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Л.П. Мартиросян, И.А. Баландина, А.Г. Гилязов

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Л.П. Мартиросян, И.А. Баландина, А.Г. Гилязов

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Рецензенты:

д-р мед. наук, профессор, зав. кафедрой нормальной и топографической анатомии с оперативной хирургией Чеченского государственного университета имени А.А. Кадырова ***Э.С. Кафаров***;
д-р мед. наук, профессор, зав. кафедрой анатомии человека медицинского института Северо-Восточного федерального университета имени М.К. Аммосова ***Д.К. Гармаева.***

Мартиросян, Л.П.

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Учебное пособие посвящено одному из важнейших разделов нормальной анатомии человека – миологии. В нем систематизированы и обобщены современные представления о строении мышечной системы. Терминология приведена в соответствии с Международной анатомической и гистологической номенклатурами.

Предназначено для студентов, обучающихся в медицинских вузах на английском языке.

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GENERAL CHARACTERISTICS OF THE MUSCULAR SYSTEM

The purpose of studying the topic: the student must have an understanding of muscle classification.

As a result, the student should know:

- Types of muscle tissue
- Classification of muscles according to the topographic principle, shape, the direction of their fibers, function, in accordance with their relationship to the joints
- Patterns of muscle distribution

The structure of the muscular system is studied by the branch of anatomy – *myology*. Skeletal muscles perform many functions, they set bones in motion, participate in the formation of the walls of body cavities, help maintain balance, provide support for the body, its movement in space, carry out breathing and swallowing movements, form facial expressions, influence the activity of the organ of vision, organ of hearing and balance. A person has about *640 muscles* that contract voluntarily in accordance with the will of the person.

The muscle mass of the human body consists of three types of muscle tissue, differing in their structure and capable of contracting due to the presence of specific elements – myofibrils, which include contractile proteins – actin and myosin:

1) smooth muscle,
2) skeletal striated muscle,
3) cardiac muscle.

Smooth muscle tissue is part of the wall and ensures the activity of hollow (tubular) internal organs – bronchi, stomach, intestines, uterus, fallopian tubes, ureters, bladder, and blood vessels. This tissue is also found in the skin and in the capsules and trabeculae of some organs (spleen, testicle).

Striated muscle tissue is part of the skeletal muscles, as well as the wall of the pharynx and the upper part of the esophagus. This type of tissue forms the tongue and extraocular muscles. The total mass of these muscles in an adult is about 40 % of body weight. The structural and functional unit of this tissue is striated muscle fibers, which consist of multinucleated myocytes that are long. The functions of skeletal muscles are under the control of the central nervous system, which is why they are also called voluntary muscles. However, they can be in a state of partial contraction and independent of our consciousness; this state is called tone.

Cardiac muscle tissue is found in the muscular lining of the heart (myocardium) and the ostia of the large vessels associated with it. The main functional property of cardiac muscle tissue is the ability for spontaneous rhythmic contractions, the activity of which is influenced by hormones and the nervous system. This tissue enables the heart to contract, which keeps blood circulating throughout the body.

Muscles are divided according to the topographic principle, according to their shape, the direction of their fibers, according to their function, in accordance with their relationship to the joints.

There are *superficial* and *deep* muscles, *lateral* and *medial*, *internal* and *external*. The shape of the muscles is very diverse. The broad muscles take part in the formation of the abdominal walls. For the limbs, the most typical are fusiform muscles, attached to bones that act as levers. The muscle fiber bundles of the fusiform muscles are oriented parallel to the long axis of the muscle. If the muscle bundles are located on one side of the tendon to which they are attached, the muscle is *unipennate*, if on both sides it is *bipennate*. Muscle bundles approach the tendon from all sides in *multipennate* muscles. Some muscles have several separate heads that start on the bones, connecting to form a common belly that turns into a tendon. Such muscles are called *biceps, triceps*, etc., according to the number of heads. Several tendons with different attachment areas can arise from one muscle belly (for example, extensor digitorum, etc.). There are muscles with a circular arrangement of fibers. Usually they surround natural openings, being compressors – *sphincters*. Around the natural openings there are also muscles with radial fibers

(expanders – *dilators*). The name of many muscles is associated with their shape, with the direction of their muscle bundles (transverse abdominal muscle), others – depending on their functions (levator scapulae muscle, etc.).

Muscles are divided into groups according to their relationship to joints. *Single-joint* muscles act on one joint, others spread across two or more joints – *bi-joint and multi-joint muscles*. Some muscles begin on the bones and are woven into the skin without spreading over the joint (for example, facial muscles, etc.). There are *synergist* and *antagonist* muscles. Muscles acting on a joint in the opposite direction (flexors, extensors) are antagonists, in one direction they are synergists.

Based on their origin (development), a distinction is made between muscles that developed from the myotomes of the gill (visceral) arches (cranial muscles) and the myotomes of the trunk region of the embryo (spinal muscles). The origin of muscles can be judged by their innervation. Thus, the muscles developed from the myotomes of the gill arches are innervated by the branches of the cranial nerves. The muscles developed from the trunk myotomes are innervated by the posterior and anterior branches of the spinal nerves. The muscles innervated by the posterior branches of the spinal nerves are dorsal in origin. The muscles innervated by the anterior branches of the spinal nerves are ventral. During development, muscles can remain in the place of their original formation. Such muscles are called autochthonous. Some muscles can change their location, move from the ventral surface of the body to the dorsal one or from the body to the limbs (truncofugal muscles). The muscles that formed on the limbs and subsequently rose to the body are called truncopetal.

Patterns of muscle distribution:

1. According to the structure of the body, according to the principle of bilateral symmetry, the muscles are paired or consist of two symmetrical halves (for example, m. trapezius).

2. In the body, which has a segmental structure, many muscles are segmental (intercostal muscles) or retain traces of metamerism (rectus abdominis muscle). The broad abdominal muscles merged into

continuous layers of segmental intercostal muscles due to the reduction of bone segments – the ribs.

3. Since the movement produced by the muscle occurs along a straight line, which is the shortest distance between two points (punctum fixum and punctum mobile), the muscles themselves are located along the shortest distance between these points. Therefore, knowing the points of attachment of the muscle, as well as the fact that during muscle contraction a moving point is attracted to a stationary point, one can always say in advance in which direction the movement produced by a given muscle will occur and determine its function.

4. Muscles, spreading over a joint, have a certain relationship to the axes of rotation, which determines the function of the muscles.

Usually, muscles with their fibers or their resultant force always cross at approximately a right angle the axis in the joint around which they produce movement. If at a uniaxial joint with a frontal axis the muscle lies vertically, that is, perpendicular to the axis, and on its flexion side, then it produces **flexion**, *flexio* (decreasing the angle between the moving links). If the muscle lies vertically, but on the extensor side, then it produces **extension**, *extensio* (increasing the angle to 180° with full extension). If there is another horizontal axis (sagittal) in the joint, the resultant force of the two antagonist muscles should be located similarly, crossing the sagittal axis on the sides of the joint (as, for example, in the wrist joint). Moreover, if the muscles or their resultant are located perpendicular to the sagittal axis and medial to it, then they produce **adduction** to the midline, *adductio*, and if laterally, then **abduction** occurs from it, *abductio*. Finally, if the joint also has a vertical axis, then the muscles cross it perpendicularly or obliquely and produce **rotation**, *rotatio*, inward (on the limbs – *pronatio*) and outward (on the limbs – *supinatio*). Thus, knowing how many axes of rotation there are in a given joint, we can say what the muscles will be like in their function and how they will be located around the joint. Knowing the location of muscles according to the axes of rotation is also of practical importance. For example, if the flexor muscle, which lies in front of the frontal axis, is transferred back, it will act as an extensor, which is what is used in tendon transfer operations to restore the function of paralyzed muscles.

ACCESSORY MUSCLE APPARATUS

The purpose of studying the topic: the student must know the structures that form the auxiliary apparatus of muscles.

As a result, the student should know:

- What structures form this apparatus
- What is fascia, synovial sheath and sesamoid bone

In addition to the main parts of the muscle – its body and tendons, there are also auxiliary structures that somehow facilitate the work of the muscles.

1. Fascia are connective tissue membranes that limit the hypodermis (subcutaneous fatty tissue), covering muscles or some internal organs and forming sheaths for large neurovascular bundles. Fasciae are classified as *superficial*, *visceral* or *deep*, and further designated according to their anatomical location.

Fasciae were traditionally thought of as passive structures that transmit mechanical tension generated by muscular activities or external forces throughout the body. An important function of muscle fasciae is to reduce friction of muscular force. In doing so, fasciae provide a supportive and movable wrapping for nerves and blood vessels as they pass through and between muscles.

Fascial tissues are frequently innervated by sensory nerve endings. These include myelinated as well as unmyelinated nerves. Research indicates that fascia has proprioceptive (the ability to determine the body's orientation with respect to itself) as well as interoceptive (the ability to discern sensations within the body like the heartbeat) capabilities. Fascial tissues – particularly those with tendinous or aponeurotic properties – are also able to store and release elastic potential energy.

Superficial fascia is the lowermost layer of the skin in nearly all of the regions of the body, that blends with the reticular dermis layer. It is present on the face, over the upper portion of the sternocleidomastoid, at the nape of the neck and overlying the breastbone. It consists mainly of loose areolar and fatty adipose connective tissue and is the layer that primarily determines the shape of a body. In addition to its subcutaneous

presence, superficial fascia surrounds organs, glands and neurovascular bundles, and fills otherwise empty space at many other locations. It serves as a storage medium of fat and water; as a passageway for lymph, nerve and blood vessels; and as a protective padding to cushion and insulate. Superficial fascia is present, but does not contain fat, in the eyelid, ear, scrotum, penis and clitoris. Due to its viscoelastic properties, superficial fascia can stretch to accommodate the deposition of adipose that accompanies both ordinary and prenatal weight gain. After pregnancy and weight loss, the superficial fascia slowly reverts to its original level of tension.

Visceral fascia (also called subserous fascia) suspends the organs within their cavities and wraps them in layers of connective tissue membranes. Each of the organs is covered in a double layer of fascia; these layers are separated by a thin serous membrane. The outermost wall of the organ is known as the parietal layer. The skin of the organ is known as the visceral layer. The organs have specialized names for their visceral fasciae. In the brain, they are known as meninges; in the heart they are known as pericardia; in the lungs, they are known as pleurae; and in the abdomen, they are known as peritonea. Visceral fascia is less extensible than superficial fascia. Due to its suspensory role for the organs, it needs to maintain its tone rather consistently. If it is too lax, it contributes to organ prolapse, yet if it is hypertonic, it restricts proper organ motility.

Deep fascia is a layer of dense fibrous connective tissue which surrounds individual muscles and divides groups of muscles into fascial compartments. This fascia has a high density of elastin fibre that determines its extensibility or resilience. Deep fascia was originally considered to be essentially avascular but later investigations have confirmed a rich presence of thin blood vessels. Deep fascia is also richly supplied with sensory receptors. Examples of deep fascia are fascia lata, fascia cruris, brachial fascia, plantar fascia, thoracolumbar fascia and Buck's fascia.

2. Synovial sheath is one of the two membranes of a tendon sheath which covers a tendon. The other membrane is the outer fibrous tendon sheath. The tendon invaginates the synovial sheath from one side so that

the tendon is suspended from the membrane by the mesotendon, through which the blood vessels reach the tendon, in places where the range of movement is extensive. The mesotendon disappears or remains in the form of narrow tendinous bands as threads known as vincula tendina. The synovial sheath is found where the tendon passes under ligaments and through osseofibrous tunnels; their function is to reduce friction between the tendon and their surrounding structure. An example is the common synovial sheath for the flexor tendons of the hand.

3. Sesamoid bone is a bone embedded within a tendon or a muscle. Its name is derived from the Greek word for "sesame seed", indicating the small size of most sesamoids. Often, these bones form in response to strain, or can be present as a normal variant. The patella is the largest sesamoid bone in the body. Sesamoids act like pulleys, providing a smooth surface for tendons to slide over, increasing the tendon's ability to transmit muscular forces.

Sesamoid bones can be found on joints throughout the human body, including:

• In the knee – the patella (within the quadriceps tendon). This is the largest sesamoid bone.

• In the hand – two sesamoid bones are commonly found in the distal portions of the first metacarpal bone (within the tendons of adductor pollicis and flexor pollicis brevis). There is also commonly a sesamoid bone in distal portions of the second metacarpal bone and fifth metacarpal bone.

• In the wrist – the pisiform of the wrist is a sesamoid bone (within the tendon of flexor carpi ulnaris). It begins to ossify in children ages 9–12.

• In the foot – the first metatarsal bone usually has two sesamoid bones at its connection to the big toe (both within the tendon of flexor hallucis brevis). One is found on the lateral side of the first metatarsal while the other is found on the medial side. In some people, only a single sesamoid is found on the first metatarsal bone.

MUSCLE DEVELOPMENT

Skeletal muscles develop from the mesoderm (middle germ layer), in which the ventral and dorsal sections are distinguished. The ventral section, the splanchnotome, along with the internal germ layer, is the source of the development of internal organs. The dorsal portion of the mesoderm, located lateral to the neural tube and notochord, is divided into segments, or somites.

A 4-week-old human embryo has about 40 pairs of such somites: 3–5 occipital, 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, 4–5 coccygeal. At the 5th week, a cavity appears inside each somite, which divides the thickness of the somite into two plates – medial and lateral. The connective tissue part of the skin, the dermis (dermatome), develops from the cellular elements of the lateral plate. The cellular elements of the medial plate form the sclerotome and myotome. The sclerotome is adjacent to the notochord. The axial skeleton of the body is formed from it. Myotomes are the main source of skeletal muscle formation.

Myotomes grow in the dorsal and ventral directions. At the 5th–7th week of the embryonic period, they are divided into dorsal (supraaxial) and ventral (subaxial). At the early stages of embryogenesis, branches of the spinal nerves grow into the myotomes: the posterior branches grow into the dorsal myotomes, and the anterior branches grow into the ventral myotomes. These myoneural relationships are preserved in all subsequent periods of ontogenesis, therefore, their origin can be determined by the innervation of the muscles.

The dorsal (supra-axial) parts of the myotomes form the rudiments of the spinal extensor muscles (deep back muscles). All other muscles of the trunk and limbs are formed from the ventral (subaxial) parts of the myotomes. In particular, the geniohyoid muscle develops from them; muscles lying below the hyoid bone; deep neck muscles; diaphragm; abdominal muscles; muscles of the limbs and muscles of the perineum.

The muscles of the head and part of the muscles of the neck are formed from the mesenchyme of the gill arches and in development are muscles of cranial origin, which are innervated by cranial nerves. Thus,

from the muscle primordium of the first gill arch (mandibular) the masticatory muscles develop; anterior belly of the digastric muscle; mylohyoid muscle; tensor veli palatini muscle; tensor tympani muscle. All of these muscles are innervated by the trigeminal nerve. From the muscle rudiment of the second visceral arch, the muscles of facial expression, platysma muscle, the posterior belly of the digastric muscle, and the stylohyoid muscle are differentiated. These muscles are innervated by the facial nerve.

The muscle primordia of the III–IV gill arches are involved in the formation of the muscles of the palate, pharynx, larynx and upper part of the esophagus. These muscles are innervated by the glossopharyngeal and vagus nerves. The muscle primordia of the V branchial arch give rise to the sternocleidomastoid and trapezius muscles, which are innervated by the accessory nerve.

The muscles of the tongue have a special origin. They are innervated by the hypoglossal nerve. The muscles of the eyeball develop from three preotic myotomes located anterior to the otic capsule. The muscles of the eyeball are innervated by the oculomotor, trochlear and abducens nerves.

During development, several muscles can arise from one myotome, and all of them are innervated by branches of the same nerve. In other cases, on the contrary, the muscle represents the result of the fusion of several myotomes or parts thereof, such as m. obliquus externus abdominis. This muscle receives innervation from various sources. If a muscle changes its original location, then the innervation indicates its origin. Thus, nerves from the anterior branches of the spinal nerves go to the superficial muscles of the back; therefore, these muscles develop from the ventral parts of the myotomes. Another example: the diaphragm, which closes the lower opening of the chest, receives innervation from the cervical plexus (n. phrenicus). This is explained by the fact that the rudiment of the diaphragm is laid in the region of the IV and V cervical segments, then the diaphragm descends, and the nerve is significantly lengthened.

MUSCLES OF THE HEAD AND NECK

The purpose of studying the topic: the student must know the structures that form muscles of the head and neck.

As a result, the student should know:

- Muscles of the head (groups, insertion, site of attachment, function)
- Muscles of the neck (groups, insertion, site of attachment, function)

Muscles of the head are divided into muscles of *facial expression* and *muscles of mastication.*

The muscles of facial expression originate from the surfaces of the bones of the skull and insert into the skin. They are located directly under the skin. The muscles of facial expression do not have fascia and, when contracting, move the skin. When they relax, the skin, due to its elasticity, returns to its previous state, so the role of antagonists here is much less than that of skeletal muscles. These muscles are thin and small muscle bundles that are grouped around natural openings: the mouth, nose, palpebral fissure and ear, taking part in one way or another in closing or, conversely, expanding these openings. These muscles are divided according to their topography *into the muscles of the roof of the skull*, *muscles of the eyelid and orbit*, *muscles of the nose*, *muscles of the mouth* and *muscles of the auricular concha*. All muscles of facial expression are innervated by the facial nerve. The muscles of facial expression give the face a certain expression that corresponds to a particular experience. This happens because they change the shape of the holes and move the skin to form folds. In addition to the main function, which is to express sensations and feelings, these muscles also take part in chewing and speech. In humans, the muscles of facial expression around the mouth are well developed, but the muscles around the ears are poorly developed (unlike animals, in which they are better developed).

