BIO 004 · HUMAN ANATOMY · SOLANO COMMUNITY COLLEGE

Week 2 Course Notes.

Skeletal · Joints

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Bone Histology

Bone Histology

A reference for the bone histology video and lab. Bone and cartilage are the supportive connective tissues. This page covers cartilage, the structure of a bone from the whole organ down to the osteon, the bone cells, and how bone forms and grows.

BY THE END

1. Describe the three types of cartilage and the cells and matrix that make up cartilage.
2. Classify bones by shape and identify the gross parts of a long bone.
3. Describe the microanatomy of compact bone, centered on the osteon, and contrast it with spongy bone.
4. Identify the four bone cell types and what each one does.
5. Outline how bones form and grow, using the growth plate and its zones in order.

Cartilage

Cartilage is a firm, flexible connective tissue. It has no blood vessels of its own, so it heals slowly.

The cartilage tissue

Chondrocytes	the cartilage cells, each one sits in a small space called a lacuna
Lacunae	the cavities in the matrix that house the chondrocytes
Matrix	a firm gel of ground substance with collagen, and in some types elastic fibers
Perichondrium	the connective tissue sheath wrapped around most cartilage

The three types of cartilage

TYPE	FIBERS AND TEXTURE	WHERE IT IS FOUND
Hyaline cartilage	fine collagen, glassy and smooth, the most common type	ends of long bones, the nose, the airways, the costal cartilages
Elastic cartilage	many elastic fibers, flexible and springy	the external ear and the epiglottis
Fibrocartilage	thick bundles of collagen, tough and shock-absorbing	the intervertebral discs, the knee menisci, the pubic symphysis

How cartilage grows

TYPE OF GROWTH	WHAT HAPPENS	WHERE IT STARTS
Appositional	new cartilage is added at the outer surface	from the perichondrium
Interstitial	the cartilage expands from within	chondrocytes divide inside the matrix

Bone Classification and the Long Bone

Bones by shape

SHAPE	DESCRIPTION	EXAMPLES
Long	longer than they are wide, a shaft with two ends	femur, humerus
Short	roughly cube-shaped	carpals, tarsals
Flat	thin and often curved	sternum, ribs, most skull bones
Irregular	complex shapes that fit no other group	vertebrae, hip bones
Sesamoid	small bones formed within a tendon	patella

Gross anatomy of a long bone

Diaphysis	the shaft, a tube of compact bone around the medullary cavity
Epiphysis	each expanded end, spongy bone under a thin compact shell
Metaphysis	the region between diaphysis and epiphysis, holds the growth plate or its remnant
Medullary cavity	the hollow core of the diaphysis, holds marrow
Articular cartilage	hyaline cartilage capping the epiphysis where it meets another bone
Periosteum	the connective tissue membrane covering the outer bone surface
Perforating (Sharpey) fibers	bundles of collagen that anchor the periosteum into the underlying bone
Nutrient foramen	the opening in the shaft where the nutrient artery enters the bone
Endosteum	the thin membrane lining the internal bone surfaces
Epiphyseal line	the remnant of the growth plate after growth in length ends
Red marrow	fills the spongy bone of the epiphyses; the site of blood cell formation
Yellow marrow	fat stored in the medullary cavity of the adult shaft

Bone Microanatomy

Compact bone

Osteon	the Haversian system, the structural unit of compact bone, a set of tubes around a canal
Central canal	the Haversian canal at the core of the osteon, carries blood vessels and nerves
Perforating canal	the Volkmann canal that runs crosswise and links central canals
Lamellae	the concentric rings of bony matrix around the central canal
Lacunae	small cavities between the lamellae, each holds one osteocyte
Canaliculi	tiny channels that connect lacunae and let osteocytes exchange materials
Interstitial lamellae	leftover fragments of old osteons, filling the gaps between intact osteons
Circumferential lamellae	rings of bone that wrap the entire outer and inner surface of the shaft

Spongy bone

Trabeculae	the open lattice of bony struts that forms spongy bone, aligned along lines of stress
No osteons	spongy bone has no osteons, its spaces hold red marrow

The four bone cells

CELL	WHAT IT DOES	ORIGIN OR FATE
Osteogenic cell	divides to produce new osteoblasts	the stem cell of bone tissue
Osteoblast	builds and secretes new bone matrix	becomes an osteocyte once surrounded by matrix
Osteocyte	maintains the bone matrix day to day	a mature osteoblast, sitting in a lacuna
Osteoclast	breaks down and resorbs bone matrix	a large multinucleated cell from a blood-cell line, unlike the other three

Bone Growth and Formation

This section follows the structures and the sequence: the two ways bone forms, the two ways it grows, and the ordered zones of the growth plate. The chemistry belongs to physiology and is not covered here.

Ossification, the two routes that form bone

ROUTE	WHAT IT BUILDS	IN BRIEF
Intramembranous	the flat bones of the skull	bone forms directly within a connective tissue membrane
Endochondral	most bones of the body	bone replaces a hyaline cartilage model

The two ways a long bone grows

The epiphyseal plate is the disc of hyaline cartilage where lengthening happens. When growth ends, the plate closes and leaves the epiphyseal line.

TYPE OF GROWTH	DIRECTION	WHERE IT HAPPENS
Interstitial growth	the bone grows longer	at the epiphyseal plate
Appositional growth	the bone grows wider	at the outer surface, beneath the periosteum

Zones of the growth plate

The five zones in order, from the epiphysis at the top to the diaphysis at the bottom.

1. **Zone of resting cartilage** anchors the growth plate to the epiphysis
2. **Zone of proliferation** chondrocytes divide and stack into columns
3. **Zone of hypertrophy** the chondrocytes enlarge
4. **Zone of calcification** the cartilage matrix calcifies
5. **Zone of ossification** cartilage is replaced by bone next to the diaphysis

Bone structure shows up in every X-ray

The growth plate is cartilage, so on a child's X-ray it looks like a gap. A fracture that runs through the plate can slow or stop a bone from growing, which is why pediatric fractures are described by how they cross it.

The epiphyseal line is the closed plate. Its presence tells a clinician the skeleton is mature.

Compact bone is built from osteons aligned with the lines of stress, so a bone is strongest along its long axis. That is why a twisting force, off that axis, is the one that tends to break it.

Classification: the supportive connective tissues

Bone histology fits inside one family. This map ties the page together: cartilage and the two kinds of bone, each with its structural unit.

