

Chapter 1 - Introduction



The objectives of this chapter are to:

1. Define types of human anatomy: systemic, regional, radiological, functional.
2. Define biological levels of organisation: cell, tissue, organ, organ system.
3. Define vegetative life and name the systems involved.
4. Define relational life and name the systems involved.
5. Define the genital system.
6. Name the main parts of the human body.
7. Name different regions of the human body.
8. Define the standard anatomical position.
9. Define the anatomical planes: sagittal, frontal, transverse.
10. Define the anatomical axes.

1 - Introduction

Human anatomy is a morphological science which studies the forms and structures of the human body. Anatomical knowledge is essential and therefore obligatory part of health sciences. Anatomy unjustly bears a reputation of a difficult subject at the level of understanding, but especially at the level of memorising concepts that are new to young students beginning their study.

Anatomy can be associated with several adjectives. One speaks of general, descriptive, topographical, artistic, functional anatomy, etc. The goal is always the same; namely, a good knowledge of the human body structure. The difference is only in the approach, depending on the objective.

Besides mastering the insight into the human body structure, anatomy begins to teach the future doctors the art of description which will be useful in their daily practice.

In this book, the general human anatomy is introduced through the description of all the elements that compose the human body, and alongside, of course, it introduces the basic medical vocabulary for all other medical and healthcare disciplines. The practical applications illustrate the importance of a perfect knowledge of anatomy.

2 - Anatomy Definitions

In this chapter, we present different definitions of anatomy, based on different approaches.

Two major types of anatomy are gross and microscopic anatomy.

- Gross anatomy refers to the macroscopic structure of the body and describes the structures visible with the naked eye.
- Microscopic anatomy, also known as histology, describes the structures that can be examined through a microscope.

Gross anatomy can be approached through two main principles:

- Systemic anatomy describes the body by defined organ systems.
- Regional anatomy describes body by defined body parts and deals with the relationships between various organs of the same anatomical region and their projections onto the skeleton and body surface.

According to the point of interest, there are several subtypes of anatomy:

- Descriptive anatomy describes the structure of body parts, describing their location, orientation, shape, dimensions, weight, colour, texture, internal structure, etc.
- General anatomy describes the body in its entirety, with all the consisting organs grouped according to their functions.

Organs that perform the same function form an organ system.

- Radiological anatomy describes images produced by various imaging modalities, i.e. conventional radiography (plain X-ray), computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography (US), and nuclear medicine imaging.
- Surgical anatomy is the anatomy applied to surgery, describing the approaches to various organs and the obstacles a surgeon must avoid.
- Functional anatomy addresses the changes in position, orientation and morphology of an organ or group of organs during their function. It differs from biomechanics, which attempts to apply the laws of mechanics of solid and fluid materials to the human body.
- Superficial or palpatory anatomy is the study of the external forms and reliefs of the body. It is the basis for clinical observation by palpation, and for artistic anatomy.
- Anthropological anatomy studies the differences between individuals and races.
- Organogenesis studies the formation and development of organs. It differs from embryology, which deals with the development of the embryo (the first two months of intrauterine life), and the foetus (from the third month of intrauterine life until birth).
- Paediatric anatomy studies human development and growth from birth to late adolescence.
- Teratology studies congenital anomalies, malformations, and monstrosities.
- Ontogenesis studies the origination and development of an organism, usually from the time of fertilization of the egg to adulthood.
- Phylogenesis studies the evolution of the species.

3 - General organisation of the human body

The human body is a composite of cells. Each type of cells has its specialisation.

Cells with the same specialisation form tissue. There are four basic tissue types in human body: epithelial tissue, connective tissue, muscular tissue, and nervous tissue.

Different tissues form organs. An organ is a group of tissues that performs a specific function (e.g. stomach, kidney, etc.).

Organs are grouped into organ systems. There are 11 organ systems in human body: integumentary system (skin), skeletal system, (bones and joints), muscular system, nervous system, endocrine system, cardiovascular system (heart and vessels), lymphatic system, respiratory system, digestive system, urinary system, and reproductive systems.

To help you understand the anatomy, we will introduce the human body according to the three main functional groups.

- The apparatuses of relational life: they sum up all the apparatuses that put the human body in contact with its environment.
- The apparatuses of vegetative life, which ensure the self-regulation of the human body and which are autonomously managed.
- The reproductive apparatus, which enables the continuation of the human species.

4 - Landmarks and plans

For each description, a marker or origin position is mandatory. The human reference position, known as the standard anatomical position, is defined as a person standing erect, with upper limbs extended by

the side of the trunk with the palms facing forward (thumbs outward), lower limbs extended with the feet parallel and together, and the head facing forward, the gaze directed toward the horizon. The position of organs is described relative to this reference position.

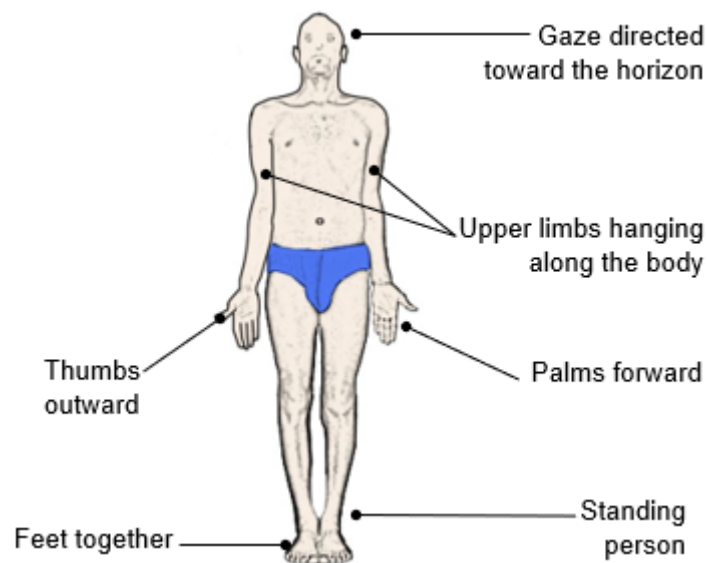


Figure 1: The standard anatomical position.

At this point we will also define the anatomical planes. Three reference groups of planes are distinguished, which are perpendicular to each other. Each group contains multiple parallel planes.

- The coronal (frontal) planes are vertical planes that are parallel to the forehead.
- The transverse (horizontal) planes are parallel to the horizon.
- The sagittal planes are vertical antero-posterior planes. The sagittal plane that passes through the midline of the body and divides the body into right and left halves is called the median plane.

Based on these scales, we will define adjectives which describe the position of two structures relative to each other:

- Cranial or superior to denote what is above.
- Caudal or inferior to denote what is below.
- Ventral or anterior to denote what is in front.
- Dorsal or posterior to denote what is behind.
- Lateral to denote what is further away from the median plane of the body.
- Medial to denote what is nearer to the median plane of the body.
- Proximal to define what is nearer to the point of attachment to the body (on the limbs).
- Distal to define what is further away from the point of attachment to the body (on the limbs).

