HUMAN ANATOMY AS A SCIENCE

Human Anatomy Department
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Plan of the lecture

- ***Anatomy as a science and its historical development***
- ***Branches of Anatomy and relationship with other disciplines***
- ***Levels and methods of Anatomical study***
- ***Anatomical terminology***
- ***Norm and abnormalities***
- ***Constitutional types***

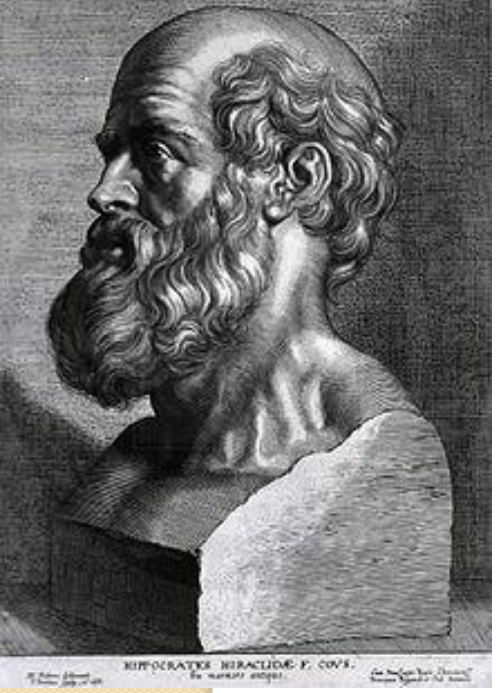
Human Anatomy **studies the shape and structure of the human body, its origin, regularities of development in relation to its function and external environment.**

- The main aim of human anatomy is description of the shape, of the macro-microscopic structure and topography of the organs related to the individual, sexual and constitutional specific features of the human organism, taking into consideration the phylogenetic and ontogenetic aspects of development.

- The term **Anatomy** "*anatemno*" derives from a Greek word that means "to cut up".

- In the past, the word *anatomize* was more commonly used than the word *dissect*.

- Anatomy as a science previously dealt with a single problem – to understand how the body is built - ***Descriptive Anatomy***.



Hippocrates *(460-377 B.C.)*

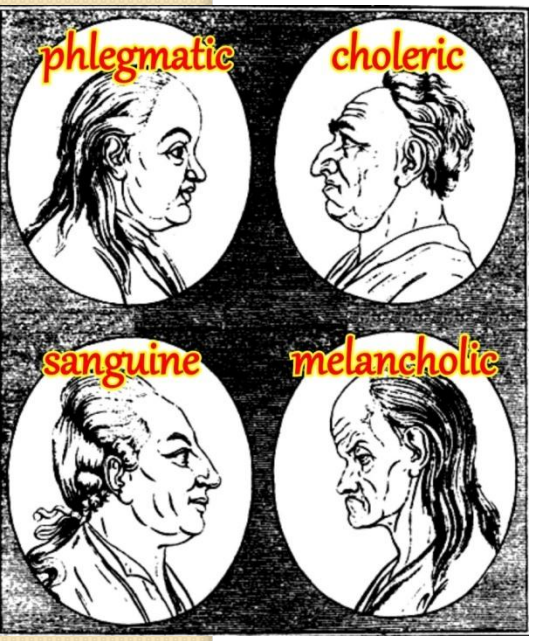
- **Hippocrates** was a famous Greek physician who is regarded as the **father of medicine.**
- The field of medicine at the time of Hippocrates held to the notion of four fluids, or humors.
- The humoral theory suggested that, if **blood, bile, black bile**, and **phlegm** were balanced, the person would be healthy and in good mood.

a) If blood was the predominant humor, one was said to have **sanguine** personality – courageous and passionate.

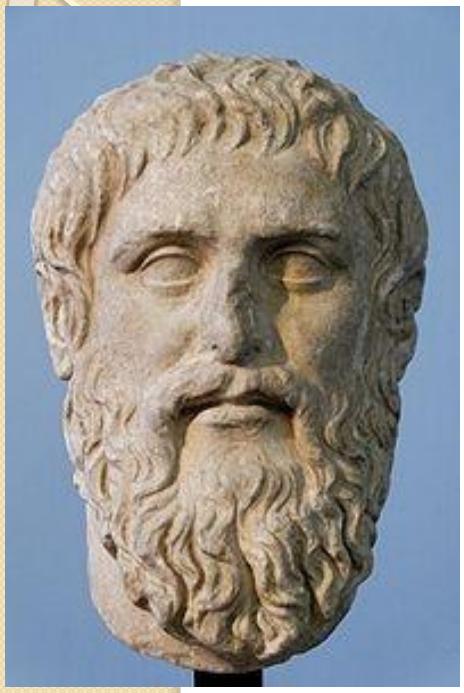
b) If there was too much bile, one was **choleric** – angry and mean.

c) A **melancholic** personality – moody and depressed – resulted from an overproduction of black bile.

d) Too much phlegm results in a **phlegmatic** personality – sluggish and apathetic. These terms are still used.

