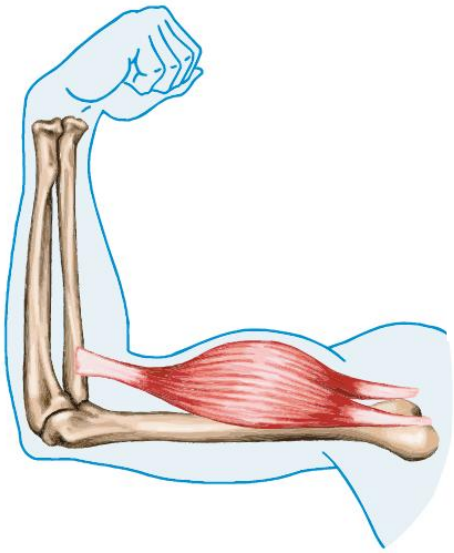
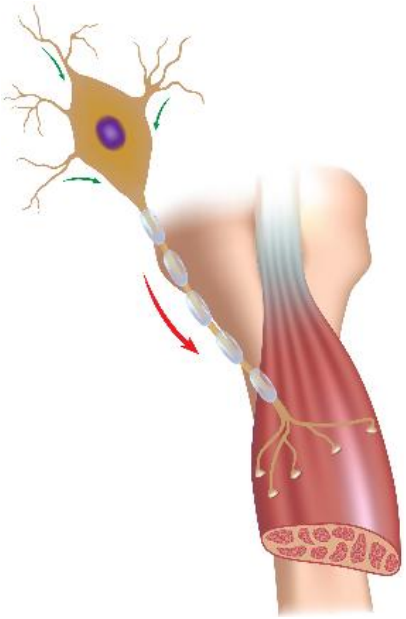
CONCEPT: MUSCULOSKELETAL SYSTEM

- ***Muscle system*** – organ system that includes skeletal, cardiac, and smooth muscle
    - □ ***Muscle*** – tissue capable of contracting through the interaction of actin and myosin proteins
        - ***Myocytes*** – muscle cells, specialized types are found in skeletal, cardiac, and smooth muscle

EXAMPLE:



- ***Skeleton*** – support structure of an organism, works with muscles for support and locomotion
    - □ ***Exoskeleton*** – external skeleton, like those of arthropods
    - □ ***Endoskeleton*** – internal skeleton composed of mineralized tissue, like bone
        - ***Bones*** – rigid, mineralized organ
- Skeletal muscles connect to bones allowing for voluntary movements of the body
- ***Locomotion*** – movement, like that produced by the interaction of muscles and bones

EXAMPLE:



CONCEPT: MUSCULOSKELETAL SYSTEM

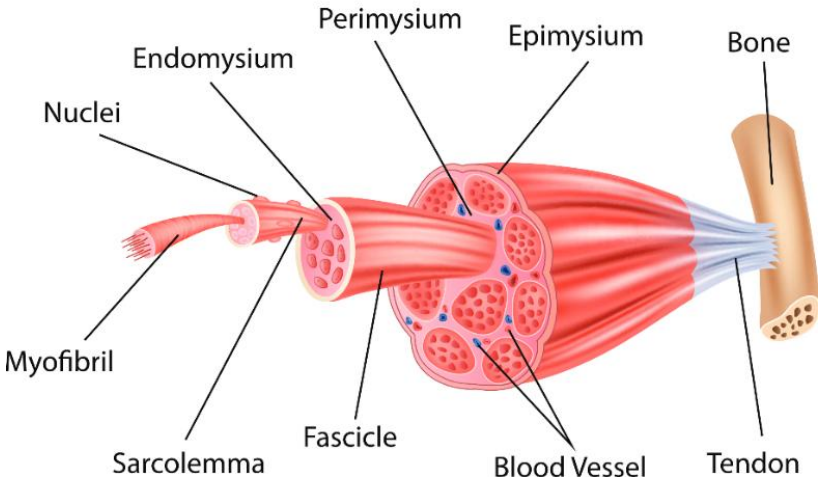
● ***Muscle fiber*** – long, thin, multinucleate myocyte containing many myofibrils

□ ***Myofibrils*** – rod-like protein structures made primarily of actin and myosin