Supportive connective tissues

Cartilage	hyaline, elastic, fibrocartilage
Compact bone	built from osteons (central canal, lamellae, lacunae, canaliculi)
Spongy bone	built from trabeculae, with red marrow in the spaces

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Use the parts of an osteon to explain how compact bone is organized.
2. Compare compact and spongy bone by structure and where each is found in a long bone.
3. Name the bone cell types and the job of each.
4. Compare intramembranous and endochondral ossification by the tissue each starts from.

The Skull

Axial Skeleton, Skull

A reference for the skull video and lab. The skull is 22 bones in two groups, the cranium that encloses the brain and the facial skeleton that frames the face. This page names every bone, the sutures and fontanelles, the key markings, the cavities, and the major foramina.

BY THE END

1. Distinguish the cranial bones from the facial bones and name the bones in each group.
2. Identify the significant markings on each cranial and facial bone, and the major sutures and fontanelles.
3. Identify the bones that form the orbit, the nasal cavity, and the hard palate, and locate the paranasal sinuses.
4. Name the major foramina of the skull and the structure each one transmits.

The Skull, an Overview

The skull has 22 bones. The eight cranial bones enclose the brain, and the fourteen facial bones frame the face. The hyoid bone of the neck is associated with the skull but is counted separately.

The skull	the bony framework of the head, 22 bones, plus the associated hyoid bone
Cranium	the eight cranial bones that enclose and protect the brain
Facial skeleton	the fourteen facial bones that frame the face and hold the teeth
Calvaria	the domed roof of the cranium, the skullcap
Cranial base	the floor of the cranium, shaped into anterior, middle, and posterior cranial fossae

The Cranial Bones

Eight bones form the **neurocranium**, the braincase: the frontal, occipital, sphenoid, and ethmoid are single, the parietal and temporal bones are paired. The grid gives them at a glance, then each bone is broken out below with its significant markings.

BONE	NUMBER	REGION IT FORMS
Frontal bone	single	the forehead, the roof of the orbits, and the floor of the anterior cranial fossa
Parietal bones	paired	the superior and lateral walls of the cranium
Temporal bones	paired	the inferior lateral walls and part of the cranial base, house the ear
Occipital bone	single	the posterior wall and much of the cranial base
Sphenoid bone	single	the central wedge of the cranial base, articulates with every other cranial bone
Ethmoid bone	single	the deepest cranial bone, between the orbits, forms part of the nasal cavity

Frontal bone

Squamous part	the broad plate of the forehead
Supraorbital margin	the ridge above each orbit
Supraorbital foramen	the opening in that margin, passes the supraorbital nerve and vessels
Glabella	the smooth area between the eyebrow ridges
Orbital plates	the paired plates that roof the orbits and floor the anterior cranial fossa
Frontal sinus	the air space within the bone, above the orbits

Parietal bones

The cranial roof	the pair form most of the superior and lateral walls of the cranium
Parietal eminence	the rounded high point of each bone, the skull's widest measure
Suture borders	they meet at the sagittal suture and form the coronal, lambdoid, and squamous sutures with neighboring bones

Temporal bones

Squamous part	the flat region forming the lower lateral wall of the skull
Zygomatic process	the bar that joins the zygomatic bone to complete the zygomatic arch
Mandibular fossa	the socket that receives the mandible, forming the temporomandibular joint
External acoustic meatus	the opening of the ear canal
Mastoid process	the bump behind the ear, a muscle attachment, filled with air cells
Styloid process	the slender spike below the ear that anchors tongue and neck muscles
Petrous part	the dense wedge of the cranial base that houses the middle and inner ear
Internal acoustic meatus	the canal carrying the nerves for hearing and facial movement
Stylomastoid foramen	the exit of the facial nerve, between the styloid and mastoid processes

Occipital bone

Foramen magnum	the large central opening for the spinal cord
Occipital condyles	the paired knobs beside the foramen magnum that articulate with the atlas
External occipital protuberance	the midline bump felt at the back of the head
Hypoglossal canal	the canal passing the hypoglossal nerve (CN XII) to the tongue muscles
Foramen magnum contents	the medulla oblongata, the vertebral arteries, the anterior and posterior spinal arteries, the spinal accessory nerve (CN XI), and the alar and apical ligaments of the dens; mnemonic "VAMPires Sing AT Midnight"
Atlanto-occipital joint	the occipital condyles meeting the superior articular facets of the atlas (C1), the "yes" nodding joint

Sphenoid bone

Body	the central cube of the bone, contains the sphenoid sinus
Sella turcica	the saddle on the body whose deep seat cradles the pituitary gland
Greater wings	the broad lateral wings forming part of the cranial floor, the orbit, and the lateral skull wall
Lesser wings	the smaller anterior wings forming part of the anterior cranial fossa
Pterygoid processes	the downward projections that anchor the chewing muscles
Optic canal	passes the optic nerve from the eye
Superior orbital fissure	passes the nerves that move the eye

Ethmoid bone

Crista galli	the upright ridge where the falx cerebri, a fold of the brain covering, attaches
Cribriform plate	the perforated horizontal plate that the olfactory nerve filaments pass through
Perpendicular plate	the vertical plate forming the upper part of the nasal septum
Lateral masses	the side portions, which contain the ethmoidal air cells
Superior and middle conchae	the scroll-shaped projections into the nasal cavity

The Facial Bones

Fourteen bones form the **viscerocranium**, the facial skeleton: six are paired and two, the vomer and the mandible, are single. The grid gives them at a glance, then the maxillae and the mandible, the largest facial bones, are broken out in detail.

BONE	NUMBER	WHAT IT FORMS
Maxillae	paired	the upper jaw, form the anterior hard palate and hold the upper teeth
Palatine bones	paired	the posterior hard palate and part of the orbit
Zygomatic bones	paired	the cheekbones
Nasal bones	paired	the bridge of the nose
Lacrimal bones	paired	the medial wall of the orbit, grooved for the tear duct
Inferior nasal conchae	paired	scroll-shaped bones on the lateral wall of the nasal cavity
Vomer	single	the inferior part of the nasal septum
Mandible	single	the lower jaw, the only freely movable bone of the skull

The maxillae

Body	the central mass of the bone, contains the maxillary sinus
Alveolar process	the ridge that holds the upper teeth
Palatine process	the shelf forming the anterior part of the hard palate
Frontal process	the upward projection that meets the frontal bone
Zygomatic process	the lateral projection that meets the cheekbone
Infraorbital foramen	the opening below the orbit, passes the infraorbital nerve to the face

The mandible

Body	the horizontal, U-shaped portion that holds the lower teeth
Ramus	the vertical portion on each side, rising to two processes
Angle	the corner where the body meets the ramus
Condylar process	the posterior process whose head meets the temporal bone at the jaw joint
Coronoid process	the anterior process where the temporalis chewing muscle attaches
Mandibular notch	the gap between the condylar and coronoid processes
Alveolar process	the ridge that holds the lower teeth
Mental foramen	the opening on the body that passes the nerve to the chin and lower lip
Mandibular foramen	the opening on the inner ramus, the entry for the nerve to the lower teeth and the target for a dental block

Sutures and Fontanelles

The major sutures

A suture is an immovable fibrous joint between skull bones. Compare the four major sutures, plus the pterion, by the bones each one joins.