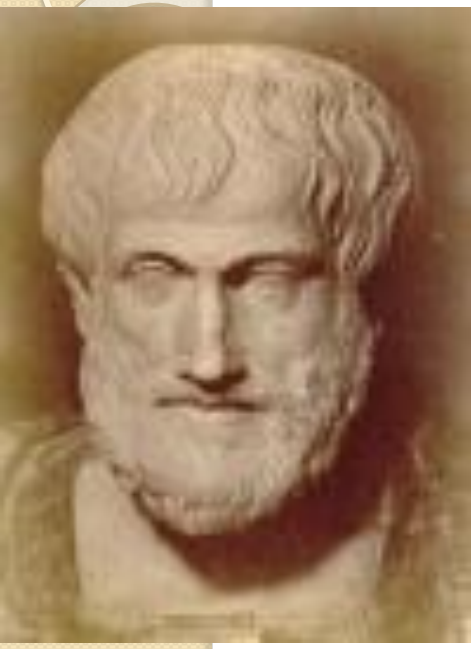


Plato *(428/427 or 424/423 – 348/347 BC)*



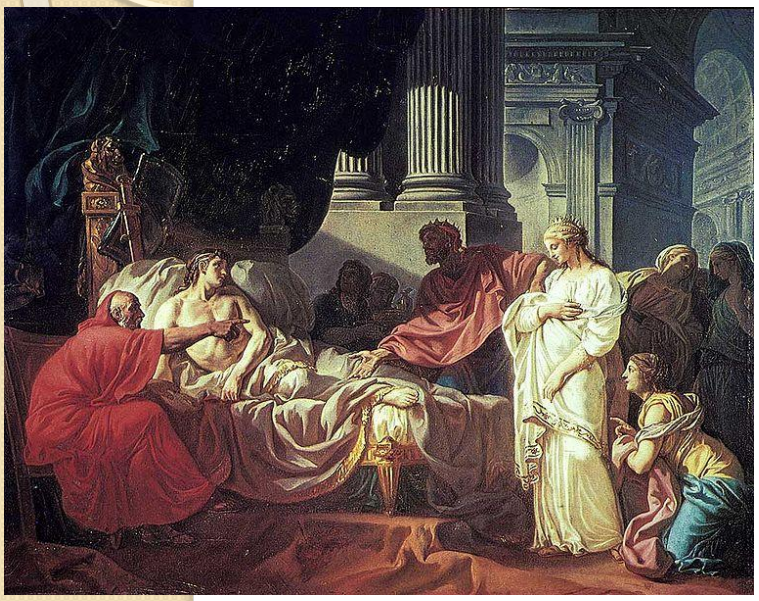
- **Plato** was a philosopher and mathematician in Classical Greece, and the founder of the Academy in Athens, the first institution of higher learning in the Western world. He is widely considered the most pivotal figure in the development of philosophy, especially the Western world.
- **Plato** was an ideologist of the reactionary aristocracy, an opponent of materialism and an advocate of antique idealism.
- Along with his teacher Socrates, and his most famous student Aristotle, Plato laid the very foundations of Western philosophy and science.
- According to Plato, the organism is controlled not by a material organ, the brain, but by three types of soul, or "***pneuma***", contained in the three main organs of the body: ***the brain, the heart, and the liver*** (Plato's tripod).

Aristotle *(384-332 B.C.)*



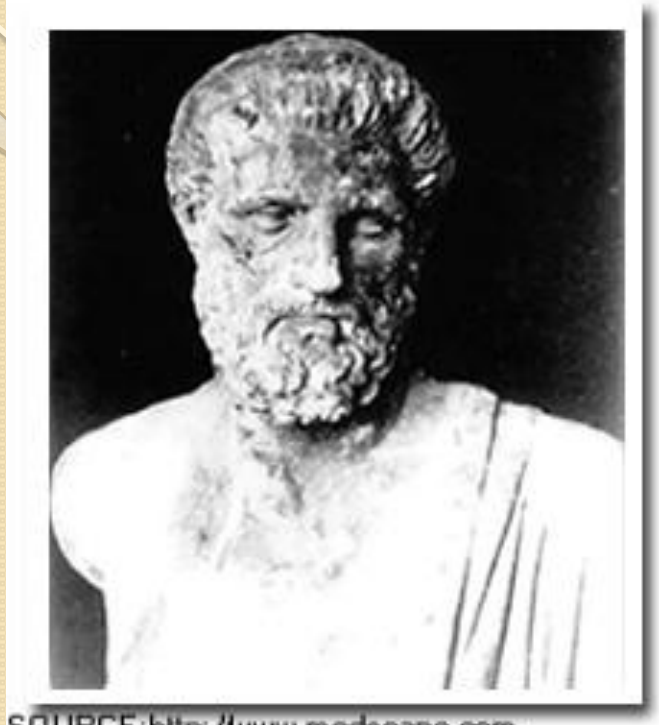
- **Aristotle** made careful investigations of all kids of animals, including humans.
- He wrote the *first known account of embryology*, in which he described the development in a chick embryo.
- His best-known zoological works are ***History of Animals, Parts of Animals, and Generation of Animals.***
- Despite his tremendous accomplishments, Aristotle perpetuated some erroneous theories regarding human anatomy.
- For example, he disagreed with Plato, who had described the brain as the seat of feeling and he proclaimed the heart to be the seat of intelligence.
- Aristotle thought that the function of the brain, which was bathed in fluid, was to cool the blood and thus to maintain body temperature.

Erasistratus *(350-300 B.C.)*



- The Greek scientist ***Erasistratus*** was more interested in body functions than structure, and is therefore frequently referred to as the ***father of physiology*.**
- *Erasistratus* had written a book on the causes of diseases, in which he included observations on the **heart, vessels, brain** and **cranial nerves**, and he was the first who had differentiated the **motor** and **sensory** nerves.
- After studying the contraction of muscles, he developed the theory of movement which was accepted until the XVII-th century. But his theory was based on *mystical* concepts, because Erasistratus thought that the nerves carried animal spirits and that muscle contracted due to distension by spirits.
- He noted the toxic effects of *snake venom* on various organs and described changes in the liver resulting from certain metabolic diseases.

