

MUSCULOSKELETAL

A&P

(A REVIEW)



2023

OBJECTIVES

- Relate the normal anatomy and physiology of the musculoskeletal system
- Explain the importance of normal functioning of the musculoskeletal system to the maintenance of life
- Explain the interrelationships of the musculoskeletal system to other body systems

FUNCTIONS OF THE SKELETAL SYSTEM

- Support soft body tissue
- Protection of vital organs
 - Movement
 - Mineral storage
 - Hematopoiesis

STRUCTURE OF BONES

- **Composition:**

- Bone cells
- Protein matrix
- Mineral deposits

- **Types of Bone Cells:**

- Osteocytes
 - Osteoblast
 - Osteoclast
- 

STRUCTURE OF BONES

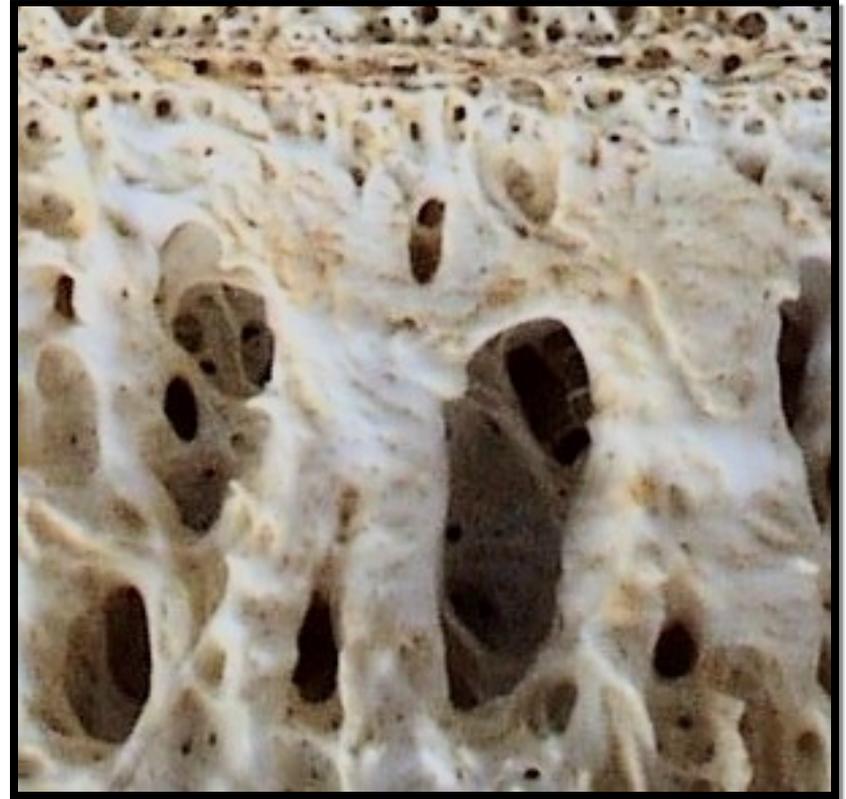
• **Types of Bones:**

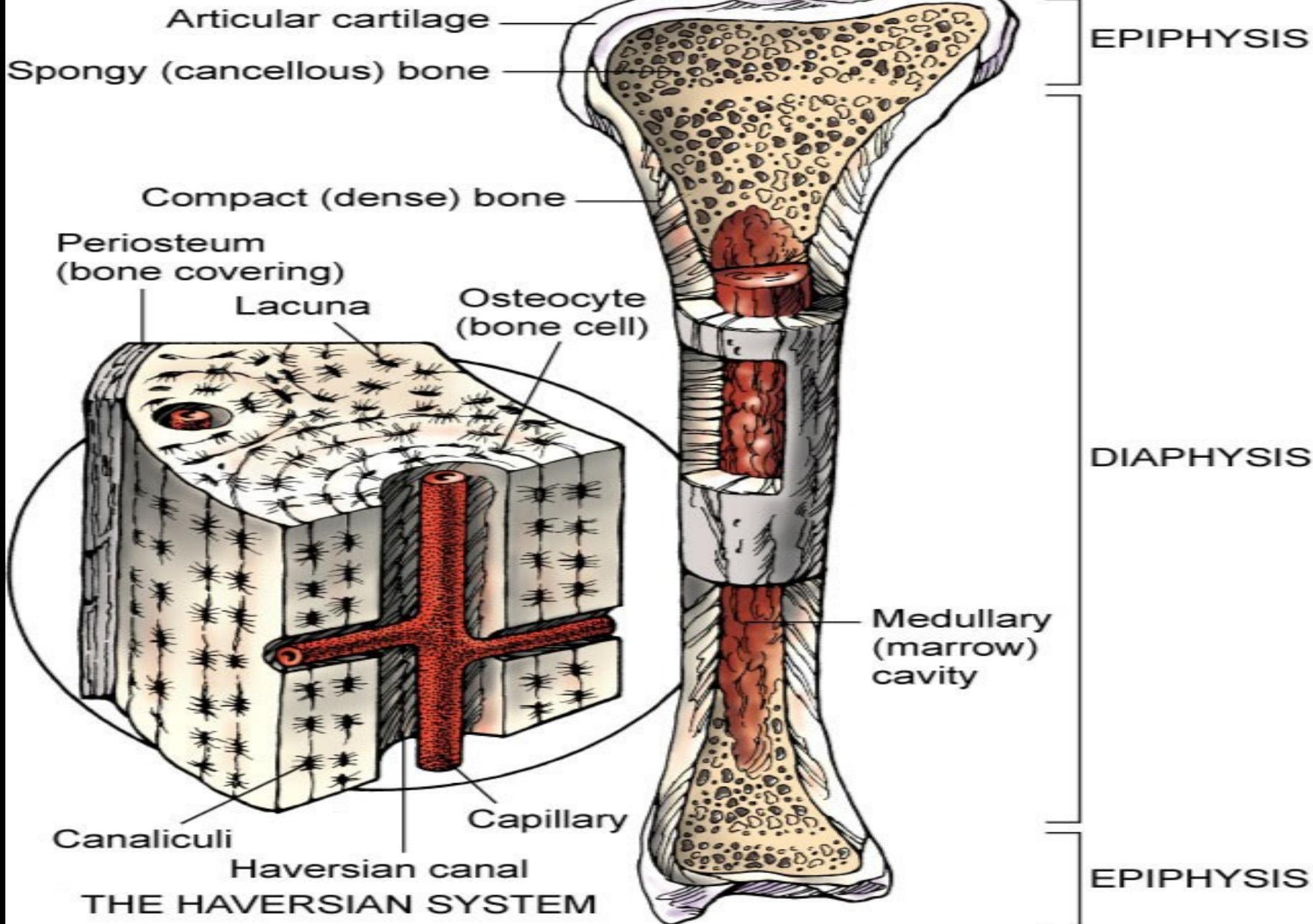
- Bones are not solids
- Categorize bone depending on the size & distribution of spaces
- Cortical: Compact & Dense
 - Hard outer layer
 - Thicker in diaphysis than epiphysis
 - Protects & supports long bones with resisting the stress of weight
 - Haversian systems fit closely together → dense consistency

