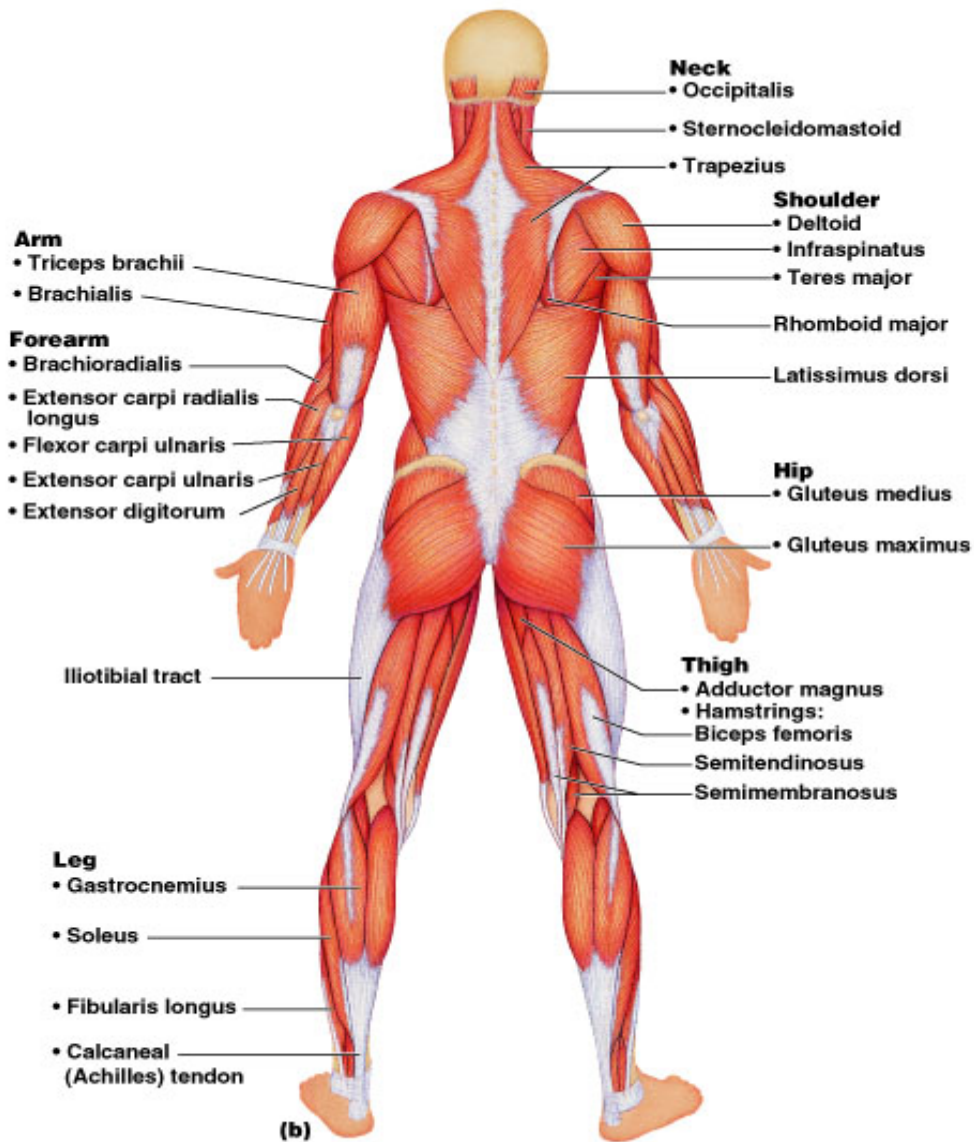


Muscular System

Dr. Gary Mumaugh – Campbellsville University





Organization of Muscles

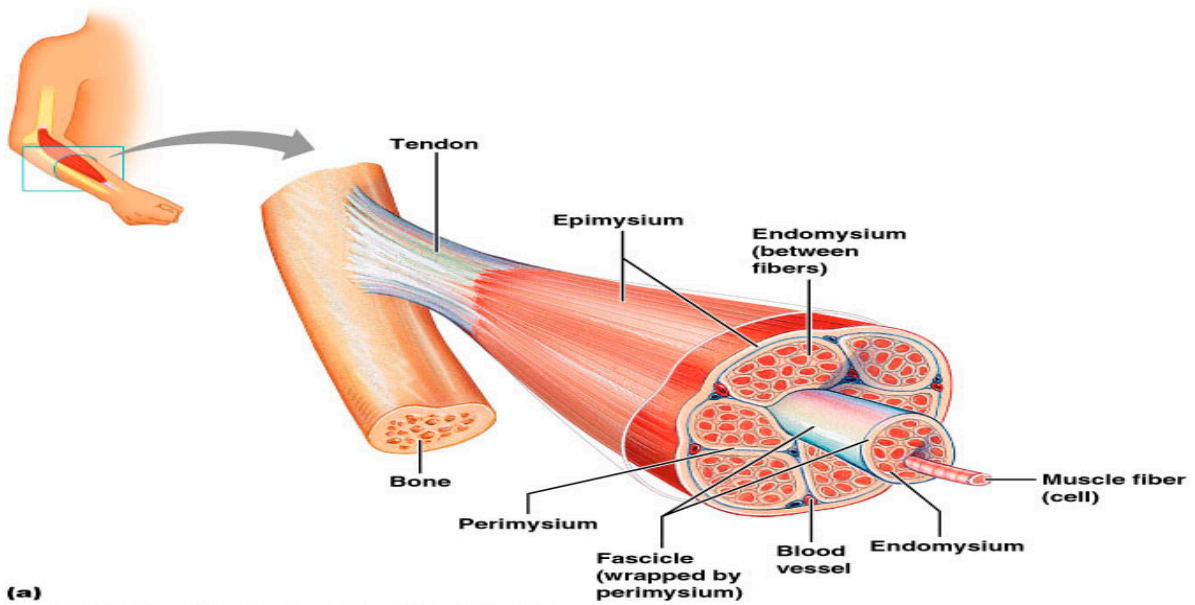
- about 600 human skeletal muscles
- constitute about half of our body weight
- three kinds of muscle tissue
 - skeletal, cardiac, smooth
- specialized for one major purpose
 - converting the chemical energy in ATP into the mechanical energy of motion
- myology – the study of the muscular system

The Functions of Muscles

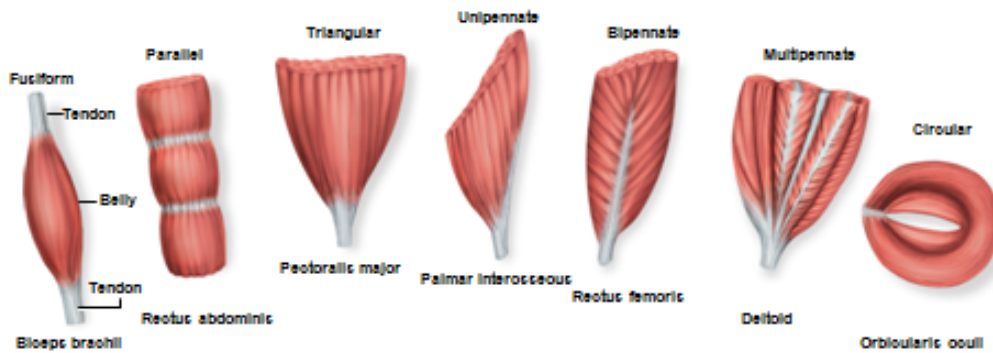
- Movement
 - move from place to place, movement of body parts and body contents in breathing, circulation, feeding and digestion, defecation, urination, and childbirth
 - role in communication – speech, writing, and nonverbal communications
- Stability
 - Maintain posture by preventing unwanted movements
 - antigravity muscles – resist the pull of gravity and prevent us from falling or slumping over
 - stabilize joints
- Control of openings and passageways
 - sphincters – internal muscular rings that control the movement of food, bile, blood, and other materials
- Heat production by skeletal muscles
 - as much as 85% of our body heat

Connective Tissues of a Muscle

- endomysium
 - thin sleeve of loose connective tissue surrounding each muscle fiber
 - allows room for capillaries and nerve fibers to reach each muscle fiber
- perimysium
 - slightly thicker layer of connective tissue
 - fascicles – bundles of muscle fibers wrapped in perimysium
 - carry larger nerves and blood vessels, and stretch receptors
- epimysium
 - fibrous sheath surrounding the entire muscle
 - outer surface grades into the fascia
 - inner surface sends projections between fascicles to form perimysium
- fascia
 - sheet of connective tissue that separates neighboring muscles or muscle groups from each other and the subcutaneous tissue



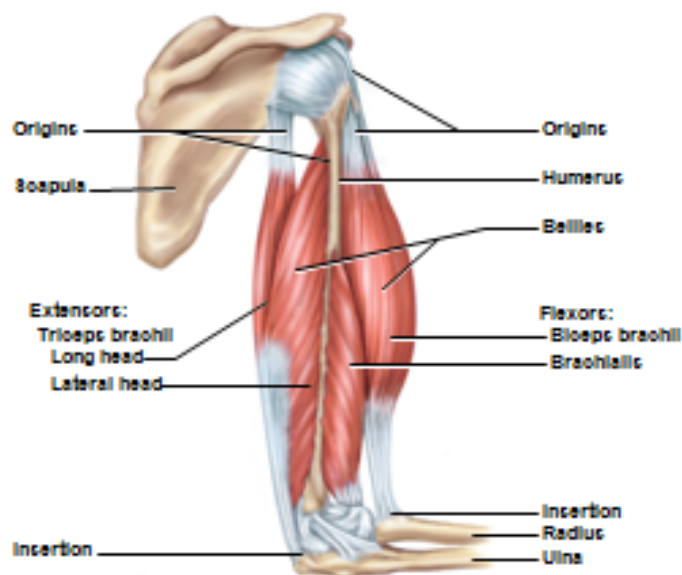
Fascicle Orientation of Muscles



strength of a muscle and the direction of its pull are determined partly by the orientation of its fascicles.

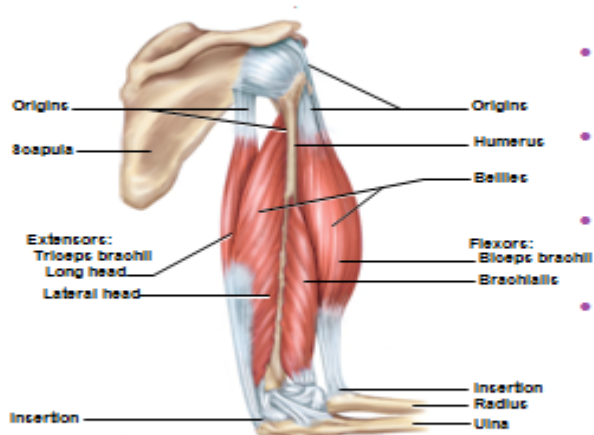
Muscle Attachments

- indirect attachment to bone
 - tendons bridge the gap between muscle ends and bony attachment
 - the collagen fibers of the endo-, peri-, and epimysium continue into the tendon
 - from there into the periosteum and the matrix of bone
 - very strong structural continuity from muscle to bone
 - aponeurosis – tendon is a broad, flat sheet (palmar aponeurosis)
- direct (fleshy) attachment to bone
 - little separation between muscle and bone
 - muscle seems to immerge directly from bone
 - margins of brachialis, lateral head of triceps brachii
- some skeletal muscles do not insert on bone, but in dermis of the skin – muscles of facial expression
- Origin
 - bony attachment at stationary end of muscle
- Belly
 - thicker, middle region of muscle between origin and insertion
- Insertion
 - bony attachment to mobile end of muscle



Functional Groups of Muscles

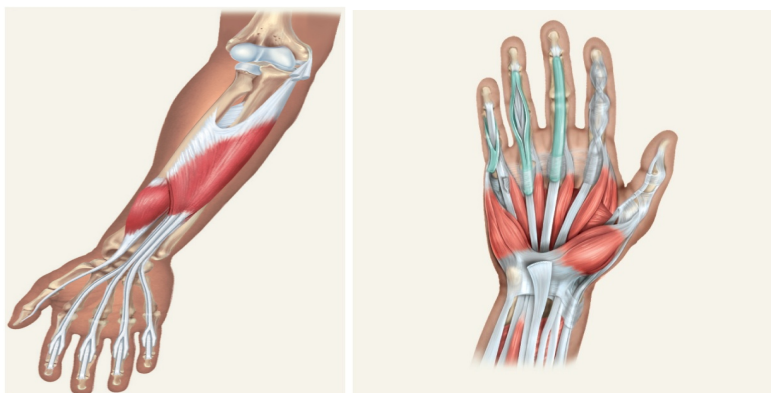
- action – the effects produced by a muscle
 - to produce or prevent movement
- prime mover (agonist) - muscle that produces most of force during a joint action
- synergist - muscle that aids the prime mover
 - stabilizes the nearby joint
 - modifies the direction of movement
- antagonist - opposes the prime mover
 - relaxes to give prime mover control over an action
 - preventing excessive movement and injury



- prime mover - brachialis
- synergist - biceps brachii
- antagonist - triceps brachii
- fixator - muscle that holds scapula firmly in place
 - rhomboids

Intrinsic and Extrinsic Muscles

- intrinsic muscles – entirely contained within a region, such as the hand
 - both its origin and insertion there
- extrinsic muscles – act on a designated region, but has its origin elsewhere
 - fingers – extrinsic muscles in the forearm