- ***Sarcomere*** – contractile unit of striated muscle, chained together to form myofibrils

● ***Striated muscle*** – muscle tissue that contains repeated units of sarcomeres

EXAMPLE:



● Sarcomeres are made of thick and thin myofilaments that interact by sliding past each other

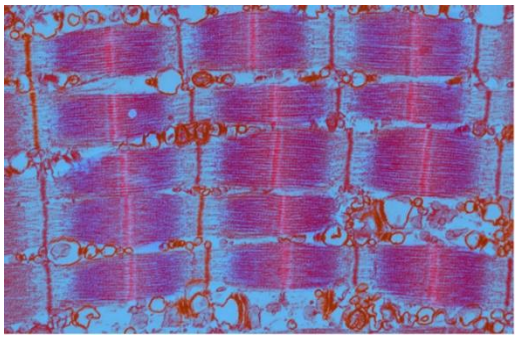
□ ***Myofilaments*** – filaments that make up myofibrils, made of actin and myosin

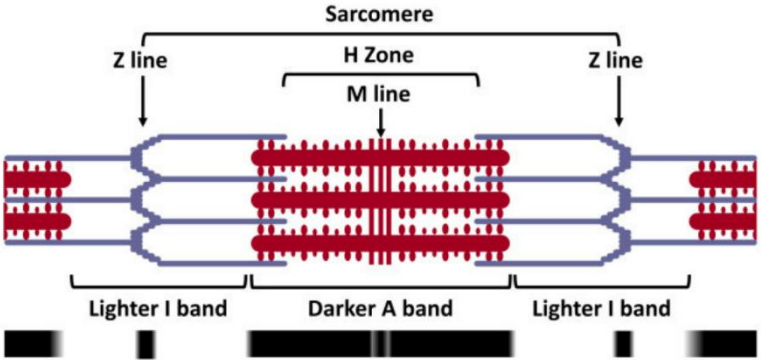
- ***Actin*** – protein that forms the ***thin filaments*** of the sarcomere

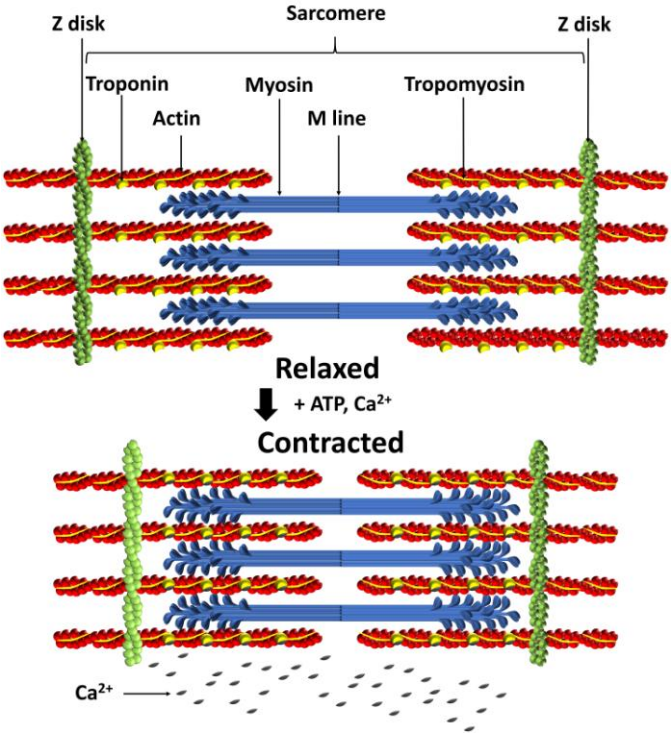
- ***Myosin*** – protein that forms the ***thick filaments*** of the sarcomere

□ ***Z-disc*** – end of a sarcomere where thin filaments attach

EXAMPLE:



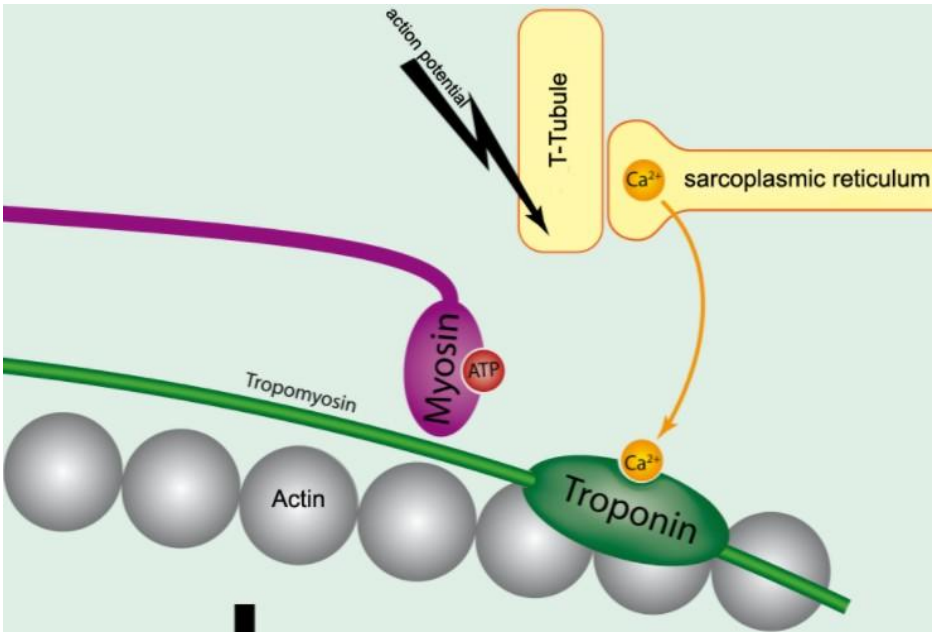


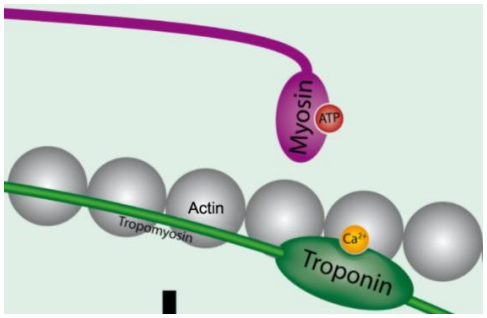


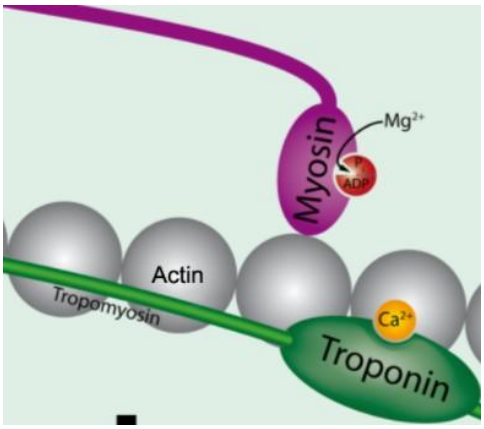
CONCEPT: MUSCULOSKELETAL SYSTEM

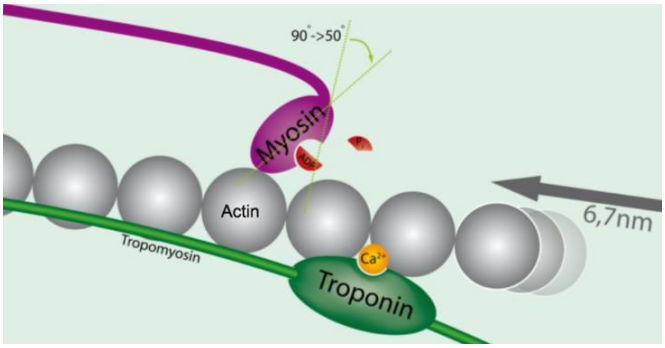
- ***Sliding-filament model*** – mechanism of muscle contraction involving thin and thick filaments sliding past each other
  - □ Actin filaments have myosin binding sites along their length that are critical to filament sliding
    - ***Tropomyosin*** – protein wrapped around actin, covering myosin binding sites
    - ***Troponin*** – Ca^{2+}-sensitive protein that interacts with tropomyosin
  - □ Troponin binds Ca^{2+}, it causes tropomyosin to move and expose the myosin binding site on the actin filaments
  - □ Myosin head with ATP binds the exposed actin filament, and hydrolyzes ATP
    - Release of the phosphate group triggers the ***power stroke***, moving the head, and causing filament sliding
    - ADP is released and a new ATP is bound, causing the myosin head to release the actin filament