STRUCTURE OF BONES

• **Types of Bones:**

- Cancellous: Spongy & Porous
 - Many large spaces filled with red marrow
 - Rich blood supply
 - No Haversian canals
 - Makes up most of the bone tissue in short, flat & irregular shaped bones and epiphysis of long bones





BONE FORMATION

•Ossification

- The process by which intracellular material is formed & hardening minerals are deposited into the bone
- Bone is made up of cells dispersed in a matrix of fibers & protein.
 - It is ossified with hard crystals of Ca^+ , Mg, phosphate & carbonate

BONE MAINTENANCE

- Dynamic → constantly reabsorbed and reformed
- **Factors affecting this balance:**
 - Aging
 - Post Menopausal
 - Weight bearing
 - Hormonal influences
 - Minerals

SHAPES OF BONES



- **206 bones in the human body**
- Long
- Short
- Flat
- Irregular

SHAPES OF BONES

- **Long Bones:** Femur & Humerus
- Characterized by central shaft (diaphysis) and two widened ends (epiphyses)
 - ❖ Diaphysis = shaft, long main portion, a thick compact bone
- Medullary or Marrow Cavity = space within the diaphysis
 - Red marrow in a child → hematopoiesis
 - Fatty, yellow marrow in adults
- Endosteum = layer of osteoblasts that line the medullary cavities

SHAPES OF BONES

- **Long Bones:**

- ❖ Epiphysis = extreme ends of the bone
 - Articulates or forms a joint
 - Spongy, cancellous bone, location of muscle attachment
- Articular Cartilage = thin layer of hyaline cartilage covering the epiphysis where bone forms a joint with another bone
 - Smooth surface for joint movement
 - Cushions jolts & shocks

SHAPES OF BONES

- **Long Bones:**

- Metaphysis = where diaphysis joins epiphysis
 - Location of epiphyseal plate → cartilage area in children that actively produces bone = growth
- Periosteum = dense white fibrous covering around bone, except at joint surfaces.
 - 2 layers → outer layer for ligament/tendon fiber attachment ; inner layer contains osteoblasts
 - Inner layer is needed for transverse bone growth & fx repair
 - Rich in blood & nerve supply

SHAPES OF BONES

- **Short Bones:**

- Carpals & Tarsals
- Cube shaped
- Spongy inner core covered by a thin layer of compact bone.

- **Flat Bones:**

- Sternum, Ribs, Skull, Scapula
- Protect delicate organs or allow attachments of large muscles
- 2 outer plates separated by a spongy inner layer

SHAPES OF BONES

• Irregular Bones:

- Vertebrae, ileum, mandible
- Variety of shapes
- Usually connected to several other bones to allow movement
- Inner core of spongy bone & outer layer of compact bone



BLOOD & NERVE SUPPLY TO THE BONES

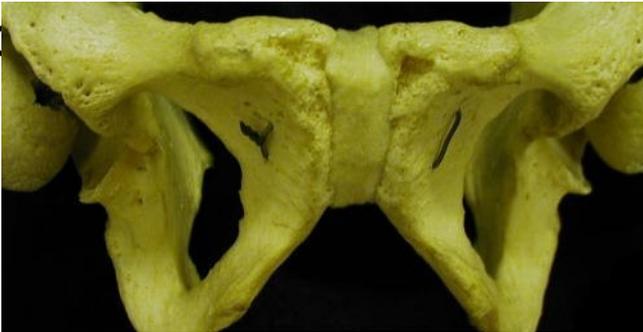
- **Provides oxygen & nutrients:**
 - Via the arterioles in the Haversian canals
 - Via vessels in the periosteum that enter bone
 - Via vessels in the marrow & bone ends
- There are sensory nerve endings in the periosteum that connect with the CNS