SUTURE	BONES IT JOINS	LOCATION
Coronal suture	the frontal bone and the two parietal bones	runs across the top of the skull, behind the forehead
Sagittal suture	the two parietal bones	the midline of the skull roof
Lambdoid suture	the parietal bones and the occipital bone	the back of the skull
Squamous suture	a parietal bone and a temporal bone	the lower side of the skull, one on each side
Pterion	the frontal, parietal, temporal, and sphenoid bones	the H-shaped junction on the side of the skull, the thinnest part

The fontanelles

Fontanelles are fibrous membrane gaps between the bones of an infant skull. They let the skull compress during birth and grow with the brain. Compare the four named fontanelles.

FONTANELLE	ALSO CALLED	LOCATION	CLOSES BY
Anterior fontanelle	the largest fontanelle	where the frontal and parietal bones meet	about 18 to 24 months
Posterior fontanelle	the occipital fontanelle	where the parietal bones meet the occipital bone	about 2 months
Anterolateral fontanelles	the sphenoidal fontanelles	on the side of the skull, one on each side	about 3 months
Posterolateral fontanelles	the mastoid fontanelles	behind the ear, one on each side	begin at 1 to 2 months, complete by about 12 months

Cavities and Special Features

The orbit and nasal cavity

The orbit	the bony eye socket, built from seven bones: frontal, sphenoid, zygomatic, maxilla, lacrimal, ethmoid, and palatine	**Nasal septum**	the partition of the nasal cavity, the vomer plus the perpendicular plate of the ethmoid plus septal cartilage
Nasal cavity	the space behind the nose, with a bony roof, floor, lateral walls, and septum	**Hard palate**	the bony roof of the mouth, the maxillae in front and the palatine bones behind

Paranasal sinuses

The paranasal sinuses are air-filled cavities that lighten the skull and drain into the nasal cavity. Compare the four by the bone each one occupies.

SINUS	BONE IT OCCUPIES	LOCATION
Frontal sinus	the frontal bone	above the orbits
Ethmoidal sinuses	the ethmoid bone	the ethmoid air cells, between the orbits
Sphenoidal sinus	the sphenoid bone	within the body of the sphenoid
Maxillary sinuses	the maxillae	the largest sinuses, in the cheek region

The hyoid bone

Hyoid bone	a U-shaped bone in the anterior neck, below the mandible	**Role**	anchors the tongue and several muscles of the neck and larynx
Unique feature	it does not articulate with any other bone, it is slung by ligaments from the styloid processes		

Major Foramina

A foramen is an opening that lets a nerve or a vessel pass through bone. Compare the major openings of the skull by the bone they pierce and what passes through.

FORAMEN	BONE	WHAT PASSES THROUGH
Foramen magnum	occipital bone	the spinal cord and the vertebral arteries
Optic canal	sphenoid bone	the optic nerve, cranial nerve II
Superior orbital fissure	sphenoid bone	nerves that supply the eye, including those that move it
Foramen ovale	sphenoid bone	a branch of the trigeminal nerve to the lower jaw
Cribriform foramina	ethmoid bone	the olfactory nerve filaments, cranial nerve I
Internal acoustic meatus	temporal bone	the nerves for hearing and for facial movement
Carotid canal	temporal bone	the internal carotid artery
Jugular foramen	between the temporal and occipital bones	the internal jugular vein
Mental foramen	mandible	the nerve and vessels to the chin and lower lip

Where the skull is thin, and where it has only one door

The **pterion**, the H-shaped junction of the frontal, parietal, temporal, and sphenoid bones, is the thinnest part of the skull, and the middle meningeal artery runs just beneath it. A blow there can tear the artery and bleed into the skull.

The **paranasal sinuses** drain into the nasal cavity through narrow openings, so a head cold can spread into them as sinusitis. The maxillary sinus sits so close to the upper teeth that a tooth infection can reach it.

A newborn is checked at the **anterior fontanelle**. A sunken fontanelle can signal dehydration, a bulging one can signal raised pressure inside the skull.

The **foramen magnum** is the one large opening between the brain and the spinal cord. When pressure builds inside the rigid skull, brain tissue can be forced down through it, which is why rising intracranial pressure is an emergency.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Name the eight cranial bones and contrast their job with that of the facial bones.
2. Trace the four major sutures of the skull and name the bones each one joins.
3. What passes through the foramen magnum, and why is its location significant?
4. Compare the orbit and the nasal cavity by which bones contribute to each.

The Vertebral Column and Thoracic Cage

Axial Skeleton, Spine

A reference for the spine video and lab. The vertebral column is the central axis of the body, and the thoracic cage is built onto it. This page covers the regions and curvatures, a typical vertebra, each region of vertebrae in detail, and the sternum and ribs.

BY THE END

1. Name the regions of the vertebral column and the number of vertebrae in each.
2. Identify the normal curvatures of the spine and tell the primary from the secondary.
3. Label the parts of a typical vertebra and the structure of an intervertebral disc.
4. Distinguish cervical, thoracic, and lumbar vertebrae, and describe the atlas, axis, sacrum, and coccyx.
5. Identify the bones and markings of the thoracic cage.

The Vertebral Column, an Overview

Early in development the column has 33 vertebrae; in the adult, 5 sacral and 4 coccygeal vertebrae fuse, leaving 26 bones: 24 separate vertebrae in three regions, plus the sacrum and the coccyx. It is the central supporting axis of the body. Compare its five regions, superior to inferior.

REGION	VERTEBRAE	DESCRIPTION
Cervical region	7, C1 to C7	the neck
Thoracic region	12, T1 to T12	the chest, each vertebra articulates with a pair of ribs
Lumbar region	5, L1 to L5	the lower back
Sacrum	5, fused	a single triangular bone wedged between the hip bones
Coccyx	4, fused	the tailbone

Intervertebral discs	fibrocartilage pads between adjacent vertebral bodies

The Curvatures

The adult spine has four front-to-back curves that act like a spring, giving the column strength, flexibility, and balance. Primary curvatures are present at birth; secondary curvatures develop with the milestones of infancy. Compare them.

