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**ANATOMY OF BONE SYSTEM
АНАТОМИЯ КОСТНОЙ СИСТЕМЫ**

The manual for medical students

*Учебное пособие для медицинских вузов
(специальность «Лечебное дело»)*

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Структура пособия соответствует современным стандартам медицинского образования в России и важнейшим Европейским стандартам. Английская и латинская терминология приведены в соответствии с Международной анатомической номенклатурой.

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LIST OF ABBREVIATIONS

A., a.	— arteria
Aa., aa.	— arteriae
Art., art.,	— articulatio
Artt., artt.,	— articulationes
For., for.	— foramen
Gl., gl.	— glandula
Gll., gll.	— glandulae
Lig., lig.	— ligamentum
Ligg., ligg.	— ligamenta
M., m.	— musculus
Mm., mm.	— musculi
N., n.	— nervus
Nn., nn.	— nervi
R., r.	— ramus
Rr., rr.	— rami
S., s.	— sulcus
V., v.	— vena
Vv., vv.	— venae

PREFACE

Creation of the manual «Anatomy of Bone System» in English meets the requirements of modern Russian medicine and education. Nowadays, many English-speaking oversea students study in Medical Universities of Russia. Besides, many Russian school leavers have a good command of English, so they will be able to use this manual by taking into consideration the fact that many Russian medical specialists work abroad after graduating from the universities or take part in different international conferences and symposiums.

The English version of the manual is based on the Russian manual by professor I. V. Gaivoronskiy «Normal Human Anatomy» which has been published in Russia 9 times and is approved by the Ministry of education of Russia.

This manual introduces the main principles of the Russian Anatomy School, such as: detailed study of the general aspects and items of Anatomy including the development of organs and anomalies of the development. If we compare theoretical approaches to Anatomy in Russia and in other countries, we will see that our approach is based on the system descriptions of organs, i.e. we describe separately the Skeletal system, Articulations, Muscular system etc. Moreover, we use Latin terminology in describing the structure of organs, and discuss clinicoanatomical and functional problems. As for foreign manuals, many of them describe Anatomical systems in accordance with the regional and topographical principles.

The structure of our manual meets the requirements of modern standards of medical education in Russia which, in their turn, correspond to the major European standards. After each chapter, we give test questions and clinicoanatomical problems. The English and Latin terminology is given in accordance with the International Anatomical Nomenclature.

The authors strongly believe that the manual will allow future doctors to form the morphological foundation for the further study of theoretical and clinical disciplines. We also hope that it will be of great help to Anatomy teachers.

ПРЕДИСЛОВИЕ

Создание учебного пособия «Остеология» на английском языке является требованием современной системы медицинского образования в России. В настоящее время в медицинских университетах нашей страны обучаются студенты из различных регионов дальнего зарубежья. Кроме того, многие выпускники российских школ хорошо владеют английским языком, поэтому они так же смогут пользоваться данным пособием, принимая во внимание, что зачастую русские специалисты в медицине после окончания университета уезжают работать за рубеж или принимают участие в различных международных конференциях и симпозиумах.

Английская версия пособия базируется на учебнике профессора И. В. Гайворонского «Нормальная анатомия человека», который был издан в России 9 раз и имеет гриф Министерства образования Российской Федерации.

Данное пособие познакомит читателей с главными принципами Русской Анатомической Школы, которые заключаются в подробном изучении общих вопросов, в том числе развития органов и аномалий развития. В России преподавание анатомии ведется с функционально-клинических позиций и основано на описании органов по системам, т. е. отдельно изучается опорно-двигательная система, артросиндесмология, миология и другие системы. Также при описании строения органов акцентируется внимание на латинской терминологии. Что касается зарубежных руководств по анатомии человека, многие из них основываются на регионально-топографическом принципе без использования латинской терминологии.

Структура данного пособия соответствует современным стандартам медицинского образования в России, которые, в свою очередь, соответствуют важнейшим Европейским стандартам. После каждой главы мы приводим контрольные вопросы и ситуационные клинические задачи. Английская и латинская терминология приведена в соответствии с Международной анатомической номенклатурой.

Авторы выражают уверенность, что данное пособие позволит будущим докторам сформировать морфологический фундамент для последующего изучения теоретических и клинических дисциплин. Мы также надеемся, что оно принесет определенную пользу и преподавателям анатомии человека.

1. GENERAL OSTEOLOGY

Osteology is the part of anatomy which studies bones. It is quite difficult to determine the exact number of bones, because their number changes with age. During life, more than 800 individual bony elements develop, 270 of them appear in the prenatal period, other ones appear after birth. The majority of individual bony elements fuse with each other, therefore the skeleton in an adult person contains only 206 bones (fig. 1.1). Apart from permanent bones, there may be inconstant (sesamoid) bones in mature age, their appearance is caused by specific features of the body structure and function.

The bones, together with their joints, form the skeleton of the human body. It serves as a place for start and attachment of muscles, provides protection of visceral organs and also carries out the form-building and some other major functions.

1.1. Bone as an Organ

Bone, *os*, is an organ, which is a component of the musculoskeletal system. It has a typical form and structure, specific architectonics of vessels and nerves, it is constructed mainly from osseous tissue covered with periosteum on the outside; *periosteum* containing inside bone marrow, *medulla osseum*.

Each bone has a certain shape, size and location in the human body. The conditions of bone development and functional loads which bones are subjected to in ontogenesis influence the morphogenesis of bones. Each bone has a certain number of blood supply sources (arteries), which have specific extra- and intraorganic architectonics. Nervous structures of bones also have such features.