Herophilus *(335-280 B.C.)*



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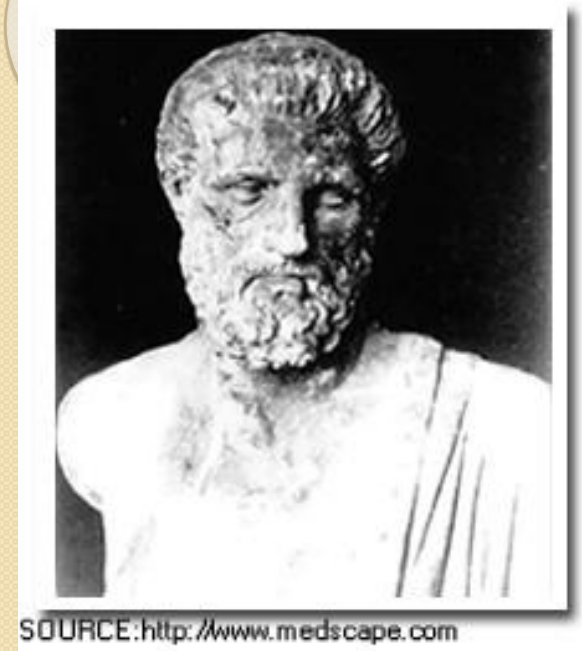
"When health is absent, wisdom cannot reveal itself, art cannot manifest, strength cannot fight, wealth becomes useless, and intelligence cannot be applied."

Herophilus

Herophilus was a court physician to Ptolemy II and he established anatomy as an independent science.

He was an early performer of public dissections on human cadavers, and often called the ***father of anatomy***.

- ***Herophilus*** began dissecting human cadavers, thus giving rise to a term ***anatomy***.



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- Using this method, he described various anatomical structures:

a) the **brain** and its **meninges**;
b) the vascular network and **venous sinuses** with their confluence (*torcular Herophili*);
c) he distinguished the **nerves** from muscle **tendons;**
d) he differentiated the **arteries from veins**;
e) the **chyliferous vessels** (though he did not appreciated their significance) and other vessels, including the **pulmonary veins**;
f) he discovered the **prostate** and **duodenum**.

Claudius Galen *(A.D. 129-220)*

- Was an eminent ***philosopher***, ***biologist***, ***anatomist***, and ***physiologist***, and considered as “father of physiology"of ancient Rome.
- His areas of expertise included physiology, neurology, logics, phylosophy and anatomy.
- The most famous physician of that time and the most influential writer to date on medical subjects.
- For nearly 1 500 years, the writings of Galen represented the ultimate authority on anatomy and medical treatment.
- Galen believed in the humors of the body, and perpetuated this concept. In his opinion the organism was controlled by three organs:

a) **the liver**, in which ***physical pneuma*** was produced and than distributed along the veins.

b) **the heart**, in which ***vital pneuma*** originated and was then transmitted along the arteries.

c) **the brain**, in which the ***psychic pneuma*** was concentrated and then distributed along the nerves.

- He also gave authoritative explanations for nearly all body functions.

Roman Era

- In many respects, the Roman Empire stifled scientific advancements and set the stage for Dark Ages.
- The interest and emphasis of science shifted from the oriental to the practical under Roman rule.
- Few dissections of cadavers were performed other than at autopsies in attempts to determine the cause of death in criminal cases.
- Medicine was not preventive but was limited, almost without exception, to the treatment of soldiers injured in battle.

Middle Ages

- The Middle Ages (Dark Ages 5th -17th centuries) came with the fall of Roman Empire in A.D. 476 and lasted nearly 1000 years.
- Dissections of cadavers were totally prohibited during this period, and molesting a corpse was a criminal act that was frequently punished by burning at the stake.
- If mysterious death occurred, examination by inspection and palpation were allowed.
- During the epidemic plague in the sixth century, however a few necropsies and dissections were performed in hopes of determining the cause of the disease.

Ibn Sina, or Avicena *(980-1037)*

- Was a great scholar, physician, poet and statesman, the “Father of Science” and an encyclopaedist who wrote about all the major problems of the second half of the Middle Ages.
- He was the author of more than one hundred works, the most prominent of which is the ***Canon of Medicine*** (c. 1000). This book contains valuable anatomical and physiological information from Hippocrates, Aristotle, and Galen to which Ibn Sina added his own belief that the organism is controlled not by three organs ***(Plato's tripod)*** but four, namely *the heart, brain, liver* and *testis* ***(Avecena's quadrangle).***
- Ibn Sina studied the structure of eye.
- The ***Canon of Medicine*** was the best medical work produced in the feudal age and served as the source of knowledge for physicians of the East and West until the seventeenth century.