CURVATURE	TYPE	WHEN IT DEVELOPS
Cervical curvature	secondary	develops as an infant holds up its head
Thoracic curvature	primary	present from birth
Lumbar curvature	secondary	develops as a child stands and walks
Sacral curvature	primary	present from birth

A Typical Vertebra

Parts of a vertebra

Body	the thick, weight-bearing anterior portion, also called the centrum	**Vertebral foramen**	the opening enclosed by the body and arch, the spinal cord runs through it
Vertebral arch	the bony ring projecting from the back of the body	**Spinous process**	the single projection pointing backward from the arch
Pedicles	the two short bars connecting the arch to the body	**Transverse processes**	the two projections pointing laterally from the arch
Laminae	the two flat plates that complete the arch behind	**Articular processes**	the superior and inferior pairs that join one vertebra to the next

Between the vertebrae

Vertebral canal	the stacked vertebral foramina, the channel that holds the spinal cord
Intervertebral foramina	the gaps between stacked vertebrae where the spinal nerves exit
Intervertebral disc	a fibrocartilage pad between two vertebral bodies, a shock absorber
Anulus fibrosus	the tough outer ring of the disc
Nucleus pulposus	the soft, gel-like core of the disc

Regional Vertebrae

Each region has a vertebra shaped for its job. Compare the three typical regions by body shape, spinous process, and distinctive feature, then study the specialized cervical vertebrae below.

REGION	BODY	SPINOUS PROCESS	DISTINCTIVE FEATURE
Cervical, C1 to C7	small and oval, the smallest vertebrae	short, often bifid, or forked	transverse foramina in the transverse processes, which pass the vertebral arteries
Thoracic, T1 to T12	heart-shaped	long, angled sharply downward	costal facets on the body and transverse processes where the ribs articulate
Lumbar, L1 to L5	thick and kidney-shaped, the largest vertebrae	short and blunt	massive build for weight bearing, no costal facets and no transverse foramina

The specialized cervical vertebrae

Atlas (C1)	a ring with no body and no spinous process, it holds up the skull
Atlanto-occipital joint	where the atlas meets the occipital condyles, the joint for the "yes" nod
Axis (C2)	bears the dens, an upward bony peg
Dens	the odontoid process, the peg of the axis that the atlas pivots around for the "no" rotation
Atlanto-axial joint	where the atlas pivots on the dens of the axis, the joint for the "no" head rotation
Vertebra prominens (C7)	a long spinous process you can feel at the base of the neck

Sacrum

Sacrum	five fused vertebrae forming a triangular bone wedged between the hip bones
Sacral promontory	the anterior ridge of the first sacral vertebra
Median sacral crest	the fused spinous processes along the posterior surface
Sacral foramina	the openings that pass the sacral nerves
Sacral canal	the continuation of the vertebral canal through the sacrum
Sacral hiatus	the opening at the inferior end of the sacral canal
Auricular surface	the ear-shaped surface that joins the hip bone at the sacroiliac joint

Coccyx

Coccyx	the fused tailbone, an attachment point for pelvic ligaments and muscles

The Thoracic Cage

The thoracic cage is the sternum in front, the ribs on the sides, and the thoracic vertebrae behind. It shields the heart and lungs.

The sternum

Sternum	the breastbone, a flat bone of three fused parts
Manubrium	the superior part, articulates with the clavicles and the first ribs
Body	the long middle part of the sternum
Xiphoid process	the small inferior tip, a muscle attachment, cartilage that ossifies with age
Jugular notch	the central dip at the top of the manubrium, easily felt
Sternal angle	the ridge where the manubrium meets the body, a landmark level with the second rib

The ribs

Ribs	twelve pairs of flat, curved bones forming the walls of the cage
Head	the posterior end of a rib, articulates with the vertebral bodies
Tubercle	the knob near the head, articulates with a transverse process
Costal cartilage	the hyaline cartilage that connects a rib toward the sternum

The twelve rib pairs are classified by how they reach the sternum. Compare the three groups.

RIB GROUP	PAIRS	ANTERIOR ATTACHMENT
True ribs	1 to 7	attach to the sternum directly, each by its own costal cartilage
False ribs	8 to 12	do not reach the sternum directly; pairs 8 to 10 join the costal cartilage of the rib above
Floating ribs	11 and 12	no anterior attachment at all; a subset of the false ribs

The spine protects a cord, the cage protects a pump

The vertebral canal carries the spinal cord, so a vertebral fracture is dangerous for what runs inside it, not only for the bone. A **herniated disc** occurs when the soft nucleus pulposus pushes through a torn anulus fibrosus and presses on a spinal nerve at an intervertebral foramen, which is why the pain travels down a limb.

The **dens** of the axis is held against the atlas by a ligament. A sharp blow can fracture it, a serious injury so close to the brainstem.

The **sternal angle** is a landmark a clinician feels for. It sits at the level of the second rib, the starting point for counting ribs. The **xiphoid process** guides hand position for chest compressions in CPR.

Abnormal curvatures have names: **scoliosis** is a sideways curve, **kyphosis** is an exaggerated thoracic curve, and **lordosis** is an exaggerated lumbar curve.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Name the five regions of the vertebral column and how many vertebrae are in each.
2. Compare a cervical, a thoracic, and a lumbar vertebra by one feature that identifies each.
3. Name the four spinal curvatures and state which are primary and which are secondary.
4. Explain how the ribs attach anteriorly, and how that distinguishes true, false, and floating ribs.

The Upper Extremity

Appendicular Skeleton, Upper Extremity

A reference for the upper extremity video and lab. This page covers the pectoral girdle that attaches the limb to the trunk, and the bones of the arm, forearm, and hand, each bone broken out with its key markings.

BY THE END

1. Name the bones of the pectoral girdle and explain how the upper limb attaches to the axial skeleton.
2. Identify the key markings of the clavicle and the scapula.
3. Identify the key markings of the humerus, the radius, and the ulna.
4. Name the bones of the hand, including the eight carpal bones in their two rows.

The Upper Extremity, an Overview

The appendicular skeleton is the bones of the limbs and the girdles that attach them to the axial skeleton. Compare the four parts of the upper limb, proximal to distal.