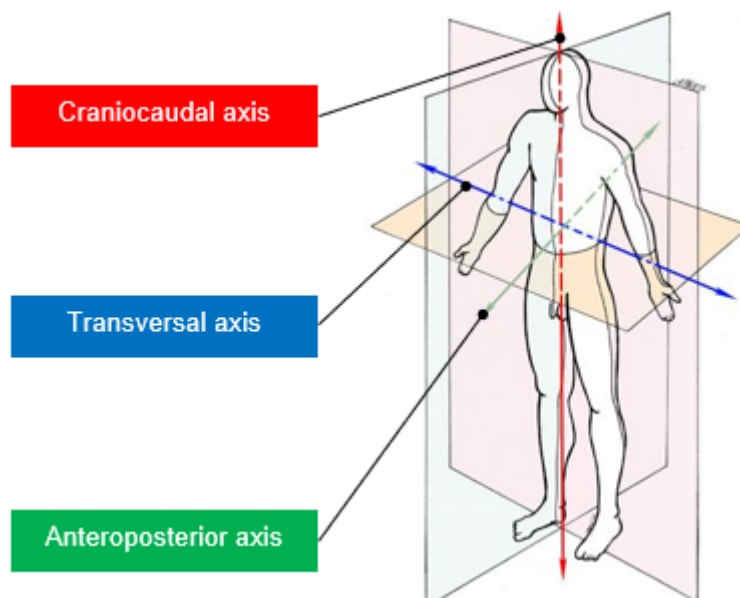


Figure 2: The reference planes and axes.

In addition to these standard planes and axes, specific planes and axes can be defined for each organ in order to obtain an easily interpretable section that facilitates understanding. An example is a plane passing through the four chambers of the heart and the longitudinal axis of the heart.

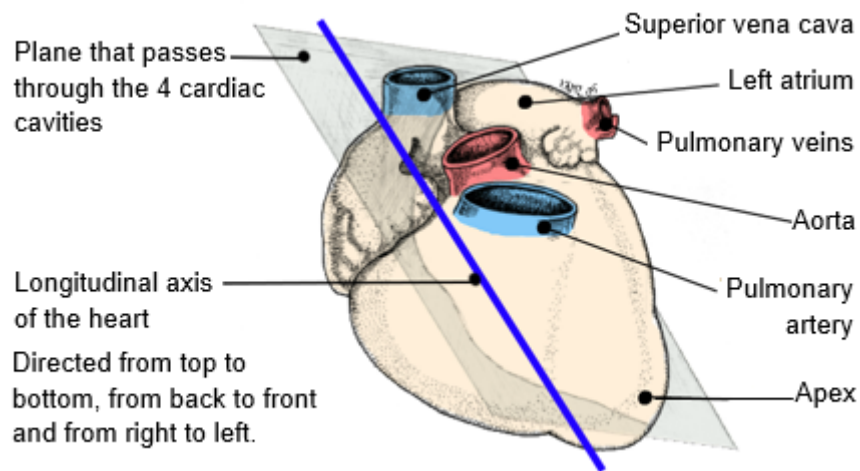


Figure 3: The longitudinal axis of the heart. Anterior view.

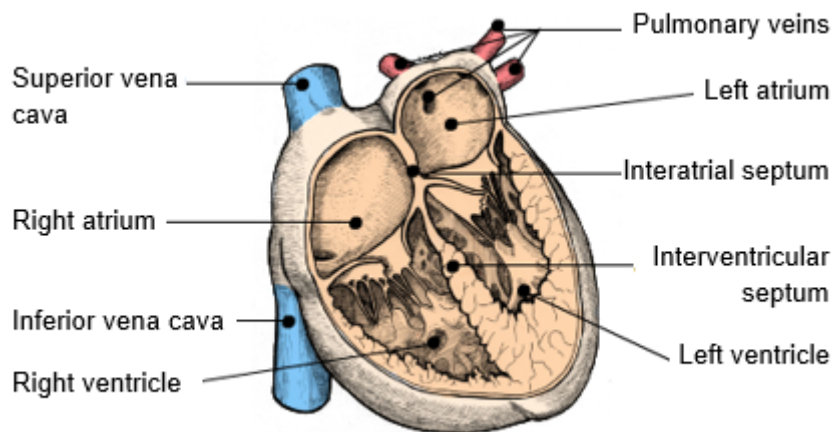


Figure 4: Frontal section through the four cardiac cavities. Anterior view.

A second example: axes can be used to study positions of the bones in relation to orthonormal landmarks, in relation to the reference position or joint amplitudes of the human body. For example, the diaphyseal axis of femur is oblique. If we want to study walking, we need to represent a mechanical axis of femur which allows us to study the transmission of forces from the femoral head to the centre of the femoral condyles.

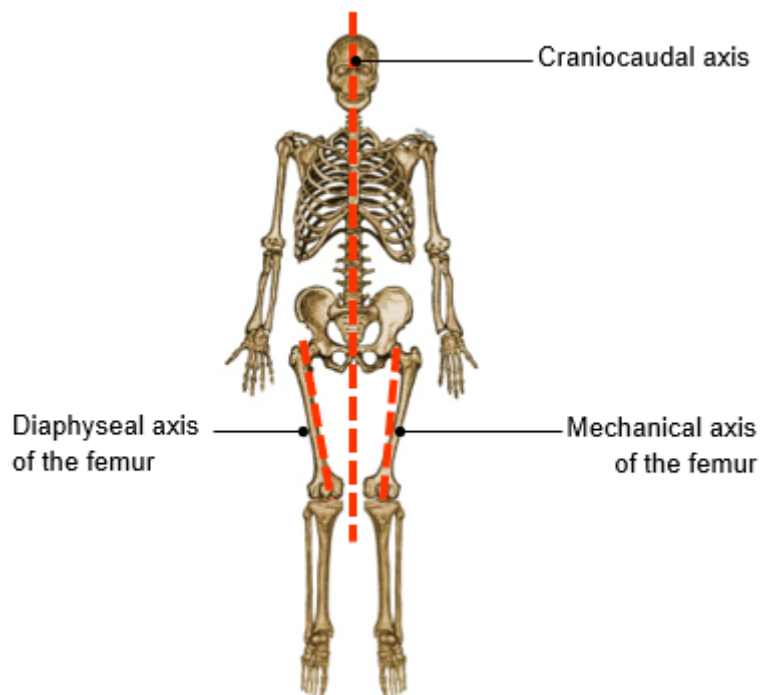


Figure 5: The diaphyseal and mechanical axes of femur.

5 - Main parts and regions of the human body

The human body can be divided into different parts and regions. The trunk supports the head over the neck. The four limbs are connected to the trunk by the girdles.