Muscles of the roof of the skull

The occipitofrontalis muscle (m. occipitofrontalis) covers the roof of the skull, and consists of an occipital belly and a frontal belly. The occipital belly originates from the superior nuchal line and the bases of the mastoid processes. It stretches upward towards the front, and

continues into an aponeurosis called the **epicranial aponeurosis (galea aponeurotica)**. The frontal belly originates from the same aponeurosis and is inserted into the skin of the eyebrows. Function: the occipital belly pulls the skin of the head to the back. During contraction of the frontal venter the skin of the forehead forms transverse folds and the eyebrows are lifted, giving the face an expression of surprise.

The temporoparietalis muscle (m. temporoparietalis) is situated on the lateral surface of the skull and is weakly developed. Separate muscular fibers stretch forward from the cartilage of the auricular concha, spread out and are inserted into the lateral parts of galea aponeurotica. The functioning of this muscle is insignificant.

The procerus muscle (m. procerus) originates from the exterior surface of the nasal bone and inserts into the skin of the forehead.

Function: forms transverse folds at the root of the nose, at the same time straightening these folds on the forehead. It gives the face an expression of anger.

Muscles of the eyelid and the orbit

The orbicularis oculi muscle (m. orbicularis oculi) is situated around the orbit, within the eyelids. This muscle is divided into the palpebral, ocular and lacrimal parts.

The palpebral part is formed by muscle fibers, which originate from the medial palpebral ligament and stretch over the anterior surface of the cartilages of the superior and inferior eyelids to the lateral corner of the eye.

The orbital part originates from the frontal process of maxilla, the nasal part of the frontal bone and the medial palpebral ligament. Its fibers stretch along the superior and inferior margins of the orbit to its lateral wall, where the upper and lower fibers continue into each other.

The lacrimal part of the muscle originates from the lacrimal crest and lateral surface of the lacrimal bone. Its fibers pass behind the lacrimal sac and are inserted into the palpebral part of the orbicularis oculi muscle.

Function: the palpebral part of this muscle shuts the eyelids. The orbital part closes the eye tightly. The lacrimal part widens the lacrimal sac, regulating the outflow of tears into the nasolacrimal duct.

The corrugator supercilii muscle (m. corrugator supercilii) originates from the medial part of the brow, stretches upward and lateral and is inserted into the skin of the eyebrow.

Function: it corrugates the eyebrow, forming vertical folds above the root of the nose. It gives the face an expression of suffering.

Muscles of the nose

The nasalis muscle (m. nasalis). Function: this muscle narrows and widens the nostrils.

The depressor septi nasi muscle (m. depressor septi nasi) originates above the medial incisor of the maxilla and is inserted into the cartilaginous nasal septum.

Function: pulls the nasal septum down.

Muscles of the mouth

The orbicularis oris muscle (m. orbicularis oris) forms the muscles of the lips. It consists of marginal and labial parts.

The marginal part (peripheral part of the orbicularis oris) is formed by fascicles of the neighboring muscles of facial expression.

The labial part is the central part of this muscle. It consists of muscle fascicles that stretch from one corner of the mouth to the other.

Function: it closes the mouth, takes part in chewing and sucking.

The depressor anguli oris muscle (m. depressor anguli oris) originates on the mandible, between the mental protuberance and the region of the first premolar tooth. Its fibers insert into the skin of the corner of the mouth.

Function: pulls the corner of the mouth down and to the side.

The depressor labii inferioris muscle (m. depressor labii inferioris) originates on the base on the mandible. It is partially covered by the depressor anguli oris muscle. Its fascicles stretch upwards and medially and are inserted into the skin and mucosa of the lower lip.

Function: it pulls the lower lip downward and lateral. With bilateral constriction it turns the lip inside out (expression of disgust).

The mentalis muscle (m. mentalis) originates on the alveolar eminencies of the incisors of mandible, stretches downward and medial, unites with the muscle fibers of the paired muscle and inserts into the skin of the chin.

Function: pulls the skin of the chin upward and lateral, forms a fossula on the chin and participates in pulling the lower lip forward.

The buccinator (m. buccinator) forms the muscular base of the cheek. It originates on the oblique line of mandible, the outer surface of the alveolar arch of maxilla on the level of the molars. Its fascicles stretch to the angle of mouth.

Function: pulls the corner of the mouth to the back and pushes the cheeks against the teeth.

The levator labii superioris muscle (m. levator labii superioris) arises from the infraorbital margin of maxilla, stretches downward and is inserted into the upper lip. Function: this muscle lifts the upper lip.

The zygomatic major muscle (m. zygomaticus major) originates on the lateral surface of the zygomatic bone and is inserted into the corner of the mouth.

Function: it pulls the corner of the mouth up and to the side and is the main muscle used during laughter.

The zygomatic minor muscle (m. zygomaticus minor) originates on the zygomatic bone besides the lateral edge of the levator labii superioris. Its fascicles stretch downward and medial and are inserted into the skin of the corner of the mouth. Function: lifts the corner of the mouth. These are the main muscles of laughter.

The levator anguli oris muscle (m. levator anguli oris) originates on the anterior surface of maxilla, in the region of the canine fossa, and inserts into the corner of the mouth.

Function: it pulls the corner of the mouth up and to the side.

The risorius muscle (m. risorius) originates from the masticatory fascia and is inserted into the skin of the angle of mouth. It is sometimes absent.

Function: it pulls the angle of mouth laterally, forming a dimple on the cheek. This is the muscle of laughter.

Muscles of the auricular concha

These muscles include the auricularis anterior, superior and posterior muscles. In the human they are usually weakly developed. These muscles are well developed in animals, such as dogs, cats.

1. *The auricularis anterior muscle* (m. auricularis anterior) originates as a thin fascicle on the galea aponeurotica and the temporal fascia. It stretches down and to the back and inserts into the skin of the auricular concha. It is often absent. Function: it pulls the auricular concha forward.

2. *The auricularis superior muscle* (m. auricularis superior) originates as a thin fascicle on the galea aponeurotica, above the auricular concha. It is inserted on the upper part of the cartilage. It may be absent. Function: pulls the auricular concha upward.

3. *The auricularis posterior muscle* (m. auricularis posterior) originates from the mastoid process and is inserted into the posterior surface of the concha. It is usually better developed than the other auricular muscles. Function: this muscle can pull the concha to the back.

Muscles of mastication

Muscles of mastication (fig. 1) act on the temporomandibular joint, participate in chewing, in the formation of articulate speech, in the acts of yawning and swallowing.

The four muscles of mastication on each side are interconnected genetically (they originate from one branchial arch – the mandibular), morphologically (they are all attached to the lower jaw, which they move during their contractions) and functionally (they perform chewing movements of the lower jaw, which determines their location).

This group of muscles includes the masseter, temporal, and lateral and medial pterygoid muscles. All muscles of mastication are innervated by the third branch of the trigeminal nerve.

The masseter (m. masseter) consists of superficial and deep parts. The superficial part is larger; it originates on zygomatic process of maxilla and anterior part of the zygomatic arch. It stretches downward and to the back and is inserted on the masseteric tuberosity of the mandible. The deep part of this muscle is partly covered by the superficial part; it originates on the lower edge and internal surface of the zygomatic arch. Its

fascicles stretch almost vertically down. Both parts are inserted on the external surface of the ramus and the angle of the mandible (to the masseteric tuberosity). Function: this muscle raises the mandible. The superficial part participates in protraction of the mandible.

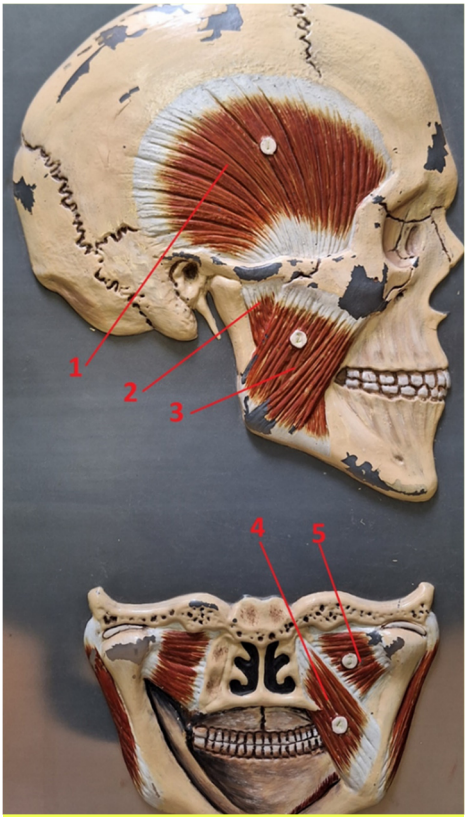

Fig. 1. Muscles of mastication: *1* – m. temporalis; *2* – m. masseter (pars profunda); *3* – m. masseter (pars superficialis); *4* – m. pterygoideus medialis; *5* – m. pterygoideus lateralis

The temporal muscle (m. temporalis) occupies the surface of the temporal fossa and the internal surface of the temporal fascia. Its fascicles stretch downward, continuing into a tendon, which attaches to the

coronoid process of the mandible. Function: it lifts the mandible. Its posterior fascicles retract the mandible.

The medial pterygoid muscle (m. pterygoideus medialis) originates in the pterygoid fossa of the pterygoid process. Its muscle fascicles stretch downwards, laterally and to the back. They are inserted on the pterygoid tuberosity of mandible. Function: lifts the mandible.

The lateral pterygoid muscle (m. pterygoideus lateralis) is short and thick. It has two heads of origin – the upper and lower. The upper head originates from the maxillary surface and infratemporal crest of the sphenoid bone; the lower head – from the external surface of lateral lamina of the pterygoid process. The two heads join each other, the fascicles stretch to the back and laterally and are inserted into the neck of the articular process of the mandible, articular capsule and articular disc of the temporomandibular joint. Function: during bilateral contraction the lower jaw is protracted. During unilateral contraction the muscle pulls the mandible to the opposite side.

Muscles of the neck (fig. 2)

The platysma muscle (m. platysma) is a very thin and flat muscle of facial expression, situated directly beneath the skin. It originates on the superficial lamina of the pectoral fascia, stretches upward covering the entire anterolateral surface of the neck. The platysma continues onto the face, inserting into the masseteric fascia and the depressor muscle of the lower lip. Function: it pulls the angle of the mouth down.

The sternocleidomastoid muscle (m. sternocleidomastoideus) originates from the anterior surface of manubrium sterni and medial end of clavicle. It stretches upward and somewhat lateral and attaches on the mastoid process of temporal bone. Function: during bilateral contraction it bends the head back; unilateral contraction bends the head to the corresponding side and turns the face toward the opposite side.

The digastric muscle, *m. digastricus*, consists of anterior and posterior venters (fig. 3). The posterior belly (venter) arises in the mastoid process of the temporal bone, stretches downward and to the front, adjoining the posterior surface of the stylohyoid muscle. It continues into the intermediate tendon, which perforates the stylohyoid muscle and is

inserted into the greater horn of the hyoid bone with a tendinous loop. The intermediate tendon continues into the anterior belly, which stretches up and to the front to the digastric fossa of the mandible. Function: during bilateral contraction this muscle pulls the hyoid bone upward and to the back. It lowers the mandible, thus opening the mouth.

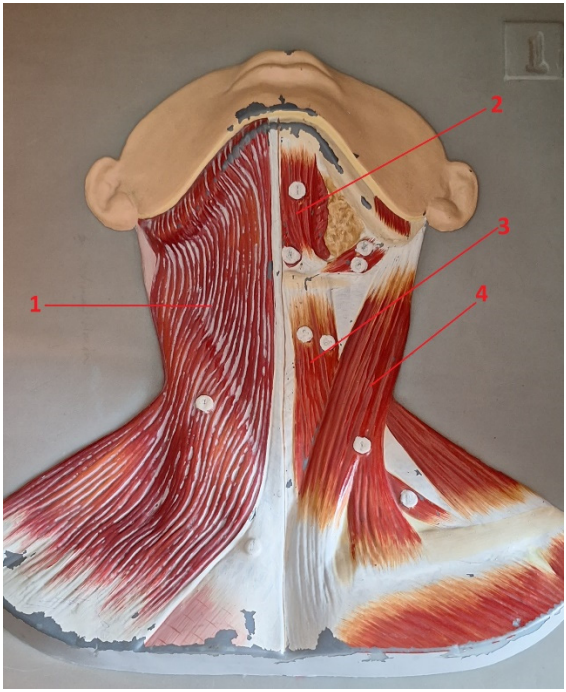

Fig. 2. Muscles of the neck: *1* – m. platysma; *2* – m. digastricus; *3* – m. thyrohyoideus; *4* – m. sternocleidomastoideus

The stylohyoid muscle (m. stylohyoideus) originates from the styloid process of the temporal bone, stretches forward and down and is inserted into the body of the hyoid bone. Function: during contraction it pulls the hyoid bone backward and up.

The mylohyoid muscle (m. mylohyoideus) is a broad flat muscle. It originates on the mylohyoid line of the mandible. The medial two thirds of its fascicles stretch toward the middle line, where they form the

tendinous raphe. Its lateral fascicles insert on the body of the hyoid bone. The mylohyoid muscle forms the muscular base of the diaphragm of the mouth. At the top it adjoins to the sublingual gland and geniohyoid muscle. At the bottom it adjoins the anterior venter of the digastric muscle. Function: this muscle raises the hyoid bone together with the larynx and it lowers the mandible.

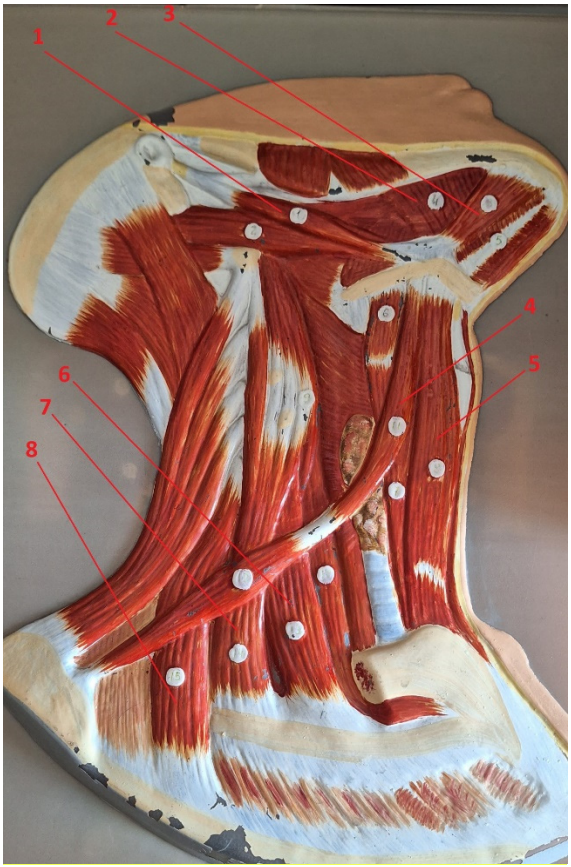

Fig. 3. Muscles of the neck: *1* – m. digastricus (venter posterior); *2* – m. mylohyoideus; *3* – m. digastricus (venter anterior); *4* – m. omohyoideus; *5* – m. sternothyroideus; *6* – m. scalenus anterior; *7* – m. scalenus medius; *8* – m. scalenus posterior

The geniohyoid muscle (m. geniohyoideus) is situated on the superior surface of the mylohyoid muscle, at either side of the middle line. It originates from the mental spine and is inserted into the body of the hyoid bone. Function: it lifts the hyoid bone together with the larynx (during swallowing or speech). It lowers the mandible.

The omohyoid muscle (m. omohyoideus) originates with its inferior belly on the superior margin of the scapula. The inferior belly stretches obliquely upward and to the front, passing lateral of the scalene muscles. Below the posterior edge of the sternocleidomastoid muscle this venter continues into the intermediate tendon, which passes into the superior venter. The superior belly stretches upward and to the front, and is inserted into the hyoid bone. Function: this muscle pulls the hyoid bone down and to the back.

The sternohyoid muscle (m. sternohyoideus) originates on the posterior surface of manubrium sterni and sternal end of clavicle and is inserted into the hyoid bone. Function: this muscle pulls the hyoid bone down.

The sternothyroid muscle (m. sternothyroideus) originates from the posterior surface of the manubrium sterni and the first costal cartilage. It stretches upward and is inserted into the oblique line of the thyroid cartilage. Function: lowers the larynx.

The thyrohyoid muscle (m. thyrohyoideus). It originates from the oblique line of the thyroid cartilage and attaches the body and greater horn of the hyoid bone. Function: it raises the larynx.