PART	REGION IT SPANS	BONES
Pectoral girdle	attaches the upper limb to the trunk	clavicle and scapula
Arm	shoulder to elbow	humerus
Forearm	elbow to wrist	radius and ulna
Hand	wrist to fingertips	carpals, metacarpals, and phalanges

The Pectoral Girdle

Clavicle

Clavicle	the collarbone, an S-shaped bone across the top of the thorax
Sternal end	the medial end, articulates with the manubrium of the sternum
Acromial end	the lateral end, articulates with the acromion of the scapula
The only bony link	the clavicle is the sole bony attachment of the upper limb to the axial skeleton

Scapula

Scapula	the shoulder blade, a flat triangular bone on the posterior thorax
Borders	the superior, medial, and lateral borders of the triangle
Spine	the ridge running across the posterior surface
Acromion	the flat process at the tip of the spine, the point of the shoulder
Coracoid process	the hook-like anterior process, a muscle attachment
Glenoid cavity	the shallow socket that receives the head of the humerus
Supraspinous fossa	the hollow above the spine
Infraspinous fossa	the hollow below the spine
Subscapular fossa	the hollow on the anterior surface

Joints of the pectoral girdle

Sternoclavicular joint	sternal end of the clavicle with the manubrium; the only joint linking the upper limb to the axial skeleton
Acromioclavicular joint	acromial end of the clavicle with the acromion of the scapula
Glenohumeral joint	head of the humerus in the glenoid cavity, the shoulder joint

The Arm and Forearm

Humerus

Humerus	the single bone of the arm, from shoulder to elbow
Head	the rounded proximal end that fits into the glenoid cavity
Anatomical neck	the narrow groove just below the head
Surgical neck	the narrowing below the tubercles, a common fracture site
Greater tubercle	the lateral bump near the head, a muscle attachment
Lesser tubercle	the anterior bump near the head, a muscle attachment
Intertubercular sulcus	the groove between the tubercles that holds a biceps tendon
Deltoid tuberosity	the roughened ridge on the shaft where the deltoid muscle attaches
Capitulum	the lateral knob at the distal end, articulates with the radius
Trochlea	the medial spool at the distal end, articulates with the ulna
Medial epicondyle	the medial projection above the trochlea
Lateral epicondyle	the lateral projection above the capitulum
Olecranon fossa	the deep posterior pit that receives the ulna when the elbow straightens

The forearm bones, radius and ulna

The two forearm bones are easy to confuse. Compare them side by side: which side of the forearm each is on, and the markings at each end.

BONE	SIDE OF THE FOREARM	PROXIMAL (ELBOW) END	DISTAL (WRIST) END
Radius	lateral, the thumb side	disc-shaped head articulates with the capitulum; neck just below; radial tuberosity, a muscle attachment, below the neck	styloid process on the lateral side; ulnar notch on the medial side receives the head of the ulna, forming the distal radioulnar joint
Ulna	medial, the little-finger side	olecranon, the point of the elbow; coronoid process in front; trochlear notch grips the trochlea of the humerus; radial notch on the lateral side receives the head of the radius, forming the proximal radioulnar joint	styloid process on the medial side

Grooves, nerves, and the joining membrane

Radial groove	an oblique groove on the posterior shaft of the humerus; the radial nerve runs in it
Ulnar nerve at the medial epicondyle	the nerve passes just behind the medial epicondyle, where it can be palpated, the "funny bone"
Interosseous membrane	a fibrous sheet, a syndesmosis, spanning the shafts of the radius and ulna; a muscle attachment that also binds the two bones
Three radioulnar joints	proximal (radial head and radial notch), distal (ulnar head and ulnar notch), and the interosseous membrane between the shafts

The Hand

Carpals, the wrist

Carpals	eight small bones arranged in two rows, forming the wrist	**Distal row**	trapezium, trapezoid, capitate, and hamate
Proximal row	scaphoid, lunate, triquetrum, and pisiform		

A common memory aid for the eight carpals: "So Long To Pinky, Here Comes The Thumb."

Metacarpals and phalanges

Metacarpals	five bones forming the palm, numbered 1 to 5 starting at the thumb	**Thumb**	the pollex, has two phalanges, a proximal and a distal
Phalanges	the finger bones, fourteen in each hand	**Fingers**	each of the other four has three phalanges, proximal, middle, and distal

The carpal tunnel

Flexor retinaculum	a strong fibrous band roofing the carpal bones; the space beneath it is the carpal tunnel	**Carpal tunnel syndrome**	narrowing of the tunnel compresses the median nerve
Contents	the long flexor tendons of the fingers and thumb, and the median nerve	**Clinically notable carpals**	capitate is the largest; scaphoid is the most frequently fractured; lunate is the most frequently dislocated

The bones that break when you fall on an outstretched hand

The **clavicle** is the most commonly broken bone in the body, usually in its middle third. It is the slender strut that takes the force when you fall onto a shoulder or an outstretched arm.

The **surgical neck** of the humerus fractures often, and the axillary nerve runs close by, so a break there is checked for nerve injury.

The **scaphoid** is the carpal bone most often fractured, again from a fall on an outstretched hand. Its blood supply is poor, so a missed scaphoid fracture may fail to heal. Tenderness in the anatomical snuffbox, the hollow at the base of the thumb, is the clue.

The ulnar nerve passes behind the **medial epicondyle** of the humerus, the spot people call the funny bone, which is why a knock there sends a jolt to the little finger.

Bone markings vocabulary

Before naming the landmarks on each bone, learn the general vocabulary. Every marking is a projection, a depression, or an opening. These terms repeat on every bone you will study.

MARKING	TYPE	DESCRIPTION	EXAMPLE
Process	projection	any bony prominence	mastoid process
Tubercle	projection	small rounded bump	greater tubercle of the humerus
Tuberosity	projection	large rough projection	deltoid tuberosity
Head	projection	bony expansion carried on a neck	head of the humerus
Epicondyle	projection	raised area above a condyle	medial epicondyle of the humerus
Facet	articular surface	smooth, nearly flat surface	articular facets of vertebrae
Fossa	depression	shallow basin	olecranon fossa
Sulcus	depression	a groove	intertubercular sulcus
Foramen	opening	hole for vessels or nerves	nutrient foramen

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Name the two bones of the pectoral girdle and explain how the girdle attaches the upper limb to the axial skeleton.
2. Trace the bones of the upper limb from shoulder to fingertips, naming each.
3. Compare the radius and the ulna: which is lateral in anatomical position, and which forms the main hinge of the elbow with the humerus?
4. Name the three groups of hand bones and how many bones are in each.

The Lower Extremity

Appendicular Skeleton, Lower Extremity

A reference for the lower extremity video and lab. This page covers the pelvic girdle that carries the body's weight to the legs, and the bones of the thigh, leg, and foot, each bone broken out with its key markings.

BY THE END

1. Name the three bones that fuse to form the hip bone, and describe the pelvis.
2. Identify the key markings of the hip bone, including the acetabulum.
3. Identify the key markings of the femur, patella, tibia, and fibula.
4. Name the bones of the foot, including the seven tarsal bones and the arches.