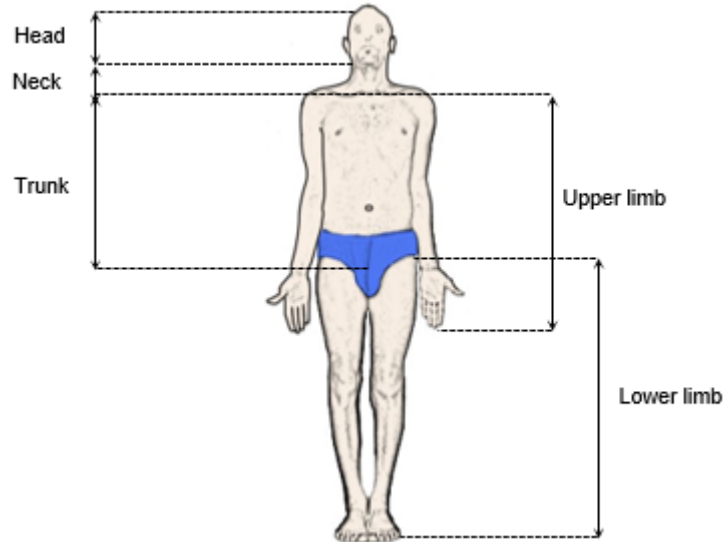


Figure 6: The main parts of the body.

5.1 - Head

The head is divided into the neurocranial part and the face. The skeleton of the head is formed by the skull or cranium, and the mandible.

Neurocranial part of the head

The neurocranial part of the head includes the forehead, occiput, temple, and auricle. Inside the neurocranial part is the cranial cavity.

Face

The face is the lower anterior part of the head, in front of the cervical spine. On the face, we describe the eyes, cheeks, external nose, mouth, and chin.

5.2 - Neck

The neck can be divided into two parts:

- A dorsal or nuchal region consists of a mass of muscles that hold the head in a vertical position.
- A prevertebral region contains the oesophagus, trachea, thyroid gland, and vessels and nerves leading to or from the head. It also contains muscles.

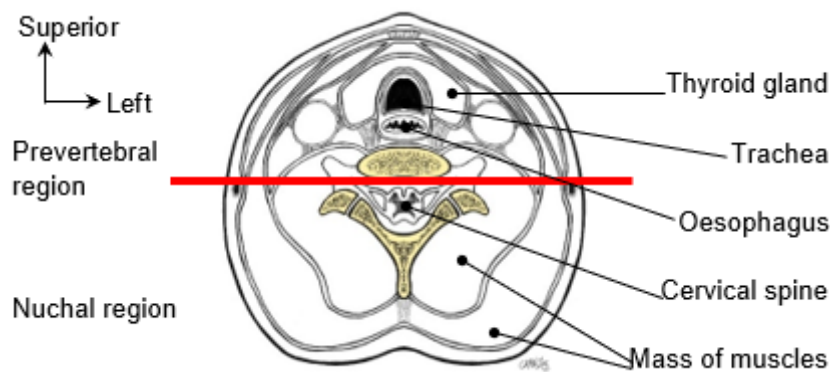


Figure 7: Cross-section of the neck. Inferior view.

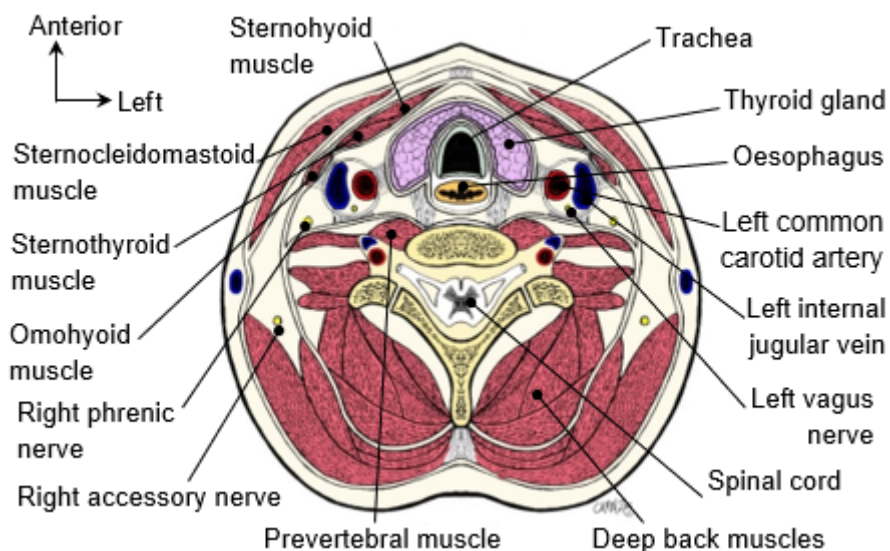


Figure 8: Cross-section of the neck passing through the vertebra C7. Inferior view.

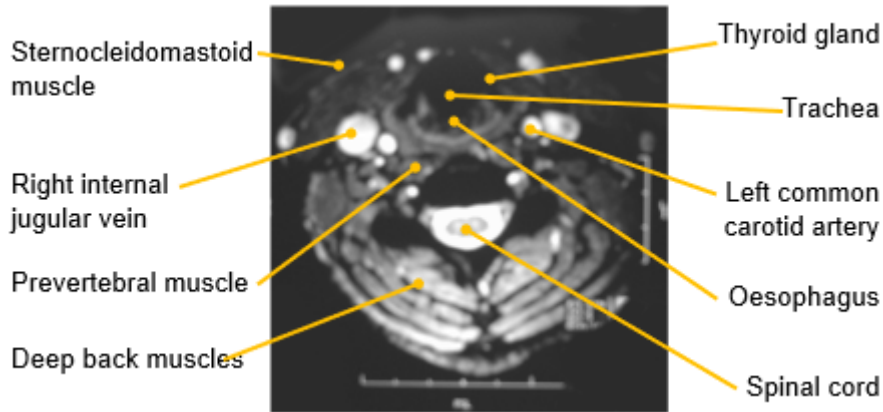


Figure 9: MRI, cross-section of the neck passing through the vertebra C7. Inferior view.

