

ANATOMY + MOVEMENT[®]

BUILD MANUAL AND RESOURCE GUIDE

VOLUME 1: ELBOWS TO KNEES, OCCIPUT TO COCCYX

By Nora St John, MS

with assistance from Joy Puleo MS, Dallas Everleth and Naomi Leiserson

Second Edition

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ANATOMY + MOVEMENT®

BUILD MANUAL AND RESOURCE GUIDE

INTRODUCTION

Anatomy + Movement uses a specially designed skeleton and modeling clay to build human muscular anatomy. The process of building the body is a powerful tool for imprinting the information into your body and mind. Anatomy + Movement® is designed for teaching anatomy to movers and movement educators including Pilates teachers, personal trainers, dancers, physical therapists, massage therapists, yoga instructors and anyone else interested in learning how the body is put together and how it works to move us from place to place.

PUTTING THE ANATOMY + MOVEMENT SKELETON TOGETHER

For many of the building activities, it is useful to have the skeleton firmly attached to the base so it will remain stable while building and attaching the muscles.

- ▶ Step 1) Use the screws to attach the legs to the pelvic girdle. Use the allen key to lightly tighten down the screws. Don't get overzealous on this, just tight will do.
- ▶ Step 2) Insert the center rod in the skeleton and thread the center rod and the screws on the bottom of the feet through the holes in the base. Place a washer on each of the screws. Use the supplied wing nuts to attach the legs and center rod to the base.
- ▶ Step 3) If you want to attach the arms, place them in the holes on the sides of the ribcage. Make sure the shape of the pegs lines up with the indents to make a solid connection. These are held on by magnets so they are easy to remove.
- ▶ Step 4) Put the head on the skeleton by fitting the post to the hole in the bottom of the skull.

WORKING WITH THE CLAY

The clay provided with the skeletons is non-toxic and oil based. In cool weather and when fresh out of the package it may feel quite firm and difficult to shape. To warm it up, hold it in the hand or toss it gently from hand to hand until it softens up. Once it is soft enough to work, use hands, tools or rollers to make tubes, sheets or balls as needed for the structure being built.

Because the clay is oil based, it will not dry out and does not need to be covered if it is left out. Store the clay in thick gallon sized plastic bags in an area where the temperature is in a moderate range. The oil will leak out of the clay when left in a hot (over 100 degrees F) area for a period of time. The clay washes out of most fabrics but we recommend wearing an apron or clothing you are not attached to when working with it to avoid stains.

USING THE TEMPLATES

Templates are included at the beginning of each section to provide a rough idea of the shape and size of the muscles. The sizes will need to be adjusted depending on which side of the skeleton is being used and each persons individual building style. The templates are based on building the left side of the body. Leg muscles will need to be slightly larger for the right thigh.

Each muscle is labeled with the best shape to start with:

- ▶ S is for thin sheets, TS is for thicker sheets.
- ▶ T is for tubes, FT is for flattened tubes.

To use a template, place it over a sheet of clay and use the wooden tool to press the shape of the outline into the clay. Remove the template and cut out the shape. For tubes, start with a tube of clay about the length and width of what is indicated on the template.

REFERENCE TEXT

This manual is designed as a guide for building the muscles on the skeleton. It is not designed to be a comprehensive anatomy text. The anatomy text that accompanies this course is [Trail Guide to the Body](#), 5th edition by Andrew Biel. Trail Guide was originally designed for manual therapists but as it has grown, it now contains information useful to students interested in the intersection of Anatomy and Movement.

ADDITIONAL ANATOMY TEXTS

[Trail Guide to the Body](#), 5th edition by Andrew Biel

[Trail Guide to Movement](#) by Andrew Biel

[Atlas of Anatomy: General Anatomy and Musculoskeletal System](#) pub. By Thieme

[Manual of Structural Kinesiology](#) 15th edition by R.T. Floyd, Ed.D., ATC, CSCS and Clem W. Thompson Ph.D., F.A.C.S.M (MSK)

[Anatomy of Movement](#) by Blandine Calais-Germain

[Dance Anatomy and Kinesiology](#) by Karen Clippinger Robertson

SUPPLEMENTARY TEXTS

[The Female Pelvis](#) by Blandine Calais-Germain

[Atlas of Human Anatomy](#) 3rd Edition by Frank H. Netter, M.D.

[Dynamic Alignment through Imagery](#) by Eric Franklin

[Anatomy Trains](#) by Thomas W. Myers

ANATOMY VOCABULARY

REGIONS OF THE BODY

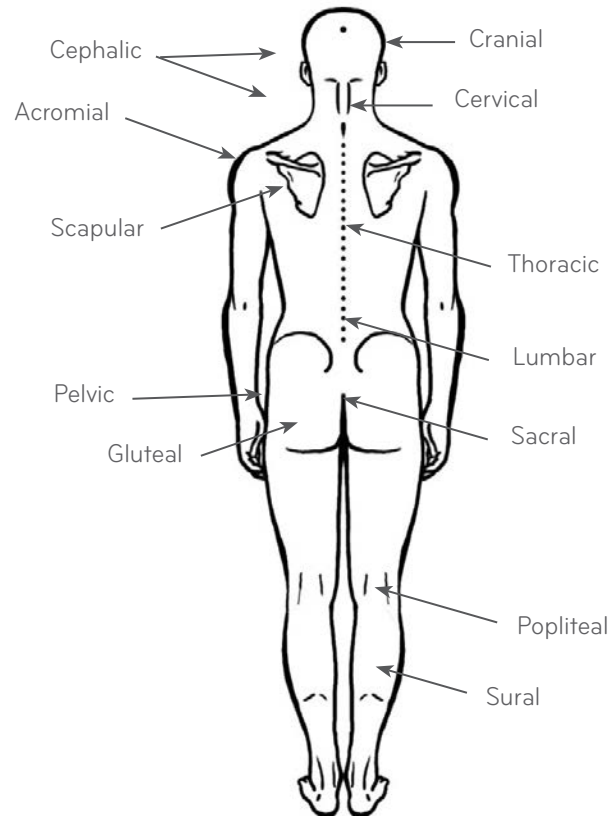
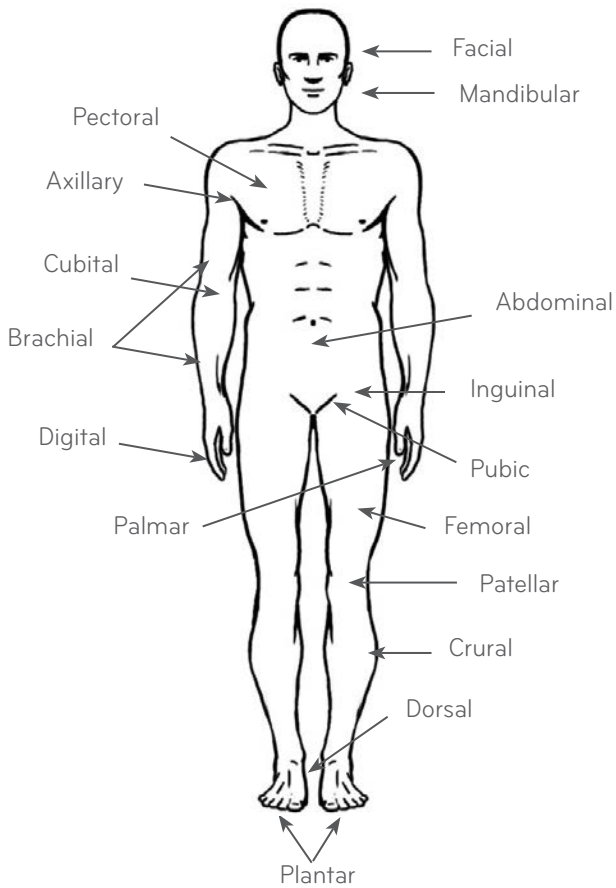
When locating a particular spot on a bone or determining where one muscle is located in relationship to another, it is important to be able to describe the location, size and position as accurately as possible. The language in this manual may seem complicated at first but with time you will appreciate how useful it is to be precise when describing the location and action of a bone, muscle or other anatomical elements.

FRONT OF THE BODY

- Facial** – face
- Mandibular** – jaw
- Supraclavicular** – above the clavicle
- Pectoral** – chest
- Axillary** – arm pit
- Brachial** – arm
- Cubital** – elbow
- Antecubital** – inside of the elbow
- Abdominal** – belly
- Inguinal** – groin
- Pubic** – pubic
- Femoral** – thigh
- Palmar** – palm of the hand or sole of the foot
- Patellar** – knee cap
- Crural** – lower leg
- Dorsal** – back of the hand or foot
- Plantar** – bottom of the foot

BACK OF THE BODY

- Cranial** – head
- Cervical** – neck or cervical vertebrae
- Cephalic** – head and neck
- Acromial** – top of the shoulder
- Scapular** – shoulder blade
- Thoracic** – ribcage or thoracic vertebrae
- Lumbar** – lower back or lumbar vertebrae
- Sacral** – sacrum
- Pelvic** – hips
- Gluteal** – butt
- Carpal** – wrist
- Digital** – fingers and toes
- Popliteal** – back of the knee
- Sural** – back of the calf



ANATOMY VOCABULARY

DIRECTIONS

DIRECTIONS

Superior - above

Inferior - below

Posterior - behind, back of the body

Anterior - in front, front of the body

Medial - closer to the midline

Lateral - farther from the midline

Proximal - closer to the heart

Distal - farther from the heart

Superficial - on the surface

Deep - closer to the bone, below the surface

Prone - lying face down

Supine - lying face up

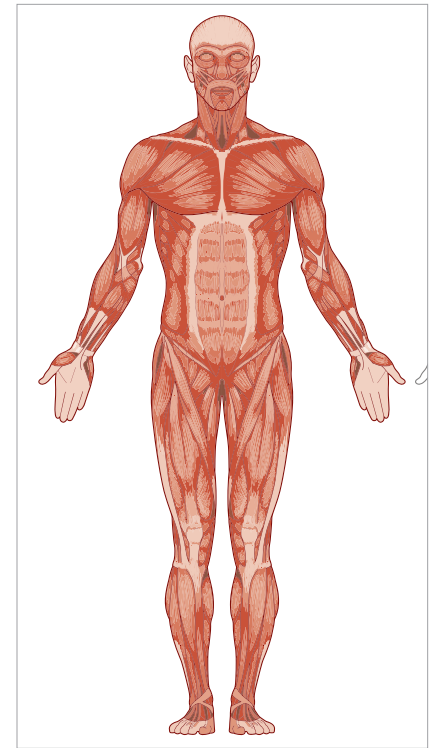
Cranial (Cephalic) - looking toward the head (cranium) from the inside of the body, higher

Caudal - looking toward the tail (cauda) from the inside of the body

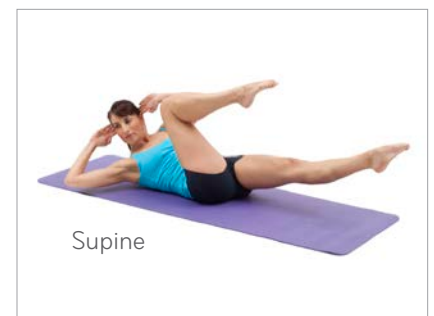
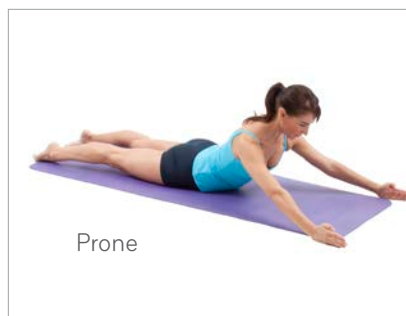
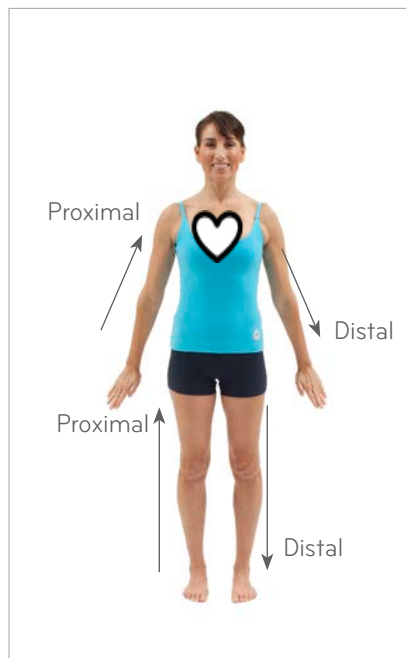
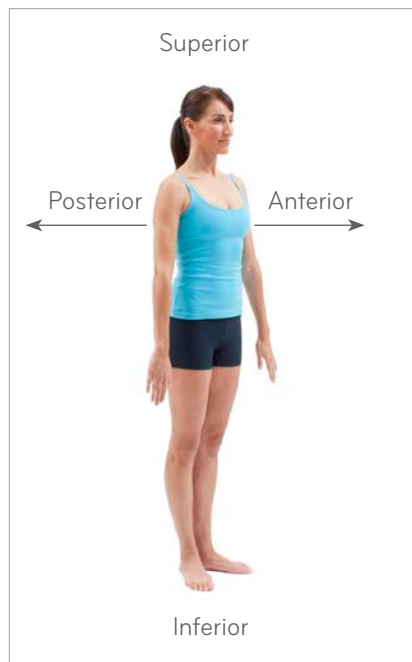


ANATOMICAL POSITION

Standing with the arms at the sides and the palms facing forward. As if a body is lying face up on a table. This is primarily how anatomists dissected bodies for centuries so this is the reference point for muscle locations.



Anatomical Position



PLANES OF MOTION

PLANES OF MOTION

Sagittal plane

- ▶ Also known as the wheel plane, anteroposterior or AP plane.
- ▶ Movements that occur parallel to a plane through the mid line of the body. As if you had a wheel running through your midline.
- ▶ All sagittal movements occur parallel to the wheel.
- ▶ From Sagittarius meaning archer.

For example: Knee flexion, elbow flexion, spinal flexion and extension

Frontal plane

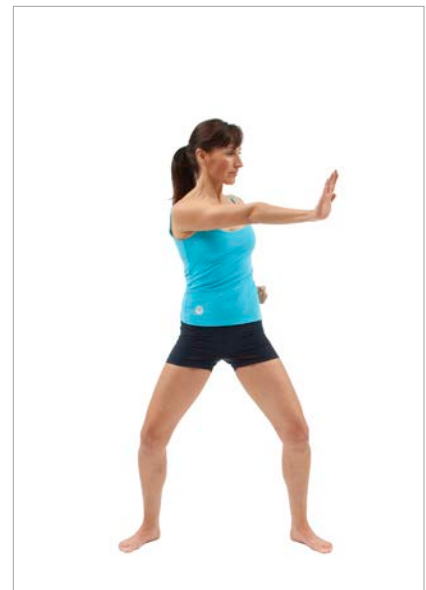
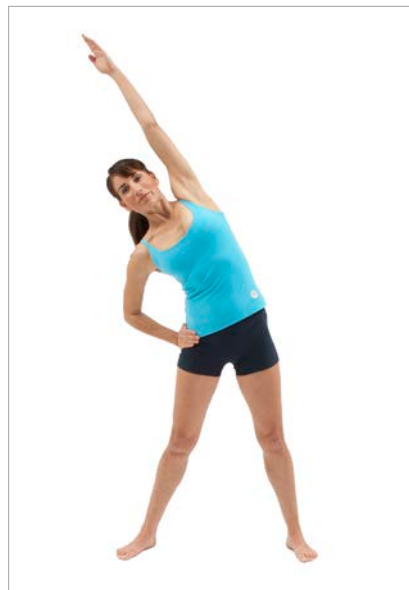
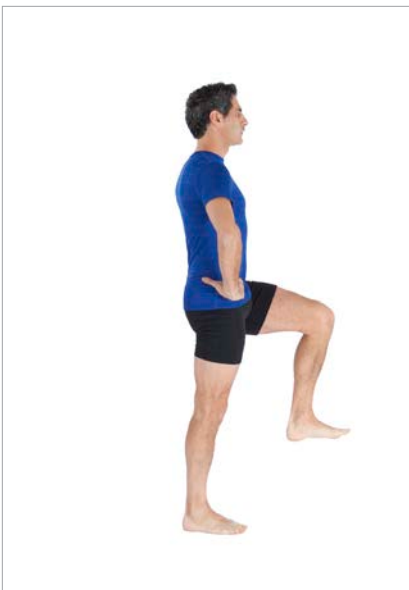
- ▶ Also known as the door, lateral or coronal plane
- ▶ Movements that occur parallel to a plane bisecting the body laterally into front and back halves. As if you were standing in a door way.
- ▶ All frontal movements occur in line with the plane of the door.

For example: Hip abduction, hip adduction, shoulder abduction and adduction, spinal lateral flexion.

Transverse plane

- ▶ Also known as the table or horizontal plane.
- ▶ Movements that occur parallel to a plane dividing the body into upper and lower halves. As if you had a table suspended around your waist.
- ▶ All transverse movements occur parallel to the table.

For example: Spinal rotation, lateral and medial rotation of the hip or glenohumeral joint, pronation and supination of the forearm.



Sagittal Plane

Frontal Plane

Transverse Plane

ANATOMY FUNDAMENTALS

TISSUES OF THE BODY

BONES

Structure

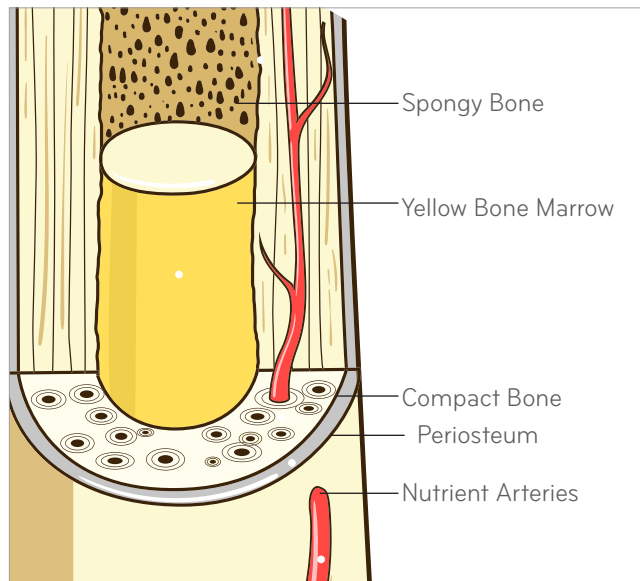
The outer layer of most bones is composed of a thick fibrous layer called the **periosteum**. The periosteum is an important blood and nerve supply for the bone as well as providing a place for ligaments and tendons to attach. The next layer is the smooth, dense **compact or cortical bone**. The compact bone surrounds the **spongy bone (also called cancellous or trabecular bone)**. The spongy bone is composed of a series of arches or trabeculae oriented along the lines of stress placed on the bone. It is these trabecular "arches" which become thinner with osteoporosis. Inside the spongy bone is the **bone marrow**. Blood cells are manufactured in the bone marrow.

Function

Protection, support, movement, blood cell production

Pathology

Breaks, fractures, osteoporosis



JOINTS

There are over 200 bones in the human body. The places where the bones come together are called joints. There are three types of joints - fibrous, cartilaginous and synovial.

Fibrous Joints

Fibrous tissue joins bone to bone in a fibrous joint. The sutures in the skull; the joints that hold the teeth into the jaw; and the strong interosseous membrane between the tibia and fibula are all examples of fibrous joints. These types of joints allow little or no movement.

Cartilaginous Joints

In cartilaginous joints bones are joined together with thickenings of cartilage. The symphysis pubis; the intervertebral joints formed by the bodies of the vertebra and the vertebral discs; and the joint between the sternum and the manubrium are all examples of cartilaginous joints. These types of joints are very strong and stable, but do allow a small amount of give or play between the bones.

Synovial Joints

With synovial joints the bones are not joined together as they are with the fibrous or cartilaginous joints. This leaves space between the bones, which will allow for movement. Synovial joints all have the following characteristics in common: a joint space between the articulating ends of the bones; articular cartilage covering the articulating surfaces of the bones; synovial fluid in the joint space; a synovial membrane; and a joint capsule.

FASCIA

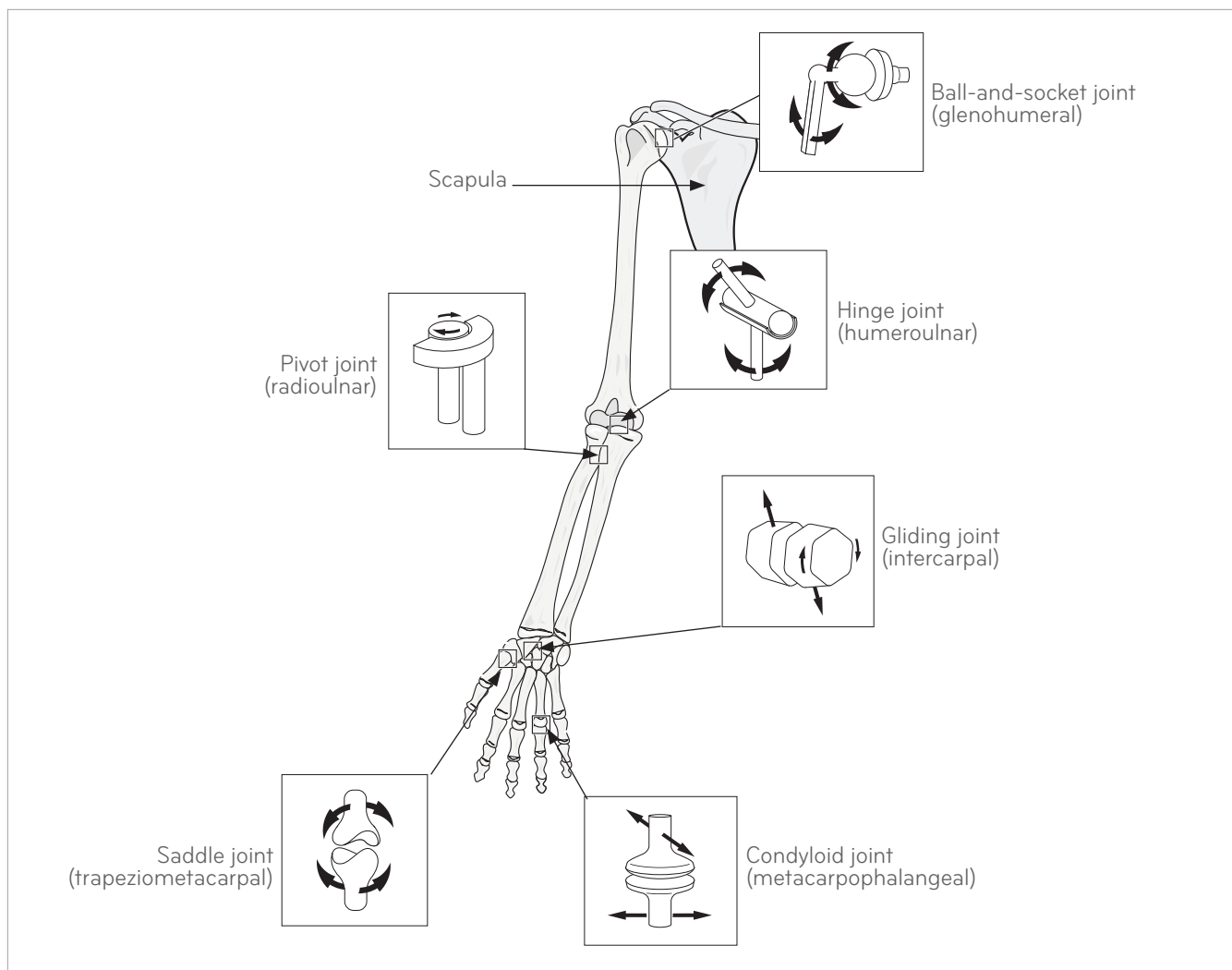
Fascia is a term for the connective tissue that organizes all of the muscles, joints, ligaments and tendons into functional units for movement. Fascia science is a rapidly growing field. The myofascial structures (muscle + fascia) create movement, provide proprioceptive feedback and provide hydration, nutrition and structure to all the tissues of the body.