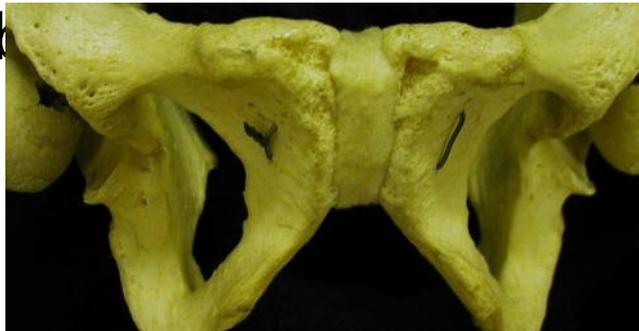
JOINTS

- **Junction between 2 or more bones**
- **Classification by degree of movement**
 - Synarthroses
 - No movement
 - Bone connected to fibrous tissue or cartilage
 - ie. Sutures of the skull



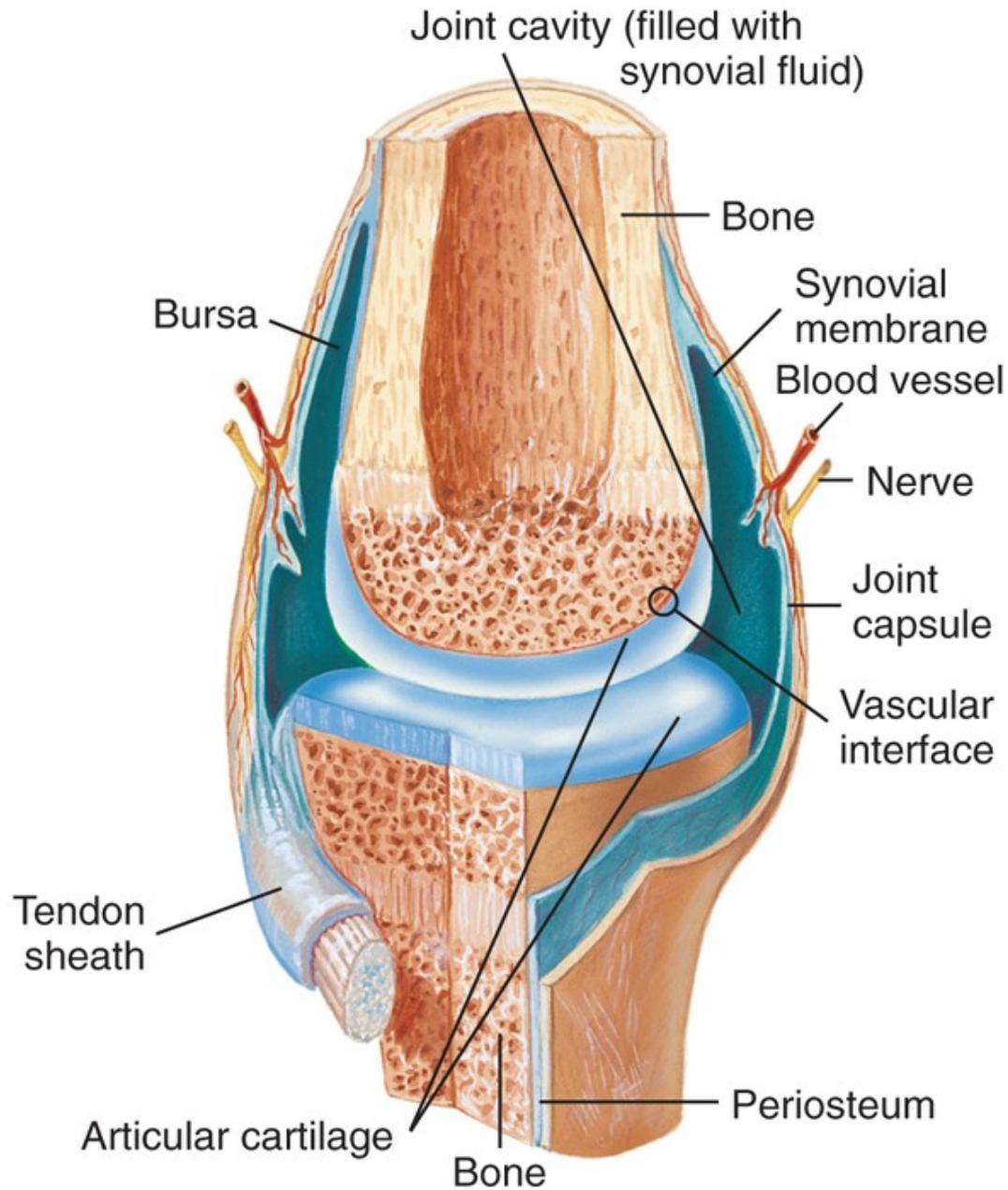
JOINTS

- **Classification by degree of movement**
- **Amphiarthroses:**
 - Slightly moveable
 - No joint cavity but cartilage found between bones.
 - Intervertebral  symphysis



