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Introduction

The skeletal; system consists of many separate bones together at a joints by flexible connective tissue.

All body movement occurs at a joint. Where two or more bones come together we find a joint. The joint's structure determines how it functions. The range of movement at joints may be zero or a just a little give, or extremely large. Freely movable joints predominate in the limbs. Immovable and slightly movable joints are found in the axial skeleton. In general, the closer the fit at the point of contact, the stronger the joint. The looser the fit, the greater the movement, but loosely fitted joints are prone to dislocation.

Movement at joints is also determined by the structure (shape) of articulating bones, the flexibility of the connective tissue that binds the bones together, and the position of associated ligaments, muscles, and tendons.

General Arthrology

Arthrology is the study of joints (Greek origin—ARTHR- meaning joint, LOGY- meaning study of).

Joint- (from French -joint-articulation -A joint or articulation is a place in the body where two bones come together. May not be bone on bone, i.e: Coracohumeral joint.)

Function of joint and its components.

Joint has several functions.

1. Bind parts of the skeletal system together.
2. Permit parts of the skeleton to change shape during childbirth.
3. Make possible bone growth.
4. Enable the body to move in response to skeletal muscle contractions.
5. Provide stability and reduce the risk of damage from constant use.
6. Acts as a shock absorber, reduces friction and aids movement.

The configuration of a joint determines the degree and direction of possible motion. Some joints, such as those between the plates of the skull, (sutures) don't move in adults. Others allow a range of motion.

Classification of Joints

In bony skeletal systems, there are three general classes of joints.

I. Continuous articulations.

II. Discontinuous articulations (synovial joints).

III. Symphyses

Continuous articulations (Synarthroses)

Continuous articulations are an articulation, when the space between the bones becomes joined by means of the continuous connective tissue.

According to different kinds of connective tissue between them, continuous articulations can be divided in to:

1. Fibrous, 2.Cartilaginous, 3. Bony

1. Fibrous *(articulationes fibrosae),* it is an articulation, when the space between the bones becomes joined by means of the connective tissue.

2. Cartilaginous *(articulationes cartilaginae* OR Synchondrosis (Gk *syn* together, *chondros* cartilage)*)* it is an articulation when the bones become joined by means of cartilaginous tissue.

3. Bony adhesions (synostoses)- If the connective tissue between the bones transforms to bone tissue or first to cartilaginous and then to bone tissue. The bones become joined by means of bone tissue.

***Fibrous joints** (junctura fibrosa)*

The three types of fibrous joints are sutures, syndesmoses and gomphoses (Fig. 1, and Fig.2)

Sutures (Fig.1)– articulations between bones of the skull. They are composed of a thin layer of dense fibrous connective tissue. The following three sutures are distinguished according to the shape of the articulating bone margins.

a. Serrate (sutura serrata), when the projections on the margin of one bone fit between the projections on the opposing bone (most bones of the skull-cap articulate in this fashion) e.g. sutura lambdoidea, sutura sagitalis.

b. Squamous suture (sutura squamosa), when the margin of one bone overlaps that of the opposing bone eg. articulation between the temporal and parietal bones.

c. Plane suture (sutura plano), apposition of smooth margins (joining of the bones of the facial cranium). After age, 40-50 many sutures become fused (synosteotic). Premature fusion of sutures can result in deformation of the skull. Asynchrony of suture fusion, particularly of paired sutures, is the main reason for asymmetry of the skull.

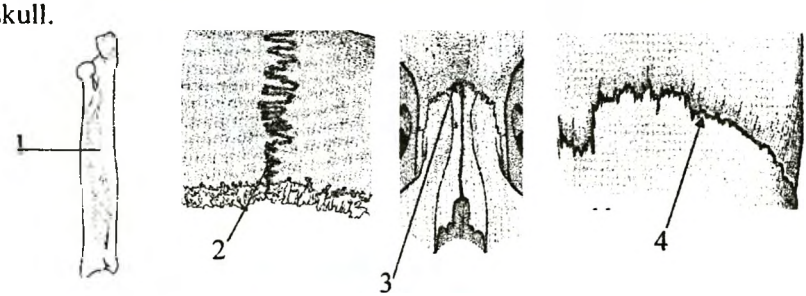


Fig.1. Fibrous joints
1-Interosseous membrane of forearm; 2- Sagittal suture;
3- Plane suture; 4- Squamous suture.

Syndesmosis

A syndesmosis is a fibrous joint that is held together by longer fibers than a suture and some movement can occur.

Types of syndesmoses :

a. Ligaments (ligamenta) - is a short band of tough fibrous dense regular connective tissue composed collagen fibers. Ligaments connect bones to other bones to form a joint.Some ligaments limit the mobility of articulations, or prevent certain movements altogether e.g. Ligamenta flava (which connect the arches of adjacent vertebrae), and interclavicular ligament.

b. Membrane interosseous (Interosseous Membrane) - is a broad and thin plane of fibrous tissue which are found between diaphyses of tubular bones. Eg. Distal articulations of the tibia and fibula or, radius and ulna.

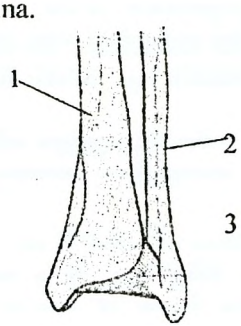


Fig.2a

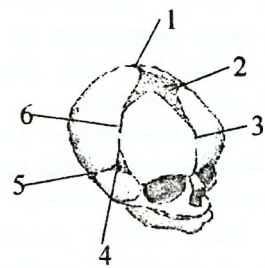
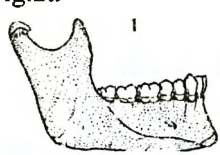


Fig.2b



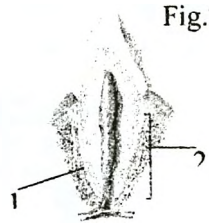


Fig.2c

Fig.2. Fibrous joints.

Fig.2a) syndesmoses 1-tibia; 2-fibula; 3-tibiofibular ligament.
Fig.2b) Location of fontanelles and sutures 1-sagital suture; 2-anterior fontanelle; 3-metopic suture; 4-anteriolateral fontanelle; 5- posterolateral fontanelle; 6-coronal suture;
Fig.2c). Gomphoses. 1-Joints between the roots of the teeth and their alveoli in mandible; 2-periodontal ligament.

Gomphoses -the joints between the roots of the teeth and their dental *alveoli* in maxilla and mandible. Periodontal ligament surrounds root of the tooth and holds it firmly in the jaw Fig.2 -c.

Fontanelles *(Fonticuli* -Fig.2-b*)*. The bones of the vault are ossified in membrane while the bones of the base are ossified in cartilage. In newborn the bones of the vault are not closely knit at suture, as in adult, but are separated by unossified membraneus intervals called fontanelles.

The character of articulation of bone is not permanent throughout life. According to the three stages of ossification, syndesmoses may change to synchondroses and synostoses. Synchondroses and synostoses are the final developmental phase of the skeleton.

Cartilaginous Joints

Cartilaginous joints are held together by cartilage. The two types of cartilaginous joints are synchondroses and symphyses.

Synchondrosis *(articulatio cartilaginae)* - is a cartilaginous joint in which the connecting material is cartilage tissue. eg epiphyseal plates in children. These joints have considerable strength and elasticity due to high elastic properties of cartilage.

In comparison to synovial joints, cartilaginous joints allow only slight movementand its movement depends on the thickness of the cartilaginous layer: the thicker the layer, the more the range of movements.

According to the property of the cartilaginous tissue, types of synchondrosis are: *(1) hyaline,* e.g. the joints between the ribs and the sternum, and (2) *fibrous.* e.g. the cartilaginous region between adjacent vertebrae

According to the duration of their existence of cartilage tissue, synchondroses subdivided into:

1. *Temporary synchondrosis (*Fig.3), existing only to a definite age after which they are replaced by synostoses, for instance, synchondrosis between the epiphysis and metaphysis or between the three bones of the pelvic girdle which fuse to form a single pelvic bone. Temporary synchondroses are the second phase of skeletal development.

2. *Permanent synchondrosis,* which exist throughout life, e.g. intervertebral disc (Fig.4-1)., synchondroses between the pyramid of the temporal bone and the sphenoid bone, between the pyramid and the

occipital bone (Fig.7-b), the joints between the ribs and the costal cartilages of the rib cage

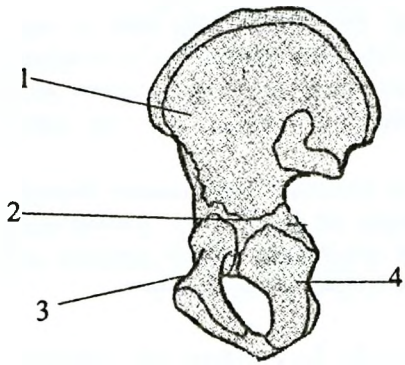


Fig.3a

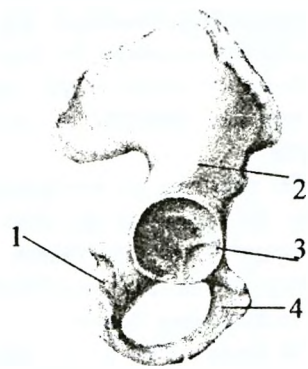


Fig.3b

Fig.3a. Medial view of hipbone (the union of ilium, ischium and pubic bone) - cartilage joints present.

Fig.3b Lateral view of hipbone after 16 years

1- ilium; 2- cartilage; 3-pubic bone; 4-ichial bone

Symphysis

"Symphysis" (Greek word meaning growing together)- It is a cartilaginous joint and a transitional form, from continuous to *discontinuous* or vice versa. It is characterized by the presence of a small gap, which does not have the structure of a true articular cavity, and because of this the articulation is also called a half-joint. The symphysis pubis and the joints formed by the intervertebral discs are examples of symphyses (Fig.4).

Fig.4. Synchondroses

1- Intervertebral disk of vertebral column; 2- Pubic symphisis

Synostoses

Synostoses- are formed as a result of substitution of cartilage tissue by bone tissue at the fusion of two bones (ossified synchondroses).

ex. 1. In humans, the plates of the cranium, initially separate, they fuse together as the child approaches adulthood. Children whose craniums fuse too early may suffer deformities and brain damage, as the skull does not expand properly to accommodate the growing brain - a condition known as craniostenosis.

ex. 2. The substitution of cartilage between pubic, iliac and ischial bones by bony tissue to form the hipbone (Fig.3b).

Discontinuous or Synovial joints (diarthroses)

The terms "Synovial joint" and "Diarthrosis joint" are often used interchangeably, although the first term refers to the structure and the second one to the function.

Synovial joints (articulation synovialis) - These joints have an articular surface (which covers the ends of the opposing bones) synovial cavity between the bones, synovial sac and synovial fluid (Fig.5.). Synovial joints have main components and additional structures associated with synovial joints.

Main components of synovial joints.

A. Articular surface (facies articularis)

B. A joint capsule (capsula articularis) that consists of two layers.

1) *The fibrous capsule.*

2) *The synovial membrane.*

C. The joint cavity (cavitas articularis).

D. Synovial fluid (synovia).

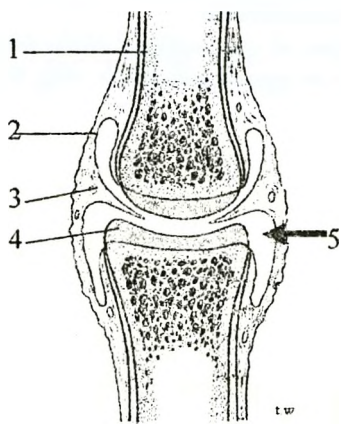


Fig.5. Diagram of a synovial joint.
1-periosteum; 2-synovial membrane; 3-fibrouse layer of capsule; 4-articular cartilage; 5-articular cavity

The articular surfaces *(facies articulares)* are covered by articular cartilage and can be congruent to each other, or may have different shape and size (incongruent). Articular cartilage (cartilagio articularis) -is generally hyaline. Fibrous articular cartilage can be found in the temporomandibular and sternoclavicular joints. The thickness of articular cartilage varies from 0.2 to 6 mm. Under mechanical loads it becomes flattened, and acts like a spring due to its resilience.

The articular capsule *(capsula articularis)* encloses the joint cavity and is attached to the articulating bones along the margin of the articular surfaces or at some distance from them. It consists of an outer *fibrous membrane (membrana fibrosa)* and an inner *synovial membrane (membrana synovialis).* The synovial membrane terminates along the edges of the articular cartilages. The synovial membrane surface facing the joint cavity is lined with a layer of endothelial cells, which makes it smooth and shiny. The membrane secretes *synovial fluid (synovia)* into the cavity of the joint. It often produces small projections called *synovial villi (villi synoviales).* In some places it also forms large and small *synovial folds (plicae synoviales),* which protrude into the joint cavity. Some of these folds contain a large amount of fat growing into them from the outside as a result of which *fatty pads (plicae adiposae)* form. eg. the plicae alares of the knee joint.

The Articular cavity (cavitas articularis) is a closed, fissure-like space bounded by the articular surfaces and the synovial membrane. It is filled with synovial fluid, a mucoid lubricant, which moistens the articular surfaces and allowing them to glide freely against each other. Synovial fluid also provides nutrients to the articular cartilage. The pressure between the articular surfaces is negative (below that of the atmosphere). That is why atmospheric pressure prevents them from drawing apart. (This explains the sensitivity of some diseased joints to fluctuations of atmospheric pressure, as a result of which such patients can predict a spell of bad weather.)

Additional structures associated with synovial joints.
Some joints may have formations such as:
1. An articular disc (discus articularis),
2. An articular meniscus (meniscus articularis,
3. An articular labrum (labrum articularis)

4 Ligament (ligamenta) – capsular ligament, intracapsular ligament or extracapsular ligament

Articular disc are *Intra-articular cartilages,* plates of different shapes, which reduce or eliminate incongruity between articular surfaces. Discs, can divide the joint cavity completely into two sections, e.g. the sternoclavicular, temporomandibular and some other joints. Menisci form a partial division in the knee joint. Discs and menisci can be shifted during movement, thus acting as shock absorbers. Some joints (shoulder and hip joints) have an articular labrum, which is attached along the border of the articular surface, increasing the depth of the articular fossa.

Classification and general characteristics of synovial joints

The classification of synovial joints can be based on: (1) the number of articular surfaces; (2) the shape of the articular surfaces; and (3) number of axis of movement.

According to the number of articular surfaces

The articulating surfaces found in the different joints in the body vary in size and shape. There is typically a concave surface on the adjacent bone. Also, there can be more than two contact points or articulating surfaces.

1. Simple joint *(art. simplex),* A joint with only two articulating surfaces, e.g. the interphalangeal, shoulder, and the hip joints.

2. Compound joint *(art. composita),* a joint with three or more articulating surfaces, e.g. the elbow and radiocarpal joint.

3. Complex joint *(art. complexa)* A joint with more than two articulating surfaces and with a disc or fibrocartilage in the articular capsule. This cartilage divides the joint into two compartments either completely (if the intra-articular cartilage is shaped like a disc, e.g. in the temporomandibular sternoclavicular joint) or incompletely (if the cartilage is a meniscus, e.g. knee joint).

4. Combined joint is a combination of several isolated joints, located separately but functioning together. (Example, the two temporomandibular joints, the proximal and distal radio-ulnar joints).

According to the shape, number of axis and movement.

The number of axes determines the function of a joint. The number of axes on which movements are accomplished in the given joint, depends on the *shape* of the articulating surfaces. For example,

cylindrically shaped joint allows movement only on one pivotal axis.

According to number of axis of movement and shape, joints are subdivided into:

I. Uniaxial -Allows movement in one axis (can perform flexion and extension or abduction and adduction or supination and pronation).

1. *Pivot joint.* It is also called the trochoid joint *(art. trochoidea).* This is a cylindrical or wheel-like articular surface with one rotation axis.

There are two types of pivot joints. In the first type the bone pivot rotates within a ring formed by the articular fossa and a ring of ligament: e.g. the proximal radio-ulnar joint in which the radius rotates inward (pronation) and outward (supination). In the second type, in contrast, the ring formed by the ligament and articular fossa rotates on a bone pivot: e.g. the articulation between atlas-axis. In this joint the ring of the atlas rotates to the right and to the left about the dens of the axial vertebra.

2. Hinge joint *(ginglymus).* The articular surface is a cylinder stretching transversely whose long axis is a transverse line running in the frontal plane perpendicular to the long axis of the articulating bones; as a result movements at a hinge joint are made on this frontal axis (flexion and extension). E.g. interphalangeal joints of the phalanges in the foot and hand, and the ulnohumeral articulation at the elbow.

II. Biaxial joints. - These types of joints allow movements on two axes, which are perpendicular to each other: flexion and extension on the frontal axis and abduction and adduction on the sagittal axis.

1. Ellipsoid joint or Condylar joint; *(*Articulatio ellipsoidea*)* such joint allows movement in two planes (flexion, extension; abduction, adduction). Examples of this joint can be found at the radiocarpal articulation at the wrist and the metacarpophalangeal articulation in the phalanges.

2. Bicondylar joint *(articulatio bicondylaris)* oval surfaces allowing movements in two planes at right angles to each other. It is found at the knee joint, the temporomandibular joint and the atlanto-occipital joint.

3. Saddle joint *(*Articulatio sellaris*)* - This joint is formed by two saddle-shaped articulating surfaces, one "astride" the other mov-

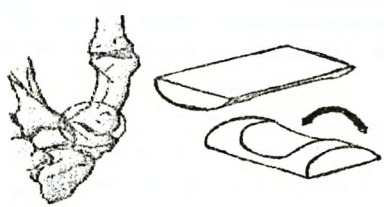
ing lengthwise and across the other. As a result this joint allows movement on two mutually perpendicular axes: frontal (flexion and extension) and sagittal (abduction and adduction). (e.g. the carpometacarpal joint of the thumb).

III. Multiaxial (Triaxial) Joints- these types of joints allow movements more than two axes (can perform all types of movement).

1. Ball and socket joint; Spheroidal joint *(*Articulatio spheroidea; Enarthrosis*)* is formed by spherical articular surfaces. One of the articular surfaces forms a convex spherical head, the other—a correspondingly concave articular cavity e.g. the shoulder joint. They can perform all types of movement: flexion-extension, abduction-adduction and supination-pronation (Circumduction). The sub division of ball and socket joint are cotyloid joint (articulatio cotylica) e.g hip joints.

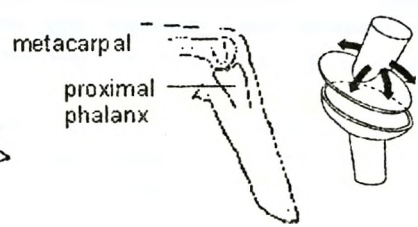
2. Plane joints *(art.plana)* (e.g. the intervertebral joints). The articular surfaces in these joints are almost flat. They can be regarded as the surfaces of a sphere with a very large radius. They allow movement on the three axes, but the range of movement is small.

1.Saddle



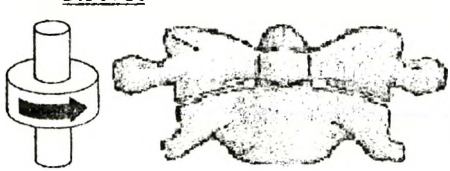
First carpometacarpal joint

2.Condyloid



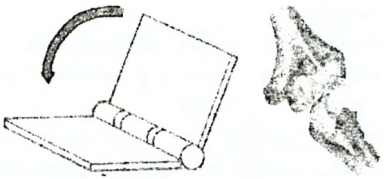
Metacarpophalangeal joint

3.Pivot



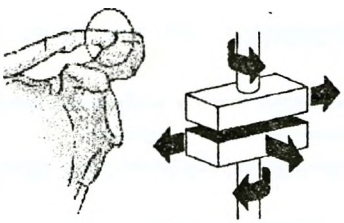
Atlantoaxial joint

4.Hinge



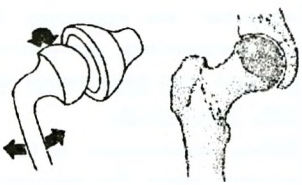
Elbow joint

5.Plane



Acomioclavicular joint

6.Ball and Socket



Hip joint

Fig.6 Types of synovial joints

Types of movement.

Movements at synovial joints are produced by the contraction of the skeletal muscles that span the joints and attach to or near the bones forming the articulations. In these actions, the bones act as levers, the muscles provide the force, and the joints are the fulcra.

The Kind of Movement Admitted in Joints:

The movements admissible in joints may be divided into four kinds: 1) Angular 2) Circular 3) Gliding and 4) Special movements.

A. Angular

1. Movement on the frontal transverse (horizontal) axis: flexion *(flexio),* i.e - decrease of angle between parts; e.g. bending elbow or knee, lowering head to chest, and extension *(extensio),* i.e increasing the angle between parts; e.g. straightening elbow or knee, raising head from chest. There is also dorsflexion and plantar flexion movement at the talo-crural (ankle) joint.

2. Movements on the sagittal axis: adduction *(adductio),* i.e. movement toward midline; e.g. bringing arm to side, and abduction *(abductio),* i.e. movement away from midline or apart; e.g. raising arm

away from side.

B. Circular

1. Movements on the vertical axis, i.e. rotation *(rotatio),* a bone or part turning on an axis; e.g. rotation of radius as in supination and pronation; turning the head.

2. Circumduction *(circumductio),* movement in which the distal end of the bone moves in a circle while the proximal end remains relatively fixed.

C. Special movements

1. Inversion and eversion: movements of the sole of the foot medially or laterally (respectively)

2. Protraction and retraction: movement of a body part forward or backward, respectively, parallel to the horizontal surface

3. Elevation and depression: movement of a body part upwards or downwards, respectively

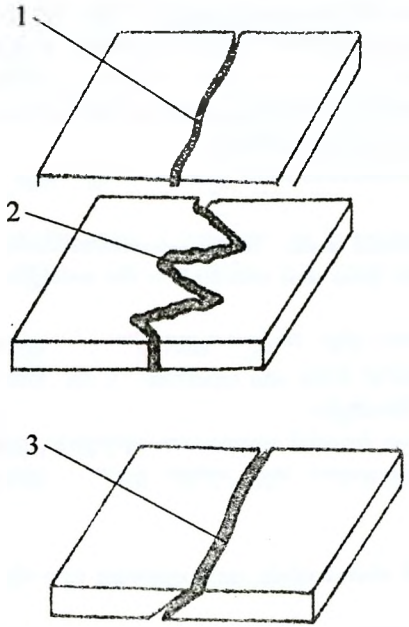
D. Gliding movements of the articular surfaces are possible as well, as they draw apart, for example, when the fingers are stretched.

Movements at joints, occur not only in one axes, but also simultaneously on two or three axes in different combinations. For example, abduction at the shoulder joint on the sagittal axis is combined with flexion of the joint on the frontal axis.

Articulations of the bones of the skull.

The bones of the skull except the temporomandibular joint are continuous articulations. On the skull of adults they are connected by sutures and on the skull of the newborn by fontanelles. Most of the bones that form the vault of the skull, articulate by means of a serrate suture *(sutura serrata).* The temporal bone joins with the squamous border of the parietal bone by means of a squamous suture *(sutura squamosa).* The bones of the visceral skull fit together at relatively smooth borders to form a plane suture *(sutura plana).* The base of the skull has synchondroses of fibrous cartilage lodged in the fissures between the bones: e.g synchondrosis petroocipitalis between the pyramid of the temporal bone and the basilar part of the occipital bone; synchondrosis sphenopetrosa is the sphenopetrosal fissure, sphenooccipital synchondrosis *(synchondrosis sphenooccipitalis)* between the body of the sphenoid bone and the basilar part of the occipital bone. Besides the sutures and synchondroses , some persons have accessory

sutures: a frontal suture *(sutura metopica)* non-fusion of both halves of the squama of the frontal bone.



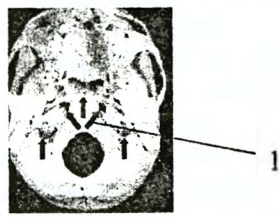


Fig.7.b

Fig.7.a

Fig.7.a Different types of suture.
1. Plane suture: the adjoining surfaces are flat. 2. Serrate suture: saw edged processes of the two bones fit in to one another.3. Squamous suture: the edge of one bone overlaps that of the other

Fig.7.b. 1.Synchondrosis -Inferior surface of the skull Joints

The temporomandibular joint

The temporomandibular joint *(articulatio temporomandibularis)* is the only diarthrosis of the skull, which is formed by the head of the mandible and the mandibular fossa of the squamous temporal bone. Between the articular surfaces there is fibrous articular disc *(discus articularis)*. The edges of the disc are joined to the articular capsule as a result of which the joint cavity is separated into two isolated compartments. The articular capsule is attached along the border of the

mandibular fossa up to the petrotympanic fissure and thus encloses the articular tubercle and the neck of the mandible inferiorly. The mandibular joint is strengthened by the following ligaments. Only, the lateral ligament *(lig. laterale),* is directly related to the joint and prevents excessive movement of the articular head to the back. It passes the lateral side of the joint from the zygomatic process of the temporal bone to the neck of the condylar process of the mandible.

The two ligaments are at a distance from the joint and help to suspend the mandible.

1.Sphenomandibular ligament (Lig. Sphenomandibulare) - *begins on the spine of the sphenoid bone and attaches to the mandibular lingua*

2. Stylomandibular ligament (*lig. Stylomandibulare)-- begins on the styloid process of the temporal bone and attaches on the internal surface of the mandible, near its angle.*

Temporomandibular joints are biaxial, combined, complex, and condyloid joint and has an intra-articular disc which allows movements in three directions.

Movements:

(1) Downward and upward movements with opening and closure of the mouth;

(2) Protraction/retraction (forward and backward movements);

(3) Lateral movements (rotation of the mandible to the right and to the left as it occurs in chewing).

Vessels and nerves. The joint is supplied with nutrients by branches of a. maxillaris. The *venous blood* drains into the venous network *(rete articulare mandibulae),* surrounding the temporomandibular joint and from there into v. retromandibnlaris.

Lymph drains along the deep lymphatics into nodi lymphatici parotidei and then into the deep cervical nodes. *Innervation* is accomplished by n. auriculotemporalis (from the third branch of n. trigeminus).

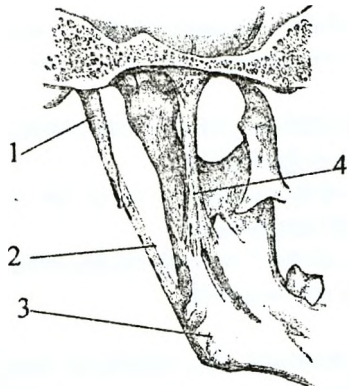


Fig.8 Temporomandibular joint
1.Styloid process 2. Stylomandibular ligament. 3. Mandible 4.Sphenomandibular ligament

Surface Anatomy of temporomandibular joint

With your mouth closed, feel the head of the mandible, just in front of the tragus of your auricle. Open and close your mouth, and feel the head of mandible slip forwards, out from under your finger. Feel your temporalis and masseter muscles while; clenching and unclenching your teeth; and protracting and retracting your jaw.

Articulations of the bones of the trunk

Articulations of the trunk may be divided into the following groups,

I Articulation of the vertebral column with the skull.

II. Articulation of vertebrae with each other to form the vertebral column

III. Articulation between the ribs and vertebrae

IV. Articulation of the sternum

V. Articulation of the cartilages of the ribs with the sternum, and articulation of ribs with each other.

VI. Articulation of the vertebral column with the pelvis

VII. Articulation of the pelvis

I. Articulation between the vertebral column and skull (the craniovertebral joints)

The vertebral column and skull are joined together by a combination of several joints permitting movement on three axes like in a ball-and-socket joint. These joints are between the skull and atlas, and between atlas and axis (C1 and C2). They are called the atlanto-occipital and atlanto-axial joints.

The main differences between the craniovertebral joints and others in the vertebral column are: the craniovertebral joints are synovial only, there are no intervertebral discs and there are no zygapophyseal joints.

I. The atlanto-occipital joint. (Articulatio atlantooccipitalis)-; is formed by superior articular facets of the atlas (fovea articulares superiores atlantis) and the two occipital condyles of occipital bone. The articulating surfaces are enclosed in separate articular capsules but move simultaneously and form a single combined joint. They are condyloid type of synovial joints.

Ligaments:

(1) The anterior atlanto-occipital membrane (Membrana atlantooccipitalis anterior) extends from the anterior arch of the atlas (C1) to the anterior margins of the foramen magnum; it is a continuation of anterior longitudinal ligament.

2) The posterior atlanto-occipital membrane *(membrana atlantooccipitalis posterior)* located between the posterior arch of the atlas

and the posterior margin of the foramen magnum. These two ligaments prevent excessive movement of the atlanto-occipital joints. The atlanto-occipital joint allows movement on two axes, the frontal (bending back and forth of head), and the sagittal (slight lateral tilting of head to either side).

II. Atlanto-axial joints *(art. Atlantoaxialis)* .The first and second cervical vertebrae articulate with each other by means of three synovial joints.

a) Two lateral atlanto-axial joints *(articulationes atlantoaxiales laterales)* - are synovial joints of the plane variety, which are formed by the inferior articular surfaces of the atlas and the similar superior surfaces of the axis, making up a combined joint.

b) One middle atlanto-axial joint (*art. Atlantoaxialis mediana),*- are synovial joints of the pivot variety in which odontoid process *(dens axis)* is joined anteriorly with the anterior arch of the atlas and posteriorly with the transverse ligament of the atlas *(lig. transuersum atlantis)* strong band extending between inner surfaces of the lateral masses of atlas (C1 vertebrae).

Ligaments:

1. Apical ligament of the odontoid process *(lig. apicis dentis):* is an accessory ligament. It extends from the tip of the dens to the anterior edge of the foramen magnum.

2. Alar ligaments *(ligamenta alaria)*: two strong ligaments of the odontoid process pass from the lateral surfaces of the dens and are attached to the medial surfaces of the condyles of the occipital bone.

3. Cruciform ligament of the axis *(lig. cruciforme atlantis):* consists of a transverse part (transverse ligament of the atlas) and vertical part. The vertical part runs from the posterior surface of the body of the axis to the anterior margin of the foramen magnum behind alar ligaments and ligament of the apex of the dens. The cruciform ligament of the axis *is* important: it is, on the one hand, an articular surface for the dens and directs its movements, and, on the other, it prevents dislocation of the dens, which might injure the spinal cord or the medulla oblongata. The whole apparatus of ligaments described is covered posteriorly from the aspect of the vertebral canal by the membrana tectoria stretching from the clivus of the sphenoid bone and anterior edge of the foramen magnum to the body of the second cervi-

cal vertebra (it is continuous with the posterior longitudinal ligament of the spine).

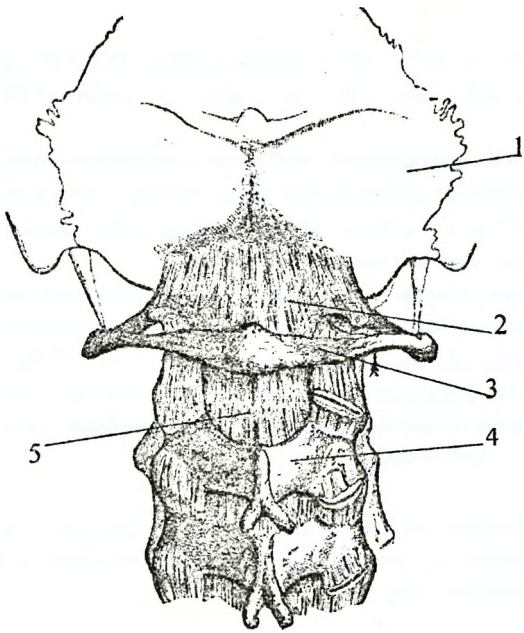


Fig.9 a

Fig.9.a. Posterior side of atlantoccipital and atlantoaxial joint.
1. Occipital bone.2.Posterior atlanto-occipital membrane 3. Posterior arc of atlant. 4. Axis 5.Posterior atlanto axial ligament

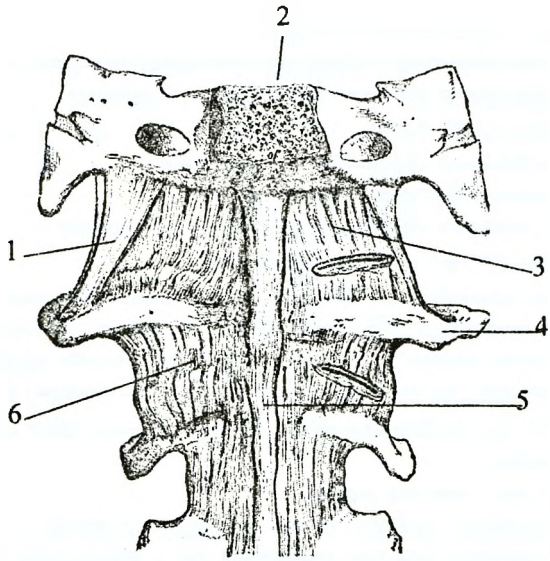


Fig.9.b

Fig.9.b. Anterior side of atlantoccipital and atlantoaxial joint.
1.Occipital bone; 2-lateral atlanto-occipital ligament; 3-anterior atlanto-occipital membrane; 4-atlant; 5- anterior longitudinal ligament; 6.Anterior Atlantoaxial Ligament.

Movement: The atlanto-axial joints permit only rotation of the head on the vertical axis (turning right and left), passing through the dens of the axial vertebra; the head moves about the dens together with the atlas (trochoid joint). Movements occur at the same time at the lateral atlanto-axial joints. The joints between the skull and the two cervical vertebrae permit only slight movements. A wider range of movements of the head is usually produced with the participation of the whole cervical part of the spine. The craniovertebral joints are most highly developed in man because of his upright posture and the erect position of the head.

Joints of the vertebral column

The human vertebral column has the following types of joint:
Synelastoses -ligaments between the arches of vertebrae,
Syndesmoses-ligaments between the transverse and spinous processes,
Synchondroses-between the bodies of vertebrae,
Synostoses -between the sacral vertebrae,
Hemiarthroses -between the bodies of a series of vertebrae,
Diarthroses -between the articular processes.

With the exception of the first two cervical vertebrae, the mobile vertebrae articulate with each other by means of cartilaginous joint between their bodies and by synovial joint between their articular processes. Articulations between vertebrae may be divided into articulations between the bodies and articulations between their arches and articular processes.

Joints of the vertebral bodies

The articulating surfaces of the adjacent vertebrae are covered with hyaline cartilage and are connected by a fibrocartilaginous intervertebral disc *(disci intervertebrales)*.

The intervertebral discs are responsible one-forth of the length of the vertebral column.

Each disc is a fibrocartilaginous plate whose periphery is formed of concentric layers of connective-tissue fibres. These fibres form a very strong peripheral *fibrous ring (anulus fibrosus),* while the central part of the plate is a *gelatinous nucleus (nucleus pulposus)* consisting of soft fibrous cartilage. The intervertebral discs correspond to the vertebral bodies in shape but are somewhat wider and protrude consequently over the edges of the vertebral bodies as swellings. The discs are the thickest where mobility is the greatest, i.e. in the lumbar region, and the least thick between the thoracic vertebrae. The intervertebral discs provide the strongest attachment between the bodies of the vertebrae. In addition to these discs, strong anterior and posterior longitudinal ligaments unite the bodies. There is no disc between C1 (atlas) and C2 (axis). The most inferior functional disc is between L5 and S1.

1. The anterior longitudinal ligament (*lig. longitudinale anterius)* extends from the pharyngeal tubercle of occipital bone, the anterior arch of the atlas on the anterior surface of the vertebral bodies and

discs to the upper part of the pelvic surface of the sacrum. This ligament prevents abnormal backward extension of the spine (hyperextension of the vertebral column).

2. The posterior longitudinal ligament *(lig. longitudinale posterius)* stretches from the axis (C2) downward on the posterior surface of the vertebral bodies inside the vertebral canal to the upper end of the sacral canal. It is the broadest superiorly where it is continuous with the tectorial membrane, which is attached to the occipital bone on the interior aspect of the foramen magnum. It helps to prevent hyperflexion of the vertebral column and posterior protrusion of the nucleus pulposus of the disc.

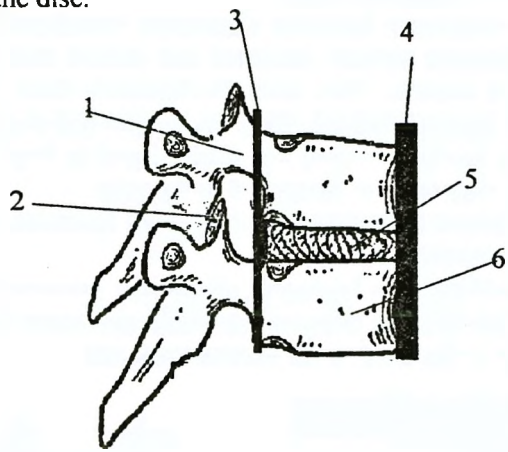


Fig.10. Joints between articular processes and between vertebral bodies
1- pedicle; 2- articular processes; 3- anterior longitudinal ligament; 4- posterior longitudinal ligament; 5- intervertebral disc; 6-Vertebral body.

Joints of the vertebral arches

Zygapophysial joints (facet joints)

Each vertebra has four articular processes or zygapophyses: Zygapophysial joints are plane type synovial joint between the inferior articular process of superior vertebrae and the superior articular process of inferior vertebrae (right and left superior, right and left inferior). Each joint is surrounded by as thin, loose articular capsule that

is attached to the articular margins of the processes. In the cervical and lumbar regions, these multiaxial joints bear some weight, sharing this function with the intervertebral discs.

Ligaments

1. The Ligamentum flavum or yellow ligaments (Fig.11-b): This ligament connects the lamina of adjacent vertebrae and stretched from the axis to the first segment of the sacrum. They are best seen from the interior of the vertebral canal. Ligamentum flavum is elastic fibres. Because of their elasticity they tend to bring the arches closer to each other and, together with the intervertebral cartilages, contribute to a straight spine and upright position.

2. The interspinous ligaments *(ligamenta interspinalia)* , Fig.11-a - connect adjoining spinous processes and extend from the root to the apex of each process. They meet the ligamenta flava in front and the supraspinal ligament behind. They are narrow and elongated in the thoracic region; broader, thicker, and quadrilateral in form in the lumbar region; and only slightly developed in the neck.

3. Supraspinous ligaments Fig.11-a – This ligaments connect the tip of adjacent spinous processes.

4.The intertransverse ligaments *(ligamenta intertransversaria)*, - are interposed between the adjacent transverse processes and limit lateral movements of the spine to the contralateral side.

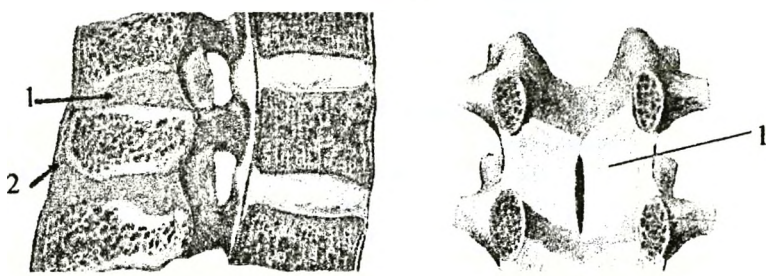


Fig.11. Section of vertebral column.
A. 1-interspinous ligament; 2-supraspinous ligament;
B.1-ligamenta flava

Lumbosacral Joints- this synovial joint is formed between fifth lumbar vertebra and superior articular facet of first sacral vertebra of the sacrum. This joint is supported by an intervertebral discs, anterior and posterior longitudinal ligaments, ligamenta flava, interspinal and supraspinal ligaments. In addition to these, the strong iliolumbar ligament passes lateral ward from the transverse process of the fifth lumbar vertebra to the posterior part of the inner lip of the iliac crest and helps to stabilize the joint. Movement is similar to intervertebral joints.

Generally the movements permitted in the vertebral column are: *flexion, extension, lateral flexion, circumduction,* and some degree of *rotation.* Most of the movements in the vertebrae occur in cervical and lumbar vertebrae

Blood supply of the intervertebral joints: In the cervical part- by the branches of a. vertebralis, in the thoracic part by aa. intercostales posterior. In the lumbar part by aa. lumbales, and in the sacral part by a. sacralis lateralis . *Venous blood* drains into the plexus venosi vertebrales and then into v. vertebralis (in the cervical segment), vv. intercostales posteriores (in the thoracic segment), vv. lumbales (in the lumbar segment), and v. iliaca interna (in the sacral segment). *Lymph* drains into nodi lymphatic! occipitales, retroauriculares, cervicales profundi (in the cervical segment), nodi lymphatic! intercostales (in the thoracic segment), nodi lymphatici lumbales (in the lumbar segment), and nodi lymphatici sacrales (in the sacral segment).

Innervation – The joint between the vertebral bodies innervated by meningeal branches of spinal nerves. The joint between the articular processes are innervated by branches from the posterior rami of the spinal nerves (from two adjacent spinal nerves).

Joints of the ribs

This joint includes articulation of the ribs with the vertebrae, ribs with the sternum and ribs with each other. It contains the following types of joints:

Synarthroses in the form of syndesmoses (e.g. different ligaments)

Synchondroses (e.g. costal cartilages),

Hemiarthroses (e.g. between some of the costal cartilages and the sternum),

Diarthroses (e.g. between the ribs and the vertebrae and between the second to seven costal cartilages and the sternum).

Joints between ribs and vertebrae.

A typical rib articulates with the vertebral column at two joints: (1) the joints of the heads of the ribs and (2) the tubercles of the ribs.

1. Costovertebral joints (articulationes costovertebraies)-Joint of the head of the rib with the side of vertebra. *(articulationes capitis costae). The fovea costales of the thoracic vertebrae and the articular facets of the heads of the ribs form these joints.* The heads of the first, eleventh, and twelfth ribs articulate with a single fovea costalis on the body of the corresponding vertebra and therefore do not have crest and an interarticular ligament (have single synovial joint). The facets of the heads of the second to tenth ribs articulate each with the fovea costales of two adjacent vertebrae. An intra-articular ligament of this joint *(lig. capitis costae intraarticulare)* runs from the crest of the costal head to the intervertebral disc; and it separates the joint cavity into two parts.

Joints of the heads of the ribs are surrounded by a thin articular capsule, which is strengthened anteriorly, by an accessory radiate ligament of the head of the rib *(lig. capitis costae radiatum).*

Movement.

The costovertebral joints are the plane type of synovial joint that allows for gliding or sliding motions.

2. Costotransverse joints *(articulationes costotransversariae). This joint* is formed by the tubercles of the ribs and the articular facets of the transverse processes of a thoracic vertebra. The last two (eleventh and twelfth) ribs do not have these joints.

The capsules of costotransverse joints are strengthened by costotransverse ligaments *(ligamenta costotransversaria).* Both articulations of the ribs with the vertebrae (costotransverse joint and Joint of the head of the rib) function as a *single combined joint* (pivotal) with the pivotal axis passing through the neck of the rib.

Connection of costal cartilages with the sternum.

The ribs are connected with the sternum by synovial and cartilage joints. (fig. 13.)

The first costal cartilages are attached to the manubrium (syn-

chondrosis), and no movement is possible. The second costal cartilages articulate with the manubrium and body of the sternum by synovial joint. The cavity of the joint between 2nd costal cartilage and the sternum is divided in to upper and lower by intra-articular ligament. The third to seventh costal cartilages articulate with the lateral border of the sternum by synovial joint *(articulationes sternocostales)*. The sixth, seven, eighth, ninth, and tenth costal cartilages articulate with each other along their borders (syndesmosis). Anteriorly and posteriorly sternocostal joints are strengthened by sternocostal ligaments *(ligamenta sternocostalia radiata)*. Sternocostal ligaments together with the periosteum on the anterior surface of the sternum form the thick sternal membrane *(membrana sterni)*.

Movement. The costal cartilages of first ribs are fixed to the manubrium and are immobile. The raising and lowering of the ribs during respiration are accompanied by movements in both the joints of the head and the tubercle, permitting the neck of each rib to rotate around its own axis.

Vessels and nerves

The joints of the ribs and sternum are supplied by the internal thoracic artery, (a. thoracica interna).

The *venous blood drains* into the internal thoracic veins.

The *lymph drains* along the deep lymphatic vessels into the parasternal and deep cervical lymph nodes.

Innervation- the intercostal nerves, rami anteriores nervi intercostales.

Joints of the sternum

There are two articulations: the manubriosternal (symphysis-manubriosternalis) and xiphisternal (symphysis -xiphosternalis) joints.

The manubriosternal Joint - it is the articulation between the manubrium and the body of the sternum. In adults joint is a secondary cartilaginous joint (symphysis type). The manubrium sterni and the body of sternum lie at angle of about 163^0 to each other.

The xiphisternal Joint-is the articulation between the xiphoid process and body of the sternum is a primary cartilaginous joint (synchrondrosis, symphysis type); these bones are united by hyaline cartilage. After the age of 40 the union becomes bony.

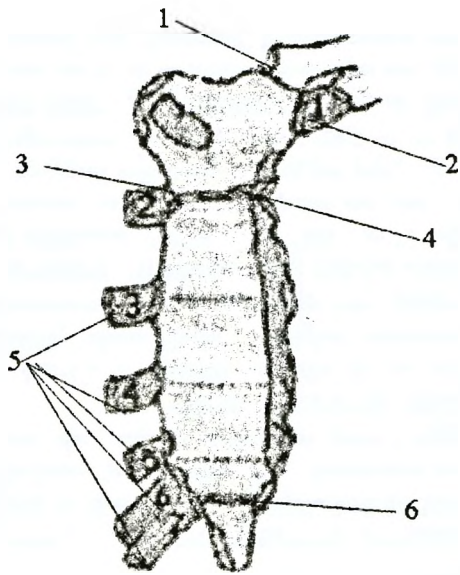


Fig 13. Joints of costal cartilages and the sternum
1. Sternoclavicular joint; 2- 1st sternocostal joint; 3- 2nd sternocostal joint; 4- manubriosternal joint; 5-(3 to7 sternocostal joint); 6-xiphisternal joint

The thorax (as a whole)

The thorax is the part of the body a lay person calls chest. *It* Consists of 12 thoracic vertebrae, 12 pairs of ribs and sternum. The thoracic cavity *(cavum thoracis) has four walls and two apertures:*

Anterior wall, -the sternum and costal cartilages

Posterior wall- all thoracic vertebrae and head of ribs

Lateral wall (two) – twelve pairs of C-shaped ribs. The spaces between the ribs are called intercostal spaces *(spatia intercostalia).*

The superior thoracic aperture *(apertura thoracis superior)* or inlet - is bounded posteriorly by the upper end of the body of the first thoracic vertebra, laterally by the inner border of the first rib, and in front by the upper border of the manubrium sterni. The superior thoracic aperture is not placed horizontally because the upper border of

the manubrium sterni lies as the level of lower border of T2.

The inferior thoracic aperture (outlet) *(apertura thoracis inferior).* - is closed by the diaphragm.

The anterior boundary of the inferior aperture is formed by 7th, 8th, 9th, 10th, costal cartilages the xiphoid process is located at its apex.

Posteriorly the inferior thoracic aperture is bounded by the lower border of 12^{th} thoracic vertebra and head of 12th pairs of ribs. Laterally, inferior thoracic aperture is bounded 12th pairs of ribs.

The primary function of the thorax is respiration. The ribs and the diaphragm move so that the thoracic cavity increases and decreases in size during the inspiratory and expiratory phases of respiration. It also probably aids in returning venous blood back to the heart because of the negative pressure produced with respiratory movements.

Secondarily it serves to protect the organs located within its cavity plus some organs of the abdominal cavity.

The *shape and size* of the thoracic cage are also marked by considerable individual variation, which depends up on the development "of the muscles and lungs. Usually distinguished: flat chest, barrel chest, and conic chest.

Flat shape chest or expiratory- thoracic cage is narrow and long with a greatly flattened anteroposterior diameter. The anterior wall is almost vertical and the infrasternal angle is acute. E.g people with weak development of the muscles and lungs

Conic shape or an inspiratory chest -its lower part is wider than the upper part and the infrasternal angle is large. E.g. people with well-developed muscles and lungs have a wide but short thoracic cage.

The *barrel chest* occupies an intermediate position between the two forms described. The female chest is shorter and narrower in the lower part and more rounded than the male chest.

Respiratory movement consists in raising and lowering the ribs, together with which the sternum moves also. During inspiration the posterior ends of the ribs rotate on the axis.

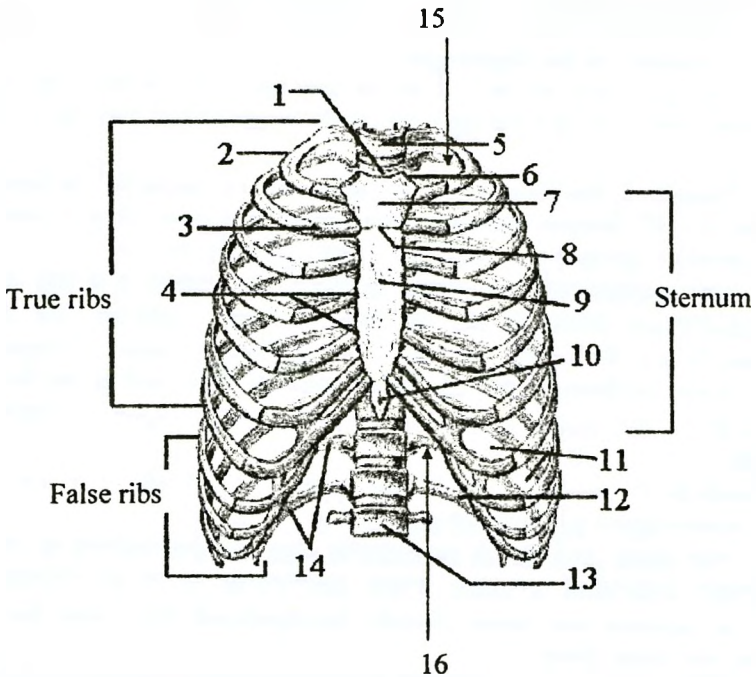


Fig 14. Skeleton of the thorax as seen from the front
1-Jugular notch; 2-First rib; 3- Costal cartilage;4-Costal notches; 5-First thoracic vertebrae; 6-Clavicular notch;7 manubrium;8- Sternal angle; 9 - body of sternum; 10-xiphoid process;11- intercostal space;12- Twelfth ribs; 13-first lumbar vertebre;14-floating ribs ;15-thoracic inlet ;16-thoracic outlet

Joints of upper limb

The Joints of upper limb (Juncturae membri superioris» includes those of joints of pectoral girdle (clavicle and scapula) and the limb proper.

The joints of the pectoral girdle

1. The sternoclavicular joint *(articulatio sternoclavicularis)* Fig.14. This is a type of synovial double plane joint and is the only bony articulation between the upper limb and the axial skeleton. This joint is formed by the clavicular notch of the sternum, the sternal end of the clavicle and the medial part of the first costal cartilage. This joint can be palpated because the medial end of the clavicle lies superior to the manubrium of the sternum. The capsule surrounds the joint and attached to the margins of the articular surfaces.

The articular surfaces are separated by articular disc *(discus articularis)*. The articular disc is located inside the joint and divides it into two synovial cavities. The disc is attached superiorly to the medial end of the clavicle and inferiorly to the junction of the sternum and the first costal cartilage. The articular disc increases the capacity of movement.

The joint cavity is strengthened by:

The anterior and posterior sternoclavicular ligaments *(ligamenta sternoclaviculare anterius* and *posterius)* in front and behind;

The costoclavicular ligament *(lig. costoclaviculare))* between the cartilage of the first rib and inferior surface of strenal end of the clavicle;

The interclavicular ligament *(lig. interclaviculare*) between the clavicles above the jugular notch.

Movements - Despite the saddle-like form of its articular surfaces, this joint moves in many directions like a ball and socket joint. On the sagittal axis, raising and lowering the clavicle, on the vertical axis, forward and backward of the clavicle, circumduction.

Rotation of the clavicle on its long axis is also possible. The scapula moves together with the clavicle, and, consequently, the whole shoulder girdle on the respective side swings into movement. The *scapula* in this case *moves* upward and downward, and forward and backward; finally, it can rotate on the anteroposterior axis with its inferior angle being displaced laterally as occurs when the arm is

raised above the shoulder.

Blood Supply -by branches of the internal thoracic and suprascapular arteries.

Nerve Supply -by The branches of the medial supraclavicular and the nerve to the subclavius muscle.

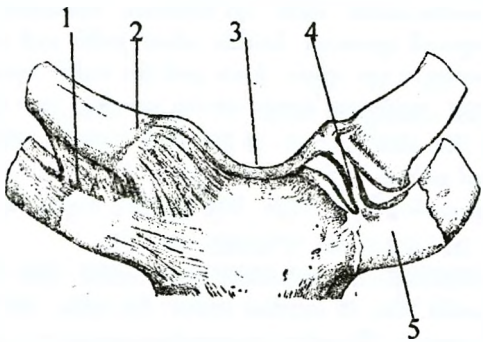


Fig.15. Anterior view of sternoclavicular joint.
1.Costoclavicular ligament; 2- Sternal end of the clavicle; 3- Interclavicular ligament; 4-Articular disc;5- Cartilage of first rib.

2. The acromioclavicular joint *(articulation acromioclavicularis)* Fig.16 - This is a plane type of synovial joint. The small oval articular facet on the lateral end of the clavicle articulates with a similar facet on the anterior part of the medial surface of the medial end of the acromion. The articular disc *(discus articularis)* projects into the joint from the superior part of the joint and partially divides the joint cavity into two. An articular capsule encloses the joint, attaching at the articular margins and strengthened superiorly by the acromioclavicular ligament and (lig. *acromioclaviculare) which* extends from the superior part of the lateral end of clavicle to the superior surface of the acromion.

The accessory ligament. The real stability of the acromioclavicular joint provides through the coracoclavicular ligament *(lig. coracoclavicularis)*, which anchors the lateral part of the clavicle to the cora-

coid process of the scapula. It is the strongest of the ligaments that binds the clavicle to the scapula. Its two parts, named according to their shapes, are the posteromedial conoid ligament and the anterolaterally placed trapezoid ligament. The conoid ligament has its apex downward, attached posteromedially to the base of the coracoid process. Its broadened base is fixed to the conoid tubercle on the under surface of the clavicle. The trapezoid ligament is strong, flat, and quadrilateral. It is attached below for about 2 cm to a rough ridge on the upper surface of the coracoid process. Above, it is attached to the oblique trapezoid line on the under surface of the clavicle which runs anterolaterally from the conoid tubercle. The conoid ligament restrains backward movement of the scapula. The trapezoid ligament prevents excessive forward movement of the scapula and is especially important in resisting displacing forces, which would cause the acromion to be carried down and under the clavicle.

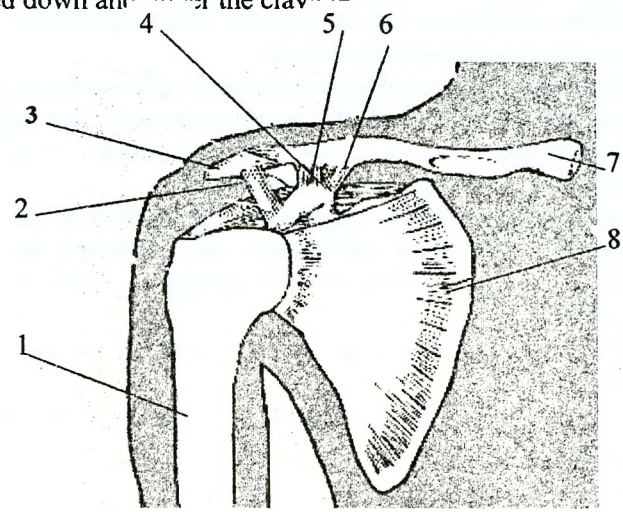


Fig.16. Acromioclavicular joint
1-Humerus; 2- Coracoacromial ligament; 3- Acromion; 4- Acromioclavicular ligament;5- Trapezoid ligaments; 6- Conoid ligaments;7- Clavicle; 8- Scapula

3. Scapular ligaments (proper ligament of scapula)

The scapula has ligaments of its own, which have no relation to the joints.

a). The coracoacromial ligament *(lig. coracoacromiale)* –this triangular ligament stretched between the anterior edge of acromion and the coracoid process. The coracoacromial arch prevents displacement of the humeral head superiorly from the glenoid cavity of the scapula.

b) The superior transverse scapular ligament *(lig. transversum scapulae superius),* stretches above the scapular notch and converts it (notch) into a foramen.

c) The inferior transverse scapular ligament *(lig. transversus scapulae inferius)* - extends from the lateral aspect of the root of the spine of the scapula to the margin of the glenoid process. With the bone, it forms a foramen for the passage of the suprascapular vessels and nerve into the infraspinatous fossa.

Movements- Acromioclavicular joint allows the acromion to rotate on the clavicle and to move anteriorly and posteriorly. These movements are associated with movements of the scapula and with those at the sternoclavicular joint.

Common injuries: Shoulder separation: Dislocation of the acromioclavicular joint. Symptoms will include pain, tenderness and edema in the area, and acromion will be very prominent and appear more prominent.

Blood Supply-by branches of the suprascapular and thoracoacromial arteries.

*Nerve Supply-by t*he branches of the supraclavicular, lateral pectoral, and axillary nerves

Articulation of the limb proper.

1. The Shoulder Joint-*(articulatio humeri)* (scapulohumeral joint) - is a ball and socket joint, has the greatest freedom of movement of all the joints of the body. The head of the humerus articulates against a glenoidal surface only a little more than one-third its size, and the articular capsule is loose. The head of the humerus is held into the glenoid cavity by a "rotator cuff" of short scapular muscles—

supraspinatus, infraspinatus, teres minor, and subscapularis. The tendons of these muscles blend with the capsule and reinforce it, and when their attachments are cut, the humeral head is allowed to fall away from the glenoid surface by about 2 cm. The glenoid cavity of the scapula is slightly deepened and enlarged by a glenoidal labrum *(labrum glenoidale)*, attached around its margin. The labrum is triangular in cross section with a free edge which is thin and sharp.

The articular capsule encloses the articular parts of the bones. It attaches to the scapula outside of the glenoid labrum and partly to the labrum itself, especially above and behind. On the humerus the capsule attaches to the anatomical neck.

Ligaments

The coracohumeral ligament *(lig. coracohumerale)*, -is a strong, broad band that strengthens the superior part of the capsule of the shoulder joint. It passes from the lateral side of the base of the coracoid process of the scapula to the anatomical neck of the humerus, adjacent to the greater tubercle

The glenohumeral ligaments consist of three strengthening bands within the capsule, superior, middle, and inferior glenohumeral ligaments. These ligaments may be seen on its inner aspect. All three lie in the anterior wall of the capsule and run from the supraglenoid tubercle of the scapula to the lesser tubercle and the anatomical neck of the humerus.

The transverse humeral ligament stretches from the greater to the lesser tubercles of the humerus.

Dislocations of glenohumeral Joint. Symptoms include the shoulder appearing more flattened due to the humeral head tearing through the inferior part of the articular capsule.

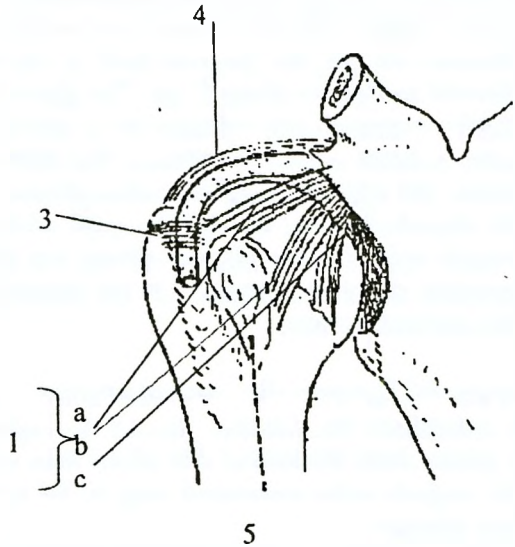


Fig.17. The shoulder joint.
1- glenohumeral ligament (a. superior, b. middle, c. inferior); 2- Tendon of long head of biceps; 3- Transverse humeral ligament; 4- Coracohumeral ligament; 5-lesser tubercle

Movement- movement at the shoulder joint takes place on three main axes: frontal (flexion and extension), sagittal, (abduction and adduction), vertical- (medial and lateral rotation) Circumduction is also possible.

Blood Supply- Articular arteries to the shoulder joint are 1.The suprascapular artery -branch of the subclavian artery 2.Anterior and posterior circumflex humeral and circumflex scapular artery - branch of the axillary artery.

Venous blood is drained along veins of the same name into the axillary vein. *Lymph flows* in the deep lymphatic vessels into the axillary lymph nodes.

Nerves are branches of the suprascapular, axillary, and lateral pectoral nerves.

2. The elbow joint *(articulatio cubiti)*- This is a hinge type of synovial joint. The elbow joint is made up of three separate articulations, the humeroulnar joint, the humeroradial joint, and the superior or proximal radio-ulnar joint. These joints are covered by the common articular capsule.

2.1. The humeroulnar articulation *(articulatio humeroulnaris),* (a hinge joint)-is formed by the articulation of the trochlea of the humerus with the trochler notch of the ulna. Uniaxial hinge joint

2.2 The humeroradial articulation *(articulatio humeroradialis),* - is formed between the capitulum of the humerus and the head of the radius .It is a ball-and-socket joint.

2.3. The proximal radioulnar articulation *(articulatio radioulnaris proximalis)*-. Is formed by the circumferentia articularis radii and the incisura radialis ulnae. This is a pivot joint, permitting rotation of the radius about the ulna. This joint functions with the distal radioulnar articulation, thus forming a complex joint. (Fig.18)

The articular capsule is attached around the articular surfaces, and blends with the annular ligament. It covers the tip of the olecranon, the coronoid process, and the radial fossa. The fibres are arranged in such a way as to provide stabilization in flexion and extension. The articular capsule is weak in front and behind but is much strengthened at the sides by the ulnar and radial collateral ligaments *(lig. collaterale ulnare* and *lig. collaterals radiale).* The ulnar collateral ligament is a strong fan shaped condensation of the fibrous joint capsule. It is located on the medial side of the joint, extending from the medial epicondyle of the humerus to the proximal portion of the ulna. This ligament prevents excessive abduction of the elbow joint.

The radial collateral ligament is also a strong fan shaped condensation of the fibrous joint capsule. It is located on the lateral side of the joint, extending from the lateral epicondyle of the humerus to the head of the radius. This ligament prevents excessive adduction of the elbow joint.

The space between the two bands is filled with fibrous fibres, which encircle the neck and head of the radius but do not fuse with them. These fibres are called the anular ligament of the radius *(lig. anulare radii), which is supported,* laterally by the radial collateral

ligament and blends with the articular capsule of the elbow joint. Below the annular ligament there is quadrate ligament that passes from the lower border of the radial notch of the ulna to the adjacent medial surface of the neck of the radius.

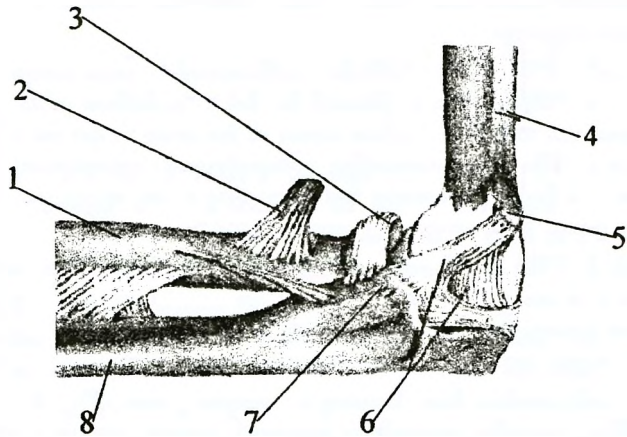


Fig.18. The elbow joint.

1-. Radius, 2-Tendon of biceps muscle, 3-Annular ligament, 4- Humerus, 5-Medial epicondyle, 6-Ulnar collateral ligament, 7- Coronoid process, 8- Ulna.

Movements

The elbow allows flexion and extension, as well as pronation and supination. When the ligaments are weak overextension is possible. Elbow flexion brings the hand to the chest, the mouth, or the face, thereby allowing the performance of most of the activities associated with feeding, dressing, and body care; elbow extension, on the other hand, takes the hand away from the body, and enables it to grasp objects. Rotation of the radius on the longitudinal axis occurs in the humeroradial articulation as well as in the proximal and distal radioulnar articulations.

Blood supply of elbow joint.

Articular arteries are derived from the anastomosis around the

elbow which are formed by:

The superior and inferior ulnar collateral arteries -from the brachial artery.

The middle collateral artery and the radial collateral artery -from the branch of deep brachial artery,

The radial recurrent artery - from the branch of radial artery,

The interosseous recurrent artery-from the branch of interosseous artery,

The anterior and posterior ulnar recurrent artery-from the branch of ulnar artery.

Venous blood drains along the veins of the same name into the deep veins of the upper limb, the ulnar, radial, and brachial veins. *Lymph* drains along the deep lymphatics into the cubital lymph nodes.

Innervation - is provided by the musculocutaneous, radial, median, and ulnar nerves.

3. Articulations between the forearm bones

The bones of the forearm are united at their proximal and distal ends by synovial joints Fig.19. In addition to this, the shafts of the radius and ulna are connected by the oblique cord and the interosseous membrane. The oblique cord is a slender, flattened fibrous band that extends from the lateral border of the tuberosity of the ulna to the radius distal to its tuberosity. Under the cord, in the membrane, is located interoses foramen, which transmits the posterior interosseous artery. In the lower part of the membrane, the foramen transmits the anterior interosseous artery.

The proximal radioulnar articulation is enclosed in the capsule of the elbow joint. See above elbow joint. The radial notch of the ulna and the annular ligament of the radius form a ring within which the head of the radius rotates.

The Distal Radioulnar Articulation – is a joint formed between the head of the ulna and the ulnar notch on the lower end of the radius. It is a synovial joint of pivot type. The cartilaginous plate *(discus articularis)* also contributes to the formation of this articulation; its triangular base is attached to the inferior margin of the ulnar notch whereas the apex is attached to the styloid process of the ulna.

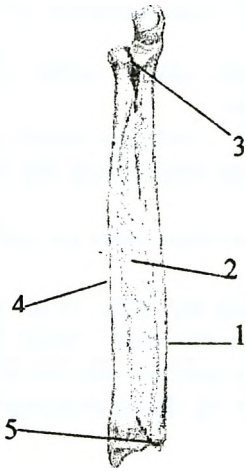


Fig.19. Joint of forearm
1-Ulna, 2-Interosseous membrane, 3-Proximal radioulnar Joint, 4-Radus, 5-Distal radioulnar Joint

Movements-pronation and supination of forearm

Arterial supply - the anterior and posterior interosseous arteries and the palmar and dorsal carpal networks.

The nerves of the joint are the posterior interosseous branch of the radial nerve and the anterior interosseus branch of the median nerve

4. Articulations of the forearm and hand.

The joints of the hand (articulationes manus) are a complex joint and consisting of two parts, the proximal and distal.

The proximal part, the radiocarpal, or wrist joint *(art. radiocarpea)* -is formed by the carpal articular surface of the radius, the articular disc of the distal radioulnar articulation and the lower articular surfaces of proximal row of carpal bones (scaphoid, lunate, and triquetral). At their proximal edges interosseous ligaments join them. Radiocarpal joint is a complex and an ellipsoid joint.

Ligament. The joint is surrounded by a capsule, and strengthened by the following ligaments:

1. The lateral or radial collateral *(lig. collaterale radiale)* passing from the styloid process of the radius to the scaphoid bone

2. The medial or ulnar collateral ligament *(lig. collaterale ulnare)* stretching from the styloid process of the ulna to the triquetral and pisiform bones.

3.The anterior radiocarpal ligament *(lig. radiocarpeum palmare)*, originate from the articular surface of the radius and attached in to the scaphoid, lunate, triquetral, and capitate bones. On the dorsal surface of the radiocarpal joint there is the posterior radiocarpal ligament *(lig. radiocarpeum dorsale)* passing from the posterior margin of articular surface of radius to the bones of the first carpal row.

Movement - flexion and extension, abduction and adduction, and circumduction

Blood supply

Arteries of radiocarpal joint are derived from the dorsal and palmar carpal networks (rete articulare), which are formed, by the branches of the radial, ulnar, and anterior and posterior interosseous arteries.

Venous blood drains into veins of the same name, which convey it to the deep veins of the forearm, the ulnar, radial, and interosseous veins. The *lymph drains* along the deep lymphatics into the cubital lymph nodes.

Innervations. The nerves are derived from the anterior interosseous branch of the median nerve, the posterior interosseous branch of the radial nerve, and the dorsal and deep branches of the ulnar nerve.

The distal part, or midcarpal joint *(art. mediocarpalis)*. This joint is formed by the articulating of the first row of carpals (distal surface) and the proximal surface of the trapezium, trapezoid, capitate, and hamate bones. Both carpal joints (radiocarpal and midcarpal) possess their own articular capsules attached to the margins of the articular surfaces

Intercarpal joints *(articulationes intercarpalis)*, formed between neghboring bones of the carpal bones interconnected by interosseous intercarpal ligaments *(ligamenta intercarpea interossea)*. The midcarpal and intercarpal joints have connection.

Ligament.

Many short ligaments passing, transversely from one bone to another strengthen them.

Posterior intercarpal ligaments *(ligamenta intercarpea dorsalia)* -on the dorsal surface

Anterior intercarpal ligaments *(ligamenta intercarpea palmaria)* and on the palmar surface.

Radial carpal ligament *(lig. carpi radiatum).* on the palmer surface from the capitate bone to the neighbouring bones.

Movements- a small amount of gliding movement is possible.

Blood supply and *Innervation*

Arteries of radiocarpal joint are derived from the dorsal and palmar carpal networks (rete articulare), which are formed by the branches of the radial, ulnar, and anterior and posterior interosseous arteries.

Venous blood drains into veins of the same name, which convey it to the deep veins of the forearm, the ulnar, radial, and interosseous veins. The *lymph drains* along the deep lymphatics into the cubital lymph nodes.

Innervation. From the anterior interosseous branch of the median nerve, the posterior inter-osseous branch of the radial nerve, and the dorsal and deep branches of the ulnar nerve.

The pisiform joint *(articulatio ossis pisiformis)* is the articulation of pisiform bone with the triquetral, which strengthened by pisohamate and pisometacarpal ligament. The pisohamate ligament *(lig. pisohamatum)* stretch from the pisiform bone to the hamate bone. The pisometacarpal ligament *(lig. pisometacarpeum)* from the pisiform bone too the base of the third to fifth metacarpals. This joint beloing to the intercarpal joints

The flexor retinaculum *(retinaculum flexorum)* - it is 2-3 cm long, lies deep to palmar carpal ligament and stretches between the eminentia carpi radialis and the eminentia carpi ulnaris and convert their in to a fibro-osseous canal *(canalis carpi)* through which transmits in to the hand, the median nerve and the tendons of the finger flexors.

The carpometacarpal joints *(articulationes carpometacarpeae)*- are joints between the articular surfaces of second row of carpal bones and the bases of the metacarpals. Except the carpometacarpal joint of the thumb (saddle type), all these joints (2-5 metacarpals)

are plane type. The joint strengthened from both the dorsal and the palmar surfaces by the dorsal and palmar carpometacarpal ligaments *(ligamenta carpometacarpea dorsalis* and *ligamenta carpometacarpea palmaris)*

Movement- the carpometacarpal joint (2-5 metacarpals) gliding - slightly movable. The carpometacarpal joint of the little finger can be opposed to the thumb, but within a very limited range. The four bones of the distal carpal row and the four metacarpal bones (second to fifth), which are firmly joined by articulations, form a whole *firm base of the hand* from the mechanical standpoint.

The carpometacarpal joint of the thumb *(art. carpometacarpea pollicis*) is formed by the articular surfaces of the trapezium and the base of the first metacarpal bone. *This saddle joint* is absolutely isolated from the other carpometacarpal joints and differs from them in structure and movements.

Movements- Flexion, extension, abduction, adduction opposition, reposition, and circumduction.

Intermetacarpal joints are formed between adjoing sides of base of II-V metacarpal bones.

Movements- gliding

The metacarpophalangeal joints *(articulationes metacarpophalangeae), are formed between* the base of the proximal phalanges and the heads of the metacarpal bone. It is ellipsoid in shape. The loose joint capsule are connected along the edge of articular surface and strengthened by ligaments. On each side - collateralligament *(ligamenta collateralia)* passing obliquely from the depressions on the radial and ulnar surfaces of the metacarpal heads to the sides of the base of the proximal phalanges. On the palmar surface - the palmar ligament *(lig. palmare).* Between the heads of the second to fifth metacarpal bones - the deep transverse metacarpal ligaments *(ligamenta metacarpea transversa profunda),* stretched

Movement

At the metacarpophalangeal joints: flexion and extension - abduction and adduction of the finger.

The interpbalangeal joints *(articulationes interphalangeae manus)* are typical hinge joints, between the head and base of the adjacent phalanges. The articular capsule are connected along the edge of articular surface and strengthened on the sides by collateral liga-

ments *(ligamenta collateralia)* , in front - by palmar ligament.

Movement- flexion and extension

Blood supply.

The hand joints are *vascularized* from the deep palmar arterial arcus and the palmar and dorsal carpal network.

Venous blood drains into the deep veins of the hand and from there into the ulnar, radial, and interosseous veins. *Lymph is drained* along the deep lymphatics into the cubital lymph nodes.

Innervation.

Branches of the median, radial, and ulnar nerves innervate the capsules of the joint

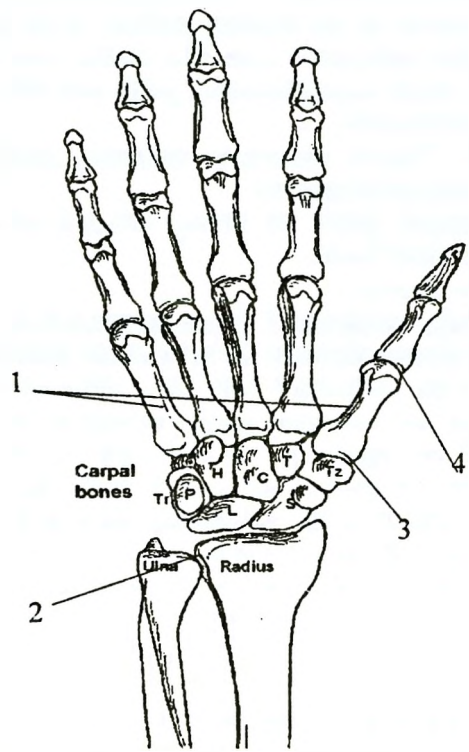


Fig.20. Joints of the bones of the hand
1- metacarpal bones; 2-distal radio-ulnar joint; 3-carpometacarpal joint; 4-metacarpophalangeal joint; 5-interphalangeal joint

Joints of the lower limb

Joints of the lower limb include those of the pelvic girdle (sacro-iliac joint, symphysis pubis) and those of the limb proper. (hip joint, knee joint, tibiofibular joint, ankle joint, intertarsal joint, tarsometatarsal joint, intermetatarsal joint, metatarsophalangeal joint, interphalangeal joint)

Joints of the pelvic bones

In the human pelvis all types of joints are present:

Synarthroses -in the form of syndesmoses (ligaments);

Synchondroses (between the separate parts of the hip bone)

Synostoses (after their fusion to form the hip bone);

Hemiarthroses (the pubic symphysis)

Diarthroses (the sacro-iliac joint).

I. **The sacro-iliac joint** *(art. sacroiliaca* are *strong synovial joint*) between the articular surfaces of the sacrum and ilium. The strong articular capsule is attached close to the articulating surfaces of the sacrum and ilium. These joint are strengthened by:

1. The interosseous sacro-iliac ligaments *(ligamenta sacroiliaca interossea)* are deep to the dorsal ligaments. They consist of a thick group of short, strong fibers that fill the narrow cleft between the rough areas on the bones immediately above and behind the auricular surfaces.

2. The posterior (dorsal) *sacroiliac ligaments (ligamenta sacroiliaca dorsalia)* running downward from the superior and inferior posterior iliac spine to the sacral vertebrae. These ligaments blend with the *sacrotuberous ligaments.*

3. *The anterior (ventral) sacroiliac ligaments (ligamenta sacroiliaca ventralia)* -which consists of numerous thin bands, which close the joint on its pelvic aspect. They connect the pelvic surface of the lateral part of the sacrum to the margin of the auricular surface of the ilium.

4. The iliolumbar ligament *(lig. iliolumbale)* stretched between the transverse process of the fifth lumbar vertebra and the iliac crest. The iliolumbar ligament stabilizes the lumbosacral joint

5. The sacrotuberous ligament *(lig. sacrotuberale)* - the ligament that connects the ischial tuberosity to the lateral surface of the

sacrum and coccyx. Together with sacrospinous ligament, it converts the greater and lesser sciatic notches into greater and lesser sciatic foramina

6. The sacrospinal ligament *(lig. Sacrospinale)* originates at the ischial spine, crosses the sacrotuberal ligament, and is attached to the lateral border of the lower part of the sacrum and the upper part of the coccyx. The ligaments described above (5,6) form the greater and lesser sciatic notches to the greater and lesser sciatic foramina *(foramen ischiadicum majus* and *minus).*

Movement. These joints are *strong weight bearing synovial joints* of an irregular plane type. Slight gliding and rotary movements between the auricular surfaces take place. The total range of movements between the pelvic bones is 4 to 10 degrees.

Blood supply. The arterial supply of the joint is by branches of the superior gluteal, the lumbar, iliolumbar, and lateral sacral arteries. *Venous blood drains* into the corresponding veins. *Lymph is drained* along the deep lymphatics into the sacral and lumbar lymph nodes. Nerves reach the joint from the superior gluteal nerve and from branches of the dorsal rami of the first and second sacral nerves

II. **The pubic symphysis** *(symphysis pubica) is* a median, secondary cartilaginous joint between the bodies of the two pubic bones. The apposed cartilaginous layers are united by fibrocartilage, *interpubic disc (discus interpubicus) which is*thicker in the female than in the male. It also contains a small cavity that is also larger in women and increases in size during pregnancy.

T*he ligaments of the pubic symphysis.*The pubic symphysis is strengthened by the superior pubic ligament *(lig. pubicum superius)* which connects the rami along their superior surfaces and extends as far lateral ward as the pubic tubercles and by the inferior pubic ligament *(lig. pubicum inferius),* which adjoins the symphysis on the bottom.

The obturator membrane *(membrana obturatoria) is* a fibrous plate closing the obturator foramen of the hipbone except obturator groove. The obturator groove of the pubis, which does not cover by obturator membrane called the obturator canal *(canalis obturatorius).* The obturator canal *serves as a passage for t*he obturator vessels and nerves.

Sacrococcygeal joint

Sacrococcygeal (art.sacrococcyga) is an amphiarthrodial joint, formed between the oval surface at the apex of the sacrum, and the base of the coccyx.The intervertebral cartilage has a small cavity in it, which allows the coccyx to bend backward during childbirth.

Ligaments. The anterior sacrococcygeal ligament *(lig.sacrococcygeum ventrale)* consists of few fibers, which descend from the anterior surface of the sacrum to the front of the coccyx, blending with the periosteum.

The posterior sacrococcygeal ligament is a flat band, which arises from the margin of the lower orifice of the sacral canal, and descends to be inserted into the posterior surface of the coccyx The deep posterior sacrococcygeal ligament *(lig. sacrococcygeum dorsale profundum) is* a continuation of the posterior longitudinal ligament and lies on the posterior surface of sacral vertebrae and coccyx. The superficial posterior sacrococcygeal ligament *(lig. sacrococcygeum dorsalis superficiale) is* closer to the surface and corresponds to the yellow ligaments and the capsules of the intervertebral joints. The lateral sacrococcygeal ligaments *(ligamenta sacrococcygea laterale)* are similar with the intertransverse ligaments *(ligamenta intertransversaria)* and attached to the transverse processes of the coccyx.

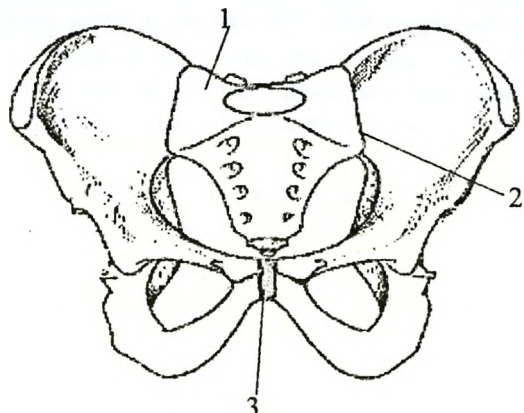


Fig.21 . Joints of the pelvic bones
1- Sacrum; 2- Sacroiliac joint;3- Pubic symphysis

The pelvis as a whole

The hip bone is originally made up of three bones: 1)ilium, 2)ischium and 3)pubis, that come together at the acetabulum at the age of 14-16. Both hipbones, coccyx and sacrum form a bony ring called the pelvis. The pelvic brim extends from promontory of the sacrum then arcuate line of the ilium, pectineal line (pectin of pubis) and pubic crest. The pelvis is divided into a greater pelvis *(pelvis major* or false pelvis*)* and lesser pelvis *(pelvis minor* or true pelvis*)*. The greater pelvis and lesser pelvis are separated by means of the pelvic brim as the limiting line. The greater pelvis is located above the pelvic brim and the lesser pelvis below the pelvic brim.

The greater or false pelvis is laterally bounded by the wing of the ilium. It has no bony walls in front but the fifth lumbar vertebrae fill the deficiency in its posterior boundary. The lesser or true pelvis *is* below the pelvic brim. Anteriorly, formed by the pubic bones and pubic symphysis, posteriorly is formed by the sacrum and coccyx. The lateral walls of the true pelvis are internal surfaces of the hipbones corresponding to the acetabuli together with the sacrotuberal and sacrospinous ligaments. The lesser *(or true) pelvis* has an inlet (*apertura pelvis superior)* and outlet *(apertura pelvis inferior). The* inlet corresponds to the pelvic brim. The out let of lesser pelvis is limited from the side by the inferior rami of the pubic bones and rami of ischia, with the ligaments stretching from the sacrum to the ischial bones. In the back by the sacrum and coccyx and in the front by pubic symphysis.

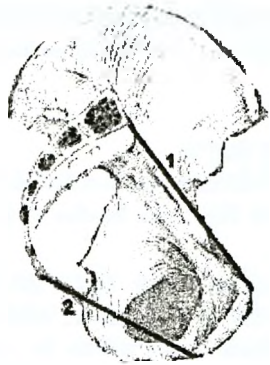


Fig.22. The pelvic inlet and pelvic outlet.
1- line from the sacral promontory to the upper pubic symphysis, represents the pelvic inlet; 2-line which extends from the coccyx to the lower border of the pubic symphysis, represents the pelvic outlet. Between the two lines is the true pelvis.

1

Dimensions of the female pelvis

During the childbirth the fetus has to pass through the true pelvis. The largest part of the fetus is the head. If the Dimensions of the true pelvis is not enough to pass fetal head through it, both mother and the fetus may die. Because of this fact we have to examine the expectant mother to make sure that the pelvis is of normal size.

The size of the greater and lesser pelvis in female is determined by measuring the distance with a pair of compasses (pelvimetry). The pelvic dimensions are measured at the inlet, in the mid-cavity and at the outlet. At each level, can measure a transverse diameter, an anteroposterior diameter and an oblique diameter. Mostly you should know the anteroposterior, transverse and oblique measurements for the inlet (brim) and outlet.

The size of the greater pelvis

1. *distantia spinarum*-the distance between the anterior superior iliac spines, 25-27 cm

2. *distantia cristarum* -the diameter between the most distant

parts of the upper flaring portion of iliac bone, 28-29cm.