Fascia takes many different forms including:

- ▶ Superficial fascia - Connects the skin to the deep fascia surrounding the muscles (epimysium). Provides structure to the skin and fat layer while allowing it to glide over the muscles.
- ▶ Deep fascia - Surrounds the muscles, creates stiffness and allows force to be transferred from the muscle to the joints. It also creates tendons, ligaments and other thickened fascial structures such as the thoracolumbar fascia or iliotibial band.
- ▶ Visceral fascia - Creates the structure of the organs and provides a scaffolding for the cells to organize around.

TYPES OF SYNOVIAL JOINTS

Type of joint	Example	Joint Shape	Joint Movement
Ball and socket	Hip, shoulder	Ball and socket	Movement in all planes
Hinge	Elbow - humeroulnar or humeroradial, knee, phalanges	Varies	Flexion and extension
Gliding	Carpals, tarsals	Two flat surfaces meeting	Small amount of glide in one or several planes
Ellipsoid or Condylod	Radiocarpal	Oval end articulates with elliptical basin	Flexion, extension, abduction, adduction, circumduction
Saddle	Thumb, sternoclavicular	Two nesting saddles	Flexion, extension, abduction, adduction, circumduction
Pivot	Atlantoaxial or radioulnar	Axle and wheel	Rotation



ANATOMY FUNDAMENTALS

TISSUES OF THE BODY

MUSCLES

Structure

- ▶ A single muscle cell is called a myofibril. Each myofibril has its own casing made up of fascia called the endomysium.
- ▶ A group of myofibrils is called a primary muscle bundle or fascicle which in turn has its own casing of fascia called the perimysium.
- ▶ Every muscle is made up of multiple fascicles which are surrounded and organized by a thicker fascial layer called the epimysium or deep fascia.
- ▶ Fascia also surrounds groups of muscles in order to organize and direct their action.
- ▶ The endomysium and perimysium are continuous with the epimysium.
- ▶ The epimysium extends past the muscle to create part of the tendon which is how the muscle attaches to the bone.

MUSCLE FIBER ORIENTATION

Muscle fibers are arranged in either parallel rows from the origin to the insertion of the muscle (fusiform) or the fibers are attached at an angle to the tendon (pennate). Pennate means featherlike.

Fusiform or parallel

- ▶ This is the typical muscle shape with parallel fibers connecting to straight tendons on either end.

Unipennate

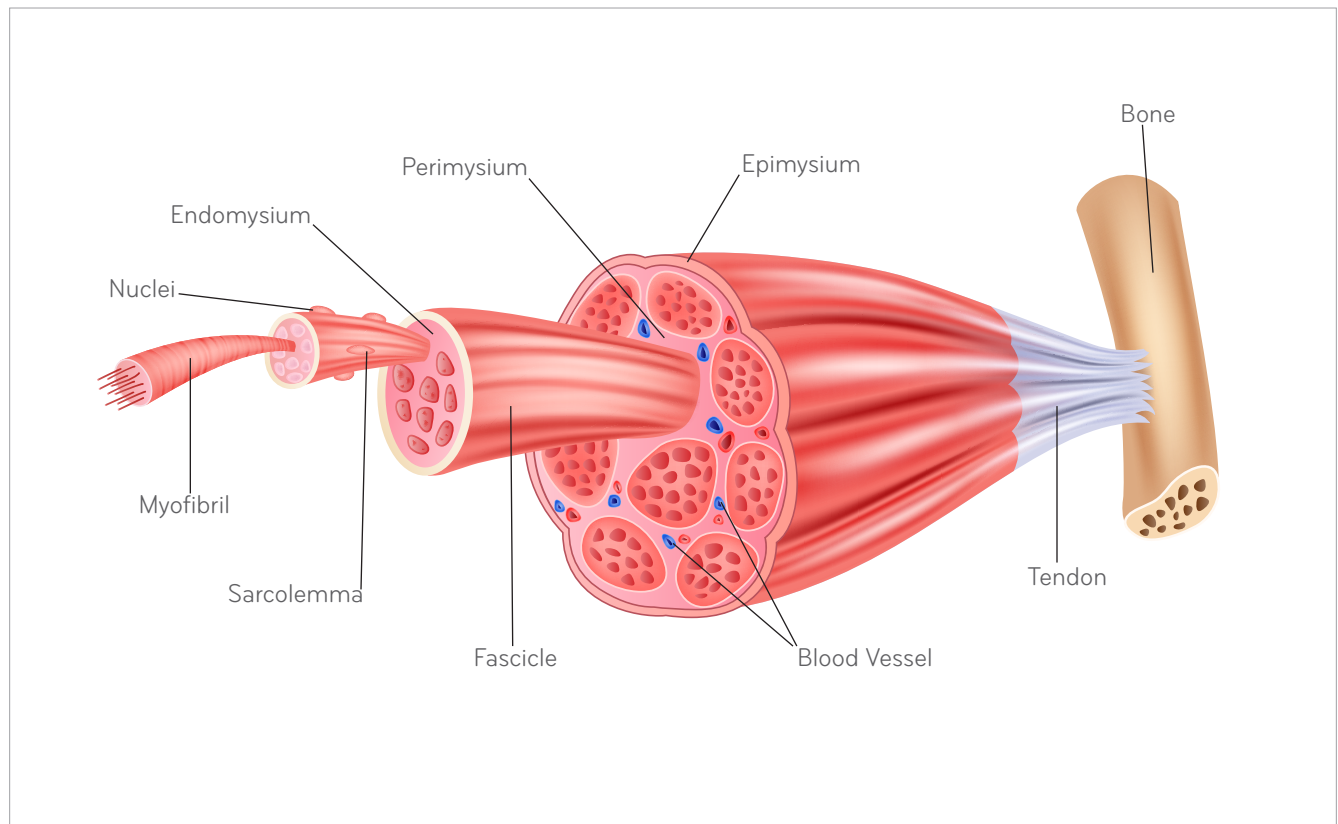
- ▶ In unipennate muscles the muscle fibers run at an angle to the tendon (i.e. tibialis posterior).

Bipennate

- ▶ In bipennate muscles, two bundles of muscle fibers come into the central tendon at two different angles (i.e. biceps brachii). This is how the individual barbs of a feather come into the central rib.

Multipennate

- ▶ In multipennate muscles, muscle fibers come into the central tendon at a variety of angles (i.e. quadriceps femoris).



Structure of Skeletal Muscle

TISSUES OF THE BODY

MUSCLE SHAPES

Muscles come in many different shapes depending on the location and the function of the muscle.

Several common shapes include:

Fusiform

- ▶ A round muscle with parallel muscle fibers (i.e. biceps brachii).

Strap or Parallel

- ▶ A long straplike muscle with parallel muscle fibers (i.e. sartorius).

Triangular or Convergent

- ▶ A muscle with multiple attachment points where the fibers run parallel to each other but fan out over a wide area (i.e. pectoralis major).

Flat

- ▶ Lies directly over a bone forming a thin sheet (i.e. frontalis).

Sphincter or circular

- ▶ A circular muscle designed to open and close an opening in the body (i.e. orbicularis oris or anal sphincter).

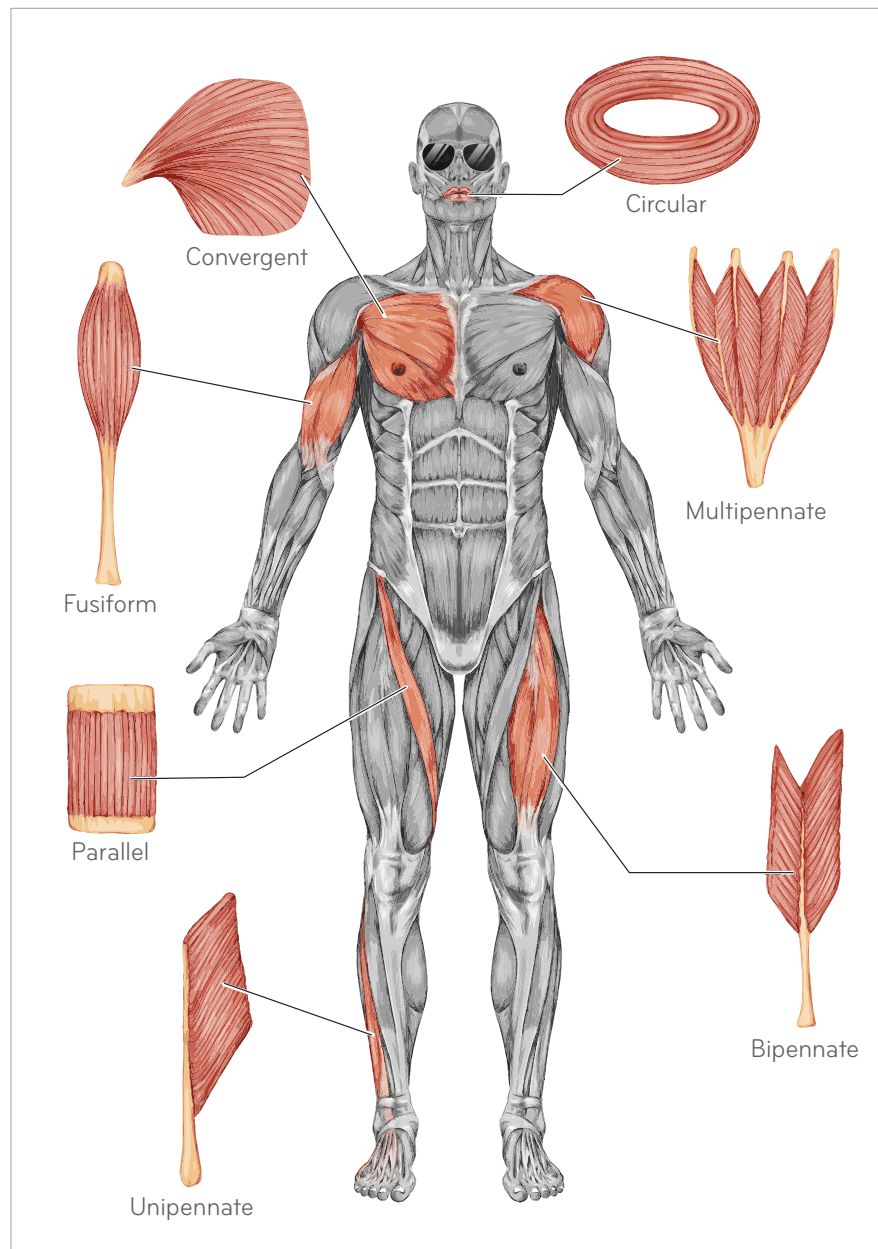
MUSCLE FUNCTION

Muscles contract in order to move bones, push blood through the body, move food through the intestines and many other essential functions.

TYPES OF MUSCLE CONTRACTIONS

Isometric

An isometric contraction does not change the length of the muscle. The muscle contracts with a force equal to the resistance.



Isotonic

- ▶ The muscle changes length. There are two kinds of isotonic contractions:

- **Concentric** - A concentric contraction is a shortening contraction. The muscle shortens when the muscle contracts with a force greater than the resistance. For example, the action of the brachialis when picking up a coffee cup.
- **Eccentric** - An eccentric contraction is a lengthening contraction. The muscle gradually lengthens with a force less than the resistance. For example, the action of the brachialis as it lowers the coffee cup back down to the table with control.

ANATOMY FUNDAMENTALS

TISSUES OF THE BODY

MUSCLE ROLES

With these different types of muscle contractions, muscles can play different roles as they work to move and stabilize our joints. The different roles are:

Agonist

▶ The prime mover - for example biceps in elbow flexion.

Antagonist

▶ The muscle or muscles that oppose the agonist – for example the triceps in elbow flexion.

Stabilizer

▶ The muscles that stabilize joints in order to allow efficient movement – for example rotator cuff in shoulder motion.

Synergist

▶ The muscles that assist the agonist but do not contribute as much force or power to the movement for example: the sartorius in hip lateral rotation.

Neutralizers

▶ The muscles that counteract the action of other muscles to assist with aligning a particular action – for example the hip internal and external rotators act to keep the femur tracking straight ahead while walking or running.

Common pathologies: Tears, strains, bruises, contusions

TENDONS

Structure

▶ A tendon is a relatively non-elastic connective tissue composed of collagen and other cellular materials. The epimysium, or fascia casing of the muscle, extends past the muscle to become continuous with the periosteum of the bone. This is the tendon. All muscles have tendons but they can have very different shapes and sizes depending on the structure and function of the muscle.

Functions

▶ Tendons connect muscles to bones transmitting the force generated by the muscle to the bone in order to move or stabilize the joint.

Common pathologies: Tendinitis, partial tears or complete ruptures (when the entire tendon pulls away from the bone).

LIGAMENTS

Structure and Function

▶ Ligaments connect bone to bone and are composed of relatively thick connective tissue or fascia. Their primary function is to limit the range of motion of the joints to keep them from moving beyond a safe range. Ligament length is primarily determined by genetics but some changes in ligament length can be made by early training for activities where extreme range of motion is necessary as in pitching a baseball or extending the hip in ballet.

Common pathologies: Ligament tears, hypermobility or hypomobility.

BURSAE

Structure and Function

▶ Small, fluid filled sacks that reduce friction and help to provide cushioning between adjacent muscles, tendons and bones.

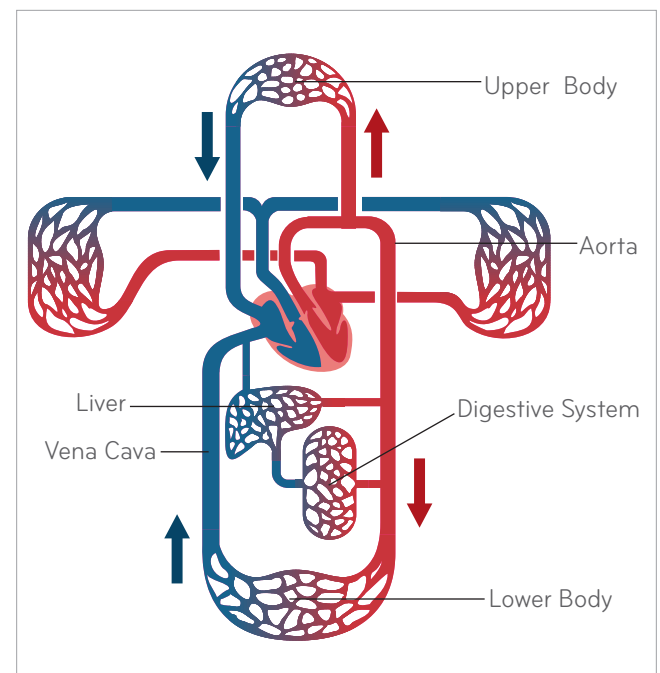
Common pathologies: Inflammation and swelling

ARTERIES AND VEINS

Structure and Function

▶ Arteries move blood away from the heart, circulating the blood though out the body bringing oxygen and nourishment to the tissues. Veins carry blood back to the heart.

Common pathologies: Phlebitis, arteriosclerosis.



Circulatory System

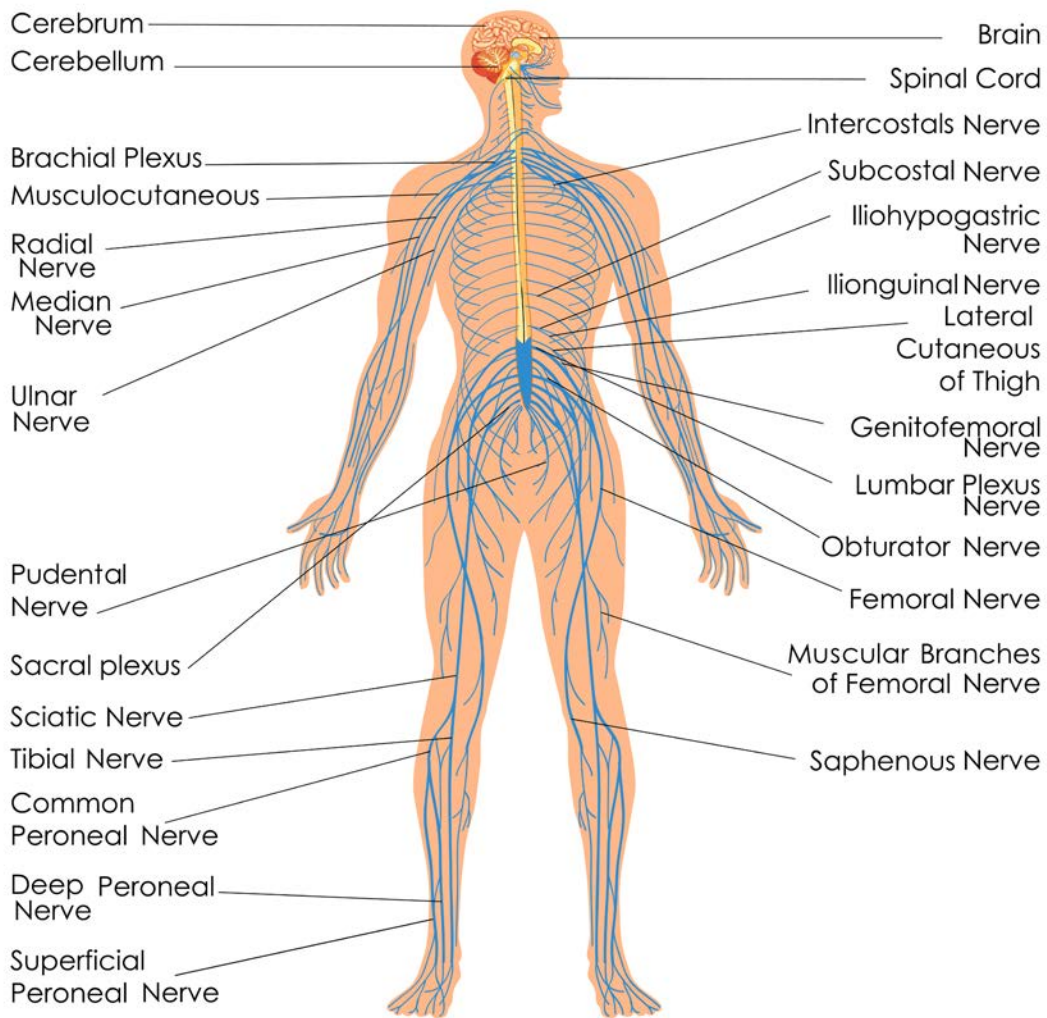
THE BRAIN AND NERVOUS SYSTEM

Structure and Function

- ▶ The brain lives inside the skull and is the central information processing organ in the body. The brain organizes movement, creates emotion, responds to the environment around us and creates consciousness.
- ▶ Nerves are long thin structures that convey information to and from the brain.
- ▶ The central nervous system is made up of the brain and the spinal cord. The peripheral nervous system is made up of the nerves branching off the spinal cord and exiting at the sides of the vertebra.
- ▶ Some nerves create connections with related nerves to form what are called a plexus. Examples of this are the brachial plexus in the anterior shoulder that innervates the arm and the lumbosacral plexus in the pelvis that innervates the lower body.

Common pathologies: Radiculopathy, "pinched" nerve, sciatica

Nervous System



THE PELVIS AND LOWER LIMB

PELVIS

The Pelvic Girdle

The pelvic girdle consists of the sacrum and the two halves of the pelvis called the hemi pelvis or hip bones. Each hemi pelvis consists of three bones, the ilium, the ischium and the pubis which fuse together as we mature to create the acetabulum or hip socket.

BONES OF THE HEMI PELVIS OR HIP BONE

Ilium

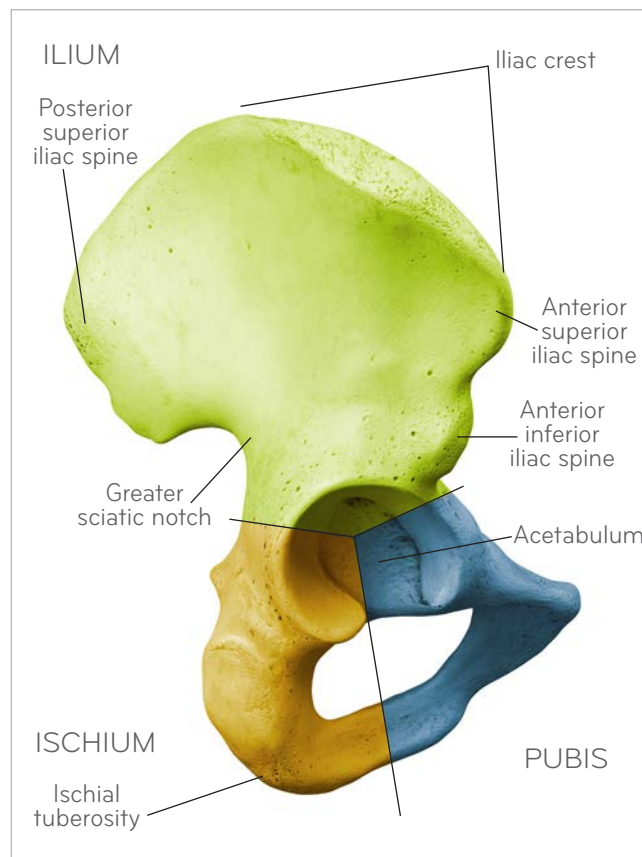
- ▶ Largest part of the hip bone.
- ▶ Comes from Latin meaning "groin" or "flank".

Ischium

- ▶ Forms the lower and back part of the hip bone and sits below the ilium and behind the pubis.

Pubis

- ▶ The pubis bone forms the most anterior part of the hip bone.
- ▶ The pubic bones are joined at the symphysis pubis by a fibrocartilaginous disc that completes the ring of the pelvis, absorbs shock and allows for movement.



The ilium, ischium and pubis, three island of bones which fuse together to form the hemi pelvis or hip bone.