JOINTS

- **Classification by degree of movement**
 - Diarthroses
 - Freely moveable (synovial)
 - Most of the joints in the body
 - Space between the articulating bones
 - Consists of an articular cavity which is lined with synovium
 - Synovium produces synovial fluid for joint lubrication & cartilage nourishment
 - Cavity is enclosed by a capsule of fibrous articular cartilage
 - Ligaments reinforce the capsule & help to limit motion
 - Cartilage covers the ends of the bones



JOINTS

• **Types of Diarthrodial Joints**

- Hinge = concave surface fits into a convex surface
 - Usually moves in one direction only
 - Flexion or extension
 - ie. Knees & elbows
- Pivot = one surface rotates around a peg or pivot
 - Proximal radial & ulnar joint
 - Atlas (C1) & Axis (C2) rotate the head

JOINTS

• **Types of Diarthrodial Joints:**

- Ball & Socket = Permits full freedom of movement
 - Most versatile
 - Flexion, Extension, Adduction, Abduction, Rotation
 - ie. Shoulder & Hip
- Gliding = both articular surfaces are flat
 - One surface moves over another surface
 - No axis of movement
 - Side to side and back & forth
 - Between the carpal bones, tarsals, sacrum & ileum

JOINTS

- **Types of Diarthrodial Joints:**

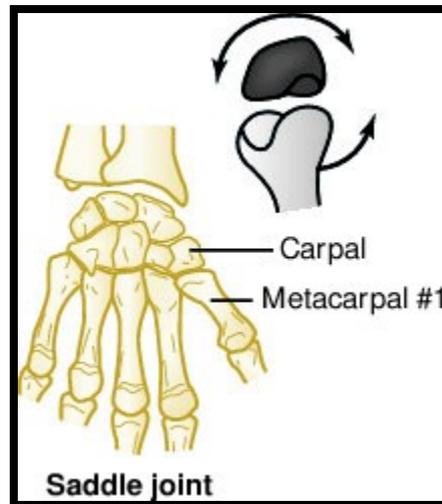
- Condyloid / Ellipsoidal

- An oval condyle (round bone) fits into an elliptical cavity (depression)
- Movement is in two planes that are perpendicular to each other
- Flex, extend, abduct, adduct, circumduction
- ie. Wrist joint – between the radius and carpals

JOINTS

•Types of Diarthrodial Joints:

- Saddle = concave end fits onto a convex surface of another bone
 - Same movements as condyloid but no axial rotation
 - Carpal - metacarpal joint in thumb - base of the thumb



Joint	Movement	Examples	Illustration
Hinge joint	Flexion, extension	Elbow joint (shown), interphalangeal joints, knee joint	
Ball and socket (spheroidal)	Flexion, extension; adduction, abduction; circumduction	Shoulder (shown), hip	
Pivot (rotary)	Rotation	Atlas-axis, proximal radioulnar joint (shown)	
Condyloid	Flexion, extension; abduction, adduction; circumduction	Wrist joint (between radial and carpals) (shown)	
Saddle	Flexion, extension; abduction, adduction; circumduction, thumb-finger opposition	Carpometacarpal joint of thumb (shown)	
Gliding	One surface moves over another surface	Between tarsal bones, sacroiliac joint, between articular processes of vertebrae, between carpal bones (shown)	

JOINTS

- **Joint Motion:**

- Flexion = bending the joint so the angle ↓ and the parts come closer together
 - ie. Arm & leg
- Extension = straightening so the angle increases and parts move farther apart
- Hyperextension = excessive extension beyond anatomical position
 - ie. Bending the head back beyond the upward position

JOINTS

• **Joint Motion:**

- Abduction = move away from mid-line of the body
- Adduction = move toward the body's mid-line
- Rotation = moving a part around an axis
 - i.e. Ball & Socket
 - Internal rotation – turn medially
 - External rotation – turn laterally
- Circumduction = moving in a circle

JOINTS

• **Joint Motion:**

- Supination = turning the hand palm up (on back)
- Pronation = turning the hand palm down (on stomach)
- Eversion = turning the sole of the foot outward
- Inversion = turning the sole of the foot inward
- Elevation = raising a part
- Depression = lowering a part
- Protraction = moving a part forward
- Retraction = moving a part backward

JOINT MOTION



- External Rotation



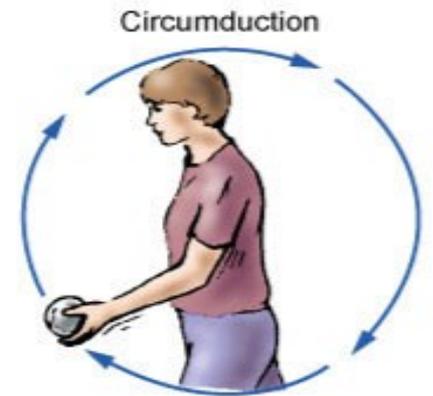
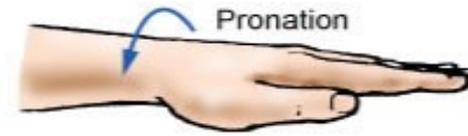
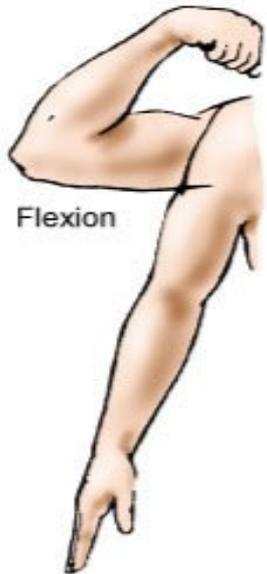
- Internal Rotation