The bone is coated with periosteum on the outside, except the surfaces and places where articular cartilages are located, and where muscles, tendons and ligaments are attached to the bone. The periosteum separates the bone from its surrounding tissues. It is a thin sheath of dense connective tissue which contains blood and lymphatic vessels and nerves. The nerves penetrate into the bone tissue from the periosteum.

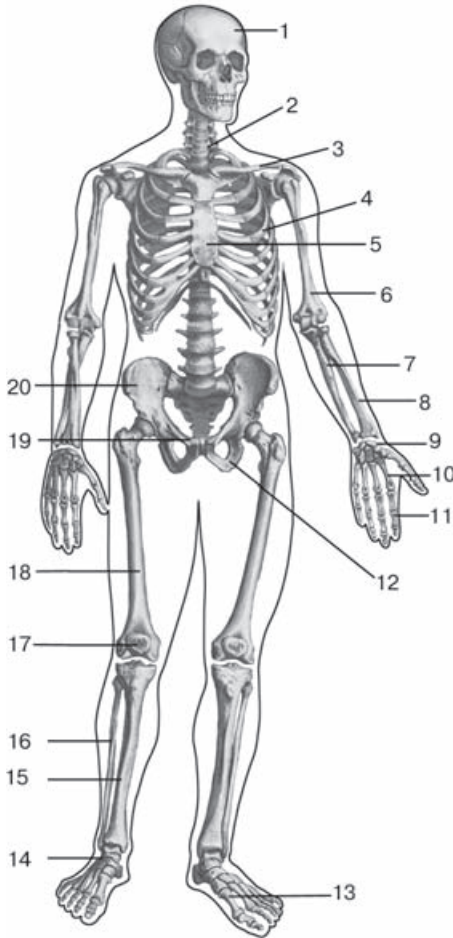


Fig. 1.1. Human skeleton (frontal aspect):

1 – skull (cranium); 2 – vertebral column (columna vertebrale); 3 – clavicle (clavicula); 4 – IV rib (costa IV); 5 – sternum (sternum); 6 – humerus (humerus); 7 – ulna (ulna); 8 – radius (radius); 9 – carpal bones (ossa carpi); 10 – metacarpal bones (ossa metacarpi); 11 – phalanges of hand (ossa digitorum manus); 12 – ischium (os ischium); 13 – metatarsal bones (ossa metatarsi); 14 – tarsal bones (ossa tarsi); 15 – tibia (tibia); 16 – fibula (fibula); 17 – patella (patella); 18 – femur (femur); 19 – pubis (os pubis); 20 – ilium (os ilium)

The periosteum, *periosteum*, plays a major role in bone growth at thickness and in its nutrition. The osseous tissue is formed in the inner osteogenic layer of the periosteum. A bone lacking periosteum becomes inviable and necrotizes. The periosteum has a rich nerve supply, therefore it is very sensitive. During surgical operations, doctors try to maximally preserve the periosteum because of its very important role in reparative processes.

Almost all bones (except for most of the skull bones) have articular surfaces for junction with other bones. The articular surfaces are covered not with periosteum, but with articular cartilage, *cartilago articularis*. The articular cartilage has a specific, non-uniform structure: its superficial layer resembles a hyaline cartilage, the deep layer is fibrous.

The majority of bones have bone marrow inside — in spaces between lamellae of the spongy bone or in the medullary cavity, *cavitas medullaris*. The medullary cavity is covered inside with a specific sheath which is termed endosteum — *endosteum*. The endosteum, as well as the periosteum, plays a great role in metabolic processes in bones.

Bones of fetuses and newborns contain only red (haematogenic) bone marrow, *medulla ossea rubra*. It is a homogenous red color mass, rich in reticulate tissue, blood corpuscles and blood vessels. The total amount of red bone marrow is about 1500 cm³. In an adult, red bone marrow is partially substituted with yellow bone marrow, *medulla osseum flava*, which is mainly composed of adipose cells. Red bone marrow is substituted with yellow bone marrow only within medullar cavities.

1.2. Classification of Bones

It should be noted that there is no comprehensive classification of bones so far. For this purpose, various criteria are used in most of manuals on anatomy. At the same time, the principles of development and external structure features are often missed. Such feature as the structure of bones has an important clinical value. It determines the level of bone durability and specifications for treatment of injuries. In terms of phylogenesis, taking into consideration the existence of acranial and cranial organisms during the evolution, it is appropriate to divide bones into two groups: 1) bones of trunk and limbs; 2) skull bones. These bones differ from each other not only in their development but also in their structure.

According to the form and structure, four types of trunk and limb bones are distinguished: tubular, flat, volumetric and mixed bones.

Tubular bones have a cavity inside. They may be divided into long (humeral, forearm bones, femoral, leg bones, clavicle) and short (carpals, metatarsals, phalanges) bones.

In long tubular bones, one size prevails over other sizes. The middle part — diaphysis, *diaphysis*, (or body, *corpus*) of such bone has a cylindrical or triangular shape and consists of compact tissue, *substantia compacta*. Within the diaphysis, the medullary cavity is located. The bone ends — epiphyses, *epiphyses*, — are somewhat thickened. Their surfaces intended for joining with adjacent bones are covered with articular cartilage. On the inside, the epiphyses consist of spongy bone — *substantia spongiosa*, and on the outside there is a thin layer of compact bone — *substantia compacta*. Long tubular bones form the proximal and middle parts of the limb skeleton and play the role of levers actuated by muscles. Short tubular bones form the distal parts of the limb skeleton and also consist of the middle part — the corpus and two ends called basis and caput.

Flat bones mainly consist of homogenous mass of spongy bone covered outside with a thin layer of compact bone. In flat bones, two sizes (width and length) prevail over 1.3.