BONY LANDMARKS OF THE PELVIS

Anterior Superior Iliac Spine (ASIS)

- ▶ Anterior superior iliac spine is the most anterior point of the iliac crest. It can be felt as the prominent bumps on the front of the iliac crest.

Anterior Inferior Iliac Spine (AIIS)

- ▶ Anterior inferior iliac spine is a small bump below the ASIS where the rectus femoris (part of the quadriceps muscle) attaches.

Iliac Crest

- ▶ The iliac crest is the top of the hip bone. It is easy to palpate and helps to identify levelness of the pelvis.

Posterior Superior Iliac Spine (PSIS)

- ▶ The posterior superior iliac spine is the most posterior point of the iliac crest. It is the bony protuberance that can be felt by following the iliac crest around to the back.
- ▶ It is roughly level with the second sacral vertebrae and it meets the sacrum to form the uppermost point of the sacroiliac joint.

Ischial Tuberosities (sit bones)

- ▶ The ischial tuberosity, or sitting bones, are the bottom most portion of the ischium. They are the bones you can feel when you are sitting. The bones are thick here because of the pull of the muscles, primarily the hamstrings, that attach to them.

Acetabulum

- ▶ The acetabulum is the socket that mates with the ball of the femoral head to form the acetabulofemoral or hip joint.

Greater Sciatic Notch

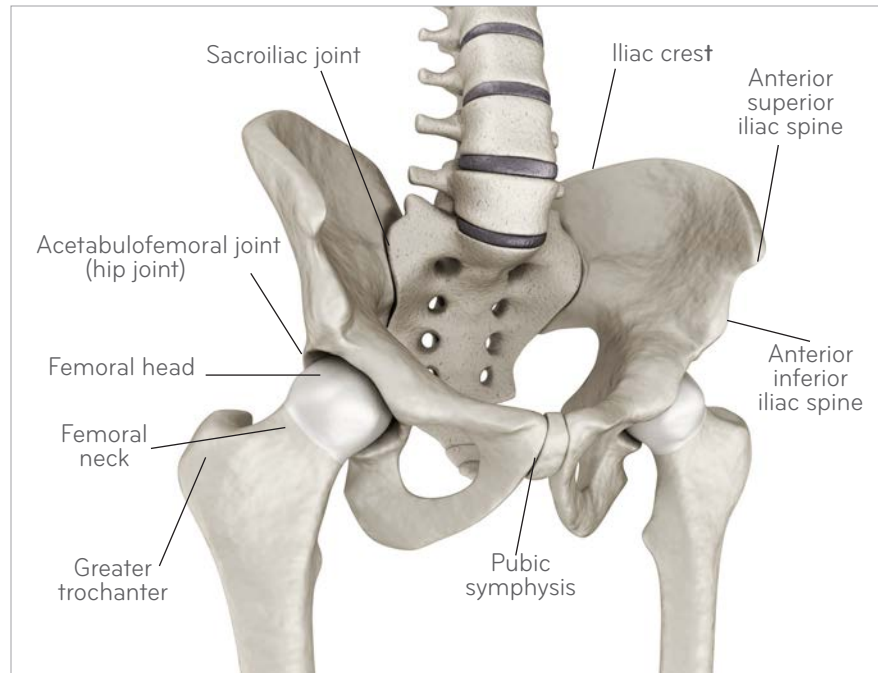
- ▶ The greater sciatic notch is where the sciatic nerve passes from the sacrum to the legs. It is filled in by the piriformis and other posterior hip muscles.

THE JOINTS OF THE PELVIS

JOINTS OF THE PELVIS

Sacroiliac joint (SI)

- ▶ Joint between the sacrum and the ilium of the pelvis.
 - The sacrum is the platform for the spine and is supported on either side by the ilium of the pelvis completing the three dimensional bony ring of the pelvis.
- ▶ Strong ligaments connect the SI joint allowing for minimal movement at the level of the joint.
 - Due to the complexity of SI joint movement and individual variability range of motion may differ widely person to person.
- ▶ The SI joint helps transfer the weight of the spine through the pelvic ring and translates the ground forces up through the spine.



Pelvis, Hip and Spine, Anterior View

Acetabulofemoral joint

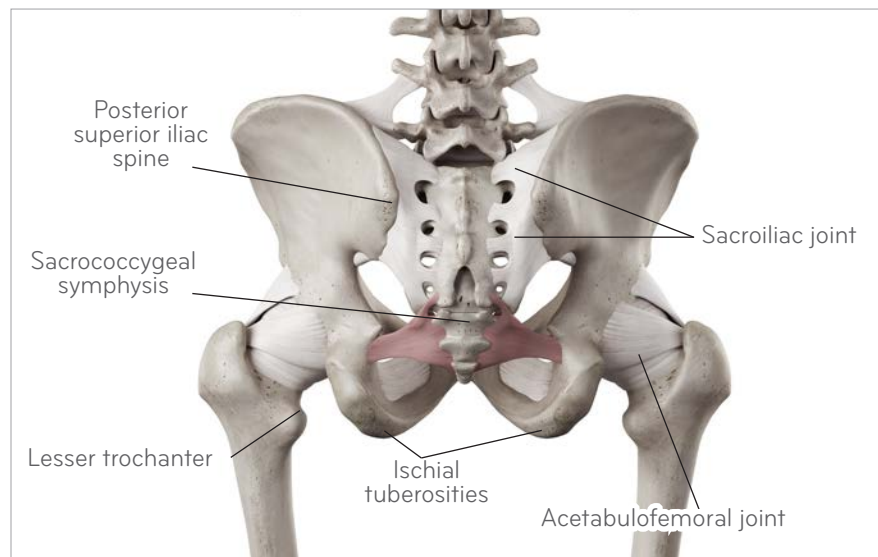
- ▶ The acetabulofemoral joint is the hip joint, where the head of the femur meets the acetabulum of the pelvis.
- ▶ The bones of the hemi pelvis (ilium, ischium and pubis) fuse to form the acetabulum.

Sacrococcygeal symphysis

- ▶ This joint is the articulation of the sacrum and the coccyx and is slightly movable in flexion and extension.

Pubic symphysis

- ▶ The pubic symphysis is a cartilaginous joint that unites the right and left pubic bones.



Pelvis, hip and spine, posterior view

THE PELVIS AND LOWER LIMB

THE LEG BONES

The Leg

The leg bones are strong long bones designed to create power, propulsion and stability for the entire body. The interface between the head of the femur and the deep hollow of the acetabulum supported by the strong ligamentous structures give the hip joint the ability to withstand significant forces while providing large ranges of motion for propulsion in any direction. The modified hinge of the knee joint and the clamp like arrangement of the ankle joint provide the stability and mobility needed to produce power and tolerate repetitive motion under load.

BONES OF THE LEG

Femur

- ▶ The femur is the longest and strongest bone in the body.
- ▶ The head of the femur articulates with the acetabulum of the pelvis.
- ▶ The distal epicondyles of the femur articulate with the tibia to create the knee joint. The medial epicondyle is larger than the lateral epicondyle.
- ▶ The femur runs vertically and at an angle. This angle creates what is commonly called the Q-angle which effects patellar tracking. A Q-angle of greater than 20 degrees places lateral stress on the patella.

Patella

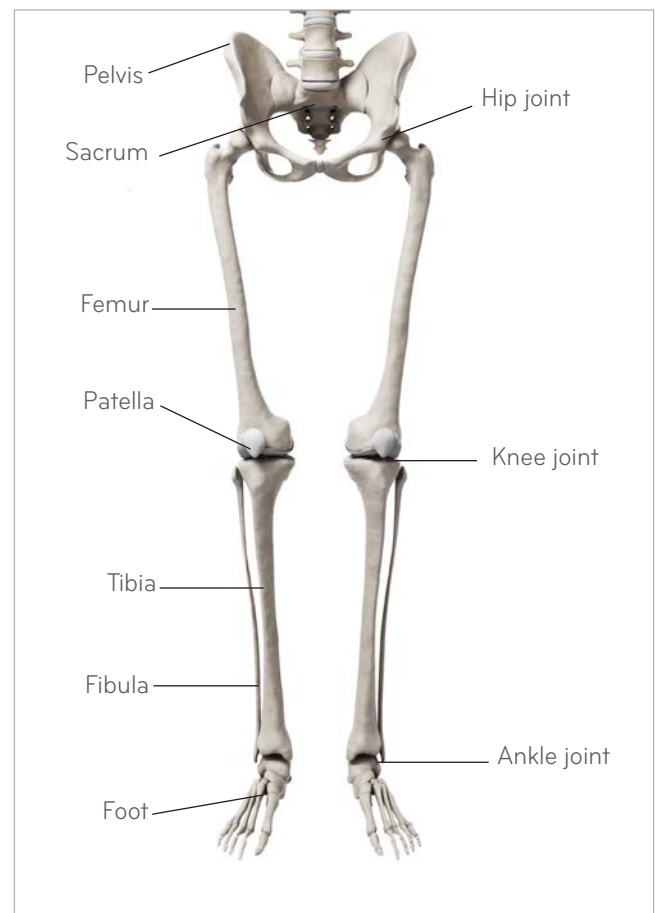
- ▶ The patella is a sesamoid bone which covers and protects the anterior surface of the knee joint.
- ▶ A sesamoid bone is a bone embedded in a tendon. These bones act like pulleys and help tendons transmit force. They protect the soft tissues of the tendons from repetitive rubbing against the bones.
- ▶ The patellar tendon, also known as the quadriceps tendon, attaches quadriceps muscles to the superior patella. The patellar ligament connects the inferior patella with the tibia.
- ▶ The patella plays a role in knee extension.

Tibia

- ▶ The tibia, or shinbone, of the lower leg connects the knee to the ankle.
- ▶ The tibia is the second strongest bone in the body as it is responsible for transferring ground reaction forces from the feet to the femurs.
- ▶ The tibia articulates with the femur, creating the knee joint, the talus, creating the ankle joint, and the fibula in two places creating the superior and inferior tibiofibular joints.

Fibula

- ▶ The fibula, the smaller of the two lower leg bones, is located on the lateral side of the tibia.
- ▶ It articulates with the head of the tibia, below the knee joint (superior tibiofibular joint).
- ▶ Distally, the fibula attaches to the tibia to form the inferior tibiofibular joint. The fibula projects below the level of the joint to create the lateral malleolus of the ankle.



Pelvis and leg bones

THE FOOT BONES

BONES OF THE FOOT

Talus

- ▶ The irregular bone of the talus forms the ankle joint.
- ▶ Articulates with the medial and lateral malleoli of the tibia and fibula.
- ▶ There are no muscles which attach to the talus, and it relies on the position of the calcaneus and the navicular for stability.
- ▶ Transmits weight of the body to the foot.

Calcaneus

- ▶ The calcaneus creates the heel of the foot.
- ▶ Posterior lower leg muscles, including gastrocnemius and the soleus attach to the calcaneus.

Midfoot or tarsal bones

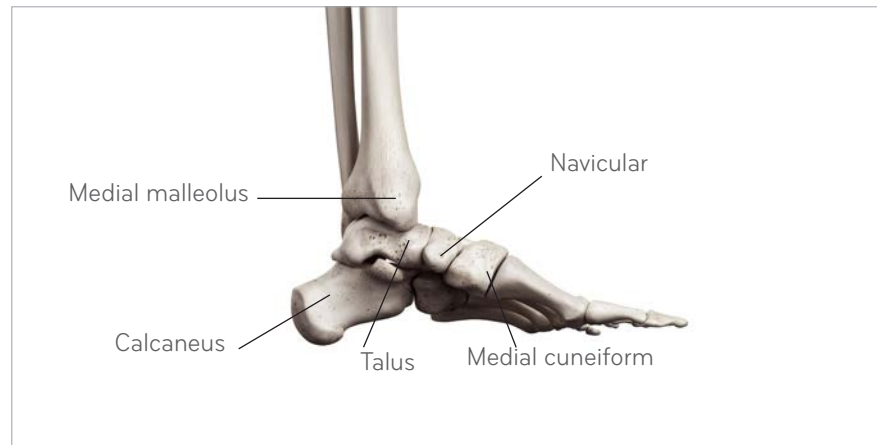
- ▶ The five irregular bones of the mid foot form the arches of the foot. These cobblestone like bones include:
 - Cuboid - anterior to the calcaneus on the lateral side of the foot.
 - Navicular - anterior to the talus on the medial side of the foot.
 - Cuneiform (3) - anterior to the navicular forming the distal portion of the arch of the foot.

Metatarsals

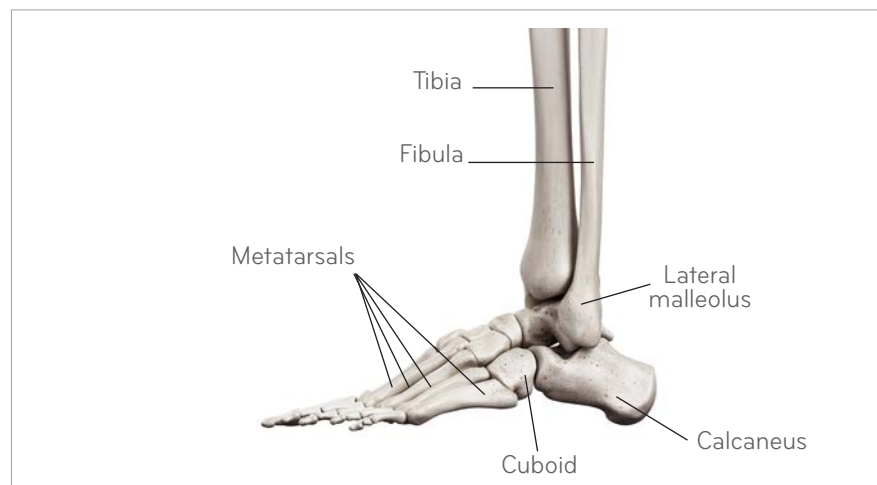
- ▶ The metatarsal bones are five long bones of the foot connecting the midfoot or tarsals and the phalanges.

Phalanges

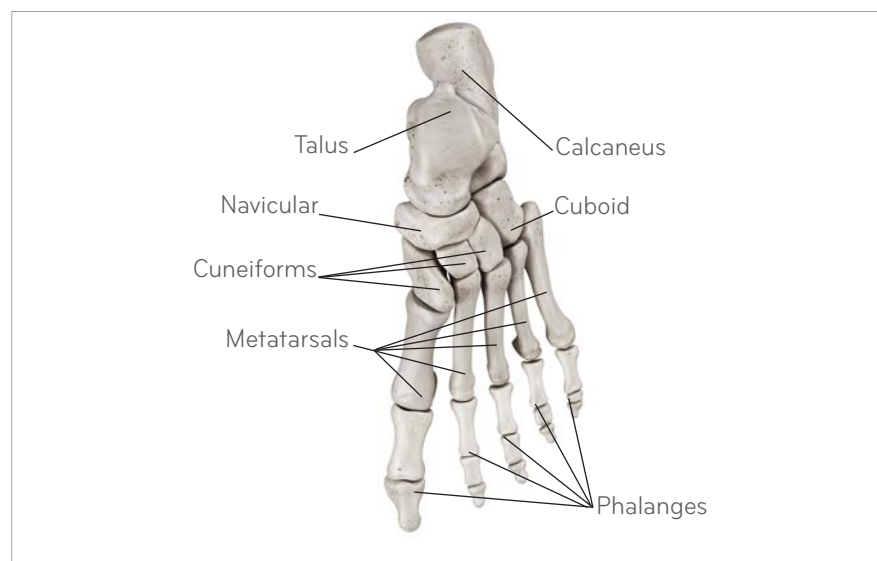
- ▶ There are 14 phalanges on each hand and foot.
- ▶ The big toe has two phalanges, while toes two through five have three on each.



Foot bones, medial view



Foot bones, lateral view



Foot bones, top view

THE PELVIS AND LOWER LIMB

THE HIP, KNEE AND ANKLE JOINTS

Joints of the Leg

The hip, knee and ankle joints are unique in their construction. Each are designed to maximize mobility, stabilize and align lower leg bones, create power, and translate weight from the pelvis to the legs and from the legs up through the pelvis.

HIP JOINT

- ▶ The primary function of the hip joint is to support the weight of the body in standing and in motion and to provide mobility in multiple planes of motion.
 - **Acetabulofemoral joint:** is a synovial ball in socket joint which consists of the head of the femur in the dome of the acetabulum of the pelvis.
- ▶ Movements of the hip joint include:
 - Flexion
 - Extension
 - Lateral or external rotation
 - Medial or internal rotation
 - Abduction
 - Adduction
 - Circumduction
- ▶ The ligaments of the hip, one of which, the iliofemoral ligament, is the strongest ligament in the body, work together to stabilize the hip, allow for great ranges of motion and organize and support balance.

KNEE JOINT

- ▶ There are two articulations that make up the knee joint:
 - **Tibiofemoral joint:** The joint between the femur and the tibia.
 - **Patellofemoral joint:** The joint between the femur and the patella.
- ▶ The knee is a modified hinge joint whose movements include:
 - Flexion
 - Extension
 - Medial rotation of the tibia on the femur
 - Lateral rotation of the tibia on the femur
- ▶ The surface area of the medial condyle of the femur is larger than that of the lateral condyle making the knee also capable of slight medial and lateral rotation.

Screw Home:

The screw home mechanism is a rotation in the knee joint that occurs between the femur and tibia at the last 20° of knee extension and the first 20° of knee flexion.

- ▶ *Open chain: Tibial lateral rotation on the femur.*
- ▶ *Closed chain: Femoral medial rotation on the tibia.*
- ▶ *Upon extension, both cruciate ligaments tighten, "locking" the knee and creating knee stability when standing upright.*

ANKLE JOINT

- ▶ The talus, tibia and fibula bones make up the ankle joint.
- ▶ There are three joints within the ankle. They are the:
 - **Talocrural joint** includes the distal ends of the tibia and the fibula and the top of the talus. Joint actions here are dorsiflexion and plantar flexion.
 - **Subtalar joint** or talocalcaneal joint is where the talus articulates with the calcaneus and other bones of the midfoot. Joint actions here are inversion and eversion.
 - **Inferior tibiofibular joint** is the articulation between the distal ends of the tibia and fibula. This joint has some gliding motion to allow the ankle to plantar and dorsiflex.
- ▶ The medial malleolus of the ankle is a bony extension of the tibia while the lateral malleolus is a bony extension of the fibula.
- ▶ Along with the foot, which must adapt to the walking surface, the ankle plays a critical role in balance and coordination.

- ▶ Movements of the ankle joint include:
 - Plantar flexion
 - Dorsiflexion
 - Inversion
 - Eversion

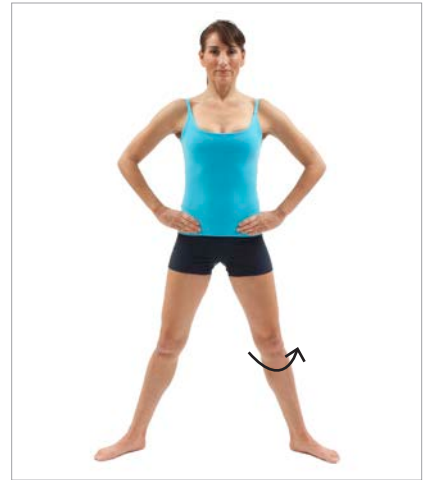
MOVEMENTS OF THE LOWER LIMB



Hip flexion



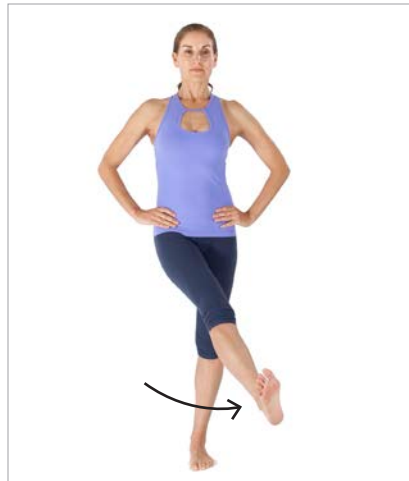
Hip abduction



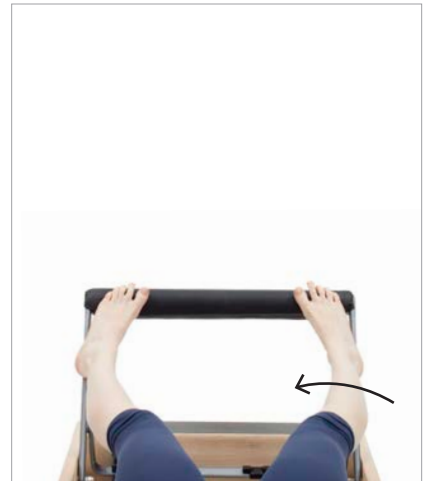
Hip lateral rotation



Hip extension



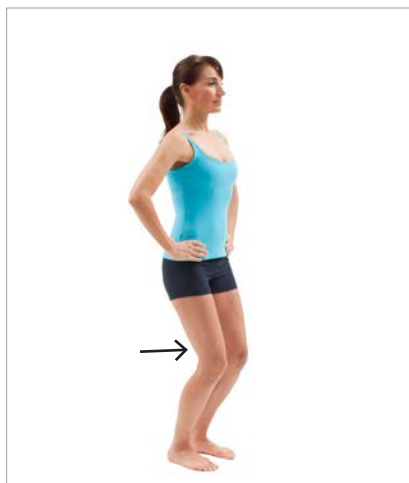
Hip adduction



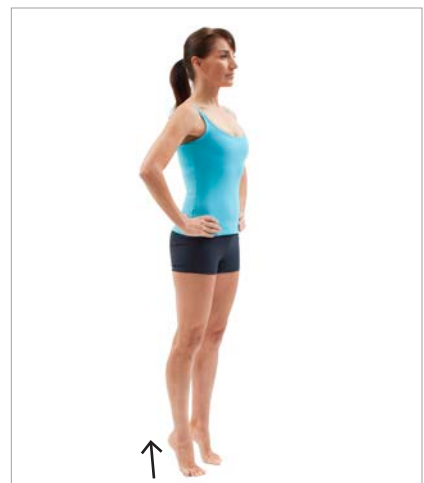
Hip medial rotation



Knee extension



Knee flexion and ankle dorsiflexion



Knee extension and ankle plantarflexion

DEEP POSTERIOR HIP MUSCLES

DEEP HIP ROTATORS

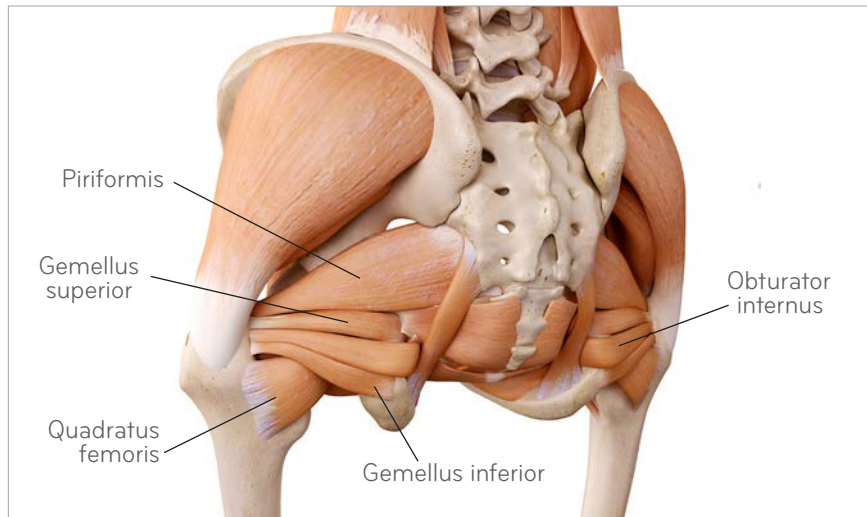
Lateral Rotators of the Hip

These muscles are primarily responsible for:

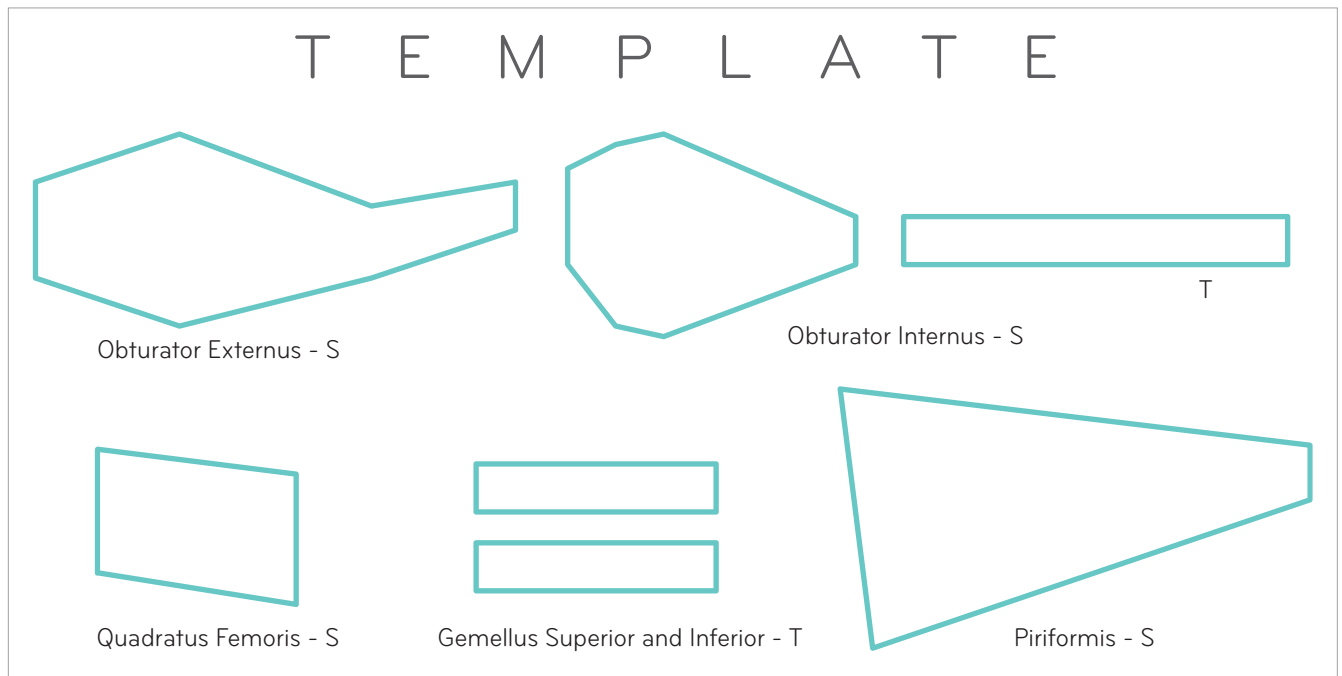
- ▶ Lateral hip rotation, hip extension and adduction or abduction when the pelvis is fixed.
- ▶ Posterior or anterior pelvic tilt and pelvic in flare and/or pelvic up slip when the leg is fixed.
- ▶ Creating stability of the hip joint and holding the femur in the acetabulum.

MUSCLES

- ▶ Obturator Internus
- ▶ Obturator Externus
- ▶ Gemellus Superior and Inferior
- ▶ Quadratus Femoris
- ▶ Piriformis



Deep muscles of the hip



OBTURATOR EXTERNUS AND INTERNUS

OBTURATOR EXTERNUS

The obturator externus connects the femur to the anterior pelvis. It also supports the neck of the femur and stabilizes the femur in the hip socket when walking or running.

Origin

- ▶ Covers pubic and ischial rami and external surface of obturator membrane.

Insertion

- ▶ Inferior to femoral neck into trochanteric fossa of femur.

Action

- ▶ Hip lateral rotation with hip neutral or in flexion.
- ▶ Hip adduction with hip flexed.
- ▶ Supports inferior surface of femoral neck and stabilizes the pelvis.



Obturator Externus, anterior view



Obturator Externus, posterior view

OBTURATOR INTERNUS

The obturator internus lines the interior of the lesser pelvis and its outer membrane acts as an attachment site for part of the levator ani muscle which makes up the posterior pelvic floor. This creates an interesting relationship between lateral rotation of the femur and the pelvic floor.

Origin

- ▶ Fills lesser pelvis covering inferior surface of obturator foramen and internal surface of obturator membrane.

Insertion

- ▶ Medial surface of greater trochanter proximal and superior to trochanteric fossa

Action

- ▶ Hip lateral rotation.
- ▶ Hip abduction with hip neutral, flexed or extended.
- ▶ Stabilizes the hip during walking.
- ▶ Serves as attachment point for Levator Ani muscle.



Obturator Internus, posterior view

DEEP POSTERIOR HIP MUSCLES

GEMELLUS SUPERIOR AND INFERIOR AND QUADRATUS FEMORIS

The gemelli which means twins act as reinforcements for the obturator internus. They run along either side of the tendon but do not connect to the inside of the pelvis.

GEMELLUS SUPERIOR

Origin

- ▶ Lateral surface of ischial spine. Above obturator internus tendon.

Insertion

- ▶ With tendon of obturator internus into medial surface of greater trochanter.

Action

- ▶ Stabilizes the hip during walking.
- ▶ Hip lateral rotation with the hip neutral or extended.
- ▶ Hip abduction with the hip neutral, flexed or extended.

GEMELLUS INFERIOR

Origin

- ▶ Lateral, proximal part of ischial tuberosity. Below obturator internus tendon.

Insertion

- ▶ With tendon of obturator internus into medial surface of greater trochanter.

Action

- ▶ Hip lateral rotation.
- ▶ Hip abduction with hip neutral, flexed or extended.
- ▶ Stabilizes the hip during walking.



Gemellus Superior and Inferior, posterior view

QUADRATUS FEMORIS

The quadratus femoris (square muscle of the femur) works very close to the hip joint to create stability of the femur in the acetabulum.

Origin

- ▶ Proximal, lateral border of ischial tuberosity. Superior to attachment of hamstrings.

Insertion

- ▶ Intertrochanteric crest between greater and lesser trochanters.

Action

- ▶ Stabilizes the femoral head in the acetabulum.
- ▶ Hip lateral rotation and adduction.

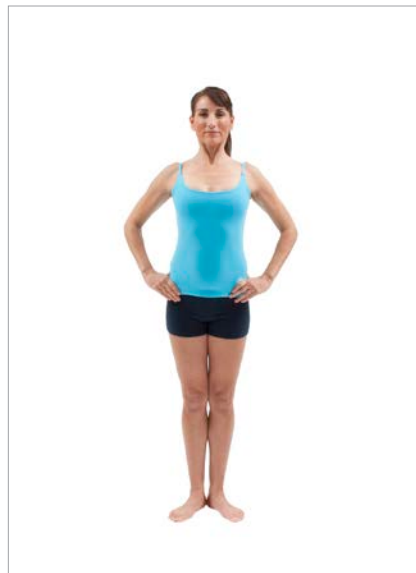


Quadratus Femoris, posterior view

DEEP POSTERIOR HIP MUSCLES

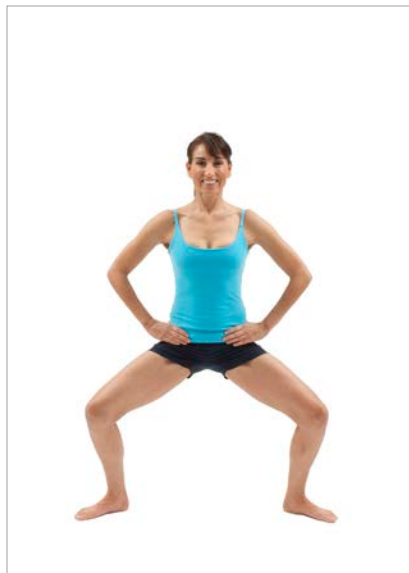
MUSCLES IN ACTION

MUSCLE	Lateral rotation	Medial rotation	Adduction	Abduction	Extension	Stabilizes femur and pelvis
Quadratus femoris	X		X			X
Obturator externus	X		X			X
Obturator internus	X			X		X
Gemellus inferior and superior	X			X		X
Piriformis	X	X (Above 60° of flexion)		X	X	X



Lateral rotation and adduction

- ▶ Quadratus femoris
- ▶ Obturator externus
- ▶ Obturator internus
- ▶ Gemellus inferior and superior



Lateral rotation and abduction with hip flexion

- ▶ Obturator internus
- ▶ Gemellus inferior and superior
- ▶ Piriformis



Lateral rotation and abduction with hip extension

- ▶ Obturator internus
- ▶ Gemellus inferior and superior
- ▶ Piriformis

DEEP ANTERIOR HIP MUSCLES

ILIACUS, PSOAS MAJOR AND MINOR

Psoas Major, Psoas Minor and Iliacus

These three muscles create internal support for the legs, pelvis and spine.

- ▶ The psoas major and iliacus are responsible for hip flexion, adduction and lateral rotation at the hip joint. They are sometimes called the iliopsoas.
- ▶ The psoas major connects the spine, pelvis and legs and creates lumbar extension, flexion, lateral flexion or rotation depending on the position of the body.
- ▶ The psoas minor connects the spine to the top of the pubic ramus and creates a posterior pelvic tilt.

MUSCLES

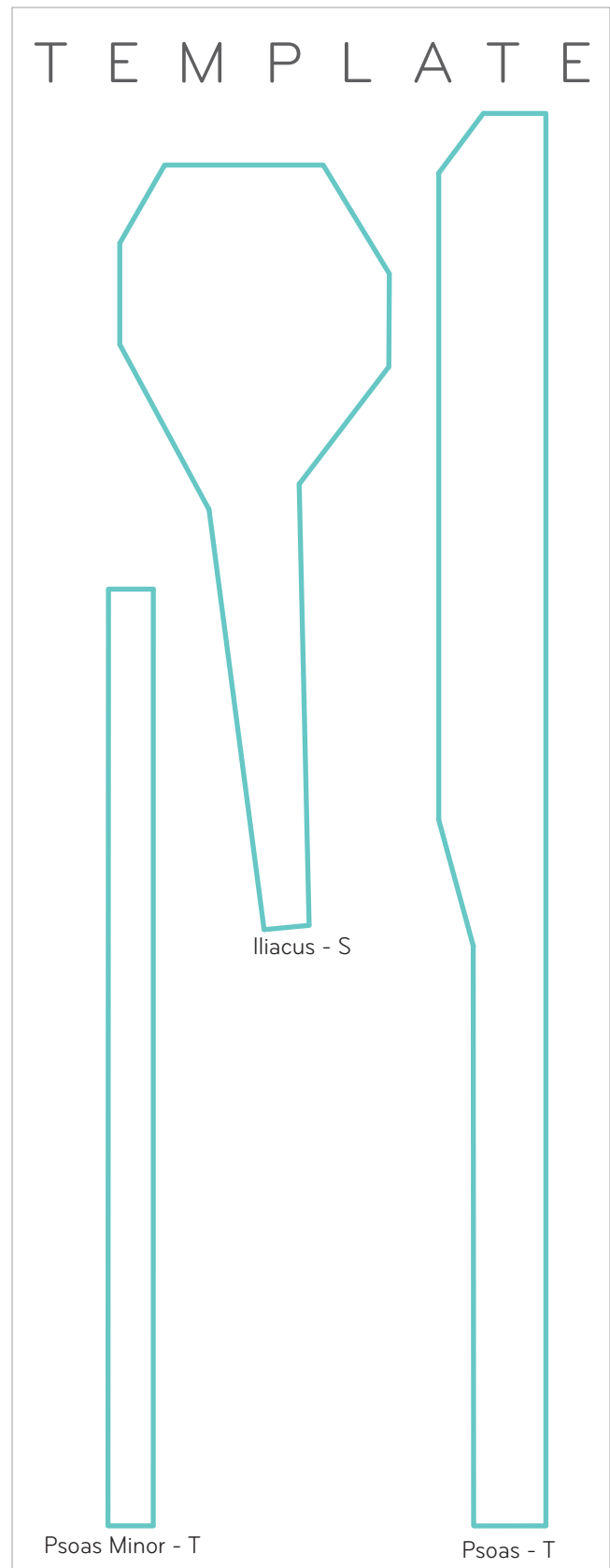
- ▶ Iliacus
- ▶ Psoas Major
- ▶ Psoas Minor



Psoas major



Iliacus



DEEP ANTERIOR HIP MUSCLES

ILIACUS AND PSOAS MAJOR

ILIACUS

The iliacus is a deep hip flexor tying the pelvis to the femur from the inside of the body.

Origin

- ▶ Covers the inside of the ilium. Attaches on superior two thirds of iliac fossa, iliolumbar and ventral sacroiliac ligaments.

Insertion

- ▶ Lesser trochanter along with the psoas major.

Action

- ▶ Fixed pelvis – Hip flexion, adduction and lateral rotation.
- ▶ Fixed leg –Anterior pelvic tilt.

PSOAS MAJOR

Psoas major is a complex muscle covering multiple joints. It connects the torso to the legs and plays a role in posture and stability of the lumbar spine and hips.

Origin

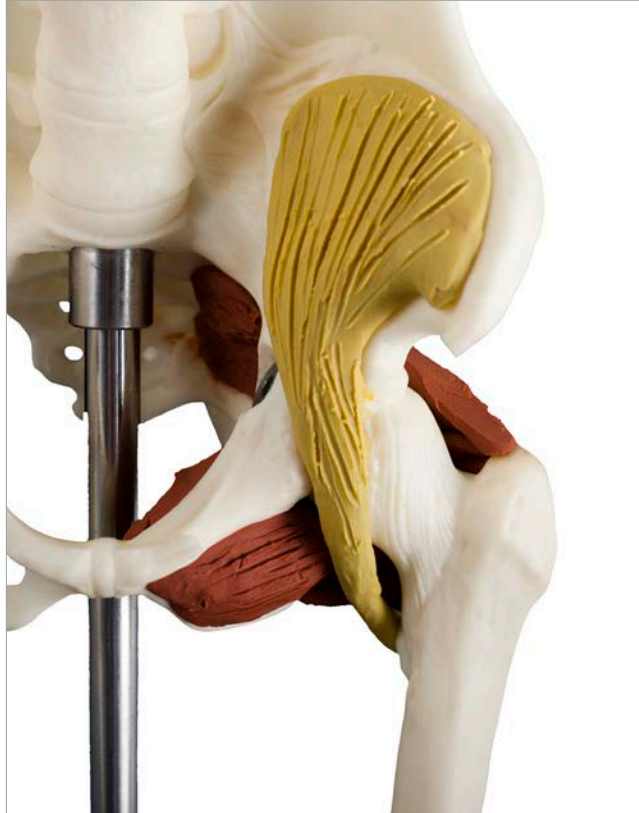
- ▶ Bodies, transverse processes and intervertebral discs of T12 to L4 vertebra.

Insertion

- ▶ Attaches to lesser trochanter via a common tendon with iliacus.

Action

- ▶ Fixed pelvis - Hip flexion, adduction and lateral rotation.
- ▶ Fixed leg - Anterior pelvic tilt, increasing lumbar lordosis (anterior translation of the lumbar vertebrae) and lateral flexion of the torso.



Iliacus, anterior view



Psoas Major, anterior view

PSOAS MINOR

PSOAS MINOR

Psoas minor is a small muscle connecting the thoracolumbar junction to the front of the pelvis. It is missing in 50 - 60% of the population.

Origin

- ▶ Lateral side of bodies of T12 and L1 vertebrae

Insertion

- ▶ Superior pubic ramus, medial to iliopsoas tendon

Action

- ▶ Posterior pelvic tilt, anterior translation of rib cage

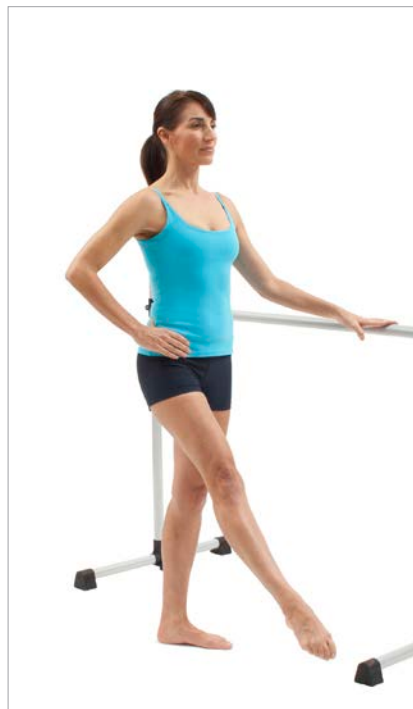


Psoas Minor, anterior view

DEEP ANTERIOR HIP MUSCLES

MUSCLES IN ACTION

MUSCLE	FIXED PELVIS, ACTIONS OF THE HIP JOINT			FIXED LEG, ACTIONS OF THE SPINE AND PELVIS	
	Flexion	Adduction	Lateral Rotation	Anterior Pelvic Tilt/Lumbar Lordosis	Posterior Pelvic Tilt
Iliacus	X	X	X	X	
Psoas major	X	X	X	X	
Psoas minor					X



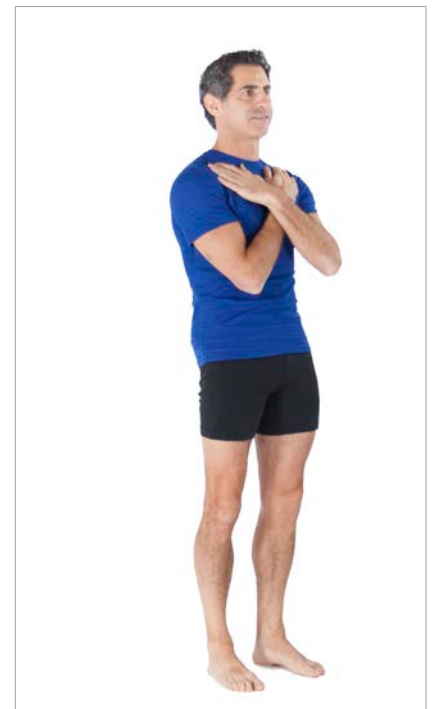
Hip flexion, adduction and lateral rotation

- ▶ Iliacus
- ▶ Psoas major



Anterior pelvic tilt and increased lumbar lordosis

- ▶ Iliacus - Anterior pelvic tilt
- ▶ Psoas major - Increased lumbar lordosis



Posterior pelvic tilt

- ▶ Psoas minor

BUILD THE KNEE JOINT

KNEE JOINT, LIGAMENTS AND MENISCI

The Knee Joint

Building the knee joint illustrates how ligaments limit motion and menisci (thickened cartilage) act to protect the joints.

Build the top of the tibia

Create a shape like a mushroom with two indentations on top to indicate the tibial condyles.

Build the end of the femur

Create two rounded wheels on the end of the femoral shaft to represent the femoral condyles. Make them the right size to match the tibial condyles.



Left knee joint, posterior view



Lateral meniscus, left knee



Left knee joint, anterolateral view



Left knee joint, anterior view



Medial meniscus, left knee

Add the menisci

Follow the illustrations to create two "C" shaped cushions that line the medial and lateral tibial condyles and create integrity of the joint.

Add the ligaments

▶ Anterior cruciate ligament - runs from posterior on the femur to anterior on the tibia to keep the tibia from sliding forward.

▶ Posterior cruciate ligament - runs from posterior on the tibia to anterior on the femur to keep the tibia from sliding backwards.

▶ Medial collateral (tibial collateral) ligament - connects the femur to the tibia on the medial side to stabilize the medial knee joint.

▶ Lateral collateral (fibular collateral) ligament - connects the femur to the tibia on the lateral side to stabilize the lateral knee joint.

ANTERIOR HIP AND THIGH MUSCLES

QUADRICEPS FEMORIS AND SARTORIUS

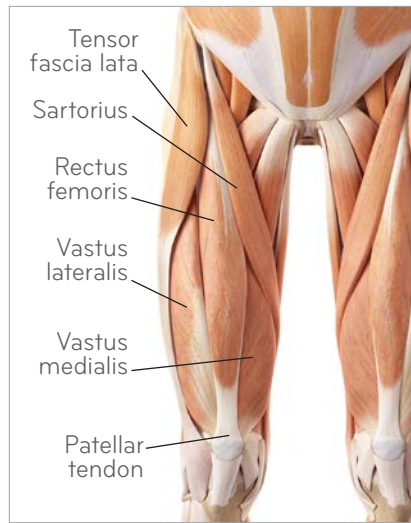
Anterior Thigh Muscles

The quadriceps femoris forms the bulk of the anterior thigh and is the primary knee extensor. Quadriceps means four heads. It is composed of four muscles who merge into one tendon. The sartorius and one part of the quadriceps - the rectus femoris - assist with hip flexion.