- Dorsi Flexion



- Plantar Flexion



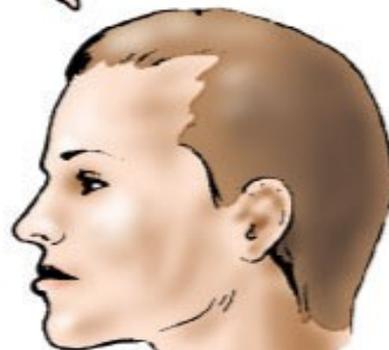
Extension

Adduction

Supination

Rotation

Elevation ↑
Depression ↓

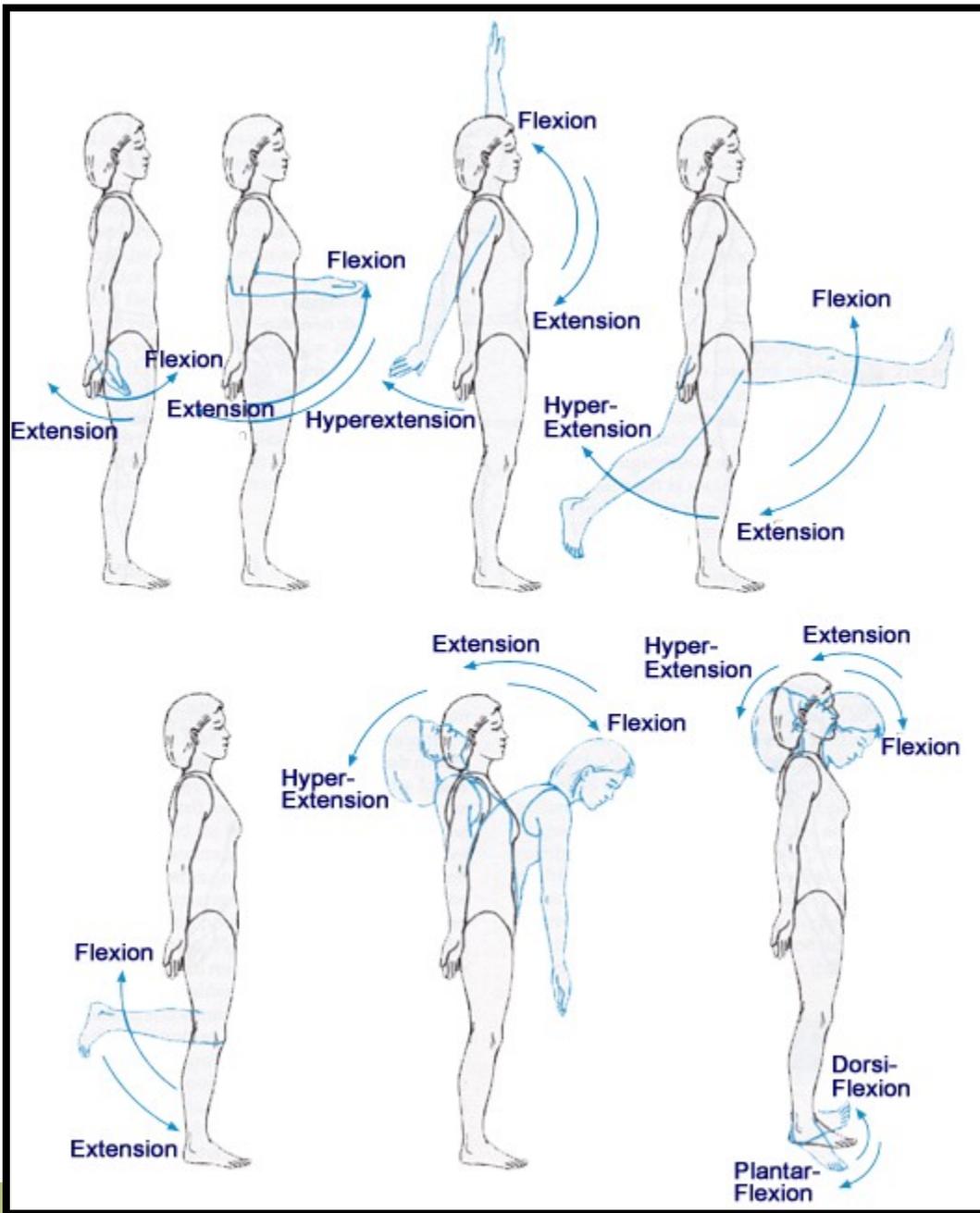


Eversion

Inversion

Protraction

Retraction



CARTILAGE

- **Functions:**

- Support soft tissue
- Provide the articular surfaces for joint movement
- Protect underlying tissue
- Essential for long bone growth prior to maturity → the cartilage that makes up the epiphyseal plate