The Lower Extremity, an Overview

The lower limb is built heavier than the upper limb because it carries the body's weight. Compare its four parts, proximal to distal.

PART	REGION IT SPANS	BONES
Pelvic girdle	attaches the lower limb to the axial skeleton	the two hip bones
Thigh	hip to knee	femur (and the patella at the knee)
Leg	knee to ankle	tibia and fibula
Foot	ankle to toes	tarsals, metatarsals, and phalanges

The Pelvic Girdle

Each hip bone, the os coxae, begins as three separate bones that fuse at the acetabulum: the ilium, the ischium, and the pubis.

Ilium

Ilium	the large, fan-shaped superior part of the hip bone
Iliac crest	the curved upper ridge, the rim you rest your hands on
Anterior superior iliac spine	the prominent point at the front of the crest, a palpable landmark
Posterior superior iliac spine	the point at the back of the iliac crest
Iliac fossa	the smooth, concave inner surface
Auricular surface	the ear-shaped surface that joins the sacrum at the sacroiliac joint
Greater sciatic notch	the deep notch on the posterior border; the sciatic nerve, the largest nerve in the body, passes through it

Ischium

Ischium	the posteroinferior part of the hip bone
Ischial tuberosity	the strong, roughened knob you sit on
Ischial spine	the pointed projection above the tuberosity

Pubis

Pubis	the anteromedial part of the hip bone
Pubic symphysis	the cartilage joint where the two pubic bones meet in front
Pubic crest	the ridge along the upper border of the pubis
Pubic rami	the superior and inferior bars of bone extending from the body

The acetabulum and the pelvis

Acetabulum	the deep cup where the three bones meet, the socket for the head of the femur
Obturator foramen	the large opening framed by the ischium and the pubis
The bony pelvis	the two hip bones together with the sacrum and the coccyx
True and false pelvis	the false pelvis is the wide flare above the pelvic brim, the true pelvis is the narrower ring below it
Sex differences	the female pelvis is wider and shallower, with a broader pubic angle and a larger outlet, adapted for childbirth

The Thigh and Knee

Femur

Femur	the thigh bone, the longest and strongest bone in the body
Head	the ball at the proximal end that fits into the acetabulum
Fovea capitis	the small pit on the head that anchors a ligament to the acetabulum
Neck	the narrow region just below the head, a common fracture site
Greater trochanter	the large lateral projection, a major muscle attachment
Lesser trochanter	the smaller projection on the medial side
Linea aspera	the rough ridge down the posterior shaft, a muscle attachment line
Medial and lateral condyles	the rounded distal knobs that articulate with the tibia
Medial and lateral epicondyles	the projections just above the condyles
Intercondylar fossa	the notch between the condyles on the posterior surface

Patella

Patella	the kneecap, a sesamoid bone formed within the quadriceps tendon
Base	the broad superior border of the patella
Apex	the pointed inferior tip

The Leg

The leg bones, tibia and fibula

The two leg bones differ in side and in whether they bear weight. Compare them side by side.

BONE	SIDE AND WEIGHT	PROXIMAL (KNEE) END	DISTAL (ANKLE) END
Tibia	medial, the shin bone, the weight-bearing bone of the leg	medial and lateral condyles articulate with the femur; tibial tuberosity on the front anchors the patellar ligament; sharp anterior border felt as the shin	medial malleolus, the medial bump of the ankle
Fibula	lateral, slender, does not bear body weight	head, the knob at the proximal end	lateral malleolus, the lateral bump of the ankle

The Foot

Tarsals, the ankle

Tarsals	seven bones forming the ankle and the back of the foot
Talus	the tarsal that articulates with the tibia and fibula and receives the body's weight
Calcaneus	the heel bone, the largest tarsal
Other tarsals	the navicular, the cuboid, and the three cuneiform bones

Metatarsals, phalanges, and arches

Metatarsals	five bones forming the sole, numbered 1 to 5 from the great toe
Phalanges	the toe bones, fourteen in each foot
Great toe	the hallux, has two phalanges, the other toes have three each
Arches of the foot	the medial and lateral longitudinal arches and the transverse arch, which spread body weight

The skeleton that carries your weight

A broken hip is usually a fracture of the **femoral neck**, common in older adults whose bone has thinned with osteoporosis. The neck is narrow and angled, and the blood supply to the femoral head runs close by, so the fracture can threaten the head itself.

The **anterior superior iliac spine** and the **iliac crest** are landmarks a clinician feels through the skin, used to locate injection sites and to check pelvic alignment.

The tibia carries body weight and the fibula does not, which is why a length of fibula can be taken as a bone graft. The **lateral malleolus** of the fibula is the common ankle fracture site, often from a rolled ankle.

The **arches of the foot** spread weight across the sole and spring back with each step. When the medial longitudinal arch drops, the result is flat feet.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Name the three bones that fuse to form the hip bone, and the point where all three meet.
2. Trace the bones of the lower limb from hip to toes in order, naming each.
3. Compare the tibia and the fibula by which one bears weight and how you would tell them apart.
4. Name the arches of the foot and explain what they contribute to standing and walking.

Articulations and Joints

Articulations and Joints

A reference for the joints video and lab. A joint is where bones meet. This page covers how joints are classified, the fibrous and cartilaginous joints, the full structure of a synovial joint, the movements joints allow, the six synovial joint types, the shoulder and knee joints, and the common joint disorders.

BY THE END

1. Classify joints by structure and by function, and state the criteria for each.
2. Describe the three types of fibrous joints and the two types of cartilaginous joints.
3. Identify the structures of a synovial joint, its accessory structures, and its nerve and blood supply.
4. Name the six types of synovial joints with their axes, and describe the movements at synovial joints.
5. List the factors that affect range of motion and the common joint disorders.
6. Describe the structure and supporting ligaments of the shoulder joint and the knee joint.

Classifying Joints

A joint, or articulation, is where two or more bones meet. Joints are classified two ways: by structure and by function. Learn both classifications.

Structural classification

The structural classification uses two criteria: whether a synovial cavity is present, and the type of connective tissue holding the bones.

STRUCTURAL CLASS	SYNOVIAL CAVITY	CONNECTIVE TISSUE HOLDING THE BONES
Fibrous joint	none	dense connective tissue rich in collagen fibers
Cartilaginous joint	none	cartilage, hyaline or fibrocartilage
Synovial joint	present	the dense irregular connective tissue of an articular capsule

Functional classification

The functional classification uses one criterion: the degree of movement the joint permits.