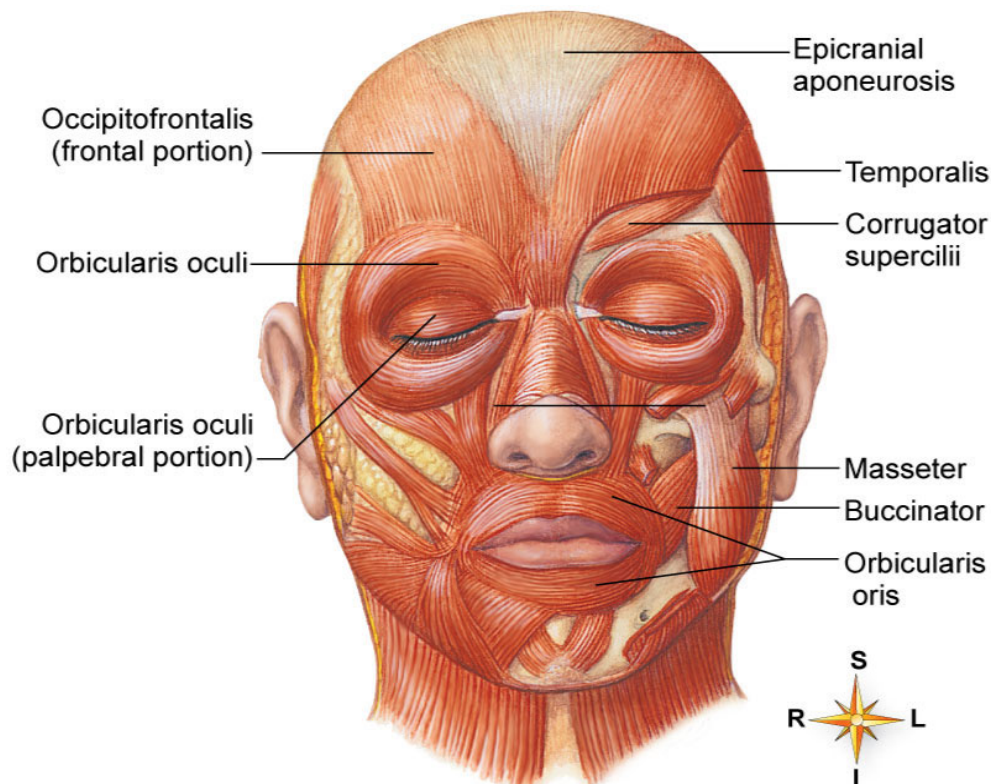


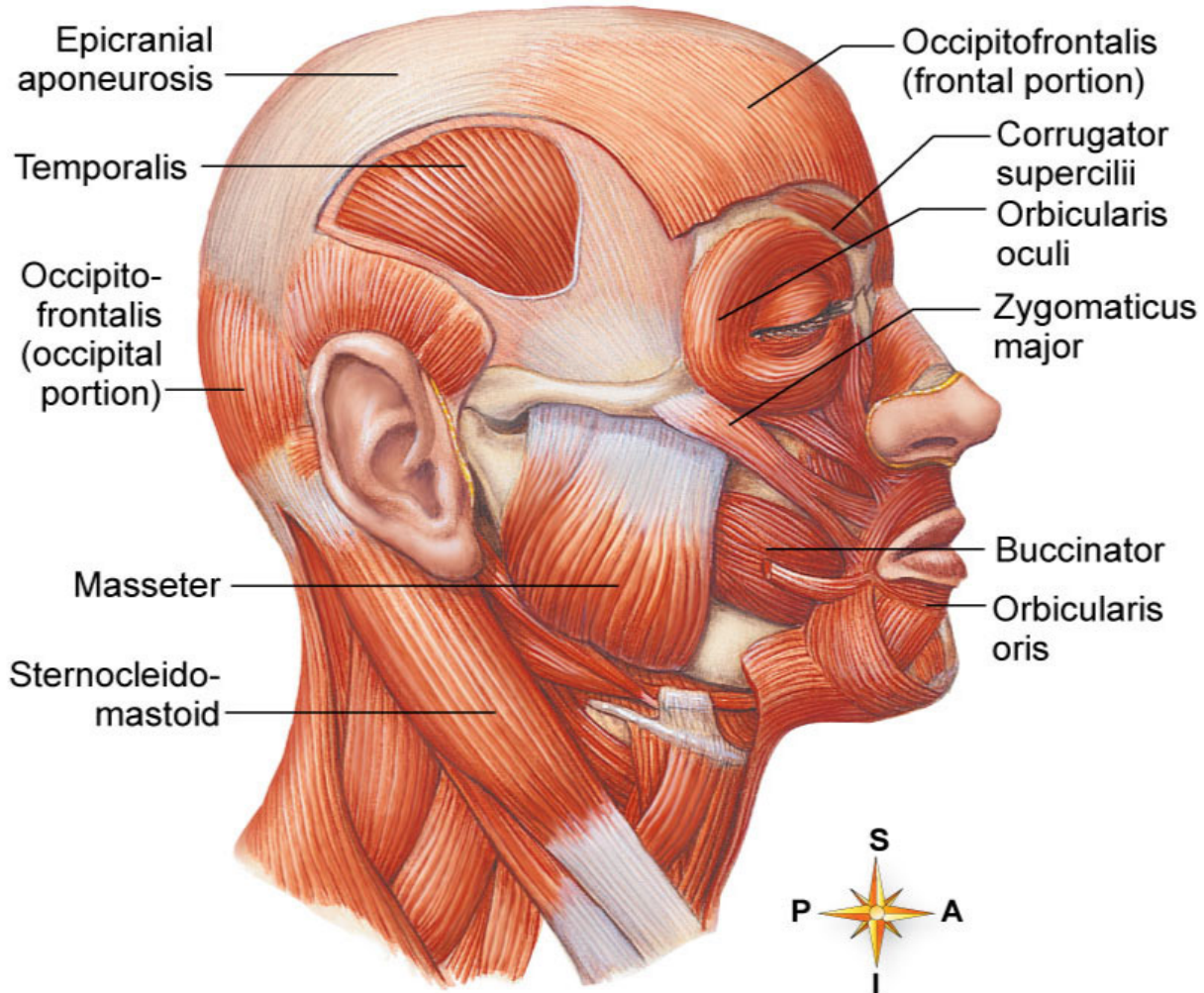
Muscle Innervation

- innervation of a muscle – refers to the identity of the nerve that stimulates it
 - enables the diagnosis of nerve, spinal cord, and brainstem injuries from their effects on muscle function
- spinal nerves arise from the spinal cord
 - emerge through intervertebral foramina
 - immediately branch into a posterior and anterior ramus
 - innervate muscles below the neck
- cranial nerves arise from the base of the brain
 - emerge through skull foramina
 - innervate the muscles of the head and neck
 - numbered I to XII

Muscles of Facial Expression

- muscles that insert in the dermis and subcutaneous tissues
- tense the skin and produce facial expressions
- innervated by facial nerve (CN VII)
- paralysis causes face to sag
- found in scalp, forehead, around the eyes, nose and mouth, and in the neck



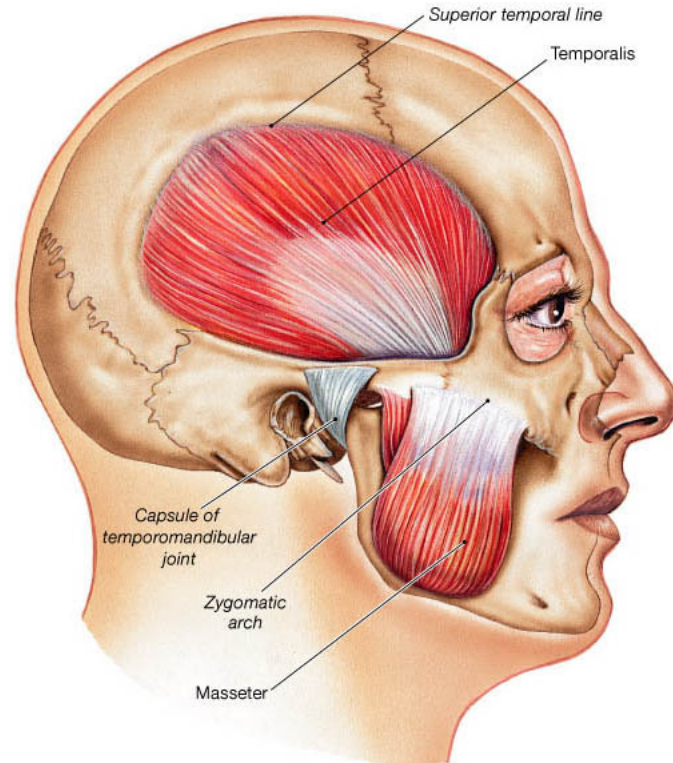


Muscles of Chewing and Swallowing

- extrinsic muscles of the tongue
 - tongue is very agile organ
 - pushes food between molars for chewing (mastication)
 - forces food into the pharynx for swallowing (deglutition)
 - crucial importance to speech
- intrinsic muscles of tongue
 - vertical, transverse, and longitudinal fascicles

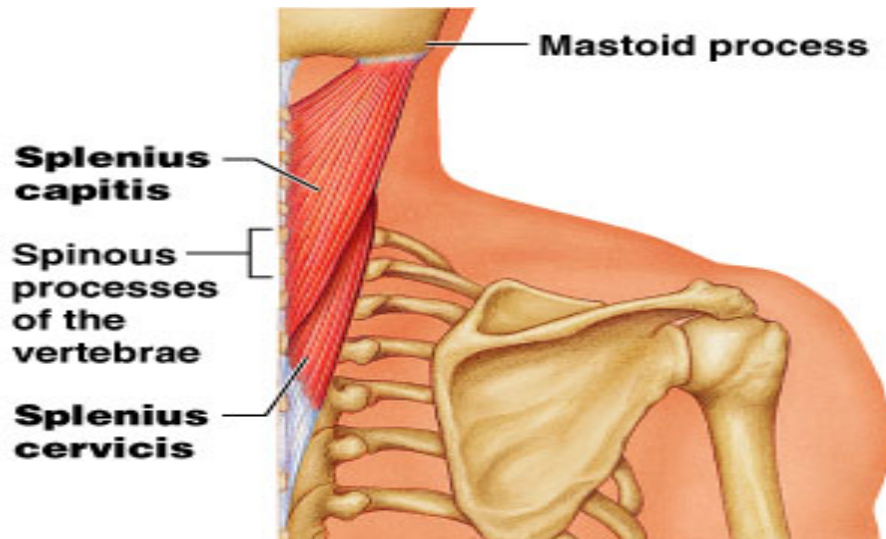
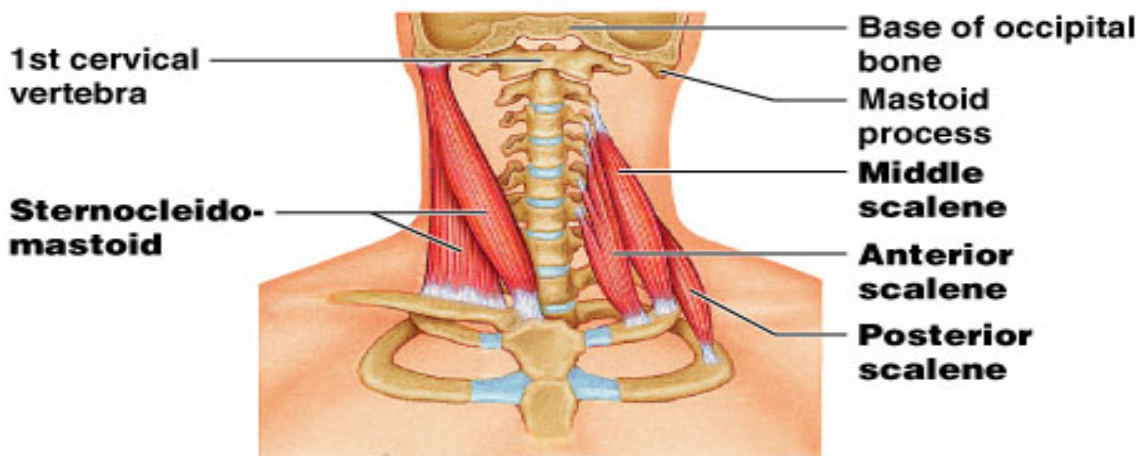
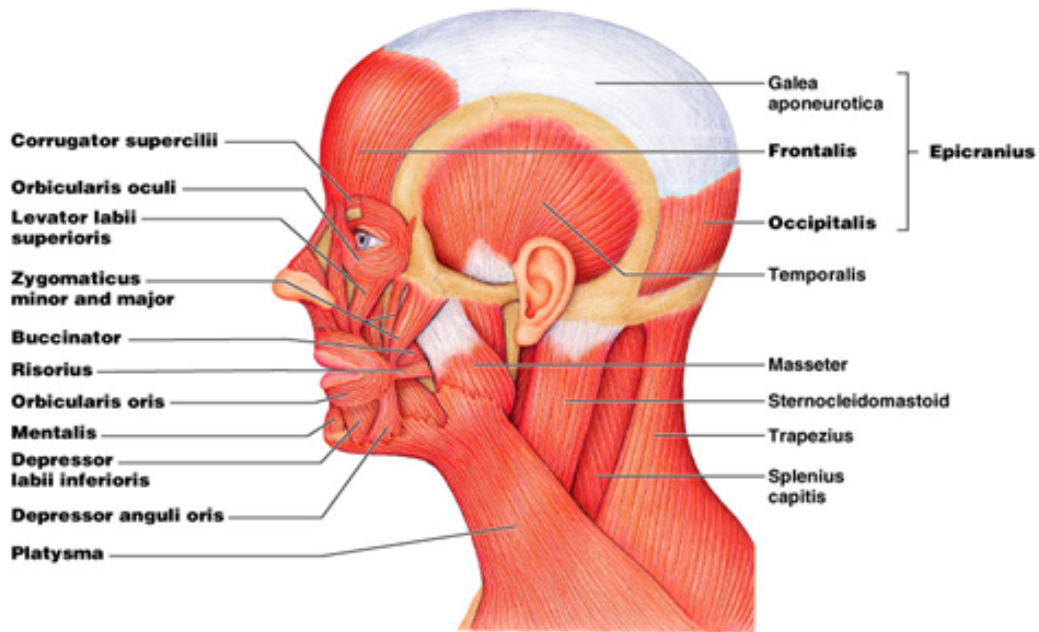
Muscles of Chewing

- four pairs of muscles produce the biting and chewing movements of the mandible
 - depression – to open mouth
 - elevation – biting and grinding
 - protraction – incisors can cut
 - retraction – make rear teeth meet
 - lateral and medial excursion – grind food
- temporalis, masseter, medial pterygoid, lateral pterygoid
- innervated by mandibular nerve which is a branch of the trigeminal (V)



Muscles Acting on the Head

- originate on the vertebral column, thoracic cage, and pectoral girdle
- insert on the cranial bones
- actions
 - flexion (tipping head forward)
 - sternocleidomastoid
 - scalenes
 - extension (holding the head erect)
 - trapezius
 - splenius capitis
 - semispinalis capitis
- Actions
 - lateral flexion (tipping head to one side)
 - rotation (turning the head to the left and right)
 - may cause contralateral movement – movement of the head toward the opposite side
 - may cause ipsilateral movement – movement of the head toward the same side





Muscles of the Trunk

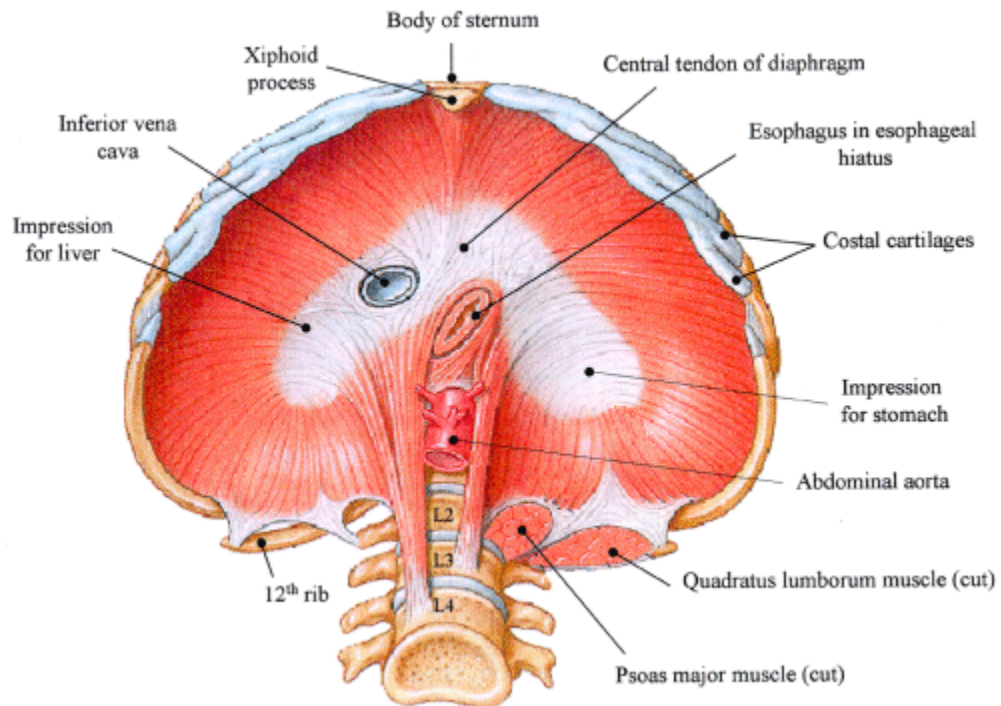
- three functional groups
 - muscles of respiration
 - muscles that support abdominal wall and pelvic floor
 - movement of vertebral column