3. *distantia trochanterica* -the distance between the two greater trochanters, 30-32 cm.

The size of the lesser pelvis

1. Anatomical conjugate diameter (conjugata anatomica) - from the tip of the sacral promontory to the upper border of the symphysis pubis. = 11.5cm

2.Obstetric conjugate (conjugata vera -true conjugate) - from the tip of the sacral promontory to the most bulging point on the back of symphysis pubis, which is about 1 cm below its upper border. It is the shortest antero-posterior diameter= 11 cm

3. Transverse diameter of the inlet of lesser pelvis is the distance between the most remote points the pelvic brim. =13 cm

Oblique diameter of the inlet of lesser pelvis is the distance

4.between the sacroiliac joint of one side and iliopubic eminence of the other=12 cm. the pelvic brim

5-Diameter recta - anteroposterior diameter of lesser pelvic outlet -the distance between the apex of the coccyx and the inferior border of the symphysis'(9-11 cm) fig-21

6- Transverse diameter of the pelvic outlet-diameter between the medial borders of the ischial tuberosities

It is important to know the exact orientation of the pelvis in the body. The front of the symphysis pubis and the anterior superior iliac spines should lie in the same vertical plane. (The pelvis can be so held by placing it against any vertical surface with the points mentioned above touching it.) When the pelvis is orientated in this way the pelvic inlet faces forwards and upwards, its plane being at an angle of 50 to 60 degrees with the horizontal plane. The pelvic outlet faces downwards and slightly backwards, making an angle of about 15 degrees with the horizontal plane. The axis of the pelvic passage is a curved one corresponding to the curve of the sacrum.

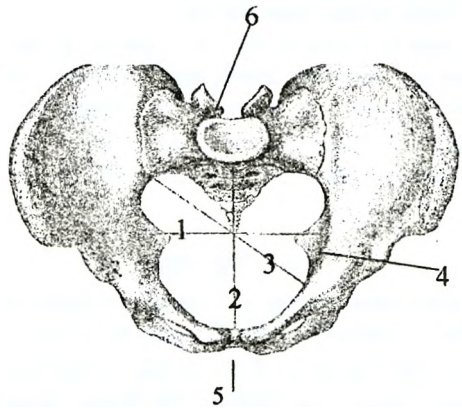


Fig.23. The size of the pelvic inlet.
1-anatomical transverse diameter=13 cm;2-antero-posterior diameter= 11cm; 3-Oblique diameter =12 cm;4-Ischial spine; 5- Pubic symphysis; 6-Sacrum

1

Sex differences in pelvis

The female pelvis shows differences from the male, which are mainly related to the childbearing function.

In the female pelvis:

1. Pelvic inlet is almost circular – the sacral promontory does not protrude into the inlet. In the male, this protrusion makes the inlet heart-shaped.

2. The sacrum has larger alae, making the inlet broader. The body of the sacrum appears relatively smaller; this is also because of the smaller average size of the female pelvis.

3. Greater sciatic notch is wide and deep, in the male it is narrow.

4. The distance from pubic symphysis to anterior margin of acetabulum is longer than the total width of acetabulum. In male the distance from pubic symphysis to anterior margin of acetabulum and total width of acetabulum are equal.

5. The subpubic angle is wider. Almost 90^0 in female while $50\text{-}60^0$ and sharp in male.

6. The bones of the female pelvis are generally thinner and smoother than those of the male pelvis.

The principal function of the bony pelvis is that of a bony member intermediate between the trunk and the lower limbs, and the services it renders include transmitting the weight of the body to the limbs, absorbing the stresses of muscular activity in the erect posture and at the same time, encloses a cavity containing the viscera.

The hip Joint

The hip joint *(art. coxae)* is a synovial joint of spheroidal type ("ball and socket", cotyloid joint). It consists of the articulation of the globular head of the femur in the cup-like acetabulum (its facies lunata) of the coxal bone. The head of the femur forms two-thirds of a sphere. It is covered by an articular cartilage, which is thickest above, in the line of weight bearing. More than half of the femoral surface is contained within the acetabulum

The articular capsule of the hip joint is strong and dense. On the anterior side of the joint Proximally, it is attached to the edge of the acetabulum, just distal to the acetabular labrum, and to the transverse acetabular ligament. Distally, the fibrous capsule is attached to the neck of the femur as follow: anteriorly to the intertrochanteric line and the root of the greater trochanter; posteriorly to the neck proximal to the greater trochanter and posterior to the neck proximal to the intertrochanteric crest.

The hip joint has also intra-articular ligaments;

1) The ligament of the head of the femur *(lig. capitis femoris)* - is attached to the transverse acetabular ligament and extends to the fovea centralis on the head of the femur (fovea capitis femoris).

2) The transverse ligament of the acetabulum, which arises from the two margins of the acetabular notch at the lower part of the acetabulum. A synovial sheath rising over it from the floor of the acetabulum covers the ligament of the head. Most of the fibers of the capsule are longitudinal, running from the pelvis to the femur, but some deeper fibers run circularly (zona orbicularis). These zona orbicularis fibers are most marked in the posterior part of the capsule and help to hold the head in the acetabulum.

The longitudinal fibers.

1. The iliofemoral ligament *(lig. iliofemorale)* lies on the anterior surface of the capsule. It is strong and has the form of an inverted Y. Its apex is attached to the anterior inferior spine of the ilium between the two heads of the rectus femoris muscle and its diverging fibers attach to the whole length of the intertrochanteric line. It resists extension and prevents the body from falling backward when walking erect.

2. The pubofemoral ligament *(lig. pubofemorale)* - is applied to the inferomedial aspect of the capsule; it stretches from superior ramus of the pubis, just above the obturator foramen to the lesser trochanter and blends with the capsule. It resists abduction and limits lateral rotation.

3. The ischiofemoral ligament *(lig. ischiofemorale)* - this ligament forms the posterior free margin of the capsule. It arises from the ischial portion of the acetabulum and spirals lateral ward and upward across the posterior part of the neck of the femur. The fibers insert into the superior portion of the neck of the femur medial to the root of the greater troch l adduction of the thigh.

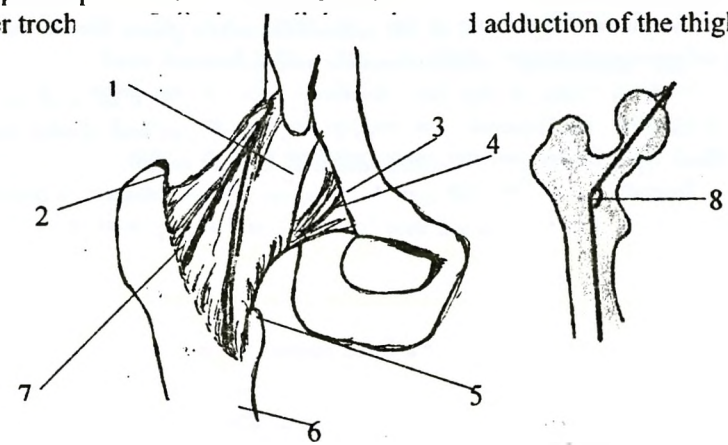


Fig.24. The anterior aspect of hip joint.
1-Ileofemoral ligament; 2-Greater trochanter of femur; 3-Pubic bone; 4-Pubofemoral ligament; 5-Lesser trochanter ; 6-femur; 7-Inter trochanteric line ;8- Angle of neck on shaft of femur

The great number of ligaments and the more pronounced curva-

ture and congruence of the articulating surfaces of the hip joint, as compared to the shoulder joint, make movements at the hip joint less free than those at the shoulder.

The angle formed by the femoral neck and the diaphysis can be determined by X-ray. It is larger in children, smaller in old people and it is smaller in females than in males. Angle of neck on shaft of femur child 160^0, male 120^0, female 100^0

Movement - extension and flexion through a transverse axis, abduction and adduction through a sagital axis, and medial and lateral rotation through a vertical axis. Circumduction is also allowed.

The hip joint receives its blood supply from small vessels, which reach it by running up the neck of the bone after passing under the attachment of the capsule. The arteries that supply the hip joint are:

The medial and lateral circumflex femoral arteries -from the deep femoral artery

The obturator artery which from the network (rete articulare)

Inferior gluteal artery

The posterior branch of the obturator artery gives rise to the artery of the ligamentum capitis femoris to the femoral head.

Venous blood drains into the deep veins of the thigh and pelvis, the deep femoral, femoral, and interal iliac veins. *Lymph drains* along the deep lymphatics into the deep inguinal lymph nodes.

Innervations- The hip joint is supplied by the femoral, obturator, sciatic, nerve, nerve to quadratus femoris , and direct branches of sacral plexus

The knee Joint

The knee joint *(art. genus)* is an articulation between the condyles of the femur and the superior articular surface of the tibia (tibiofemoral joints) as well as the lower anterior end of the femur and the patella (the femoropatellar articulation). The articulation between the femur and tibia is essentially a hinge joint with a very small amount of rotation. The articulation between the femur and patella is a plane joint where the patella glides on the femur.

The menisci of the knee joint

The knee joint contains lateral and medial intra-articular cartilages called menisci *(menisci lateralis* and *medialis) that* interposed

between the femoral condyles and the articular surfaces of the tibia. Medial meniscus firmly attached to the tibial collateral ligament. These act like shock absorbers. Because they are basically C-shaped, they were formally called semilunar cartilages The lateral meniscus is smaller and more freely movable than the medial meniscus, but it covers a larger area of articular surface than does the medial meniscus. The menisci inserted between the femur and tibia divide the joint into the superior and anterior parts (articulationes meniscofemoralis and meniscotibialis.

The inner edges of menisci are thin and attached to the intercondylar eminence (which separate condyles of tibia). The front edges of the menisci are connected by the transverse ligament *(lig. transversum genus)* of the knee.

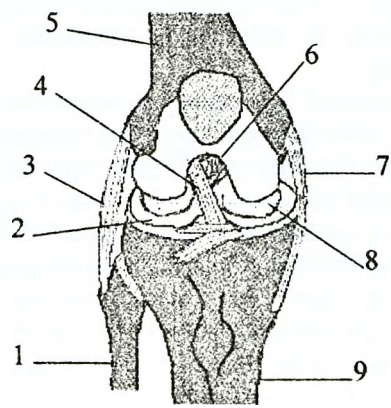


Fig.25. Front view of knee joint
1-fibula; 2-lateral meniscus; 3- lateral collateral ligament; 4- anterior cruciate ligament; 5-femur; 6-posterior cruciate ligament; 7- medial collateral ligament; 8- medial meniscus; 9-tibia

The articular capsule is attached at some distance (1 cm) from the edges of the femoral, tibial and patellar articular surfaces. On the femur it stretches in front upward, by passing the facies patellaris. On the sides it passes between the condyles and epicondyles with the latter left outside the capsule for attachment of muscles and ligaments, and at the back it descends to the edges of the condylar articular sur-

face. In addition, in front the synovial membrane forms a large recess, the suprapatellar bursa *(bursa suprapatellaris),* extending rather high between the femur and the quadriceps muscle of the thigh. Sometimes the suprapatellar bursa may not communicate with the knee joint and may be separated from it.

Ligament.

The knee joint has the following ligaments

I. Extracapsular ligaments- medial collateral ligament, lateral collateral ligament, patellar ligament and oblique popliteal ligament, arcuate popliteal ligament

II. Intracapsular ligaments -anterior and posterior cruciate ligament, transverse ligament, posterior meniscofemoral ligament.

The tibial collateral ligament (ligamentum collaterale tibiale) extends from the medial epicondyle of the femur to the medial condyle of the tibia and fuses with the capsule and the medial meniscus. This ligament (also known as the medial ligament) is a strong, flat band, 8 to 9 cm long.

The fibular collateral ligament (ligamentum collaterale fibulare) passes on the lateral side between the lateral epicondyle of the femur and the fibular head. The fibular collateral ligament is about 5 cm long and has the shape of a round cord, which is not attached to the articular capsule but is separated from it by a pad of fat.

The posterior reinforcement of the capsule provided by arcuate popliteal ligament *(lig. popliteum arcuatum)* and the oblique popliteal ligament *(lig. popliteum obliquum).* Arcuate popliteal ligament begins on the posterior surface of the head of the fibula then, curves medially and attaches to the posterior surface of the tibia. The oblique popliteal ligament is one of the three end bundles of the tendon of the semimembranous muscle.

Patellar ligament *(lig. patellae)* is the continuation of the tendon of the quadriceps femoris muscle, which passes downward from the apex of the patella and is attached to the tuberosity of the tibia. This ligament is separated from the articular capsule by fatty tissue, which also serves as the foundation for the alar folds *(plicae alares)* of the synovial membrane. On the sides of the patella, expansions of the tendon of the quadriceps muscle form the *lateral* and *medial patellar ligaments (retinacula patellae laterals* and *medialis),* which is made up of vertical and horizontal bundles. The vertical bundles are at-

tached to the tibial condyles, the horizontal to both femoral epicondyles. These bundles hold the patella in place during movement.

Intracapsular ligaments.

1. The anterior cruciate ligament *(lig. cruciatum anterius), which connect* the medial surface of the lateral femoral condyle of the femur with the area intercondylaris anterior tibiae.

2. The posterior cruciate ligament *(lig. cruciatum posterius),* which extends from the area behind the tibial intercondylar eminence to the lateral side of the medial condyle of the femur.

Movement: main movement at the knee joint it flexion and extension but when the knee is bent with the foot on the ground, some rotation of the distal end of the femur is possible on the upper end of the tibia. In flexion the menisci straighten out, while the collateral ligaments relax because the points of their attachment come closer to each other. The posterior cruciate prevents the movement of the femur forward on the tibia and the anterior cruciate prevents the movement backward. Medial meniscus does connect to the fibular collateral ligament but lateral meniscus does not connect to the tibial collateral ligament so if the tibial collateral ligament is damaged, the medial meniscus could easily be damaged with it.

Menisci Blood supply by the rete articulare;

1. From popliteal artery-, which is formed by the medial and lateral superior genicular arteries, the medial and lateral inferior genicular arteries, the middle genicular artery

2. From the femoral artery-the descending genicular artery

3. From the anterior tibial artery- the anterior and posterior tibial recurrent arteries.

The *venous blood drains* into the deep veins of the lower limb, the anterior tibial, popliteal, and femoral veins. Its lymphatics drain to the popliteal and inguinal node groups.

Innervation. From the femoral nerve, articular branches reach the joint by way of the nerves to the vastus muscles and through the saphenous nerve. The posterior division of the obturator nerve, after supplying the adductor magnus muscle, ends in the knee joint. Articular branches arise from both the tibial and common fibular (peroneal) nerves.

Synovial bursa.

A bursa is a synovial closed fibrous sac lined with a smooth membrane, producing a viscous lubricant known as synovial fluid. Bursas are found in regions where muscles or tendons rub against other muscles, tendons, or bones. The bursas function in two ways, lubricating points of friction, and dissipating force by distributing it through a fluid medium. Normally, the bursas produce just enough synovial fluid to reduce friction. However, constant irritation may lead to oversecretion and consequent enlargement of the bursa, a condition known as bursitis. In the hand and foot, the bursa assumes a tubular form. Called the synovial sheath, the structure encloses the tendons along their entire length

Synovial bursa (bursae synoviales) of the knee joint.

Several bursae are present around the knee because most tendons around the knee joint run parallel to the bones and pull lengthwise across the joint. Four bursae are situated in front of the joint and six are found behind the joint. Some of them communicate with the synovial cavity of the knee joint; they lie deep to the tendons of the quadriceps femoris, the popliteus, and the medial head of the gastrocnemius muscle

1. The subcutaneous prepatellar bursa *(bursa subcutanea prepatellaris);* this bursa lies between the skin and the anterior surface of the patella. It allows free movement of the skin over the patella during flexion and extension of the leg.
2. The suprapatellar bursa - This large saccular extension of the synovial capsule passes superiorly between the femur and the tendon of the quadriceps femoris muscle. The clinically important suprapatellar bursa extends about 8 cm superior to the base of the patella.
3. The superifical infrapatellar bursa -This bursa is located between the skin and the front of the lower part of ligamentum patellae.

It allows the skin to glide over the tibial tuberosity and withstand pressure when kneeling with the trunk upright (e.g., when one kneels or genuflects during praying).

4. The deep infrapatellar bursa *(bursa infrapatellaris profunda)*, which does not communicate with the joint. This small bursa lies between the patellar ligament and the anterior surface of the tibia, superior to the tibial tuberosity

In the posterior region of the joint, bursae are encountered under

the sites of attachment of almost all muscles (the Popliteus bursa, the anserine bursa, the gastrocnemius bursa, the semimembranosus bursa)

Articulations between the tibia and the fibula

The union of the tibia and the fibula may be divided in to three parts: the tibiofibular articulation at their proximal ends, a connection between their shafts by means of an interosseous membrane, and the distal tibiofibular syndesmosis.