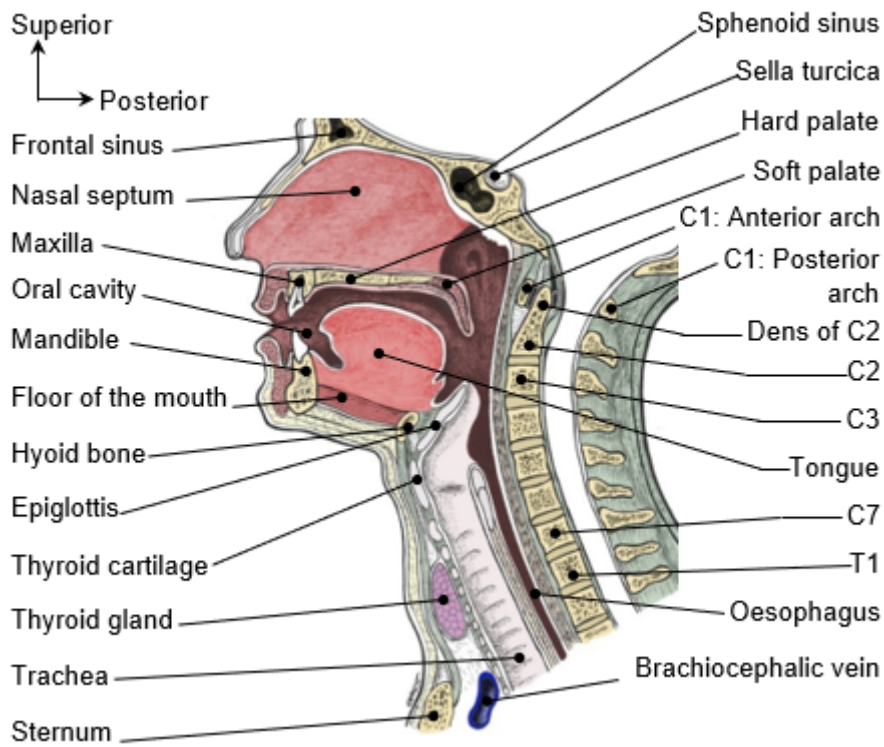


Figure 10: Median section of the face and neck. View from the left.

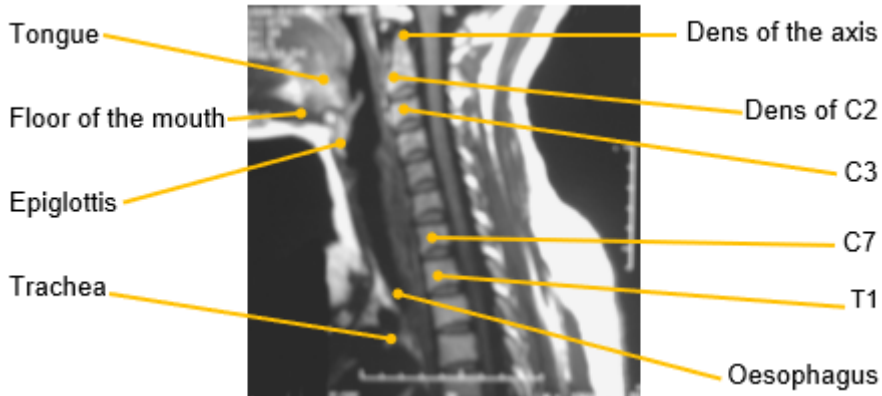


Figure 11: MRI, median section of the neck. View from the left.

5.3 - Trunk

The trunk is composed of the anterior trunk and the back. The anterior trunk is divided in three parts – thorax, abdomen and pelvis.

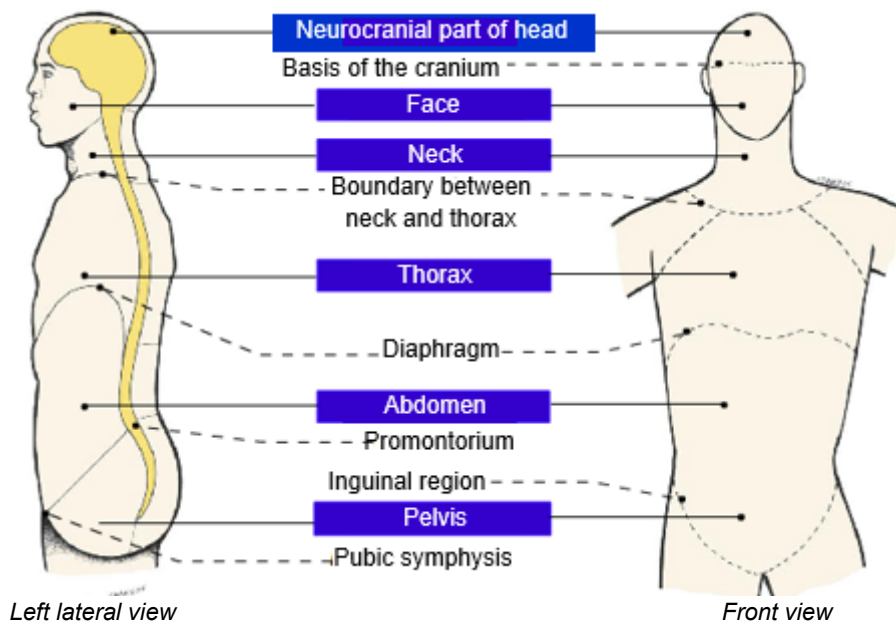


Figure 12: Parts of the head and trunk.

Thorax

The thorax is the uppermost part of the trunk. Its upper boundary is a fictitious plane at the level of superior thoracic aperture, separating thorax from the base of the neck. Its lower boundary is formed by the inferior thoracic aperture and the diaphragm, separating the thoracic cavity from the abdominal cavity. The dorsal boundary is the thoracic spine, and the ventral boundary the sternum.

The walls of the thorax enclose the thoracic cavity.

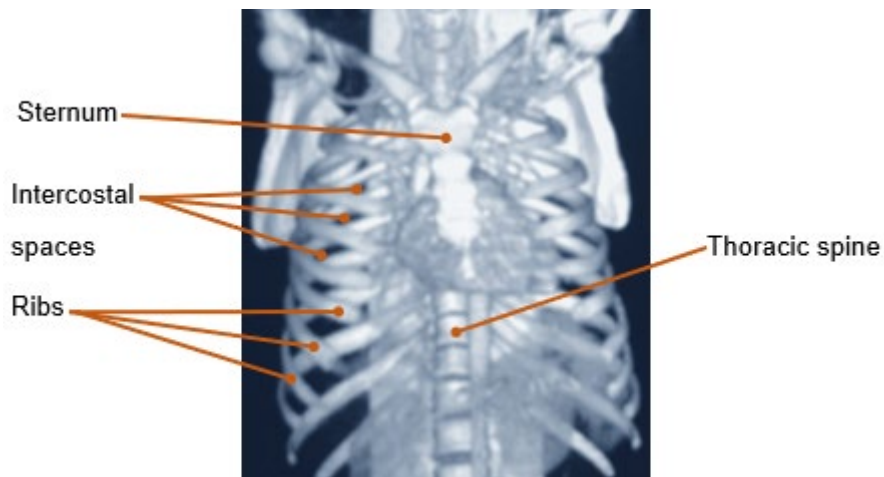


Figure 13: 3D reconstruction of the thorax skeleton. Anterior view.

Thoracic cavity

The thoracic cavity is divided into paired pleuro-pulmonary compartments and the mediastinum.

The mediastinum is bounded by the superior thoracic aperture above, by the diaphragm below, and by the mediastinal pleura laterally.