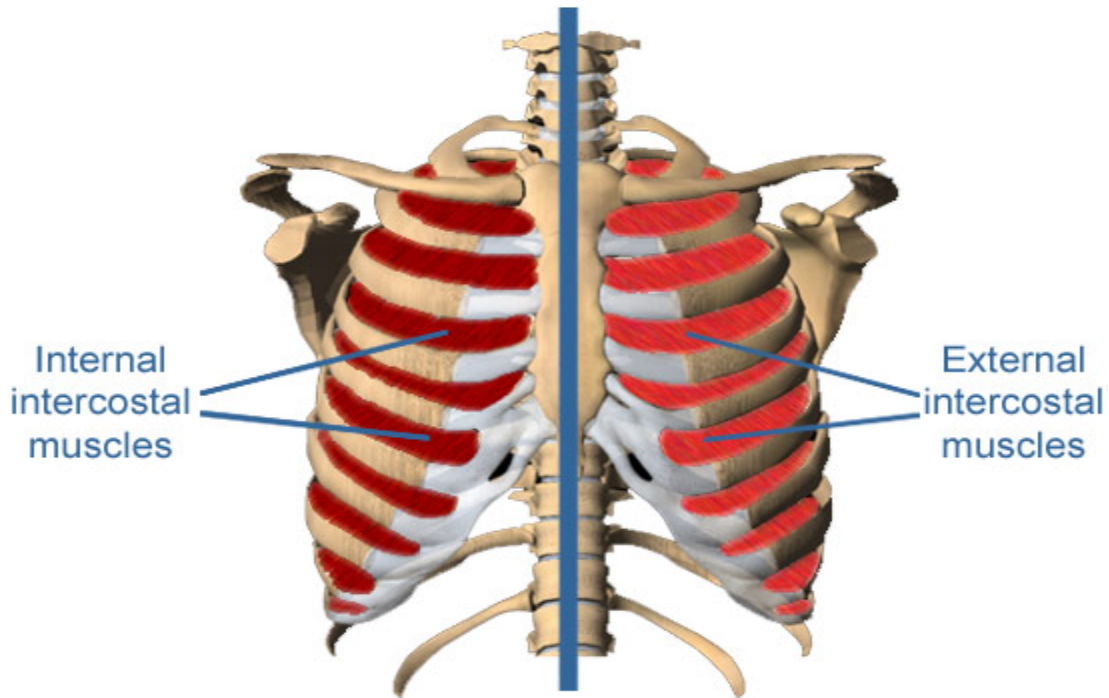
Muscles of Respiration

- breathing requires the use of muscles enclosing thoracic cavity
 - diaphragm, external and internal intercostal,
- inspiration – air intake
- expiration – expelling air
- other muscles of chest and abdomen that contribute to breathing
 - sternocleidomastoid, scalenes of neck
 - pectoralis major and serratus anterior of chest
 - latissimus dorsi of back
 - abdominal muscles – internal and external obliques, and transverse abdominis
 - some anal muscles

Muscles of Respiration - Intercostals

- external intercostals
 - elevates ribs
 - expand thoracic cavity
 - create partial vacuum causing inflow of air
- internal intercostals
 - depresses and retracts ribs
 - compresses thoracic cavity
 - expelling air



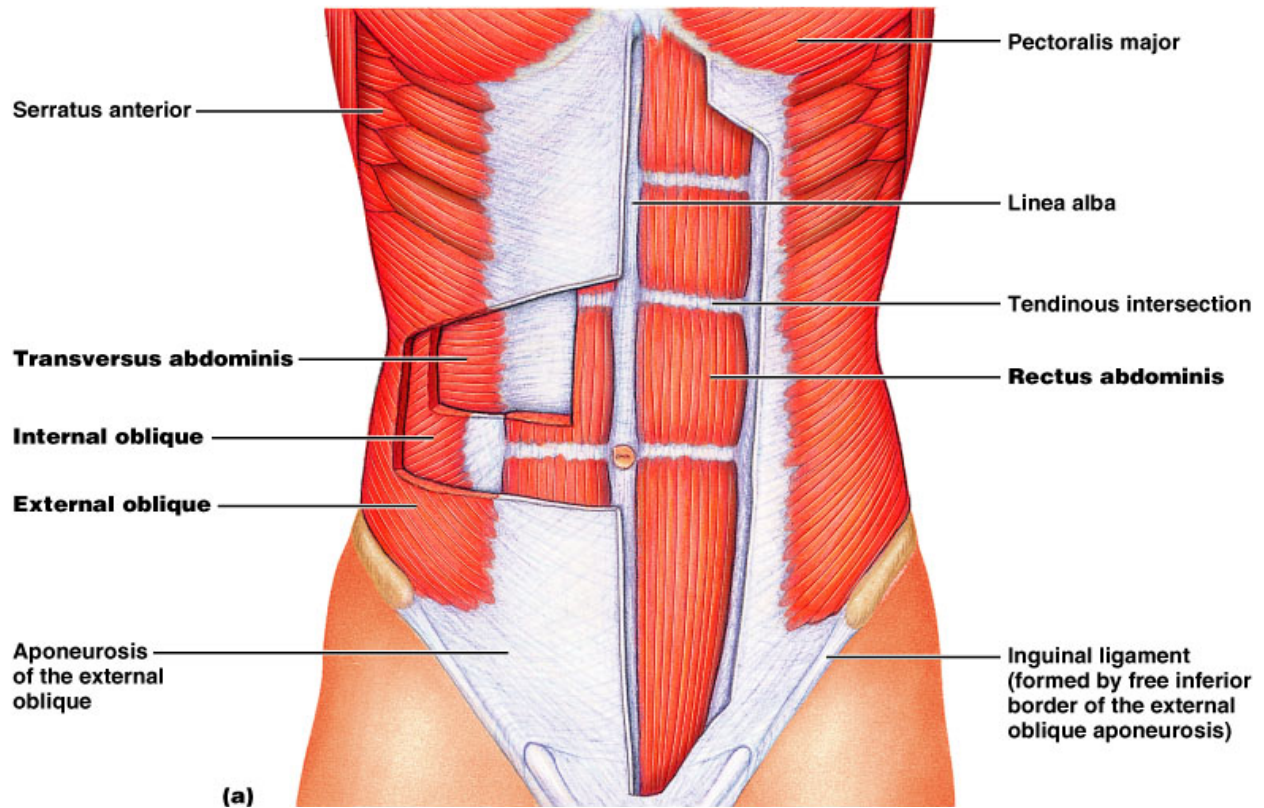


Muscles of the Anterior Abdominal Wall

- four pairs of sheetlike muscles
 - external abdominal oblique
 - internal abdominal oblique
 - transverse abdominal
 - rectus abdominis
- strengthen abdominal wall

External Abdominal Oblique

- most superficial of lateral abdominal muscles
- supports abdominal viscera against pull of gravity
- stabilizes vertebral column during heavy lifting
- maintains posture
- compresses abdominal organs
- aids in forced expiration
- rotation at waist



Internal Abdominal Oblique

- intermediate layer of lateral abdominal muscles
- unilateral contraction causes ipsilateral rotation of waist
- aponeurosis – tendons of oblique and transverse muscles –broad, fibrous sheets

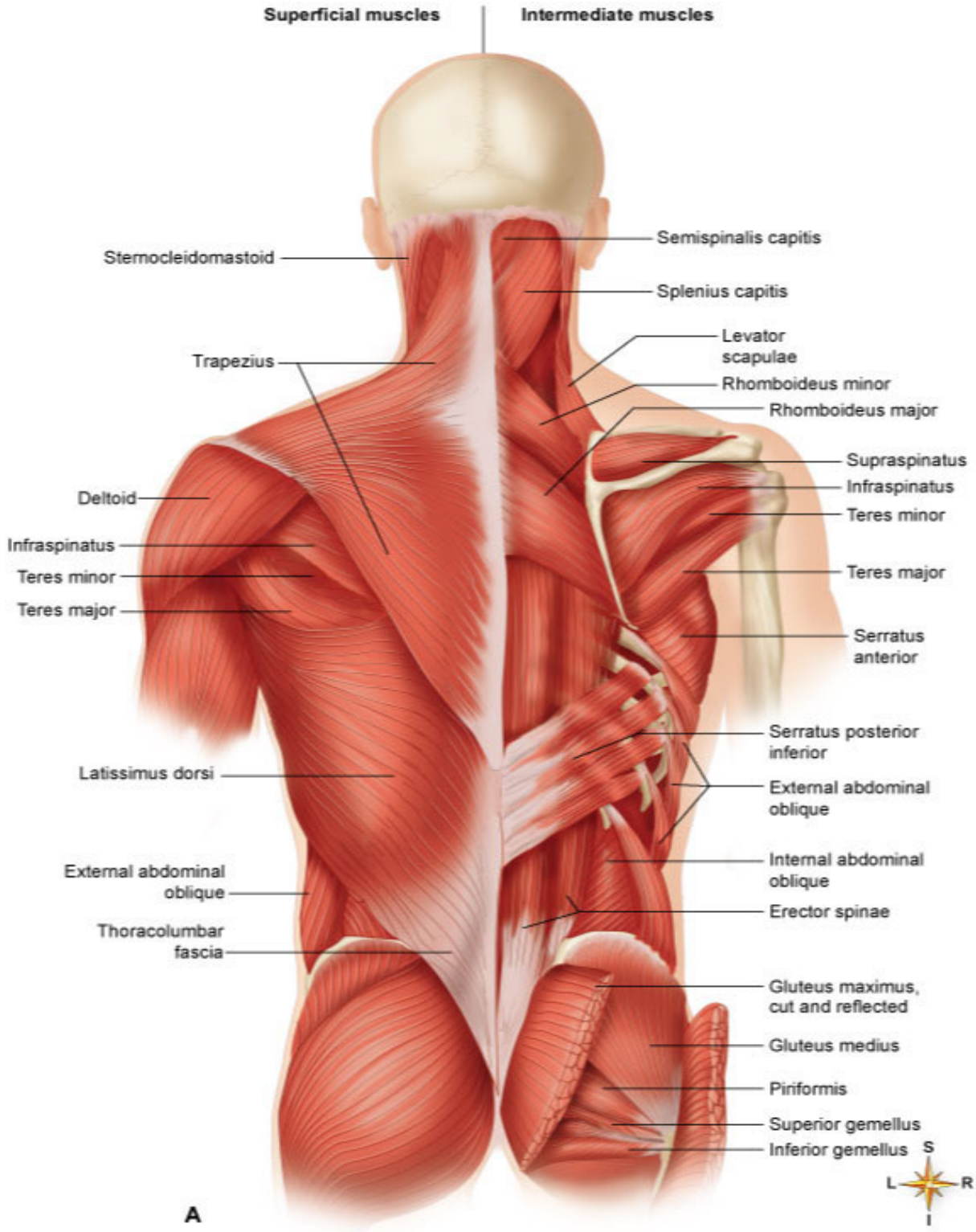
Transverse Abdominal

- deepest of lateral abdominal muscles
- horizontal fibers
- compresses abdominal contents
- contributes to movements of vertebral column

Rectus Abdominis

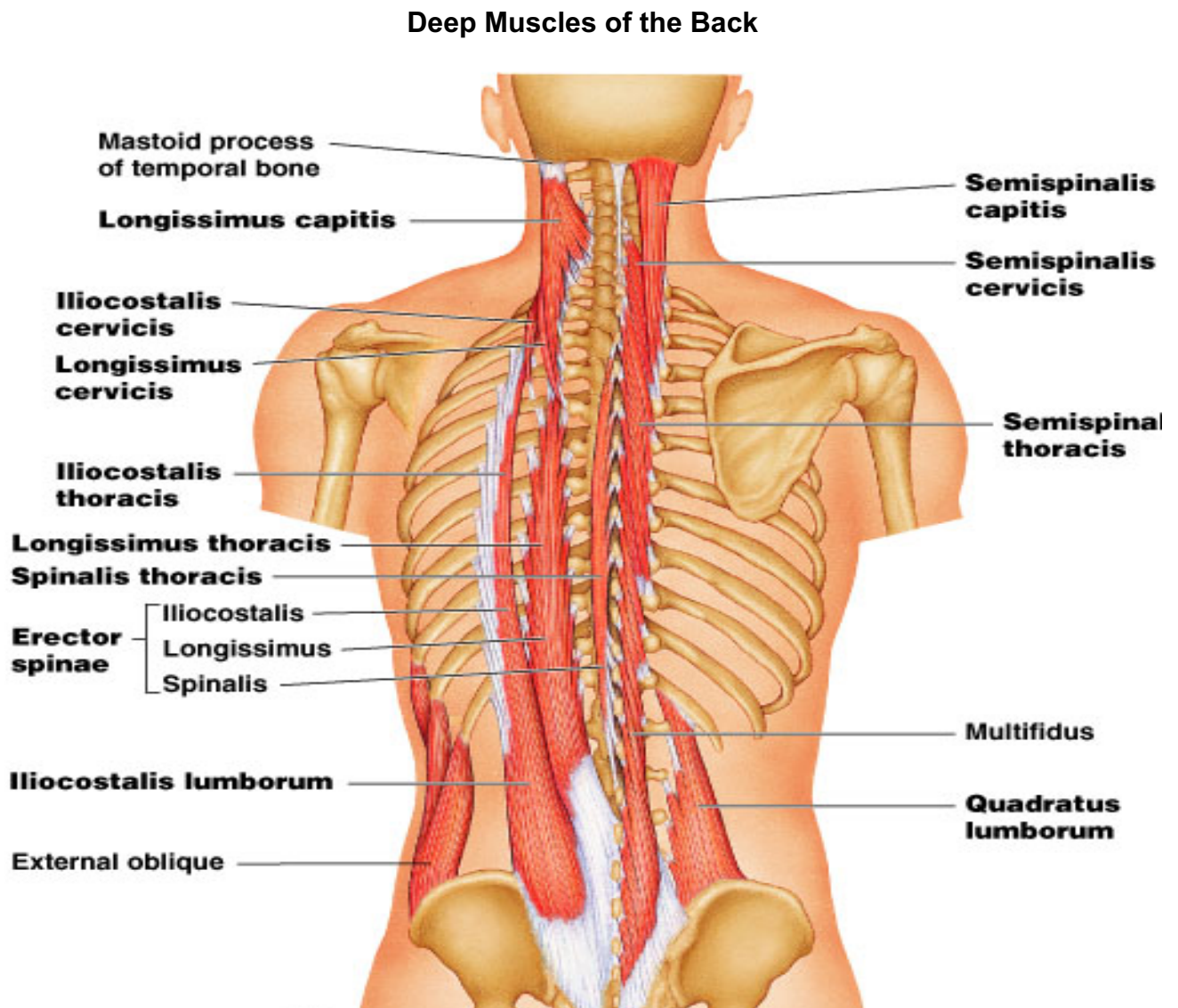
- flexes lumbar region of vertebral column
- produces forward bending at the waist
- extends from sternum to pubis
- rectus sheath encloses muscle
- three transverse tendinous intersections divide rectus abdominis into segments – “six pack”

Superficial Back Muscles



Deep Muscles of the Back

- erector spinae
 - iliocostalis, longissimus, spinalis
 - from cranium to sacrum
 - extension and lateral flexion of vertebral column
- semispinalis thoracis
 - extension and contralateral rotation of vertebral column
- quadratus lumborum
 - aids respiration
 - ipsilateral flexion of lumbar vertebral column
- multifidus
 - stabilizes adjacent vertebrae
 - maintains posture