1.The proximal union of the tibia and fibula *(art. tibiofibularis proximalis)* is a plane joint. The flat, oval-to-circular facet on the head of the fibula articulates with a similar facet located posterolaterally on the inferior aspect of the lateral condyle of the tibia.

The fibrous capsule surrounds the joint and is attached to the margins of the articular facets on the fibula and tibia and strengthened by anterior and posterior ligament of the head of the fibula *(ligamenta capitis fibulae anterius* and *posterius)*. The fibres of these ligaments run superomedially from the fibula to the tibia. The joint cavity can communicate with the knee joint.

Movement: Slight movement occurs at the superior tibiofibular joint during dorsiflexion of the foot at the ankle joint.

Blood supply: The articular arteries are derived from the inferior lateral genicular and anterior tibial recurrent arteries.

Inervation:The articular nerves are derived from the common fibular (peroneal) nerve and the nerve to the popliteus muscle

2.The interosseous membrane of the leg *(membrana interossea cruris)* extends between the interosseous borders of the tibia and the fibula. It closes almost the entire space between the bones but has an opening in the upper part through which the vessels and the nerve pass. Small openings are also found in its lower part.

3.The distal tibiofibular joint (fig-25). This is a fibrous joint of the syndesmosis type. The rough, convex, triangular articular area on the medial surface of the inferior end of the fibular articulates with a facet on the inferior end of the tibia. A small superior projection of the synovial capsule of the ankle joint extends into the inferior part of the distal tibiofibular joint. This articulation is strengthened by anterior and posterior tibiofibular ligaments *(ligamenta tibiofibularis anterius* and *posterius)*, which extend from the border of the fibular notch of

the tibia to the anterior and posterior surfaces of the lateral malleolus, respectively. Each *ligament* inclined downward and lateral ward. When we compare joints between the forearm bone and leg bone, the mobility of the leg bones is extremely limited because the lower limb is concerned with the function of weight bearing and is a strong support for the body.

Movement: Slight movement occurs during movement at the ankle joint

Blood Supply-The articular arteries are derived from the perforating branch of the fibular (peroneal) artery and the medial malleolar branches of the anterior and posterior tibial arteries

Nerve Supply -the articular nerves are derived from the deep fibular (peroneal), tibial nerves.

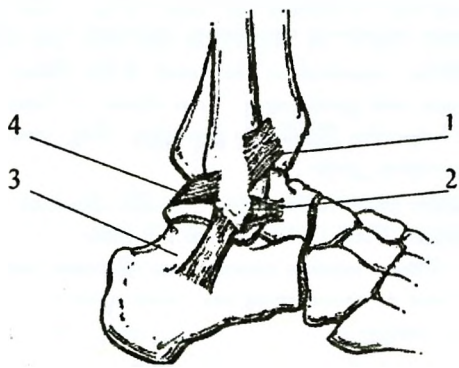


Fig.26. The distal tibiofibular and ankle joint lateral side 1-Anterior tibiofibular ligament; 2-the anterior talofibular ligament ;3-calcaneofibular ligament ; 4-the posterior talofibular ligament.

Joints of the bones of the foot

The bones of the foot form articulations with the leg, articulations of tarsus, metatarsus, phalanges and may be divided into:

I. Ankle joint (art. talocruralis); - Joint of the foot with the leg bones

II.Articulation of tarsus, or intertarsal (art. intertarsales)- Joints between the bones of the tarsus which include; a) sub talar b) talocalcaneonavicular c) transverse tarsal d) calcanecuboid e)cuneonavicular

III. Joints between the bones of tarsus and metatarsus - tarsometatarsal joints (art.tarsometatarseae) and joints between the bones of the metatarsus (art. intermetatarseae) .

IV. Joints of the toe bones mettatarsophalangeal (articulationes metatarsophalangeae)

V. Interphalangeal joints (arti.interphalangeae pedis).

I. The talocrural or ankle joint *(art. talocruralis)* is a synovial joint of the hinge type. Ankle joint is an articulation between the articular surfaces of the distal ends of tibia, the medial and lateral malleoli, and the trochlea of the talus.

The lower articular surface of the tibia articulates with the facies articularis superior of the trochlea, while the articular surface of the tibial malleoli articulate with the articular surfaces on the sides of the talus.

Ligaments: Ankle joint is strengthened at the lateral and medial side by the following ligaments:

a. Lateral side. In the lateral side ankle joint consists of three separate ligaments (Fig26.) All begins from the lateral malleolus and spread into three different directions: forward, the anterior talofibular ligament *(lig. talofibulare anterius),* downward, the calcaneofibular ligament *(lig. calcaneofibulare),* and backward, the posterior talofibular *(lig. talofibulare posterius).* The anterior talofibular ligament is the most commonly injured ankle ligament.

b. Medial side. The strong ligaments, medial or deltoid ligament *(lig. mediale* or deltoideum), which resemble in shape the Greek letter delta, assure the stability of the joint. Deltoid ligament attached by its apex to the anterior and posterior borders and the tip of the medial malleolus with the bones of the foot, (navicular, talus, calcaneus bone).

According to their separate distal attachments there are four ligaments 1.anterior tibiotalar ligament, 2.tibio-navicular ligament, 3.tibiocalcaneal ligament, 4.posterior tibiotalar ligament.

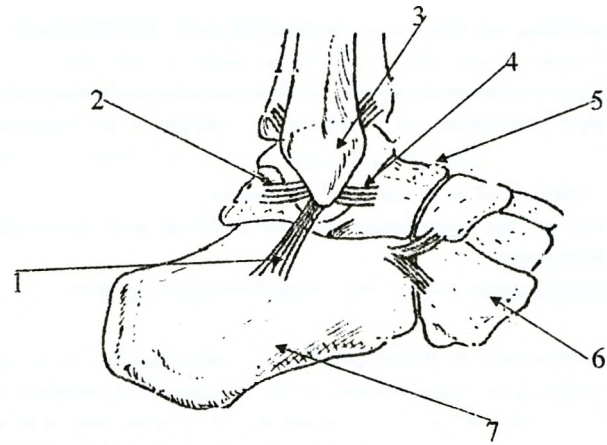


Fig.27. Ankle joint, lateral side.
1-calcaneofibular ligament ;2-the posterior talofibular ligament; 3-fibula; 4-the anterior talofibular ligament; 5- Talus; 6-cuboid; 7- calcaneus

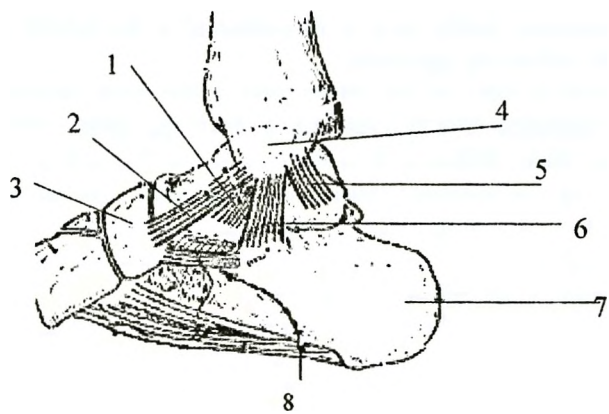


Fig.28. The medial ligaments of the ankle joint
Deltoid ligaments (1,2,5,6).1-Anterior tibiotalar ligament; 2-Tibionavicular ligament; 3-Navicular bone; 4-Medial malleolus;5-Posterior tibiotalar ligament ; 6-Tibiocalcaneal ligament ; 7-Calcaneus; 8-Plantar calcaneonavicular ligament.

Movement of ankle joint. In this joint two movements are possible dorsiflexion (extension) or plantarflexion (flexion). Slight movements to the sides are also possible.

Blood supply. The ankle joint receives its blood supply from the malleolar branches of the anterior tibial, fibular (peroneal), and posterior tibial arteries. *Venous blood drains* into the deep veins of the leg, the anterior and posterior tibial and peroneal veins. *Lymph drains* along the deep lymphatics into the popliteal lymph nodes.

Nerve supply.Branches from the tibial and deep peroneal nerves innervate the articular capsule.

II.Articulations of the tarsal bones

A) The subtalar joint *(art. subtalaris).* This joint is formed between the large concave facet on the under surface of the body of the talus and the convex posterior articular surface on the superior aspect of the calcaneus.

Type. -Synovial, of plane variety.

An articular capsule strengthened on the sides by medial and lateral talocalcaneal ligaments. The interosseous (talocalcaneal ligaments) is strong and the main bond of union between the two bones. It attached above the sulcus tail and below to the sulcus calcanei. The cavity does not communicate with any other joint.

Movements- gliding and rotary movements are possible.

B)The talocalcaneonavicular joint *(art. talocalcaneonavicularis)* a complex spheroid joint- *is located* to the front of the subtalar joint and is formed by articular surface of the head of talus, the navicular bone and the articular facet on the sustenaculum tali of the calcaneus.

The articular capsule attaches along the edges of articular surfaces and strengthened by the:

1.Plantar calcaneonavicular ligament *(lig. calcaneonaviculare plantare), which* is located between the sustenaculum and the posterior margin of the navicular bone.

2. Talonavicular ligament *(lig. talonaviculare)* strengthened the articular capsule on the dorsal surface of the neck of talus and navicular bone. Plantar calcaneonavicular ligament mentioned above serves as an accessory ligament on the plantar aspect. Between sulci of the calcaneus and talus there is a bony canal, sinus tarsi, which lodges a strong interosseous talocalcaneal ligament *(lig. talocalcaneum in-*

terosseum) .

Movements- gliding and rotary movements are possible.

C)The calcaneocuboid joint *(art. calcaneocuboidea)- this plane or* saddle *type joint is* formed by the articulation between the saddle-shaped facets of the anterior surface of the calcaneus and the posterior surface of the cuboid bone. It has a tightly stretched capsule strengthened by ligaments binding the articulating bones on the dorsal and plantar aspects.

1. The long plantar ligament (lig. plantare longum)-begins on the inferior surface of the calcaneus and attaches to the base of II-V metatarsal bone.

2. The calcaneocuboid ligament *(lig. calcaneocuboideum),* is attached to the dorsal surface of the cuboid bone. The calcaneocuboid joint together with the talonavicular (which are part of talocalcaneonavicular joints) are usually described under the common name transverse tarsal joint *(art. tarsi transversa)* or Chopart's joint. The Chopart's joint resemble to a Latin letter S placed transversely.

Chopart's joint has a bifurcate ligament *(lig. bifurcatum),* which begins posteriorly on the upper lateral border of the calcaneus and then separates into two parts, calcanonavicular and calcaneocuboid ligament. This short and strong ligament is called "key" of the Chopart's joint since only when this ligament has been cut, the articular surfaces be drawn widely apart in an operation for the exarticulation of the foot at this joint.

Movements in the joint of the foot

In medial rotation of the foot (eversion), its lateral border is raised, while the dorsal surface faces medially; in contrast, in lateral rotation (inversion) the medial border is raised, and the dorsal surface of the foot faces laterally. In addition, abduction and adduction on the vertical axis can take place, with the tip of the foot displaced medially or laterally from the midline. Finally, dorsal and plantar flexion can occur on the frontal axis

D. The cuneonavicular joint *(art. Cuneonavicularis)* is formed by articular surface of the navicular bone and three cuneiform bones. It is a synovial joint of gliding variety. All these articular surfaces are enclosed in a single common capsule, and the joint cavity extends between the opposed surfaces of the cuneiform bones. Between the medial and intermediate cuneiform bones, the cavity often communicates

with the second and third tarsometatarsal joints.

The cuneonavicular joint is strengthened on the dorsal and plantar surfaces by dorsal and plantar cuneform ligaments, interosses intercuneiform ligaments, dorsal and plantar intercuneiform ligaments, that stretch between the bones forming this joint and are designated accordingly.

Movement: Movement is very slight. Usually combined so that during supination, the anterior part of the foot is also adducted and slight plantar flexion occurs, pronation is attended by abduction and dorsiflection. Generally the ankle joint, together with the intertarsal joints, permits freedom of movement of the foot as a multiaxial joint.

III. The tarsometatarsal joints *(art. tarsometatarsales,*Lisfranc's joint),. These joints are formed between the adjacent surfaces of the distal row of tarsal bones (the three cuneiform, cuboid bones) and the bases of the metatarsal bones. It is a synovial joint of plane variety. These articulations include three independent, isolated tarsometatarsal joint cavities

1) The medial one is a separate cavity for the joint between the first metatarsal and the medial cuneiform bone.

2) The intermediate joint includes the articulations of the second and third metatarsal bones with intermediate and the lateral cuneiform bones.

3) The lateral articular cavity includes the articulations of the fourth and fifth metatarsal bones with the cuboid bone. The capsules are attached along the edges of articular surfaces.

The tarsometatarsal joints are strengthened by-

Weak dorsal tarsometatarsal ligaments(*(ligamenta tarsometatarsalia dorsalia,)* pass between adjacent surfaces of the bones concerned, each metatarsal bone receiving a slip from each tarsal bone with which it articulates.

Plantar tarsometatarsal ligaments *(ligamenta tarsometatarsalia plantaria,)* are less regularly arranged and consist of both longitudinal and oblique bands.

Two or three interosseous cuneometatarsal ligaments (*cuneometatarsea interossea).* The first ligament passes from the lateral surface of the medial cuneiform to the adjacent angle of the second metatarsal bone and called key of the Lisfranc's joint. The second ligament, small and inconstant, connects the lateral aspect of the sec-

ond metatarsal bone with the lateral cuneiform bone. The third interosseous ligament connects the lateral angle of the lateral cuneiform to the adjacent side of the base of the third metatarsal bone.

The intermetatarsal joints *(articulationes intermetatarseae)* are formed between adjacent surface of base of the metatarsal bones. It is a synovial joint of plane variety. The joint cavities of intermetatarsal joints often communicate with the cavity of the tarsometatarsal joints. The joints are strengthened by transverse dorsal, plantar and inteross metatarsal ligament (ligamenta metatarsea dorsalia, plantaria and interossea).

Movement- very limited

Metatarsophalangeal joints *(articulationes metatarsophalangeae)* are condyloid joints. These joints are formed between the rounded heads of the metatarsal bones and the cupped posterior extremities of the proximal phalanges. Resemble the analogous joints of the hand in their structure and in the ligamentous apparatus.

Movement -The movements permitted in the metatarsophalangeal joints are dorsiflexion, plantar flexion, extension, abduction, adduction, and circumduction. The capsule is strengthened by collateral ligament, plantar ligament and deep transverse metatarsal ligament.

Movemen-flexion, extension and abduction and adduction within limited volume.

The interphalangeal joints *(articulationes interphalangeae pedis) hinge joint*-are similar to the metatarsophalangeal articulations. Each joint is provided with an articular capsule and with plantar and collateral ligaments. It should be pointed out that synostosis of the distal and middle phalanges of the little toe is often encountered.

Movement- dorsiflexion and plantar flexion.

Blood supply.

The joints of the foot get blood supply by branches of the arcus plantaris and rete plantaris profundus a. dorsalis pedis. The *venous blood drains* into the deep veins of the lower limb, vv. tibiales anterior and posterior and v. peronea. *Lymph drains* along the deep lymphatics into the popliteal lymph nodes. *Innervation* of the articular capsules is supplied by branches of the medial and lateral plantar nerves and the musculocutaneous and anterior tibial nerves.

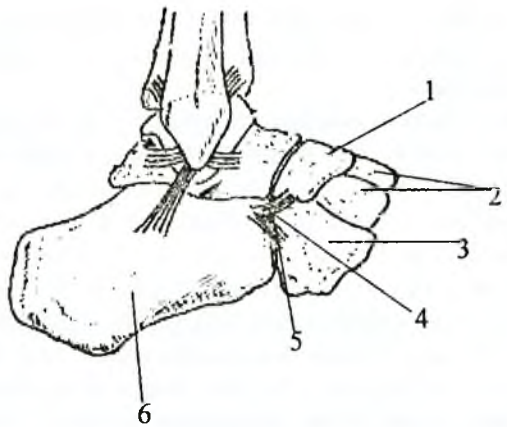


Fig.29. The lateral side of ankle joint, the tibiofubular syndesmosis and dorsal side of tarsal joint .
1-navicular bone; 2-inter mediate and lateral cuneiform bone; 3-cuboid bone; 4- Calcaneocuboid ligament 5-calcaneonavicular ligament (4-calcaneocuboid ligament and5-calcaneonavicular ligament are called *Bifurcate Ligaments*. 6 – calcaneum.

The foot as a whole.

The foot is strong to support the weight of the body, but it is also flexible and resilient to absorb the shocks transmitted to it and to provide spring and lift for the activities of the body. The joints and ligaments, together with muscle action, provide for spring, for they yield when weight is applied and recoil when the weight is removed. It has an arched structure composed of a number of bones and their interconnecting joints.

The bones of the foot are arranged in five longitudinal and one transverse arches. The longitudinal arch is supported posteriorly on the tuberosity of the calcaneus and, anteriorly, on the heads of the metatarsal bones. Each longitudinal arch is made up of one metatarsal bone (the first in the first arch, the second in the second arch, etc.) and parts of the tarsal bones located between it and the tuberosity of the calcaneus. The sustentaculum tali play an important role in the formation of the first (medial longitudinal) arch. The second arch is the longest and the highest of all the longitudinal arches. At the level of the highest points of the longitudinal arches is transverse arch. The transverse arch results from the shape of the tarsal bones of the distal row (cuboid, the three cuneiform and of the bases of the metatarsal bones. The arches of foot are maintained by the shape and arrangement of the bones, by ligament, muscles and fasciae.

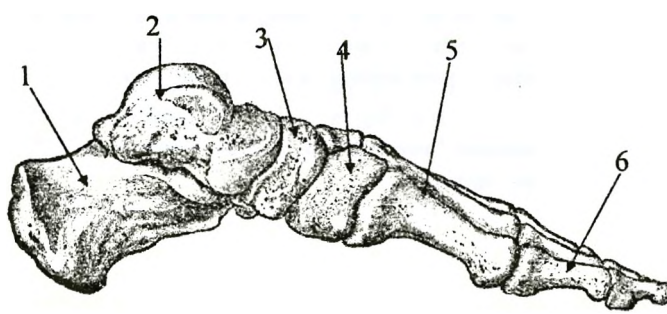


Fig. 30. foot as a whole
1. calcaneus 2. talus 3.navicular. 4. medial cuneiform 5.first1 metatarsal 6 phalanges

Ligament

The long plantar ligament *(lig. plantare longum)* plays the decisive role in strengthening the arch of the foot. It originates from the inferior surface of the calcaneus, and attaches to the tuberosity of the cuboid bone and to the base of the metatarsals.

Bridging the sulcus in the cuboid bone, the long peroneal ligament converts it to an osteofibrous canal through which the tendon of the long peroneal muscle passes.

The muscles are active supporter of the arches. The longitudinally arranged muscles shorten the foot, while the oblique and transverse muscles make it narrower. Such a two-way effect exerted by the tightening muscles preserves the arched form of the foot, which acts as a spring and lends elasticity to the gait. When the apparatus described loses its strength, the foot becomes flat. The resulting faulty structure called flat-foot and it is painful.

The complex of the foot bones are connected by tight joints, and permit almost no movement, which is called "the *hard foundation of the foot*".

The *hard foundation of the foot* consisting of ten bones: the navicular bone, the medial, intermediate, and lateral cuneiform bones, the cuboid bone, and the first, second, third, fourth, and fifth metatarsal bones.

Frequently used terms in arthrology

Arthrology-the scientific study of joints

An articulation is a point of contact between two bones.

Bursae- is a fluid-filled sac found between skin & bone, tendons & bone, muscles & bone, and ligaments & bone. Their functions are to reduce friction between soft tissue and bones, and bones, and between the skin and bones (between moving parts at joints). The wall of the bursa is connective tissue and the fluid inside is similar to synovial fluid.

Ligament- is a band of fibrous connective tissue, which connects the bones to each other. Sometimes bands of connective tissue which support the viscera or the thorax or abdomen are also known as ligaments.

Meniscus- a cartilage disk between certain joints for shock absorbtion, cushioning, and stability

Synovial joint -a joint in which there is a space between the articulating bones articular cartilage- is glassy-smooth hyaline cartilage that covers the ends (the epiphyses) of the bones in synovial joints.

Synoval capsule - the outer layer or fibrous capsule which consists of dense irregular connective tissue, that attached to the periosteum of the neighboring bones.

Synovial membrane-the inner layer of the synoval capsule (articular capsule) which secrets synovial fluid.

Synoval cavity- a space between the articulating bones, which contains synovial fluid.

Tendons -are tough bands of connective tissue which connects end of a muscle to the bone.

Main joints of the body

Shoulder (glenohumeral) Joint- (Ball and Socket Type) -formed by head of the humerus and glenoid cavity of scapula. Movement involves flexion-extension, abduction-adduction, medial rotation, lateral rotation, and circumduction.

Elbow Joint- (Hinge Type)-Formed by trochlea of humerus, trochlear notch of the ulna, and the head of the radius. Movement is flexion and extension of forearm.

Wrist (radiocarpal) Joint- (Condyloid Type) -formed by distal end of radius, and numerous carpal bones. Movement is flexion-extension, abduction-adduction, circumduction, and rotation

Hip (coxal) Joint- (Ball and Socket Type) -formed by head of femur and acetabulum of hipbone. Movements are flexion-extension, slight medial rotation, and lateral rotation in flexed position.

Knee (tibiofemoral)- (Hinge/ Gliding Type) Formed by three joints; (1) Between lateral condyle of femur, lateral meniscus, mad lateral condyle of the tibia. (2) Patellofemoral joint between patella and patellar surface of femur (3) a medial tibiofemoral joint between medial condyle of femur, medial meniscus, and medial condyle of tibia. Movement involves flexion-extension, slight medial rotation, and lateral rotation in fixed position.

Ankle (talocrural) Joint- (Hinge Type) Formed by two joints as well: (1) Between distal end of tibia and the tallus. (2) Formed lateral malleolus of the fibula and the tallus. Movement involves dorsiflexion and plantar flexion.

Types of synovial joints

1. Ball-and-socket: globular/spheroidal surface of one bone articulates with a cup-shaped surface of another bone; triaxial. (Having movement in three planes and three axes) ex. shoulder and hip joint

2. Ellipsoidal (condyloid): oval-shaped surface of one bone articulates with an elliptical surface of another bone; biaxial (two planes and two axes).ex. joint between radius and carples

3. Saddle (Sellar): articulating surfaces have both concave and convex regions; surface of one bone fits complementary surface of another; biaxial (two planes and two axes).ex. meticarples of the thumb

4. Gliding (Arthrodial): articulating surfaces are nearly flat; nonaxial ex. tarsals, carpals

5. Hinge (ginglymal): convex (cylindrical) surface of one bone articulates with concave surface of another; uniaxial (one plane, one axis).ex elbow, knee, and interphalangeal joints of the fingers

6. Pivotl (trochoid): cylindrical surface of one bone rotates within a ring formed of bone and ligament; uniaxial one axis of movement with rotation as in the pronation/suppination of the radius with the humerus and the atlantoaxial joint in spine

Clinical considerations

1. Dislocation: displacement of a bone within a joint; partial (subluxation) or total (luxation)

2. Sprains: overstretching or tearing of connective tissue associated with a synovial joint. e.g overstretching ligaments

3. Strain: overstretching muscle

4. Tendonitis: inflammation of a tendon sheath

5. Bursitis: inflammation of a bursa

6. Arthritis: inflammation of a joint(s)

I. Rheumatoid arthritis: an autoimmune disease of joints

a. Autoimmune disease involving synovial joints

b. Characterized by inflammation of the synovial membrane

c. Typically bilateral, affecting small joints of hands and feet

d. Genetic in nature, relatively early age of onset

II. Osteoarthritis: bone deposition in a joint

Multiple-choice questioning for self-preparation:

1. Which spinous process is an exact reference point to determine the number of vertebrae?
    1. C I
    2. C V
    3. C VII
    4. Th I
    5. L III

2. Along which margin of the ribs carried out pleural puncture of thorax?
    1. Lateral
    2. Medial
    3. Superior
    4. Inferior
    5. Posterior

3. Determining the skeletotopy of the lung on the scapular lines, which ribs are located under the inferior angle (corner) of scapula?
    1. III ribs
    2. V ribs
    3. VII ribs
    4. IX ribs
    5. X ribs

4. Connective tissue sacs, which decrease friction, are referred as
    1. Bone and tendons
    2. Menisci
    3. Ligaments
    4. Tendons
    5. Bursae

5. The Alar ligaments extend from the:
    1. Dens to the occipital bone
    2. Body of the axis to the occipital bone
    3. Atlas to the temporal bone
    4. Axis to the atlas
    5. C3 to the Atlas

6. Which anatomical structure of the bone can be palpated on the pelvic griddle?
    1. Iliac crest

2. Pubic symphysis
3. Acetabulum
4. Sacroiliac joint
5. Sciatic notch

7. The movement of a bone around its long axis is an example of
1. Flexion
2. Circumduction
3. Protraction
4. Rotation
5. Elevation

8. The upper jaw is connected by suture to the following bones:
1. Nasal
2. Frontal
3. Sphenoid
4. Temporal
5. Hyoid

9. Which of the following belong to synovial joints?
1. Tempero mandibular
2. Pivot
3. Gliding
4. Ball and socket
5. Symphysis

10. Which of the following ligaments change the greater sciatic notch into the foramen?
1. Interosseous sacroiliac
2. Sacrospinous
3. Dorsal sacroiliac
4. Ventral sacroiliac l
5. Arcuate

11. The greatest freedom of movements is observed in:
1. Shoulder joint
2. Elbow joint
3. Hip joint
4. Knee joint
5. Radiocarpal

12. Which of the following are plane joints, according to the shape of articular surfaces?
1. Atlanto-axial

2. Zygaphophysial
3. Sternocostal
4. Knee
5. Elbow

13. In temporomandibular joint the following movements are possible:
1. Downward movements (opening of the mouth)
2. Protraction
3. Abduction
4. Adduction
5. Upward movements

14. The following anatomical structure of the knee joint is intra-articular?
1. Meniscus medialis
2. Lig. trasversum genus
3. Plicae alares
4. Lig. collaterale fibulare
5. Lig. cruciatum posterius

15. Boundary of pelvic outlet is:
1. Apex of coccyges
2. Interpubic disc
3. Ischial ramus
4. Inferior ramus of pubic bone
5. Sacrotuberal ligament

16. Between the following vertebrae, intervertebral disc is present
1. First and second cervical vertebra
2. Last cervical and first thoracic vertebra
3. Last thoracic and first lumbar vertebra
4. Last lumbar vertebra and sacrum
5. Last sacral and first coccyx.

17. The tubercle of a typical rib articulates with the facet on the transverse process of
1. Its own vertebra
2. Vertebra above
3. Vertebra below
4. Vertebra above and below
5. Typical rib does not articulates with vertebrae

18. Which of the following ribs do not articulate with the transverse process of vertebra?

1. First
2. Second
3. Tenth
4. Eleventh
5. First and second

19. All of the following statements regarding manubriosternal joints true except
    1. It is a symphysis type of joint
    2. In about 30% of people it shows synovial joint cavity
    3. It moves slightly during respiration
    4. The sternal angle indicates manubriosternal joint
    5. It is a joint between manubrium and sternum
20. What type of joint sacroiliac is?
    1. Primary cartilaginous
    2. Secondary cartilaginous
    3. Plane synovial
    4. Ellipsoid
    5. Ball and socket
21. In syndesmosis which of the following structures connects the two bones?
    1. Collagenous sutural ligament
    2. Collagenous interosseous ligament
    3. Hyaline cartilage
    4. Fibrocartilage
    5. Elasic cartilage
22. All of the following joints are symphyses
    1. Acrdmioclavicular
    2. Intervertebral
    3. Pubic symphysis
    4. Manubriosternal
    5. Elbow
23. Synostosis can be defined as union of bones with:
    1. Interosseous ligaments
    2. Hyline cartilage
    3. Fibrocartilage
    4. Bone
    5. Muscle

24. What type of joint is present between the epiphysis and diaphysis of long bones?

1. Primary cartilaginous
2. Secondary cartilaginous
3. Synovial
4. Fibrous
5. Un known

25. Which of the following is not a source of nourishment of articular cartilage?

1. Direct arterial supply
2. Synovial fluid
3. Vascular plexus in synovial membrane
4. Blood vessels in adjacent marrow spaces
5. There is no nourishment

26. First sternochondral joint is

1. A permanant synchondrosis
2. A temporary synchondrosis
3. Fibrocartilaginous joint
4. Syndesmoses joints
5. Ball and socket joint

27. In synovial joints the articular surfaces of bones are covered by

1. Synovial membrane
2. Articular cartilage
3. Joint capsule
4. Periosteum
5. Muscle

28. Which of the following joints shows the presence of an articular disc?

1. Ankle joint
2. Elbow joint
3. Wrist joint
4. First carpometacarpal joint
5. Temporomandibular joint

29. Which of the following joints does not show the presence of articular disc?

1. Temporomandibular
2. Wrist
3. Sternoclavicular

4. Elbow
5. Shoulder

30. All of the following statements regarding hinge joint are correct except
1. They move only in one axis
2. They permit extension and flexion only
3. Bones are joined by strong collateral ligaments
4. The articular capsule of these joints is very thick
5. It is hinge type

31. Condyloid joints are
1. Uniaxial
2. Biaxial
3. Multiaxial
4. Immobile
5. There are no condyloid joints in humanbeng.

32. The following joints are ball and socket type:
1. Talocalcaneonavicular
2. Shoulder
3. Hip
4. Temporomandibular
5. Elbow

33. Which of the following is not a pivot joint?
1. Superior radioulnar
2. Inferior radioulnar
3. First carpometacarpal
4. Middle atalantoaxial
5. Elbow

34. Which of the following ligaments is continuous above as membrana tectoria?
1. Anterior longitudinal
2. Posterior longitudinal
3. Ligamenta flava
4. Ligamentum nuchae
5. Igamentum cuniformis

35. Between which of the following vertebrae, intervertebral disc is absent?
1. First and second cervical vertebra
2. Last cervical and first thoracic vertebra

3. Last thoracic and first lumbar vertebra
4. Last lumbar vertebra and sacrum
5. Forth and fifth cervical vertebra

36. Which of the following ligaments is formed mostly by elastic tissue?

1. Anterior longitudinal
2. Posterior longitudinal
3. Ligamenta flava
4. Ligamentum nuchae
5. all ligament

37. Movement at atlantoaxial joint involves

1. Rotation of dens in the ring of atlas
2. Rotation of atlas on the axis
3. Rotation of both atlas and axis in reverse direction
4. No rotation
5. Flexion and extension

38. The bone in the carpus having only one articular facet is the?

1. Schaphoid
2. Hamate
3. Pisiform
4. Triquetral
5. Trapezoid

39. Which of the following structures acts as a retinaculum for the tendon of long head of biceps brachi?

1. Coracohumeral ligament
2. Transverse humeral ligament
3. Glenohumeral ligaments
4. Glenoidal labrum
5. Transverse scapular ligament

40. Which of the following cartilages of the ribs form the costal margin?

1. 10th to 12th
2. 9th to llth
3. 8th to llth
4. 7th to 10^{th}
5. 5th and 6th

41. Which of the following terms describes the intervertebral joints?

1. Joints are formed between vertebral bodies and between vertebral arches.
2. There is symphysis type joint.
3. Between arches there is a synovial type joint.
4. Involves flexion-extension.
5. Involves lateral flexion (bending side to side action).

42. Which of the following articular surfaces is involved in the radio-carpal joint?
1. Proximal surface of the pisiform
2. Head of the ulnar
3. Proximal surface of the scaphoid
4. Proximal surface of the lunate
5. Head of radius

43. The lambdoid suture is located between the:
1. Sphenoid and temporal bones
2. Occipital, frontal and sphenoid bones
3. Parietal and occipital bones
4. Frontal and parietal bones
5. Sphenoid and parietal bones

44. Which of the following terms describe the manubri-sternal joint?
1. Gomphosis
2. Synovial joint
3. Synchondrosis
4. Symphysis
5. Suture

45. How many synovial joints contain articulation of atlas with axis?
1. One
2. Two
3. Three
4. Four
5. Ten

46. Movement at atlantoaxial joint involves
1. Rotation of dens in the ring of atlas
2. Rotation of atlas on the axis
3. Rotation of both atlas and axis in reverse direction
4. No rotation
5. Flexion

47. Which of the following joints have an articular disc?
    1. Ankle joint
    2. Elbow joint
    3. Wrist joint
    4. First carpometacarpal joint/
    5. Hip joint
48. All of the following ribs articulate only with one vertebra except
    1. First
    2. Ninth
    3. Twelfth
    4. Eleventh
    5. Each ribs articulate with three vertebrae
49. The tubercle of a typical rib articulates with the facet on the transverse process of:
    1. Its own vertebra
    2. Above vertebra
    3. Below vertebra
    4. Typical rib does not have tubercle
    5. a typical rib never articulate
50. Which of the following ribs articulates with the transverse process of vertebra?
    1. First ribs
    2. Eleventh ribs
    3. Twelfth ribs
    4. Each ribs articulate with three transverse process of vertebrae
    6. Ribs never articulate with transverse process

Answer for multiple-choice questioning

Question Number	Answer	Question Number	Answer
1	3	26	1
2	3	27	2
3	3	28	5
4	5	29	4,5
5	1	30	4
6	1,2	31	2
7	4	32	1,2,3
8	1,2	33	3,5
9	1,2,3,4	34	2
10	2	35	1
11	1	36	3
12	2,3	37	2
13	1,2,5	38	3
14	1,2,3,5	39	2
15	1,3,4,5	40	4
16	2,3,4	41	1,2,3,4,5
17	1	42	3,4,5
18	4	43	3
19	2	44	3
20	3	45	3
21	2	46	2
22	1,2,3	47	3
23	4	48	2
24	1	49	1
25	2	50	1

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