Ibn-al-Nafiz *(1213 – 1288 A.D.)*

- In the East, Arabic physicians continued contributing to the process of medicine, and one of them, **Ibn-al-Nafiz** from Damascus (twelfth century), discovered the ***pulmonary circulation.***

Leonardo da Vinci (1452-1519)

- **Leonardo da Vinci** (1452-1519), the genius of Renaissance, was a painter, engineer, philosopher, and scientist in various fields of science, including anatomy. He first becomes interest in anatomy as an artist but latter approaches the subject from a scientific point of view.
- He did not restrict himself to the study of the external relief of the human body but was one of the first scholars to dissect human cadavers and was a genuine innovator in the study of the human organism. His methods of investigation were themselves innovative.
- He dissected human cadavers, sawed and analyzed bones, and prepared models, which drew from various perspectives to produce three-dimensional images of the organs. These drawings were the first correct representations of various organs of the human body.

Andreas Vesalius *(1514-1564)*

- **Andreas Vesalius** was an anatomist and physician.
- Vesalius was born in Brussels, but he activated as a professor at the University in Padua, and later became imperial physician at the court of Emperor Charles V.
- By the time he was 28 years old, Vesalius has completed the masterpiece of his life, "***De Humany Corporis Fabrica***", in which he beautifully illustrated and described the various body systems and individual organs. Because of the eventual impact of this book, Vesalius is often called the ***father of anatomy***.
- His book was especially important because it boldly challenged Galen's erroneous teaching (more than 200) and thus undermine the authority of Galen's anatomy which reined at the time.
- Vesalius studied the structure of the human body systematically for the first time.
- Vesalius was subjected to persecution, because he was slanderously accused of dissecting the body of a noble woman whose heart was allegedly still beating.

William Harvey *(1578-1657)*

- **William Harvey** *was the first who provided a true picture of blood circulation.*
- In 1628, he published his pioneering work ***"Anatomical Treatise on the Movement of the Heart and Blood in Animals".***
- This brilliant work proved the continuous circulation of blood within vessels and provided a classic example of the scientific investigation.
- The controversy over the circulation of the blood raged for 20 years until other anatomists finally repeated Harvey's experiments and confirmed his observations.

Branches of human anatomy

- The **systemic anatomy** emphasizes the functional relationships of various organs within a system and of each system to every other, but especially to the nervous system, which unites the organism into a single entity.
- The **topographic anatomy** describes relationships of portions of several systems and their location towards the skeleton cavities.
- The **dynamic anatomy** studies the dynamics of supportive and motor apparatus.
- Other branch of anatomy is the **sport anatomy**, which studies the structure of the organism of individuals engaged in sports and the effect produced on the body's structure by various sports.

Branches of human anatomy

- **Applied anatomy** for artists and sculptors studies only the external form and proportions of the body and is called **plastic anatomy.**
- Anatomy which studies the normal healthy organism is called **normal anatomy**, and vice versa anatomy that studies sick organism and the morbid changes in its organs is called **pathological** or **morbid anatomy**.
- Especially necessary for physician is the study of the anatomy of a living human being or **anatomy on alive person.**
- **All these branches of anatomical science are different aspects of a single human anatomy.**

HUMAN ANATOMY AND MEDICAL SCIENCES RELATED TO IT

- Anatomy and ***physiology*** are both subdivisions of science of biology, the study of living organisms. To understand the structure of the organism in light of the connection between form and function anatomy uses the data of physiology, the study of the organism's vital functions.
- ***Physiology*** attempts to explain how the body functions through physical and chemical processes.
- The external shape of organs cannot be separated from their internal structure and in this respect anatomy is closely related to ***histology***, the science of tissues, particularly to the branch of histology known as microscopic anatomy.

HUMAN ANATOMY AND MEDICAL SCIENCES RELATED TO IT

- ***Histology*** and ***cytology*** the science of cell are considered independent branches of science, because of the specific character of the examination methods (under the microscope), specific patterns governing the development of tissues, cells and extracellular substance.
- The invention of electron microscope, made possible to examine submicroscopic structures and molecules of living matter.
- These structures are objects of study in chemistry but because they belong to living matter, cytology and chemistry joined to form a new science called ***cytochemistry***.
- ***Anatomy, histology, cytology*** and ***embryology*** constitute the general science of the form, structure and development of the organism, which is called ***morphology*** (GK. morphe- form or shape).

HUMAN ANATOMY AND ITS MODERN CONTENT

- ***Modern anatomy*** attempts to explain not only how the body is built, but to find out, why it is so built.
- The human organism changes continuously from the time of birth to the moment of death. The human species is the product of prolonged evolution.
- Anatomy, therefore, studies not only the structure of the modern adult man, but discovers the regularities governing the structure and development of the human body and investigates the human organism in its historical development.

Historical development of the human organism

- The development of the human genus in relations to the evolutionary process of the lower life forms is called ***phylogenesis*** (Gk phylon – genus, genesis – development). Thus appeared comparative anatomy, which compares the structure of various animals and man.
- The formation and development of the human being in relations to the development of society is called ***anthropogenesis*** (Gk anthropos – human being).
- The process of the development of individual organism throughout life is called ***ontogenesis*** (Gk onthos – being) and it is concerned with intrauterine and extrauterine periods of development.

TRADITIONAL AND CONTEMPORARY METHODS OF EXAMINATION USED BY HUMAN ANATOMY

There are two main methods of anatomical study:

a) **Examination of a cadaver**

b) **Examination of a living person**

- **Examination of a cadaver** by opening the body cavities and dissecting the organs and tissues with surgical instruments.

1. **Tubular systems** (vessels, ducts etc.) are injected with various media (injection method) and then *exposed to X-rays*, *clarification, or corrosion.*
2. **Nerves** are treated by *elective staining* (for **example silver impregnation)**.
3. The **bones** are prepared by *maceration method*.
4. Fragments of the body or organs are *frozen* and after that are sectioned for study the relationship of anatomical formations (Pirogov's method).