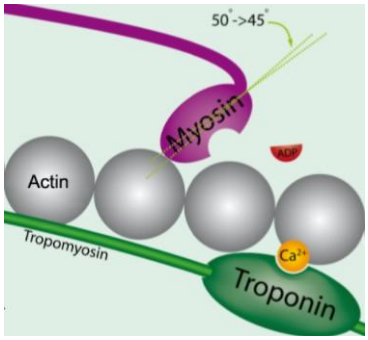
EXAMPLE:

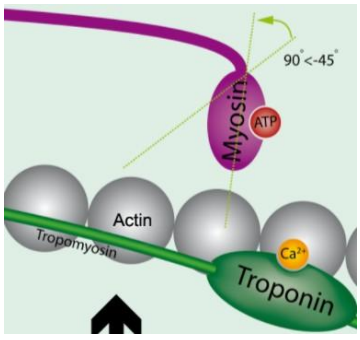










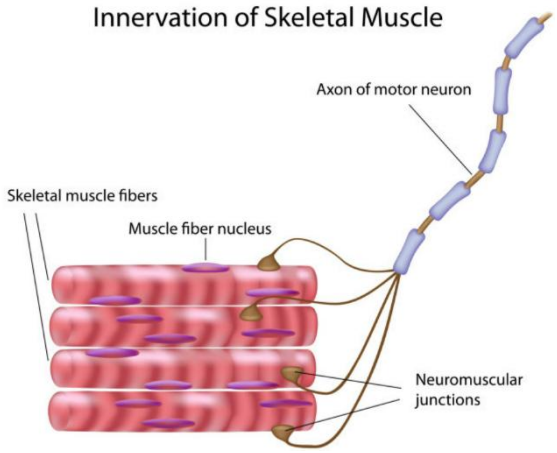


CONCEPT: MUSCULOSKELETAL SYSTEM

● ***Motor unit*** – single motor neuron and the muscle fibers in controls

□ ***Neuromuscular junction*** – connection between a motor neuron and muscle fiber

EXAMPLE:



● Muscle fibers of a motor unit contract as a group

□ Nerves release acetylcholine at the neuromuscular junction to stimulate muscle contraction

□ Muscle fibers binding acetylcholine depolarizes the membrane, leading to an action potential

