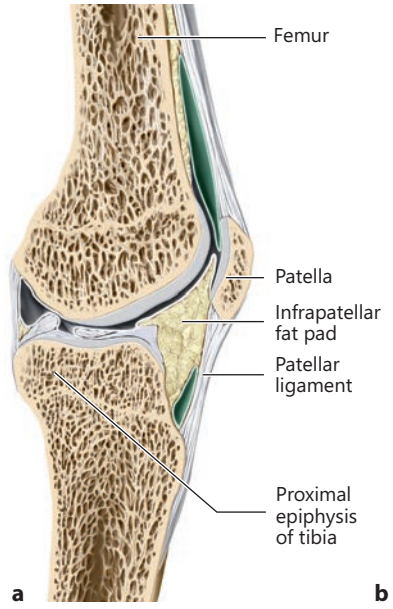


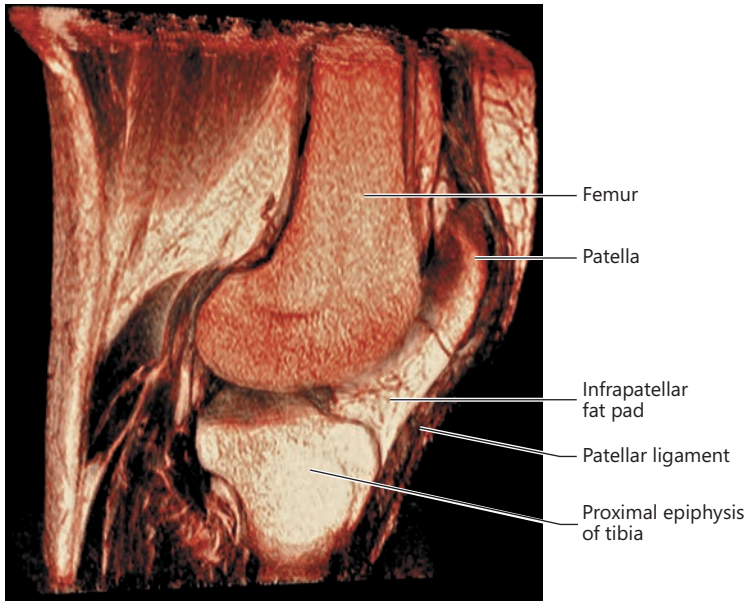


Figure 1.5 - Lateral view of the right knee. **a**, Paramedian sagittal section. **b**, Image of a living human body obtained by **computed tomography** using a 3D volume rendering technique.

the observation of muscles, tendons and fasciae, in addition to bone segments (typical of radiology). It is also possible to perform *in vivo* observations of structures, cavities and spaces, which can be compared to classic sections, as shown in **Fig. 1.5 a-b**, displaying, respectively, a sagittal section of the right knee and the corresponding image obtained with **computed tomography**.

Positron emission tomography (PET) is a technique which belongs to the field of nuclear medicine. It can provide physiological information, in contrast to CT and MR, which give morphological details of the anatomical area under examination (**Fig. 1.6**).

A more sophisticated version, called **single photon emission computed tomography** (SPECT), allows to obtain single sections of an organ.

The **methods of injection** allow injecting several liquids, fixatives or dyes into the lumen of blood or lymphatic vessels or, in general, into hollow organs, such as the excretory system of glands or the respiratory tree; in case of a cadaver, the procedure continues with the destruction of the parenchyma of the organ and the visualization of the mold of the injected organ (**Fig. 1.7**).

These techniques have been historically very used and take advantage of contrast agents in living subject under different conditions.

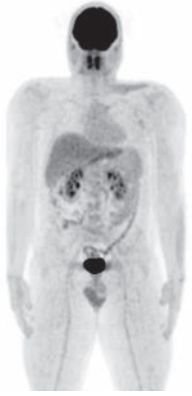


Figure 1.6 - MIP (Maximum Intensity Projection) reconstruction from PET (**positron emission tomography**) scans showing the physiological accumulation of 18F-fluorodeoxyglucose (18F-FDG) in brain, heart, liver and spleen. The radiopharmaceutical is excreted with urine.