Muscles of the Pelvic Floor

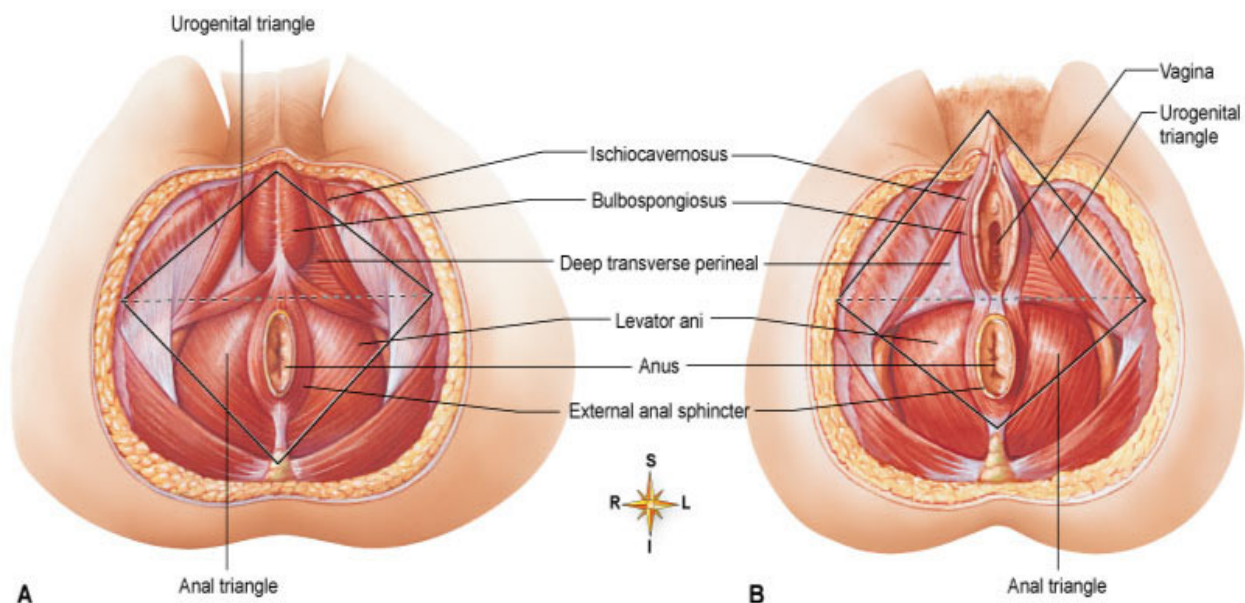
- three layers of muscles and fasciae that span pelvic outlet
 - penetrated by anal canal, urethra, and vagina
- perineum – diamond-shaped region between the thighs
 - bordered by four bony landmarks
 - urogenital triangle – anterior half of perineum
 - anal triangle – posterior half of perineum
- three layers or compartments of the perineum
 - superficial perineal space – three muscles
- ischiocavernosus, bulbospongiosus, superficial transverse peritoneal
 - middle compartment - spanned by urogenital diaphragm
 - composed of a fibrous membrane and two or three muscles
 - deep transverse perineal muscle, external urethral and anal sphincters
 - compressor urethrae in females only
 - pelvic diaphragm – deepest layer consists of two muscle pairs
 - levator ani and coccygeus

Superficial Perineal Space

- muscles found just deep to the skin
- ischiocavernosus – maintains erection
- bulbospongiosus – aids in erection, expels remaining urine

Muscles of Pelvic Diaphragm

- deepest compartment of the perineum
- pelvic diaphragm – two muscle pairs
 - levator ani - supports viscera and defecation
 - coccygeus - supports and elevates pelvic floor



Hernias

- hernia – any condition in which the viscera protrudes through a weak point in the muscular wall of the abdominopelvic cavity
- inguinal hernia
 - most common type of hernia (rare in women)
 - viscera enter inguinal canal or even the scrotum
- hiatal hernia
 - stomach protrudes through diaphragm into thorax
 - overweight people over 40
- umbilical hernia
 - viscera protrude through the navel

Muscles Acting on Shoulder and Upper Limb

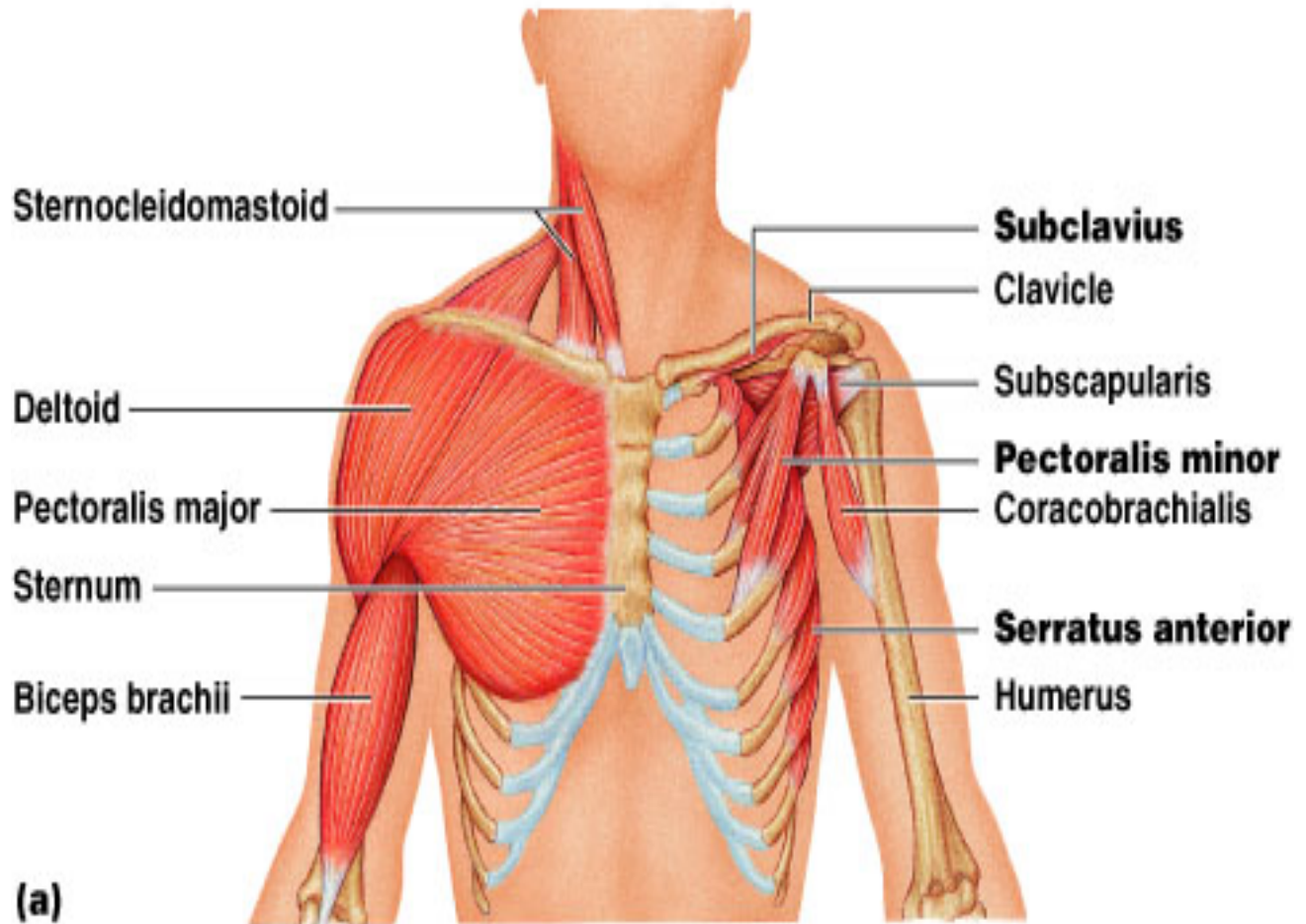
- compartments – spaces in which muscles are organized and are separated by fibrous connective tissue sheets (fasciae)
 - each compartment contains one or more functionally related muscles along with their nerve and blood supplies
- muscles of upper limbs divided into anterior and posterior compartments
- muscles of lower limbs divided into anterior, posterior, medial, and lateral compartments
- compartment syndrome – one of the muscles or blood vessels in a compartment is injured

Compartment Syndrome

- fasciae of arms and legs enclose muscle compartments very snugly
- if a blood vessel in a compartment is damaged, blood and tissue fluid accumulate in the compartment
- fasciae prevent compartment from expanding with increasing pressure
- compartment syndrome – mounting pressure on the muscles, nerves and blood vessel triggers a sequence of degenerative events
 - blood flow to compartment is obstructed by pressure
 - if ischemia (poor blood flow) persists for more than 2 – 4 hours, nerves begin to die
 - after 6 hours, muscles begin to die
- nerves can regenerate after pressure relieved, but muscle damage is permanent
- myoglobin in urine indicates compartment syndrome
- treatment – immobilization of limb and fasciotomy – incision to relieve compartment pressure

Muscles Acting on the Shoulder

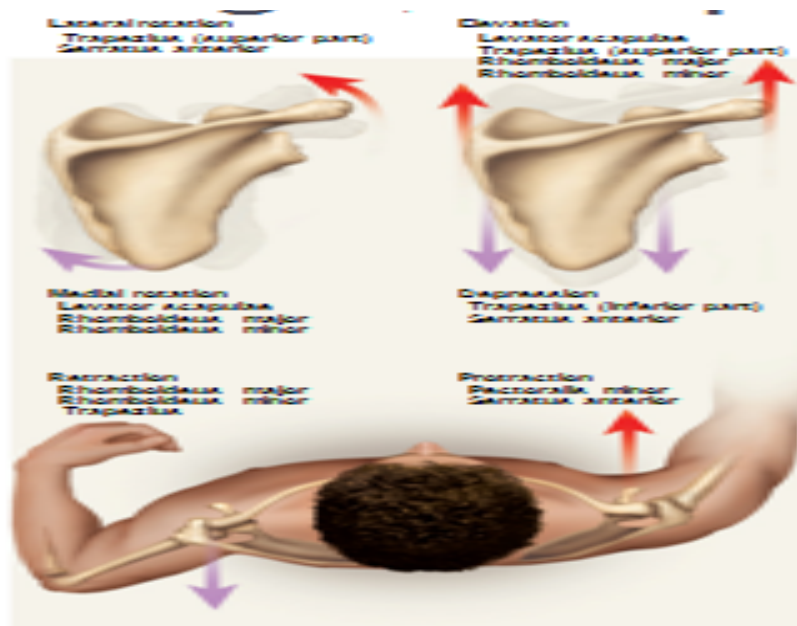
- originate on the axial skeleton
- insert on clavicle and scapula
- scapula loosely attached to thoracic cage
 - capable of great movement
 - rotation, elevation, depression, protraction, retraction
- clavicle braces the shoulder and moderates movements



Anterior Muscles of Pectoral Girdle

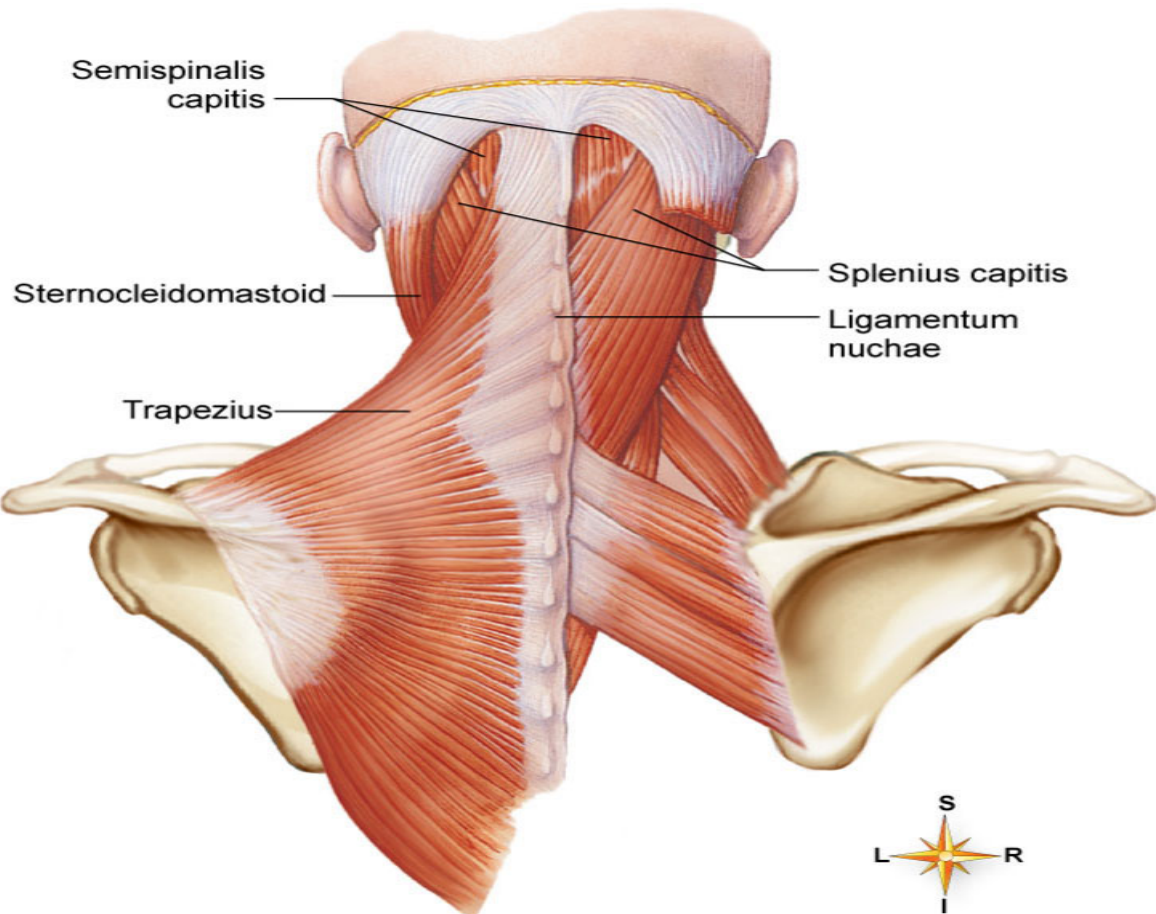
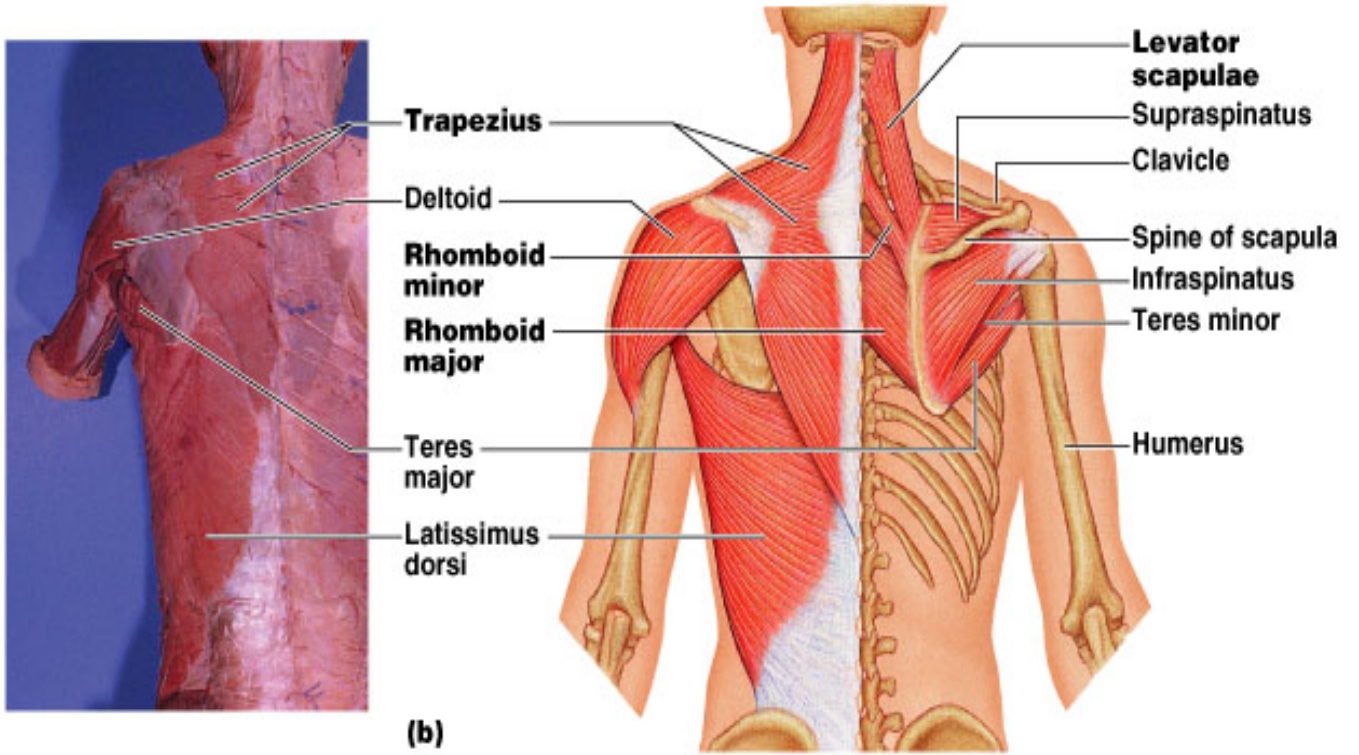
- pectoralis minor
 - ribs 3-5 to coracoid process of scapula
 - draws scapula laterally
- serratus anterior
 - ribs 1-9 to medial border of scapula
 - abducts and rotates or depresses scapula