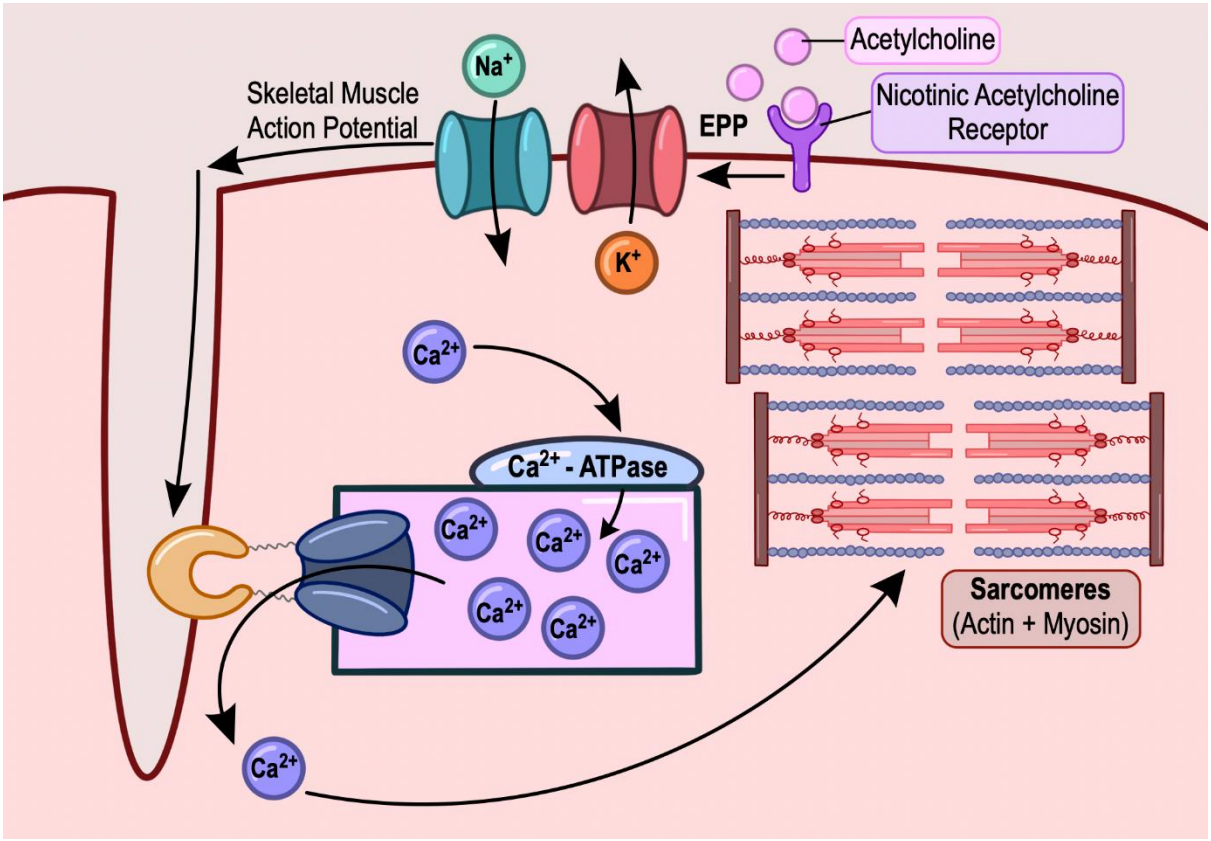
□ ***Transverse tubules*** – indentation in the membrane that move action potentials to the sarcoplasmic reticulum

□ ***Sarcoplasmic reticulum*** (***SR***) – special type of smooth endoplasmic reticulum found in myocytes

- Action potentials cause SR to release Ca^{2+} to bind to troponin

- Ca^{2+} must be pumped out of the cytosol, back into the SR

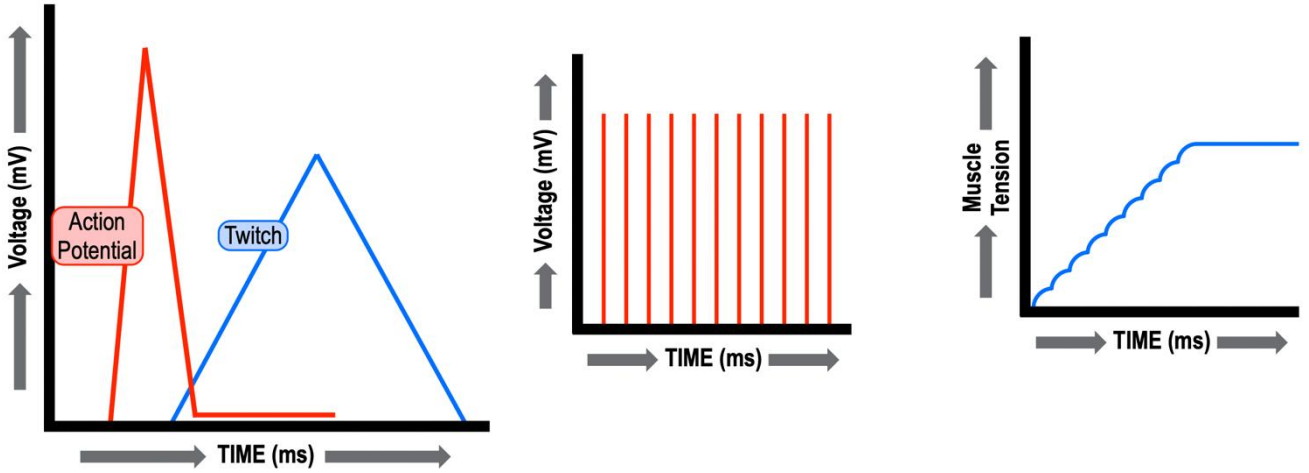
EXAMPLE:



CONCEPT: MUSCULOSKELETAL SYSTEM

- Single action potential results in a twitch of the muscle fibers
    - □ Action potential frequency translates into degree of muscle tension
    - □ ***Tetanus*** – sustained muscle contraction from twitches fusing together
- ***Fast-twitch fibers*** – contract rapidly, but tire quickly; rely on glycolysis for ATP rather than aerobic respiration
- ***Slow-twitch fibers*** – contract slowly due to myosin's rate of ATP hydrolysis, but can sustain longer contractions
    - □ ***Myoglobin*** – oxygen binding protein in muscle, used to store oxygen

EXAMPLE:

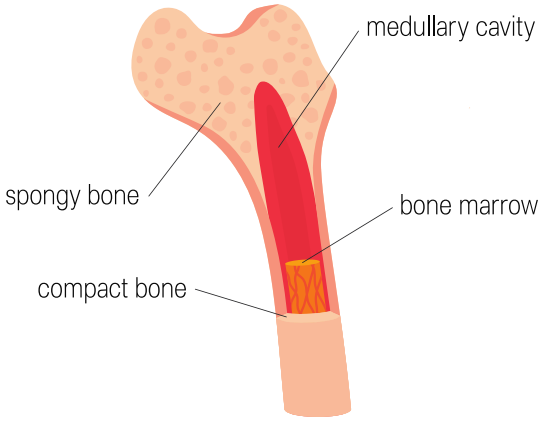


- ***Voluntary muscles*** – controlled by conscious thought
    - □ ***Skeletal muscle*** – voluntary muscle made of long myofibrils
- ***Involuntary muscles*** – controlled by unconscious signals, regulated by the autonomic nervous system
    - □ ***Smooth muscle*** – involuntary muscles that don't contain myofibrils
        - Line blood vessels, and digestive tract, responsible for peristalsis
    - □ ***Cardiac muscle*** – involuntary muscles, contain sarcomeres, but have a branched structure
        - ***Intercalated disks*** – allow action potentials to spread through cardiac muscle