Mediastinum is further divided (Figure 19) in the superior and inferior mediastinum. The superior mediastinum lies above the pericardial sac. The inferior is divided into three parts: the anterior mediastinum, located in front of the pericardial sac, middle mediastinum, which includes the pericardial sac with heart, and posterior mediastinum, located behind the pericardial sac.

Some structures are found only at one level of the mediastinum (e.g. the heart), while others cross different parts of the mediastinum (e.g. the oesophagus).

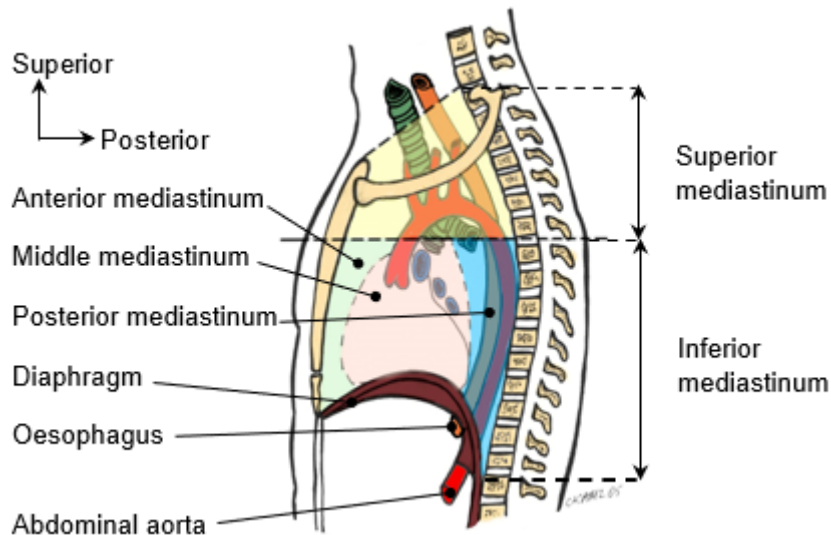


Figure 14: The regions of mediastinum. Left lateral view.

The left and right pleuro-pulmonary compartment include the lungs enveloped in a double layer of a serous membrane named pleura. Both pleural layers enclose the pleural cavity.

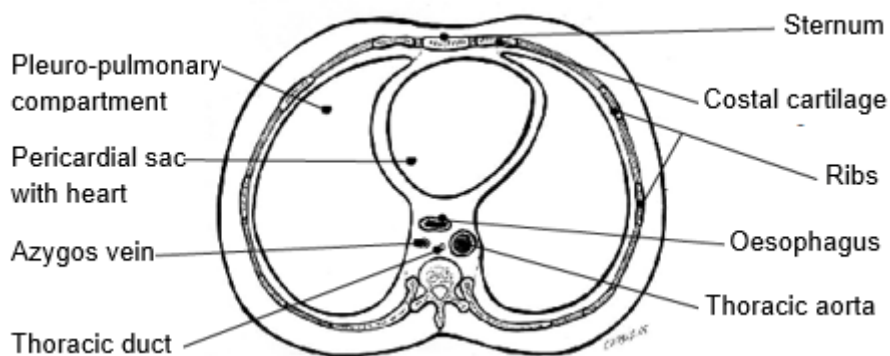


Figure 15: The regions of thorax. Cross-section, inferior view.

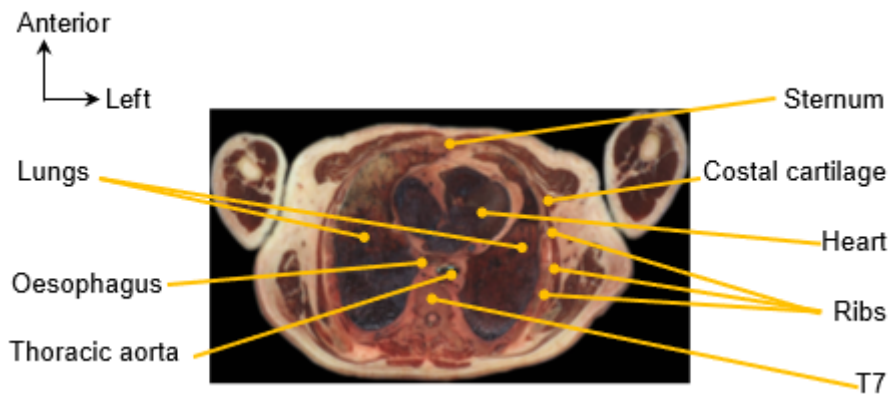


Figure 16: Cross-section of thorax through the vertebra T7. Inferior view.

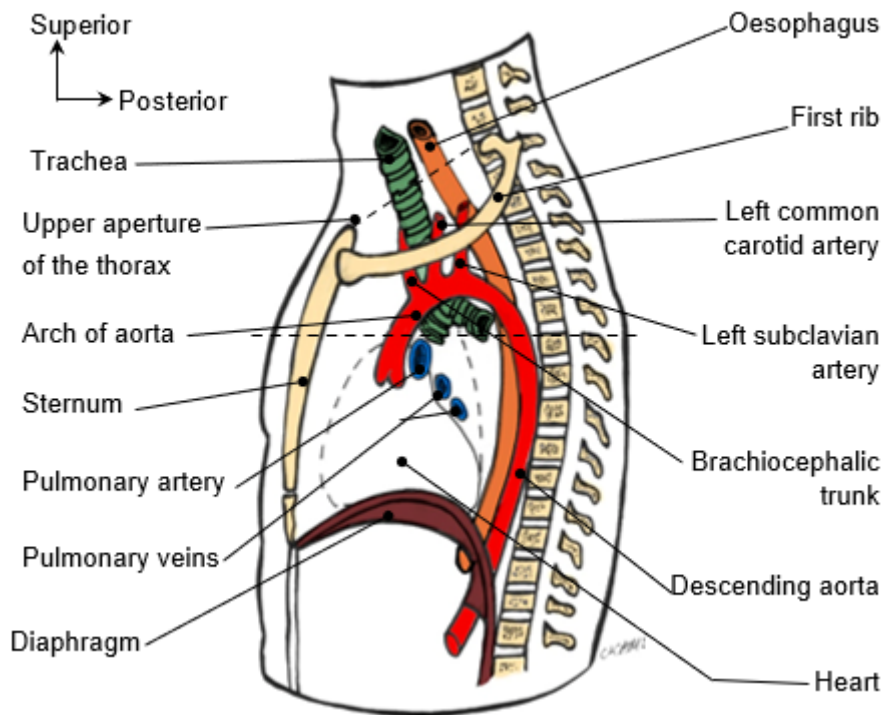


Figure 17: The structures of mediastinum. Left lateral view.