FUNCTIONAL CLASS	DEGREE OF MOVEMENT	EXAMPLES
Synarthrosis	immovable	sutures of the skull, gomphoses
Amphiarthrosis	slightly movable	syndesmoses, symphyses
Diarthrosis	freely movable	all synovial joints

Fibrous Joints

Fibrous joints lack a synovial cavity, the bones are held closely by dense connective tissue, and they permit little or no movement. Compare the types by structure, mobility, and example.

TYPE	STRUCTURE	MOBILITY	EXAMPLES
Suture	thin layers of dense irregular connective tissue, with interlocking edges that add strength and absorb shock	immovable in adults, a synarthrosis; slightly movable in infants and children, an amphiarthrosis	only between the bones of the skull; the metopic suture is a frontal suture that persists past about age six
Syndesmosis	more dense connective tissue and more space than a suture, the bones united by a ligament	slightly movable, an amphiarthrosis	the distal tibiofibular joint, united by the anterior tibiofibular ligament
Gomphosis	a cone-shaped peg held in a socket by the periodontal ligament	immovable, a synarthrosis	a tooth in its bony socket

TYPE	STRUCTURE	MOBILITY	EXAMPLES
Interosseous membrane	a substantial sheet of dense connective tissue binding neighboring long bones	slightly movable, an amphiarthrosis	between the radius and ulna; between the tibia and fibula

Synostosis a joint where two separate bones fuse completely into one, for example a suture that ossifies in adulthood

Cartilaginous Joints

Cartilaginous joints lack a synovial cavity and allow little or no movement. Compare the two types by the cartilage that connects the bones.

TYPE	CONNECTING CARTILAGE	MOBILITY	EXAMPLES
Synchondrosis	hyaline cartilage	immovable, a synarthrosis	the epiphyseal growth plate, which becomes a synostosis when bone replaces the cartilage; the joint between the first rib and the manubrium
Symphysis	a broad, flat disc of fibrocartilage	slightly movable, an amphiarthrosis	the pubic symphysis, the manubriosternal joint, the intervertebral joints between vertebral bodies; all symphyses lie in the midline

Synovial Joint Structure

A synovial joint has a synovial cavity between the articulating bones and allows considerable movement. All synovial joints are freely movable, diarthroses.

Articular cartilage and capsule

Articular cartilage hyaline cartilage covering the articulating bone surfaces, smooth and slippery, it reduces friction and absorbs shock but does not bind the bones

Articular capsule a sleeve-like capsule that surrounds the joint, encloses the synovial cavity, and unites the bones

Fibrous membrane the outer layer of the capsule, dense irregular connective tissue attached to the periosteum, strong and flexible

Ligaments thickened fibrous bundles of the fibrous membrane that resist strain and prevent dislocation

Synovial membrane the inner layer of the capsule, areolar connective tissue with elastic fibers

Articular fat pads accumulations of adipose tissue that may cushion the joint

Synovial fluid

Synovial fluid a viscous, clear, pale-yellow fluid of hyaluronic acid and interstitial fluid, secreted by the synovial membrane

Lubrication forms a thin film that reduces friction between the joint surfaces

Nourishment supplies oxygen and nutrients to, and removes wastes from, the avascular articular cartilage

Defense contains phagocytic cells that clear microbes and debris from normal wear

Warm-up effect gel-like at rest, it thins with movement, which is why warming up before exercise eases the joints

Accessory Structures of Synovial Joints

Accessory ligaments and discs

Extracapsular ligaments	ligaments that lie outside the articular capsule, as the collateral ligaments of the knee
Intracapsular ligaments	ligaments inside the capsule but kept out of the synovial cavity by synovial folds, as the cruciate ligaments of the knee
Articular discs (menisci)	crescent-shaped fibrocartilage pads between the bone surfaces, they improve fit, absorb shock, distribute weight, and spread synovial fluid
Labrum	a fibrocartilage rim around the socket of a ball-and-socket joint that deepens it, found at the shoulder and hip

Bursae and tendon sheaths

Bursae	small sac-like structures filled with fluid, placed to reduce friction between skin, bone, muscle, tendon, or ligament
Tendon sheaths	tube-shaped bursae that wrap a tendon where it passes through a tight space, as at the wrist and ankle

Nerve and blood supply

Nerve supply	the same nerves that supply the muscles moving the joint, they carry pain information and help adjust movement
Blood supply	arteries near the joint branch into the capsule and ligaments, veins carry wastes away, the articular cartilage is fed instead by the synovial fluid

Movements at Synovial Joints

Gliding and angular movements

Gliding	simple back-and-forth or side-to-side movement, no change in the angle between bones
Flexion	decreases the angle between bones, usually in the sagittal plane
Extension	increases the angle between bones, the reverse of flexion
Lateral flexion	bending the trunk or head sideways, in the frontal plane
Hyperextension	extension that continues past the anatomical position
Abduction	movement away from the midline of the body
Adduction	movement toward the midline of the body
Circumduction	movement of the distal end of a part in a circle

Rotation and special movements

Rotation	a bone turns around its own long axis, medial rotation toward the midline, lateral rotation away
Elevation, depression	lifting a body part upward, then lowering it
Protraction, retraction	moving a body part forward, then back to position
Inversion, eversion	turning the sole of the foot inward, then outward
Dorsiflexion, plantar flexion	bending the foot up at the ankle, then pointing the toes down
Supination, pronation	turning the palm to face anteriorly, then posteriorly
Opposition	moving the thumb across the palm to touch the fingertips

The Six Types of Synovial Joints

Synovial joints are sorted by the shape of their surfaces, which sets the axes of movement: uniaxial moves around one axis, biaxial around two, triaxial around three. Compare the six.

JOINT TYPE	SHAPE OF THE SURFACES	AXES OF MOVEMENT	EXAMPLES
Plane joint	flat or slightly curved surfaces that glide	biaxial or triaxial gliding	the intercarpal and intertarsal joints
Hinge joint	a convex surface fits a concave one	uniaxial, flexion and extension	the elbow, ankle, and interphalangeal joints
Pivot joint	a rounded surface fits a ring of bone and ligament	uniaxial, rotation	the atlantoaxial and radioulnar joints
Condyloid joint	an oval projection fits an oval depression	biaxial	the radiocarpal and metacarpophalangeal joints
Saddle joint	each surface is both concave and convex	biaxial	the carpometacarpal joint of the thumb
Ball-and-socket joint	a ball fits a cup	triaxial	the shoulder and hip joints

Factors Affecting Range of Motion

Range of motion is the arc, measured in degrees, through which the bones of a joint can move. Several factors set its limits.