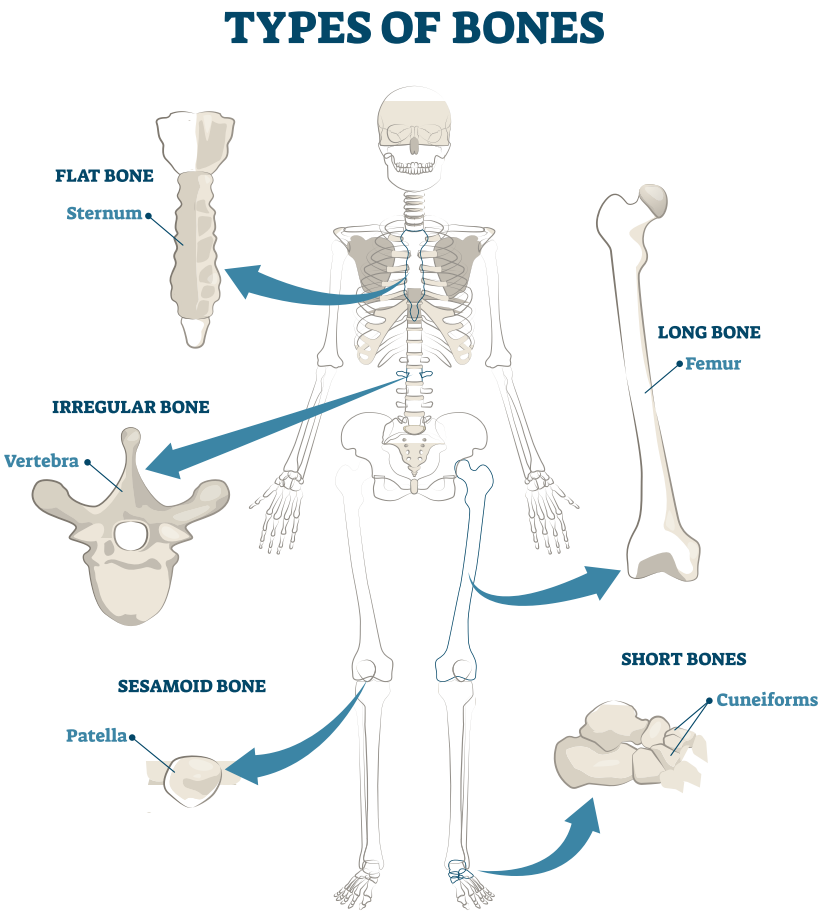
CONCEPT: MUSCULOSKELETAL SYSTEM

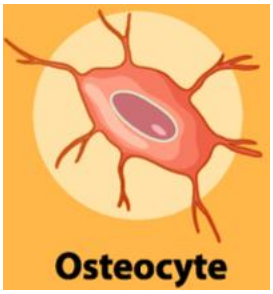
- Vertebrate endoskeletons are composed of bone, cartilage, tendons, and ligaments
- ***Bones*** – composed of cells in a hard extracellular matrix containing calcium
    - □ Osteoblasts – synthesize and secrete bone matrix
    - □ Osteoclast – breaks down and reabsorbs bone tissue for remodeling and repair
    - □ Medullary cavity – cavity in bone in which red and yellow bone marrow is stored

EXAMPLE:



BONE MARROW

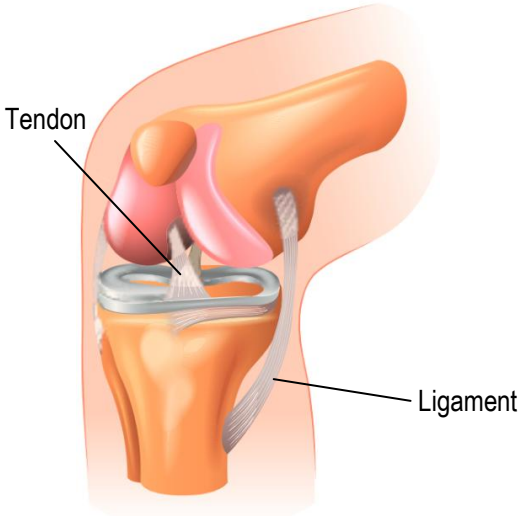


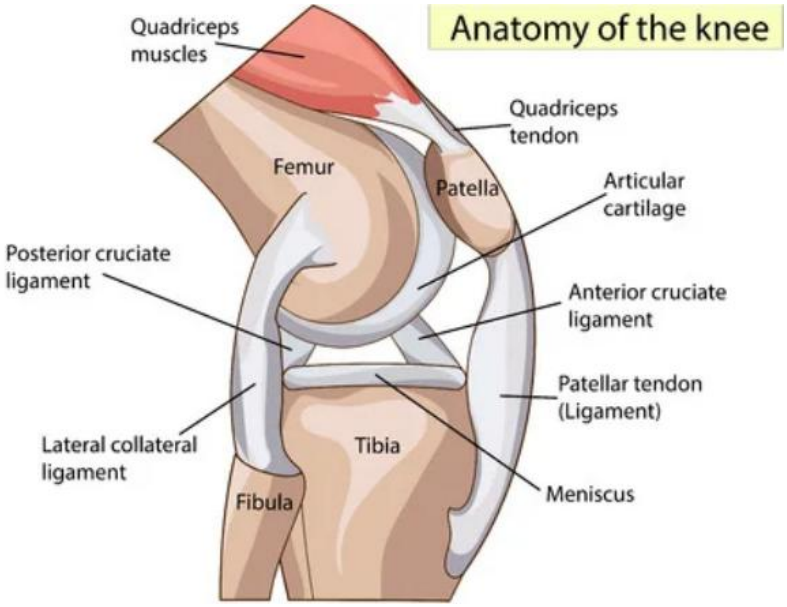


CONCEPT: MUSCULOSKELETAL SYSTEM

- ***Cartilage*** – elastic tissue containing collagen proteins
- ***Tendons*** – connective tissue that links muscle to bone
- ***Ligaments*** – connective tissue that links bones
- ***Joints*** – connection between bones that allows for specific types of movement
    - □ Ball and socket joints, like the hips and shoulders allow for many types of rotation
    - □ Hinge joints limit movement to a single plane

EXAMPLE:





- ***Flexors*** – a muscle that bends a limb, and pull bones closer together
- ***Extensors*** – muscle that straightens, or extends a limb

EXAMPLE: