tongue.

- Genioglossus is one of these extrinsic muscles. It moves the tongue forwards.

Origin = mandible
Insertion = tongue

بنودي اللسان الى الفك يعني بطلع لسانك لبرا

- All muscles of the tongue are supplied by the Hypoglossal nerve, ^{الي اخذناه رقمه 12} except the palatoglossus. ^{اما هذه vagus nerve الي رقمه 10}

Origin = palatal bone
Insertion = tongue

يعني بتودي اللسان وبرجع الى الوراء

Extrinsic
muscles

Palatoglossus

Genioglossus

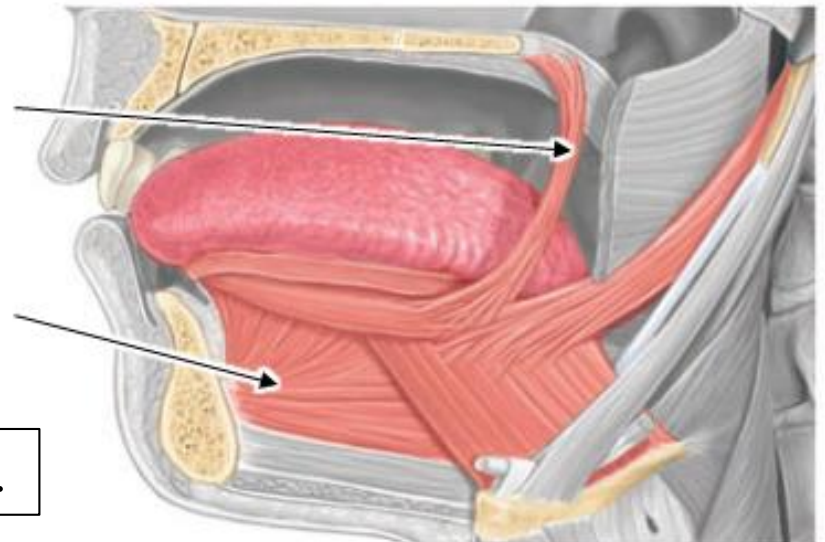


Fig.9: Muscles of the tongue.

Muscles Of The Neck

- The **Sternocleidomastoid** (SCM) muscle is an important anatomical landmark in the neck. It divides the neck into an anterior and a posterior triangle.

Origin = Sternum and Clavicle bone
Insertion = Mastoid process and the occipital bone

- The SCM muscle arises from the sternum and clavicle and is inserted into the mastoid process and the occipital bone. Its motor supply is by the accessory (XI) nerve. If the muscles on both sides contract, they'll flex the head. If the SCM muscle of one side contracts, it'll rotate the head to the side.

If the muscles on both sides contract
(Neck flexion)
ثني الرقبة للأمام

If the muscles on one sides contract
Rotation to the opposite side (Contralateral rotation)
تدوير الرأس للجهة المعاكسة
Tilting to the same side (Ipsilateral tilt)
ميلان الرأس لنفس الجهة

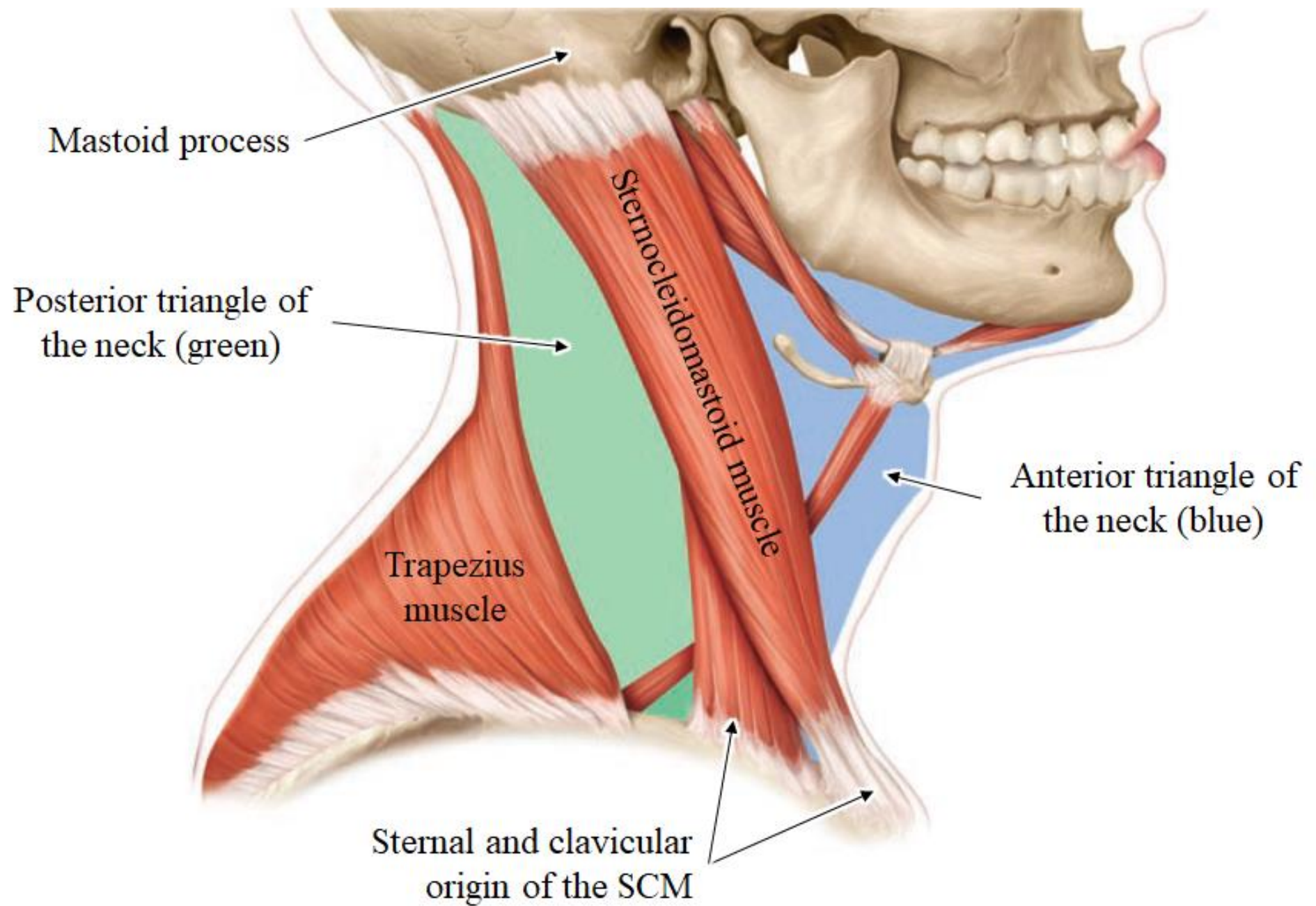


Fig.10: The sternocleidomastoid muscle.

■ **Anterior Triangle:**

1. **Anterior border:** midline
2. **Posterior border:** SCM muscle
3. **Superior border:** Mandible

■ **Posterior Triangle:**

1. **Anterior border:** SCM muscle
2. **Posterior border:** Trapezius muscle
3. **Inferior border:** Clavicle

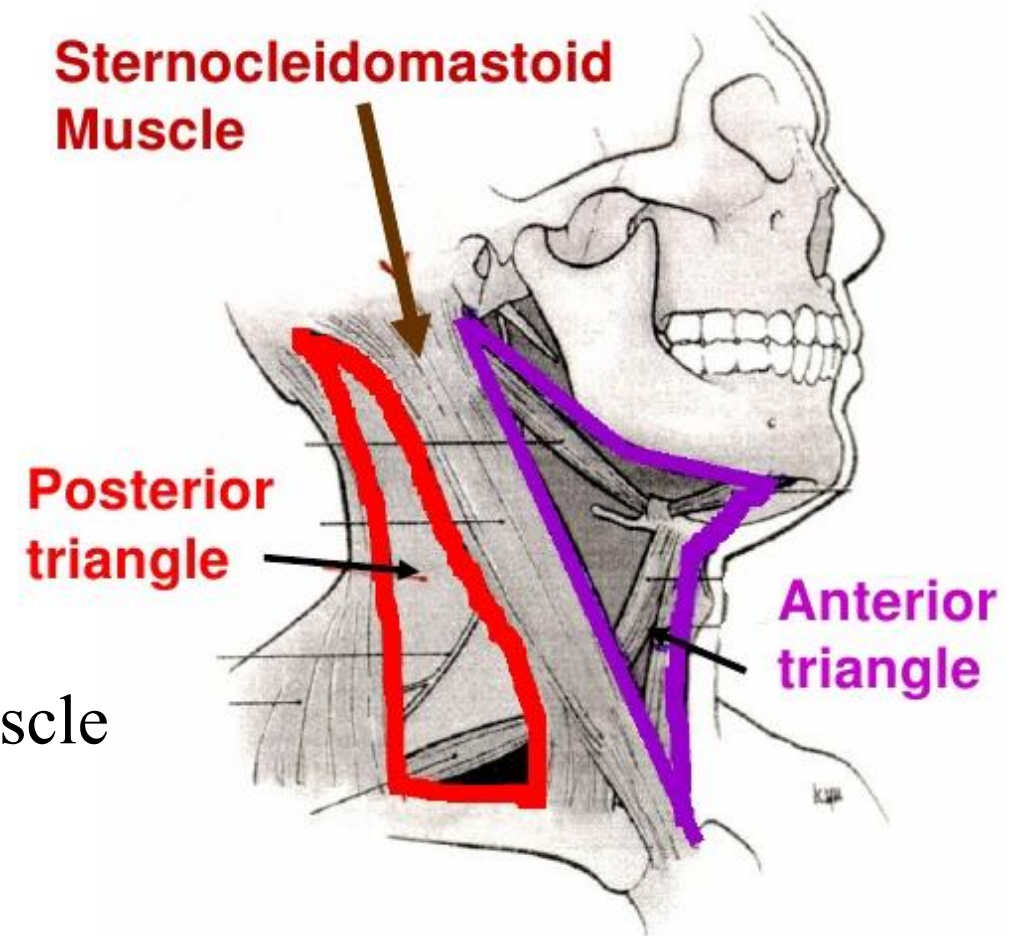


Fig.11: Boundaries of the triangles of the neck.

- In the *anterior part of the neck*, we have the suprahyoid and infrahyoid muscles. These muscles move the hyoid bone and perform other functions.

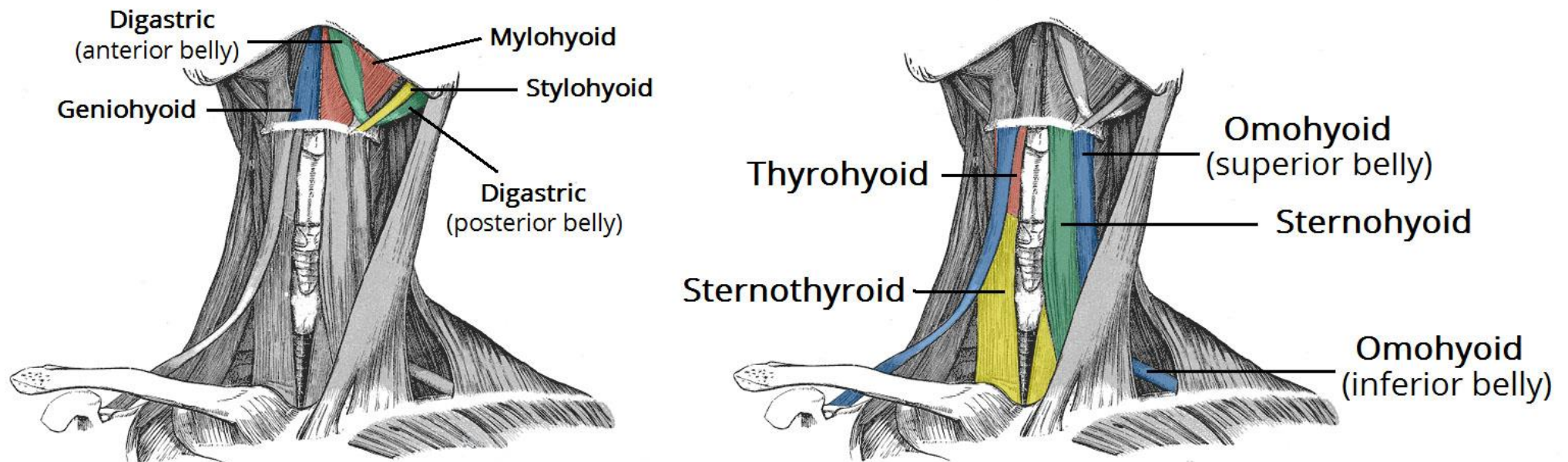


Fig.12: The suprahyoid (left) and infrahyoid muscles (right).

- In the **lateral part of the neck**, we have the **scaleni muscles**. *Scalenus anterior* is an important landmark in the neck with several important relations. Among these relations we have: the subclavian artery and vein and the trunks of the brachial plexus.

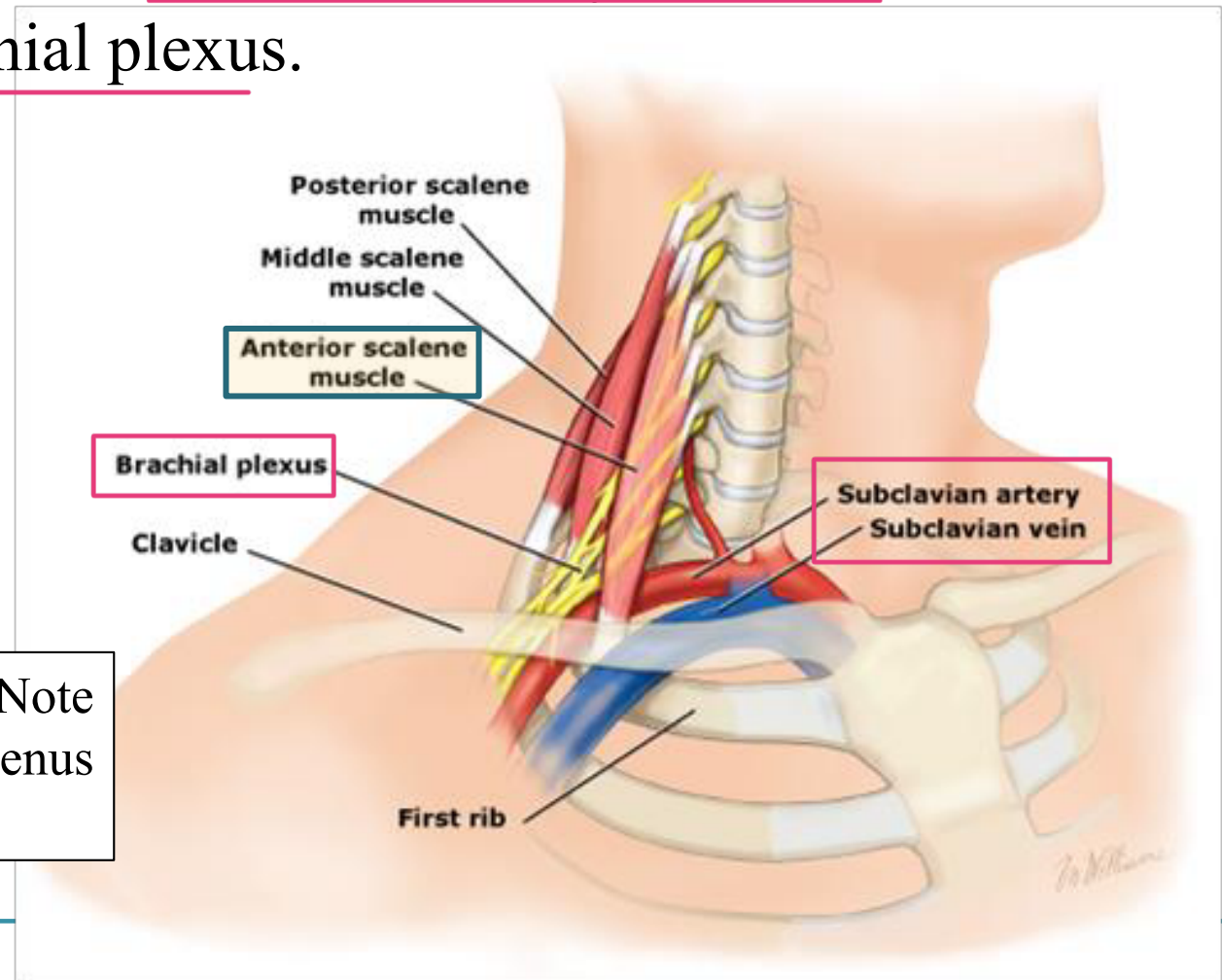


Fig.13: The scaleni. Note the relations of the scalenus anterior muscle.

Respiratory Muscles Of The Thorax

- Respiratory muscles alter the size of the thoracic cavity which affects the pressure in the lungs, and that determines whether we inhale or exhale.
شہیق زفير
- Between the ribs we have the intercostal muscles arranged in three layers: the **external, internal, and innermost intercostal muscles**. Between the internal and innermost intercostal muscles, we have the intercostal nerve and vessels.
- There are also a number of accessory muscles useful in forced breathing: SCM and the scaleni muscles.

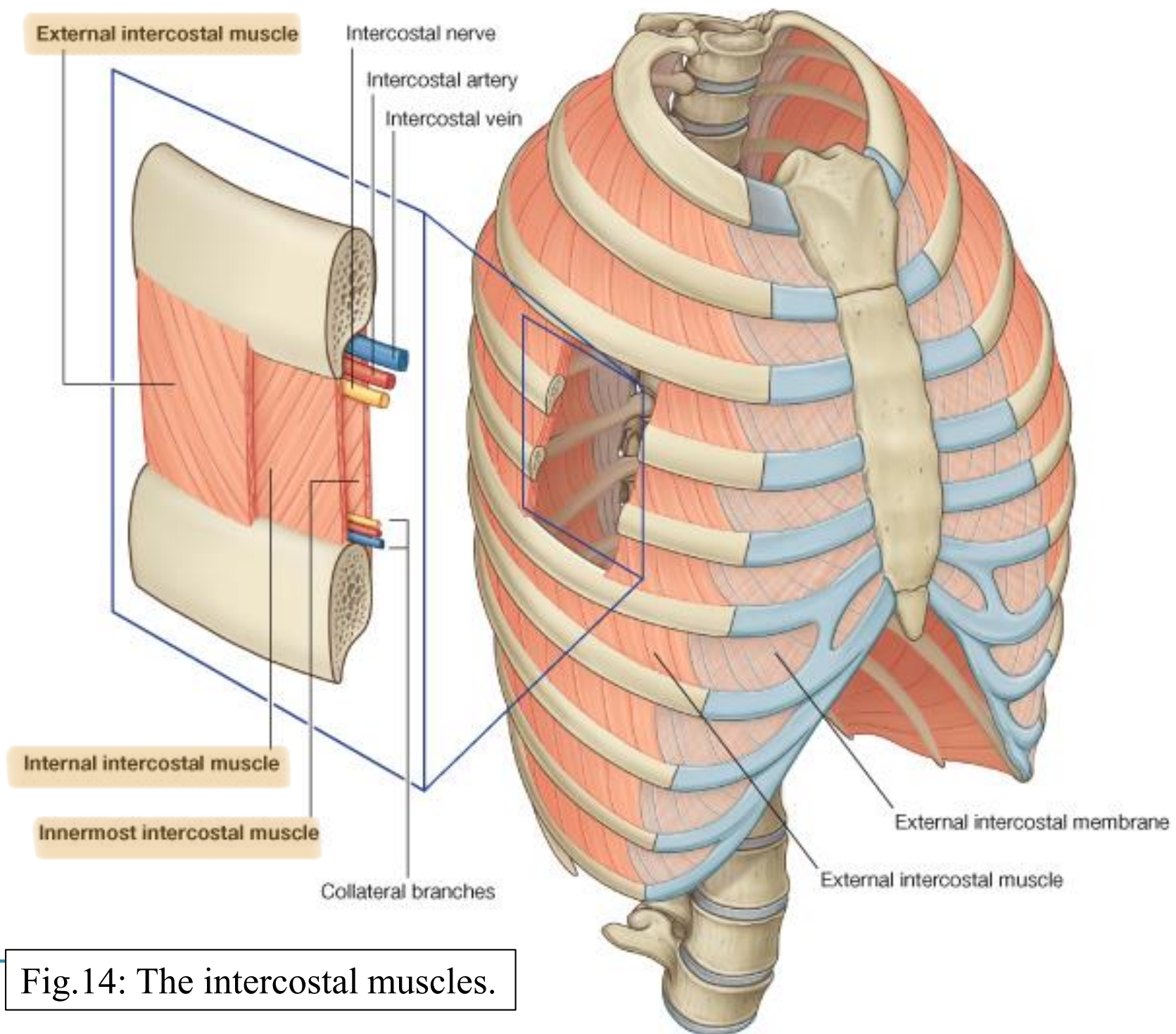


Fig.14: The intercostal muscles.

The Diaphragm

The diaphragm is the most important muscle of respiration

Muscle	Origin	Insertion	Nerve	Action
Diaphragm	<ol style="list-style-type: none">Sternal part: Xiphoid processCostal part: Lower 6 costal cartilages and adjacent ribsVertebral part: Upper 3 lumbar vertebrae and their discs	All muscle fibers converge to be inserted into a centrally located tendon	Phrenic nerve	Contraction of the diaphragm <u>increases vertical diameter of thoracic cage</u> causing <u>inhalation</u> . Its relaxation leads to <u>exhalation</u> .

هي عبارة عن نقطة في نص
بطنك بتشغل زي كانها
عضمة بتمسك العضلات



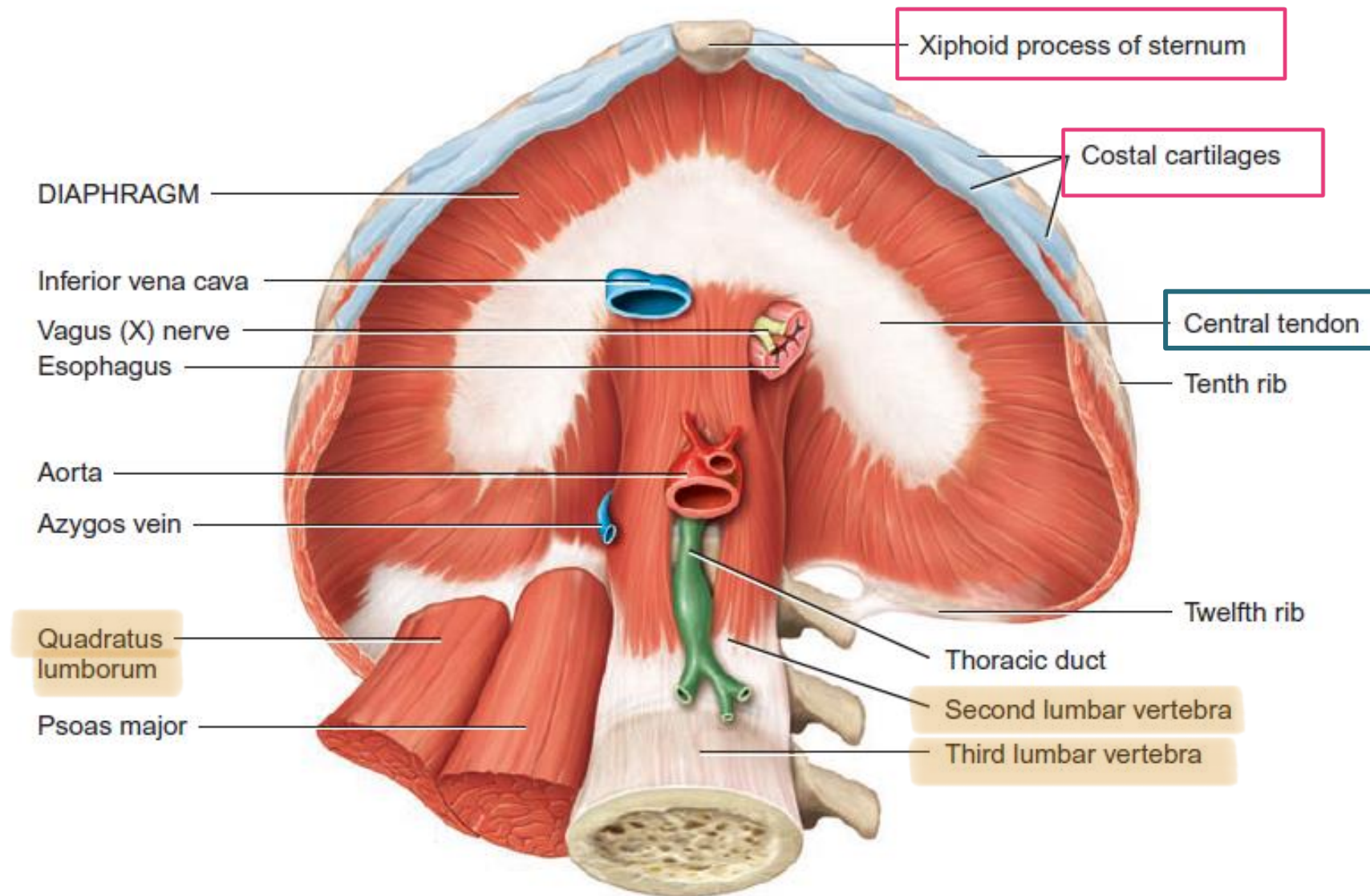
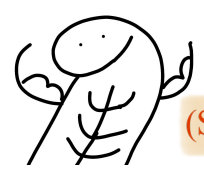


Fig.15: The diaphragm.

Anterolateral Abdominal Wall Muscles

- Include the **external oblique, internal oblique, and transversus abdominis**.
- The aponeurosis (broad tendon) of the external oblique forms the **thick inguinal ligament** inferiorly.
- The aponeuroses of these 3 muscles form the **rectus sheaths** which enclose the **rectus abdominis muscles**. The sheaths meet each other in the midline to form the **linea alba**, a **connective tissue band** extending from the xiphoid process to the pubic symphysis.

بلتقوا الثلاث عضلات في



التي هي بنسبها (Six-Pack)
- **Actions:**
 1. They retain the organs within the abdominal cavity.
 2. The **rectus abdominis** flexes the lumbar vertebrae.
 3. They assist in micturition, defecation, vomiting, and labor.

التبول التغوط القيء الولادة
 4. They assist in expiration.

تساعد على الزفير

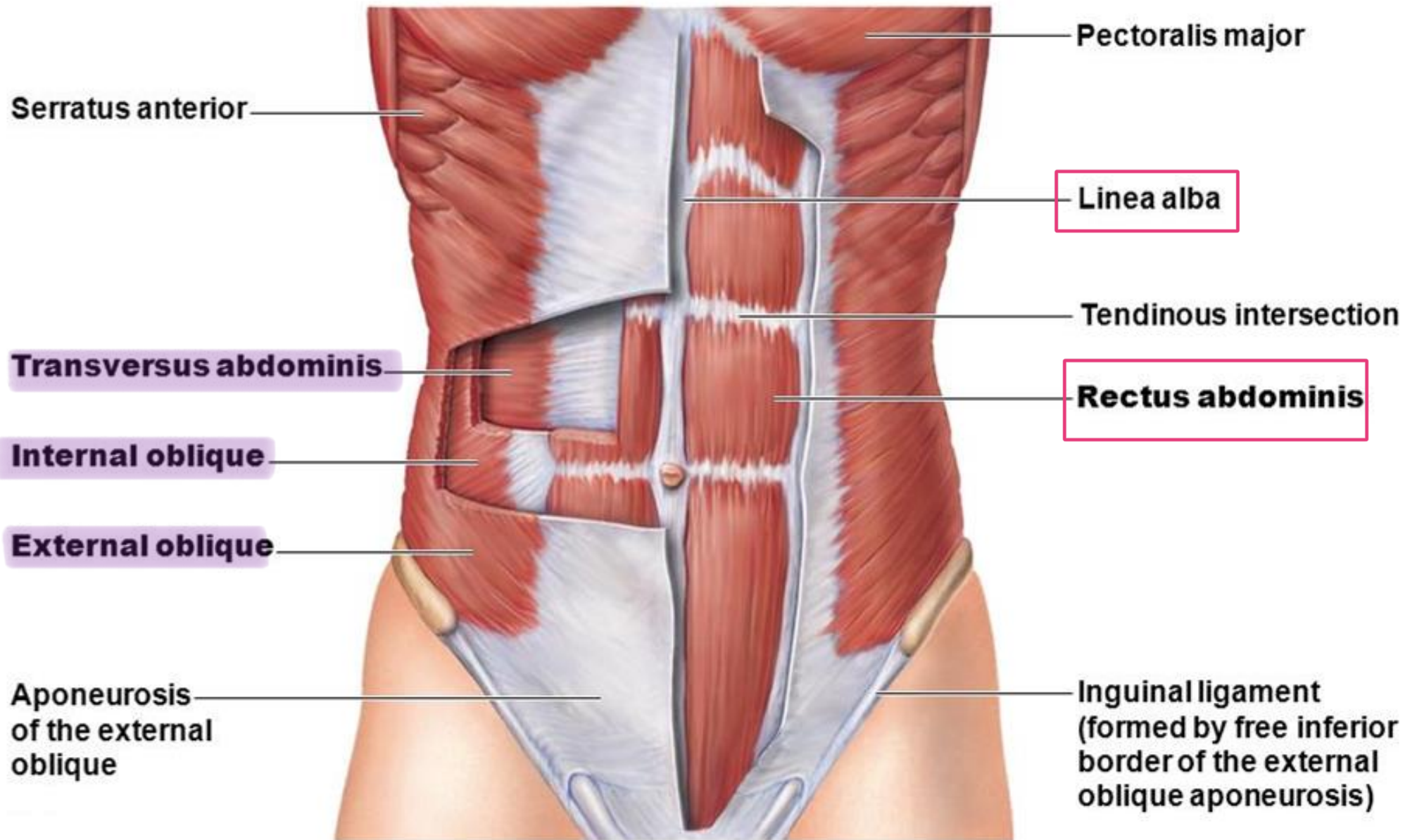


Fig.16: Anterior abdominal wall muscles.