Figure 1.7 - Tracheobronchial tree. **Mold**, posterior view. In *yellow*, trachea and bronchial tree; in *red*, pulmonary trunk and its ramifications (courtesy of D. Sasse, Anatomical collection, Basilea).

ORGANIZATION OF THE HUMAN BODY

Normal human anatomy defines the general organization of the human body, thanks to appropriate investigation methods, both at macroscopic, microscopic and submicroscopic levels; it focuses on the healthy body at all ages, even in presence of anomalies (hereditary or congenital deviations in the constitution of the organism) compatible with life.

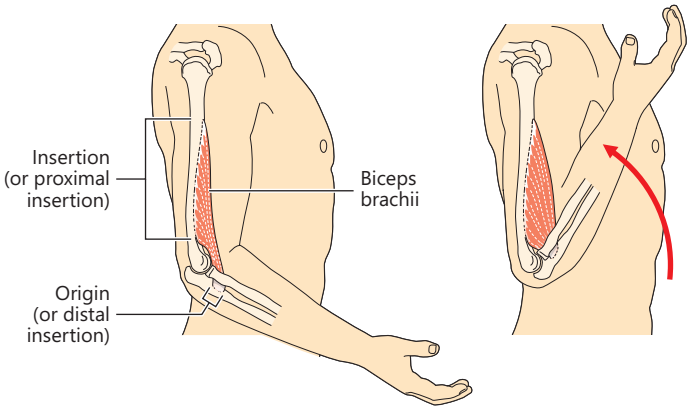


Figure 1.13 - **Contraction** of the biceps branchii.

Before listing the main terms of movement, it is important to clearly explain the basic principles of the skeletal muscle activity, without which any other reasoning becomes abstract and not easy to understand (**Fig. 1.13**).

- Muscles can only actively shorten (contract, then pull) and passively lengthen: they cannot push.
- All muscles have at least two insertions on two or more bones, called origin (or proximal insertion) and insertion (or distal insertion).
- All muscles pass over at least one joint.
- Muscle mass is usually proximal to the joint.
- When the muscle contracts, the insertion gets closer to the origin.

In order to better understand the logic underlying the description of a movement, it is useful to think of a door that closes a gap on a wall: the door can either open or close. The movement that the door makes as it moves away from the gap and the wall is defined as "opening". The wall represents the plane respect to which the movement is done. The opposite situation, which is the antagonist movement, it the "closing" of the door, defined as the movement that brings the door closer to the wall in which the gap is.

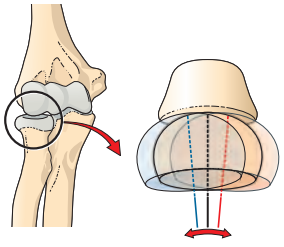
In order to open or close, the door must be inserted into hinges, which represent, in this example, the joint along which the movement happens. The hinges are oriented in such a way that the door can only open in one direction. In other words, if the hinges have a vertical orientation, the door can open as a common door. On the contrary, if they have a horizontal orientation, the door will open either upward or downward. Therefore, the axis along which the movement occurs, established by the orientation of the joint, is another parameter used to define the movement in a correct way. A movement occurs getting far or close to a specific reference plane and along a defined axis.

The movements and the terms described below will be further clarified after the description of the joints. The terms indicating the most common movements (for example, the everyday movements of the body and its parts, but also the exercises that we perform at the gym or training for a sport competition) are listed and exemplified by a figure in the following box (➔ *Joint movements*).

JOINT MOVEMENTS

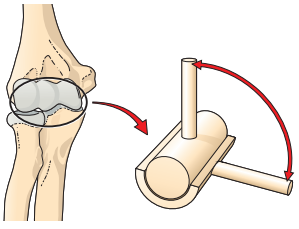
Simple joint movements

Sliding movement



It is the simplest movement of a joint and consists in the sliding of an articular surface over another one, without any rotational component or angular change, and is typical of plane, spheroidal and condylar joints. *Examples*: movements of the carpal and tarsal joints, combining with angular and rotational movements; movements of the costotransverse joints; movements of the sternocostal joints.

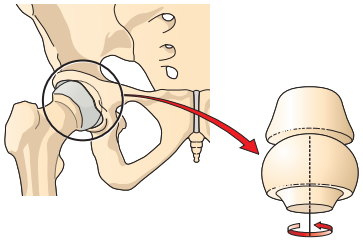
Angular movement



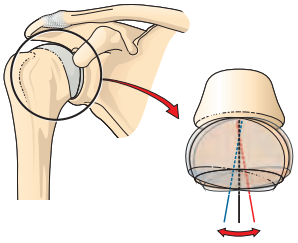
It determines the reduction or widening of the angle between the two bones forming the joint and it is typical of the hinge and condylar joints. *Examples*: the angular movements typically executed by humans are flexion-extension and abduction-adduction.

Rotation

The rotation movement makes a bone, or a body part, to rotate around its axis and is typical of the spheroidal joint. *Examples*: head movement to say "no" or to look to the right and to the left staying in upright position.

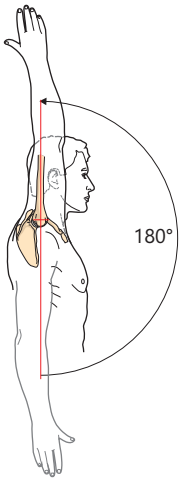


Oscillation



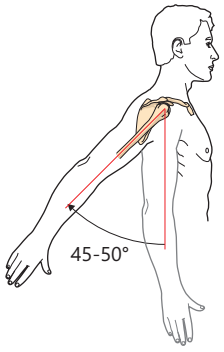
It consists in the oscillatory movement of a bone or a body part, during which the axis remains fixed in one point.

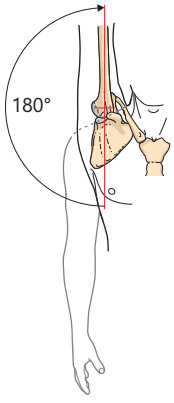
The result is the biomechanics of the simple movements.



Flexion - Movement usually occurring on the sagittal plane, reducing the distance between two body parts, with the reduction of the angle between them. *Examples*: flexion of the head (the chin gets closer to the thorax); flexion of the leg (the foot rises and moves backwards); flexion of the forearm (the forearm goes towards the shoulder); flexion with anterosuperior elevation of the shoulder joint.

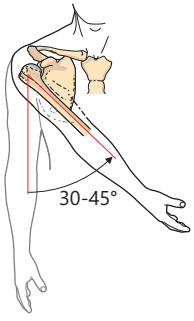
Extension - It is the opposite of flexion. It occurs on the sagittal plane and allows increasing the distance between two body parts and the angle between them. It is called hyperextension when the angle is larger than 180°. *Examples*: extension of the head raising the chin upwards; extension of the leg, when the football player kicks the ball; extension of the forearm, when the hand moves forward or downward from the shoulder; extension of the shoulder joint.

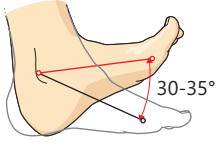




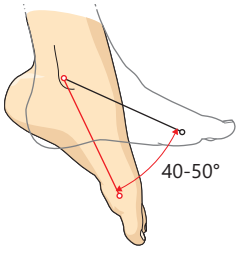
Abduction - It is a movement usually occurring on the frontal plane and allows increasing the distance between two body parts. *Examples*: starting from the anatomical position, the upper limb moves increasing the distance from the trunk with an amplitude of 180°; the fingers or the toes make a fan-like movement. The abduction movement of the foot is the one that brings the forefoot outward.

Adduction - It is the opposite of abduction. It also occurs on the frontal plane and causes a reduction of the distance between two body parts. *Examples*: the limb gets closer to the sagittal plane; the fingers or the toes get closer to each other from a fan-like position. The adduction movement in the foot is the inward movement of the forefoot.

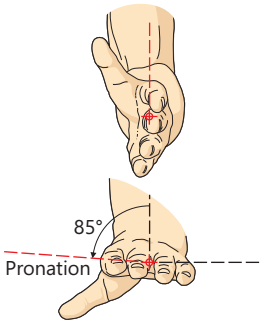




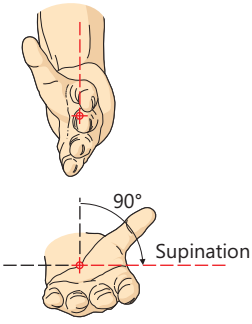
Dorsiflexion - Flexion of the foot on the sagittal plane, occurring when the dorsum of the foot gets closer to the anterior region of the leg. It allows standing on the heels.



Plantar flexion - Movement of the foot opposite of dorsal flexion, occurring when the sole of the foot moves backward and the toes downward. It consists in an extension of the foot, therefore the muscles involved are called extensor muscles. It allows standing on tiptoes.

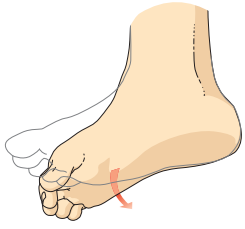


Pronation - It occurs in forearm and hand when the palm rotates from an anterior plane (as in the anatomical position) to a posterior plane or from a superior to an inferior plane. Regarding the foot, it occurs when its external side is lifted.



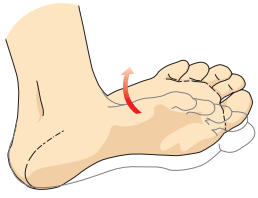
Supination - It is the opposite of pronation, occurring when the palm of the hand moves from posterior to anterior position or from inferior to superior position. Regarding the foot, it occurs when its internal side is lifted.

Composite joint movements

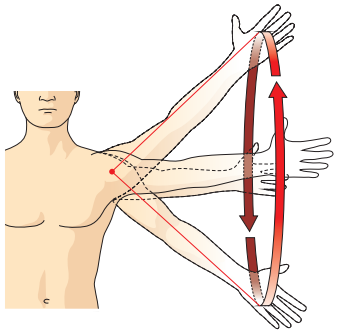


Inversion - It is a movement involving only the feet. It is the sum of adduction, plantar flexion and supination of the foot, causing the inward exposure of the plant of the foot.

Eversion - It is a movement involving only the feet and it is opposite to the inversion. It is the sum of abduction, dorsal flexion and pronation of the foot, causing the outward exposure of the plant of the foot.



Circumduction - It is the most complex movement, typical of the joints of shoulder and hip. It is obtained by summing, in sequence, flexion, extension, abduction and adduction. The graphical representation of the sequence of these movements of the upper limb is a cone with the tip on the head of humerus.



cal viscera, delimiting the **visceral compartment of the neck** (➔ **Figs. 3.266** and **3.267**).

THORAX

The *thorax* is the part of the trunk located between neck and abdomen, where the upper limbs attach.

Boundaries

A *thoracic wall* and a *thoracic cavity* are identified in the thorax.

The boundaries of the **thoracic wall** (**Fig. 1.21**) are the *inferior border of the neck*, previously described, and the *thoracoabdominal line*, which begins at the base of the xiphoid process of the sternum and follows, on each side, the costal margin and the inferior border of the last rib, reaching the spinous process of the twelfth thoracic vertebra. This line divides the thorax from the abdomen. Moreover, it is possible to identify the *thoracoappendicular lines* marked on the anterior and posterior axillary lines.

The thorax is separated from the upper limb by a line that passes medially through the glenohumeral joint or shoulder joint, along the lateral surface of the thorax. Therefore, this plane divides the thorax from the axilla, located between the regions of the upper limb.

The **thoracic cavity** has different boundaries from those of the wall (**Fig. 1.22**): indeed, superiorly, it goes beyond the inferior border of the neck reaching the supraclavicular fossae with the cervical pleurae and the apex of the lungs, whereas, inferiorly, corresponds to the diaphragmatic cupula, located above the thoracoabdominal line, therefore some abdominal viscera are situated in a region that, superficially, corresponds to the thorax.

General organization

The thorax is formed by a *thoracic wall* and a *thoracic cavity*.

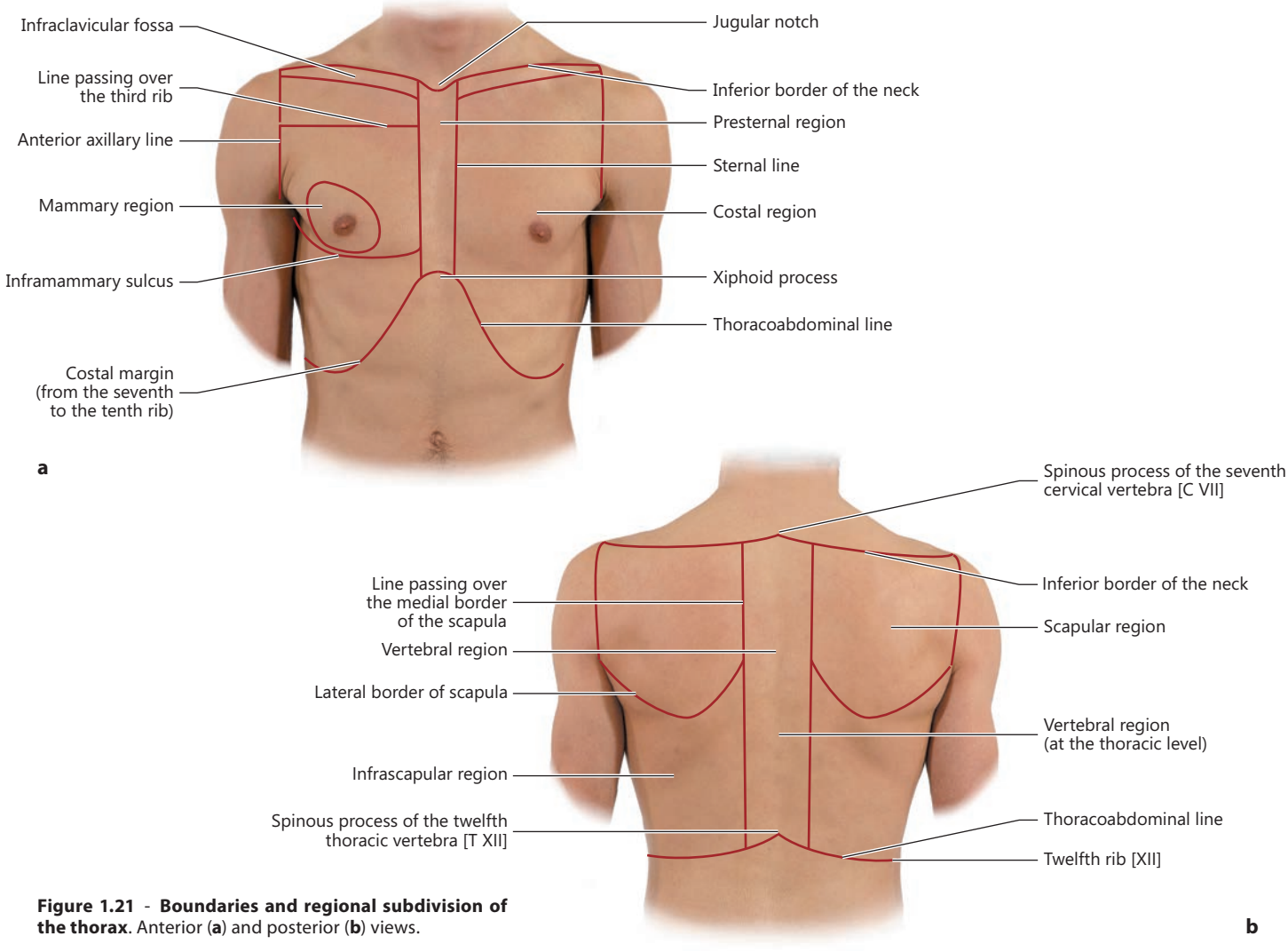


Figure 1.21 - **Boundaries and regional subdivision of the thorax**. Anterior (**a**) and posterior (**b**) views.