- **Examination of a living human being**. This method includes ***clinical*** and ***paraclinical*** methods.

Clinical examination

- *Inspection*
- *Palpation*
- *Percussion*
- *Auscultation*
- *Anthropometry (various measurement of the body)*

Paraclinical methods of examination

- ***X-rays*** provide the best possibility for studying "living anatomy". X-rays are used for making X-rays photographs (radiography) and for visualization on a special screen (radioscopy).
- X-rays examination give to a physician the possibility to examine the structure of an organ without pain and without opening the body cavities.

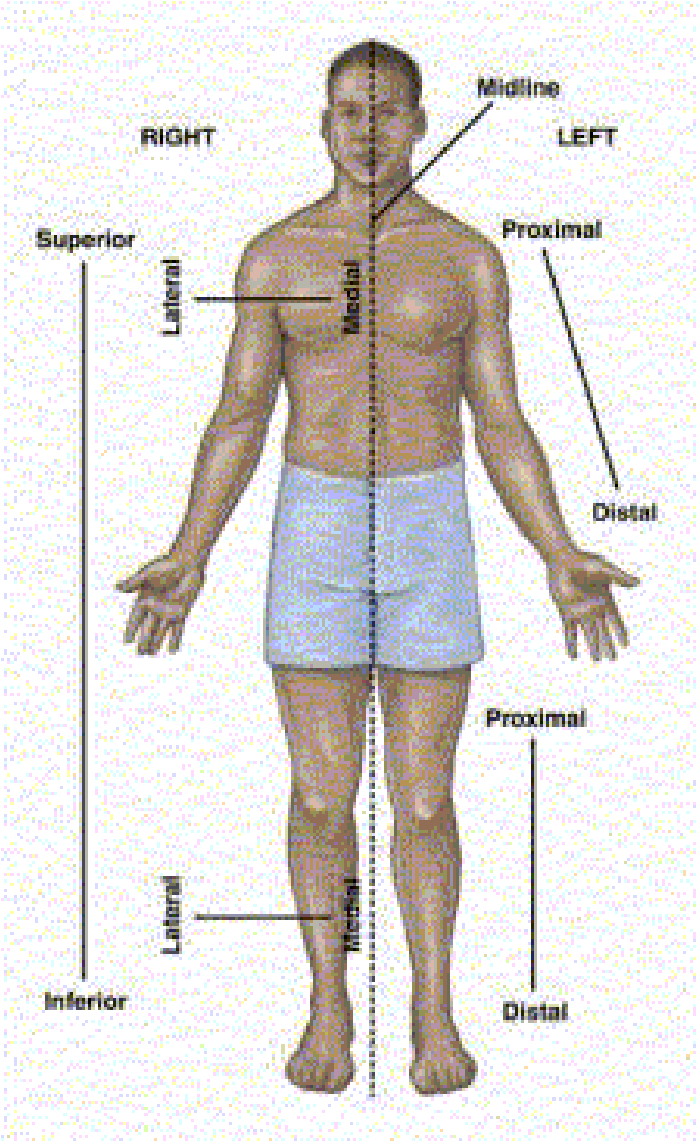
Paraclinical methods of examination

- ***Electroradiography*** produces an X-rays image of the soft tissues (skin, subcutaneous fat tissue, the connective tissue framework of the parenchymatous organs, ligaments, cartilages etc.), which are invisible on ordinary radiographs because they are radiolucent.
- ***Computer tomography*** produces an image of all the organs in a single plane of body tissue, much like sections of a frozen cadaver.
- ***Magnetic Resonance Imaging,*** etc.

ANATOMICAL TERMINOLOGY

- The names of all the consisting parts and organs of the human body were established at three Congresses in Basel, Jena and Paris.
- **In 1895 the Basel Nomina Anatomica** *or BNA was introduced.*
- **In 1935** *it was greatly changed at the* **Congress of Anatomists in Jena**.
- **In 1955 the IV-th International Federal Congress of Anatomists in Paris** *established new universal anatomical terms, the so-called* **Paris Nomina Anatomica,** *or PNA.*

- All terms of direction that describe the relationship of one part to another are made in reference to the anatomical position.
- In the anatomical position, the body is erect, the feet are parallel to one another and flat on the floor, and the arms are at the sides of the body with the palms of the hands turned forward.
- Directional terms are used to locate the position of structures, surfaces, and regions of the body.



Body regions and body cavities

- The human body is divided into regions and specific areas that are identified on the surface. The major body regions are:

a) the *head,*

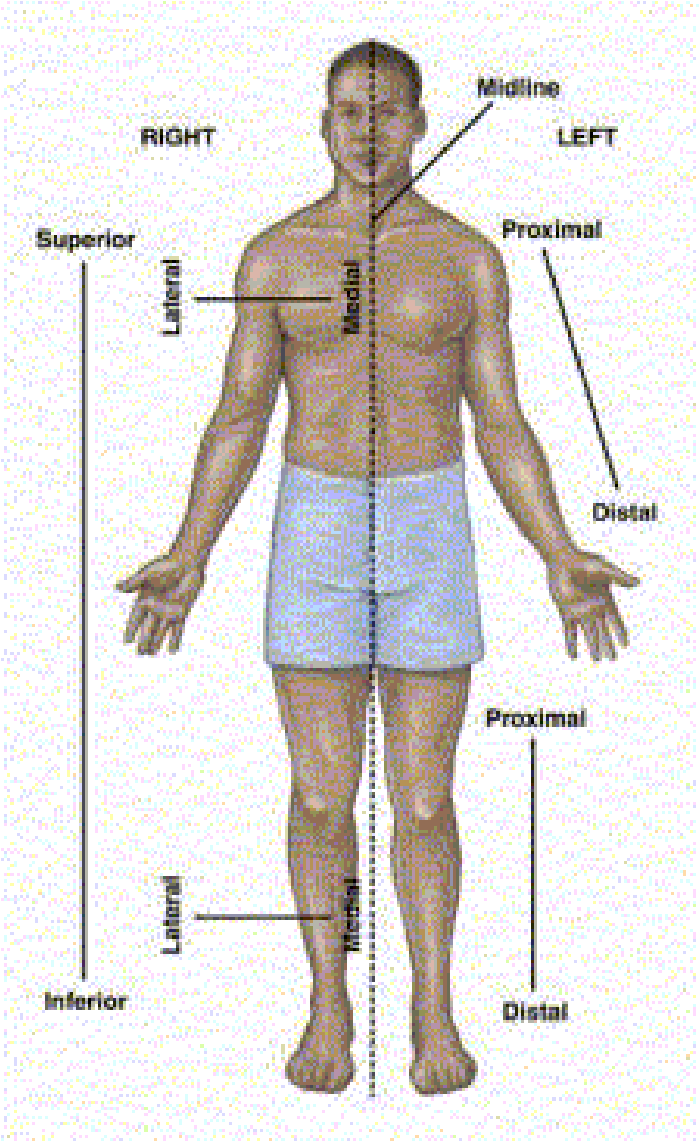
b) *the neck,*

c) *the trunk,*

d) *the upper limb*

e) *the lower limb.*

- The trunk is frequently divided into the thorax and abdomen.



PLANES OF REFERENCE

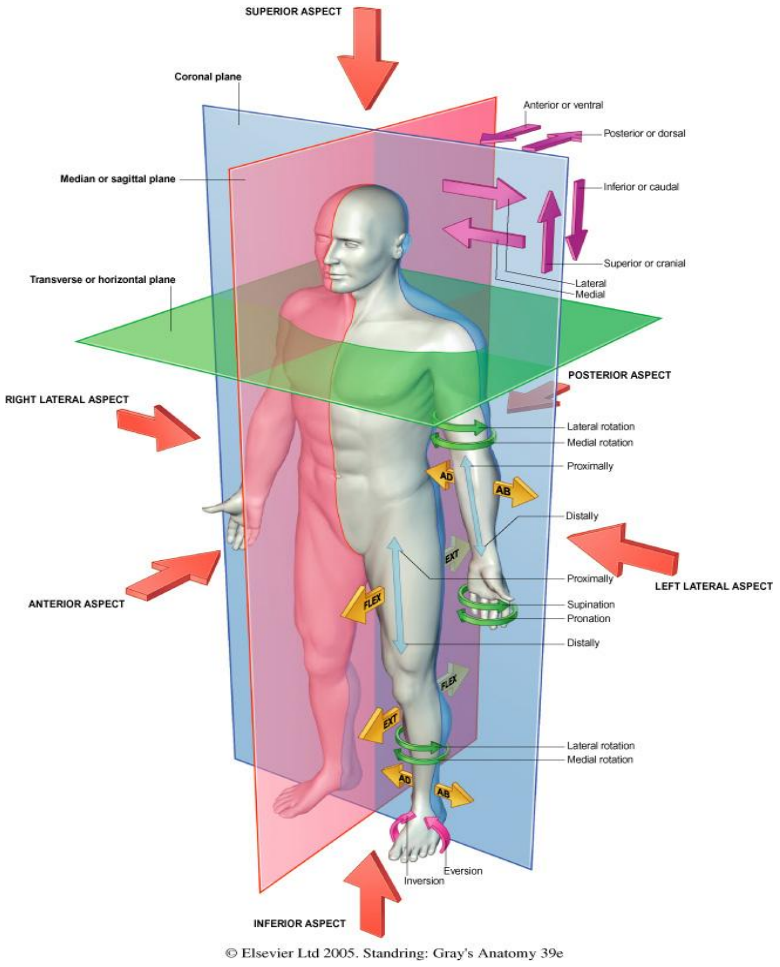
- In order to visualize and study the structural arrangements of various organs, the body may be sectioned (cut) and diagrammed accordingly to planes of reference.
- Three fundamental planes of reference are used:

a) **Sagittal plan** divides the body into unequal right and left parts.

b) **Midsagittal plane** passes lengthwise through the middle plan of the body, dividing it into equal right and left halves.

c) **Frontal** plan passes lengthwise and divides the human body into anterior (front) and posterior (back) parts.

d) **Transverse plane**, also called **horizontal**, or **cross-sectional plane**, divides the body into superior (upper) and inferior (lower) portions.



