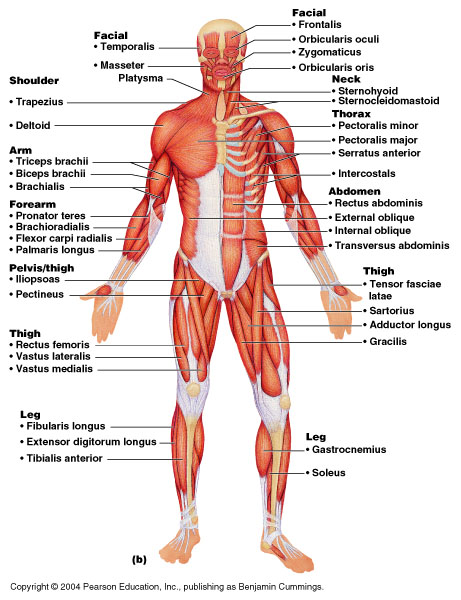
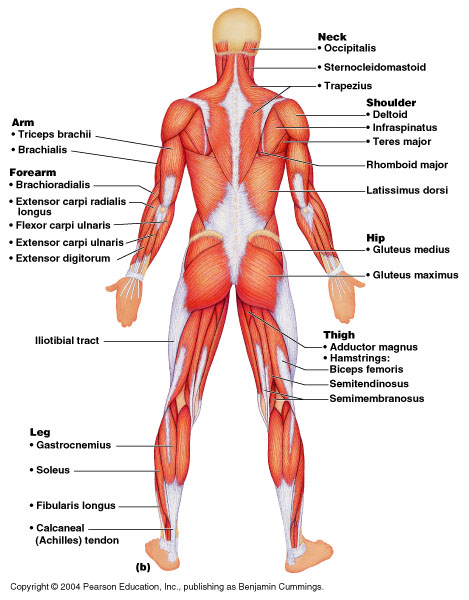
**Muscular System**

**Dr. Gary Mumaugh**





**Organization of Muscles**

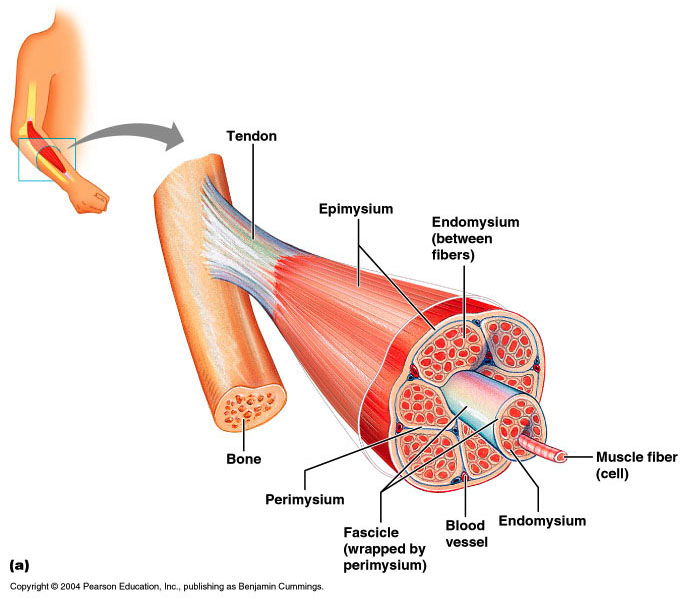
* about 600 human skeletal muscles
* constitute about half of our body weight
* three kinds of muscle tissue
  + skeletal, cardiac, smooth
* specialized for one major purpose
  + converting the chemical energy in ATP into the mechanical energy of motion
* myology – the study of the muscular system

**The Functions of Muscles**

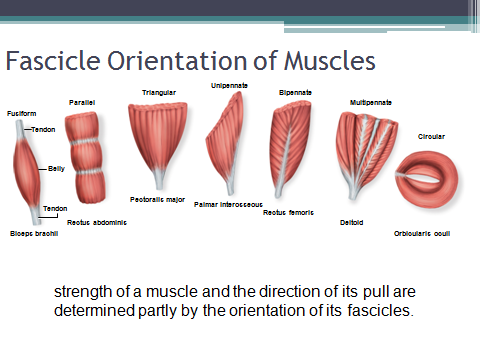
* Movement
  + move from place to place, movement of body parts and body contents in breathing, circulation, feeding and digestion, defecation, urination, and childbirth
  + role in communication – speech, writing, and nonverbal communications
* Stability
  + Maintain posture by preventing unwanted movements
  + 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

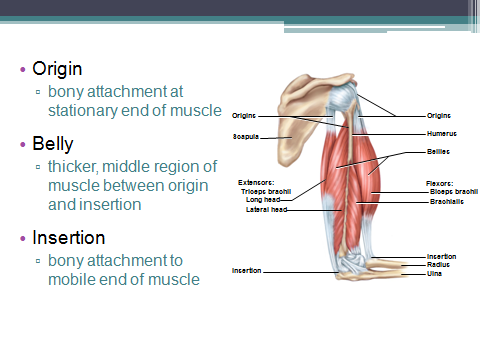


**Fascicle Orientation of Muscles**



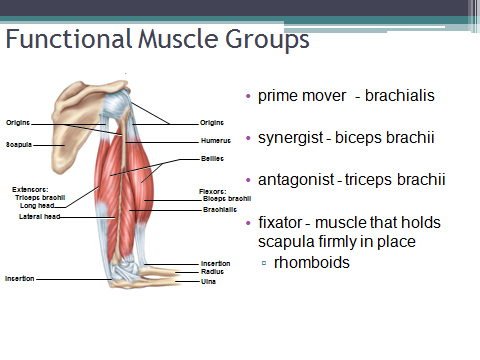
**Muscle Attachments**

* 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



**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

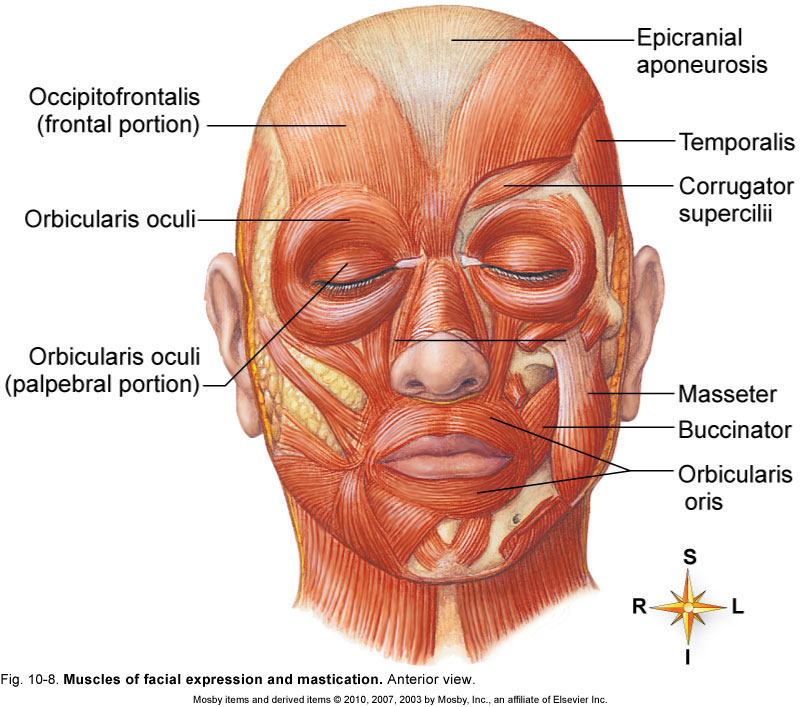


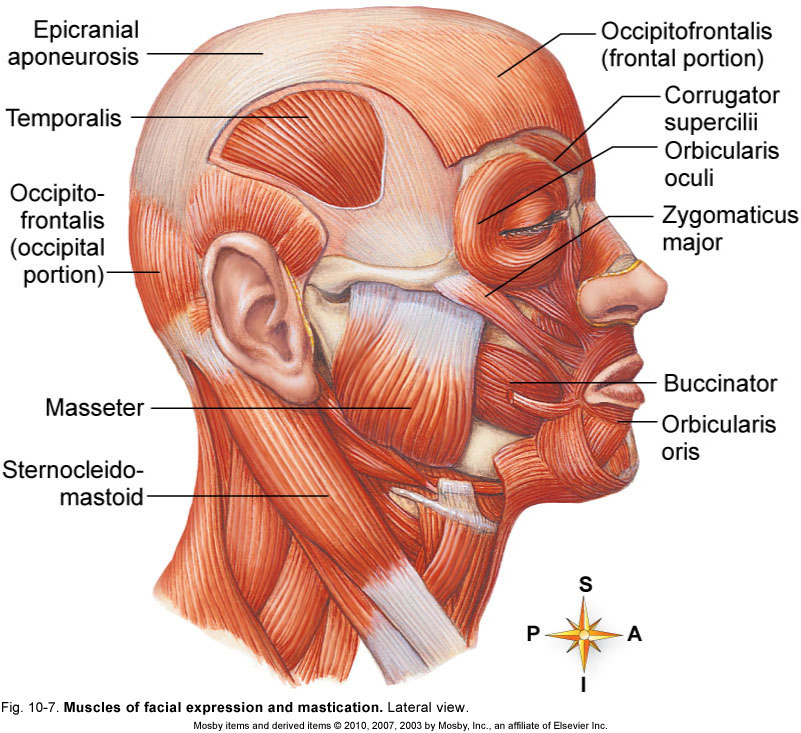
**Muscle Innervation**

* 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



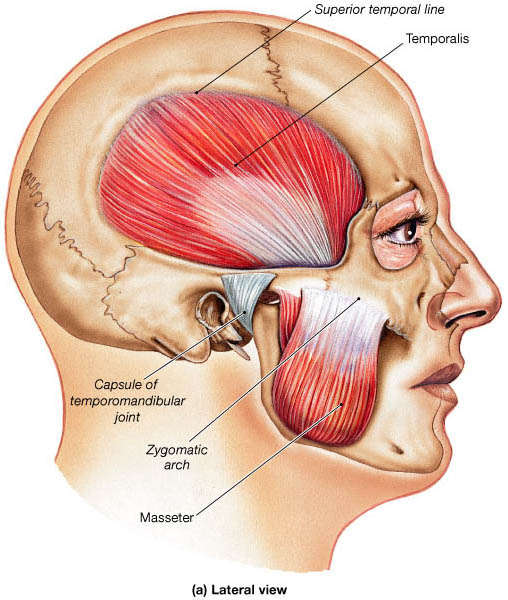


**Muscles of Chewing and Swallowing**

* 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

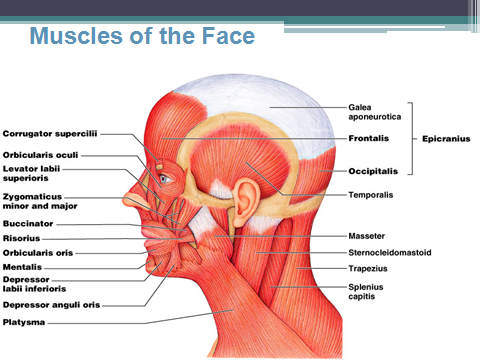
**Muscles of Chewing**

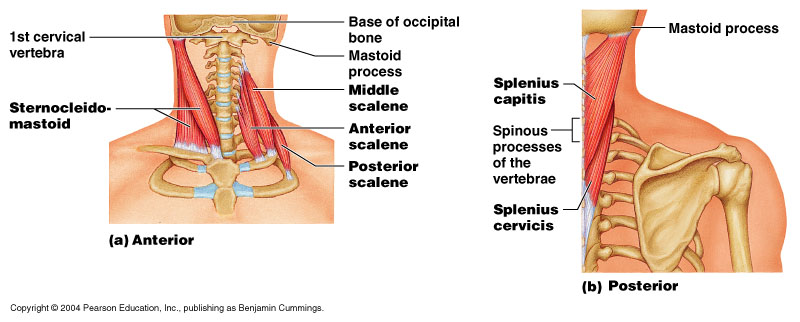
* four pairs of muscles produce the biting and chewing movements of the mandible
  + depression – to open mouth
  + elevation – biting and grinding
  + protraction – incisors can cut
  + retraction – make rear teeth meet
  + lateral and medial excursion – grind food
* temporalis, masseter, medial pterygoid,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

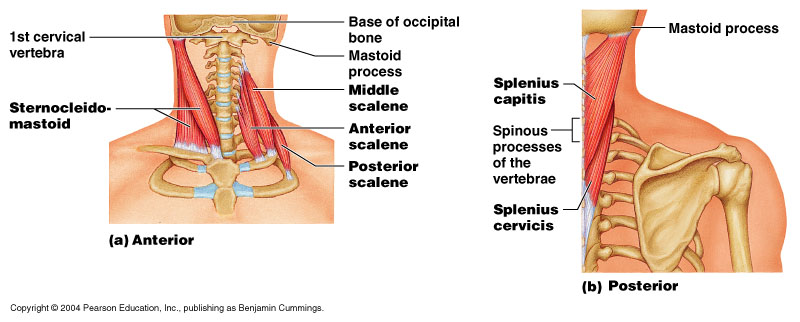
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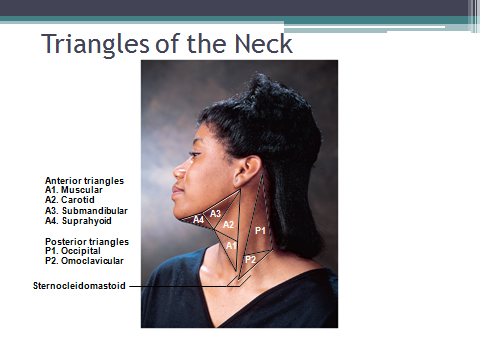
**Muscles Acting on the Head**

* 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





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**Muscles of the Trunk**

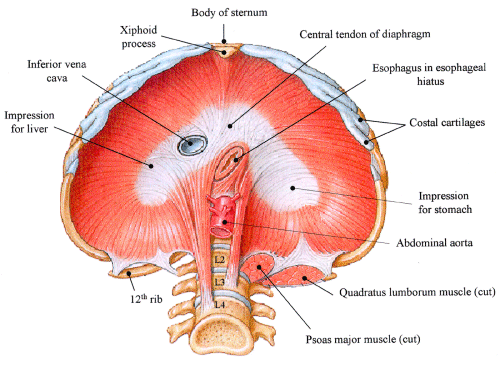
* three functional groups
  + muscles of respiration
  + muscles that support abdominal wall and pelvic floor
  + movement of vertebral column

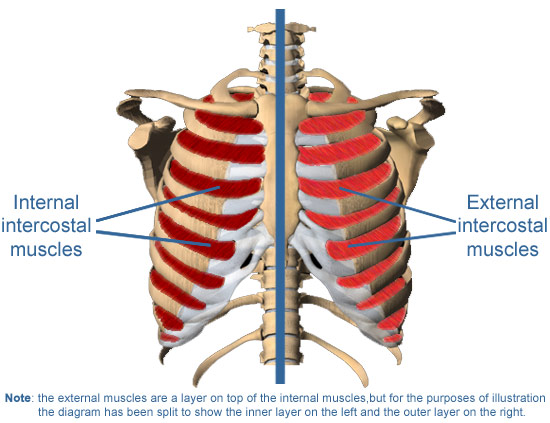
**Muscles of Respiration**

* 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



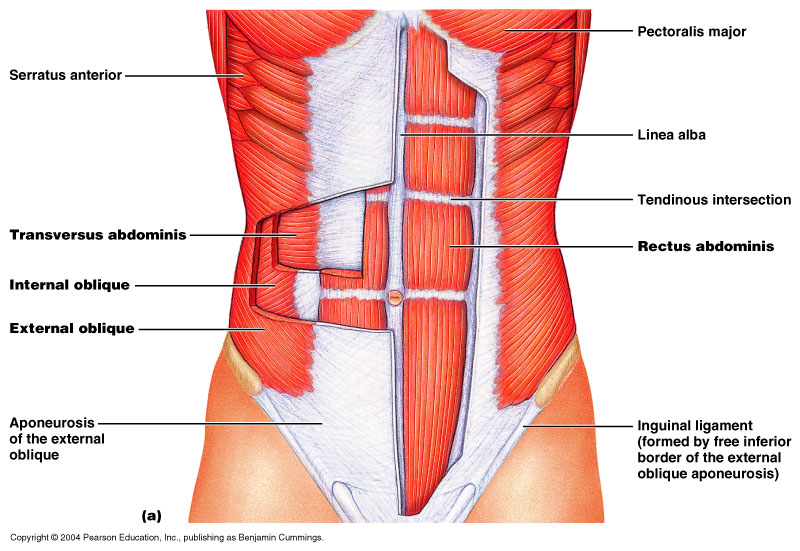


**Muscles of the Anterior Abdominal Wall**

* 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

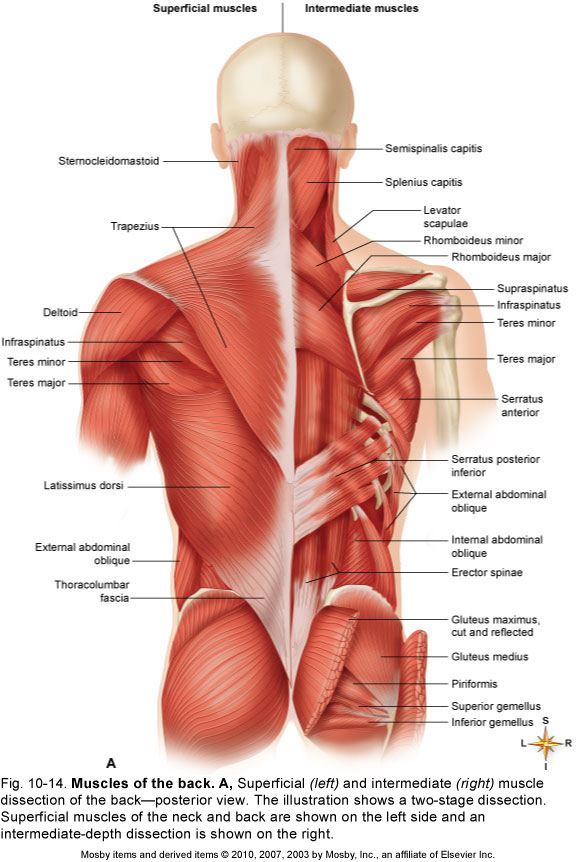
**Transverse Abdominal**

* 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”

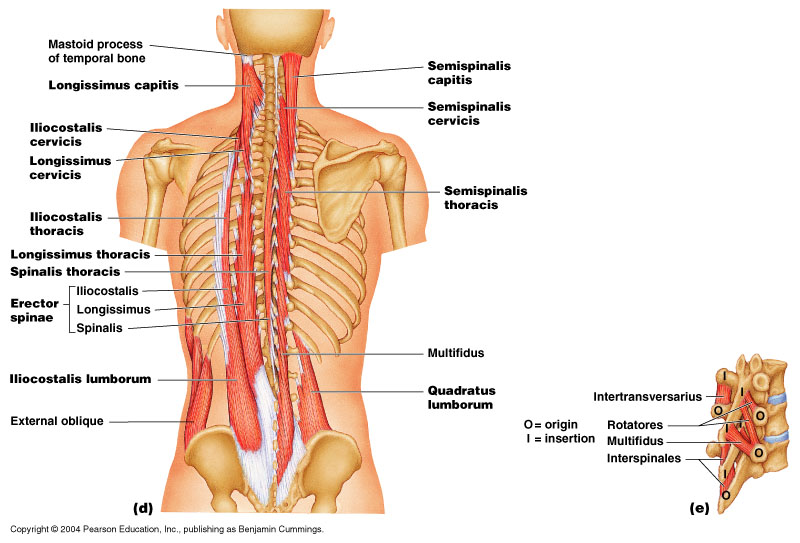
**Superficial Back Muscles**



**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

**Deep Muscles of the Back**



**Muscles of the Pelvic Floor**

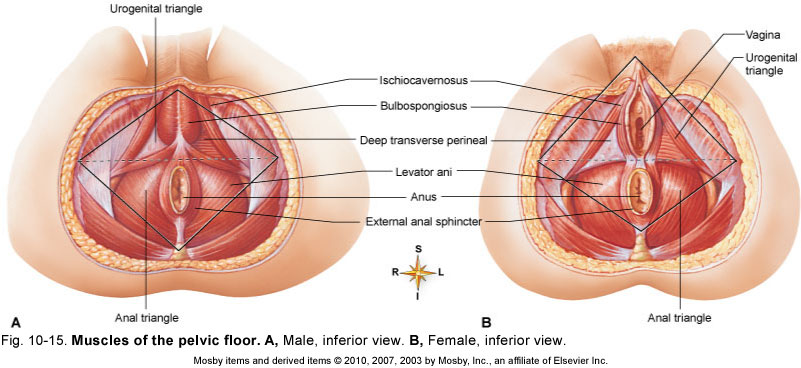
* three layers of muscles and fasciae that span pelvic outlet
  + penetrated by anal canal, urethra, and vagina
* perineum – diamond-shaped region between the thighs
  + bordered by four bony landmarks
  + urogenital triangle – anterior half of perineum
  + anal triangle – posterior half of perineum
* 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 nave

**Muscles Acting on Shoulder and Upper Limb**

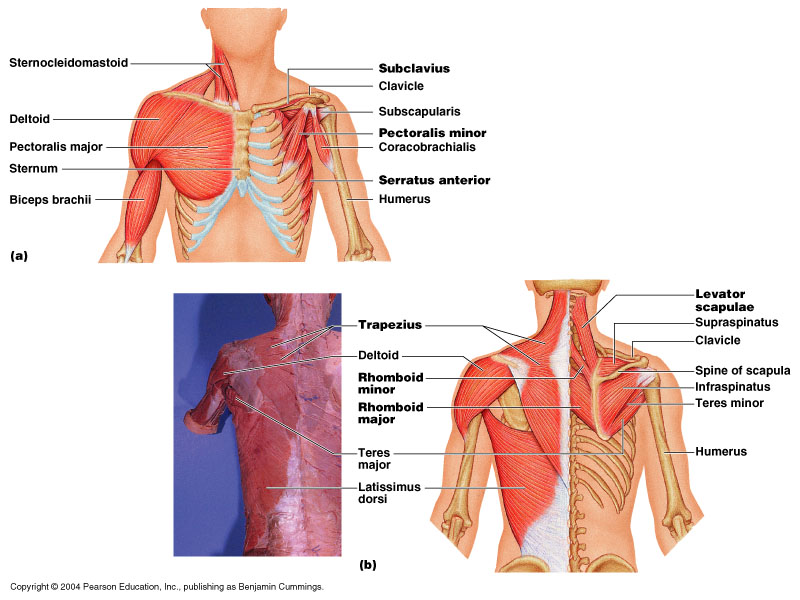
* compartments – spaces in which muscles are organized and are separated by fibrous connective tissue sheets (fasciae)
  + each compartment contains one or more functionally related muscles along with their nerve and blood supplies
* muscles of upper limbs divided into anterior and posterior compartments
* 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**

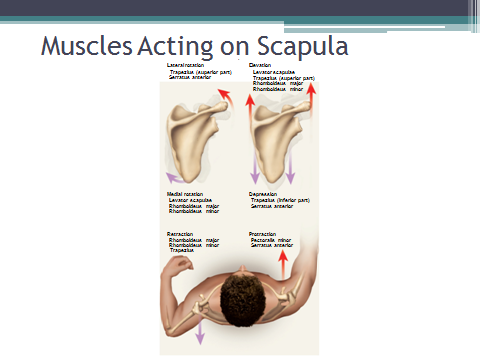
* originate on the axial skeleton
* insert on clavicle and scapula
* scapula loosely attached to thoracic cage
  + capable of great movement
  + rotation, elevation, depression, protraction, retraction
* clavicle braces the shoulder and moderates movements



**Anterior Muscles of Pectoral Girdle**

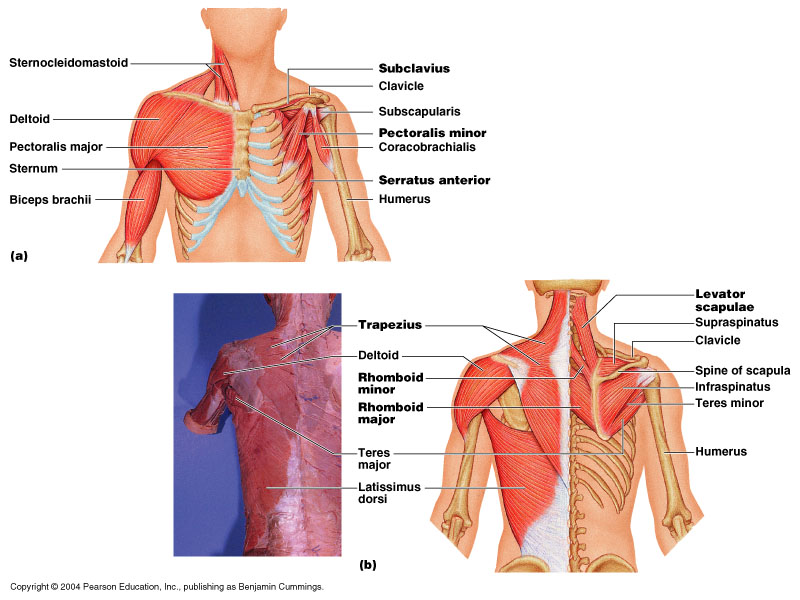
* pectoralis minor
  + ribs 3-5 to coracoid process of scapula
  + draws scapula laterally
* serratus anterior
  + ribs 1-9 to medial border of scapula
  + abducts and rotates or depresses scapula

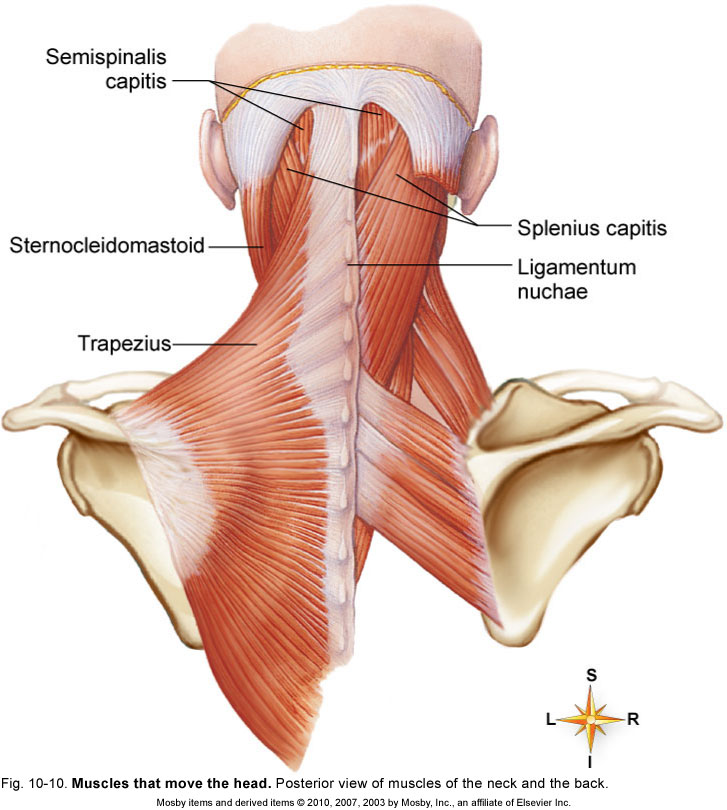
**Movement of the Scapula**

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**Posterior Muscles of Pectoral Girdle**

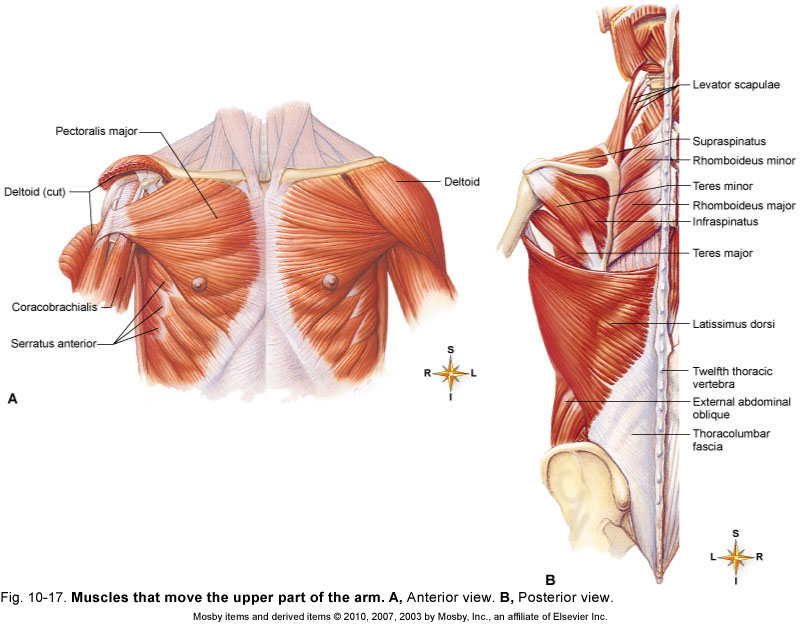
* four muscles of posterior group
  + trapezius – superficial
  + levator scapulae, rhomboideus minor, and rhomboideus major – deep
* trapezius
  + stabilizes scapula and shoulder
  + elevates and depresses shoulder apex
* levator scapulae
  + elevates scapula
  + flexes neck laterally
* rhomboideus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

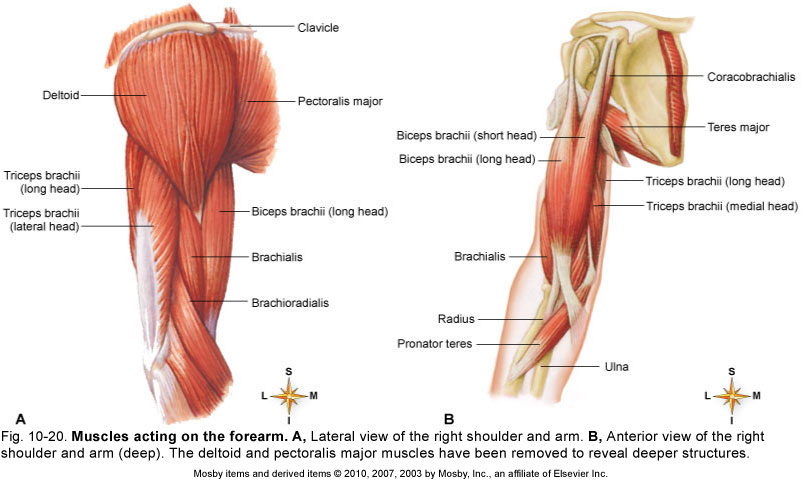


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**Muscles Acting on Arm**

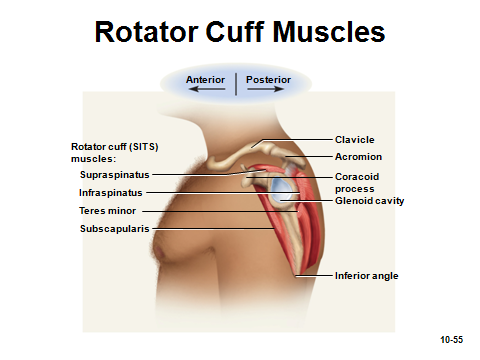
* nine muscles cross the shoulder joint and insert on humerus
  + two are axial muscles because they originate on axial skeleton
    - pectoralis major – flexes, adducts, and medially rotates humerus
    - latissimus dorsi – adducts and medially rotated humerus
* seven scapular muscles
  + originate 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

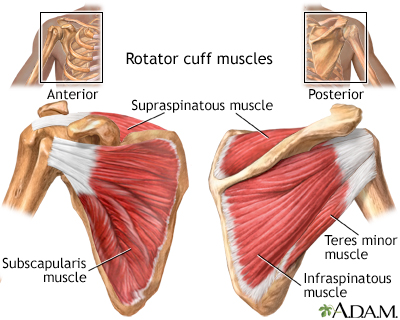


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**Rotator Cuff Muscles**

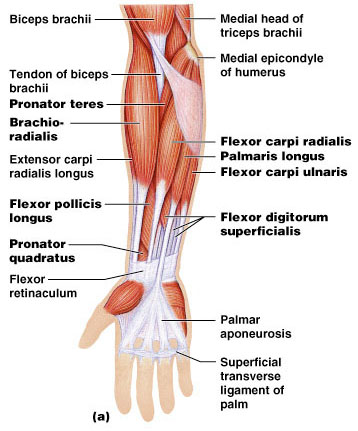
* tendons of the remaining four scapular muscles form the rotator cuff
* “SITS” muscles – for the first letter of their names
  + Supraspinatus
  + Infraspinatus
  + teres minor
  + subscapularis
* tendons of these muscles merge with the joint capsule of the shoulder as they cross it in route to the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





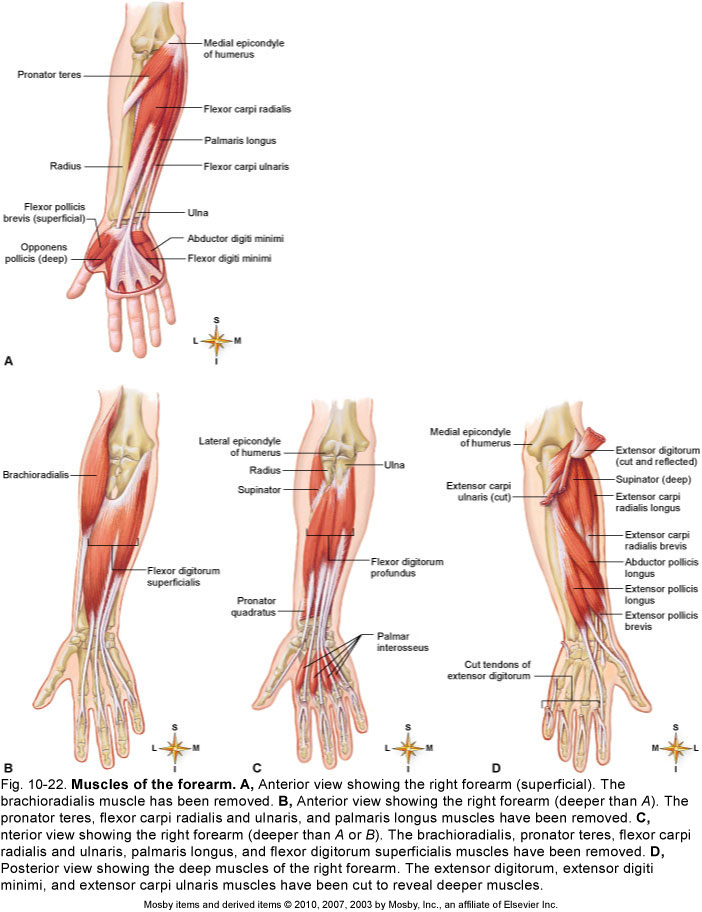
**Muscles Acting on Forearm**

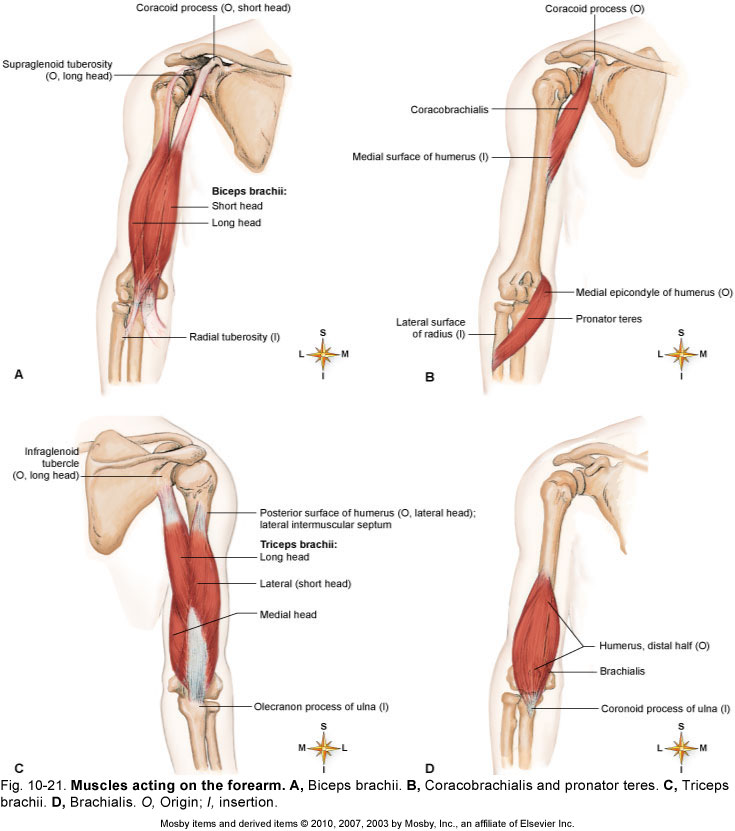
* elbow and forearm capable of flexion, extension, pronation, and supination
  + carried out by muscles in both brachium (arm) and antebrachium (forearm)
* muscles with bellies in the arm (brachium)
  + principal elbow flexors – anterior compartment
    - brachialis and biceps brachii
    - brachialis 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

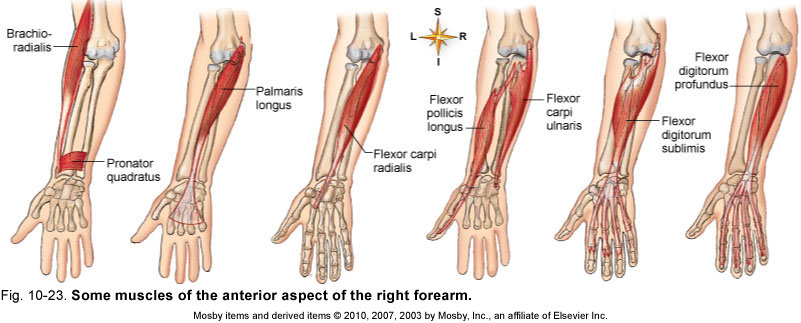


**Muscles Acting on Forearm**

* 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





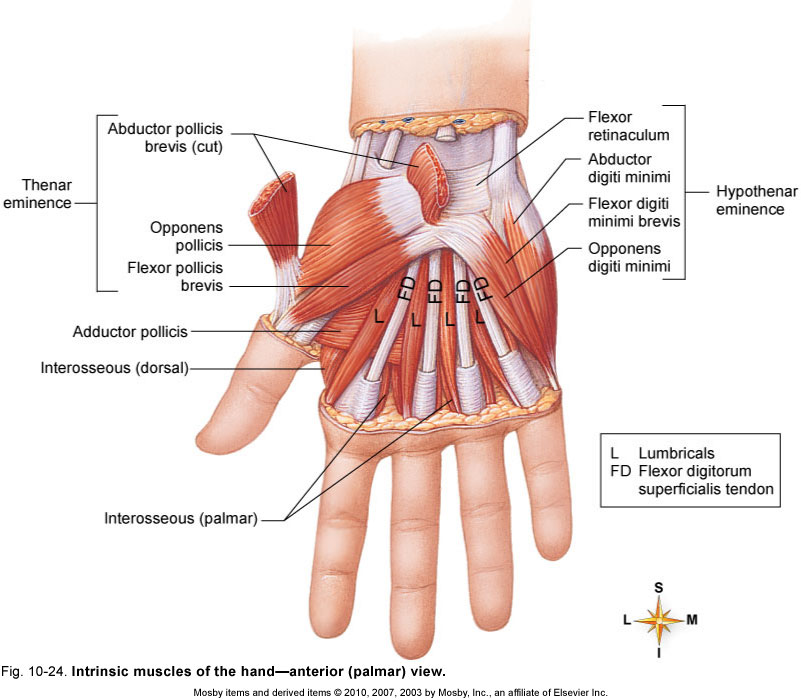


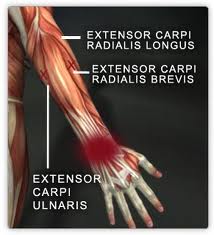
**Anterior Muscles on Wrist and Hand**

* 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**

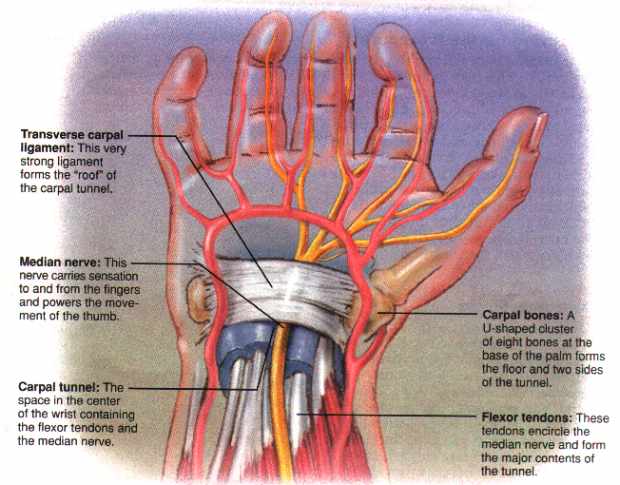
* Posterior (Extensor) Compartment – superficial layer
  + extensor carpi radialis longus
  + extensor carpi radialis brevis
  + extensor digitorum
  + extensor digiti minimi
  + extensor carpi ulnaris
* Posterior (Extensor) Compartment – deep layer
  + abductor pollicis longus
  + extensor pollicis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



[](http://www.google.com/imgres?hl=en&rlz=1I7GGLD_en&biw=1366&bih=589&tbm=isch&tbnid=Z9pOLzRe923rxM:&imgrefurl=http://www.realbodywork.com/learn/hand/wristE.htm&docid=65608W4r2jTqcM&imgurl=http://www.realbodywork.com/learn/hand/extcarpi.jpg&w=291&h=319&ei=UU5xT5_WIseogwe6o6BO&zoom=1)

**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)

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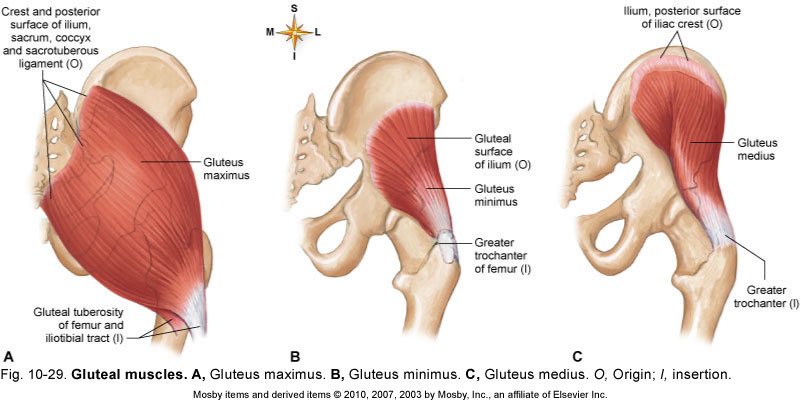
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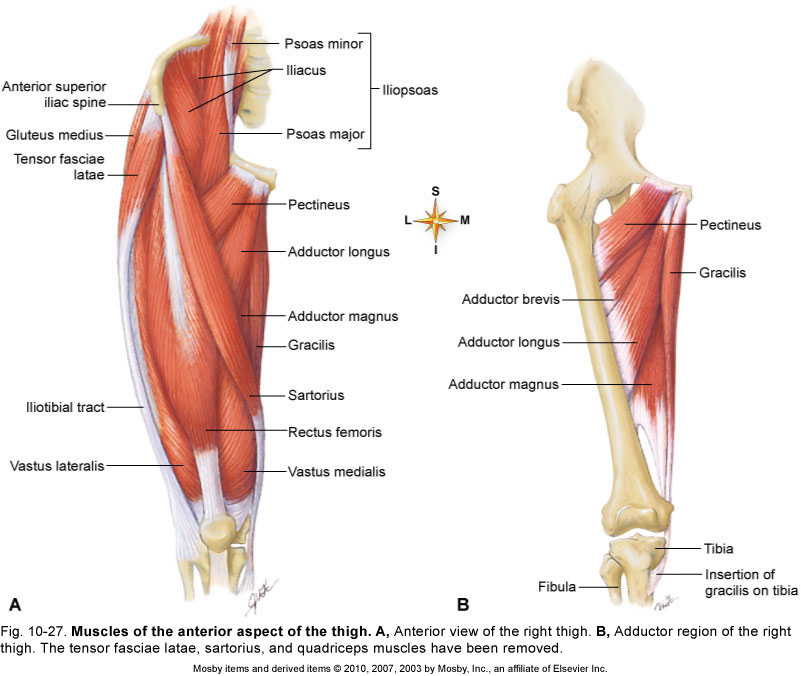
**Muscles on the Hip and Lower Limb**

* 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



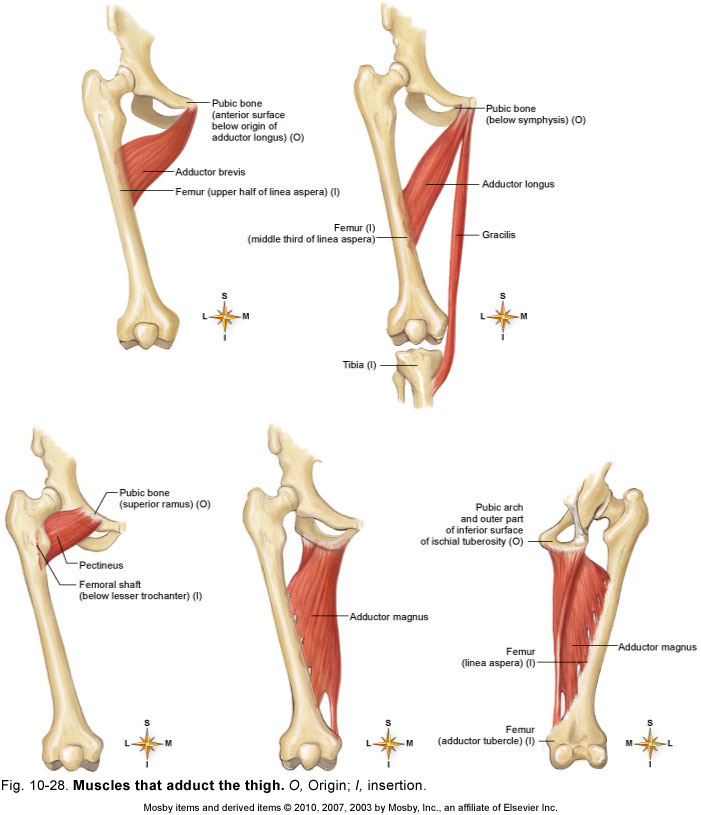


**Posterior Muscles on Hip and Femur**

* 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

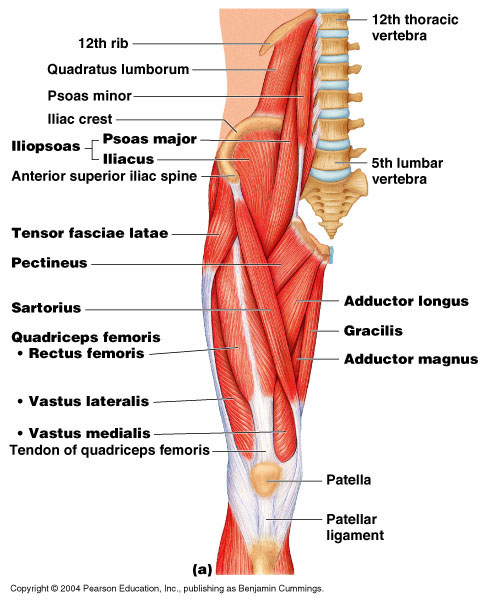
**Muscles Acting on Hip and Femur**

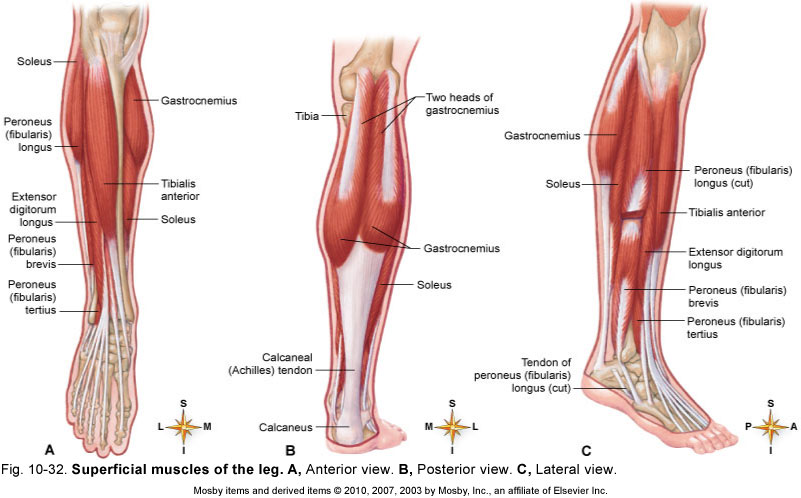
* medial (adductor) compartment of thigh
* five muscles act as primary adductors of the thigh
  + adductor brevis
  + adductor longus
  + adductor magnus
  + gracilis
  + pectineus



**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



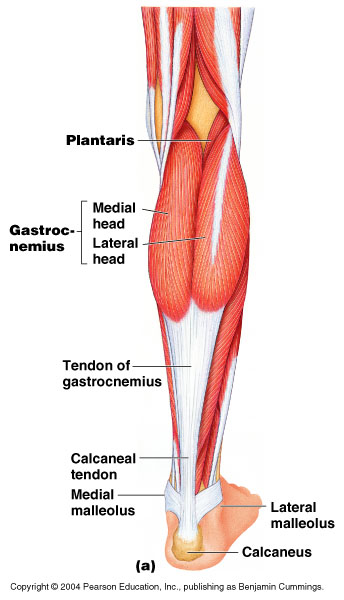


**Muscles Acting on the Knee and Leg**

* 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

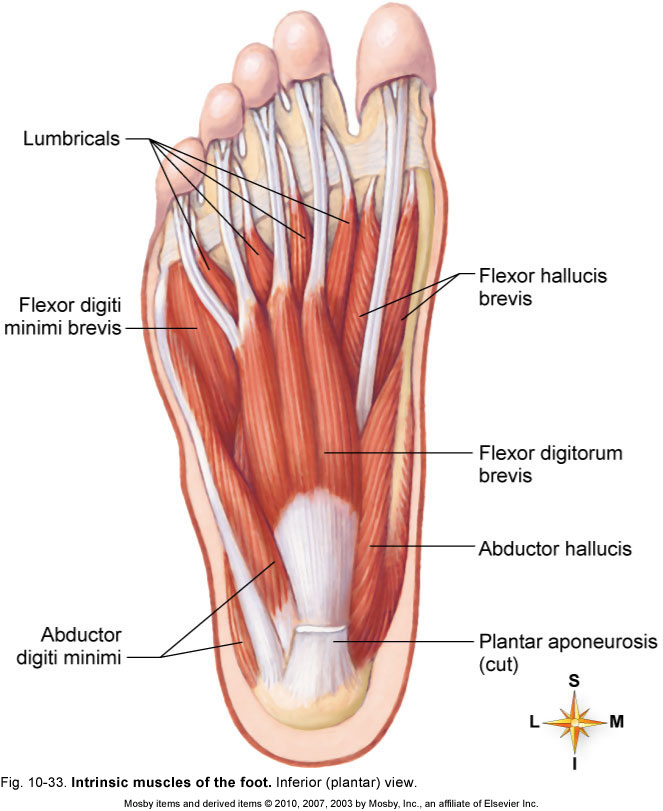
**Muscles Acting on the Knee and Leg**

* 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

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**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