Bone shape	the structure and fit of the articulating bones
Ligament tension	taut ligaments restrict movement and direct the bones
Muscle arrangement	muscle tension reinforces the restraint set by the ligaments
Contact of soft parts	one body surface meeting another can limit movement
Hormones	relaxin loosens the pubic symphysis and pelvic ligaments late in pregnancy
Disuse	a joint unused for a long time loses range as fluid, ligament flexibility, and muscle decline

The Shoulder Joint

The glenohumeral joint, a ball-and-socket joint between the head of the humerus and the glenoid cavity of the scapula. It is the most freely movable joint in the body, and the price of that mobility is instability.

Structure

Type	a ball-and-socket joint, also called the glenohumeral or humeroscapular joint
Articulating bones	the head of the humerus and the glenoid cavity of the scapula
Why it moves so freely	the articular capsule is loose and the glenoid cavity is shallow relative to the large humeral head

Ligaments and supporting structures

Articular capsule	a thin, loose sac that envelops the joint, from the glenoid cavity to the anatomical neck of the humerus
Coracohumeral ligament	runs from the coracoid process to the greater tubercle, strengthens the superior part of the capsule
Glenohumeral ligaments	three thickenings of the anterior capsule, from the glenoid cavity to the lesser tubercle and anatomical neck, stabilize the joint near the limits of motion
Transverse humeral ligament	a narrow band between the greater and lesser tubercles that holds the long head of the biceps tendon in place
Glenoid labrum	a rim of fibrocartilage around the glenoid cavity that slightly deepens and enlarges it
Bursae	four are associated with the joint: the subscapular, subdeltoid, subacromial, and subcoracoid bursae

Movement and the rotator cuff

Movements	flexion, extension, hyperextension, abduction, adduction, medial and lateral rotation, and circumduction	**Rotator cuff (SITS)**	the supraspinatus, infraspinatus, teres minor, and subscapularis, which hold the humeral head in the glenoid cavity
Source of stability	the ligaments add little strength, most stability comes from the rotator cuff muscles		

The Knee Joint

The tibiofemoral joint, the largest and most complex joint in the body. It is a modified hinge joint, and the joint most often injured.

Structure

Type	a modified hinge joint, the largest and most complex joint in the body	**Three joints, one cavity**	a medial and a lateral tibiofemoral joint between the femoral and tibial condyles, and a patellofemoral joint between the patella and the femur

Ligaments, anterior and posterior

Articular capsule	the capsule that encloses the joint	**Patellar ligament**	the continuation of the quadriceps tendon from the patella to the tibial tuberosity, strengthens the anterior surface
Patellar retinacula	the medial and lateral retinacula, fused quadriceps tendon and fascia, strengthen the anterior surface	**Oblique popliteal ligament**	a broad ligament that strengthens the posterior surface of the joint
		Arcuate popliteal ligament	strengthens the lower lateral part of the posterior surface

The collateral and cruciate ligaments

Four ligaments are the heart of knee stability. Compare them by where they sit and what each one resists.

LIGAMENT	LOCATION	WHAT IT RESISTS
Tibial collateral ligament	the broad ligament on the medial side, from the medial epicondyle of the femur to the medial condyle of the tibia	forces that would open the knee on the medial side
Fibular collateral ligament	the round ligament on the lateral side, from the lateral epicondyle of the femur to the head of the fibula	forces that would open the knee on the lateral side
Anterior cruciate ligament	an intracapsular ligament, crossing within the joint	limits hyperextension and stops the tibia from sliding forward; torn in roughly 70 percent of serious knee injuries
Posterior cruciate ligament	an intracapsular ligament, crossing within the joint	stops the tibia from sliding backward; important on stairs and inclines

The menisci

Medial meniscus	the C-shaped fibrocartilage disc on the medial side of the joint	**Transverse ligament**	the band that joins the two menisci to each other
Lateral meniscus	the more circular, O-shaped disc on the lateral side		

Knee injuries

Unhappy triad	a lateral blow to a planted knee that tears three structures at once: the tibial collateral ligament, the medial meniscus, and the anterior cruciate ligament
ACL and women	the anterior cruciate ligament is torn three to six times more often in women, from a narrower intercondylar space, a wider pelvis and greater knee angle, ligament-loosening hormones, and less protective muscle strength
Swollen knee	immediate swelling is blood from torn vessels, delayed swelling is excess synovial fluid
Dislocated knee	displacement of the tibia relative to the femur, most often anterior, it can damage the popliteal artery
PRICE	the first-aid approach to a knee injury: protection, rest, ice, compression, elevation

Common Joint Disorders

Double-jointed	greater ligament flexibility and range of motion, the joints are less stable and dislocate more easily
Bursitis	inflammation of a bursa, from repeated overuse, infection, or rheumatoid arthritis, with pain, swelling, and limited movement
Torn meniscus	a tear of the knee cartilage, common in athletes, repaired by arthroscopy with a fiber-optic camera
Rheumatism	any painful disorder of the supporting structures, bones, ligaments, tendons, or muscles, not caused by infection or injury
Arthritis	a form of rheumatism with swollen, stiff, painful joints, the leading cause of physical disability in adults over 65
Osteoarthritis	a progressive, degenerative loss of joint cartilage from aging and wear, in the large weight-bearing joints
Rheumatoid arthritis	an autoimmune disease that attacks the cartilage and joint linings, usually on both sides, inflaming the synovial membrane
Gouty arthritis	sodium urate crystals deposit in joints, often the base of the big toe, eroding the cartilage with inflammation and pain

Freedom of movement has a cost

Synovial joints are freely movable, and that is exactly why they are the joints that get injured. A **sprain** is a stretched or torn ligament, the band that stabilizes a joint.

Two arthritis types are worth telling apart. **Osteoarthritis** strikes the large joints and is wear of the cartilage. **Rheumatoid arthritis** attacks the small joints first and actively destroys the cartilage and synovial membrane.

Knowing the joint type tells you the movements to expect, and the ways the joint can fail.

Classification: joints by structure

Joints are classified two ways, by how much they move (function) and by what holds them together (structure). This map shows the structural classes and their subtypes.

Joints by structure

Fibrous (joined by dense connective tissue)	sutures (skull), gomphoses (tooth sockets), syndesmoses (radius to ulna)
Cartilaginous (joined by cartilage)	synchondroses (epiphyseal plate, first rib), symphyses (pubic symphysis, intervertebral discs)
Synovial (joined across a fluid-filled cavity)	plane, hinge, pivot, condylar, saddle, ball-and-socket

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Classify joints by structure into fibrous, cartilaginous, and synovial, and give one example of each.
2. Name the six types of synovial joint and give a body example of each.
3. Use the parts of a synovial joint to explain how it allows movement with little friction.
4. Compare a suture and a synovial joint by how much movement each allows and why.