► Quadriceps "heads"

- Vastus intermedius, medialis and lateralis - cross the knee joint
- Rectus Femoris - crosses hip and knee

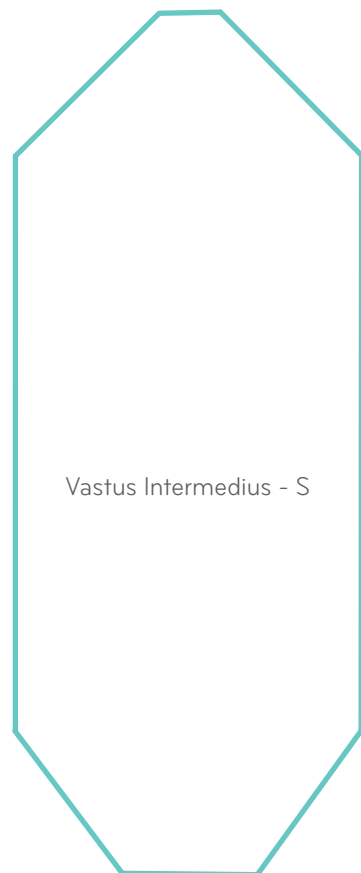
► Sartorius



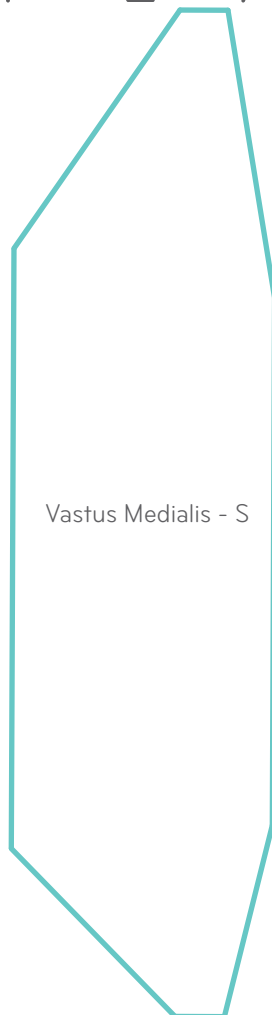
Anterior leg muscles



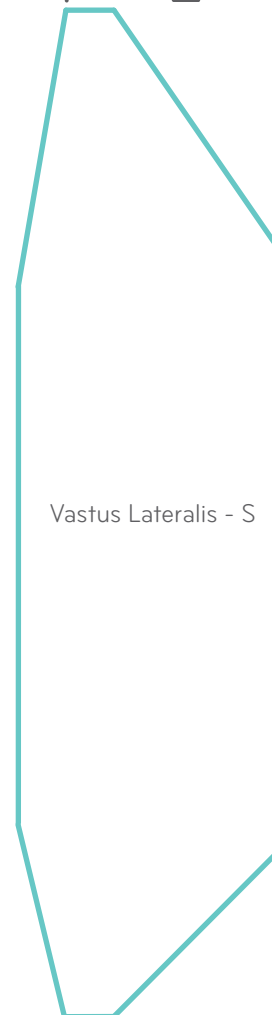
T E M P L A T E



Vastus Intermedius - S



Vastus Medialis - S



Vastus Lateralis - S

Rectus Femoris - S

Sartorius - S

VASTUS INTERMEDIUS

VASTUS INTERMEDIUS

The vastus intermedius forms the bulk of the anterior thigh and contains a long tendon to which all of the quadriceps attach.

Origin

- ▶ Anterior and lateral surfaces of proximal two thirds of shaft of femur.
- ▶ The muscle wraps around the femur to attach to distal half of medial and lateral edges of the linea aspera and lateral intermuscular septum.

Insertion

- ▶ Superior border of patella through patellar tendon and patellar ligament to tibial tuberosity.

Action

- ▶ Knee extension.



Vastus Intermedius, anterior view



Vastus Intermedius, posterior view

ANTERIOR HIP AND THIGH MUSCLES

VASTUS MEDIALIS AND VASTUS LATERALIS

VASTUS MEDIALIS

The vastus medialis lies on top of the medial side of the vastus intermedius and balances the vastus lateralis by pulling the patella towards the medial side of the thigh.

Origin

- ▶ Covers the medial side of the vastus intermedius by attaching in the back to the distal half of intertrochanteric line, medial lip of the linea aspera, proximal part of the medial supracondylar line, tendons of Adductor longus and Adductor magnus and medial intermuscular septum.
- ▶ In the front of the thigh it attaches to the central tendon of the quadriceps.

Insertion

- ▶ Superior medial border of patella through patellar tendon and patellar ligament to tibial tuberosity.

Action

- ▶ Knee extension and tibial medial rotation.
- ▶ Tracks the patella medially.

VASTUS LATERALIS

The vastus lateralis covers the lateral section of the vastus intermedius and along with the vastus medialis, tracks the patella as it glides in the trochlea of the femur.

Origin

- ▶ Covers the lateral side of the vastus intermedius by attaching to the proximal part of the intertrochanteric line, anterior and inferior borders of greater trochanter, lateral lip of gluteal tuberosity, proximal half of lateral lip of linea aspera and lateral intermuscular septum.

Insertion

- ▶ Superior lateral border of patella through patellar tendon and patellar ligament to tibial tuberosity.

Action

- ▶ Knee extension and tibial lateral rotation.
- ▶ Tracks the patella laterally.



Vastus Medialis and Lateralis, anterior view



Vastus Medialis and Lateralis, posterior view

RECTUS FEMORIS

RECTUS FEMORIS

The rectus femoris is the one quadriceps muscle that crosses both the knee and the hip. Its fibers run up toward the hip providing power for hip flexion as well as knee extension.

Origin

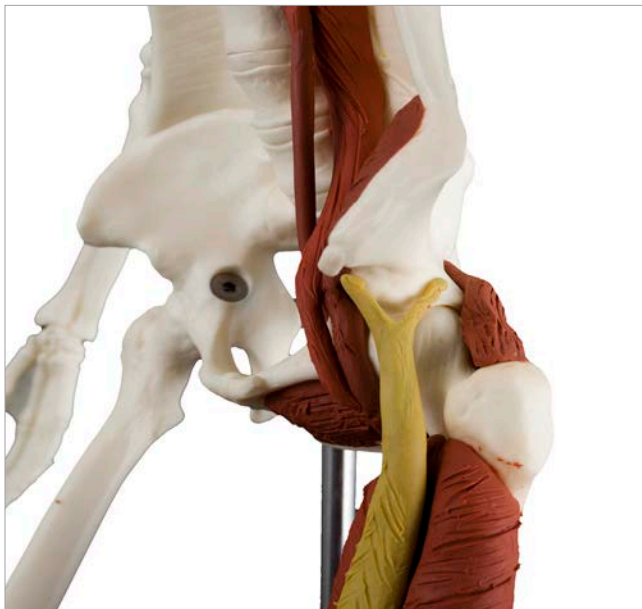
- ▶ Straight head – From the anterior inferior iliac spine.
- ▶ Reflected head – From superior lip of acetabulum.

Insertion

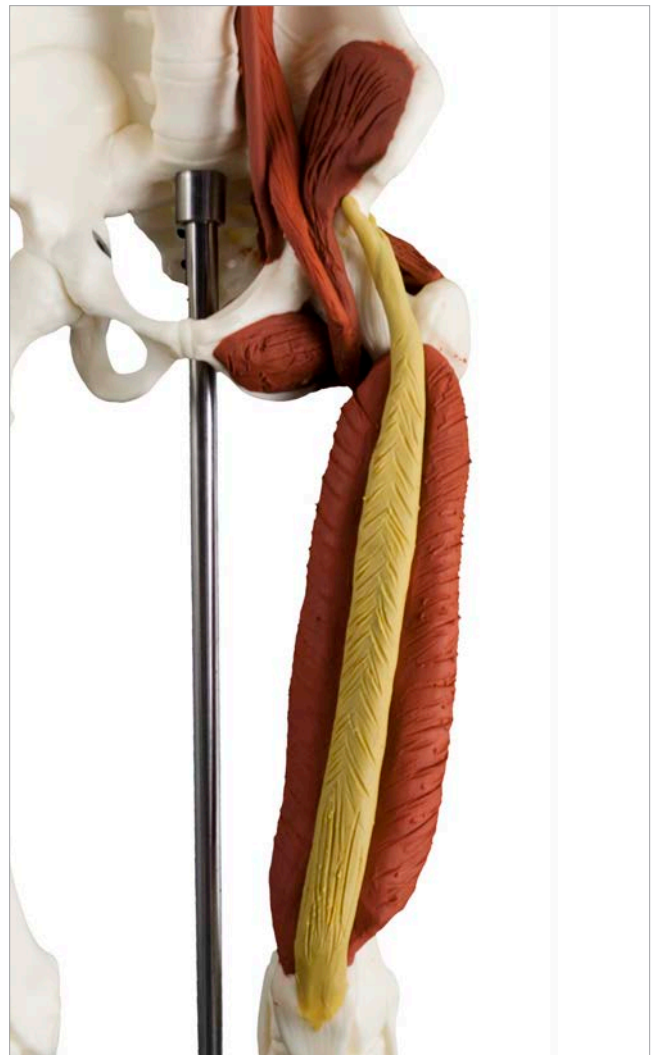
- ▶ Proximal border of the patella through the patellar tendon to the tibial tuberosity.

Action

- ▶ Fixed pelvis - Hip flexion and knee extension
- ▶ Fixed leg - Anterior pelvic tilt



Rectus Femoris, showing both heads



Rectus Femoris, anterior view

ANTERIOR HIP AND THIGH MUSCLES

SARTORIUS

SARTORIUS

This is the longest muscle in the body and is named after a tailor because they used to sit cross legged. It is the first of three leg muscles to attach to the pes anserinus or goose's foot on the tibia.

Origin

- ▶ Anterior superior iliac spine (ASIS) and superior half of notch just distal to spine.

Insertion

- ▶ Proximal part of medial surface of tibia near the anterior border.
- ▶ Pes Anserinus "goose foot" is where the Sartorius, Gracilis and Semitendinosus converge to attach along the medial surface of the tibia.

Action

- ▶ Fixed pelvis - Hip flexion, lateral rotation, abduction and knee flexion.
- ▶ Medial tibial rotation with knee flexed.
- ▶ Fixed leg - Anterior pelvic tilt



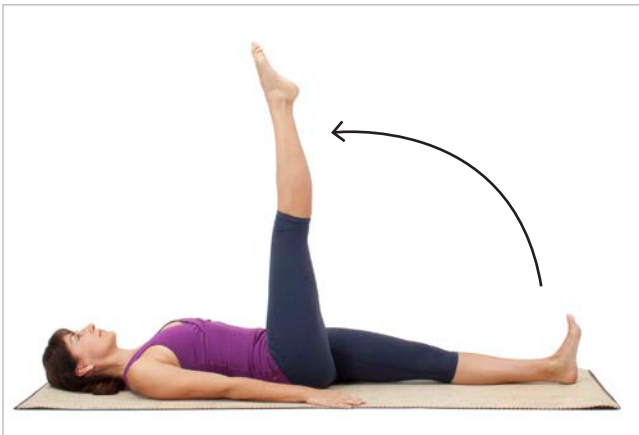
Sartorius, anterior view



Sartorius, medial view

MUSCLES IN ACTION

MUSCLE	Hip Flexion	Hip Lateral Rotation	Hip Abduction	Knee Extension	Knee Flexion
Vastus intermedius, medialis and lateralis				X	
Rectus femoris	X			X	
Sartorius	X	X	X		X (With medial tibial rotation)



Hip flexion and knee extension

- ▶ Quadriceps femoris
 - Rectus femoris
 - Vastus intermedius, medialis and lateralis (knee extension only)



Hip flexion, lateral rotation, abduction and knee flexion

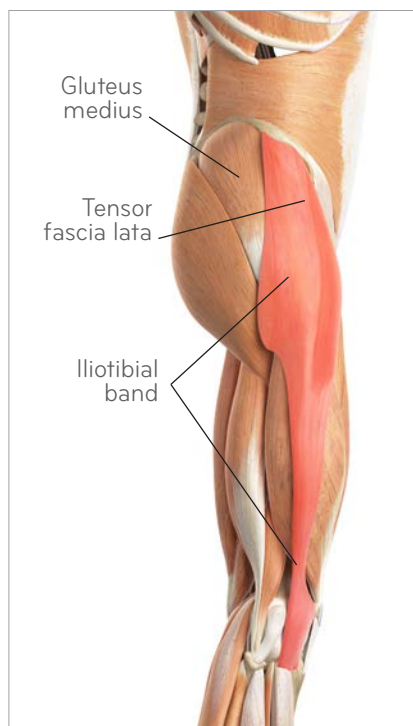
- ▶ Sartorius

LATERAL HIP AND THIGH MUSCLES

GLUTEUS MINIMUS, GLUTEUS MEDIUS, ILIOTIBIAL BAND AND TENSOR FASCIA LATA

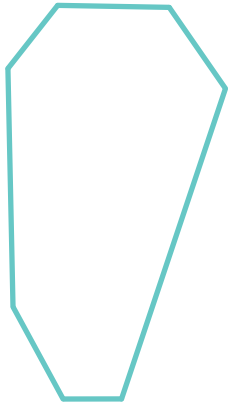
The following muscles are muscles of the lateral thigh and are primarily responsible for abduction, hip extension, hip flexion and medial and lateral hip rotation when the pelvis is fixed. When the legs are fixed, these muscles can tilt the pelvis posterior or anteriorly, create pelvic down slip or pelvic in flare and or out flare.

- ▶ Gluteus Minimus
- ▶ Gluteus Medius
- ▶ Iliotibial Band
- ▶ Tensor Fascia Lata

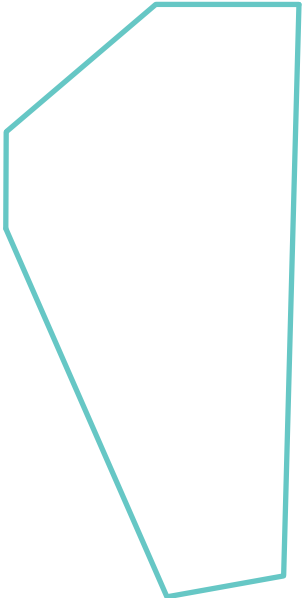


Hip abductors


T E M P L A T E




Gluteus Minimus - TS



Gluteus Medius - TS



Tensor Fascia Lata - TS



Iliotibial Band - T

GLUTEUS MINIMUS AND GLUTEUS MEDIUS

GLUTEUS MINIMUS

Gluteus minimus is the deepest abductor lying underneath the medius and maximus.

Origin

- ▶ External surface of ilium between anterior and inferior gluteal lines and margin of greater sciatic notch.

Insertion

- ▶ Anterior border of greater trochanter of femur and hip joint capsule.

Action

- ▶ Fixed pelvis – Hip abduction, flexion and medial rotation.
- ▶ Fixed leg – Anterior pelvic tilt and pelvic down slip.



Gluteus Minimus, side view



Gluteus Minimus, posterior view

GLUTEUS MEDIUS

Gluteus medius covers a large portion of the outer ilium and has fibers running in multiple directions. Hip abduction in any plane is performed by the gluteus medius.

Origin

- ▶ External surface of ilium between iliac crest and posterior gluteal line. Superior and superficial to gluteus minimus.

Insertion

- ▶ Lateral surface of greater trochanter of femur.

Action

Anterior fibers

- ▶ Fixed pelvis - Hip abduction, flexion and medial rotation.
- ▶ Fixed leg - Anterior pelvic tilt and pelvic down slip

Posterior fibers

- ▶ Fixed pelvis - Hip abduction, extension and lateral rotation.
- ▶ Fixed leg - Posterior pelvic tilt and pelvic down slip



Gluteus Medius, side view

LATERAL HIP AND THIGH MUSCLES

ILIOTIBIAL BAND AND TENSOR FASCIA LATA

ILIOTIBIAL BAND (NOT A MUSCLE!)

- ▶ The iliotibial band is a thick band of connective tissue originating on the lateral iliac crest and inserting onto the lateral side of the tibia.
- ▶ It is continuous with the thoracolumbar fascia, connects to the lateral intermuscular septum between the quadriceps and the hamstrings and merges with the fascia around the knee.
- ▶ It acts like a large tendon for the tensor fascia lata and the gluteus maximus and as a stabilizer of the lateral hip.
- ▶ Build it as a flattened tube from the high point of the iliac crest to the lateral side of the tibia (not the fibula).



Iliotibial Band (in green)

TENSOR FASCIA LATA

Tensor fasciae latae (tensor of the fascia of the leg) runs anterior to the gluteus minimus and attaches to the iliotibial band rather than directly to the femur bone.

Origin

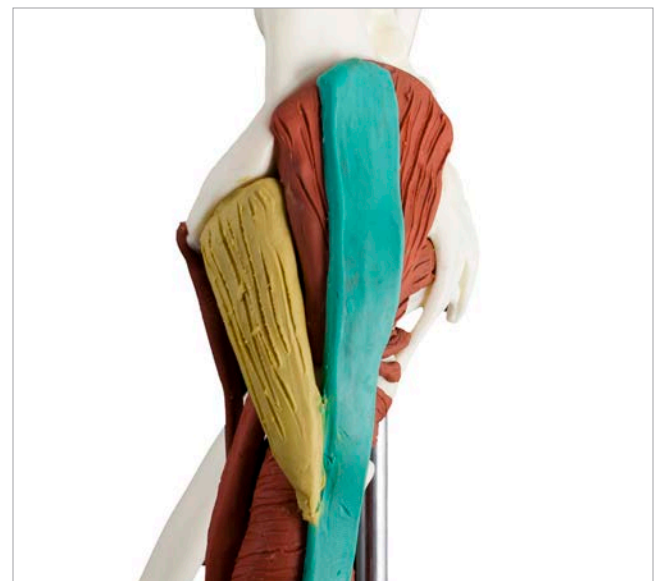
- ▶ Anterior part of external lip of iliac crest, outer surface of ASIS and proximal part of iliotibial band.

Insertion

- ▶ Into iliotibial band at junction of proximal and middle third of thigh.

Action

- ▶ Fixed pelvis - Hip abduction, flexion and medial rotation.
- ▶ Fixed leg - Anterior pelvic tilt and pelvic down slip.
- ▶ Stabilizes lateral hip and knee.



Tensor Fascia Lata (in yellow)

MUSCLES IN ACTION

MUSCLE	Hip Abduction	Hip Flexion	Hip Extension	Hip Medial Rotation	Hip Lateral Rotation
Gluteus minimus	X	X		X	
Gluteus medius (anterior fibers)	X	X		X	
Gluteus medius (posterior fibers)	X		X		X
Tensor fascia lata	X	X		X	



Hip abduction, flexion and medial rotation

- ▶ Gluteus minimus
- ▶ Gluteus medius (anterior fibers)
- ▶ Tensor fascia lata



Hip abduction, extension and lateral rotation

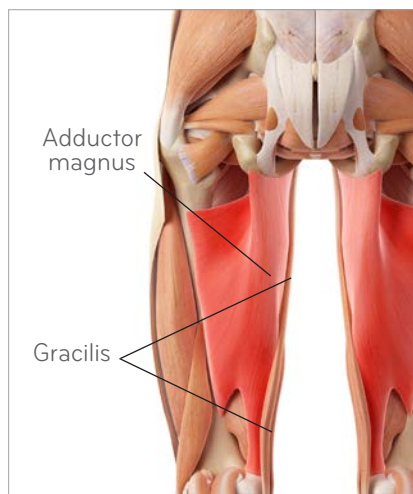
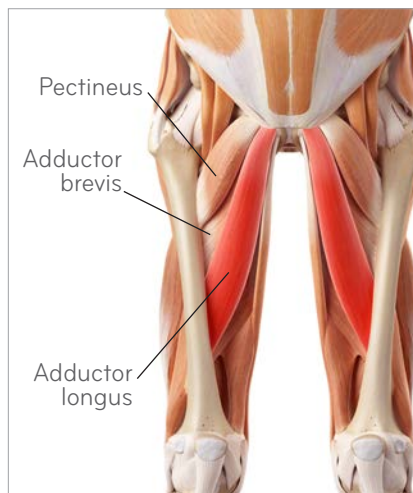
- ▶ Gluteus medius (posterior fibers)

MEDIAL HIP AND THIGH MUSCLES

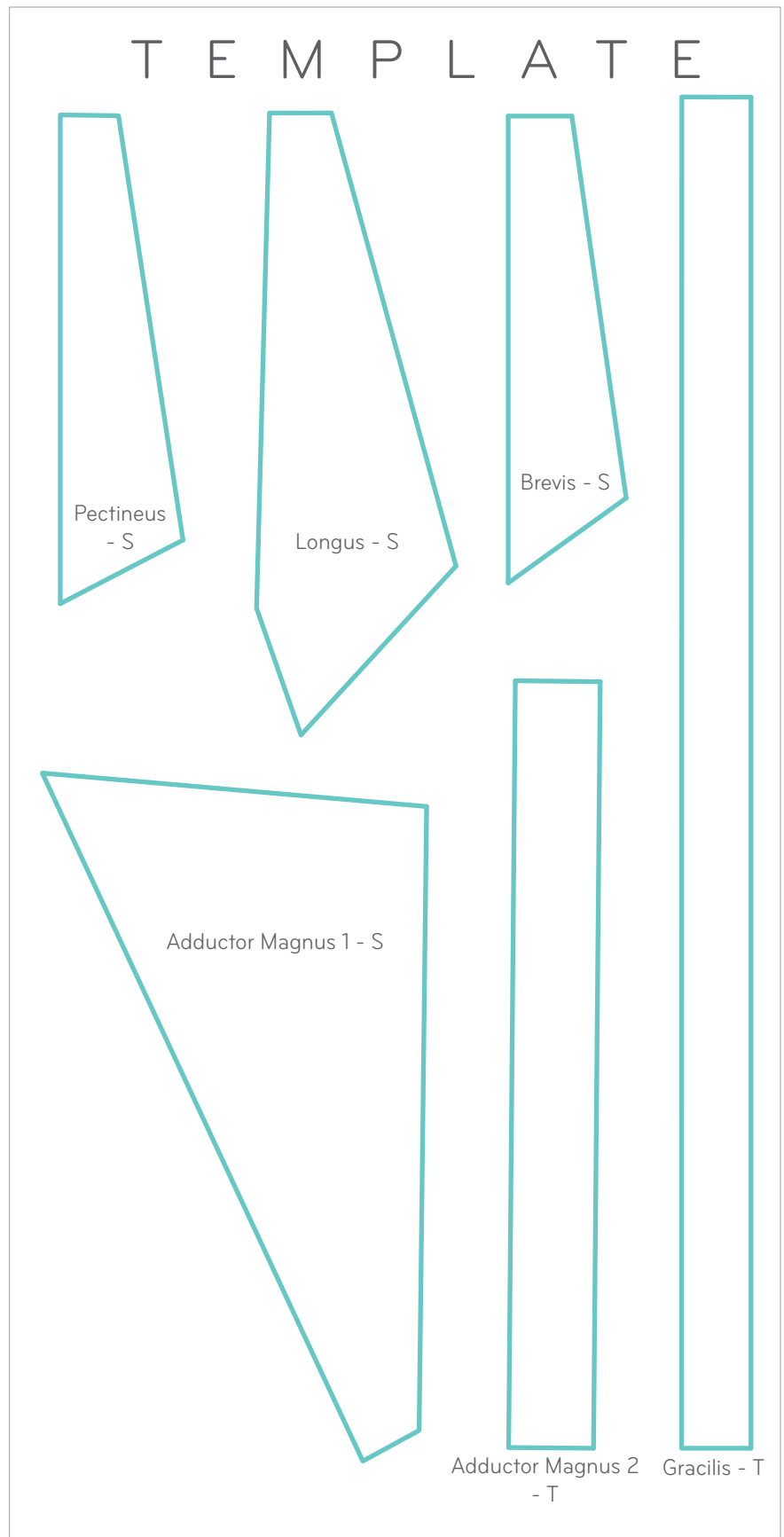
PECTINEUS, ADDUCTOR LONGUS, ADDUCTOR BREVIS, ADDUCTOR MAGNUS, GRACILIS

The adductors of the hip are primarily responsible for hip adduction. In addition, when the pelvis is fixed, these muscles may assist with hip flexion or extension and medial or lateral rotation of the hip joint. When the leg is fixed, these muscles may participate as the pelvis anteriorly or posteriorly tilts, in pelvic up slips and in flares or out flares.