Posterior Abdominal Wall Muscles

- Muscles of the posterior abdominal wall perform different functions.
- The most important are the *psoas major* and *iliacus* muscles. They are inserted by a common tendon into the thigh. When they contract, they flex the thigh on the trunk. ترفعها فوق

الفخذ

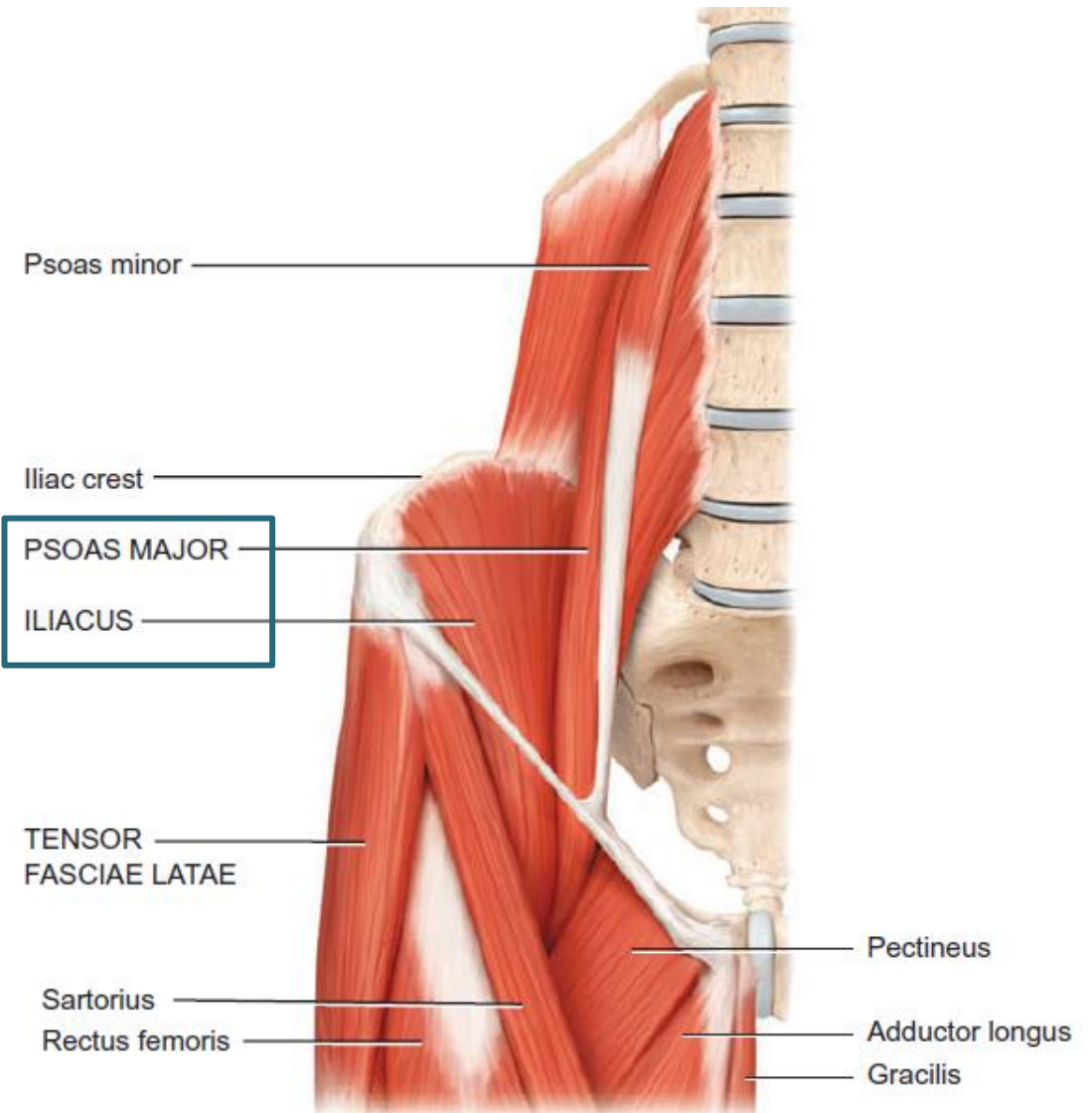


Fig.17: Posterior abdominal wall muscles.

Muscles Of The Upper Limb

معلومة من سلايد 31+30

Muscles that move the Pectoral Girdle

- Several muscles move and stabilize the pectoral girdle.
- The **serratus anterior** (punching) muscle fixes the scapula in position.
- **Trapezius** is a large muscle seen on the back. With the serratus anterior muscle, it rotates the scapula so that its glenoid cavity is raised. This allows the arm to be **abducted** above the head.

Trapezius + serratus anterior
هدول العضلتين كمان مسؤولات عن rotation لعظمة scapula



في اربع عضلات بتعمل abduction of the arm

serratus anterior muscle
Trapezius muscle
deltoid muscle
supraspinatus muscle

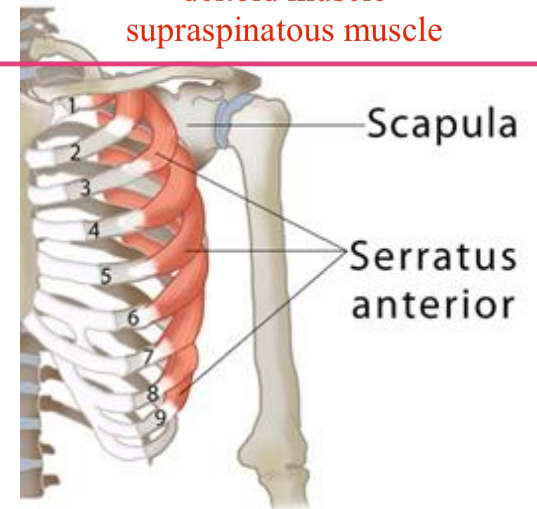
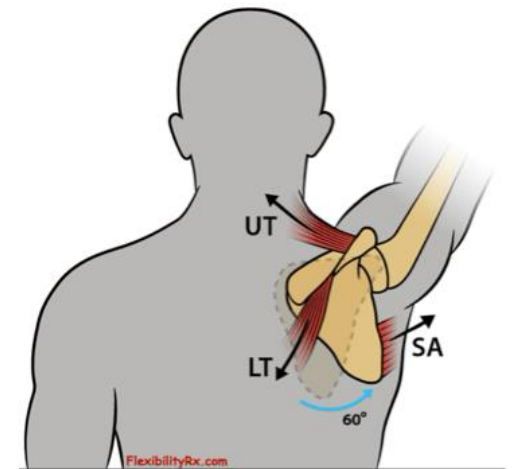


Fig.18: Serratus anterior and trapezius and their action together.



Muscles of shoulder and thorax that move the humerus

- The *deltoid* muscle arises from the clavicle and scapula and is inserted into the shaft of the humerus. When it contracts, it abducts, and extends the humerus.
Origin = clavicle and scapula
Insertion = shaft of the humerus
- The *rotator cuff* muscles (*subscapularis*, *supraspinatous*, *infraspinatous*, and *teres minor*) arise from the scapula. Their tendons blend with the capsule of the shoulder joint stabilizing it. In addition, the *supraspinatous* initiates abduction of the arm.
- The *pectoralis major* is a big anterior muscle that arises from the clavicle, sternum, and costal cartilages to be inserted into the humerus. When it contracts, it adducts, and medially rotates the arm. It's one of the main muscle used in swimming.

Origin = clavicle, sternum, and costal cartilages
Insertion = humerus

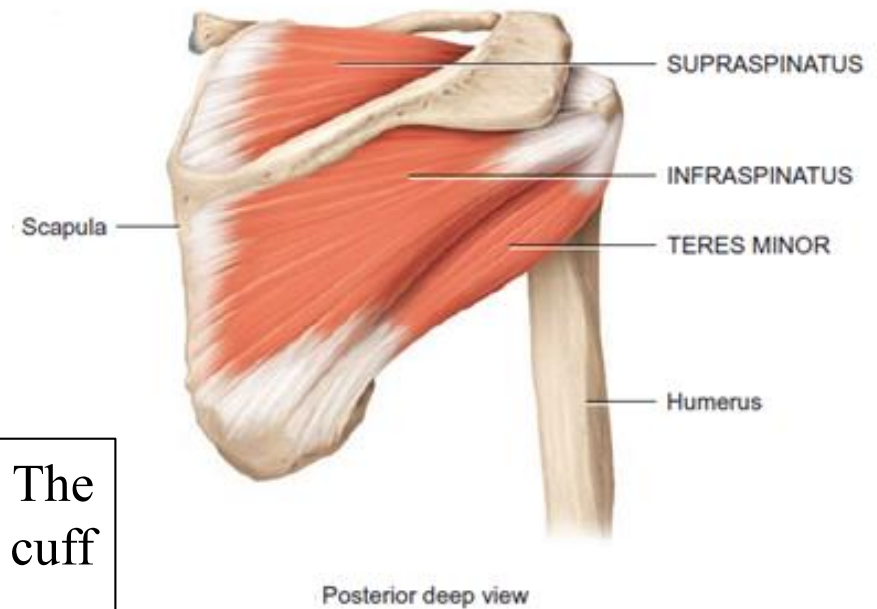
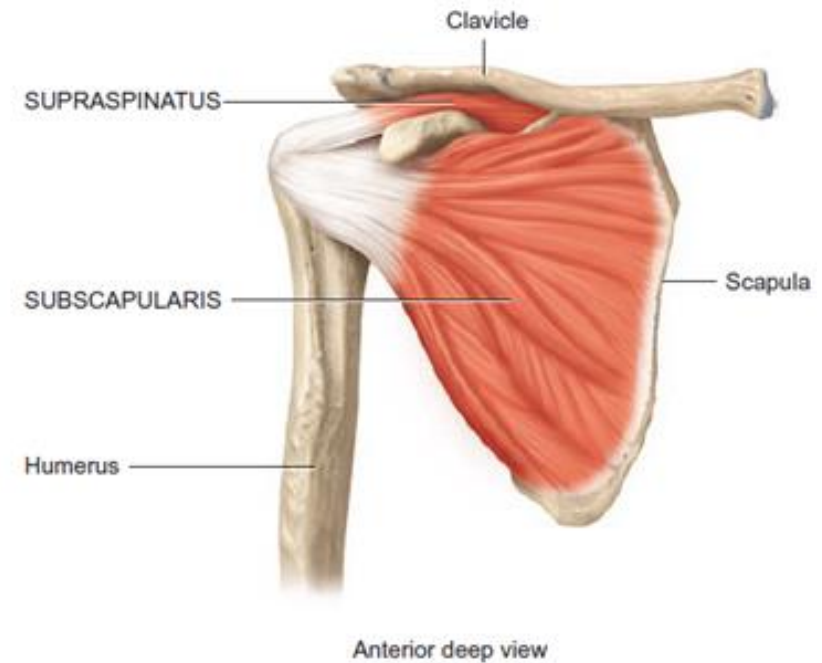
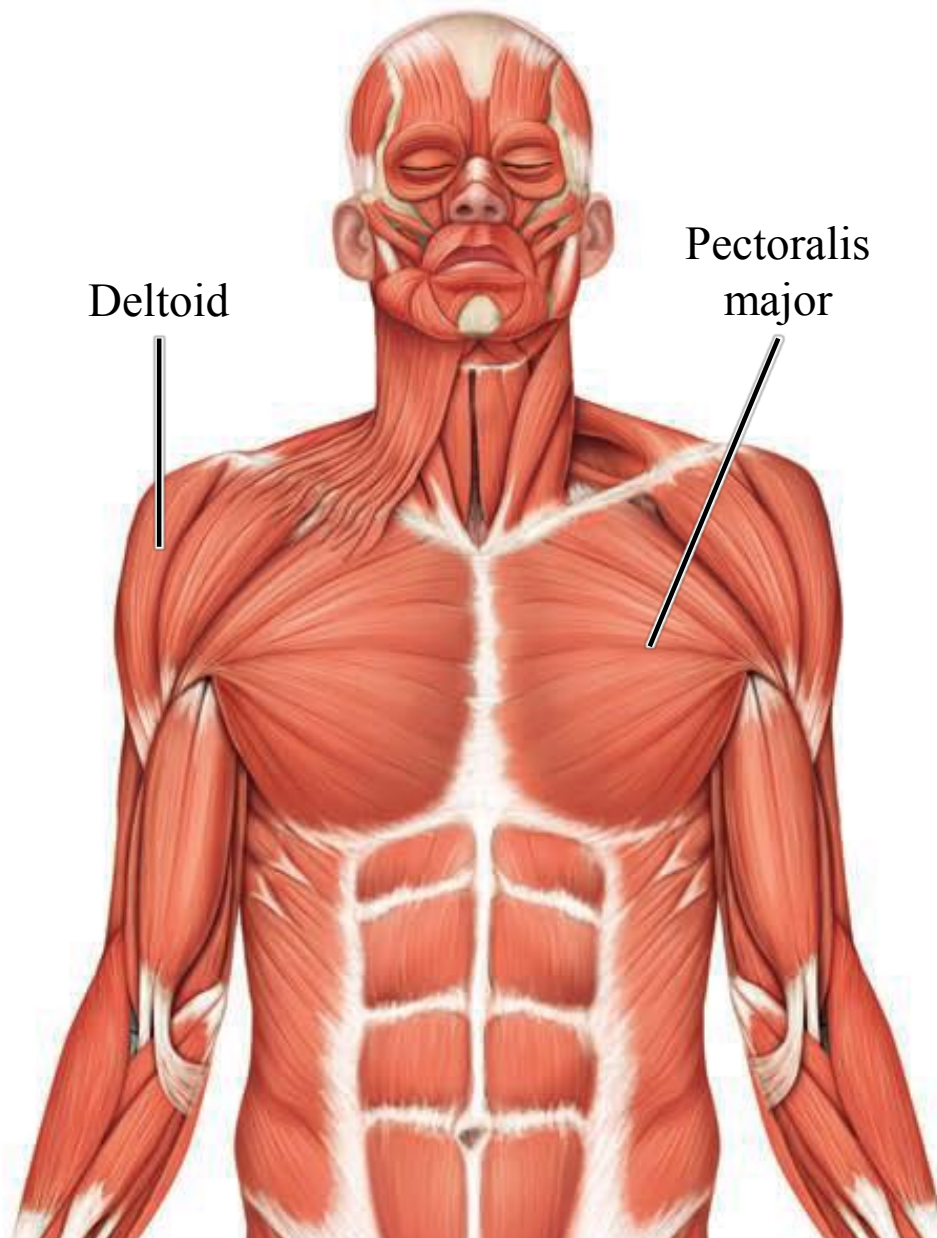


Fig.19: Deltoid and pectoralis major muscle. The two views of the scapula show the rotator cuff muscles.

Muscles of the arm (that move the forearm)

- The biceps brachii, brachialis, and brachioradialis are flexors. The triceps brachii extends the forearm.
- The biceps has two heads of origin. The long head passes through the intertubercular sulcus of the humerus. The biceps inserts into the radial tuberosity.
- It also forms an aponeurosis that inserts medially into fascia and that protects the underlying brachial artery and median nerve as they pass in the cubital fossa.

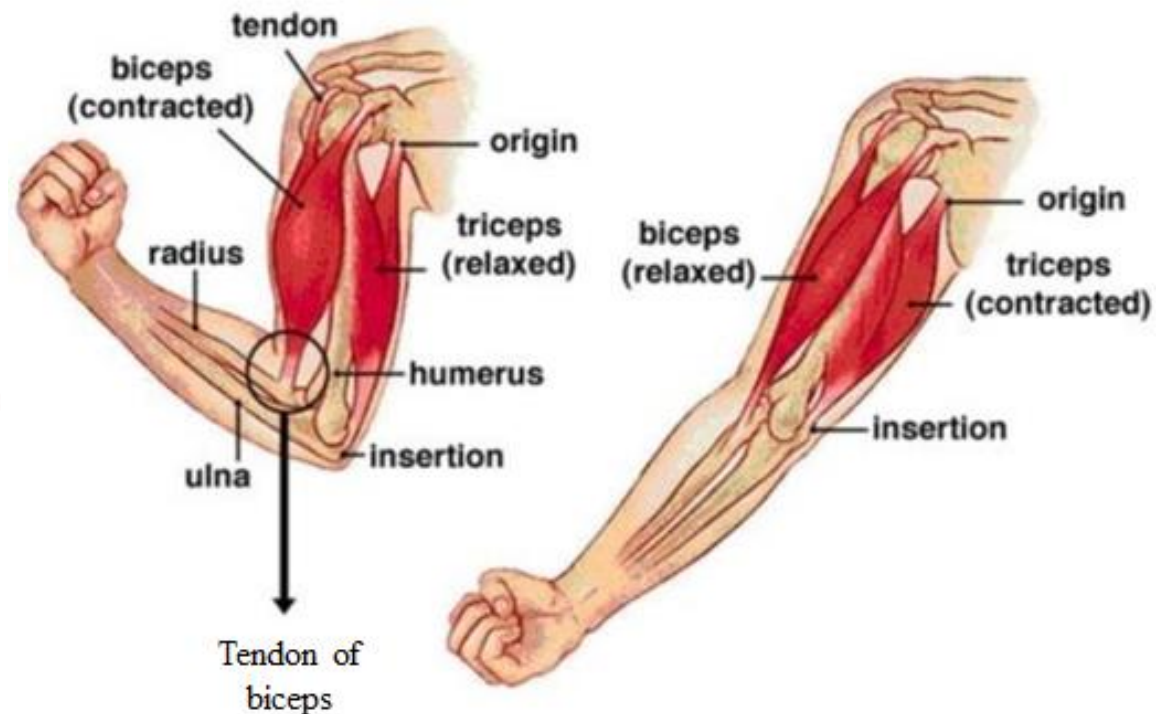


Fig.20: The biceps and triceps muscles.



The biceps has two heads

Short head

Origin = Coracoid process of scapula bone

long head

Origin = Supraglenoid tubercle then passes through the intertubercular sulcus of the humerus bone

Insertion مشترك = radial tuberosity of Radius bone

brachialis and brachioradialis

Origin = shaft of humers

brachialis insertion = ulna

brachioradialis insertion = radius

triceps has three heads

Two origin

One insertion

العضلة الوحيدة المسؤولة عن extention

The Cubital Fossa:

- Shallow triangular depression anterior to elbow joint.
- Tendon of biceps, brachial artery and median nerve pass through it.
- Site of measuring brachial artery pulse and taking blood pressure.
- The superficial veins passing in the skin overlying this fossa can be used to take blood samples.

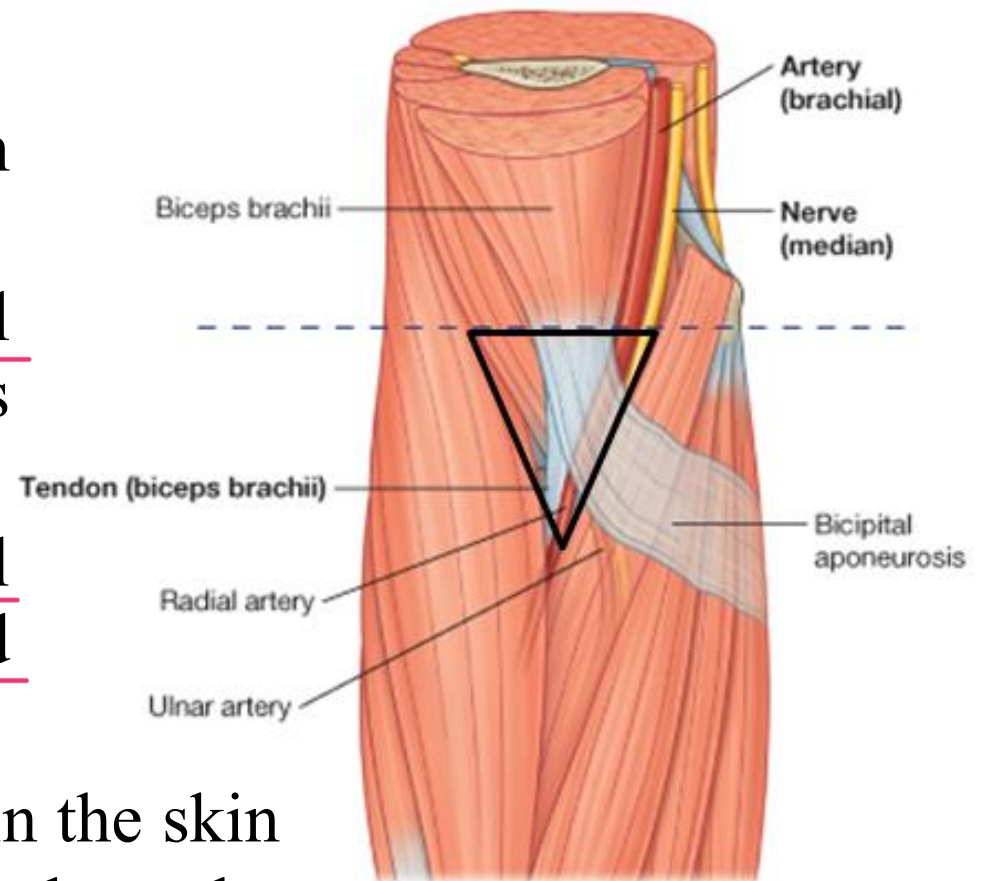


Fig.21: The cubital fossa.

Muscles of the Forearm

- Muscles in this group that act on the wrist and fingers are known as **extrinsic muscles of the hand** because they originate outside the hand and insert within it.
- Based on location and function, these muscles are divided into an **anterior (flexor) compartment** and a **posterior (extensor) compartment**.
- Anconeus, supinator and pronator quadratus are muscles in the forearm that act on the forearm.

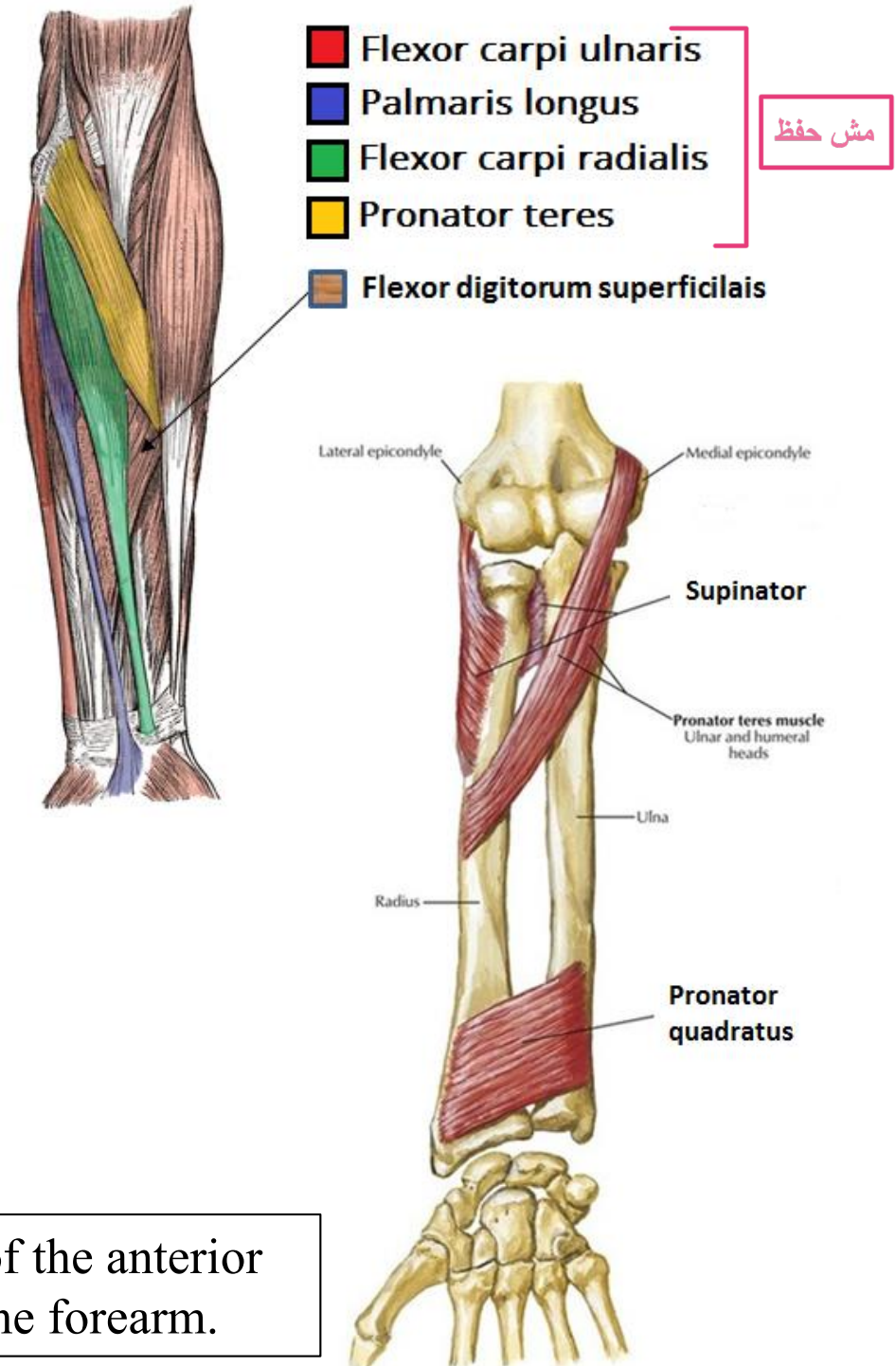


Fig.22: Muscles of the anterior compartment of the forearm.

- As the long muscles of the anterior forearm pass over the carpal bones, they are held in place by a thick band of connective tissue called the ***flexor retinaculum*** (***transverse carpal ligament***). This band with the carpal bones form a tunnel called the **carpal tunnel**.

- Also passing through this tunnel is the **median nerve**.

- Certain conditions may affect this tunnel (**like inflammation of the tendons or the joints**) leading to compression of the median nerve. This is called **Carpal Tunnel Syndrome**.

- The affected person may have **pain in the hand, change in sensations** and even weakness in the hand muscles supplied by the median nerve.

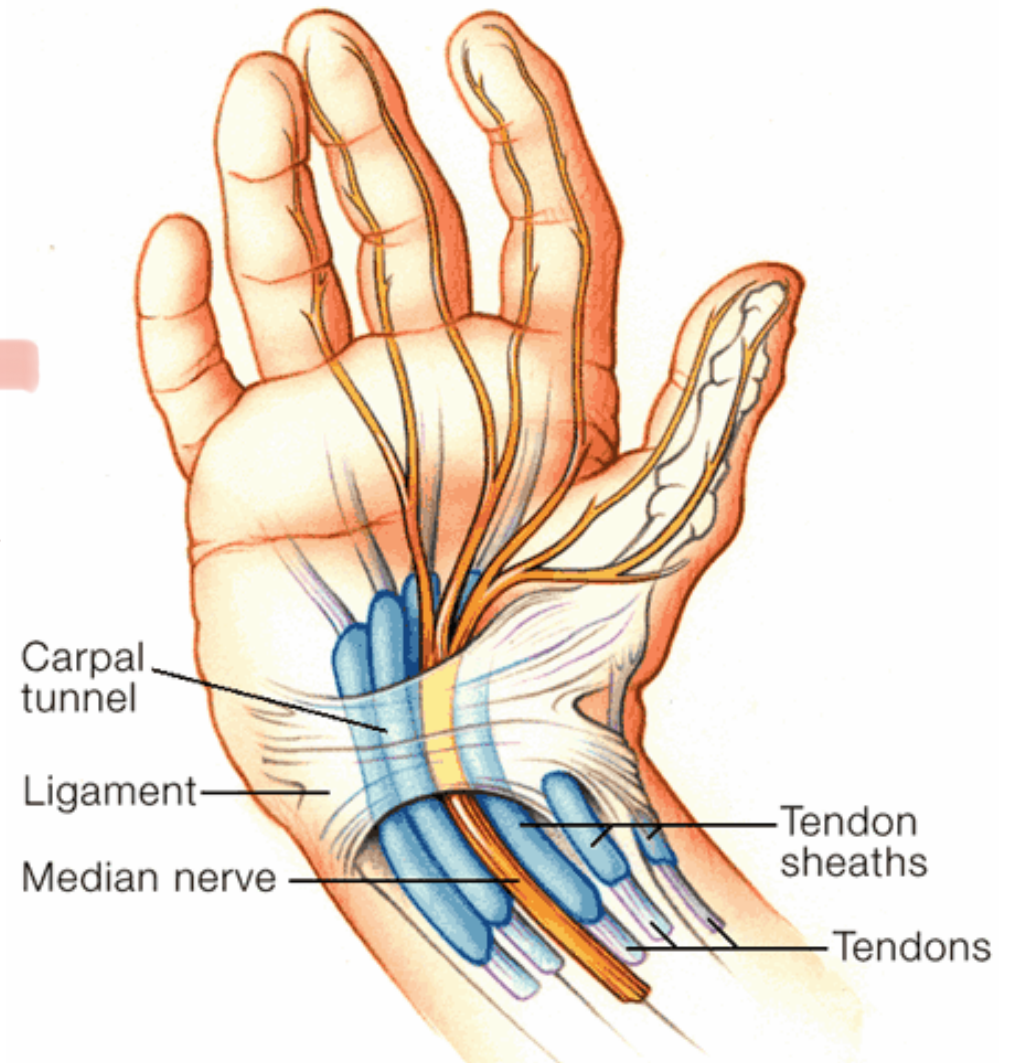
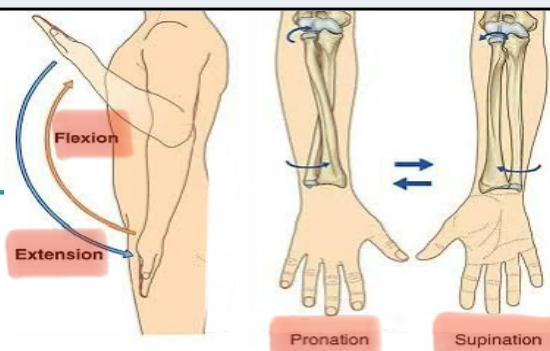


Fig.23: The carpal tunnel.