Movement of the Scapula



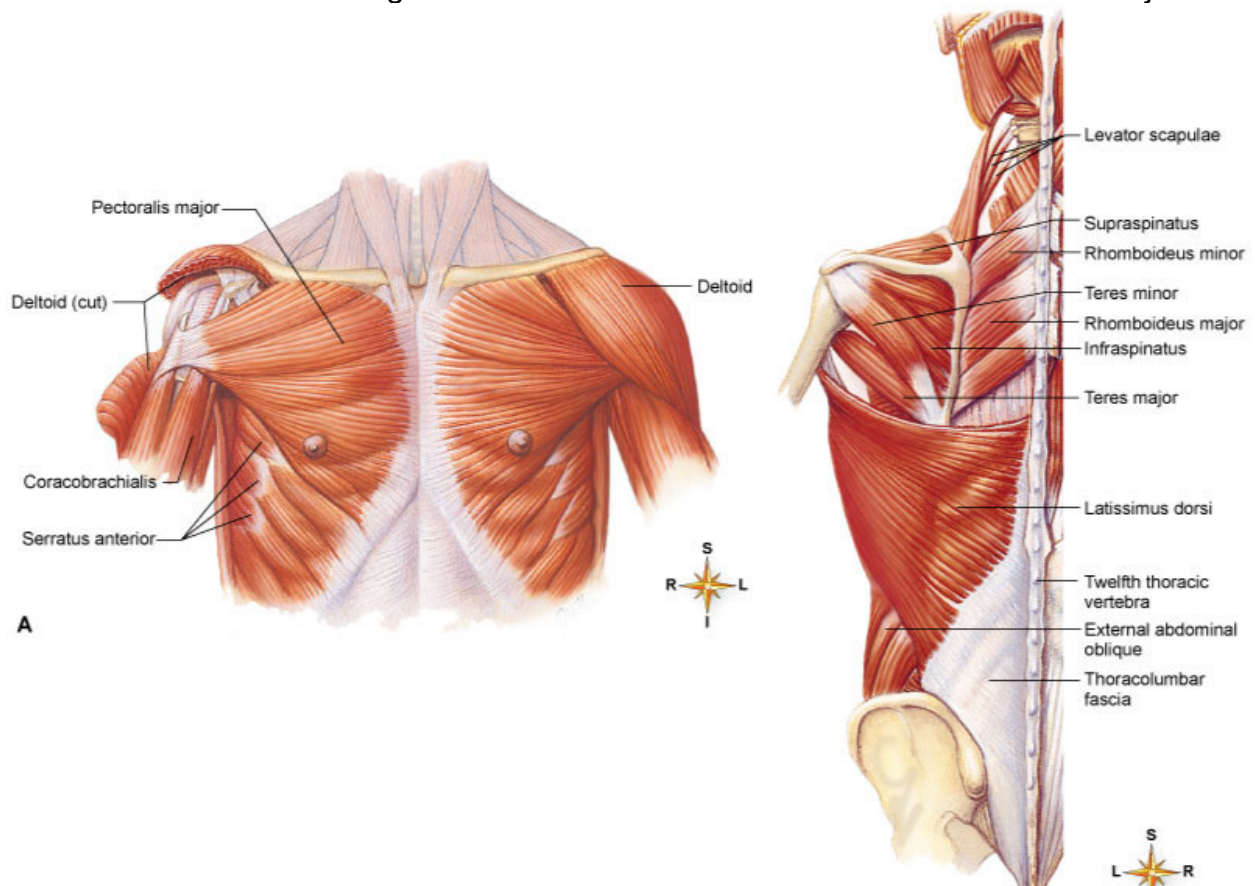
Posterior Muscles of Pectoral Girdle

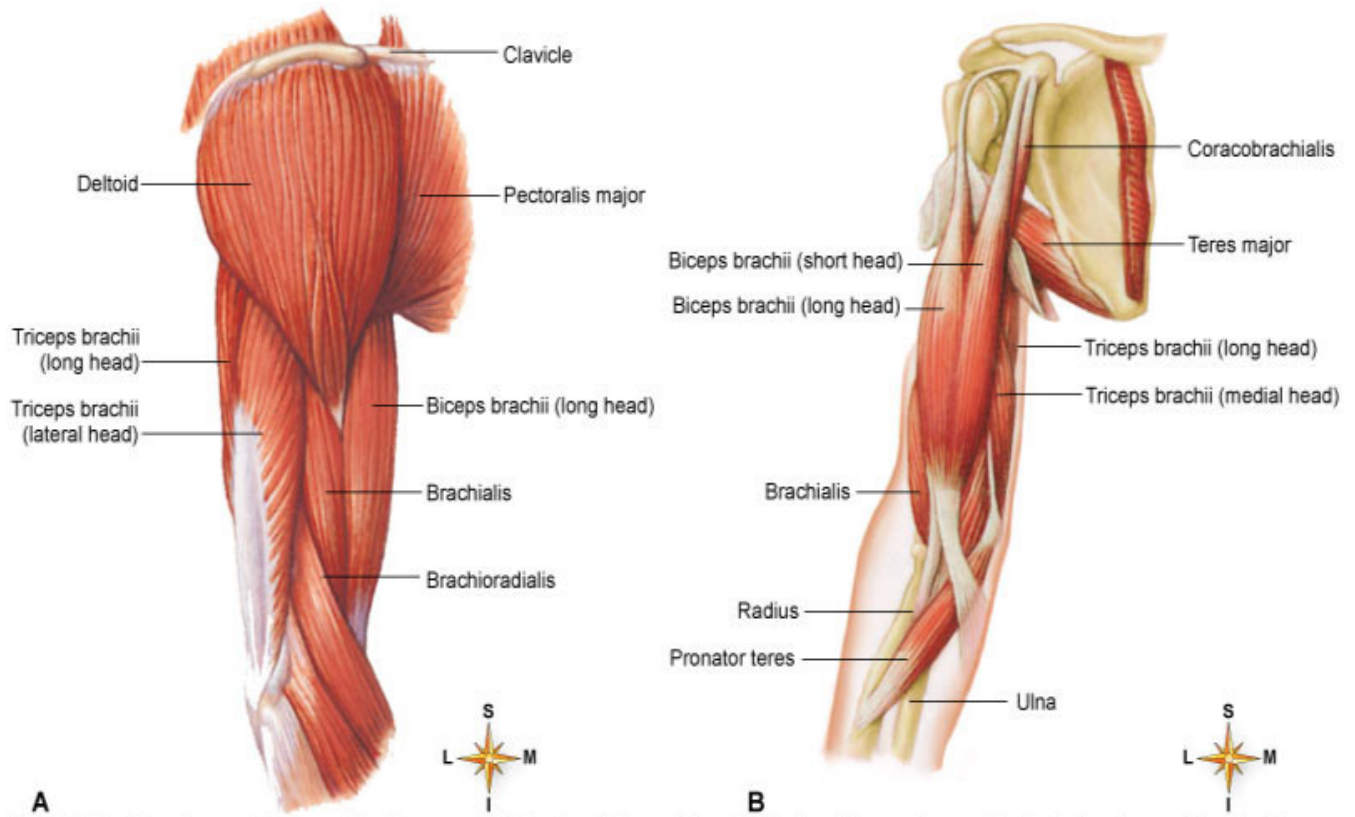
- four muscles of posterior group
 - trapezius – superficial
 - levator scapulae, rhomboideus minor, and rhomboideus major – deep
- trapezius
 - stabilizes scapula and shoulder
 - elevates and depresses shoulder apex
- levator scapulae
 - elevates scapula
 - flexes neck laterally
- rhomboideus minor
 - retracts scapula and braces shoulder
- rhomboideus major
 - same as rhomboideus minor



Muscles Acting on Arm

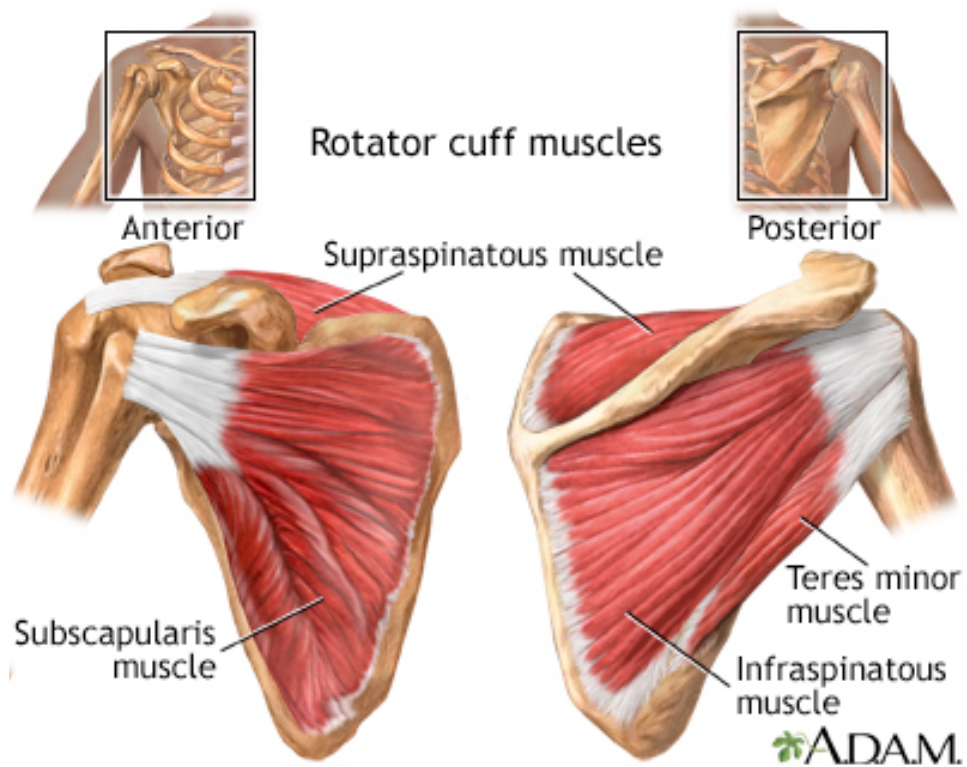
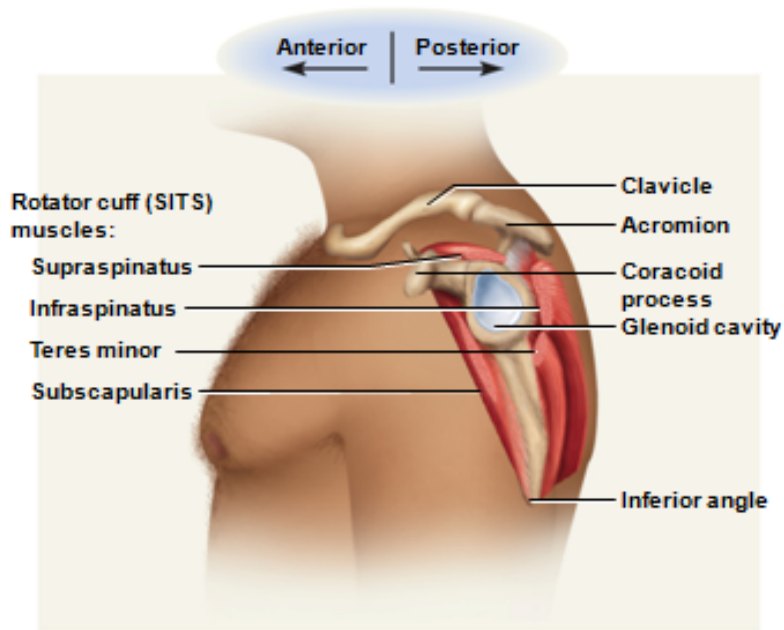
- nine muscles cross the shoulder joint and insert on humerus
 - two are axial muscles because they originate on axial skeleton
 - pectoralis major – flexes, adducts, and medially rotates humerus
 - latissimus dorsi – adducts and medially rotated humerus
- seven scapular muscles
 - originate on scapula
 - deltoid
 - rotates and abducts arm
 - intramuscular injection site
 - teres major
 - extension and medial rotation of humerus
 - coracobrachialis
 - flexes and medially rotates arm
 - remaining four form the rotator cuff that reinforce the shoulder joint