- ▶ Pectineus
- ▶ Adductor Longus, Adductor Brevis, Adductor Magnus
- ▶ Gracilis



Hip adductors



MEDIAL HIP AND THIGH MUSCLES

ADDUCTOR LONGUS

ADDUCTOR LONGUS

Adductor longus connects the pubic symphysis to the back of the femur. Its tendon can be easily felt where it attaches to the pelvis.

Origin

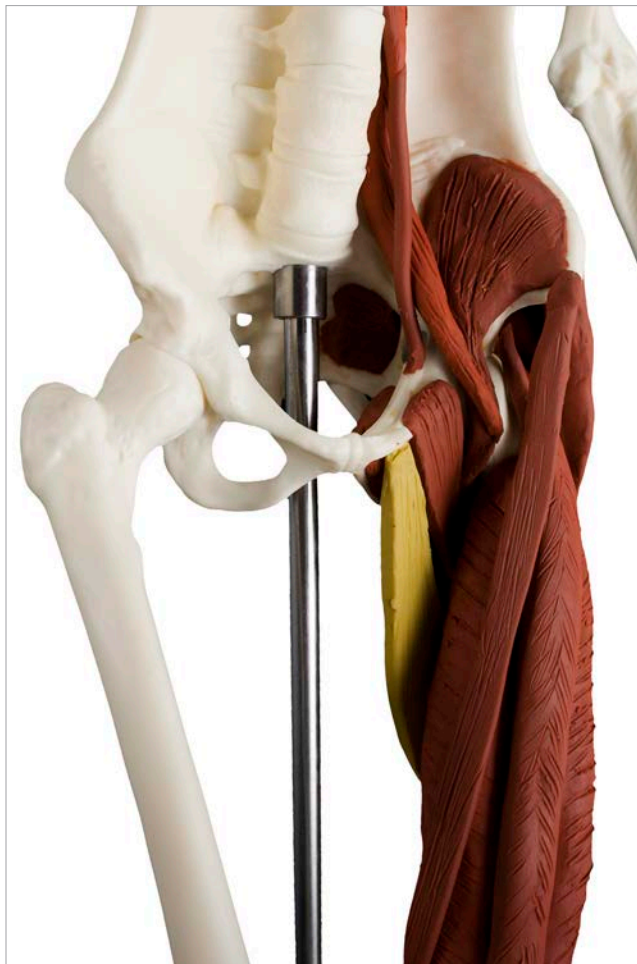
Anterior surface of pubis at junction of pubic crest and pubic symphysis.

Insertion

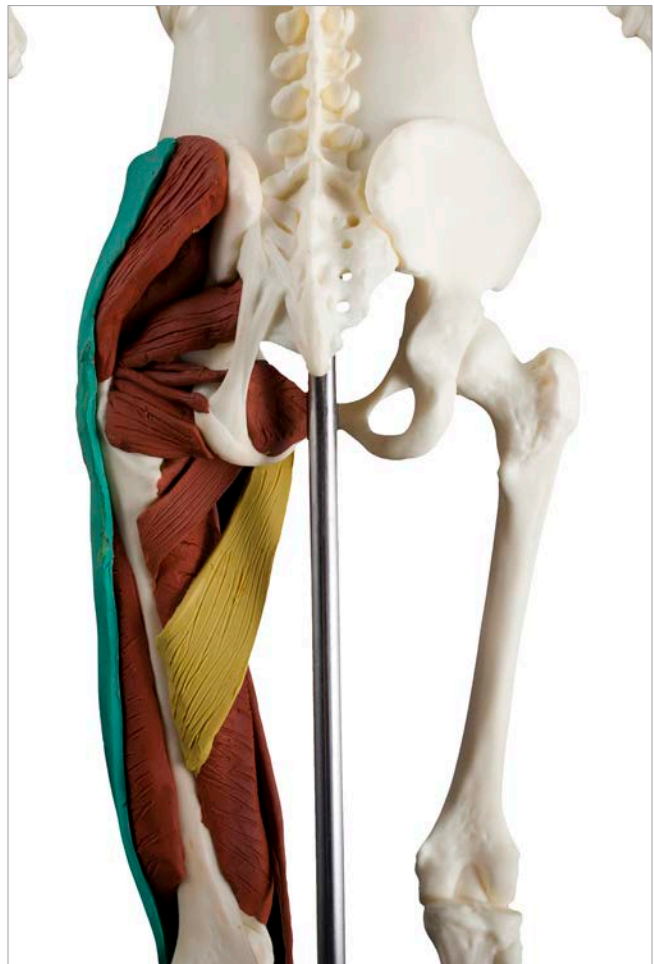
Middle one third of medial lip of linea aspera.

Action

- ▶ Fixed pelvis - Hip adduction and flexion.
- ▶ Fixed leg - Anterior pelvic tilt and pelvic up slip



Adductor Longus, anterior view



Adductor Longus, posterior view

MEDIAL HIP AND THIGH MUSCLES

ADDUCTOR MAGNUS

ADDUCTOR MAGNUS

Adductor magnus is the largest of the adductor muscles and because it attaches to the ischial ramus and ischial tuberosity or sit bone, its actions include hip extension because its posterior fibers run in a similar pattern to the hamstrings.

Origin

Anterior fibers - Inferior pubic ramus and ischial ramus.

Posterior fibers - On the ischial tuberosity medial and anterior to the hamstring attachments for the Biceps femoris, Semimembranosus and Semitendinosus.

NOTE: The photo shows the origin being medial to the anterior fibers. This is incorrect, it should be lateral and posterior to the anterior fibers so place it closer to the ischial tuberosity.

Insertion

Anterior fibers - medial to gluteal tuberosity, middle line of linea aspera, medial supracondylar line.

Posterior fibers - adductor tubercle of medial condyle of femur.

Action

Anterior, superior fibers

- ▶ Fixed pelvis - Hip adduction, flexion and stabilizes the femur in neutral regardless of the position of the hip.
- ▶ Fixed leg - Anterior pelvic tilt and pelvic up slip.

Posterior, inferior fibers

- ▶ Fixed pelvis - Hip adduction, extension and slight flexion depending on the position of the hip and thigh.
- ▶ Fixed leg - Posterior pelvic tilt and pelvic up slip.

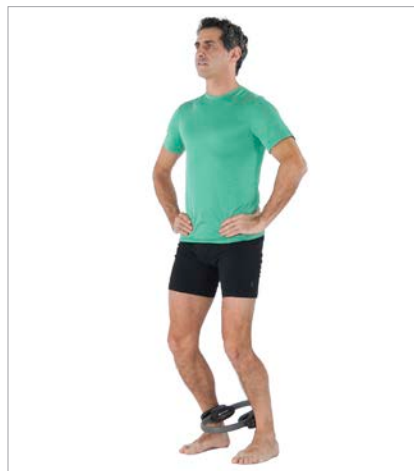


Adductor Magnus, posterior view

MEDIAL HIP AND THIGH MUSCLES

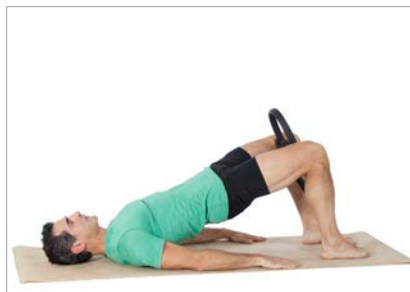
MUSCLES IN ACTION

MUSCLE	FIXED PELVIS			FIXED LEG			KNEE
	Hip Adduction	Hip Flexion	Hip Extension	Anterior Pelvic Tilt	Posterior Pelvic Tilt	Pelvic Upslip	Flexion and medial rotation
Pectineus	X	X		X		X	
Adductor longus	X	X		X		X	
Adductor brevis	X	X		X		X	
Adductor magnus	X	X	X (Posterior fibers)	X	X (Posterior fibers)		
Gracilis	X	X		X		X	X



Hip adduction and flexion

- ▶ Pectineus
- ▶ Adductor longus
- ▶ Adductor brevis
- ▶ Gracilis
- ▶ Adductor magnus (anterior fibers)



Hip adduction and extension with knee flexion

- ▶ Adductor magnus (posterior fibers)
- ▶ Gracilis (knee flexion and adduction)



Hip adduction and flexion with knee flexion

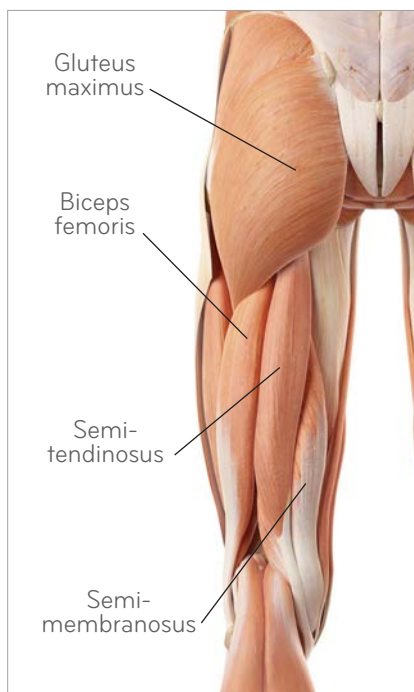
- ▶ Pectineus
- ▶ Adductor longus
- ▶ Adductor brevis
- ▶ Gracilis (knee flexion)
- ▶ Adductor magnus (anterior fibers)

POSTERIOR HIP AND THIGH MUSCLES

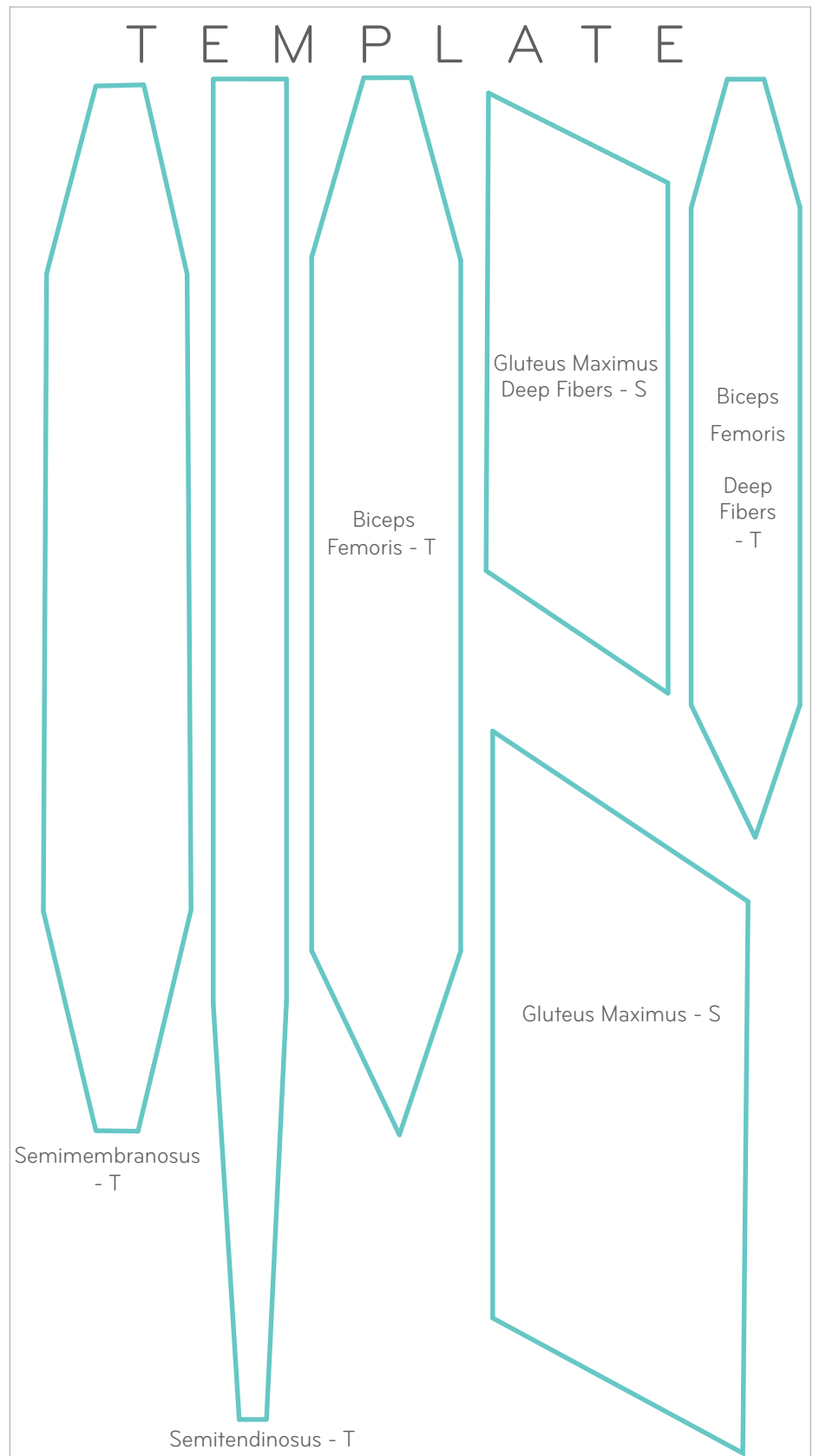
SEMIMEMBRANOSUS, SEMITENDINOSUS, BICEPS FEMORIS, GLUTEUS MAXIMUS

The muscles of the posterior hip and leg are generally referred to as the Hamstrings and Glutes. The Hamstrings consist of three muscles, semimembranosus, semitendinosus and biceps femoris. These muscles are primarily responsible for hip extension and knee flexion when the pelvis is fixed. When the legs are fixed, these muscles will tilt the pelvis posteriorly or create pelvic obliquities. The largest of the gluteal muscles, gluteus maximus, is a powerful hip extensor muscle.

- ▶ Biceps Femoris
- ▶ Semimembranosus
- ▶ Semitendinosus
- ▶ Gluteus Maximus



Posterior Leg Muscles



POSTERIOR HIP AND THIGH MUSCLES

BICEPS FEMORIS

BICEPS FEMORIS

Biceps femoris is the lateral hamstring muscle. It has 2 heads, a short head crossing just the knee and a long head crossing both the hip and the knee.

Origin

Long head – Distal part of sacrotuberous ligament and posterior part of ischial tuberosity.

Short head – Lateral lip of linea aspera, proximal two thirds of supracondylar line and lateral intermuscular septum.

Insertion

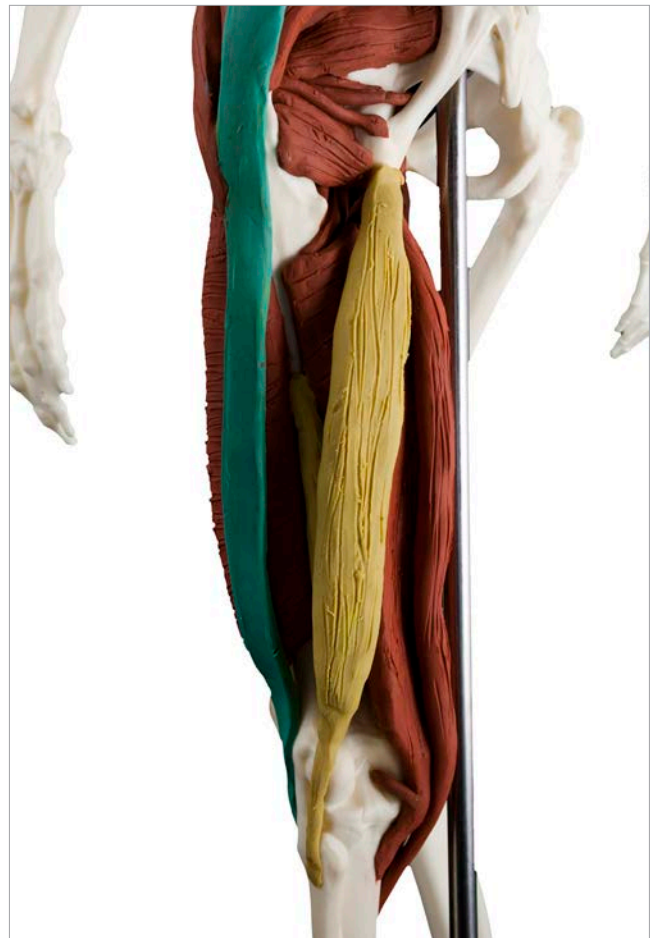
Lateral side of head of fibula, lateral condyle of tibia and deep fascia on lateral side of leg.

Action

- ▶ Knee flexion and tibial lateral rotation.
- ▶ Fixed pelvis - Hip extension, lateral rotation and assists with abduction.
- ▶ Fixed leg - Posterior pelvic tilt.



Biceps Femoris, short head posterior view



Biceps Femoris, long head lateral view to show insertion on fibula

SEMIMEMBRANOSUS AND SEMITENDINOSUS

Semimembranosus and semitendinosus together make up the medial hamstrings. The semimembranosus is deeper and semitendinosus sits on top of it. Both muscles cross the hip and the knee joint to cause hip extension and knee flexion.

SEMIMEMBRANOSUS

Origin

Ischial tuberosity, proximal and lateral to Biceps femoris and Semitendinosus.

Insertion

Posteromedial aspect of medial condyle of tibia, popliteal fossa and medial meniscus.

Action

- ▶ Knee flexion and tibial medial rotation.
- ▶ Fixed pelvis - Hip extension, adduction and medial rotation.
- ▶ Fixed leg - Posterior pelvic tilt.



Semimembranosus, posterior view

SEMITENDINOSUS

Origin

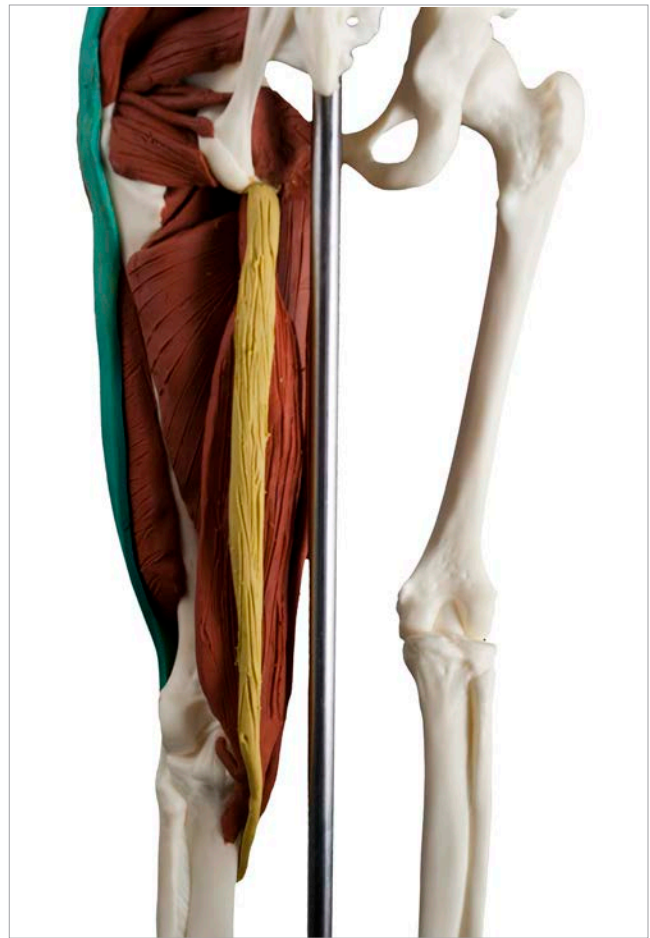
Ischial tuberosity by common tendon with long head of Biceps femoris.

Insertion

Pes anserinus along with the Sartorius and Gracilis.

Action

- ▶ Knee flexion and tibial medial rotation.
- ▶ Fixed pelvis - Hip extension, adduction and medial rotation.
- ▶ Fixed leg - Posterior pelvic tilt.



Semitendinosus, posterior view

POSTERIOR HIP AND THIGH MUSCLES

GLUTEUS MAXIMUS

GLUTEUS MAXIMUS

The Gluteus maximus is the largest and most superficial gluteal muscle. It attaches to the posterolateral femur and to the Iliotibial band. It produces power for jumping and running.

Origin

Posterior gluteal line of ilium and a portion of bone superior and posterior to it, posterior surface of lower part of sacrum, side of coccyx, aponeurosis of erector spinae, sacrotuberous ligament and gluteal aponeurosis.

Insertion

Deep fibers insert into the gluteal tuberosity of femur.

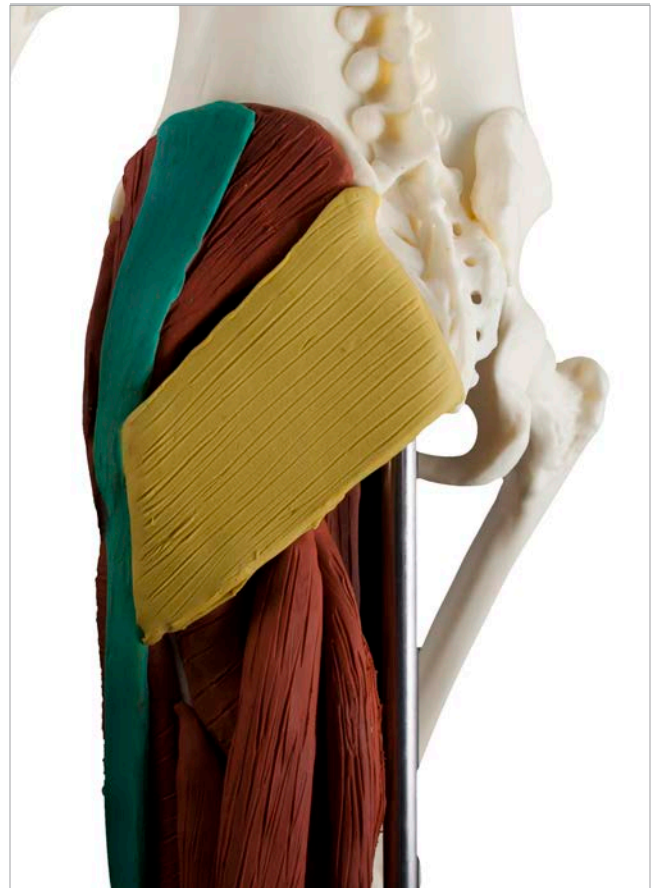
Proximal and superficial fibers of distal portion of muscle inserts into iliotibial tract of fascia lata.

Action

- ▶ Fixed pelvis – Hip extension, lateral rotation, adduction and abduction.
- ▶ Fixed leg – Posterior pelvic tilt.