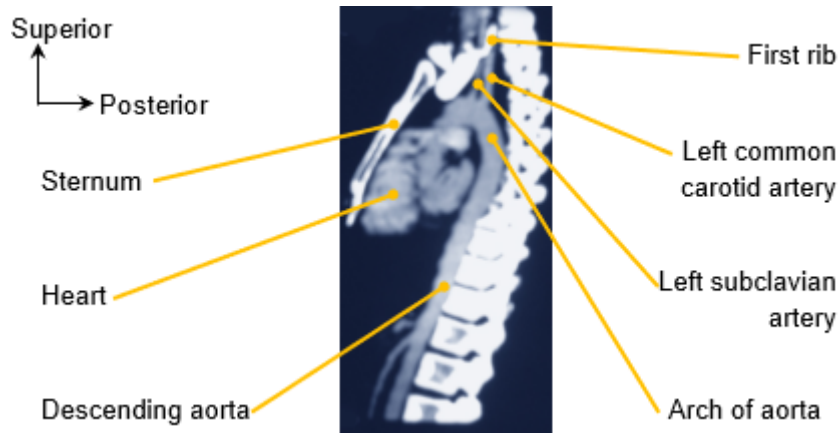


Figure 18: CT reconstruction of the mediastinal organs. Left lateral view.

Abdomen

The abdomen is the middle part of the trunk. Its upper boundary is formed by the inferior thoracic aperture and the diaphragm. Its lower boundary is a fictitious plane at the level of pelvic inlet (linea terminalis), separating the abdominal cavity and the pelvic cavity. The dorsal boundary is formed by the lumbar spine and the quadratus lumborum muscle.

The walls of the abdomen enclose the abdominal cavity.

Abdominal cavity

The abdominal cavity is divided into two major regions, the peritoneal cavity anteriorly and the retroperitoneal space posteriorly.

The peritoneal cavity is enveloped in a serous membrane named peritoneum. Various peritoneal structures divide the peritoneal cavity into compartments. The peritoneal structure that connects the transverse colon to the posterior abdominal wall (the transverse mesocolon) divides the cavity into upper and lower part. The upper part (supracolic compartment) contains the abdominal part of the oesophagus, stomach, and two solid organs, liver and spleen. The lower part (infracolic compartment) contains the rest of the digestive tract.

The retroperitoneal space contains the abdominal aorta, inferior vena cava, kidneys, ureters, adrenal glands, duodenum, pancreas, etc.

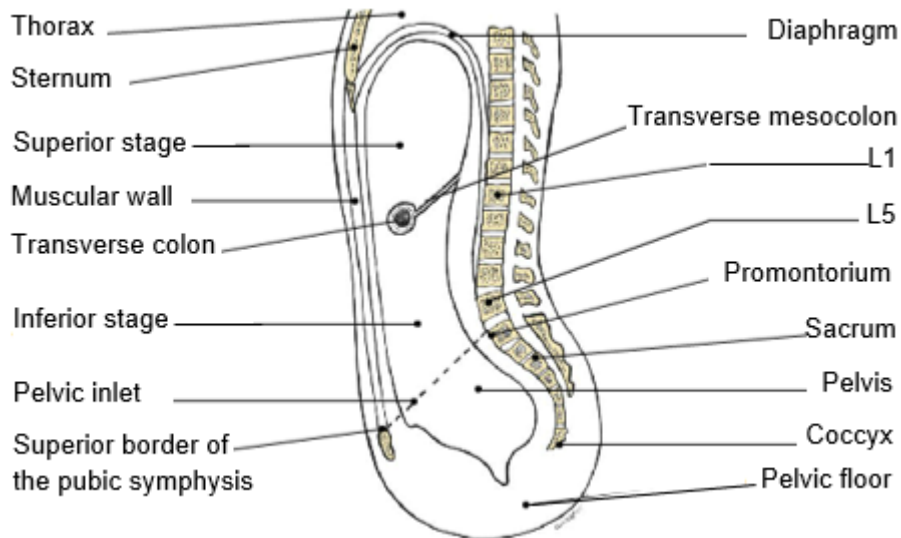


Figure 19: The compartments of the abdominal cavity. Median section, view from the left.

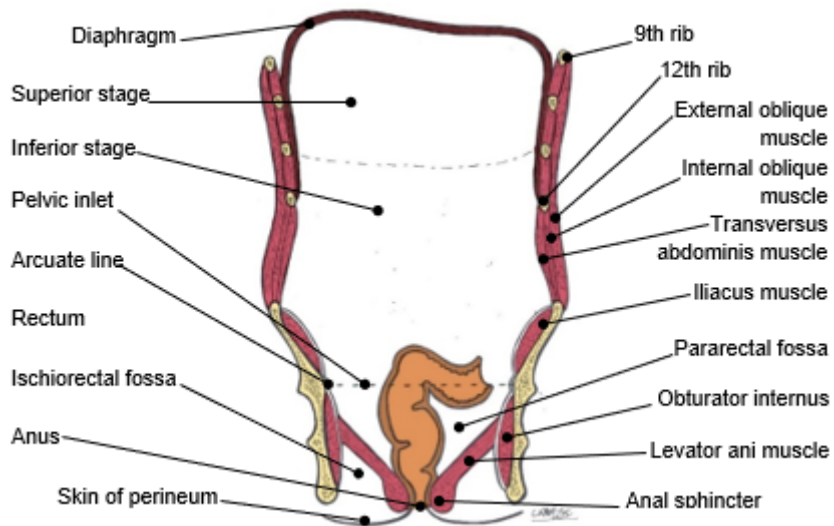


Figure 20: The walls of the abdominal cavity. Frontal section, anterior view.

Regions of abdomen

The abdomen can be divided into nine regions by two vertical midclavicular planes, and two horizontal planes: one at the level of the lower edge of the 10th ribs, and the other at the level of the iliac crests. The abdominal organs project into these regions. For example:

- The right hypochondrium: the liver.
- The left hypochondrium: the spleen.
- The epigastric region: the stomach.
- The right iliac fossa: the appendix, the right ovary.
- The left iliac fossa: the sigmoid colon, the left ovary.
- The hypogastrium: the urinary bladder, the uterus.
- The umbilical region: the small intestine.
- The left and right lumbar region: the kidney.