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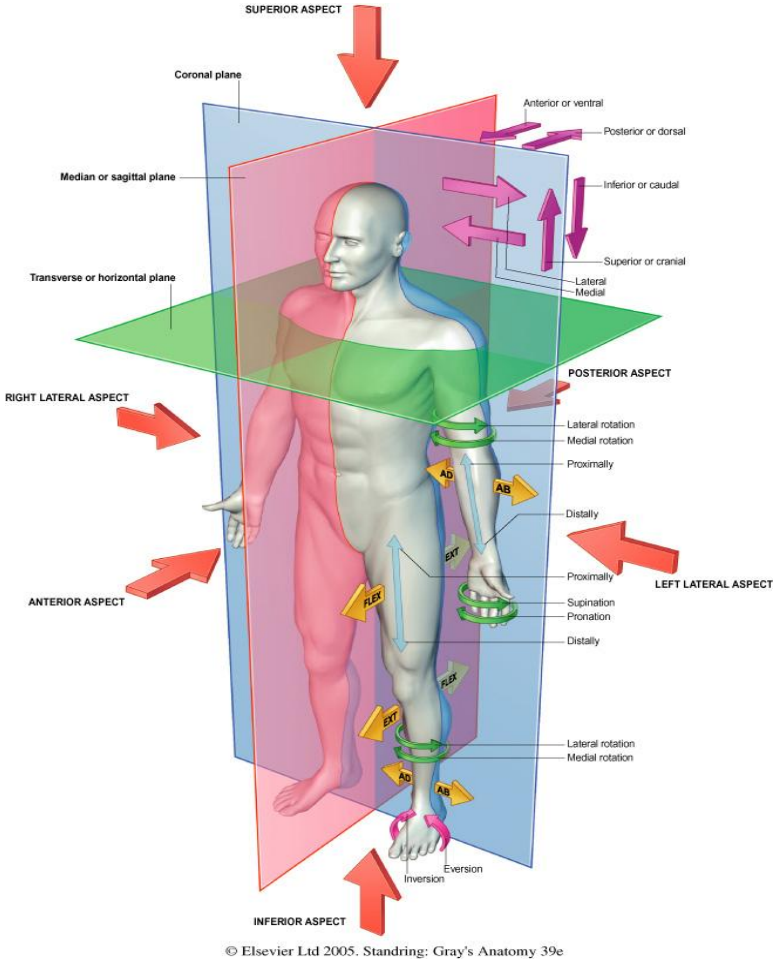
The axes of the human body

- The **sagittal axis** pierces the body from front to back.
- The **frontal axis** passes from the right side to the left.
- The **vertical axis** passes along the body of a man having vertical position.
- The **longitudinal axis** as well passes along the human body, but the position of the man does not matter; as well this axis passes along the limbs, organs etc.
- **NB: The axes do not divide the human body into parts.**



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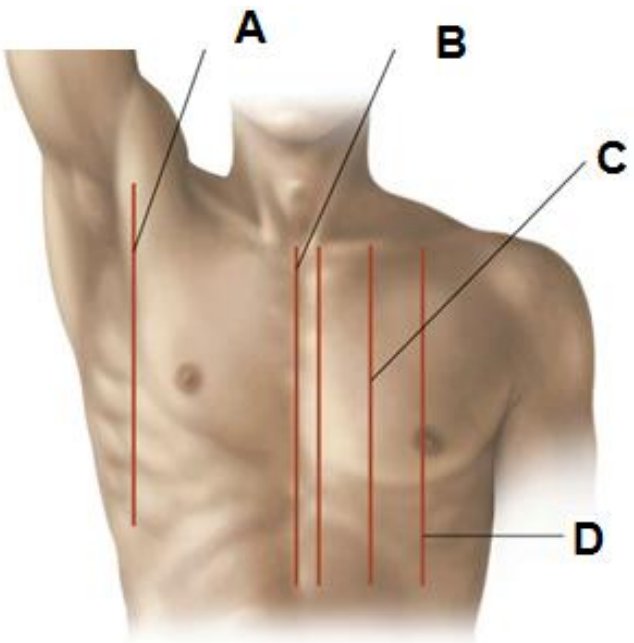
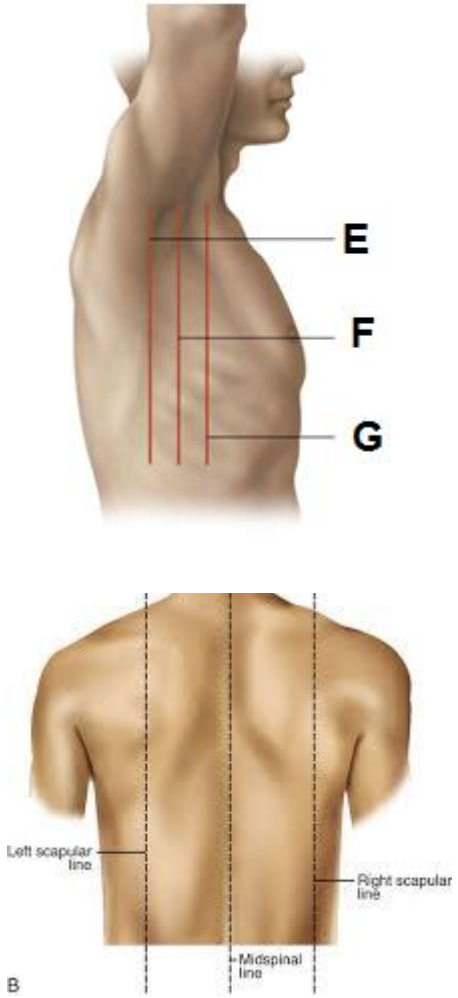
Conventional vertical lines of the thorax

- On the both sides of the thorax on its anterior, lateral and posterior walls can be traced some vertical conventional lines.
- The **anterior median** line which passes through the middle side of the sternum.
- The **posterior median** line passes along the spinous processes of the thoracic vertebrae.
- The **sternal line** passes along the lateral border of the sternum (B).
- The **medioclavicular line** passes through the middle of the clavicle (D).
- The **parasternal line** passes on the middle distance between the sternal and medioclavicular lines (C).