- **Characteristics:**

- Rigid connective tissue with a fibrous covering (perichondrium)
- Avascular → nourished by diffusion from capillaries
- *Slow to reproduce & heal*

CARTILAGE

• **Types of Cartilage:**

- Hyaline: most common
 - Moderate amount of collagen fibers
 - Articular surfaces of the bone – covers ends of bones in a joint
 - Trachea, bronchi, nose, articular surfaces of bone
- Elastic:
 - Contains collagen and elastic fibers
 - More flexible than hyaline
 - Ear, epiglottis, larynx

CARTILAGE

- **Types of Cartilage:**

- Fibrocartilage:

- Mostly collagen
- Tough tissue
- Functions as a shock absorber
- Between vertebral discs, knee, cushion between bones of the pelvic girdle

MUSCLE

- 40-50% body weight
- Rich vascular supply
- Bones can not move without muscle contraction

MUSCLE

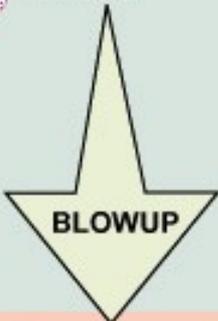
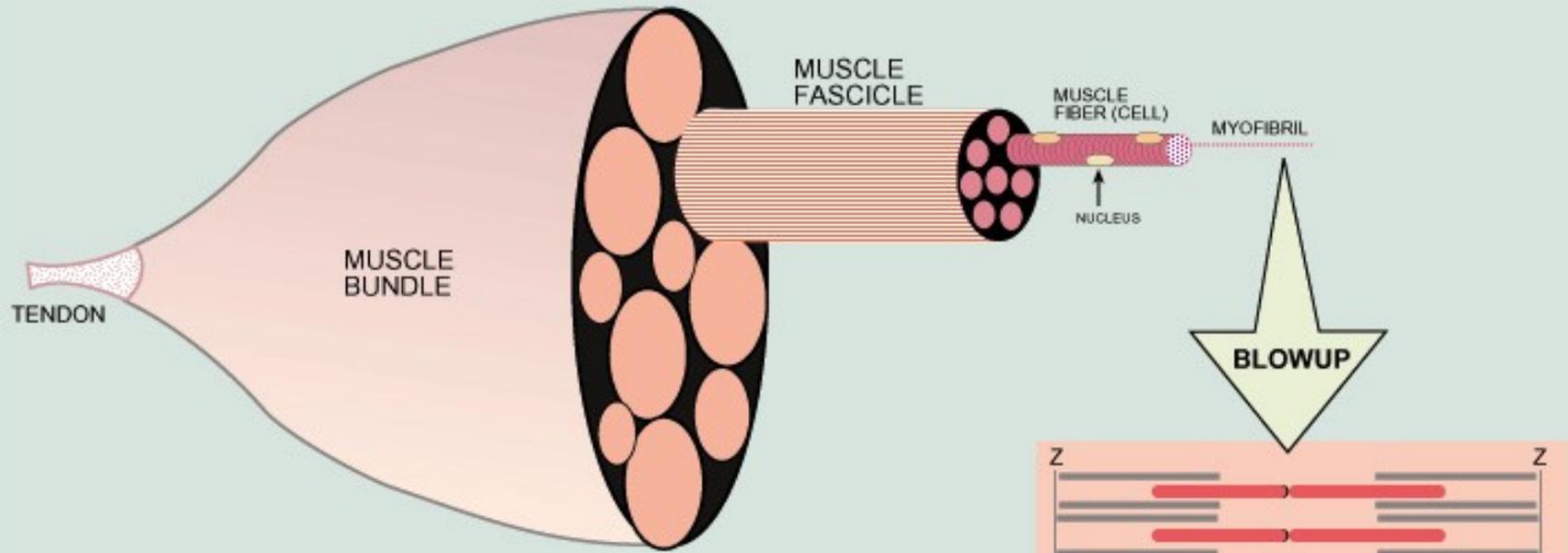
3 Types of Muscles:

- Cardiac: found in the heart – involuntary – controlled by the ANS
- Smooth: found in the walls of the hollow structures
 - GI tract, Bladder, Uterus, Blood vessels
 - No striations
 - Involuntary – controlled by the ANS
- Skeletal: striated (bands)
 - Voluntary
 - Attached to bones
 - Provides controlled movement, maintains posture & produces heat
 - Acts in groups

MUSCLE

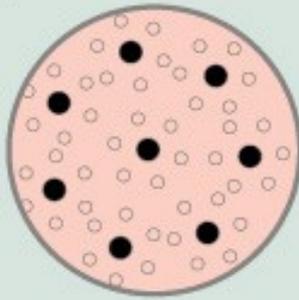
• **Structure**

- Muscle cell and muscle fiber = structured unit of the muscle
 - Muscle fibers are held together by connective tissue
- Composed of myofibrils which are made of filaments
- Sarcomere = contractile unit of the myofibril
- Banding = arrangement of thick and thin filaments in the sarcomere
 - Sarcolemma = cell membrane
 - Sarcoplasm = cytoplasm within the cells