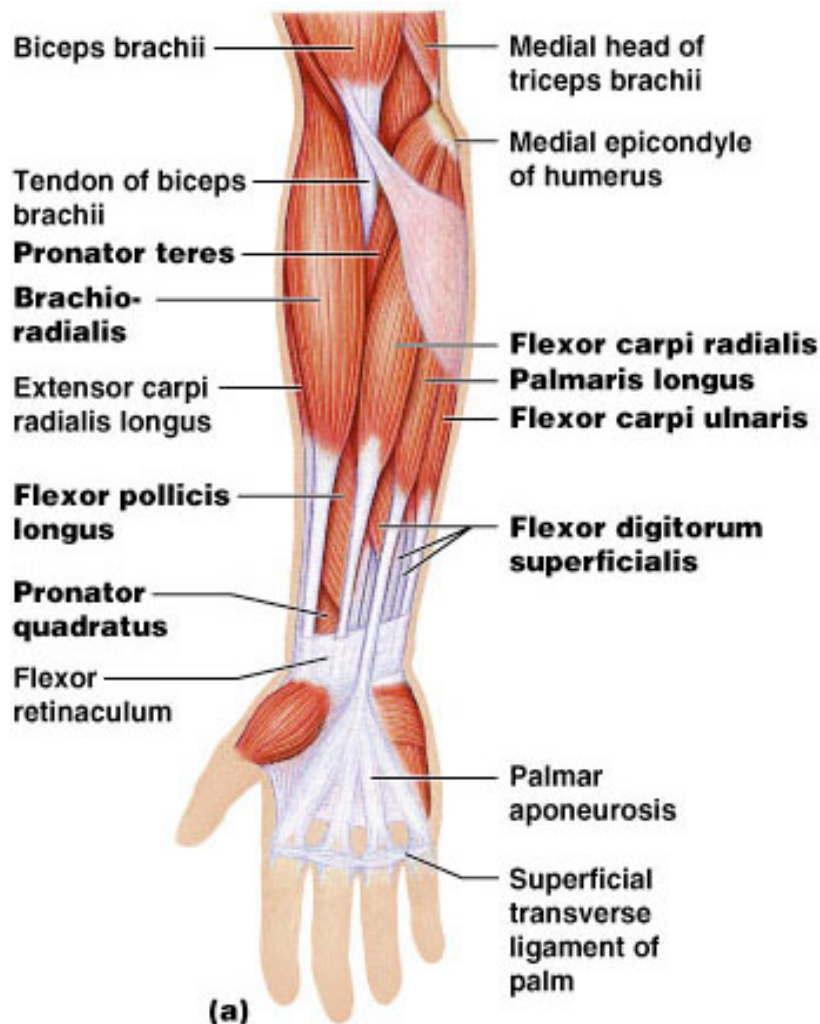
Rotator Cuff Muscles

- tendons of the remaining four scapular muscles form the rotator cuff
- “SITS” muscles – for the first letter of their names
 - Supraspinatus
 - Infraspinatus
 - teres minor
 - subscapularis
- tendons of these muscles merge with the joint capsule of the shoulder as they cross it in route to the humerus
- holds head of humerus into glenoid cavity
- supraspinatus tendon most easily damaged



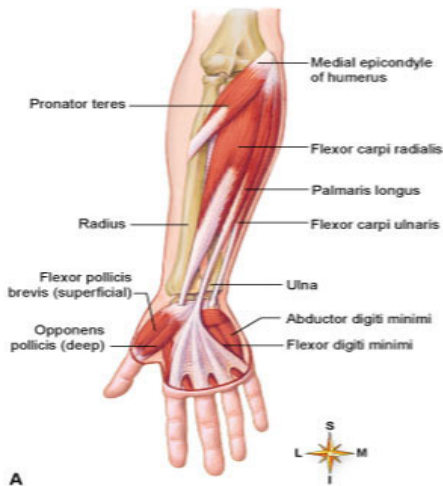
Muscles Acting on Forearm

- elbow and forearm capable of flexion, extension, pronation, and supination
 - carried out by muscles in both brachium (arm) and antebrachium (forearm)
- muscles with bellies in the arm (brachium)
 - principal elbow flexors – anterior compartment
 - brachialis and biceps brachii
 - brachialis produces 50% more power than biceps brachii
 - brachialis is prime mover of elbow flexion
 - principal elbow extensor – posterior compartment
 - triceps brachii - prime mover of elbow extension
- muscles with bellies in the forearm (antebrachium)
 - most forearm muscles act on the hand and wrist
 - brachioradialis – flexes elbow
 - anconeus – extends elbow
 - pronator quadratus – prime mover in forearm pronation
 - pronator teres – assists pronator quadratus in pronation
 - supinator – supinates the forearm



Muscles Acting on Forearm

- principal flexor
 - brachialis
- synergistic flexors
 - biceps brachii
 - brachioradialis
- principal extensor
 - triceps brachii
- Supination and Pronation
 - Supination
 - supinator muscle
 - palm facing anteriorly or superiorly
 - Pronation
 - pronator quadratus and pronator teres
 - palm faces posteriorly or inferiorly



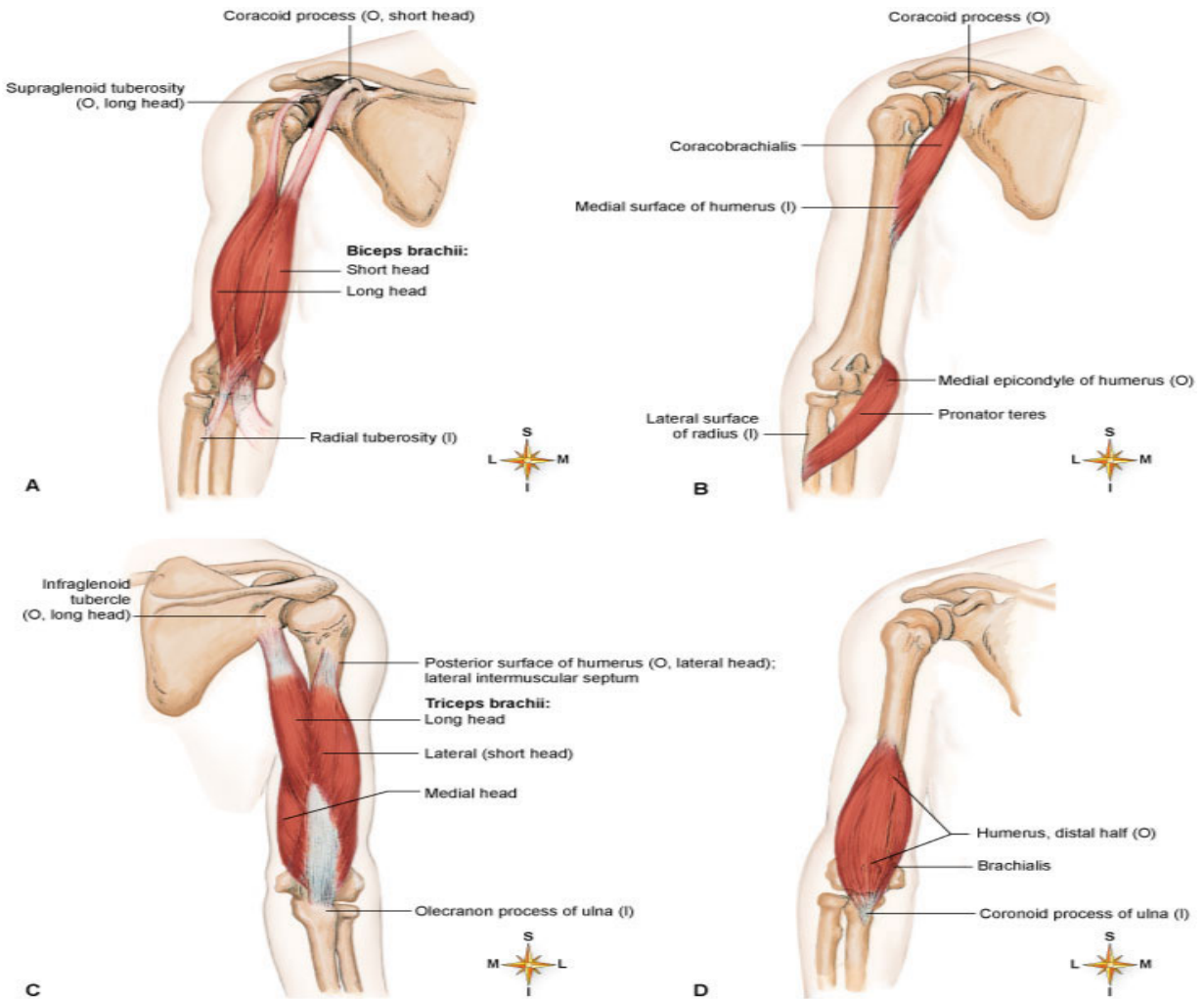
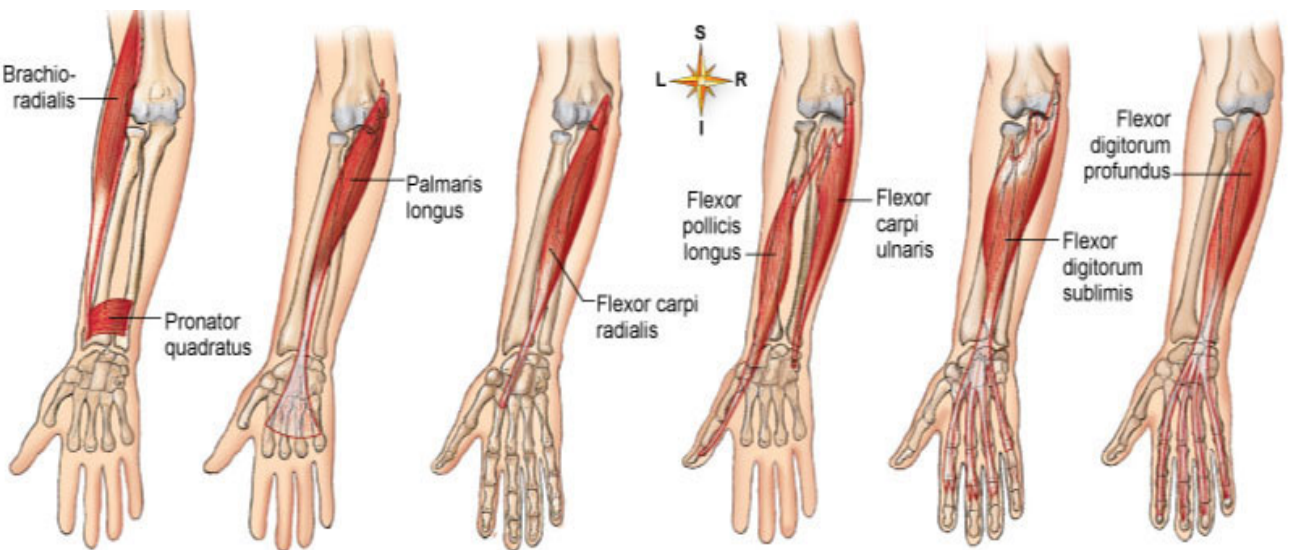


Fig. 10-21. **Muscles acting on the forearm.** A, Biceps brachii. B, Coracobrachialis and pronator teres. C, Triceps brachii. D, Brachialis. O, Origin; I, insertion.

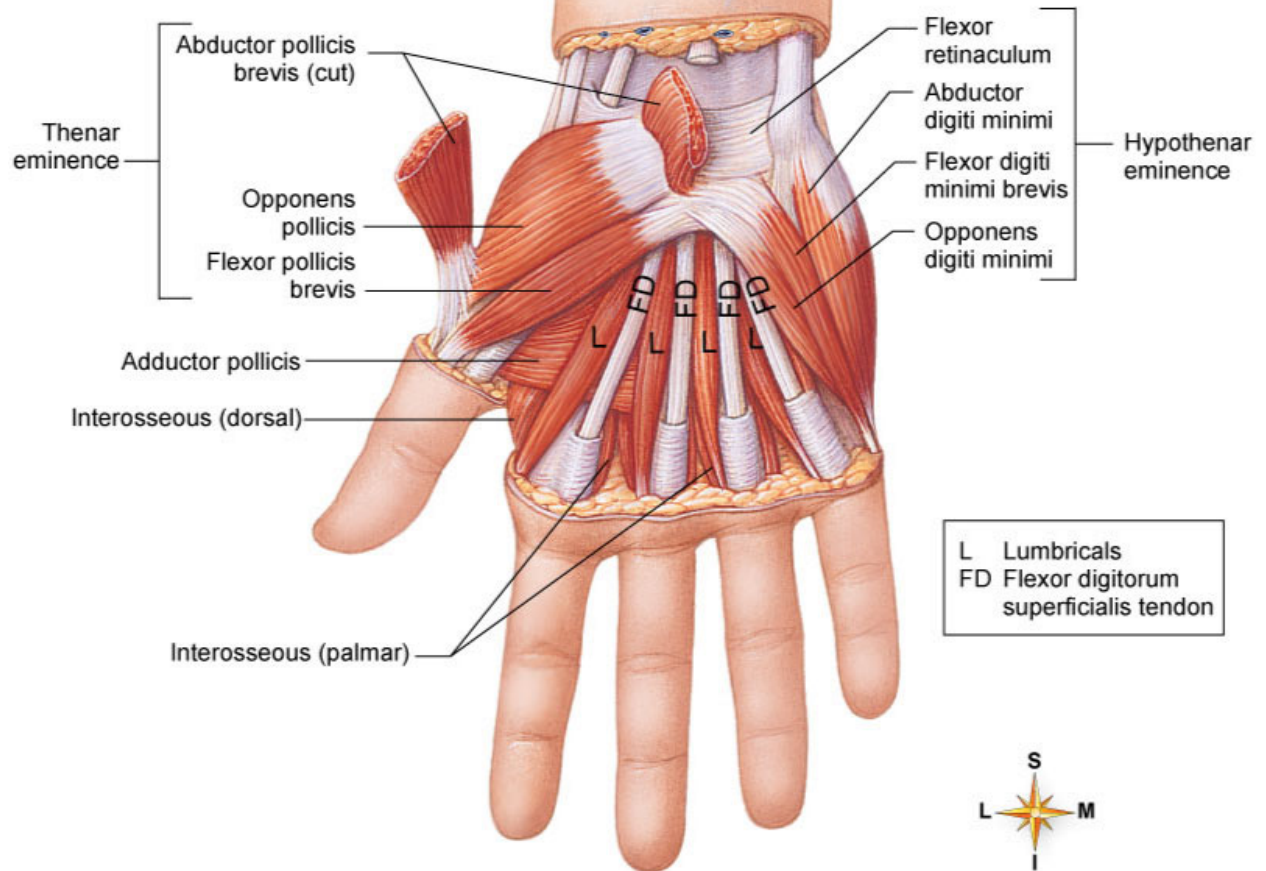


Anterior Muscles on Wrist and Hand

- extrinsic muscles of the forearm
- intrinsic muscles in the hand itself
- extrinsic muscle actions
 - flexion and extension of wrist and digits
 - radial and ulnar flexion
 - finger abduction and adduction
 - thumb opposition
- Anterior (Flexor) Compartment – superficial layer
 - flexor carpi radialis
 - flexor carpi ulnaris
 - flexor digitorum superficialis
 - palmaris longus
- Anterior (Flexor) Compartment – deep layer
 - flexor digitorum profundus
 - flexor pollicis longus
- extension of wrist and fingers, adduct / abduct wrist
- extension and abduction of thumb (pollicis)
- brevis - short, ulnaris - on ulna side of forearm

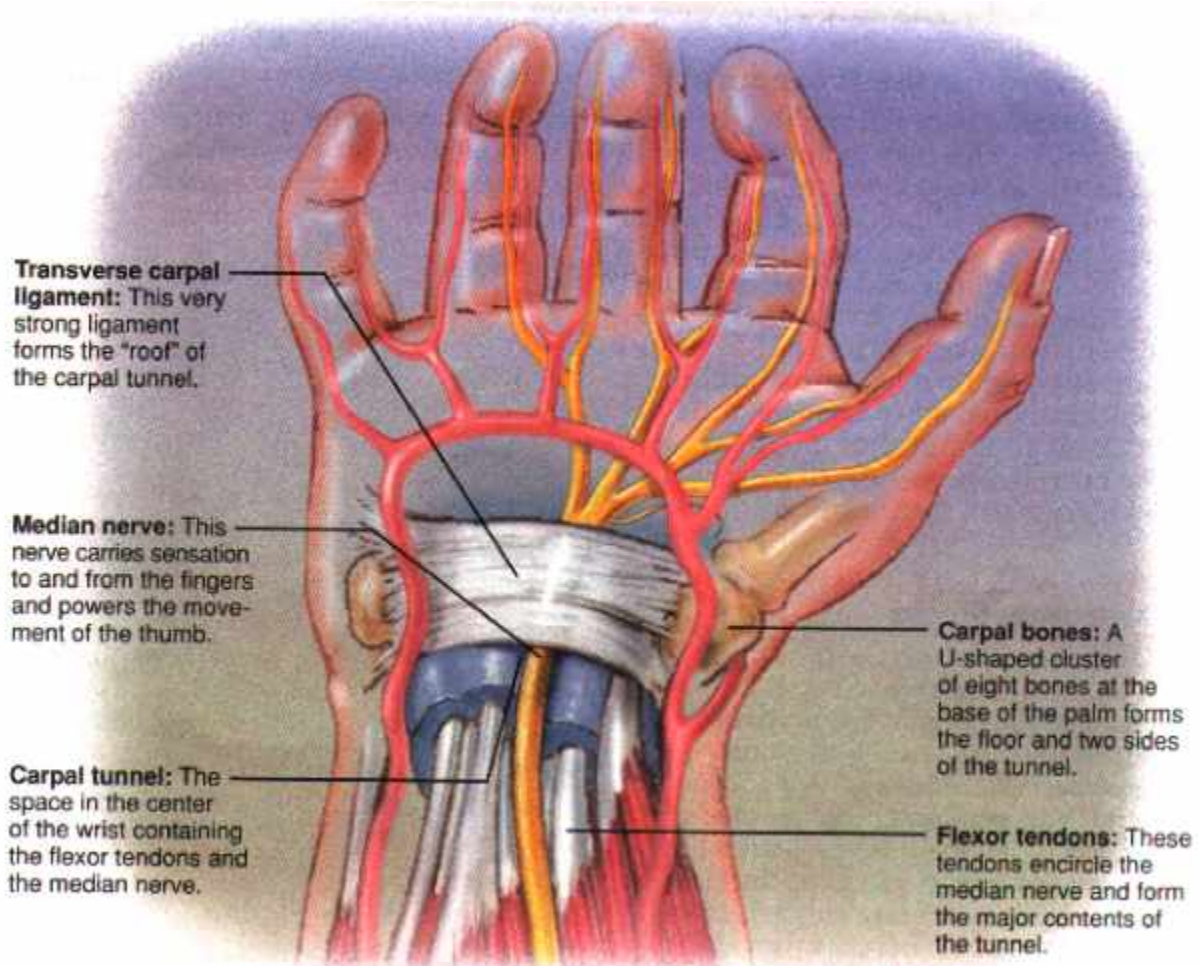
Posterior Muscles on Wrist and Hand

- Posterior (Extensor) Compartment – superficial layer
 - extensor carpi radialis longus
 - extensor carpi radialis brevis
 - extensor digitorum
 - extensor digiti minimi
 - extensor carpi ulnaris
- Posterior (Extensor) Compartment – deep layer
 - abductor pollicis longus
 - extensor pollicis brevis
 - extensor pollicis longus
 - extensor indicis



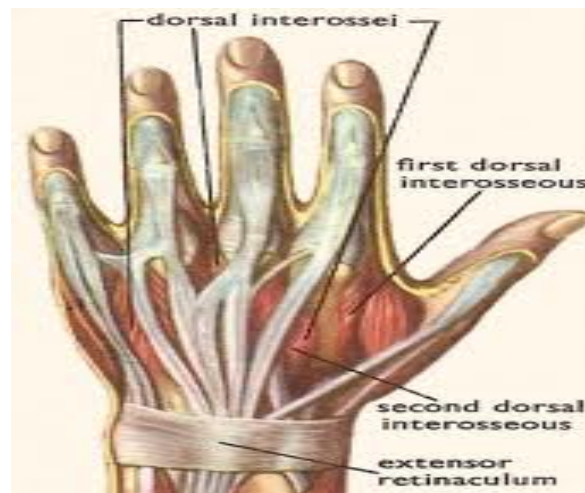
Carpal Tunnel Syndrome

- flexor retinaculum – bracelet-like fibrous sheet that the flexor tendons of the extrinsic muscles that flex the wrist pass on their way to their insertions
- carpal tunnel – tight space between the flexor retinaculum and the carpal bones
 - flexor tendons passing through the tunnel are enclosed in tendon sheaths
 - enable tendons to slide back and forth quite easily
- carpal tunnel syndrome - prolonged, repetitive motions of wrist and fingers can cause tissues in the carpal tunnel to become inflamed, swollen, or fibrotic
 - puts pressure on the median nerve of the wrist that passes through the carpal tunnel along with the flexor tendons
 - tingling and muscular weakness in the palm and medial side of the hand
 - pain may radiate to arm and shoulder
 - treatment – anti-inflammatory drugs, immobilization of the wrist, and sometimes surgery to remove part or all of flexor retinaculum



Intrinsic Hand Muscles

- thenar group – form thick, fleshy mass at base of thumb
 - adductor pollicis
 - abductor pollicis brevis
 - flexor pollicis brevis
 - opponens pollicis
- Hypothenar group - fleshy base of the little finger
 - abductor digiti minimi
 - flexor digiti minimi brevis
 - opponens digiti minimi
- Midpalmar group – hollow of palm
 - dorsal interosseous muscles (4)
 - palmar interosseous muscles (3)
 - lumbricals (4 muscles)

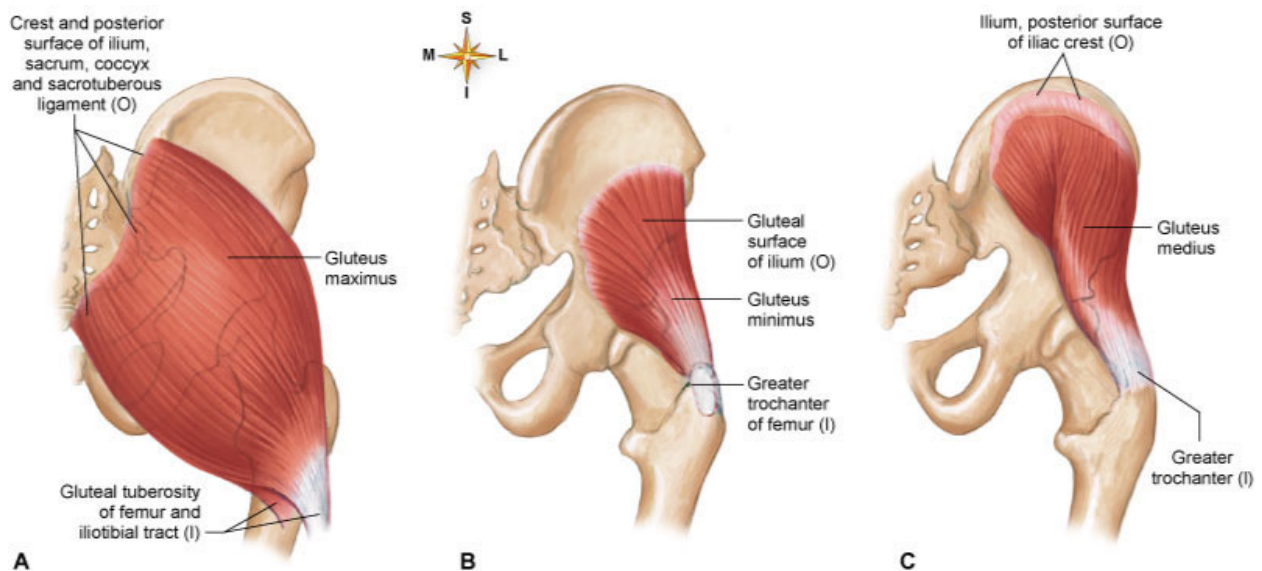


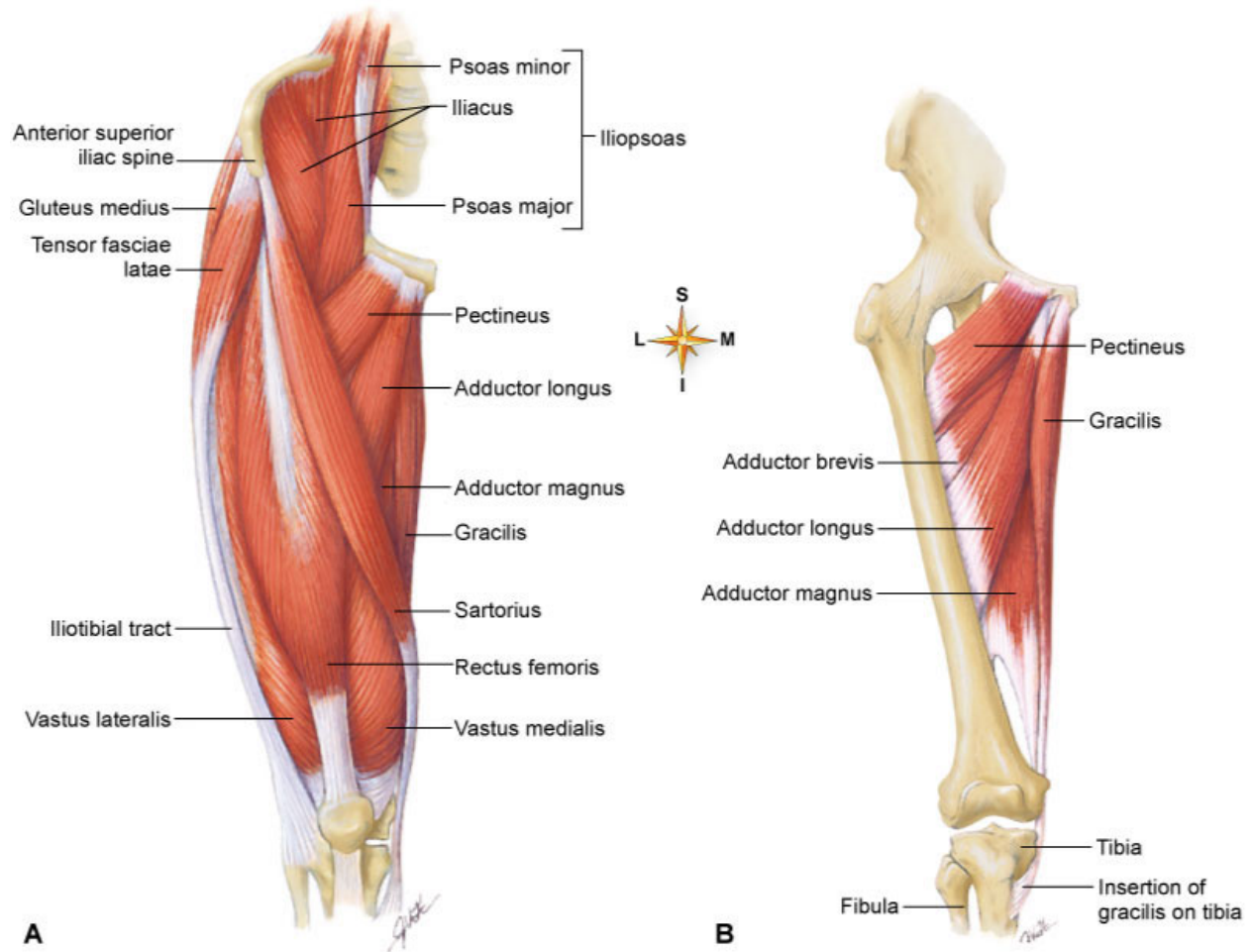
Muscles on the Hip and Lower Limb

- largest muscles found in lower limb
- less for precision, more for strength needed to stand, maintain balance, walk, and run
- several cross and act on two or more joints
- leg – the part of the limb between the knee and ankle
- foot – includes tarsal region (ankle), metatarsal region, and the toes

Muscles Acting on the Hip and Femur

- Anterior muscles of the hip
 - iliacus
 - flexes thigh at hip
 - iliacus portion arises from iliac crest and fossa
 - psoas major
 - flexes thigh at hip
 - arises from lumbar vertebrae
 - they share a common tendon on the femur
- Posterior Muscles on Hip and Femur
- Lateral and posterior muscles of the hip
 - tensor fasciae latae
 - extends knee, laterally rotates knee
 - gluteus maximus
 - forms mass of the buttock
 - prime hip extensor
 - provides most of lift when you climb stairs
 - gluteus medius and minimus
 - abduct and medially rotate thigh



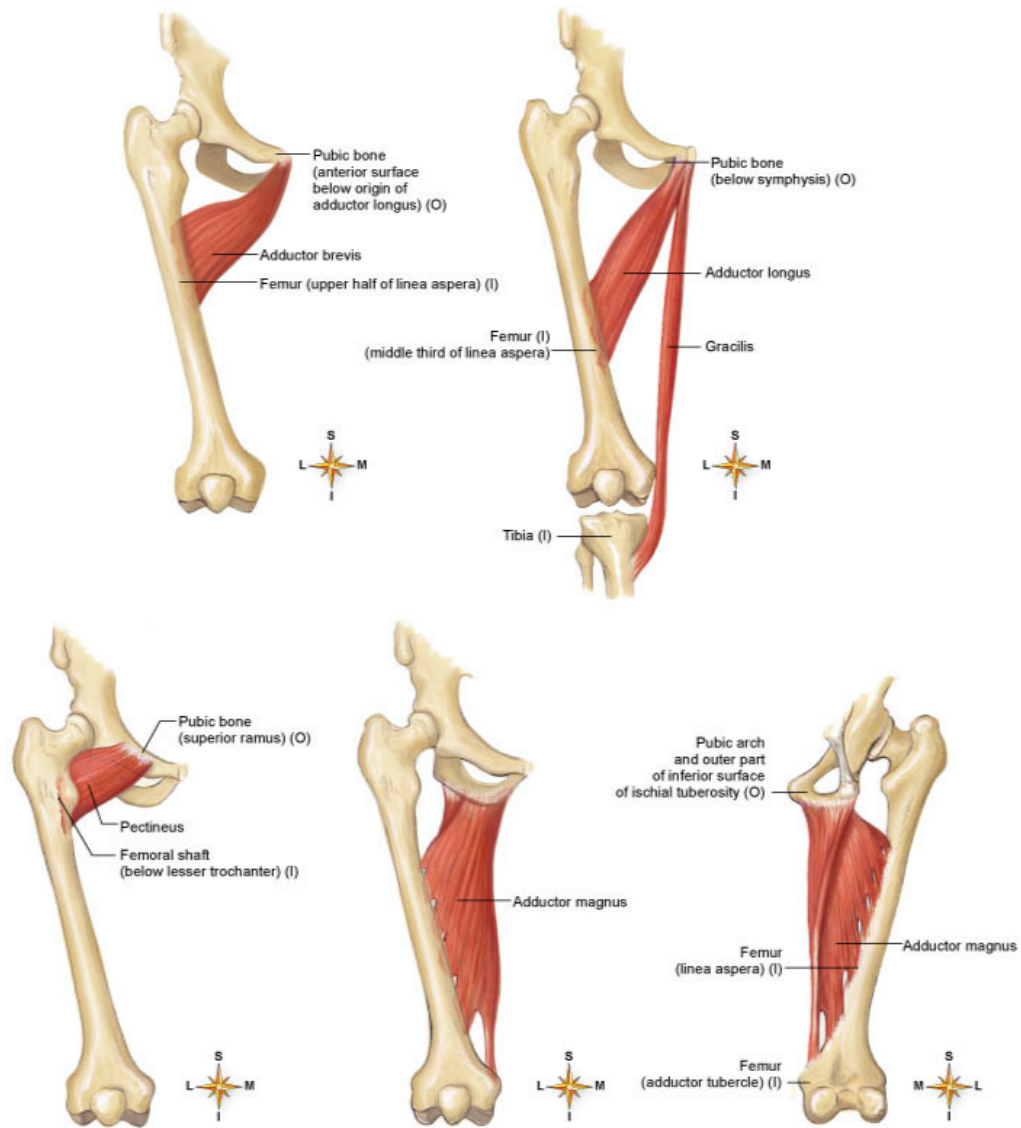


Posterior Muscles on Hip and Femur

- lateral rotators - six muscles inferior to gluteus minimus
- deep to the two other gluteal muscles
 - gemellus superior
 - gemellus inferior
 - obturator externus
 - obturator internus
 - piriformis
 - quadratus femoris

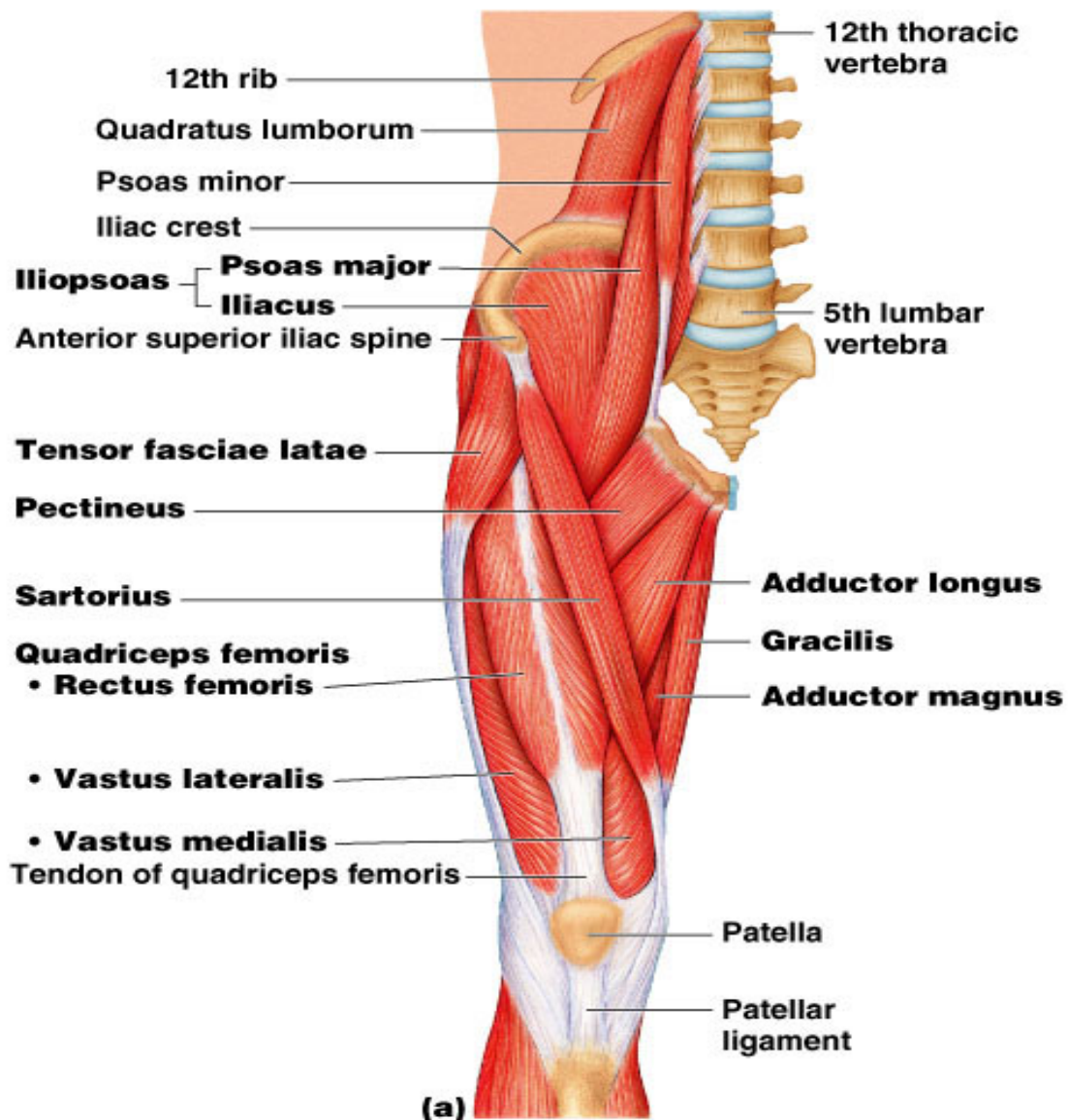
Muscles Acting on Hip and Femur

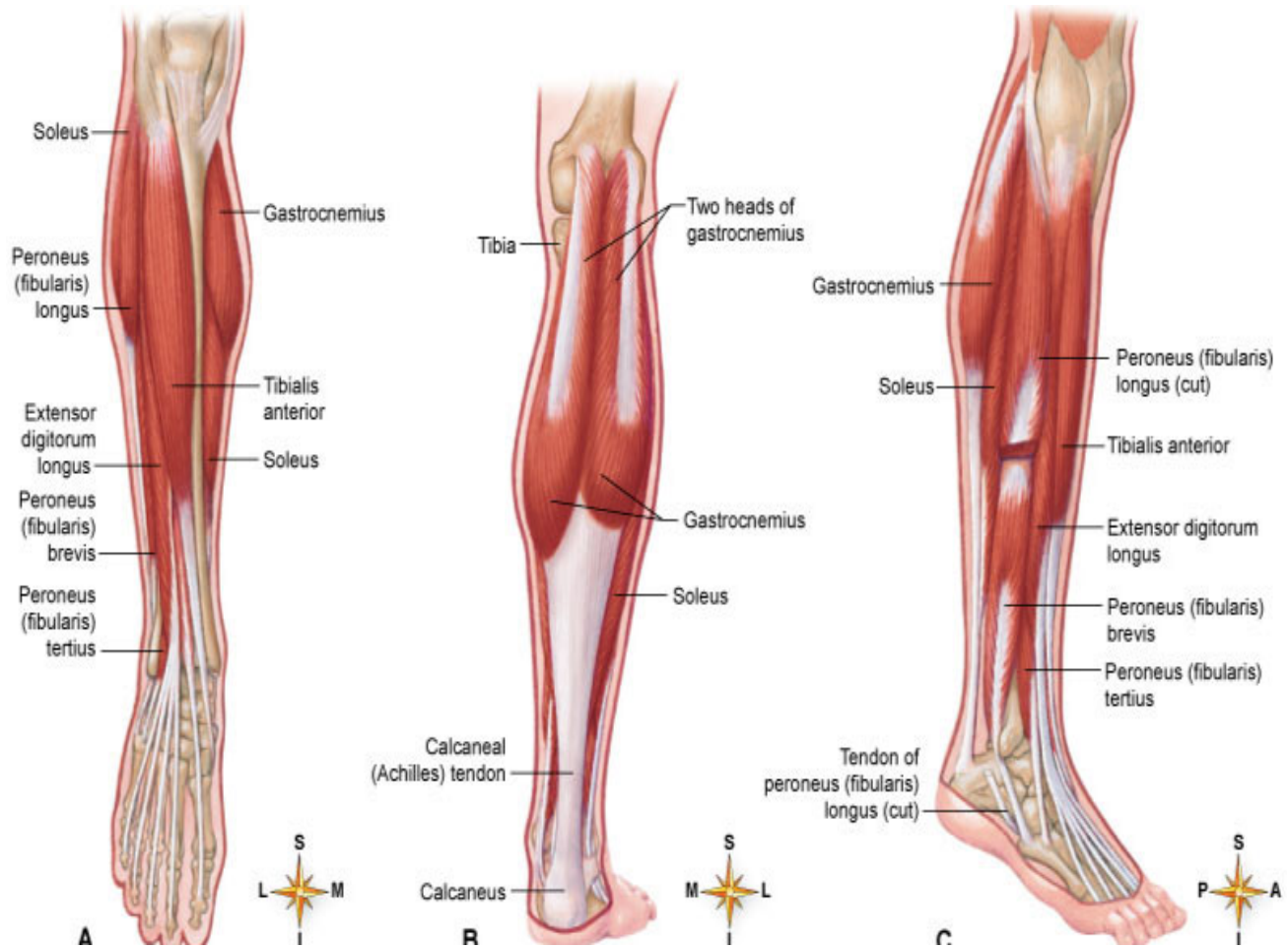
- medial (adductor) compartment of thigh
- five muscles act as primary adductors of the thigh
 - adductor brevis
 - adductor longus
 - adductor magnus
 - gracilis
 - pectineus



Muscles on the Knee and Leg

- anterior (extensor) compartment of the thigh
 - contains large quadriceps femoris muscle
 - prime mover of knee extension
 - most powerful muscle in the body
 - has four heads – rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius
 - all converge on single quadriceps (patellar) tendon
 - extends to patella
 - then continues as patellar ligament
 - inserts on tibial tuberosity
 - sartorius – longest muscle in the body
 - tailor’s muscle



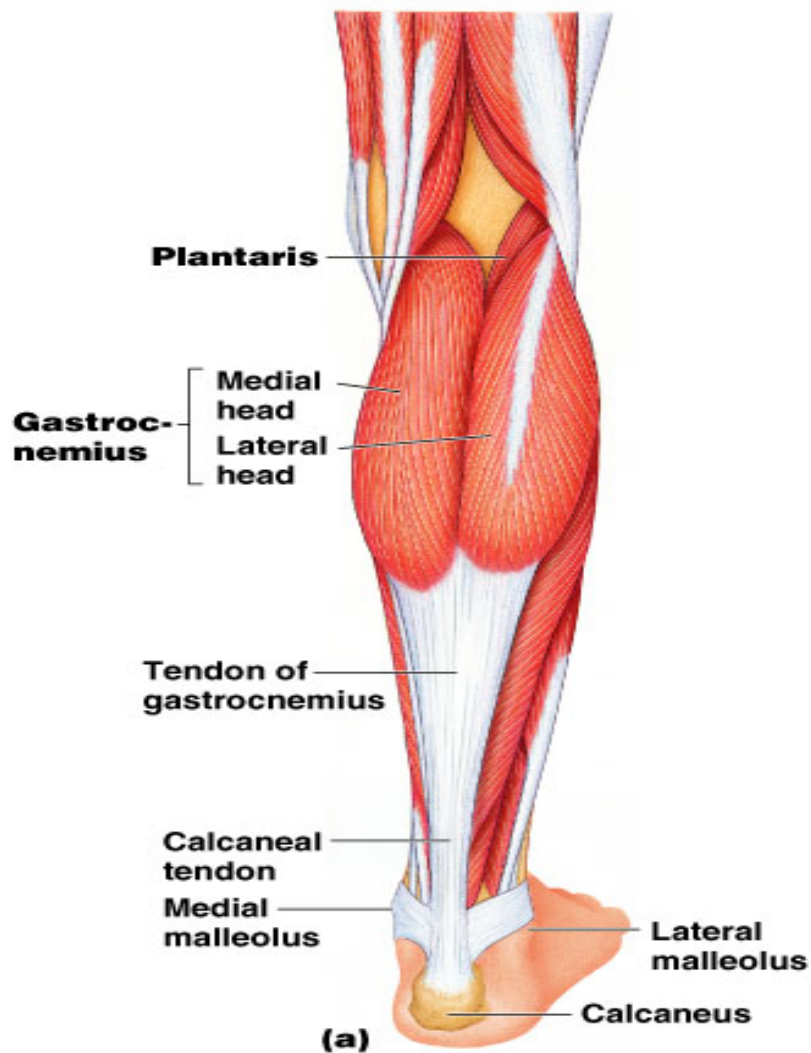


Muscles Acting on the Knee and Leg

- Posterior (flexor) compartment of the thigh
 - contains hamstring muscles
 - from lateral to medial; biceps femoris, semitendinosus, semimembranosus
- Anterior Compartment of Leg
 - anterior (extensor) compartment of the leg
 - dorsiflex the ankle
 - prevent toes from scuffing when walking
 - *fibularis (peroneus) tertius*
 - *extensor digitorum longus*
 - *extensor hallucis longus*
 - *tibialis anterior*
- Posterior Compartment of Leg - Superficial Group
 - three muscles of the superficial group
 - gastrocnemius - plantar flexes foot, flexes knee
 - soleus – plantar flexes foot
 - plantaris - weak synergist of triceps

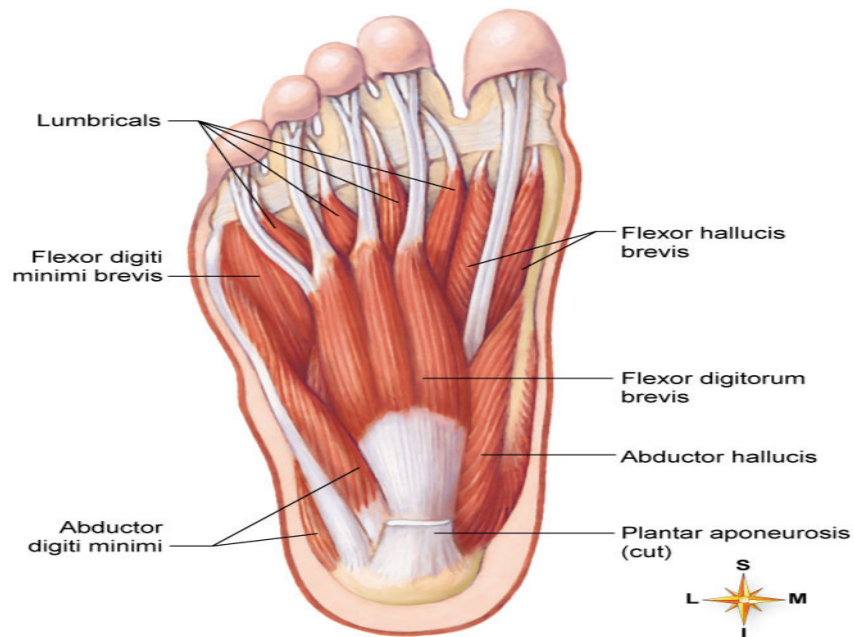
Muscles Acting on the Knee and Leg

- Posterior Compartment of Leg - Deep Group
 - four muscles in the deep group
 - flexor digitorum longus – flexes phalanges
 - flexor hallucis longus – flexes great toe
 - tibialis posterior – inverts foot
 - popliteus – acts on knee
- Lateral (Fibular) Compartment of the Leg
 - two muscles in this compartment
 - fibularis longus
 - fibularis brevis
 - both plantar flex and evert the foot
 - provides lift and forward thrust



Intrinsic Muscles of Foot

- support for arches
 - abduct and adduct the toes
 - flex the toes
- one dorsal muscle
 - extensor digitorum brevis extends toes



Athletic Injuries

- muscles and tendons are vulnerable to sudden and intense stress
- proper conditioning and warm-up needed
- common injuries;
 - compartment syndrome
 - shinsplints
 - pulled hamstrings
 - tennis elbow
 - pulled groin
 - rotator cuff injury
- treat with rest, ice, compression and elevation
- “no pain, no gain” is a dangerous misconception