The deep muscles of the neck (fig. 4) are divided into a lateral and medial groups.

The lateral group includes the anterior, middle and posterior scalene muscles.

The medial group includes the longus colly and longus capitis muscles, rectus capitis anterior and rectus capitis lateralis muscles.

The anterior scalene muscle (m. scalenus anterior) originates from the transverse processes of C3 and C4 vertebrae. It stretches downward and is inserted into the tubercle of anterior scalene muscle of the first rib.

The middle scalene muscle (m. scalenus medius) originates from the transverse processes of C2–C7 vertebrae. It stretches down and lateral and is inserted into the upper edge of rib 1, behind the groove of the subclavian artery.

The posterior scalene muscle (m. scalenus posterior) originates from the posterior tubercles of transverse processes of C4–C6 vertebrae, and is inserted into the upper edge of rib 2. Function of the scalene muscles: these muscles raise ribs 1 and 2 lifting the thorax. They also bend the cervical spine forward and toward the corresponding side.

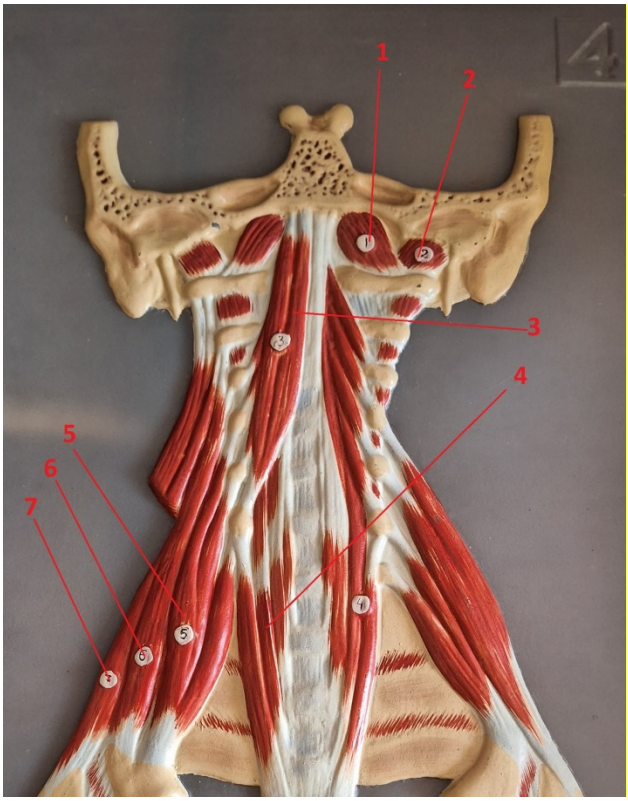

Fig. 4. Deep muscles of the neck: *1* – m. rectus capitis anterior; *2* – m. rectus capitis lateralis; *3* – m. longus capitis; *4* – m. longus colli; *5* – m. scalenus anterior; *6* – m. scalenus medius; *7* – m. scalenus posterior

The rectus capitis anterior muscle (m. rectus capitis anterior) originates from anterior surface of lateral mass of the atlas and fixes to the basilar part of occipital bone. It bends head forward.

The rectus capitis lateralis muscle (m. rectus capitis lateralis) originates from the transverse process of atlas and fixes to the inferior surface of jugular process of occipital bone. It bends head sideways.

Longus colli (m. longus colli):

• origin: anterior surfaces of bodies and transverse processes of C3–C7 and T1–T3 vertebrae;

• insertion: bodies and transverse processes of C1–C5 vertebrae and anterior tubercle of atlas;

• function: flexion of cervical spine (during unilateral contraction – bending to same side).

Longus capitis (m. longus capitis):

• origin: transverse processes of C3–C6 vertebrae;

• insertion: underside of basilar part of occipital hone;

• function: bends head forward.

MUSCLES OF THE UPPER EXTREMITY

The purpose of studying the topic: the student must know the layered structure of the muscles of the upper limb.

As a result, the student should know:

- Muscles of the shoulder girdle (insertion, site of attachment, function)
- Muscles of the free upper extremity (insertion, site of attachment, function)
- Muscles of the hand (insertion, site of attachment, function)

The muscles of the upper limb carry out the movements of the hand necessary to perform its function as an organ of labor. According to the points of origin and insertion and to the joints, which are moved, the muscles of the upper extremity are divided into the *muscles of the upper limb (shoulder) girdle* and *muscles of the free upper extremity.*

Muscles of the shoulder girdle

The muscles of the shoulder girdle originate from the clavicle and the scapula and are inserted into the humerus. These muscles cause movement in the glenohumeral, or shoulder, joint.

The most superficial of these is the deltoid muscle.

Deeper, beneath the deltoid muscle, lie the supraspinous and infraspinous muscles, teres major and teres minor muscles and the subscapularis muscle.

The deltoid muscle (m. deltoideus) is situated directly below the skin and covers the shoulder joints from the front, back, the side and the top, forming the characteristic curve of the shoulder. It originates on the anterior edge of lateral end of clavicle, the acromion, the scapular spine. Its fascicles converge on the lateral surface of the humerus and are inserted into the deltoid tuberosity.

Function: during contraction of the entire muscle the arm is abducted approximately 70 percent of possible amplitude. During contraction of its anterior (clavicular) fascicles the arm is partially flexed and pronated. If the arm is raised the clavicular part of the muscle lowers it. The middle (acromial) part of the muscle abducts the arm.

The supraspinatus muscle (m. supraspinatus) originates from the posterior surface of the scapula, above its spine. Its fascicles stretch laterally and are inserted into the lower part of the greater tubercle of the humerus. Function: abducts the arm.

The infraspinatus muscle (m. infraspinatus) originates from the posterior surface of the scapula (beneath the spine). It stretches laterally, behind the shoulder joint, and is inserted into the greater tubercle of the humerus, below the tendon of the suprascapular muscle. Function: it supinates the arm.

The teres minor muscle (m. teres minor) originates from the lateral margin of scapula. It is inserted into the greater tubercle of the humerus, below the tendon of the infraspinous muscle. The teres minor muscle lies adjacent to the infraspinous muscle and is covered in the back by the scapular part of deltoid muscle. Function: it supinates the arm.

The teres major muscle (m. teres major) originates from the lower part of the lateral margin of the scapula. Its muscle fascicles stretch along the lateral margin of the scapula, crossing the humerus on the medial side, below its surgical neck. It is inserted into the crest of the lesser tubercle of the humerus, more distal and to the back than the latissimus dorsi muscle. Function: it extends the shoulder and pronates it. It adducts the arm.

The subscapularis muscle (m. subscapularis) is strong and thick. It originates from the entire surface of the subscapular fossa and the lateral margin of the scapula. It is inserted into the lesser tubercle of the humerus and its crest. Function: it pronates the arm and adducts it to the body.

Muscles of the free upper extremity

According to their topography and anatomic structure the muscles of the arm (fig. 5) are divided into an anterior (flexor muscles) and a posterior (extensor muscles) groups.

They act on the elbow joint, producing movement around the frontal axis, and therefore are located on the anterior and posterior surfaces of the shoulder, attaching to the bones of the forearm. Both muscle groups are separated from each other by two connective tissue septa, septa intermuscularia brachii, running to the lateral and medial edges of the humerus from the common fascia of the shoulder, which covers all the muscles of the latter.

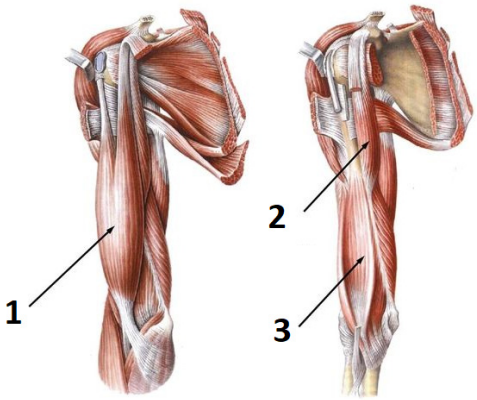

Fig. 5. Muscles of the arm (anterior group): *1* – m. biceps brachii; *2* – m. coracobrachialis; *3* – m. brachialis

The anterior group includes the coracobrachialis, biceps brachii and brachial muscles.

The posterior group (fig. 6) consists of the triceps brachii and anconeus muscles.

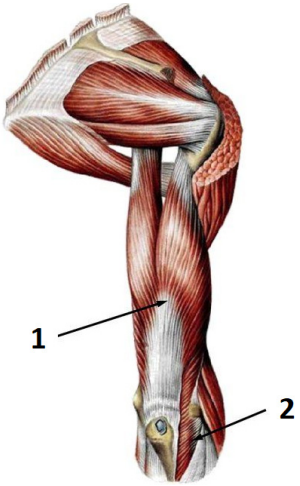

Fig. 6. Muscles of the arm (posterior group): *1* – m. triceps brachii; *2* – m. anconeus

The coracobrachialis muscle (m. coracobrachialis) originates from the apex of the coracoid process and is inserted into the humerus, below the crest of the lesser tubercle, at the same level with the deltoid muscle.

Function: it flexes the arm and adducts it to the body. When the arm is pronated this muscle supinates it.

The biceps brachii muscle (m. biceps brachii) has a long and a short heads of origin. The long head originates from the supraglenoid tubercle of scapula. Its tendon stretches through the articular cavity of the shoulder joint and passes along the intertubercular groove. The short head originates from the coracoid process of the scapula. The two heads unite at midlevel of humerus into a common venter, which continues into a tendon. This tendon is inserted into the tuberosity of the radius. Function: it flexes the arm in the shoulder joint and the forearm in the elbow joint. When the forearm is pronated this muscle supinates it.

The brachialis muscle (m. brachialis) originates from the lower two thirds of the body of the humerus, between the deltoid tuberosity and articular capsule of the elbow joint. It attaches to the tuberosity of the ulna. Function: it flexes the forearm in the elbow joint.

The triceps brachii muscle (m. triceps brachii) covers the entire posterior surface of the humerus. It has a long, a medial and a lateral heads of origin. The long head originates on the infraglenoid tubercle of the scapula. Approximately at midlevel of the humerus it unites with the lateral and medial heads. The lateral head originates from the lateral surface of the humerus. The medial head of triceps originates from the posterior surface of humerus. The common venter of the triceps continues into a broad flat tendon, which is inserted into the olecranon process of ulna. Function: extends the forearm in the elbow joint. The long head extends and adducts the arm in the shoulder joint.

The anconeus muscle (m. anconeus) is a small triangular muscle. It originates from the posterior surface of the lateral epicondyle of the humerus, and is inserted into the lateral surface of the olecranon process and the posterior surface of the ulna. Function: it participates in extension of the forearm.

The muscles of the forearm are divided into an anterior (flexors of the wrist and fingers) (fig. 7) and posterior (extensors) (fig. 8) groups. The muscles of the anterior group are situated in 4 layers. The muscles of the posterior group are situated in two layers.

First (superficial) layer of the anterior muscles of the forearm

The brachioradialis muscle (m. brachioradialis) originates from the lateral epicondyle of humerus. At midlevel of the forearm its venter continues into a narrow flat tendon. This tendon is inserted into the lateral surface of the distal end of radius.

Function: it flexes the forearm in the elbow joint; sets the hand in an intermediate position between pronation and supination.

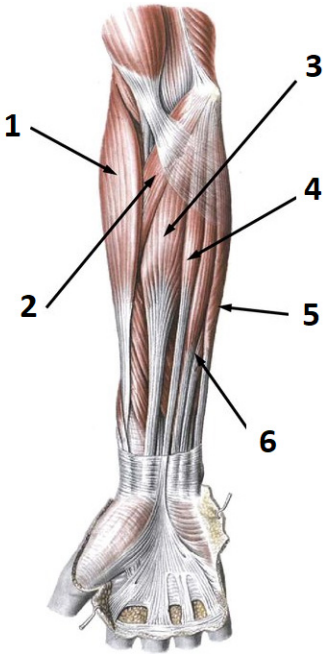

Fig. 7. Muscles of the forearm (anterior group): *1* – m. brachioradialis; *2* – m. pronator teres; *3* – m. flexor carpi radialis; *4* – m. palmaris longus; 5 – m. flexor carpi ulnaris; *6* – m. flexor digitorum superficialis

The pronator teres muscle (m. pronator teres) is a short muscle. The humeral head originates from the medial epicondyle of the humerus. The lesser head has a deeper origin on the coronoid process of the ulna. This muscle stretches downward and laterally. Its tendon is inserted into the lateral surface of the radius, approximately at its middle. Function: this muscle pronates the forearm together with the hand. It takes part in flexion of the forearm.

The flexor carpi radialis muscle (m. flexor carpi radialis) originates on the medial epicondyle of humerus. Approximately at the middle of the forearm it continues into a long narrow tendon, which is inserted into the base of the second metacarpal bone. Function: it flexes the wrist in the radiocarpal joint. It abducts the hand.

The palmaris longus muscle (m. palmaris longus). It originates on the medial epicondyle of humerus. Its long thin tendon is inserted into the palmar aponeurosis. This muscle is sometimes absent. Function: it stretches the palmar aponeurosis and participates in flexion of the hand in the radiocarpal joint.

The flexor carpi ulnaris muscle (m. flexor carpi ulnaris) has a humeral and an ulnar heads of origin. The humeral head originates on the medial epicondyle of the humerus.

The ulnar head originates from the medial edge of olecranon process and posterior margin of the ulna. On the proximal part of the forearm both heads continue into a common venter. The muscle stretches along the medial edge of the forearm and is inserted with a long tendon into the pisiform bone. Function: flexion of the forearm. It adducts the hand.

Second layer of the anterior muscles of the forearm

The flexor digitorum superficialis muscle (m. flexor digitorum superficialis) has a humeroulnar and radial heads. The humeroulnar head originates from the medial epicondyle of the humerus. The radial head originates from the proximal two thirds of anterior edge of the radius. They form a common venter on the proximal end of the forearm. Approximately at the middle of the forearm this venter is divided into four parts, which continue into separate tendons. These tendons are inserted into palmar surfaces of the bases of the middle phalanges (fingers II–V).

Function: this muscle flexes the middle phalanges and takes part in flexion of the wrist.

Third layer of anterior muscles of the forearm

The flexor digitorum profundus muscle (m. flexor digitorum profundus) originates from the front proximal two thirds of the interosseous membrane of the forearm. Its tendons are inserted into the base of distal phalanges. Function: it flexes the distal phalanges of the fingers II–V and participates in flexion of the wrist.

The flexor pollicis longus muscle (m. flexor pollicis longus) originates from the upper anterior surface of the radius and interosseous membrane of the forearm. Its tendon attaches on the base of the distal phalanx of the thumb. Function: it flexes the distal phalanx of the thumb and participates in flexion of the wrist.

Fourth (deep) layer of the anterior muscles of the forearm

The pronator quadratus muscle (m. pronator quadratus) is a flat muscle, situated on the distal end of the forearm. It originates on the anterior edge and anterior lower third of the body of the ulna, stretches across and is inserted into the anterior lower third of the radius. Function: this muscle pronates the forearm.

Posterior muscles of the forearm

Muscles of the posterior surface of the forearm are situated in two layers: superficial and deep.

Superficial layer of the posterior muscles of the forearm

The extensor carpi radialis longus muscle (m. extensor carpi radialis longus) originates on the lateral epicondyle of the humerus. On the forearm this muscle lies to the front of the extensor carpi radialis brevis and behind the brachioradial muscle. At midlevel of the forearm, its venter continues into a flat tendon, which is inserted into the base of the second metacarpal bone. Function: it extends the wrist and abducts the wrist in the radiocarpal joint.

The extensor carpi radialis brevis (m. extensor carpi radialis brevis) originates on the lateral epicondyle of humerus. It is inserted into the dorsal surface of the base of the third metacarpal bone. Function: it extends the wrist and abducts the wrist in the radiocarpal joint.

The extensor digitorum muscle (m. extensor digitorum). It originates from the lateral epicondyle of the humerus. At the level of the radiocarpal joint it is divided into four tendons. These tendons are inserted into the bases of middle phalanges and on the distal phalanges. Function: this muscle extends fingers II–V and participates in extension of the wrist in the radiocarpal joint.

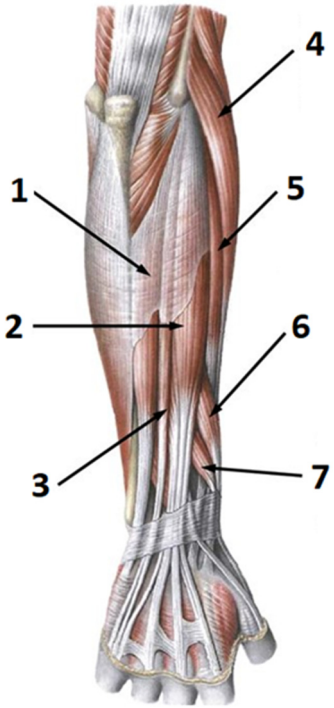

Fig. 8. Muscles of the forearm (posterior group): *1* – m. extensor carpi ulnaris; *2* – m. extensor digitorum; 3 – m. extensor digiti minimi; *4* – m. extensor carpi radialis longus; *5* – m. extensor carpi radialis brevis; *6* – m. abductor pollicis longus; *7* – m. extensor pollicis brevis

The extensor digiti minimi muscle (m. extensor digiti minimi) has a common origin with the extensor of the fingers. Its long thin tendon is inserted into the dorsal surface of the bases of middle and distal

phalanges of the little finger. Function: extends the little finger; participates in extending the wrist in the radiocarpal joint.

The extensor carpi ulnaris (m. extensor carpi ulnaris) originates on the lateral epicondyle of humerus, the posterior surface of ulna. It is inserted into the dorsal surface of the base of the fifth metacarpal bone. Function: it extends the wrist and adducts the wrist in the radiocarpal joint.

Deep layer of the posterior muscles of the forearm

The supinator muscle (m. supinator) is almost completely covered by superficial muscles. It originates from the lateral epicondyle of the humerus. This muscle stretches obliquely laterally and is inserted into the lateral surface of upper third of the radial bone. Function: it supinates the radius (together with the hand).

The abductor pollicis longus muscle (m. abductor pollicis longus) originates on the posterior surfaces of the ulna and radius and the interosseous membrane of the forearm. It stretches downwards and laterally. Its tendon is inserted into the base of the first metacarpal bone. Function: abduction of the thumb.

The extensor pollicis brevis muscle (m. extensor pollicis brevis) originates on the posterior surface of radius and the interosseous membrane of forearm. Its tendon is inserted into the dorsal surface of the base of proximal phalanx of thumb. Function: it extends the proximal phalanx of the thumb (thus straightening the thumb), and participates in abduction of the thumb.

The extensor pollicis longus muscle (m. extensor pollicic longus) originates from the lateral middle third of the posterior surface of the ulna and the interosseous membrane. Its tendon is inserted into the dorsal surface of base of the distal phalanx of the thumb. Function: extension of the thumb.

The extensor indicis muscle (m. extensor indicis) originates from the posterior surface of ulna and the interosseous membrane. Its tendon is inserted into the dorsal surface of the proximal phalanx of the index finger. Function: extension of the index finger.

Muscles of the hand

In humans, the muscles of the hand (fig. 9), which represents the most important part of the upper limb – the organ of labor, reach the

greatest perfection. At the same time, in the process of human evolution, the muscles of the thumb reached the greatest development in comparison with anthropoids, thanks to which man has the ability to maximally oppose it. An expression of this is the ability, with the hand clenched into a fist, to reach the joints of the fifth finger with the end of the thumb. In humans, the extensors also reach their greatest development, and each finger gains the ability to fully straighten. As a result, the hand and each of its fingers acquire the ability of maximum flexion and extension, which is necessary for work.

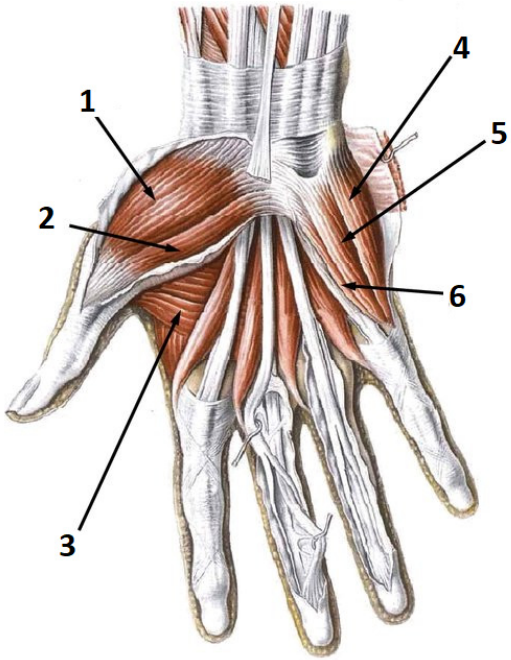

Fig. 9. Muscles of the hand: *1* – m. abductor pollicis brevis; *2* – m. flexor pollicis brevis; *3* – m. adductor pollicis; *4* – m. abductor digiti minimi; *5* – m. flexor digiti minimi brevis; *6* – m. opponens digiti minimi

Muscles of the hand are divided into three groups: muscles of the thenar eminence, muscles of the hypothenar eminence and the middle group of muscles.

Muscles of the thenar eminence

The abductor pollicis brevis muscle (m. abductor pollicis brevis) is flat and is situated superficially. It originates from the scaphoid and trapezium bones and from the lateral region of the flexor retinaculum. The muscle stretches lateral and downwards to be inserted into the lateral edge of the base of the proximal phalanx of the thumb and the lateral edge of the tendon of extensor pollicis longus. Function: abduction of the thumb.

The opponens pollicis muscle (m. opponens pollicis) is partially covered by the short abductor muscle of the thumb. Often if unites with the short flexor of the thumb. This muscle originates from the trapezium bone and the flexor retinaculum, and is inserted into the anterior surface of the first metacarpal bone. Function: opposition of the thumb to the other fingers.

The flexor pollicis brevis muscle (m. flexor pollicis brevis) is partially covered by the short abductor of the thumb. It has a superficial and a deep heads. The superficial head originates from the flexor retinaculum. The deep head originates from the trapezium, trapezoid and second metacarpal bones. The muscle is inserted into the proximal phalanx of the thumb. Function: it flexes the proximal phalanx of the thumb (thus bending the thumb) and participates in its adduction.

The adductor pollicis muscle (m. adductor pollicis) is located in the middle of the thenar region. It lies beneath the tendons of the long flexors of fingers and the lumbrical muscles. It has an oblique and a transverse heads. Its ob1ique head originates on the capitate bone and bases of II and III metacarpals. The transverse head originates from the anterior surface of the III metacarpal bone. The common tendon of this muscle is inserted into the base of the proximal phalanx of the thumb. Function: it adducts the thumb to the index finger and participates in its flexion.

Muscles of the hypothenar

The palmaris brevis muscle (m. palmaris brevis) originates from the flexor retinaculum and is inserted into the skin of the medial edge of the hand. This muscle is not always present. Function: it wrinkles the skin of the hypothenar region.

The abductor digiti minimi brevis muscle (m. abductor digiti minimi) begins as a thin plate on the flexor retinaculum and the pisiform bone. It is inserted into the medial side of the proximal phalanx of the little finger. Function: abduction of the little finger.

The opponens digiti minimi muscle (m. opponens digiti minimi) is a thin muscle, which originates on the flexor retinaculum and hook of hamate bone. It is inserted into the medial surface of the fifth metacarpal bone. Function: opposition of the little finger (bringing it toward the thumb).

The flexor digiti minimi brevis muscle (m. flexor digiti minimi) is a thin band; it originates from the hook of the hamate bone and the flexor retinaculum. It is inserted into the palmar surface of the proximal phalanx of the fifth finger. Function: flexion of the little finger.

Middle group of the muscles of the hand

The lumbrical muscles (mm. lumbricales) are four thin fusiform muscles, which are situated beneath the palmar aponeurosis. They originate from tendons of the deep flexor of the fingers. The first and second lumbrical muscles originate from the radial edge of tendons, directed towards the index and middle fingers; the third lumbrical originates from adjoining edges of the tendons, which are inserted into the middle and fourth fingers; the fourth lumbrical originates from adjoining edges of tendons of the fourth and little fingers. The lumbrical muscles stretch to the radial sides of II–V fingers and attach on the dorsal side of their proximal phalanges. Function: they flex the proximal phalanges and straighten the middle and distal phalanges of fingers II–V.

The palmar interossei muscles (mm. interossei palmares) are three muscles, situated on the carpal side of the hand, in the II, III and IV intermetacarpal spaces. They originate from medial edges of the second and lateral edges of fourth and fifth metacarpals. They are inserted into the dorsal side of proximal phalanges of fingers II, IV and V. Function: they adduct fingers II, IV and V to the third finger.

The dorsal interossei muscles (mm. interossei dorsales) are four pennate muscles, situated in the dorsal parts of the intermetacarpal spaces. Each originates by two heads on the adjacent sides of I–

V metacarpals. The tendon of the first dorsal interosseous muscle is inserted into the radial side of proximal phalanx of the index finger; the second – on the radial side of the proximal phalanx of middle finger; the third – on the ulnar side of the proximal phalanx of the middle finger; and fourth – on the ulnar side of the proximal phalanx of the fourth finger. Function: abduction of the I, II, IV and V fingers from the third finger.

TOPOGRAPHY OF THE UPPER LIMB

The purpose of studying the topic: the student must know topography of the upper limb.

As a result, the student should know:

- What is axillary fossa?
- What is axillary cavity?
- What is trilateral space?
- What is quadrilateral space?
- Triangles of the anterior wall of the axillary fossa.
- What is humeromuscular canal?

The upper extremity has several bone and muscle structures that are easily definable surfaces. These include the scapular spine, acromion, medial and lateral margins and the inferior angle of the scapula. In the subclavicular region one can palpate the coracoid process. The deltoid region, which is occupied by the large deltoid muscle, is separated from the greater pectoral muscle by the deltopectoral groove. The axillary region corresponds to the **axillary fossa**, which can be seen when the arm is raised. The anterior border of this fossa is the lower edge of the greater pectoral muscle, and the posterior border is the lower edge of the latissimus dorsi. On the arm there are a medial and a lateral grooves, which continue into the cubital fossa. At the sides of the elbow it is possible to palpate the medial and lateral epicondyles of the humerus. On the dorsal side of the elbow joint is the prominent olecranon process. On the anterior surface of the forearm are the radial and ulnar grooves, and at the level of the radiocarpal joint it is possible to palpate the styloid processes of the ulna and radius. On the palm one can easily see the thenar and hypothenar, and between them a triangular depression. Also well definable are the creases over metacarpophalangeal and interphalangeal joints and the balls of the fingers. The dorsal surface of the hand is convex. At the base of the thumb, when it is abducted, a fossa appears between tendons of the long and short extensors. This fossa is called the anatomical snuffbox; in it lies the radial artery, which passes between the first two fingers onto the palm.

The skin on the scapular region is thick and tightly accreted with the subcutaneous tissue and the superficial fascia. The skin above the deltoid muscle is also thick and almost immovable.

In the subclavicular region the skin is thin, and the subcutaneous tissue is well developed, especially in women. The axillary region, which confines the axillary fossa, is bordered medially by the level of the third rib. Its lateral border is a line drawn on the arm between points of insertion of the latissimus dorsi and pectoralis major muscles. Beginning in puberty, the skin of the axillary region acquires characteristic hair growth. The skin of this region contains many sweat and sebaceous glands; the subcutaneous tissue is weakly developed. On the arm the skin is thicker on the posterior and lateral sides than on the medial; the subcutaneous tissue is loose. On the elbow joint the skin is thick on its posterior surface and thin in the front. Above the apex of the olecranon there is a subcutaneous synovial bursa. In cases of injury or prolonged compression this bursa is likely to be a site of pathological processes. On the front of the forearm the skin is thin and relatively movable, whereas on the posterior side it is thicker and has less mobility. On the palm the skin is thick and lacks hair. Its subcutaneous tissue has a cellulate structure. On the dorsal side of the hand the skin is thin and movable. The subcutaneous tissue is loose, which contributes to formation of an edema during inflammatory processes in the hand.

The subcutaneous tissue contains almost no adipose cells. The skin is attached by fibers to the proper fascia of the trapezius muscle. The fascia of the supraspinous muscle is attached at the top to the transverse ligament of the scapula, the coracoid process and the capsule of the shoulder joint. Between the supraspinous muscle and the floor of the supraspinous fossa there is a thin layer of fatty tissue, which contains the supraspinous nerve, artery and veins. The loose connective tissue beneath the infraspinous muscle contains the circumflex artery of scapula. The supraspinous and infraspinous fascial sheaths communicate with each other near the base of the acromion (where blood vessels and nerves enter the infraspinous fossa).

The subdeltoid connective tissues space continues downward until the insertion point of the deltoid muscles. This space contains the tendon

of the long head of biceps brachii, branches of the axillary nerve and the posterior circumflex humeral artery.

Beneath the axillary fascia is the **axillary cavity** (cavum axillare), which is shaped like a pyramid, the apex of which is directed upward and medially, and the base – downward and laterally. The upper aperture of the axillary cavity is bordered by the clavicle, the first rib and the superior margin of the clavicle. This aperture connects the axillary and the cervical regions. The axillary cavity has four walls. The anterior wall is formed by the major and minor pectoral muscles; the posterior – by the latissimus dorsi, teres major and subscapular muscles; the medial wall is formed by the serratus anterior muscle; and the lateral – by the biceps brachii and the coracobrachialis muscle.

The posterior wall of the axillary cavity has two relatively large openings, which are normally covered by loose connective tissue. **The triangular space (foramen trilaterum)** is more medial, and is bordered by the subscapular muscle at the top, the teres major muscle at the bottom, and by the long head of the triceps on the lateral side. Through this opening pass the circumflex scapular artery and vein. **The quadrilateral space (foramen quadrilaterum)** is more lateral; it is bordered by the surgical neck of humerus on the lateral side, the long head of the triceps on the medial side, the subscapular muscle at the top, and the major teres muscle at the bottom. This foramen serves as a passage for the posterior circumflex humeral artery and vein and the axillary nerve. The axillary cavity contains a lot of loose fibrous connective tissue rich in adipocytes, as well as blood vessels, nerves and axillary lymph nodes.

On the anterior wall of the axillary fossa there are three triangles, the borders of which define the topography of some blood vessels and nerves. The **clavipectoral triangle (trigonum clavipectorale)** is situated between the clavicle and the upper edge of the minor pectoral muscle. Within its boundaries lie the axillary artery and vein and the medial bundle of the brachial plexus.

The **pectoral triangle (trigonum pectoral)** corresponds to the contours of the minor pectoral muscle. Within its boundaries lie the long thoracic nerve and the lateral thoracic artery branches off the axillary

artery. Through the **subpectoral triangle (trigonum subpectorale)**, which is situated between the lower boundaries of the minor and greater pectoral muscles, pass the axillary artery and vein, as well as the median, musculocutaneous, ulnar and other nerves. Within this triangle the axillary artery gives off the subscapular and the anterior and posterior circumflex humoral arteries.

The neurovascular bundle, formed by the median nerve and the brachial artery and veins, passes on the arm through the medial sulcus (of the biceps muscle). On the back of the arm the proper fascia forms a sheath for the triceps muscle. In front of this sheath, through the radial canal, passes the posterior neurovascular bundle. **The radial, or humeromuscular, canal** (canalis nervi radialis) is situated between the posterior surface of the humerus and the triceps brachii muscle. Its upper opening (entrance) is situated at the boundary between the upper and middle thirds of the body of the humerus. At the medial side this opening is bordered by the humerus and the lateral and medial heads of triceps brachii muscle. Its lower opening (exit) is situated at the boundary between the middle and bottom thirds of humerus, between the brachialis and brachioradialis muscles. This canal serves as a passage for the radial nerve and the deep brachial artery and veins. On the back of the elbow, on either side of the olecranon process, there are two grooves. In the posterior medial cubital groove, within a tunnel, formed by the medial epicondyle, the olecranon and the fascia, lies the ulnar nerve.

Situated on the front cubital surface is the **cubital fossa** (fossa cubitalis). Its bottom and upper border are formed by the brachioradialis muscle and the pronator teres. The cubital fossa contains as lateral and medial bicipital grooves. The lateral groove is bordered by the brachioradialis muscle on the lateral side, and the brachialis muscle medially. The medial bicipital groove is situated between the pronator teres and the brachialis muscle. Situated in the subcutaneous tissue of this region are the basilic and cephalic veins. Beneath the bicipital aponeurosis pass the brachial artery and veins, and the median nerve. On the anterior cubital region there are three fascial muscle sheaths. The medial one contains the pronator teres, flexor carpi radialis, palmaris longus muscle, flexor

carpi ulnaris muscles and, at the very bottom, the flexor digitorum superficialis. The lateral sheath contains the brachioradialis muscle and, beneath it, the supinator. The middle fascial sheath, which lies between the two bicipital grooves, encases the distal part of the biceps brachii and its tendon, and the anconeus muscle. In the anterior forearm region, on the antebrachial fascia there are three grooves called the radial, median and ulnar. The radial groove is situated between the brachioradialis muscle and the flexor carpi radialis. The median groove passes between the flexor carpi radialis and the flexor digitorum superficialis. The ulnar groove is bordered by the flexor digitorum superficialis and the flexor carpi ulnaris.

The antebrachial fascia (fascia antebrachii) gives off two intermuscular septa toward the radius, which separate the anterior, posterior and lateral fascial sheaths of the forearm. Each of these sheaths contains muscles, together with nerves and blood vessels. The largest one is the anterior fascial sheath. It contains the anterior muscles of the forearm, excluding the brachioradialis muscle, situated in four corresponding layers. Between the flexor digitorum profundus and the flexor pollicis longus there is a connective tissue space (or Pirogoff), filled by loose connective tissue. Situated beneath all the muscles, on the interosseous membrane, is a neurovascular bundle, which is formed by the anterior interosseous blood vessels and nerves. The lateral fascial sheath contains only three muscles. More superficially lies the brachioradialis muscle, and beneath it – the extensor carpi radialis longus and extensor carpi radialis brevis muscles. The posterior sheath contains the posterior muscles of the forearm, excluding the extensor carpi radialis longus and extensor carpi radialis brevis. Between the superficial and deep layers of muscles lies the posterior brachial connective tissue space. The posterior and anterior connective tissue spaces communicate through an opening in the interosseous membrane of forearm, which serves as a passage for interosseous vessels. Within the posterior fascial sheath, on the interosseous membrane, lies a neurovascular bundle, containing blood vessels and the deep branch of the radial nerve.

MUSCLES OF THE THORAX, BACK AND ABDOMEN

The purpose of studying the topic: the student must know the structure of the muscles of thorax, back and abdomen.

As a result, the student should know:

- Muscles of the back (insertion, site of attachment, function)
- Muscles of the thorax (insertion, site of attachment, function)
- Muscles of the abdomen (insertion, site of attachment, function)

The muscles of the back are paired; they are situated in layers and can be divided into superficial and deep.

The first layer includes the trapezius and the latissimus dorsi muscles.

The second layer consists of the major and minor rhomboid muscles, the levator scapulae, the serratus posterior superior and inferior muscles.

The trapezius muscle (m. trapezius) is flat and triangular. It begins with a short tendon on the external occipital protuberance, the medial part of the upper nuchal line, the nuchal ligament and the spinous processes of the C7 vertebra and all thoracic vertebrae. Its upper fascicles pass downwards lateraly, the middle fascicles pass almost horizontally and the lower bunches pass upwards and to the lateral. The trapezius muscle is inserted into the lateral third of the clavicle, the acromion and the scapular spine.

Function: by simultaneous contraction of all its parts, the trapezius moves the scapula to the vertebral column. The upper fascicles of the muscle bring the scapula up. During simultaneous contraction of its upper and lower fascicles, the trapezius moves the lateral scapular angle upwards medially, while its lower angle moves forwards laterally. Contraction of only one side turns the face toward the opposite side.

The latissimus dorsi muscle (m. latissimus dorsi) (fig. 10) is flat and triangular. It begins from the spinous processes of the lower six thoracic and all lumbar vertebrae, the iliac crest, the median sacral crest and the 3–4 lower ribs. Fascicles of the muscle are directed upwards and laterally. Near the posterior margin of the axillary fossa the muscle continues into a flat thick tendon, which attaches to the crest of the lesser tubercle

of humerus. Function: the latissimus dorsi muscle causes adduction of the arm to the body and lowering of a raised arm, and pronation and extension in the shoulder.

The levator scapulae muscle (m. levator scapulae) begins with tendon fascicles from the transverse processes of 3–4 upper cervical vertebrae, passes downwards and attaches the upper part of the medial margin of the scapula. In its upper third it is covered by the sternocleidomastoid muscle, and in its lower third – by the trapezius. Function: this muscle lifts the scapula, bringing it closer to the spine.

The rhomboid major and minor muscles (mm. rhomboidei minor et major) are situated beneath the trapezius muscle.

The rhomboid minor muscle begins from the spinous processes of the C7 and T1 vertebrae. The muscle stretches downwards and laterally, and attaches to the medial margin of scapula, above the scapular spine.

The rhomboid major muscle begins from the spinous processes of T2–T5 vertebrae and ends at the medial margin of the scapula, below the scapular spine. The rhomboid major and minor muscles are often accreted with each other. Function: the rhomboid muscles move the scapula towards the vertebral column, raising it up.

The serratus posterior superior muscle (m. serratus posterior superior) is thin and flat. It is situated beneath the rhomboid muscles. It begins with a flat tendon from the spinous processes of the C6, C7, T1 and T2 vertebrae. The muscle stretches downwards laterally, and attaches to the back surfaces of ribs 1–5 lateral of their angles. Function: this muscle lifts the ribs.

The serratus posterior inferior muscle (m. serratus posterior inferior) is flat and thin; it is situated to the front of the latissimus dorsi muscle. It begins on the spinous processes of the T11, T12, L1 and L2 vertebrae and attaches to the lower 4 ribs. Function: it lowers the ribs.

The splenius capitis muscle (m. splenius capitis) is situated in front of the upper parts of the sternocleidomastoid and trapezius muscles. It begins on the spinous processes of the C7 and the upper 3–4 thoracic vertebrae. It stretches laterally upwards and attaches to the mastoid process of the temporal bone. Function: one-sided contraction turns the head to the corresponding side; contraction on both sides straightens the cervical part of the vertebral column.

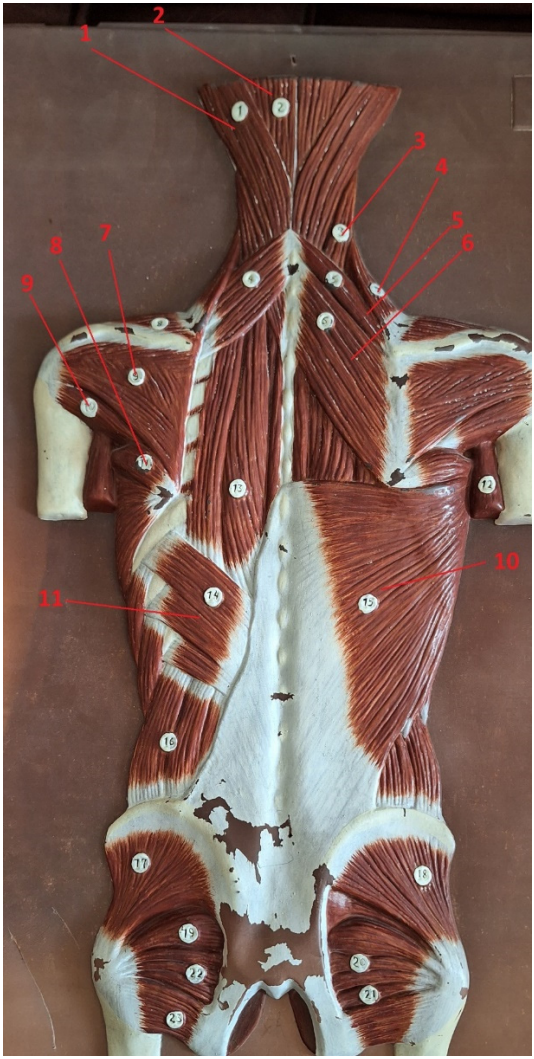

Fig. 10. Muscles of the thorax and back: *1* – m. splenius capitis; *2* – m. semispinalis capitis; *3* – m. splenius colli; *4* – m. levator scapulae; *5* – m. romboideus minor; *6* – m. rhomboideus major; *7* – m. infraspinatus; *8* – m. teres major; *9* – m. teres minor; *10* – m. latissimus dorsi; *11* – m. serratus posterior inferior

The splenius cervicis muscle (m. splenius cervicis) is situated to the front of the trapezius muscle. It begins on the spinous processes of the T3 and T4 vertebrae and attaches to the posterior tubercles of the transverse processes of 2–3 upper cervical vertebrae. Function: during one-sided contraction the cervical part of the spine turns to the corresponding side.

The erector spinae muscle (m. erector spinae) (fig. 11) is situated along the entire length of the spine. It is situated to the front of the trapezius, rhomboid, and the latissimus dorsi muscles.

The erector spinae muscle is divided into three parts:

1) lateral (*the iliocostalis muscle, m. iliocostalis*),

2) intermediate (*the longissimus muscle, m. longissimus*),

3) medial (*the spinalis muscle, m. spinalis*).

These muscles straighten and rotate the back.

The transversospinales muscle (m. transversospinales) consists of many muscle fibers of different lengths, obliquely oriented and situated in layers. They are called the semispinal, multifidus and rotatores muscles.

The semispinalis muscle (m. semispinalis) consists of long muscle fascicles, which originate from the transverse processes of vertebrae, stretch upward and medially, span 4–6 vertebrae and attach to the spinous processes. The semispinalis muscle has a thorax, neck and head sections. The semispinalis thoracis and cervicis muscles originate from the transverse processes of all thoracic vertebrae and are inserted on the spinous processes of T1–T6 and C2–C7 vertebrae.

The semispinalis capitis muscle of the head originates on the transverse processes of T1–T4 and C4–C7 vertebrae, and inserts in the occipital bone (between the superior and inferior nuchal lines). Function: contraction of semispinales muscles on both sides causes the thoracic and cervical parts of the spine and the head to straighten. During one-sided contraction they turn the neck and the head toward the opposite side.

The multifidus muscles (mm. multifidi) originate from the dorsal surface of the sacrum and on transverse processes of all vertebrae up to C2. They stretch upward and medially, span 2–4 vertebrae and insert into spinous processes. Function: these muscles turn the vertebral column about the vertical axis, toward the opposite side.

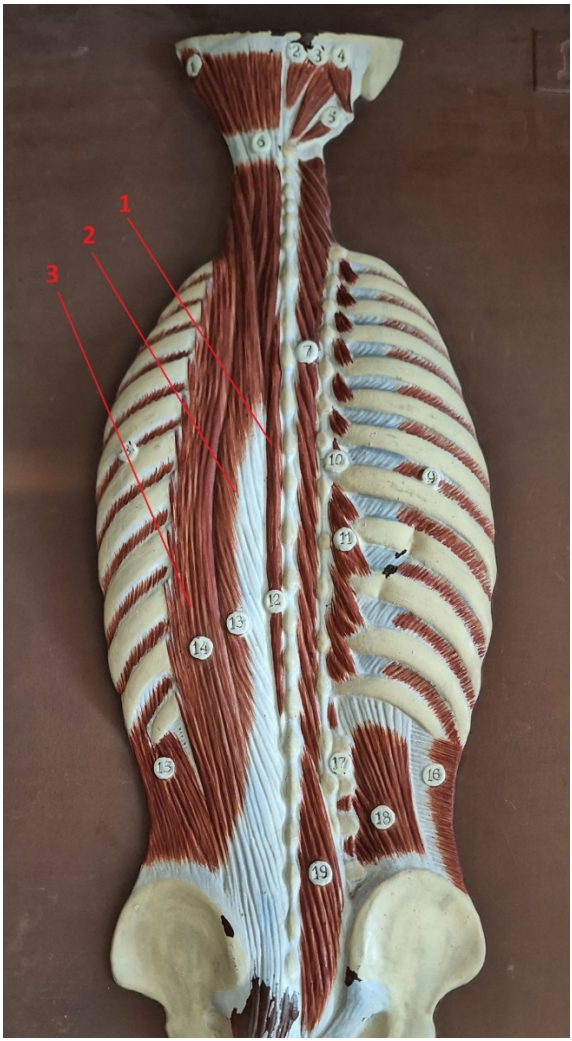

Fig. 11. The erector spinae muscle: *1* – m. spinalis;
2 – m. longissimus; *3* – m. iliocostalis

The rotatores muscles (mm. rotatores) form the deepest layer of muscles of the back. They are best expressed in the thoracic section of the spine. These muscles originate from transverse processes and stretch

upward and medially. They insert into the base of the next vertebra. Function: they turn the vertebral column about the vertical axis to the opposite side.

The interspinales muscles (mm. interspinales) stretch between the spinuos processes of neighboring vertebrae. In the thoracic part of the spine these muscles are often absent. Function: they participate in straightening the vertebral column.

The suboccipital muscles (mm. suboccipitales). There are four muscles included in this group. They are situated in the occipital region between the skull and the C1 and C2 vertebrae, to the front of the semispinalis and splenius capitis muscles.

These are the paired rectus capitis posterior major, rectus capitis posterior minor muscles, obliquus capitis superior muscle, obliquus capitis inferior muscles.

The rectus capitis posterior major (m. rectus capitis posterior major) originates on the spinous process of the C2 vertebra. It stretches upwards and to the laterally and inserts on the occipital bone, beneath the lower nuchal line. Function: during two-sided contraction the muscle bends the head backwards; and during one-sided contraction it moves the head to its side.

The rectus capitis posterior minor (m. rectus capitis posterior minor) originates from the posterior tubercle of the atlas, passes upwards and inserts into the occipital bone below the nuchal line, deeper and more medially than the rectus capitis posterior major muscle. Function: straightening the head.

The obliquus capitis superior muscle (m. obliquus capitis superior) stretches from the transverse process of the atlas medially and upwards, and inserts into the occipital bone above the inferior nuchal line. Function: during two-sided contraction the head extends backwards, and during one-sided contraction the head turns to the corresponding side.

The obliquus capitis inferior muscle (m. obliquus capitis inferior) begins on the spinous process of the C2 vertebra and passes laterally and upwards to the transverse process of the atlas. Function: the head is turned to the opposite side.

Muscles of the thorax

The pectoralis major muscle (m. pectoralis major) occupies a large area of the front thoracic wall. It has three parts, named according to their origin. The sternocostal part originates from the anterior surface of the sternum and cartilages of the upper 6 ribs. The clavicular part originates from the medial half of the clavicle; and the abdominal part – from the front of the rectus abdominis muscle. Fascicles of the pectoralis major muscle converge laterally and insert into the crest of the greater tubercle of humerus. Function: it lowers the raised arm, causes adduction and pronation. It raises the ribs and sternum.

The pectoralis minor muscle (m. pectoralis minor) is flat and narrow. It is situated beneath the pectoralis major muscle. Its origin is on the anterior ends of ribs 3–5. It stretches laterally and upwards and is inserted into the coracoid process of the scapula. Function: this muscle bends the scapula forward and lifts the ribs.

The subclavius muscle (m. subclavius) is long and thin, and is situated between the clavicle and the first rib. It stretches laterally and attaches to the inferior surface of the acromial end of the clavicle. Function: moves the clavicle downwards and towards the front.

The serratus anterior (m. serratus anterior) is a flat muscle, situated on the anterolateral surface of the thorax. It originates from the upper 8–9 ribs by separate muscle fascicles, and inserts on the medial margin and inferior angle of the scapula.

Function: it shifts the scapula to the front and the side; lower fascicles turn its lateral angle medial and upwards. This muscle lifts the ribs.

The external intercostal muscles (mm. intercostales externi) are located in the intercostal spaces. They originate from lower edges of ribs, outside the costal grooves. Their fascicles stretch down and forward and insert into the upper border of the next rib. Function: these muscles lift the ribs.

The internal intercostal muscles (mm. intercostales interni) are situated behind the external intercostals. They originate from the upper borders of ribs and insert into the lower borders of above-lying ribs. They

are oriented obliquely, almost perpendicularly to the fascicles of the external intercostal muscles. Function: lowering the ribs.

The transversus thoracis muscle (m. transversus thoracis) lies on the internal surface of the anterior thoracic wall. It originates from the xiphoid process and lower half of the sternum. Its muscle fascicles diverge like a fan and insert into cartilages of ribs 2–11. Function: the muscle pulls down the costal cartilages and lowers the ribs.

The subcostales muscles (mm. subcostales) are situated in the lower back portion of the internal surface of the thorax. They originate from the angles of ribs 10–12 and stretch upward and laterally. They span one or two ribs and insert into the internal surface of the above-lying rib. Function: these muscles raise the ribs.

The diaphragm (diaphragma, m. phrenicus) (fig. 12) is a thin, wide musculotendinous septum, which separates the thoracic and abdominal cavities. The diaphragm is the main breathing muscle. It develops from cervical myotomes. Its convex side is turned upward, into the thoracic cavity, and its concave side looks into the abdominal cavity.

Its muscle fascicles originate from the periphery and converging towards the center they form the central tendon of diaphragm (centrum tendineum). According to the origin, the diaphragm is divided into the lumbar, costal and sternal parts. The lumbar part originates from the right and left cruses from the medial and lateral arcuate ligaments and the anterior surface on lumbar vertebrae. The medial arcuate ligament (lig. arcuatum mediale) begins from the lateral surface of the L1 vertebra and attaches to the transverse process of the L2 vertebra. This ligament is stretched over the psoas major muscle. The lateral arcuate ligament (lig. arcuatum laterale) stretches between the apex of L2 vertebra and rib 12. It is situated in front of the lumbar quadrate muscle. The two peduncles of the lumbar part of the diaphragm cross each other on the level of L1 vertebra, forming the aortic hiatus (hiatus aorticus) that serves as a passage for the aorta and the thoracic duct. The edges of this opening are limited by fibrous lamina called the middle arcuate ligament, which protects the vessels, which pass through this opening from compression. Above and somewhat to the left of the aortic hiatus, in the lumbar part of

the diaphragm, is the esophageal hiatus opening (hiatus oesophageus), which is a passage for the esophagus and vagus nerve. Other vessels and nerves also pass between muscle fascicles of the lumbar part (the azygos and hemiazygos veins, the greater and lesser splanchnic nerves, the sympathetic trunk).

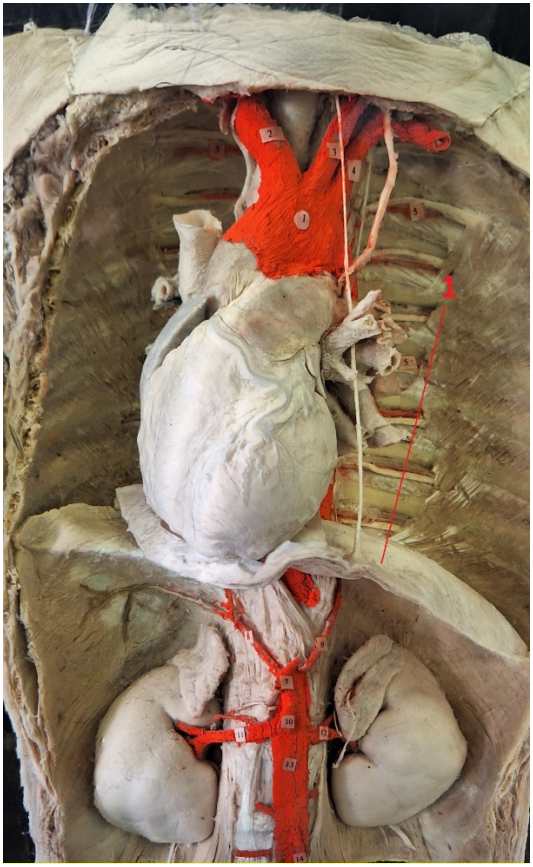

Fig. 12. Abdominal and thoracic cavity: *1* – m. phrenicus

The costal part of the diaphragm is formed by muscle fascicles, which originate from the internal surfaces of the lower six-seven ribs and insert into the central tendon of the diaphragm.

The sternal part is the most narrow. It originates from the posterior surface of the sternum and converges into the central tendon.

There central tendon has caval opening (foramen venae cavae).

On top the diaphragm is covered by the endothoracic fascia and from below – by the endoabdominal fascia. The diaphragm has weak places, in which muscle fibers are absent and the organs of the abdominal and thoracic cavities are separated only by the endoabdominal and endothoracic fasciae. These are the paired lumbocostal and sternocostal triangles. The lumbocostal triangle is situated between lumbar and costal parts of the diaphragm. The sternocostal triangle is smaller and is situated between sternal and costal parts of the diaphragm. These triangles often become a site of diaphragmatic hernias.

Function: during contraction, the diaphragm flattens and drops down increasing the volume of the thorax. When the diaphragm contracts simultaneously with the muscles of the abdominal press, the intra-abdominal pressure increases.

Muscles of the abdomen

The abdomen is the region between the thorax and pelvis. Its upper border is drawn along the xiphoid process of the sternum, the costal arches and the T12 vertebra. Its lateral border passes from the costal arches, along the posterior axillary line down to the iliac crest. Its lower border is formed by anterior parts of the iliac crests and a provisory line that corresponds to the inguinal folds.

External oblique muscle (m. obliquus externus abdominis) is situated superficially. It originates by muscle serrations on lateral surfaces on the lower 8th–9th ribs. The five upper serrations pass between serrations of the serratus anterior muscle, and the three lower ones – between serrations of the latissimus dorsi muscle. Its fascicles stretch down and medial, continuing into a wide flat aponeurosis. The upper and middle fascicles of the aponeurosis reach the anterior middle line, where they accrete with the aponeurosis of the opposite side, taking part in formation of the linea alba of the abdomen. The lower fascicles attach to the external lip of the iliac crest and the pubic tubercle, forming between them a thickened tendinous cord called the inguinal ligament (lig. inguinale).

Linea alba is a compact connective tissue plate, which stretches along the anterior middle line from the xiphoid process to the pubic symphysis. The linea alba is formed by crossing fibers of the aponeuroses of abdominal muscles.

Function: during bilateral contraction this muscle lowers the ribs and bends the spine. With unilateral contraction, turns the spine in the opposite direction.

Internal oblique muscle (m. obliquus internus abdominis) is situated beneath the external oblique muscle. It originates on the lateral two thirds of the inguinal ligament, the anterior two thirds of the intermediate line of the iliac crest. Its fascicles stretch upwards, diverge like a fan and continue into a wide aponeurosis. The upper fascicles of the aponeurosis attach to cartilages of the lower ribs. The middle fascicles stretch medially and lower – obliquely downwards and to the front. The middle and lower tendinous fascicles of the left and right aponeurosis of this muscle participate in the formation of the white line of the abdomen.

Function: bilateral contraction of this muscle bends the vertebral column and lowers the ribs. During unilateral contraction (simultaneously with the external oblique muscle of the abdomen on the opposite side) the body is turned to the same side.

Transversus abdominis muscle (m. transversus abdominis) forms the deepest muscle layer of the lateral abdominal walls. It originates on the internal surface of the lower six ribs, the anterior part of the internal lip of the iliac crest and on the lateral part of the inguinal ligament. Its fascicles stretch transversely medial and to the front. At the level of the lateral edge of rectus abdominis it continues into a wide aponeurosis. Function: brings the lower ribs down and to the front; decreases the size of the abdominal cavity.

The rectus abdominis muscle (m. rectus abdominis) is a paired flattened muscle, situated at either side of the anterior middle line. The two rectus abdominis muscles are separated by the linea alba of the abdomen. The origin of these muscles is on the pubic crest and the pubic symphysis. The rectus abdominis stretches upward and inserts on the anterior surface of the xiphoid process and costal cartilages of ribs V–VII.

Function: this muscle pulls the ribs down, lowering the thorax. It causes flexion of the vertebral column.

The pyramidalis muscle (m. pyramidalis) is paired and is situated in front of the lower section of the rectus abdominis muscle. It originates from the pubic crest and inserts into the linea alba of abdomen. This muscle is often absent. Function: stretches the linea alba of the abdomen.

The quadratus lumborum muscle (m. quadratus lumborum) originates from the iliac crest, the transverse processes of lower lumbar vertebrae. The muscle stretches upwards and inserts into the lower edge of the last rib and the transverse processes of the upper lumbar vertebrae. Function: during bilateral contraction it helps support the trunk in an upright position. Lateral contraction causes the spine to bend to the corresponding side and pulls the twelfth rib down.

MUSCLES OF THE LOWER EXTREMITY

The purpose of studying the topic: the student must know the structure of the muscles of the lower extremity.

As a result, the student should know:

- Muscles of the pelvic girdle (insertion, site of attachment, function)
- Muscles of the free lower extremity (insertion, site of attachment, function)
- Muscles of the foot (insertion, site of attachment, function)

The muscles of the lower extremity are divided, according to their location, into the muscles of the *pelvis (pelvic girdle)* and muscles of the *free lower extremity* (of the thigh, leg and foot).

Muscles of the pelvic girdle (muscles of the pelvis)

Muscles of the pelvis (fig. 13) surround the coxal joint from all sides. They have points of origin on the hipbone, lumbar vertebrae and the sacrum, and are divided into external and internal groups of muscles.

The internal muscles, which are situated inside the pelvic cavity, include:

- the iliopsoas muscle (consists of the iliacus and the psoas major muscles),
- the psoas minor muscle,
- the obturator internus muscle,
- the superior gemellus muscle,
- the inferior gemellus muscle,
- the piriformis muscle.

The external muscle group consists of muscles of the sides and of the gluteal regions of the pelvis. These include:

- the gluteus maximus muscle,
- the gluteus medius muscle,
- the gluteus minimus muscle,
- the quadratus femoris muscle,
- the tensor of fascia lata,
- the obturator externus muscle.

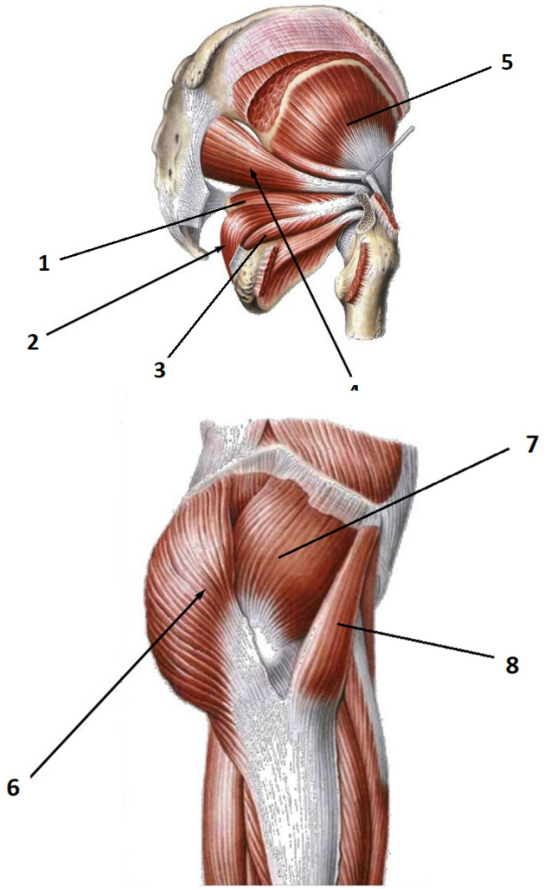

Fig. 13. Muscles of the pelvis: *1* – m. gemellus superior; *2* – m. obturatorius internus; *3* – m. gemellus inferior; *4* – m. piriformis; *5* – m. gluteus minimus; *6* – m. gluteus maximus; *7* – m. gluteus medius; *8* – m. tensor fasciae latae

The iliopsoas muscle (m. iliopsoas) forms part of the posterior abdominal wall. This muscle consists of two parts with two different points of origin. The iliopsoas muscle consists of psoas major muscle and iliacus muscle.

Psoas major muscle: originates along the lateral surfaces of the vertebral bodies of T12 and L1–L3 and their associated intervertebral discs. Iliacus muscle: originates in the iliac fossa of the pelvis.

The psoas major unites with the iliacus at the level of the inguinal ligament and crosses the hip joint to insert on the lesser trochanter of the femur. Function: the iliopsoas is involved in flexion and lateral rotation (supination) of the thigh. If the limb is fixed they involve in flexion of the trunk.

The psoas minor muscle (m. psoas minor) lies on the anterior surface of the psoas major muscle. It originates on the lateral surfaces of the T12 and L1 vertebrae and the intervertebral disk. Its long tendon inserted into the arcuate line of ilium and the pubic crest. Part of its fibers continues into the iliac fascia. Function: it stretches the iliac fascia, increasing the support for the iliopsoas muscle. This muscle also participates in flexion of the lumbar part of the spine.

The obturator internus (m. obturatorius internus) is a flat, triangular muscle. It originates on the internal surface of the obturator membrane, the edges of the obturator foramen and the obturator fascia. It exits the pelvic cavity through the lesser sciatic foramen. Then it makes a sharp turn around the edge of the lesser sciatic notch and is inserted into the medial surface of the greater trochanter of femur. Function: supination of the femur.

The superior gemellus muscle (m. gemellus superior) is short and flat; it originates from the ischial bone.

The inferior gemellus muscle (m. gemellus inferior) is also flattened and short, and originates from the ischial tuberosity.

Both muscles join the internal obturator muscle on the way out of the pelvic cavity and are inserted into the greater trochanter of femur. Function: supination of the thigh.

The piriformis muscle (m. piriformis) is spindle-shaped; it originates on the pelvic surface of the sacrum (S2–S4 vertebrae), lateral of the pelvic sacral foramina. It exits the pelvis through the greater sciatic foramen. Behind the neck of femur it continues into a tendon, which is inserted into the apex of the greater trochanter. Function: this muscle supinates and slightly abducts the thigh.

The external muscles of the pelvic girdle are situated in three layers.

The superficial layer consists of the gluteus maximus and the tensor fascia lata muscle.

The middle layer includes the gluteus medius and the quadrate muscle of the thigh.

The deep layer is made up of the gluteus minimus and the obturator externus muscle.

All of the above named muscles act upon the coxal joint.

The gluteus maximus muscle (m. gluteus maximus) is a thick tetragonal muscle, which forms the surface contour of the buttock. It originates on the crest of ilium, the dorsal surface of the sacrum and coccyx and on the sacrotuberal ligament. The muscle stretches obliquely down and is inserted into the gluteal tuberosity of the femur. Function: it extends and supinates the femur. When the lower extremity is fixed, this muscle straightens the body, and supports the balance of the pelvis and trunk. Its anterosuperior fascicles abduct the thigh. Its posteroinferior fascicles adduct and supinate the thigh.

The gluteus medius muscle (m. gluteus medius) is thick and triangular; it is situated beneath the gluteus maximus. Its origin is on the external surface of ilium, between the anterior and posterior gluteal lines. The fascicles of this muscle converge downward and are inserted into the apex and lateral surface of the greater trochanter of the femur. Function: it abducts the thigh. Its anterior fascicles pronate the femur, and the posterior fascicles supinate it. When the lower extremity is fixed, the gluteus medius and minimus muscles support the body in a vertical position.

The gluteus minimus muscle (m. gluteus minimus) is flat and triangular and is situated beneath the gluteus medius muscle. It originates from the outer surface of the ilium, on the edge of the greater sciatic notch. The gluteus minimus muscle is inserted into the greater trochanter of femur. Function: it abducts the thigh. Its anterior fascicles participate in pronation of the femur, and the posterior – in its supination.

The tensor of fascia lata muscle (m. tensor fasciae latae) is a flat, long strap muscle, narrow towards the bottom. It is situated on the lateral side of the thigh, between the superficial and deep laminae of the fascia

lata. It originates on the superior anterior iliac spine and the adjacent part of the iliac crest. At the level of the upper and middle thirds of the hip it continues into the iliotibial tract, which stretches down and attaches to the lateral condyle of tibia. Function: this muscle stretches the fascia lata and supports the knee joint in a straightened position. It also flexes the thigh.

The quadratus femoris muscle (m. quadratus femoris) originates on the upper part of the ischial tuberosity and is inserted into the upper part of the intertrochanteric crest. Function: supination of the thigh.

The obturator externus muscle (m. obturatorius externus) originates on the external surfaces of the obturator membrane, the pubic bone and the ramus of the ischial bone. Its fascicles are directed to the back, laterally and upwards. They continue into a tendon, which is inserted into the trochanteric fossa of the greater trochanter and to the capsule of the hip joint. Function: supination of the thigh.

MUSCLES OF THE FREE LOWER EXTREMITY

Muscles of the thigh (fig. 14) are divided into three groups:

- the anterior (flexors of the thigh and extensors of the leg),
- posterior (extensors of the thigh and flexors of the leg),
- and medial (adductors of the thigh).

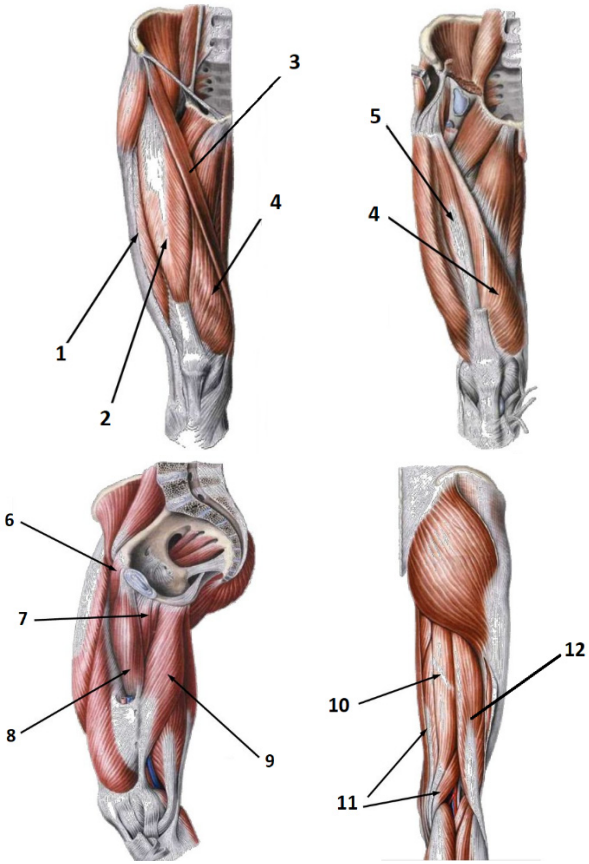

Fig. 14. Muscles of the thigh: *1* – m. vastus lateralis; *2* – m. rectus femoris; *3* – m. sartorius; *4* – m. vastus medialis; *5* – m. vastus intermedius; *6* – m. pectineus; *7* – m. adductor brevis; *8* – m. adductor longus; *9* – m. adductor magnus; *10* – m. semitendinosus; *11* – m. semimembranosus; *12* – m. biceps femoris

Anterior muscles of the thigh

The sartorius (m. sartorius) is a narrow strap muscle. It originates on the superior anterior iliac spine and stretches obliquely down and medially. Its tendon is inserted into the tibial tuberosity and into the crural fascia. Function: it flexes the thigh and leg, and abducts and supinates the thigh.

The quadriceps femoris muscle (m. quadriceps femoris) takes up the anterior, anterolateral anteromedial surfaces of the thigh. It consists of four parts, which are the rectus muscle of thigh and the lateral, medial and intermediate vastus muscles of thigh.

The rectus femoris muscle originates on the inferior anterior iliac spine and the iliac bone, above the acetabulum. It stretches down in front of the coxal joint.

The vastus lateralis muscle is the largest of the four parts. It originates from the intertrochanteric line, the lower part of the greater trochanter and the gluteal tuberosity. It stretches obliquely down and medially.

The vastus medialis muscle originates from the lower half of the intertrochanteric line, the medial labium of the rough line of the femur. It is directed obliquely down and laterally.

The vastus intermedius muscle is situated between the vastus medialis and vastus lateralis muscles and is partially covered by them. It originates on the anterior and lateral surfaces of the body of the femur and the lateral labium of the rough line. It stretches downwards.

The common tendon of the quadriceps femoris muscle is inserted into the side edges of the patella and the tibial tuberosity. Below the patella the central part of the ligament continues into the patellar ligament.

Function: the quadriceps fumoirs muscle extends the leg in the knee joint. The rectus femoris muscle takes part in flexion of the femur.

Posterior muscles of the thigh

The biceps femoris muscle (m. biceps femoris) has a long and a short heads.

The long head originates from the upper medial surface of the ischial tuberosity and the sacrotuberal ligament.

The short head originates on the lateral labium of the rough line.

The two heads fuse on the lower third of the femur and continue into a flat tendon. This tendon stretches along the back lateral surface of the knee joint and is inserted into the head of fibula.

Function: it extends the thigh and flexes the leg. When the leg is bent in the knee joint this muscle slightly supinates it.

The semimembranosus muscle (m. semimembranosus) originates from the ischial tuberosity as a long tendinous lamina, which continues into a venter at midlevel of the thigh. This venter is situated in front of the semitendinous muscle and the long head of the biceps of the thigh. It inserts on the medial condyle of tibia; intercondylar fossa of femur and lateral condyle of femur.

Function: this muscle extends the thigh and flexes the leg. When the leg is bent in the knee joint, this muscle pronates it.

The semitendinosus muscle (m. semitendinosus) originates on the ischial tuberosity, next to the long head of the biceps of the thigh. On the middle third of the thigh its venter continues into a long tendon, which inserts on the proximal medial surface of the tibia.

Function: it extends the thigh and flexes the leg; when the knee joint is bent, this muscle pronates the leg.

Medial muscles of the thigh

The gracilis muscle (m. gracilis) is long and flat. It originates on the inferior side of the pubic symphysis and the inferior ramus of the pubis. Its tendon is inserted into the upper medial part of the tibia. Function: it adducts the thigh and also flexes and pronates the leg.

The pectineus muscle (m. pectineus) originates on the crest and superior ramus of pubis. It is inserted into the proximal part of femur, between the back of the lesser trochanter and the rough line. Function: it adducts the thigh and participates in its flexion.

The adductor longus muscle (m. adductor longus) originates from a thick tendon on the external surface of pubis, between its crest and the pubic symphysis. This muscle covers from the front the adductor brevis and the upper part of the adductor magnus. It stretches down and laterally, is inserted into the medial labium of the rough line of the thigh. Function: adduction of the thigh. This muscle also takes part in flexion and supination of the thigh.

The adductor brevis muscle (m. adductor brevis) originates from the external surface of the body and lower inferior ramus of the pubic bone. It is situated behind the pectineus and adductor longus muscles. Its fascicle stretches down and laterally, and is inserted into the rough line of femur. Function: it adducts the thigh and takes part in its flexion.

The adductor magnus muscle (m. adductor magnus) is the largest muscle of the medial group. It originates on the ischial tuberosity, ramus of ischium and inferior ramus of pubis. It is situated behind the adductor longus, adductor brevis and in front of the semitendinosus and semimembranosus muscles and the long head of biceps femoris. It inserts along the whole length of the medial lip of the rough line. Function: this muscle adducts the thigh. Its medial fascicles participate in extension of the thigh.

MUSCLES OF THE LEG

The leg muscles (fig. 15) are divided into anterior, lateral and posterior groups.

The anterior group consists of the tibialis anterior muscle, extensor hallucis longus muscle and extensor digitorum longus muscle.

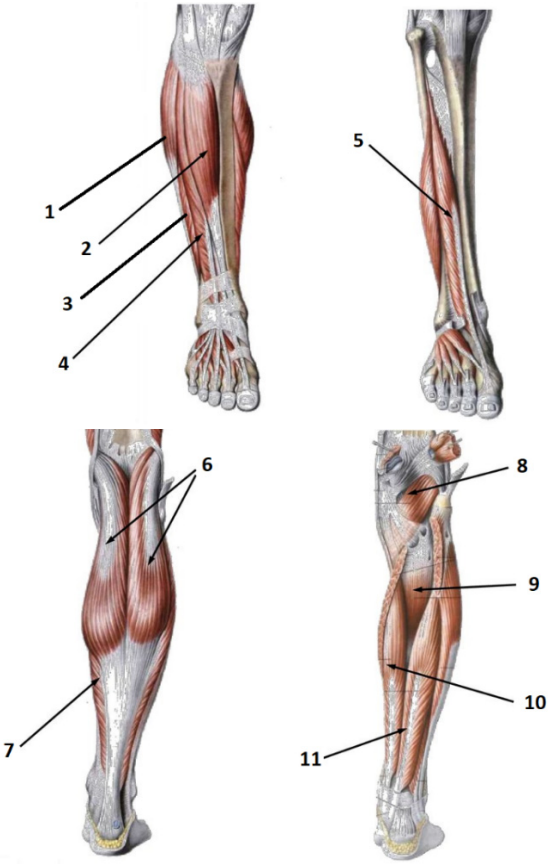

Fig. 15. Muscles of the leg: *1* – m. peroneus longus; *2* – m. tibialis anterior; *3* – m. peroneus brevis; *4* – m. extensor digitorum longus; *5* – m. extensor hallucis longus; *6* – m. gastrocnemius; *7* – m. soleus; *8* – m. popliteus; *9* – m. tibialis posterior; *10* – m. flexor digitorum longus; *11* – m. flexor hallucis longus

The lateral group includes the long and short peroneal muscles.

The posterior group consists of the triceps surae muscle and the plantaris muscle, which form the superficial layer, and the popliteus muscle, the flexor digitorum longus, the flexor hallucis longus and the tibialis posterior muscles forming the deep layer.

The tibialis anterior muscle (m. tibialis anterior) is situated on the anterolateral side of the leg. It originates on the lateral condyle, the lateral upper half of the body of the tibia, the upper part of the interosseous membrane.

On the distal third of the leg the venter of this muscle continues into a long tendon, which is inserted into the plantar surface of the medial cuneiform and the base of the first metatarsal bones.

Function: this muscle extends and supinates the foot.

The extensor digitorum longus muscle (m. extensor digitorum longus) originates from the lateral condyle of tibia, on the anterior surface of fibula, the upper part of the interosseous membrane. At the level of the talocrural joint it divides into four tendons, which are inserted into the bases of the middle and distal phalanges of toes II–V. Function: the extensor digitorum longus extends toes II–V in the metatarsophalangeal joints.

The extensor hallucis longus muscle (m. extensor hallucis longus) is situated between the tibialis anterior muscle and the extensor digitorum longus, and is partially covered by them in the front. It originates from the middle third of tibia and the interosseous membrane of leg. Its tendon is inserted into the distal phalanx of the great toe. Function: it extends the great toe.

The peroneus longus muscle (m. peroneus longus; m. fibularis longus) is situated superficially on the lateral region of the leg. It originates from the upper lateral two thirds of the fibula, lateral condyle of the fibula. Its tendon is inserted into the plantar surface of the medial cuneiform and bases of the first and second metatarsal bones. Function: this muscle flexes and pronates the foot.

The peroneus brevis muscle (m. peroneus brevis; m. fibularis brevis) originates on the lower lateral part of the fibula. Its tendon is

inserted into the base of the fifth metatarsal bone. Function: this muscle flexes and pronates the foot.

The triceps surae muscle (m. triceps surae) consists of the gastrocnemius and soleus muscles.

The gastrocnemius muscle (m. gastrocnemius) has a lateral (caput laterale) and a medial (caput mediale) heads. The lateral head originates from the lateral side of the distal epiphysis of femur and the lateral condyle. The medial head originates on the medial condyle of the femur. At midlevel of the calf the two heads unite and form the thick calcaneal tendon, which, together with the tendon of the soleus, is inserted into the calcaneal tuberosity.

The soleus muscle (m. soleus) is covered from behind by the gastrocnemius muscle. It originates from the soleus line of tibia. Function: the triceps surae muscle flexes the leg and foot.

The plantaris muscle (m. plantaris) is small; it originates from the lateral epicondyle of femur. Its long thin tendon passes between the gastrocnemius and soleus muscles, joins the calcaneal tendon on its medial side and is inserted into the calcaneal tuberosity. Function: it stretches the capsule of the knee joint and takes part in flexion of the leg and foot.

The popliteus muscle (m. popliteus) is situated in the popliteal fossa. It originates from the outer surface of the lateral condyle of the femur and is inserted into the back of the tibia, above the soleus line. Function: it flexes and pronates the leg, and stretches the capsule of the knee joint.

The flexor digitorum longus muscle (m. flexor digitorum longus) is situated behind and medial of the posterior tibial muscle. It originates from the back of tibia, beneath the soleus line and on the crural fascia. Its tendon stretches downward and divides into four separate tendons, which are inserted into the distal phalanges of toes II–V. Function: flexion of distal phalanges of toes II–V. This muscle flexes and supinates the foot.

The flexor hallucis longus muscle (m. flexor hallucis longus) originates on the lower two thirds of fibula and the interosseous membrane of leg. This muscle passes behind and laterally of the tibialis posterior muscle. Its tendon is inserted into the base of the distal phalanx of the great toe. Function: it flexes the great toe.

The tibialis posterior muscle (m. tibialis posterior) is situated between the flexor digitorum longus and the flexor hallucis longus. It originates from the back of fibula, the inferior surface of the lateral condyle and the upper two thirds of tibia, and on the interosseous membrane of the leg. The tendon of this muscle is inserted into the tuberosity of the navicular bone, all three cuneiform bones and into the base of the fourth metatarsal bone. Function: this muscle flexes, adducts and supinates the foot.

Muscles of the foot

Muscles of this group originate from and are inserted within the limits of the foot, that is, into the dorsal and plantar surfaces of tarsal and metatarsal bones and phalanges. The dorsal group of muscles includes the extensor hallucis brevis and the extensor digitorum brevis. The muscles of the plantar side are divided into the lateral, middle and the medial groups. The medial group includes the abductor hallucis muscle, the flexor hallucis brevis and the adductor hallucis. The middle group consists of four lumbricals and seven interossei muscles, the flexor digitorum brevis and the quadratus plantae muscles. The lateral group includes the abductor digiti minimi, the flexor digiti minimi brevis, opponens digiti minimi muscles.

Dorsal muscles of the foot

The extensor digitorum brevis (m. extensor digitorum brevis) is a small muscle, which originates on the anterior pail of the upper and lateral surfaces of calcaneus. It stretches obliquely forward and medially and divides into three tendons, which join the tendons of the extensor digitorum longus and are inserted into bases of middle and distal phalanges. Function: extension of the toes.

The extensor hallucis brevis (m. extensor hallucis brevis) is situated to the medial of the extensor digitorum brevis. It originates from the superior surface of calcaneus, stretches forward and medially, and is inserted with a narrow tendon into top of the base of the proximal phalanx of great toe. Function: extension of the great toe.

Medial group of the muscles of the sole

The abductor hallucis muscle (m. abductor hallucis) originates from the medial surface of the calcaneal tuberosity and the plantar

aponeurosis. It stretches along the medial edge of the foot and is inserted from the medial side into the base of the proximal phalanx of great toe. Function: abduction of the great toe.

The flexor hallucis brevis (m. flexor hallucis brevis) originates from the medial side of the plantar surface of the cuboid and cuneiform bones. Its tendon is inserted into the proximal phalanx of the great toe and the sesamoid bone, located near the first metatarsophalangeal joint. Function: flexion of the great toe.

The adductor hallucis muscle (m. adductor hallucis) has an oblique and transverse heads. The oblique head originates on the cuboid and lateral cuneiform bones, bases of II–IV metatarsals and the tendon of the long peroneal muscle. Its venter stretches forward and medially and unites with the transverse head, forming a common tendon. The transverse head originates as a narrow muscle strap on capsules of the III–V metatarsophalangeal joints. The common tendon of the muscle is inserted into the base of the proximal phalanx of great toe and the lateral sesamoid bone. Function: it adducts the great toe and participates in its flexion.

Lateral group of muscles of the sole

The abductor digiti minimi muscle (m. abductor digiti minimi) originates from the bottom of the calcaneal protuberance, tuberosity of the fifth metatarsal and the plantar aponeurosis. Its tendon passes along the lateral side of the foot and inserts into the lateral side of the proximal phalanx of the little toe. Function: it flexes the proximal phalanx of the little toe and adducts it.

The flexor digiti minimi brevis (m. flexor digiti minimi brevis) originates from the medial plantar surface of the fifth metatarsal bone and the plantar ligament. Its tendon is inserted into the base of the proximal phalanx of little toe. Function: flexion of the little toe.

Middle group of the muscles of the sole

The flexor digitorum brevis (m. flexor digitorum brevis) is situated beneath the plantar aponeurosis, between the abductor hallucis muscle and the abductor digiti minimi muscle. Beneath this muscle lies the quadratus plantae muscle and tendons of the flexor digitorum longus. The flexor digitorum brevis originates from the bottom of the calcaneal

tuberosity and on the plantar aponeurosis. It divides into four tendons, which are inserted into the middle phalanges of toes II–V. At the level of the proximal phalanges each tendon splits into two fascicles, beneath which pass the tendons of the flexor digitorum longus. Part of the tendinous fascicles of the flexor digitorum brevis weaves into the fibrous sheaths of toes. Function: flexion of toes II–V.

The quadratus plantae muscle (m. quadratus plantae) has a medial and a lateral heads. The lateral head originates from the lateral bottom surface of the calcaneus and the lateral edge of the long plantar ligament. The medial head originates from the medial bottom surface of calcaneus and the medial edge of the long plantar ligament. The two heads unite into a flattened muscle, which is inserted at midlevel of the sole into the tendons of the long flexor of the toes. Function: it plantar flexes the foot and directs the pull of the long flexor of toes.

The lumbricals muscles (m. lumbricales) are four thin fusiform muscles, situated between distal parts of the tendons of the long flexor of the toes. The lateral three of these muscles originate with two heads on adjacent sides of tendons. The medialmost lumbrical originates with only one head on the medial side of the tendon of second toe. Each lumbrical is inserted into the medial edges of the proximal phalanges of toes II–V. Function: they flex the proximal phalanges and extend the middle and distal phalanges of toes II–V, abducting them away from the great toe.

The plantar and dorsal interossei muscles (mm. interossei dorsales et plantares) are thin muscles, situated deep in the spaces between the metatarsal bones. The plantar interossei muscles originate from the bases and medial surfaces of the III–V metatarsals. The dorsal interossei muscles originate with two heads from the adjacent surfaces of the metatarsal bones. The plantar muscles insert on medial surfaces of bases of proximal phalanges of toes III–V. The dorsal muscles are inserted into bases of the proximal phalanges and to tendons of the long extensor of toes. The first interosseous muscle is inserted into the medial side of the second toe, while the second to fourth muscles are inserted into lateral sides of toes II–V. Function: plantar muscles adduct toes III–V towards the second toe and flex the proximal phalanges. The dorsal muscles abduct toes II–IV and flex the proximal phalanges.

TOPOGRAPHY OF THE LOWER LIMB

The purpose of studying the topic: the student must know topography of the lower limb.

As a result, the student should know:

- What is adductor (Hunter's) canal?
- What are superior and inferior musculoperoneal canals?
- What is cruropopliteal canal?

Among surface structures of the gluteal region one can see prominences of the muscles, the gluteal cleft and the gluteal fold. Deep in the medial side of this fold it is possible to palpate the ischial tuberosity. In very thin people, visible on the front of the hip, are the inguinal fold and the borders of the femoral triangle. The contours of the quadriceps muscle of the thigh are also relatively prominent. On the knee it is possible to palpate the patella and, at its sides, the condyles of the femur and tibia. On the back of the knee is the popliteal fossa. Visible on the front of the leg is the anterior crest of the tibia. On the posterior surface of the leg are the contours of the gastrocnemius muscle and the calcaneal (Achilles) tendon. At either side of the talocrural joint it is possible to see the lateral and medial malleoli.

The skin of the buttocks, of the front surface of the knee and of the sole of the foot is thick, while on the thigh, the back of the knee, the leg and the dorsal side of the foot the skin is thin and movable. Through the subcutaneous tissue of the medial leg surface the great saphenous vein and the saphenous nerve pass. The subcutaneous tissue of the posterior leg surface contains the small saphenous vein. Subcutaneous tissue is best developed on the buttocks, from where it continues onto the lumbar region, forming the lumbogluteal adipose accumulation.

The sacrotuberal and sacrospinous ligaments and the greater sciatic notch form the *greater sciatic foramen*. This foramen is divided by the piriform muscle into the *suprapiriform (foramen suprapiriforme)* and *infrapiriform (foramen infrapiriforme)* foramina. Both these foramina serve as passages for blood vessels and nerves.

On the front of the thigh the iliolumbar fascia accretes with the lateral part of the inguinal ligaments. The medial part of this fascia continues from the inguinal ligament onto the thigh, together with the iliolumbar muscle. On the thigh it connects with the pectineal fascia. Part of the fascicles of the iliolumbar fascia stretches from the inguinal ligament to the pubic crest (medial of the iliolumbar muscle), forming the *iliopectineal arch*. This arch separates the muscular and vascular lacunae, or compartments. *The muscular compartment* is occupied by the iliolumbar muscle and the femoral nerve. Through the *vascular compartment* the femoral artery and vein pass.

In the medial pail of the vascular compartment, between the inguinal ligament and the pubic crest, the *deep femoral ring (anulus femoralis profundus)* of the femoral canal is situated. This canal sometimes becomes an outlet for a femoral hernia. *The femoral canal (canalis femoralis*) is 1–3 cm long and has three walls. Its lateral wall is formed by the femoral vein; the anterior wall – by the falciform margin and superior cornu of the fascia lata; the posterior fall is formed by the deep lamina of fascia lata. *The saphenous ring (anulus saphenus)* of the femoral canal is bordered laterally by the falciform margin of the fascia lata and is covered by the cribriform fascia. The deep femoral ring contains a small amount of loose connective tissue and the lymph node of Piragoff–Rosenmoller. This ring has four walls, formed by the inguinal ligament, the femoral vein, the lacunar ligament and the pectineal ligament, which is a thickening of the periosteum in the region of the pubic crest. The lacunar ligament is formed by connective tissue fibers stretched between the medial end of the inguinal ligament laterally and to the back, along the superior ramus of pubis. These fibers form a curve in the sharp angle between inguinal ligament and the pubic bone.

The femoral triangle, situated on the front of the thigh, is bordered by the long adductor muscle, the sartorius muscle and the inguinal ligament. Through this triangle, beneath the superficial lamina of the fascia lata, passes the *iliopectineal groove (sulcus iliopectineus)*, bordered on the sides by the iliopsoas and pectineal muscles. Through this groove, covered by the deep lamina of the fascia lata, pass the femoral artery and

vein. At the bottom this groove continues into the **adductor (Hunter's) canal (canalis adductorius)**, which contains the femoral artery and vein, and the saphenous nerve. The medial vastus muscle and the great adductor muscle form the lateral and medial walls of the adductor canal.

The popliteal fossa (fossa poplitea) is complicated in structure. At the top it is bordered by the tendons of the semitendinosus and semimembranosus muscles on the medial side, and of the biceps on the lateral side. At the bottom it is bordered by the two heads of the gastrocnemius muscle. Beneath the thick popliteal fascia the popliteal fossa is filled by connective tissue. Situated in the connective tissue is a neurovascular bundle, formed by the tibial nerve and the popliteal artery and vein. The popliteal fossa also contains lymph nodes. Its floor is formed by the popliteal surface of femur and the back of the knee joint. This fossa communicates through the femoral canal with the femoral triangle, and at the bottom, through the cruropopliteal canal, with the back of the leg. Through the superior musculoperoneal canal this fossa communicates with the lateral muscle bed of the leg.

The superior musculoperoneal canal (canalis musculoperoneus superior) is situated in the upper part of the lateral osteomuscular bed. It is formed by the two heads of the peroneus longus muscle on the lateral side, and the head of fibula and lateral condyle of tibia on the medial side. This canal contains the common peroneal nerve. **The inferior musculoperoneal canal (canalis musculoperoneus inferior)** is situated behind the middle part of the fibula. Its front wall is formed by the fibula, the back wall – by the flexor hallucis longus and tibialis posterior muscle. This canal contains a section of the peroneal artery, which also passes through the cruropopliteal canal.

The cruropopliteal canal (canalis cruropopliteus) is situated in the posterior muscle bed. Its front wall is formed by the posterior surface of the tibia. The back wall is formed by the soleus muscle and its fascia. The lateral wall of the cruropopliteal canal is formed by the flexor hallucis longus, and the medial – by the flexor digitorum longus. The superior opening of the canal is formed by the tendinous arch of the soleus muscle and the popliteus muscle. This opening serves as an entrance for the

posterior tibial artery and vein, and the tibial nerve. Through the inferior opening, which is formed by the posterior tibial muscle and the tendon of triceps surae (Achilles' tendon), this neurovascular bundle goes out onto the foot. On the intermuscular septum of the leg is the anterior opening of the cruropopliteal canal, through which the anterior tibial artery passes onto the front of the leg. Approximately 4–5 cm below the entrance of this canal, there is a foramen leading into the inferior musculoperoneal canal.

The dorsal surface of the foot is covered with the thin movable skin. Located on the front of the medial malleolus is the beginning of the great saphenous vein, situated in the superficial fascia, next to the saphenous nerve. Situated behind the lateral malleolus, next to the sural nerve, is the beginning of the small saphenous vein. On the medial side of the foot, 3–4 cm to the front of the medial malleolus is the navicular tuberosity. On the lateral edge of the foot it is possible to palpate the tuberosity of the V metatarsal bone. Beneath the apex of the lateral malleolus is the lateral process of the talus. In the region beneath the medial malleolus, beneath the flexor retinaculum, is a space called the *medial malleolar canal*. This canal is bordered at the top and front by the medial malleolus and the talus, and at the lateral side – by the calcaneus. In the front it continues into the *calcaneal canal*, situated between the calcaneus on the medial side, and the abductor hallucis on the lateral. The calcaneal canal passes into posterior part of the fascial space of the sole.

On the sole of the foot the *plantar aponeurosis*, which is tightly connected with the skin, gives off intermuscular septa, forming muscle beds for the medial, lateral and middle groups of muscles. The medial muscle bed contains the adductor and abductor muscles of the great toe, its short flexor, and the medial neurovascular bundle of sole, after it exits from the calcaneal canal. The middle muscle bed is divided by the deep lamina of the plantar fascia into a superior (deep) and an inferior (superficial) spaces. The deep space contains the interosseous muscles. The superficial space contains the short flexor of toes and the plantar quadrate muscle, as well as the tendons of the long flexor of the toes with the lumbrical muscles. The lateral muscle bed contains the short flexor of little toe and the abductor of little toe.

SITUATIONAL TASKS WITH ANSWERS

1. A woman was diagnosed with a femoral hernia. What anatomical structure contributed to the formation of the hernia?

2. A girl with a sedentary profession, who has thin, underdeveloped calf muscles, consulted a physical education doctor. What regular exercises during work did the doctor recommend to achieve hypertrophy of these muscles?

3. The patient squeezed out pus from a boil in the armpit area on his own, a complication developed – the purulent process spread through the cellular spaces of neighboring areas of the body. By what routes and into which areas did the infection penetrate?

4. A patient came to the doctor complaining that when lifting weights, a bulge under the skin forms in the navel area. What is this and what weak points should the doctor check in the patient?

5. The patient has had an asthma attack for the first time – breathing is severely difficult due to bronchospasm. What did the doctor advise the patient to do to increase respiratory movements and increase the air pressure circulating through the narrowed bronchioles: a) lie down and relax; b) sit up and lean your hands on the edge of the bed. Why?

6. As a result of the disease, the victim lost the ability to move his mandible forward. Which muscles are affected?

7. If the zygomatic arch is fractured, is it possible to change the act of chewing?

8. Inflammation of the right facial nerve has led to a disruption of the motor function of the muscles of the facial muscles. What will be the facial expression?

9. In lung diseases, when there is a disturbance of inhalation, patients take a forced position (fixing the shoulder girdle, sitting). Explain why this position facilitates the act of breathing.

10. In case of traumatic injury to the shoulder joint area, the victim's shoulder joint movement was sharply limited, except for the adduction function. Which muscle of this area was damaged to the greatest extent?

11. As a result of the motor innervation disorder of the upper limb, the patient is unable to abduct the arm more than 80 degrees. Innervation of which muscles is impaired in this case?

12. Name the weak points in the anterior abdominal wall in the epigastric region that, when intra-abdominal pressure increases, can become sites of hernia formation.

13. To strengthen the abdominal muscles and especially the oblique muscles, the patient should be recommended movements that would specifically target the oblique abdominal muscles. What movements are appropriate for strengthening the oblique abdominal muscles?

14. As a result of the injury, the victim's posterior shoulder muscle function was impaired. What impairments will occur in the elbow joint function?

15. With a bruise of the gluteal region, the patient cannot abduct the thigh. Which muscles were damaged by the bruise?

16. Following an intramuscular injection, a patient developed an abscess of the gluteus maximus muscle. Which function of the hip joint will be limited?

17. After a hip dislocation, the patient's motor innervation of the rectus femoris muscle was disrupted. On which joint will the effect of this muscle be weakened?

18. After inflammation of the sciatic nerve, a patient developed a complication in the form of paralysis of the posterior group of the thigh muscles. What disturbances in the movement of the lower limb will accompany this complication?

19. With an open fracture of the tibia, the victim's anterior calf muscle function was impaired. How did the function of the lower limb change under the conditions of this injury?

20. In a street injury, the victim suffered a comminuted open fracture of the fibula. Which muscles were injured in this injury?

21. The edge of a fallen glass caused a deep cut wound on the dorsum of the patient's foot. Which muscle tendons may be damaged by this injury?

22. The patient consulted an orthopedist because of his flat feet. The doctor recommended strengthening the function of some muscles of the lower limb for therapeutic purposes. Which muscles of the foot should be trained to strengthen the longitudinal arches of the foot?

ANSWERS

1. Internal femoral ring.

2. She should plantar flex her feet and rise on her toes.

3. Along the course of the vessels and nerves – into the subclavian space, down – onto the medial surface of the shoulder, through trilateral and quadrilateral openings – onto the posterior surface of the shoulder and scapula.

4. This is an umbilical or linea alba hernia. It is necessary to check the femoral and inguinal area.

5. Sit up and lean your hands on the edge of the bed to tense the accessory muscles of breathing.

6. The medial and lateral pterygoid muscles and the masseter may be damaged.

7. The masseter begins at the zygomatic arch. When the zygomatic arch is fractured, the lifting of the lower jaw and the forward movement of the lower jaw are impaired.

8. Facial asymmetry appears, muscle tone decreases, the nasolabial fold is smoothed out, the corner of the mouth drops, and the palpebral fissure becomes wider.

9. When the shoulder girdle is fixed, the auxiliary respiratory muscles (serratus anterior, pectoralis minor, pectoralis major) work.

10. Deltoid muscle.

11. Serratus anterior and trapezius muscles.

12. White line of the abdomen, sternocostal triangles of the diaphragm.

13. In a standing position – turns and bends of the body; in a lying position – lifting of the pelvis.

14. Extension in the elbow joint will be impaired.

15. Gluteal muscles.

16. Thigh extension and adduction, supination of the thigh.

17. Hip joint.

18. Extension of the thigh, flexion of the shin at the knee joint; with the shin bent at the knee joint, its rotation.

19. The extension of the foot at the ankle joint and the extension of the toes will be impaired.

20. Peroneus longus and brevis, flexor hallucis longus, tibialis posterior.

21. Tendons of the tibialis anterior, extensor digitorum longus, and extensor hallucis longus.

22. Muscles located longitudinally on the sole, attached to the phalanges of the fingers (flexors of the toes).

CONTROL QUESTIONS AND STANDARD ANSWERS

1. WHAT STRUCTURES ARE INVOLVED IN THE FORMATION OF THE INGUINAL LIGAMENT?

a) aponeurosis of the internal oblique muscle
b) fascia of the transverse abdominal muscle
c) aponeurosis of the transversus abdominis muscle
d) aponeurosis of the external oblique muscle

2. WHAT ANATOMICAL STRUCTURES CORRESPOND TO THE DEEP INGUINAL RING ON THE POSTERIOR SURFACE OF THE ANTERIOR ABDOMINAL WALL?

a) medial inguinal fossa
b) supravesical fossa
c) lateral inguinal fossa
d) vascular lacuna

3. WHICH MUSCLE IS INVOLVED IN THE FORMATION OF THE SUBMANDIBULAR TRIANGLE?

a) stylohyoid muscle
b) mandibular-hyoid muscle
c) geniohyoid muscle
d) digastric muscle

4. SPECIFY THE LOCATION OF THE MUSCULAR LACUNA

a) greater sciatic foramen
b) lesser sciatic foramen
c) under the inguinal ligament
d) medial to the iliopectineal arch

5. SPECIFY THE FORMATION THAT LIMITS THE SUPERFICIAL RING OF THE FEMORAL CANAL

a) spermatic cord
b) iliopectineal arch
c) inguinal ligament
d) falciform margin of the cribriform fascia

6. SPECIFY THE CHANNEL COMMUNICATING WITH THE CRUROPOPLITEAL CANAL

a) inferior musculoperoneal canal
b) adductor canal
c) superior musculoperoneal canal
d) femoral canal

7. TO WHICH STRUCTURE IS THE LATISSIMUS DORSI MUSCLE ATTACHED?

a) spine of the scapula
b) crest of the lesser tubercle of the humerus
c) acromion
d) crest of the greater tubercle of the humerus

8. TO WHICH STRUCTURE IS THE MAJOR RHOMBOID MUSCLE ATTACHED?

a) angle of the 2nd–5th ribs
b) upper margin of the scapula
c) medial margin of the scapula
d) lateral margin of the scapula

9. ON WHICH BONES DOES THE PECTORALIS MINOR MUSCLE ORIGINATE?

a) 1–2 ribs
b) 6–8 ribs
c) 3–5 ribs
d) sternum

10. TO WHICH STRUCTURE IS THE PECTORALIS MAJOR MUSCLE ATTACHED?

a) crest of the lesser tubercle of the humerus
b) crest of the greater tubercle of the humerus
c) coracoid process of the scapula
d) medial border of the scapula

11. SPECIFY THE ATTACHMENT SITES OF THE RIGHT CRUS OF THE LUMBAR PART OF THE DIAPHRAGM

a) transverse processes of the I–IV lumbar vertebrae

b) X–XII ribs

c) anterior surface of the bodies of the sacral vertebrae

d) anterior surface of the bodies of the I–IV lumbar vertebrae

12. TO WHICH FORMATION IS THE TEMPORAL MUSCLE ATTACHED?

a) outer surface of the angle of the mandible

b) inner surface of the angle of the mandible

c) neck of the mandible

d) coronoid process

13. TO WHICH STRUCTURE IS THE TERES MINOR MUSCLE ATTACHED?

a) lesser tubercle of the humerus

b) greater tubercle of the humerus

c) crest of the lesser tubercle

d) acromion

14. TO WHICH STRUCTURE IS THE BRACHIALIS MUSCLE ATTACHED?

a) tuberosity of the radius

b) medial epicondyle of the humerus

c) lateral epicondyle of the humerus

d) tuberosity of the ulna

15. TO WHICH BONES IS THE FLEXOR DIGITORUM SUPERFICIALIS MUSCLE ATTACHED?

a) proximal phalanx of fingers 2–5

b) distal phalanx of fingers 2–5

c) middle phalanx of fingers 2–5

d) 2–5 metacarpal bones

16. SPECIFY THE MUSCLE LYING IN THE SECOND LAYER ON THE ANTERIOR SURFACE OF THE FOREARM?

a) flexor carpi ulnaris muscle
b) flexor carpi radialis muscle
c) flexor digitorum superficialis muscle
d0 flexor hallucis longus muscle

17. TO WHICH FORMATION IS THE FLEXOR POLLICIS BREVIS MUSCLE ATTACHED?

a) 1st metacarpal bone
b) base of the proximal phalanx of the thumb
c) distal phalanx of the thumb
d) head of the proximal phalanx of the thumb

18. SPECIFY THE ANATOMICAL STRUCTURE TO WHICH THE ILIOPSOAS MUSCLE IS ATTACHED

a) patella
b) greater trochanter
c) lesser trochanter
d) intertrochanteric crest

19. TO WHICH STRUCTURE IS THE GLUTEUS MAXIMUS MUSCLE ATTACHED?

a) lesser trochanter
b) greater trochanter
c) gluteal tuberosity
d) intertrochanteric crest

20. WHICH MUSCLE PASSES THROUGH THE GREATER SCIATIC FORAMEN?

a) iliopsoas muscle
b) obturator internus
c) obturator externus
d) piriformis muscle

21. WHICH MUSCLE PASSES THROUGH THE LESSER SCIATIC FORAMEN?

a) iliopsoas muscle
b) obturator internus
c) piriformis muscle
d) obturator externus

22. INDICATE THE MUSCLES INVOLVED IN THE ACT OF INHALATION

a) mm. intercostales externi
b) m. semitendinosus
c) mm. intercostales interni
d) m. transversus thoracis

23. INDICATE THE MUSCLES INVOLVED IN THE ACT OF EXHALATION

a) mm.intercostales interni
b) mm.intercostales externi
c) m.longus colli
d) m.poplieus

24. SPECIFY THE MUSCLE THAT LIMITS THE CRUROPOPLITEAL CANAL

a) soleus muscle
b) gastrocnemius muscle
c) tibialis anterior muscle
d) peroneus longus muscle

25. INDICATE THE MUSCLE THAT SEPARATES THE TRILATERAL AND QUADRILATERAL SPACES

a) biceps muscle
b) brachialis muscle
c) deltoid muscle
d) triceps brachii muscle

ANSWERS

1	d	14	d
2	c	15	c
3	d	16	c
4	c	17	b
5	d	18	c
6	a	19	c
7	b	20	d
8	c	21	b
9	c	22	a
10	b	23	a
11	d	24	a
12	d	25	d
13	b		

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Мартиросян Лусине Пилосовна,
Баландина Ирина Анатольевна,
Гилязов Артур Гаязович

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