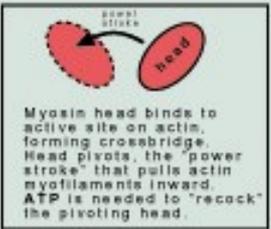
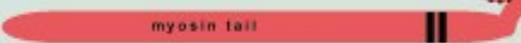
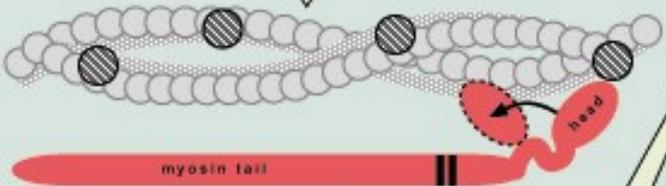
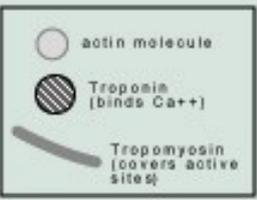
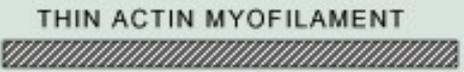


side view of myofibril

view down long axis of myofibril



Myofilament array in the myofibril viewed head-on showing the 6:1 hexagonal packing array (6 thin actin myofilaments for every thick myosin myofilament)



MUSCLE

- **Structure**

- As thick and thin filaments in sarcomere slide past each other → sarcomeres shorten & muscle contracts
- Motor Unit = neuron and muscle cell it activates
- Neuromuscular Junction = motor end plate
 - Junction between the nerve cell & muscle cell it supplies.

MUSCLE

• Structure

- Muscles are made up of muscle fibers held together and supported by connective tissue
- They contain many myofibrils made up of alternating bands of actin & myosin → they slide together to shorten the muscle fibers
- *Origin* = point of attachment on the bone, closest to the trunk
- *Insertion* = point of attachment farthest from the trunk
- Prime Movers = contract to produce movement
- Antagonists = relax the muscle
- Synergists = contract to stabilize the area involved.

MUSCLE

- **Skeletal Muscle Contraction:**

= responsible for posture & movement

- Types:

- **Tonic:** do not produce movement, hold muscles in position, maintain posture
- **Isotonic:** produce movement, muscle shortens
- **Isometric:** ↑ tension in muscle but does not produce movement
- **Twitch:** A quick, jerky reaction to a single stimulus
- **Tetany:** sustained twitch → series of stimuli in rapid succession

MUSCLE

- **Skeletal Muscle Contraction:**

- Types:

- **Fibrillation:** asynchronous contraction of individual fibers
- **Convulsion:** abnormal uncoordinated tetanic contractions in varying muscle groups

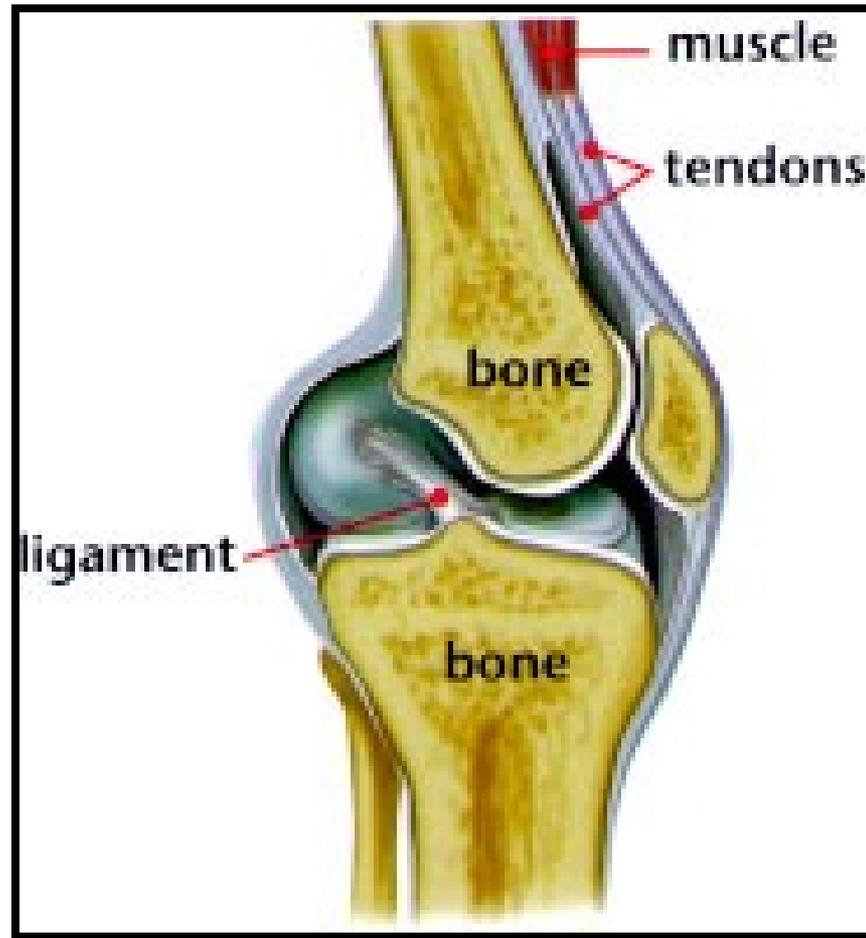
- **Energy Source:**

- ATP needed for muscle contractions
- Muscle cells require large amounts of O₂ and glucose to generate power → have a rich vascular supply
- If not enough O₂ to muscle, lactic acid accumulates from anaerobic metabolism = painful!