Gluteus Maximus, deep portion, posterolateral view



Gluteus Maximus, superficial portion, posterolateral view

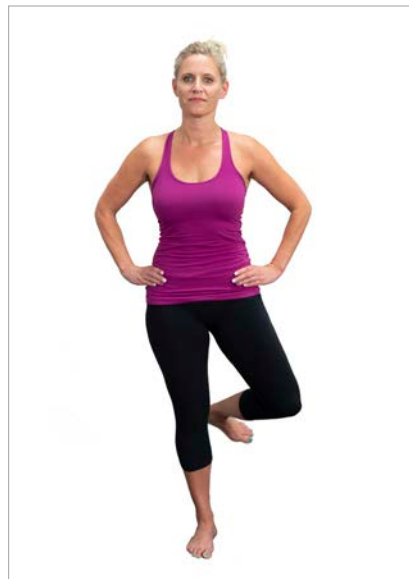
MUSCLES IN ACTION

MUSCLE	FIXED PELVIS					FIXED LEG	KNEE	
	Hip Extension	Hip Abduction	Hip Adduction	Hip Medial Rotation	Hip Lateral Rotation	Posterior Pelvic Tilt	Flexion and medial rotation	Flexion and lateral rotation
Semimembranosus	X		X	X		X	X	
Semitendinosus	X		X	X		X	X	
Biceps femoris	X	X			X	X		X
Gluteus maximus	X	X	X		X	X		



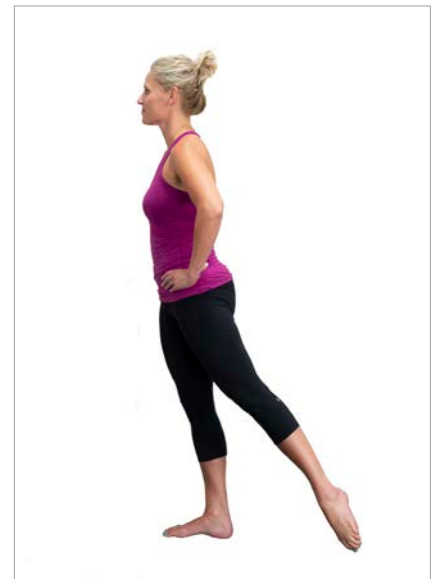
Hip extension, adduction, medial rotation and knee flexion with medial rotation

- ▶ Semimembranosus
- ▶ Semitendinosus



Hip extension, abduction, lateral rotation with knee lateral rotation

- ▶ Biceps femoris



Hip extension, abduction, adduction and lateral rotation

- ▶ Gluteus maximus

THE SPINE AND THORAX

OVERVIEW

OVERVIEW OF THE SPINE

The spine is made up of twenty four interlocking vertebrae plus the fused vertebrae of the sacrum and coccyx. The spine is part of the axial skeleton and articulates with the head, ribs and pelvis

Cervical spine

- ▶ 7 small vertebrae providing good range of motion in all directions.

Thoracic spine

- ▶ 12 medium sized vertebrae with good range of motion in all directions except extension.
- ▶ Articulates with the ribs which protect the heart and lungs.

Lumbar spine

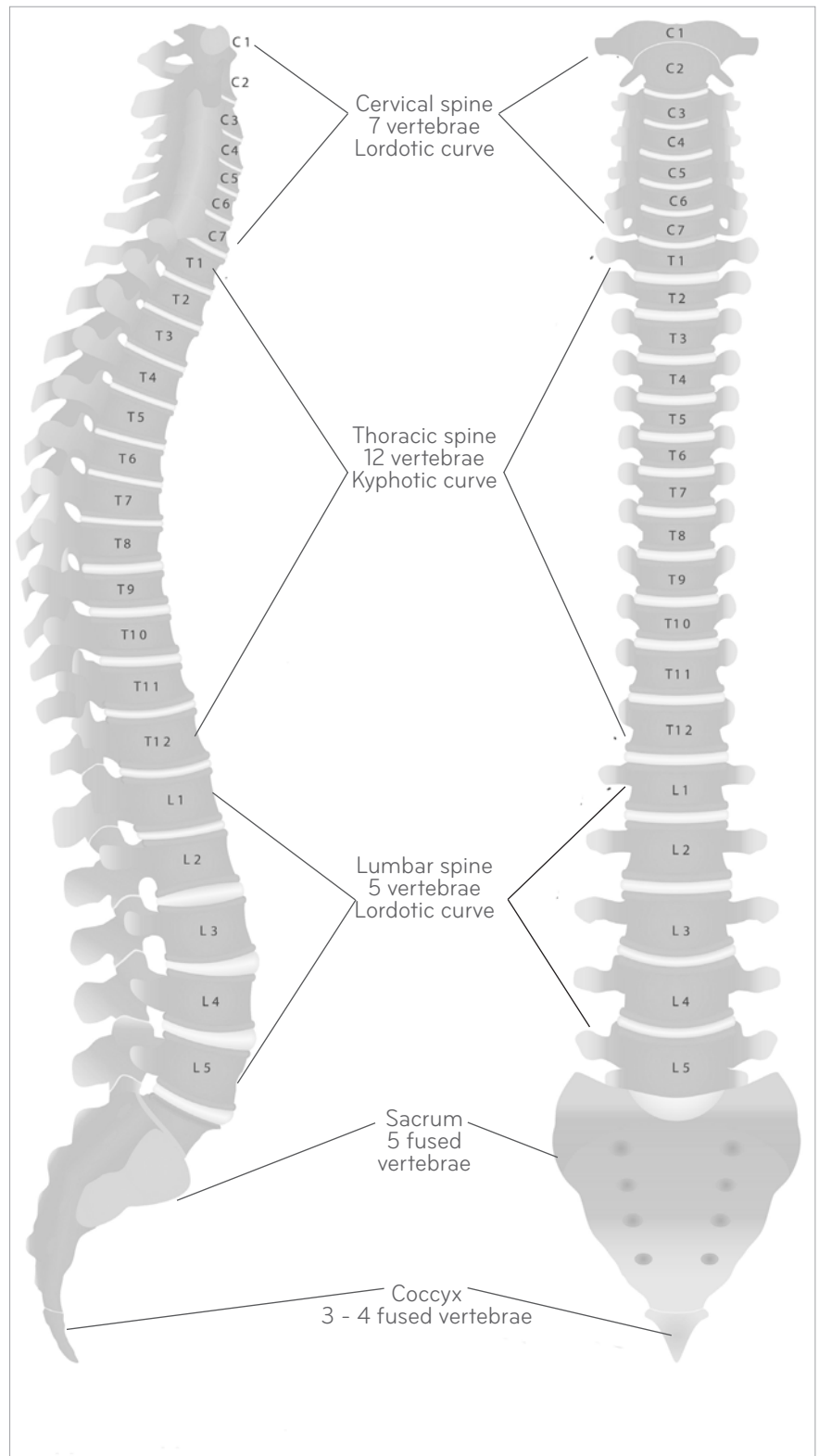
- ▶ 5 large vertebrae designed to support the rest of the spine.
- ▶ Good range of motion in all directions except rotation.

Sacrum

- ▶ Made up of 5 fused vertebrae, the sacrum is the platform which supports the spine.
- ▶ Transfers force from the legs through the pelvis to the spine.

Coccyx

- ▶ Composed of 3 to 4 fused vertebrae, the coccyx, was once our tail. There is still a joint between the coccyx and the sacrum so it is appropriately called the tail bone.

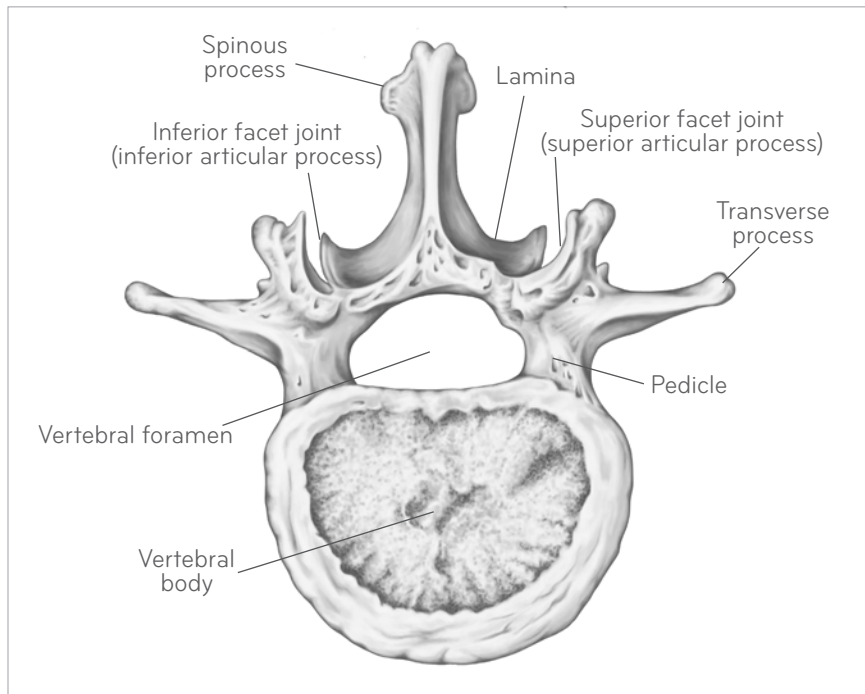


The spine

Vertebrae

The size and shape of the 24 individual and the 8 or 9 fused vertebra varies depending on where they are in the spine. The tapering curves of the spine are created by the unique shape of each vertebra and the spinal loading needed at each segment. The bones of the cervical, for example, support the weight of the head and are smaller than the vertebrae of the thoracic spine and much smaller than the vertebrae of the lumbar spine which are responsible for supporting the cumulative weight of the upper body and transferring it down into the sacrum. The vertebrae articulate with each other, giving the spine its strength and flexibility. Between each vertebrae, providing cushioning and protection lie the intervertebral discs.

ANATOMY OF A VERTEBRA



A lumbar vertebra

Vertebral body

- ▶ The vertebral body is a thick oval segment of bone which forms the front of the vertebrae.
- ▶ The broad, rounded surface supports the weight of the spine and supports the intervertebral disc.

Vertebral foramen

- ▶ The vertebral foramen is the opening created by the posterior surface of the vertebral body and the vertebral arch.
- ▶ It forms a protective channel for the spinal cord.

Vertebral arch

- ▶ Created by the fusion of the pedicle and lamina, it forms the vertebral foramen which protects the spinal cord.
- ▶ Also called the neural arch.

Spinous process

- ▶ The spinous process protrudes from the posterior side of each vertebra.
- ▶ The size and shape of the process changes at each segment. For example, the spinous process of the thoracic vertebrae have a steep downward projection while the lumbar spinous processes are relatively horizontal in orientation.

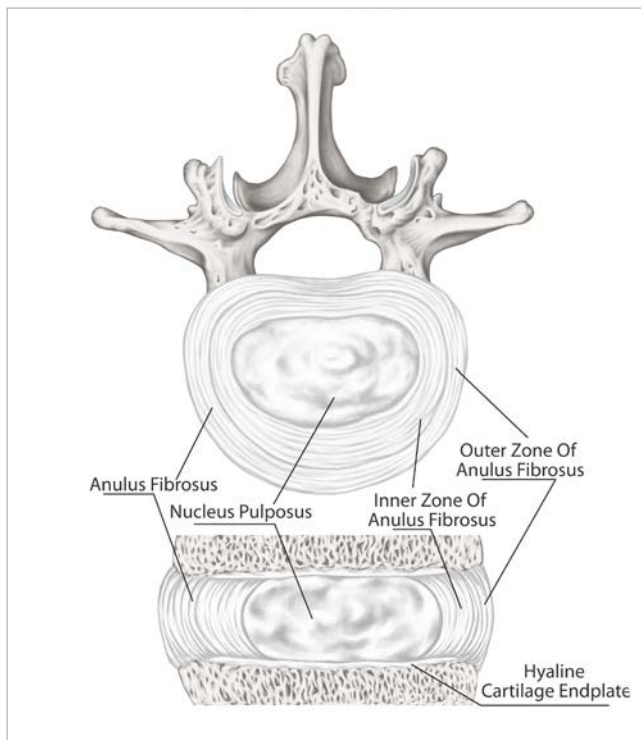
Transverse process

- ▶ The transverse processes project laterally off the sides of each individual vertebra.
- ▶ There are two on each vertebrae, one on the right and one on the left.
- ▶ These processes are the site of muscle and ligament attachments.
- ▶ In the thoracic spine, the ribs also articulate with the transverse processes.
- ▶ The size and shape of these processes changes at each segment depending on the muscles, ligaments and bones attached. For example, the lumbar transverse processes are thicker and broader than the cervical or thoracic processes.

INTERVERTEBRAL DISCS

INTERVERTEBRAL DISCS

- ▶ An intervertebral disc lies between each vertebrae.
- ▶ Intervertebral discs absorb shock, allow for slight vertebral movement and function much like a ligament to limit the range of motion at each joint.
- ▶ The annulus fibrosus is composed of rings of fibers that run at a diagonal between one vertebral body and the next. The angle of the fibers alternates directions in each layer to provide and limit mobility in rotation.
- ▶ The nucleus pulposus is the soft, jelly like, center of the disc.
- ▶ The intervertebral discs are a very common source of back injuries. Maintaining support for the spine from the core is essential to keeping the back safe and injury free.



Intervertebral disc

Discs in motion

The nucleus pulposus floats inside the annulus fibrosis and responds to movements of the spine.

- Flexion: when the spine flexes, the nucleus pulposus moves toward the back of the annulus fibrosis.
- Extension: when the spine extends, the nucleus pulposus moves toward the front of the annulus fibrosis.
- Lateral Flexion: when the spine laterally flexes the nucleus pulposus moves toward the opposite side the body is bending toward.
- Rotation: when the spine rotates the nucleus pulposus floats centrally in the disc. The crossing fibers of the annulus fibrosus act as ligamentous structures both allowing and limiting the amount of intervertebral movement.

Disc pathologies

In a healthy disc, the nucleus pulposus remains intact within the fibrous ring of the annulus fibrosis. When the annulus fibrosis is compromised, the nucleus pulposus can push the wall out or break through the wall and cause pain by putting pressure on adjacent nerves and tissues.

- ▶ If the wall is stretched but not breached, it is called a disc herniation or bulging disc.
- ▶ If the wall is ruptured, it is called an annular tear or a disc protrusion
- ▶ If the disc material escapes from the annulus fibrosus, it is called a leaky disc or degenerative disc disease.

Disc Health:

The intervertebral discs have very limited blood supply so they rely on the movements of the spine for transmission of nutrients. Compression and elongation of the spine in breathing or in spinal movements creates a "squeezing" or "wringing" action of the disc which moves fluid between the disc and the adjacent end plate of the vertebral body to nourish the disc and remove waste products. This is one reason why maintaining mobility is important for spinal health.

THE SPINE AND THORAX

BONES OF THE SPINE - SACRUM AND COCCYX

SACRUM

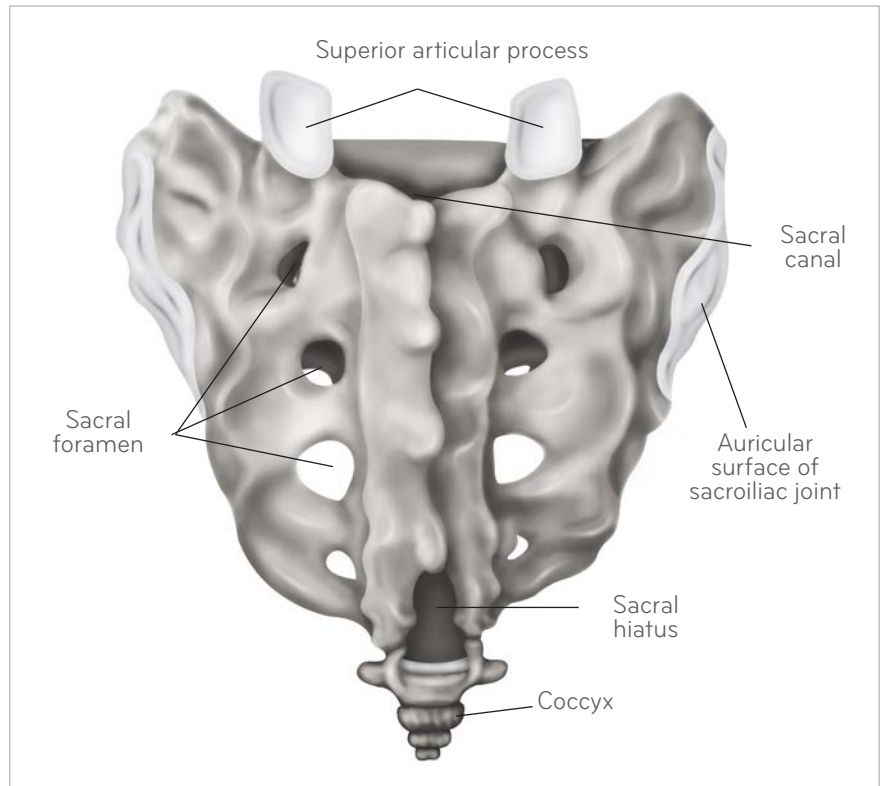
The sacrum forms the base of the spine and connects the legs to the spine through the pelvis. It has a small amount of motion at the sacroiliac joint and the pubic symphysis.

- ▶ Composed of 5 fused vertebrae (S1-S5).
- ▶ Sacral promontory, or sacral base, supports L5 and the rest of the spine.
- ▶ Sacral foramina are openings for the sacral nerves to connect the spinal cord to the lower body.
- ▶ Auricular surface - lateral, ear-shaped surface of the sacrum which articulates with the ilium to create the sacroiliac joint.
- ▶ Sacral canal is a channel for the spinal nerves through the sacrum.
- ▶ Movements of the sacrum include:
 - Nutation - the top of the sacrum angles slightly forward and the coccyx moves back. This increases the lumbar curve.
 - Counternutation - The coccyx moves forward and the top of the sacrum moves back. This decreases the lumbar curve.

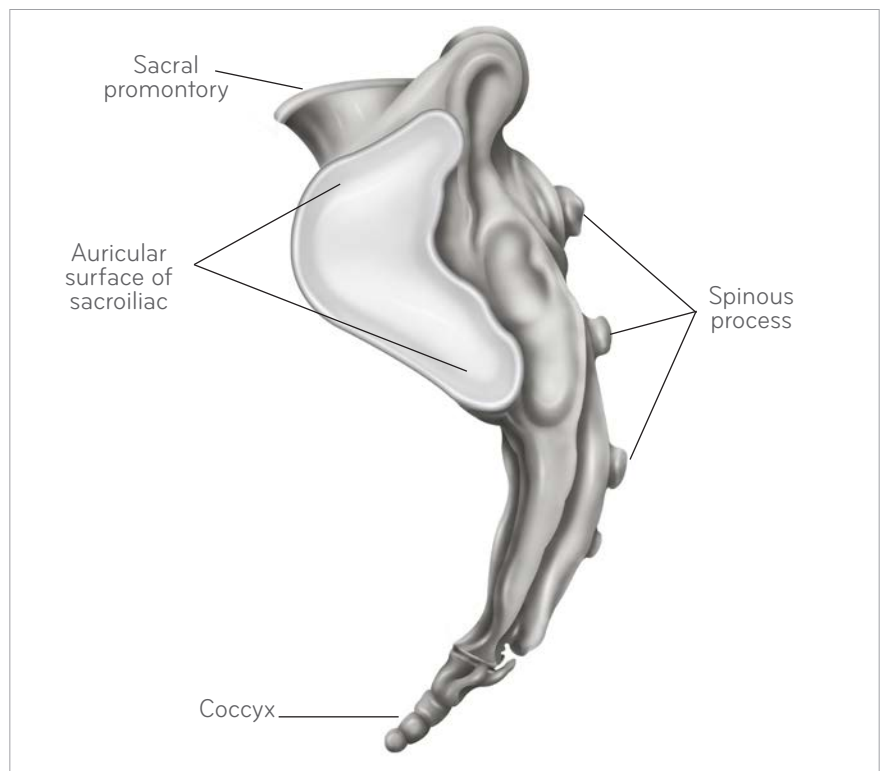
COCCYX (TAILBONE)

The coccyx, a short segment of fused vertebrae below the sacrum is all that's left of our tail!

- ▶ Composed of 3-4 fused vertebrae.
- ▶ Has a small joint with the bottom of the sacrum. This joint has a small disc and is stabilized by a ligamentous sleeve.
- ▶ The coccyx is the attachment point for many of the pelvic floor muscles.
- ▶ The coccyx has a small amount of movement in flexion and extension.



Sacrum, back view



Sacrum, side view

BONES OF THE SPINE - LUMBAR AND THORACIC VERTEBRAE

LUMBAR SPINE

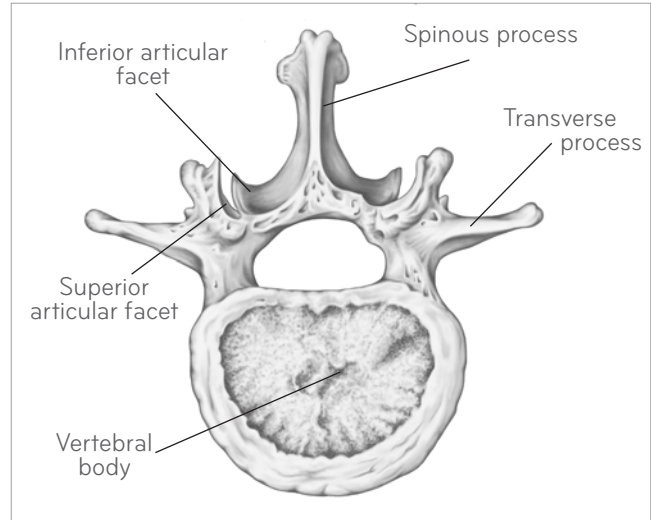
The lumbar are the largest vertebrae sitting on top of the sacrum and supporting the rest of the spine. The lumbar spine is engineered to be incredibly strong, to support the weight of the body and to allow movement in all planes of motion except rotation.

- ▶ Composed of 5 vertebrae (L1-L5).
- ▶ L5 sits on the sacral base. The angle of the sacral base directly effects the shape of the lumbar lordosis.
- ▶ Facet joints of the lumbar spine are shaped like little ears and face one another. As a result of this orientation, the lumbar spine is designed for stability, is protected against anterior shear forces and has a limited range of motion in rotation.
- ▶ The spinous processes are roughly horizontal allowing movement in extension, flexion and lateral flexion.
- ▶ The lumbar curve is concave. Without postural support, it may default to extension or hyperlordosis.

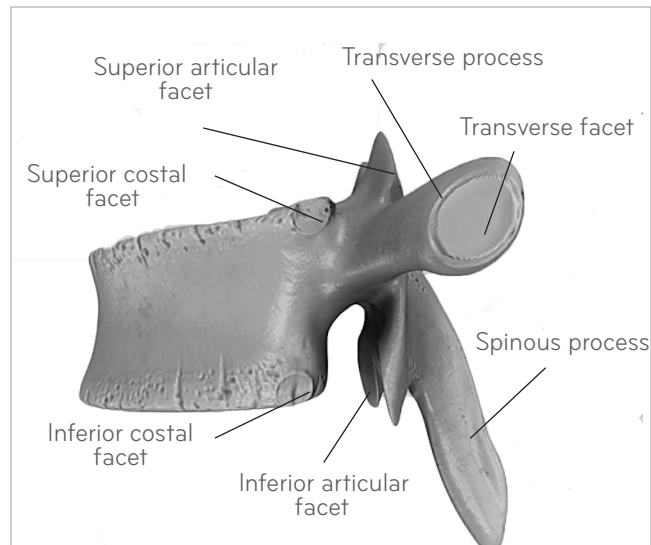
THORACIC SPINE

The thoracic vertebrae articulate with twelve pairs of ribs which attach to the sternum to form the rib cage. The primary function of this bony cage is to protect the heart and lungs.