Conventional vertical lines of the thorax



- The **anterior axillary** line descends along the thorax from the anterior end of the anterior axillary fold (G).
- The **middle axillary** line comes downwards from the highest point of the axillary fossa (F).
- The **posterior axillary** line descends from the posterior end of the posterior axillary fold (E).
- The **scapular line** passes through the inferior angle of the scapula.
- The **vertebral line** comes downwards through the costo-transverse joints.
- The **paravertebral line** is situated on the middle distance between the vertebral and scapular lines.

GENERAL NOTIONS CONCERNING NORM, VARIANTS OF NORM AND ABNORMALITIES

- In the process of development the human organism became adapted to the environment.
- As a result definite equilibrium was established between the organism and the environmental conditions. The condition when all the organs and systems of the human body function and exist in a definite equilibrium was established as **norm**.
- The **norm** is range of deviations within certain limits of statistical indexes, which are not accompanied by functional disorders - the most common from statistical point of view.
- The organism and its organs have many variations, or **variants of norm** but the function of the organ is not disturbed.
- **The variant of norm (*varitas*) is** a particular (individual) way of manifestation of an anatomical structure that appeared as a result of deviations of development, but does not exeed the normal limits.

Abnormality

- Abnormalities result from improper development.

- Deviation from the specific structure or/and function inhereted in the respective biological species, which appeared due to disturbances of embryogenesis/morphogenesis, of one or another anatomical structure, leading to functional disorders.

- Some abnormalities do not disturb essentially the equilibrium between the organism and the environment (e.g. dextrocardia–location of the heart on the right side, abnormal position of the organs, when the organs are located on the opposite side).
- Other abnormalities are attended by impaired function of the organism or of some organs such abnormalities disturb the equilibrium between the organism and the environment (e.g. cleft palate, absence of a limb or of a part of the limb etc), or even they are incompatible with life (e.g. absence of the heart, acrania etc).
- ***Gross developmental anomalies are called monstrosities*** or ***teratisms***.
- The branch of anatomy and embryology which studied the abnormalities and malformations is named ***teratology*** (Gk. teras-monster, logos-science).

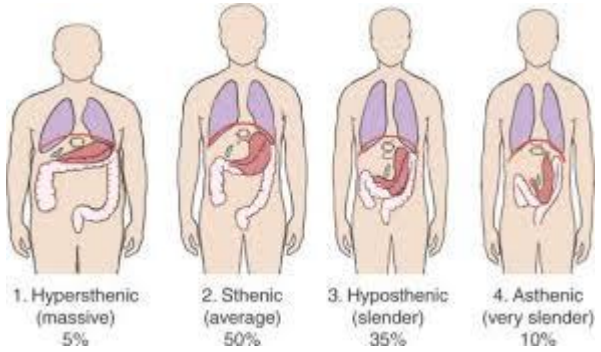
HUMAN ORGANISM AND CONSTITUTIONAL TYPES

Constitutional types of the human body:

1. ***Hypersthenic type***
2. ***Asthenic type***
3. ***Normosthenic type***

- ***Hypersthenic type,*** marked by predominant growth in breadth, massive bulk, and good nourishment.
- The trunk is relatively long, but the limbs are short.
- The head, chest, and abdomen are very large because the corresponding body cavities are greatly developed.
- There is relative predominance of the size of the abdomen over that of the chest and of the transverse dimensions over the longitudinal dimensions.

Схема трьох основних конституціональних типів в юнацькому віці.
Зліва – астенік, посередині – нормостенік, справа – гіперстенік.



- ***Asthenic type,*** characterized by predominant growth in length, just proportions, slenderness of body build, and poor general development.
- The limbs predominate over a relatively short trunk, the chest over the abdomen, and the longitudinal dimensions over the transverse dimensions.
- ***Normosthenic type,*** a constitutional type intermediate between the ***hypersthenic*** and ***asthenic***.

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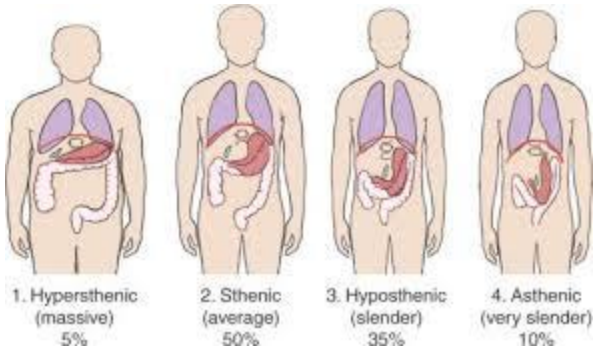

According to another classification the following three types of body built can be distinguished:

- ***Dolicomorphic type,*** marked by a body that is long, or of above average height, a relatively short trunk, a small chest circumference, narrow or moderately wide shoulders, long lower limbs, and slight tilting of the pelvis.
- ***Brachymorphic type,*** characterized by moderate or shorter than average height, a relatively long trunk, a large chest circumference, relatively wide shoulders, short lower limbs, and marked inclination of the pelvis.
- ***Mesomophic type,*** is an average body build, intermediate between the two described above.

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