Movement of Forearm	Muscles that produce them
Flexion	Biceps Brachialis Brachioradialis
Extension	Triceps Anconeus
Supination	Biceps Supinator
Pronation	Pronator teres Pronator quadratus



Intrinsic Muscles of the Hand (3 groups)

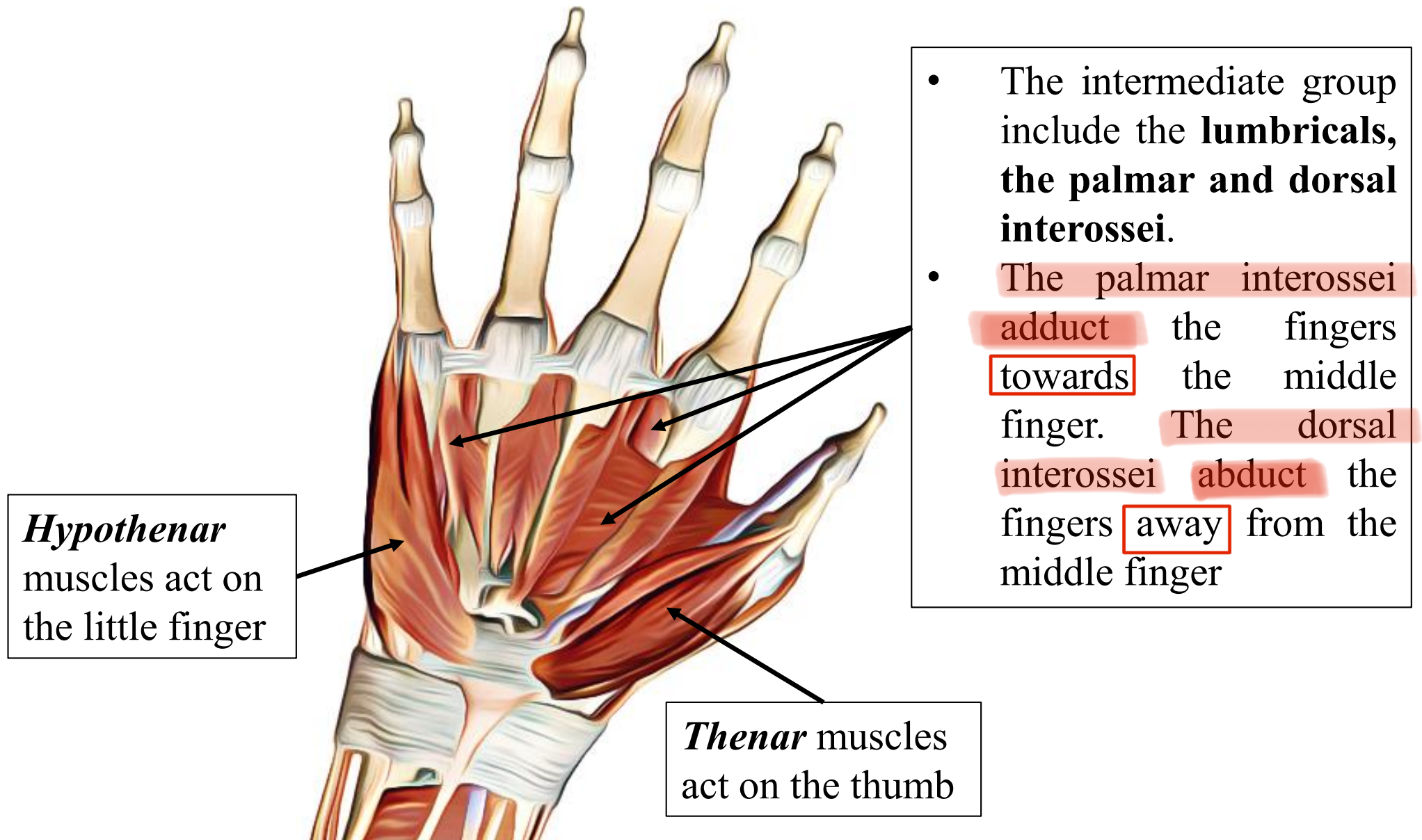
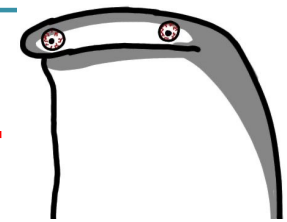


Fig.24: Intrinsic muscles of the hand.

Muscles Of The Lower Limb

- Lower limb muscles function in stability, locomotion, and maintaining posture. In contrast, upper limb muscles are characterized by versatility of movement.
- Muscles of the lower limbs often cross two joints and can act equally on both.
- Most muscles that move the femur originate from the pelvic girdle and insert on the femur.

Muscles of the Gluteal region (Buttocks)



Muscle	Action	Notes
Gluteus maximus	Extends thigh	الارداف With fat forms the buttocks
Gluteus medius	1. Abduct thigh 2. Medial rotation of thigh 3. Tilt hip	These muscles are essential in initiating walking, because they allow the legs to be lifted off the ground
Gluteus minimus		
Piriformis	1. Abduct thigh 2. Lateral rotation of the thigh	Between the piriformis and gemellus superior muscles is a small space through which pass the big Sciatic nerve
Gemellus superior		
Obturator internus		
Gemellus inferior		
Quadratus femoris		

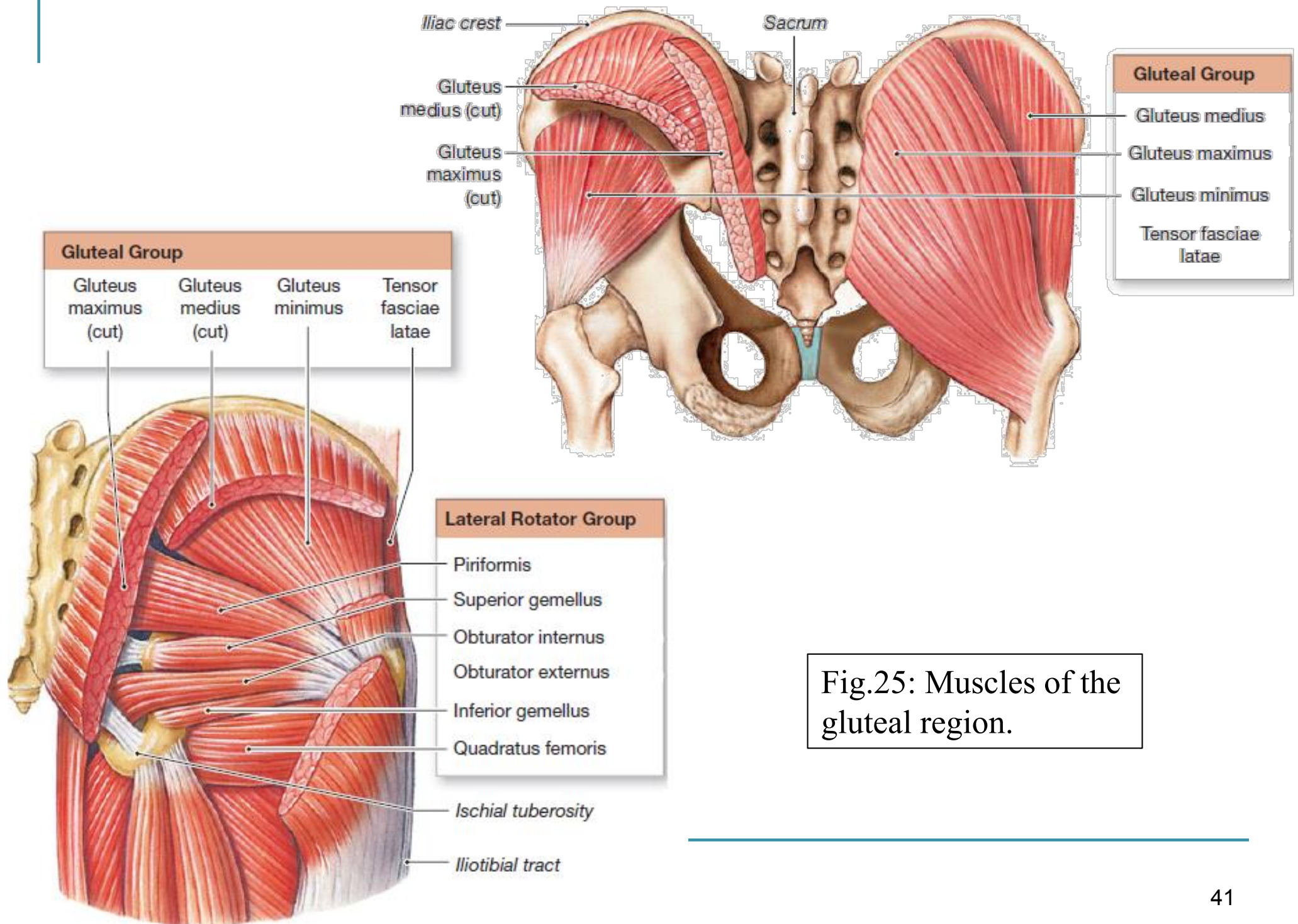


Fig.25: Muscles of the gluteal region.