LIGAMENTS & TENDONS

- Both composed of dense, fibrous connective tissue → large collagen fibers packed closely together.
 - Therefore....*poor vascular supply & slow healing process*
- **Tendons** = attach muscle to bones
 - ie. achilles
- **Ligaments** = connect bones to bones at joints
 - Permit movement & provide stability
 - ie. knee

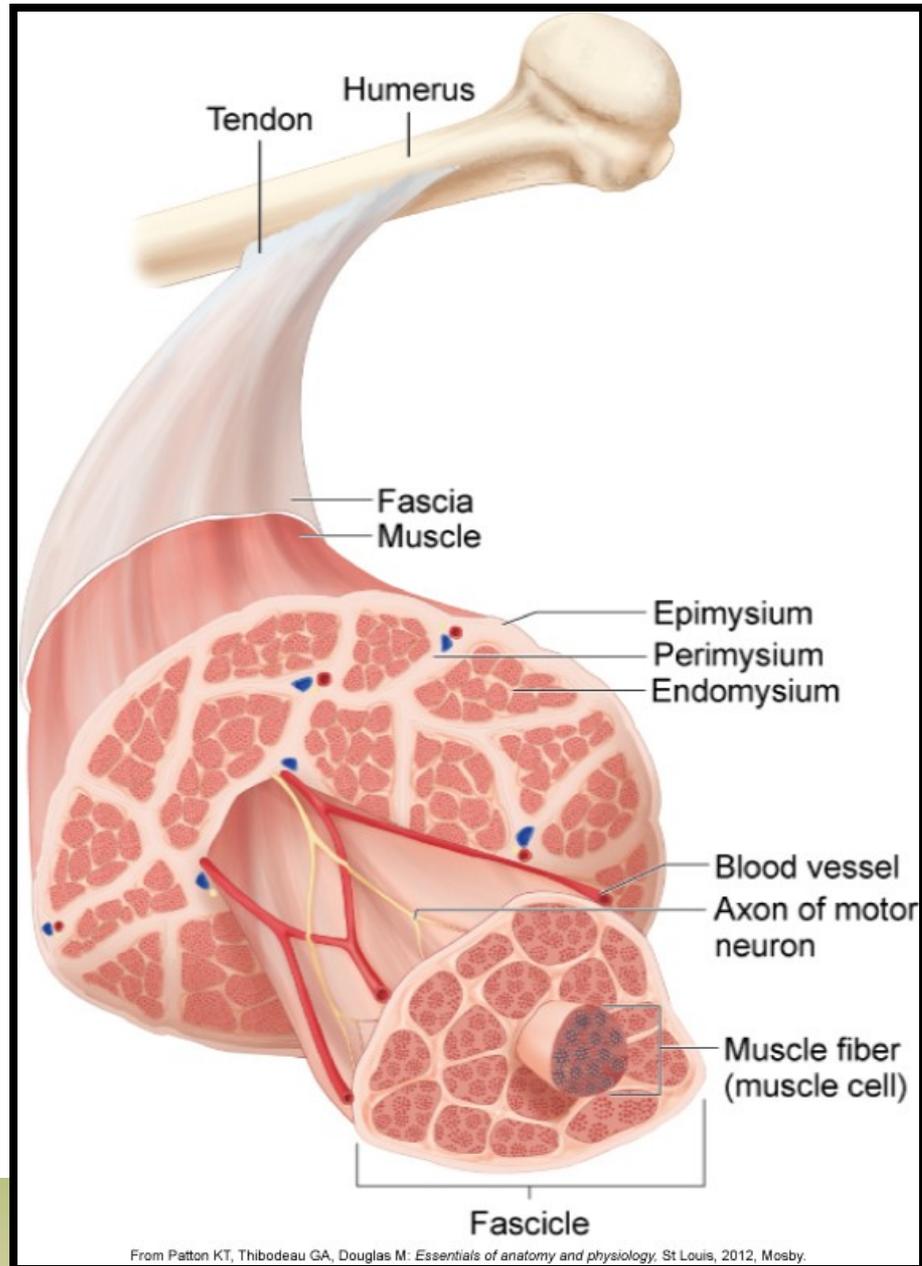
LIGAMENTS & TENDONS



FASCIA

- Layers of connective tissue
- Function: separates one muscle from another
 - Provides strength to muscle tissue
- Superficial Fascia - found directly under the skin
- Deep Fascia - dense fibrous connective tissue that surrounds muscles
 - Found between muscles, around nerve & blood vessel bundles
- Compartment Syndrome

FASCIA



BURSAE

- Small sacs of connective tissue located wherever pressure is exerted over moving parts
 - Usually at joints to ↓ friction
- Cushion between moving parts
- Lined with synovial membrane and contains synovial fluid
- **Bursitis** = inflammation of the bursa due to mechanical injury or excessive use
 - ie. Tennis elbow