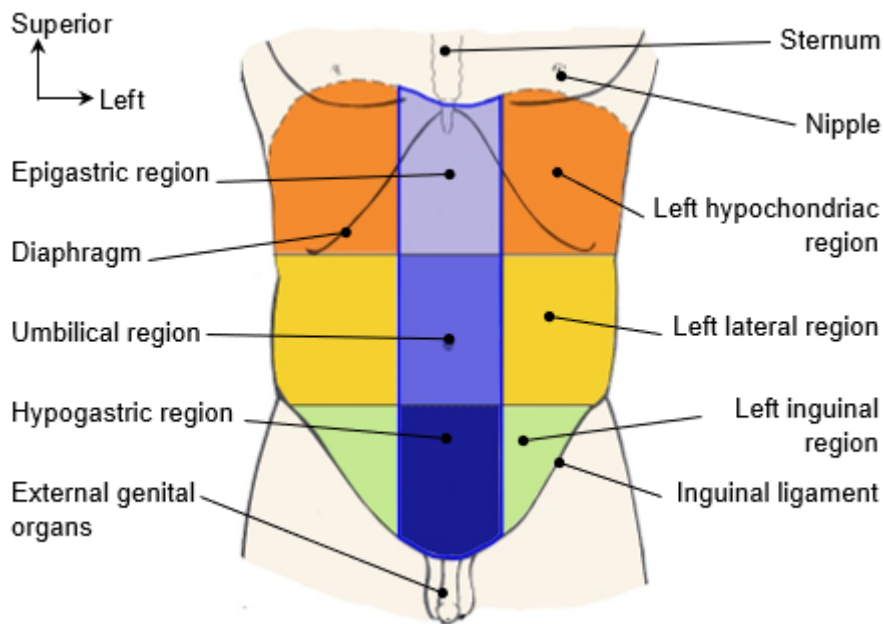


Figure 21: The regions of the abdomen.

Pelvis

The pelvis is the lowermost part of the trunk. Its upper boundary is the pelvic inlet. Its lower boundary is the skin covering the perineum. The dorsal boundary is formed by the sacrum and the coccygeal bone.

The pelvic inlet is a fictitious plane at the level of the terminal line separating the abdomen from the pelvis. The terminal line runs across the promontory of sacrum, arcuate line of ilium, pectineal line of pubis, and upper margin of the pubic symphysis.

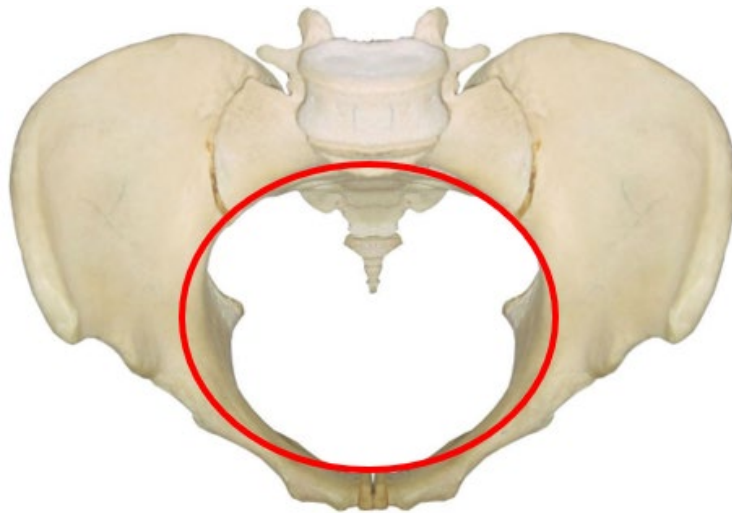


Figure 22: The pelvis and the terminal line (in red). Anterosuperior view.

The pelvic diaphragm forms a boundary between the pelvic cavity and the perineum. In women, the pelvic diaphragm can be weakened by childbirth.

The contents of the pelvic cavity are parts of the urinary system, genital system and parts of digestive system.

The perineum is the lowest part of the trunk, below the pelvic diaphragm. It includes the external orifice of the urethra and anus in both men and women, plus the vaginal orifice in women.

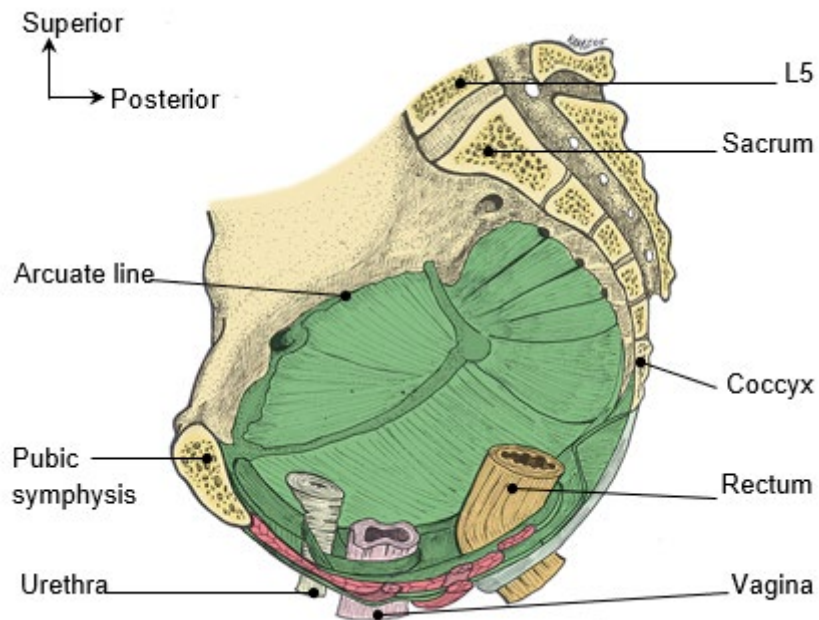


Figure 23: The walls of the pelvis in women.

5.4 - Upper limb

The upper limb is anchored to the trunk by its root, represented by the shoulder girdle. It consists of two major parts: the shoulder and the free part. The latter is divided into the arm, the elbow, the forearm, the wrist, and the hand.

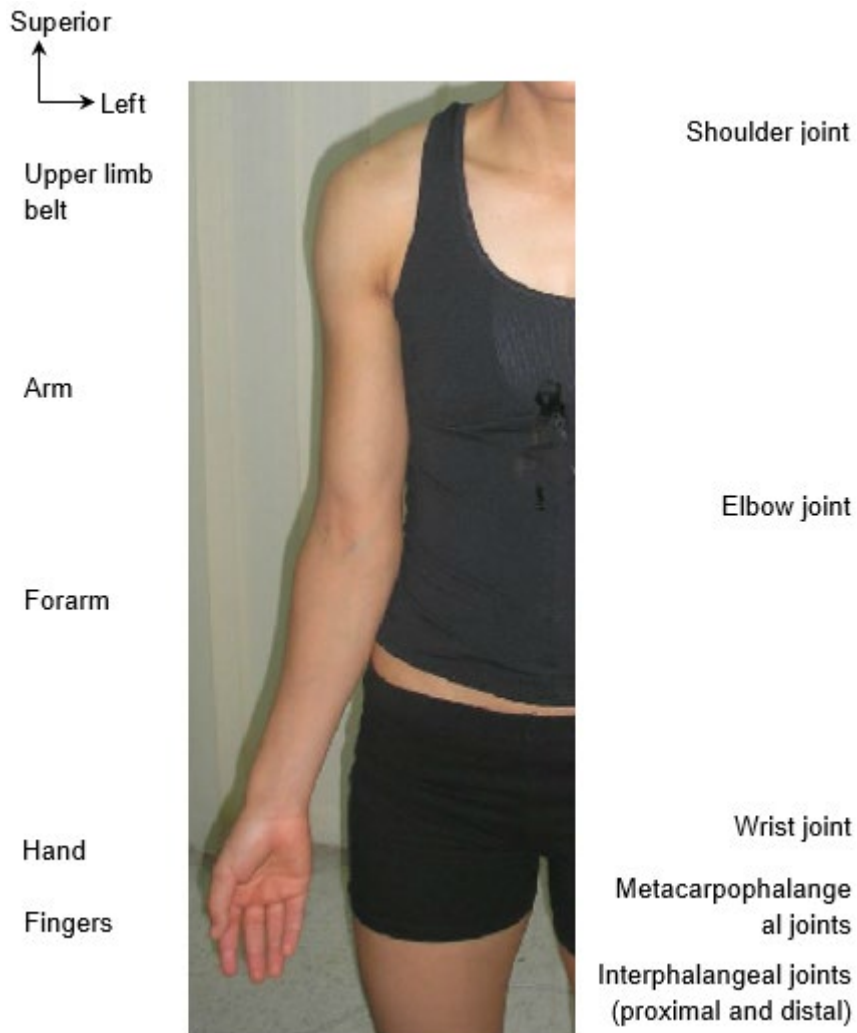


Figure 24: The right upper limb. Anterior view.

5.5 - Lower limb

The lower limb is anchored to the trunk by its root, the pelvic girdle. It consists of three major parts: the buttock, the hip, and the free part. The latter is divided in the thigh, the knee, the leg, the ankle, and the foot.

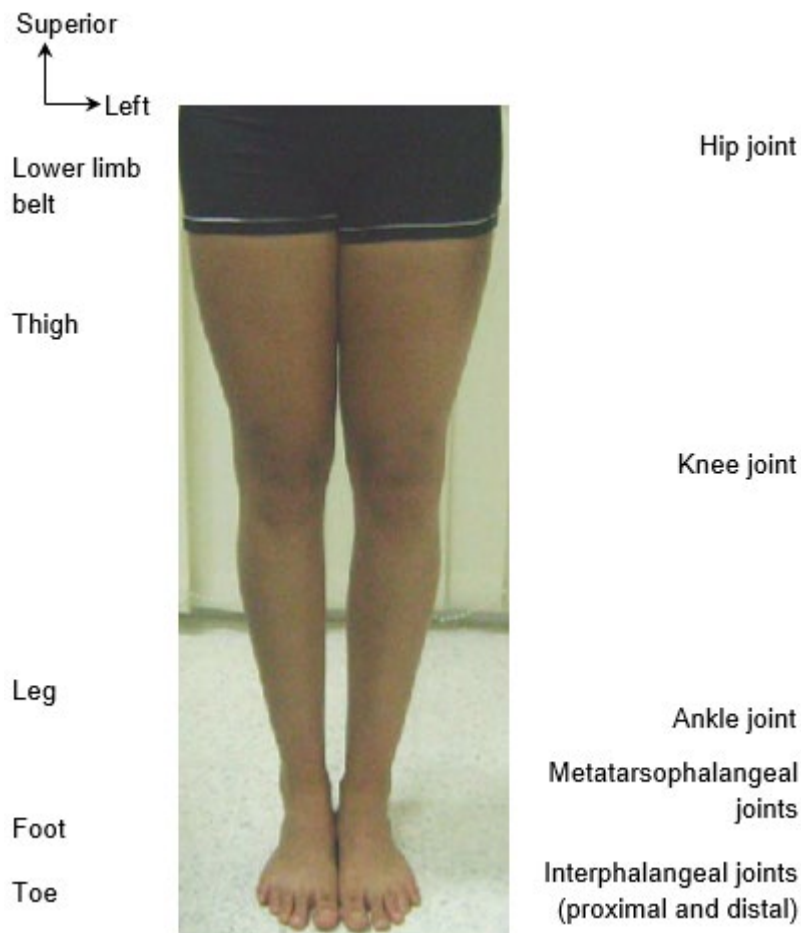


Figure 25: The lower limbs. Anterior view.

6 - Organisation of the human body in apparatuses

The human body is controlled by the nervous system, which provides the control of relational life (ascending or sensory pathways, descending or motor pathways) and of vegetative life (the vegetative nerve centres and pathways).

Morphologically, a distinction is made between the central nervous system (brain and spinal cord) and the peripheral nervous system (cranial nerves and spinal nerves).

The nerve networks and cords that connect the central nervous system to the various organs are called nerves and constitute the peripheral nervous system.

We will present the organisation of the human body according to the apparatuses:

- The apparatus of relational life.
- The apparatus of vegetative life.
- The apparatus of sexual reproduction.

6.1 - Apparatus of relational life

The apparatus of relational life is concerned with the life of the body in relation to its environment. The maintenance of posture and movements are the result of the locomotor system. The sensory organs and the nervous system are closely connected and provide for the reception of information from the environment, its integration and the corresponding reactions. The phonatory apparatus enables precise and rapid communication in humans.

Musculoskeletal systems

The musculoskeletal systems encompass the skeletal and the muscular system.

- The skeletal system includes the bones and the joints that form the framework of the body, i.e. the skeleton.

Osteology is the study of bones, and arthrology is the study of joints.

- The muscular system includes the skeletal muscles, fasciae, synovial bursae, and tendon sheaths.

Sensory apparatus

The sensory apparatus consists of the sense organs, which are specialised in receiving information and are connected to the central nervous system by ascending pathways.

There are four sense organs: olfactory organ, eye, ear, and gustatory organ. They inform the nervous system about the body's environment.

6.2 - The apparatus of vegetative life

The apparatus of vegetative life enables the regulation of the human body homeostasis by all the vital phenomena of animal existence.

The cardiovascular and the lymphatic systems

The cardiovascular system enables the transport of blood and lymph through the body, supplies the tissues with oxygen and nutrients, and removes the waste products of metabolism from the tissues.

- The blood system includes the heart and the vessels: arteries, veins, and blood capillaries.
- The lymphatic system and the hematopoietic organs: the lymph nodes and lymph vessels, the red bone marrow, the spleen, and the thymus.

The respiratory system

The respiratory system enables the exchange of oxygen and carbon-dioxide between the body and air, maintenance of the acid-base balance, and phonation.

The digestive system

The digestive system enables the mechanical and chemical degradation of food:

- the dental system: the teeth;
- the tubular system: the digestive tract;
- the glands: the liver, the pancreas and the salivary glands.

The urinary system

The urinary system enables filtration of blood and elimination of the waste products and unnecessary compounds:

- the kidneys: filtration system;
- the tubular system: the ureters, the urinary bladder and the urethra.

The endocrine system

The endocrine system regulates a wide variety of bodily functions through the production of hormones. It includes the endocrine glands.

6.3 - The apparatus of sexual reproduction

The genital systems enable the reproduction.

- the male genital system;
- the female genital system.