Muscles of the Thigh

- Divided into anterior, medial, and posterior compartments.
 - **Anterior (extensor) compartment** of the thigh **extend the leg**.
Supplied by the femoral nerve.
 - **Medial (adductor) compartment** of the thigh **adduct the femur** at the hip joint. Supplied by the obturator nerve.
 - **Posterior (flexor) compartment** of the thigh **flex the leg**.
Supplied by the sciatic nerve.
- The **anterior compartment** of the thigh is divided into 2 triangles by the Sartorius muscle. The **sartorius** (cross-leg, tailor's) **muscle is the longest muscle in the body**. It **originates** from the anterior superior iliac spine and **is inserted** into the medial surface of the upper part of the shaft of tibia. It **flexes, abduct and laterally rotates the thigh**.

- Below the sartorius, we have the **quadriceps femoris** muscle which is formed of the *rectus femoris*, *vastus medialis*, *vastus intermedius* and *vastus lateralis*. The tendon of the quadriceps inserts into the patellar base. The patellar ligament arises from the apex of the patella and inserts into the tibial tuberosity.

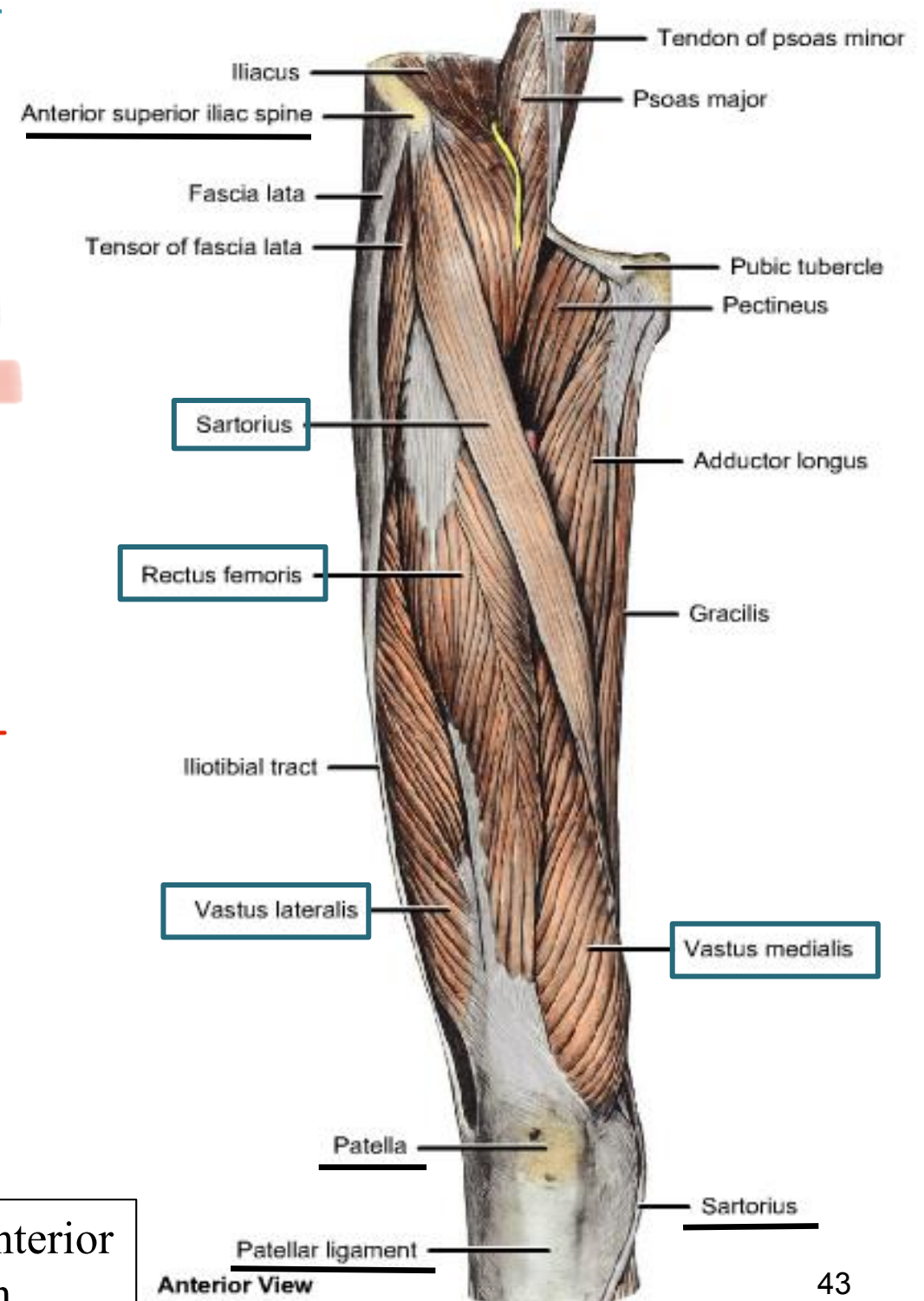


Fig.26: Muscles of the anterior compartment of the thigh.

Muscles of the Leg

- Leg muscles, like those of the thigh, are divided into three compartments: anterior, lateral, and posterior.
 - **Anterior compartment** muscles **dorsiflex** the foot.
 - **Lateral compartment** muscles **plantar flex** & **evert** the foot.
 - **Posterior compartment** muscles are split into a superficial group: the **gastrocnemius**, **soleus** and **plantaris**; and a deep group (e.g., **tibialis posterior**). The superficial muscles share a common tendon of insertion, the **calcaneal tendon** (**Achilles tendon** – the **largest and strongest tendon** in the body). They **plantar flex** the foot.

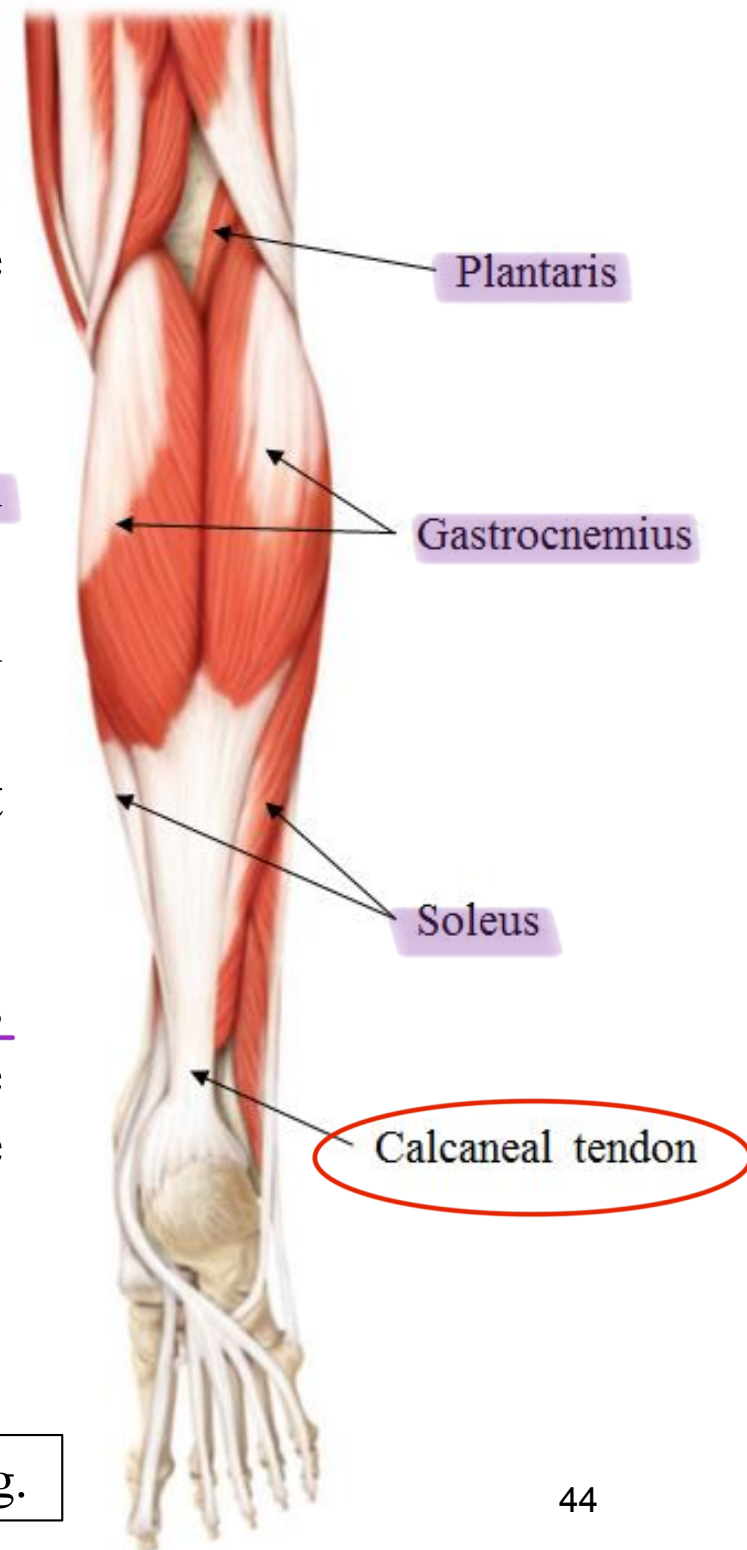


Fig.27: Muscles of the posterior compartment of the leg.

Intrinsic Muscles of the Foot

- These muscles are termed **intrinsic** because they originate & insert *within* the foot.
- These muscles are limited in action. They're designed for **locomotion and support (of the arches).**
- They include **dorsal** and **plantar** groups.



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Fig.28: Intrinsic muscle of the foot (plantar group).