- ▶ Composed of 12 vertebrae (T1-T12).
- ▶ The articular facet joints face posteriorly which allows for good range of motion in all directions.
- ▶ In addition to the articular facet joints, the thoracic vertebrae articulate with the ribs through the superior and inferior costal facets and the transverse facet on the transverse process.
- ▶ The vertebral bodies of the thoracic spine are smaller than the bodies of the lumbar spine.
- ▶ The spinous process are long and relatively thin and many of them point down like shingles on a roof creating a limitation in thoracic extension.
- ▶ T12 is very unique in its architecture as it is the junction between the lumbar and the thoracic segments of the spine. Its inferior facet joints look and function much like lumbar facet joints but its superior facet joints are similar to the other thoracic facet joints.
- ▶ The thoracic curve is convex. Without postural support it defaults to flexion or hyperkyphosis.



Lumbar vertebrae



Thoracic vertebrae

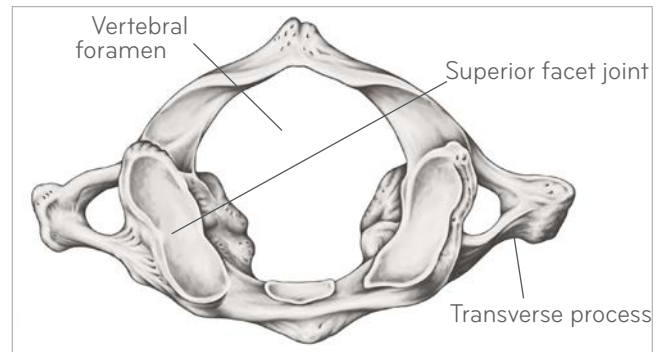
THE SPINE AND THORAX

BONES OF THE SPINE - CERVICAL VERTEBRAE

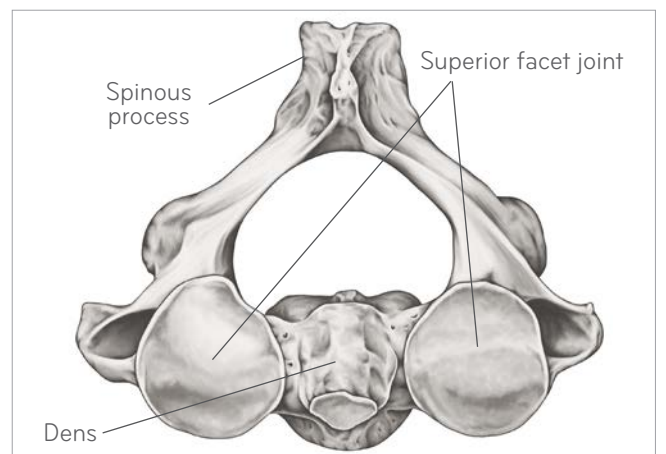
CERVICAL SPINE

The cervical spine bears the axial load of the head. Its small, delicate bones hold up our head and protect not only the spinal cord but also arterial circulation to the brain.

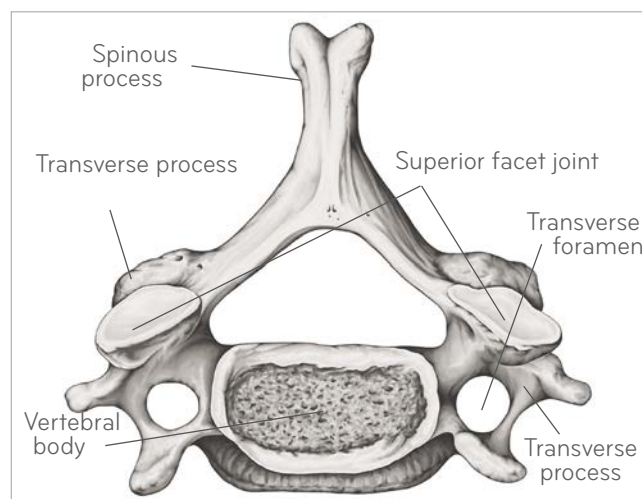
- ▶ Composed of 7 vertebrae (C1-C7).
- ▶ The vertebrae are small and delicate.
- ▶ The cervical vertebrae are designed for maximum mobility so our eyes can see the world in stereoscopic vision. This provides depth perception so we can see how far away our dinner is.
- ▶ C1 (Atlas) supports the weight of the head. The C1 articulates with the rocker shaped condyles of the occipital bone of the skull, allowing for nodding of the head in flexion and extension.
- ▶ The unique shape of C2 (Axis) creates up to 35 degrees of rotation. The peg like projection called the dens is the pivot upon which C1 rotates.
- ▶ The facet joints of C3-C7 run at a slight upward angle allowing for flexion, extension, rotation and lateral flexion.
- ▶ The transverse processes have a hole in them called the transverse foramen which protects the cervical artery and vein.
- ▶ The cervical curve is concave. Without postural support it defaults to forward head and extension.



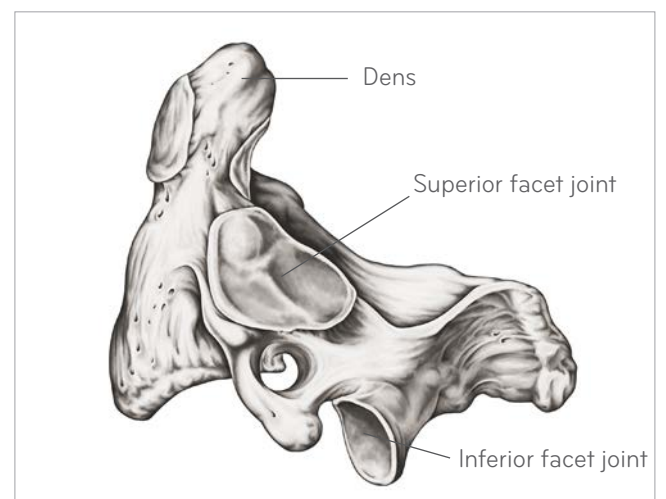
Atlas, C1 top view



Axis, C2 top view



Cervical vertebra top view



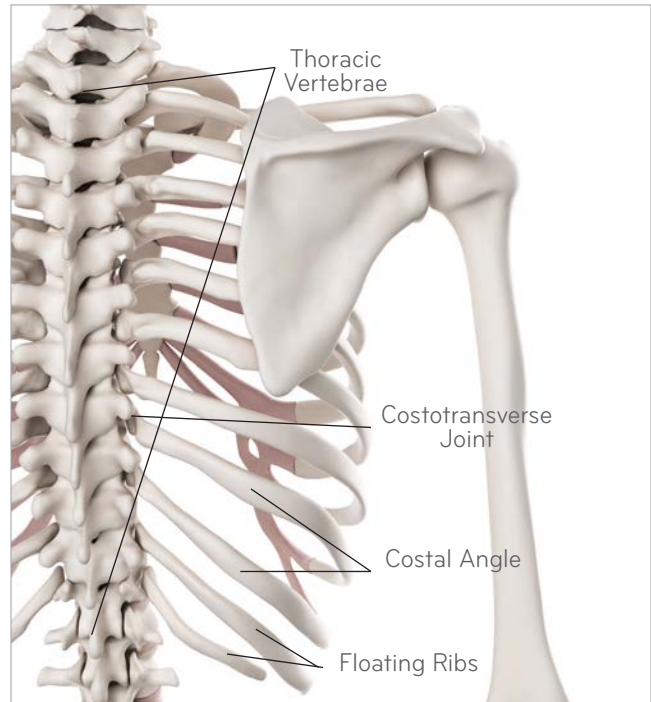
Axis, C2 side view

THE THORAX

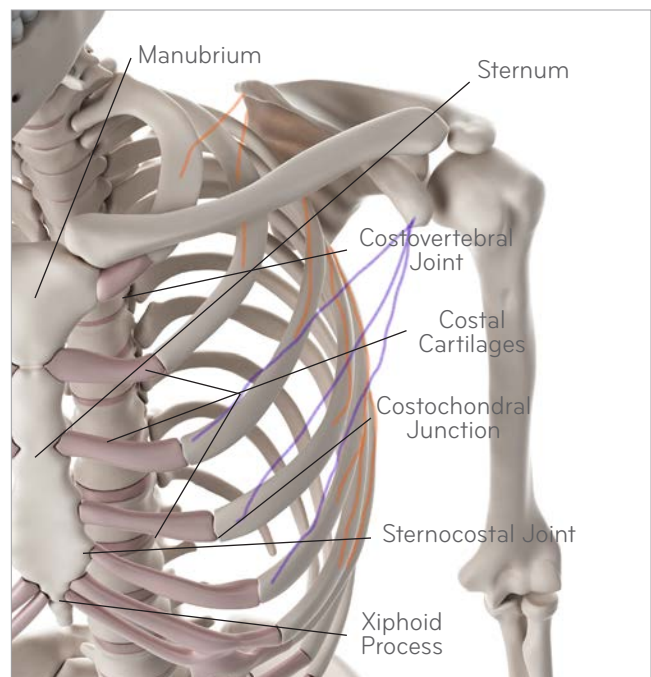
THE THORAX

The thorax consists of the thoracic vertebrae, 12 pairs of ribs, the costal cartilages, the manubrium, sternum and xiphoid process. All of these structures create the rib cage which has the important job of protecting the heart and the lungs.

- ▶ The **sternum** provides the anterior attachment for the ribs. This top section which the clavicle attaches to is called the **manubrium**. At the bottom of the sternum is a small pointed piece of bone called the **xiphoid process**.
- ▶ **12 thoracic vertebrae**
- ▶ **12 pairs of ribs**
 - **Ribs 1-7 are true ribs.** They each have a direct connection to the sternum through individual costal cartilages
 - **Ribs 8-10 are false ribs.** They all connect to the sternum through a shared costal cartilage
 - **Ribs 11 and 12 are floating ribs.** They do not connect to the sternum and do not have a costal cartilage.
- ▶ Each of the ribs have a head, a neck and a costal tubercle on the dorsal end to articulate with the thoracic vertebrae.
- ▶ Ribs 2-10 articulate with the spine at the **costovertebral joints**. The head of the rib articulates with the body of it's accompanying vertebrae and the vertebrae directly superior. The costal tubercle articulates with the transverse process of it's accompanying vertebrae to form the **costotransverse joints**.
- ▶ **Costal cartilage** connects the anterior ends of the ribs to the sternum providing a flexible attachment point to allow for breathing and rib cage mobility. These are the **sternocostal joints**.
- ▶ The costal angle is on the back of the thorax where the rib angle changes to go around to the front of the body.



Thorax, posterior view



Thorax, anterior view

THE SPINE AND THORAX

THE SKULL

THE SKULL

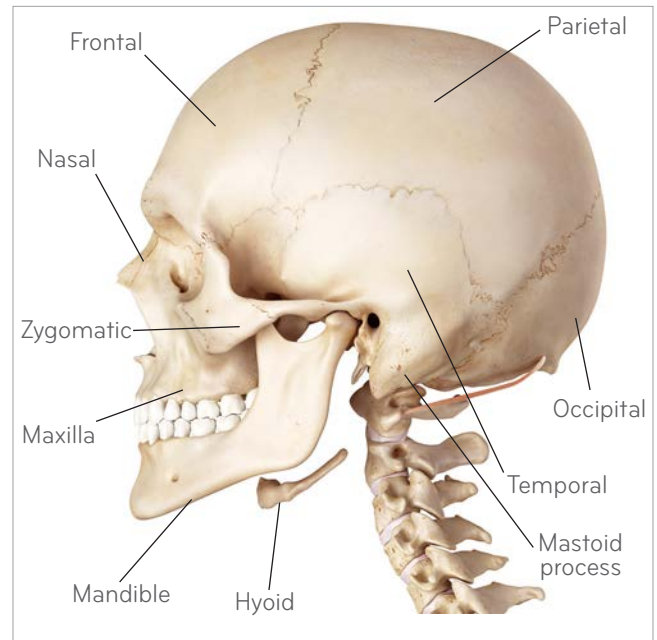
The skull houses the brain, most of the sensory organs and the jaw. The bones can be categorized as belonging to the neurocranium that protects the brain and the viscerocranium that includes the face, the jaw and most of the sensory organs on the head.

► The **neurocranium** protects the brain and is composed of several bony plates including:

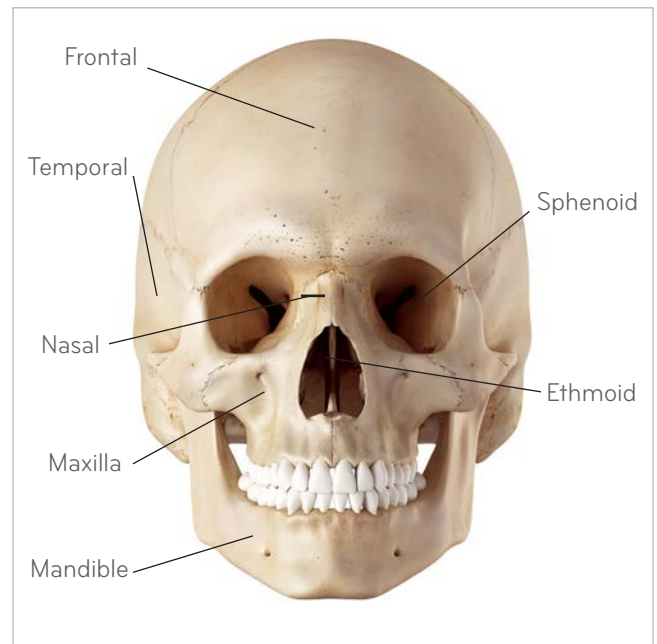
- The **frontal bone** forming the forehead.
- The **parietal bone** creating the sides of the head and meeting on the top of the head at the **sagittal suture**.
- The **occipital bone** forms the back of the skull and is an attachment point for many of the cervical and spinal muscles.
- The **temporal bone** creates the sides of the head inferior to the parietal bone.
- The **sphenoid bone** runs connects to the anterior part of the temporal bone to form the back of the eye socket.

► The viscerocranium includes the more complex bones that make up the face including:

- The mouth is made up of the **maxilla** (upper jaw bone) and **mandible** (lower jaw bone) which articulate at the **temporomandibular joint (TMJ)** to allow us to speak and eat. In addition, the **palatine bone** forms the back of the roof of the mouth and the top of the throat.
 - The **zygomatic bone** and a projection of the **temporal bone** form the cheek bone.
 - The nose is made up of the **ethmoid, nasal and sphenoid bones**.
 - The eye socket or orbit is made up of the **sphenoid, lacrimal, zygomatic, ethmoid and frontal bones**.
- The **hyoid bone** floats in front of the upper cervical vertebrae and is an attachment point for muscles involved in swallowing, tongue movement and talking.

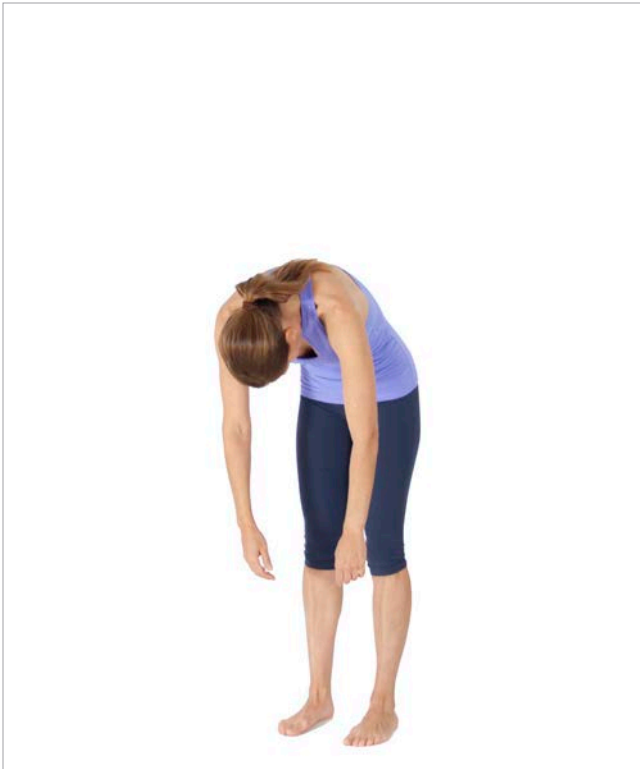


Skull, lateral view

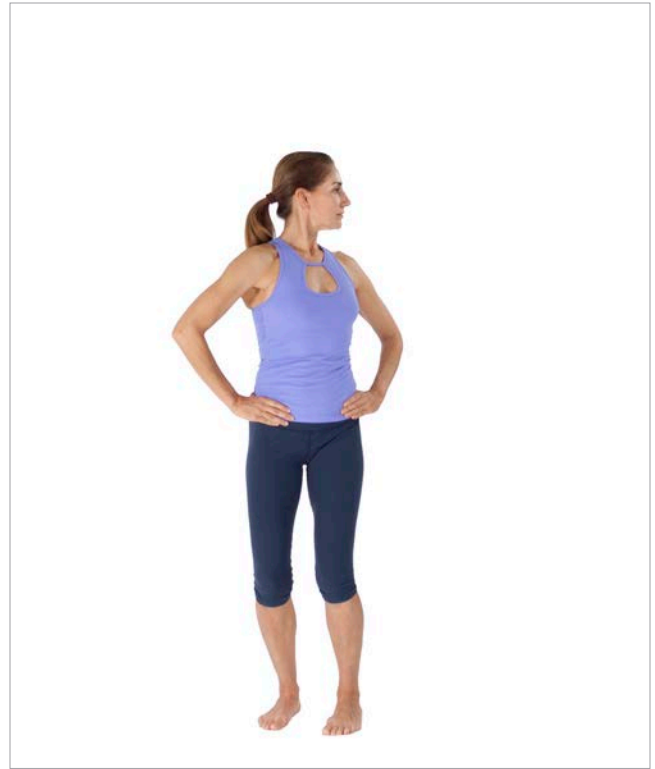


Skull, anterior view

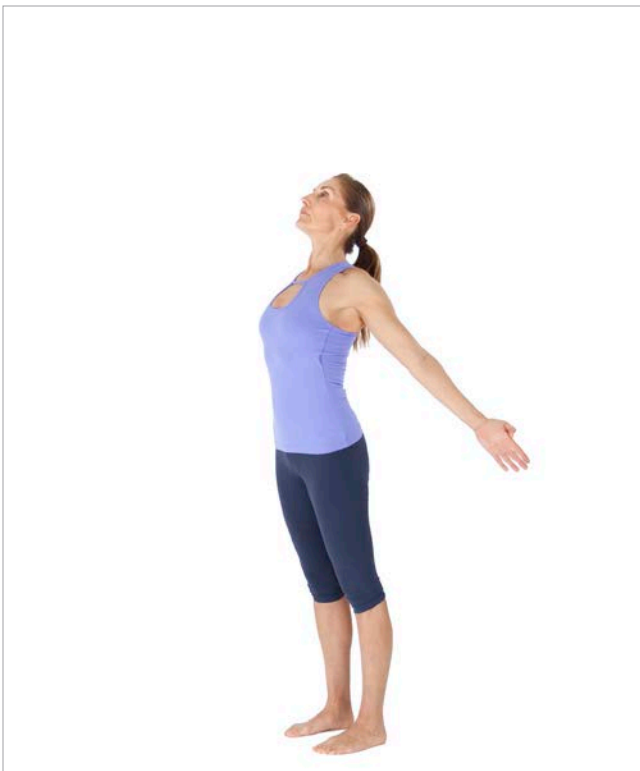
MOVEMENTS OF THE SPINE



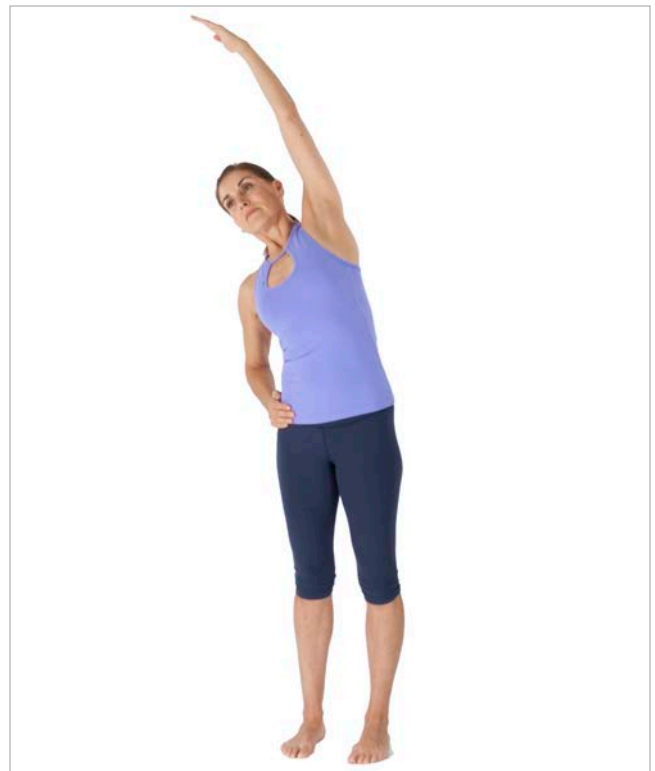
Spinal flexion



Spinal rotation



Spinal extension



Spinal lateral flexion

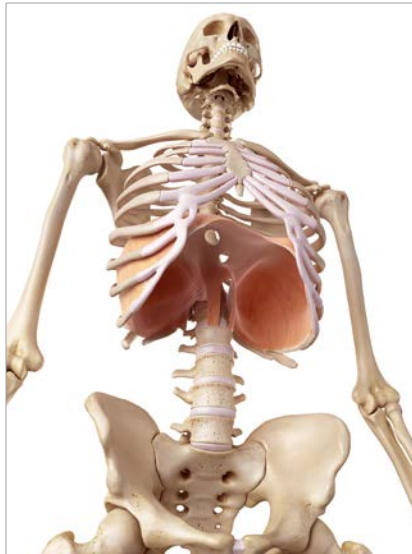
MUSCLES OF BREATHING

DIAPHRAGM, INTERCOSTALS, SCALENES

Muscles of Breathing

The diaphragm is considered the primary muscle of respiration but many other muscles assist with moving the ribs to change the volume of the lungs. The intercostals and scalenes are two of the muscles, other assistants are built after the spinal muscles and will appear in that section.

- ▶ Diaphragm
- ▶ Intercostals
- ▶ Scalenes



Diaphragm, inferior view

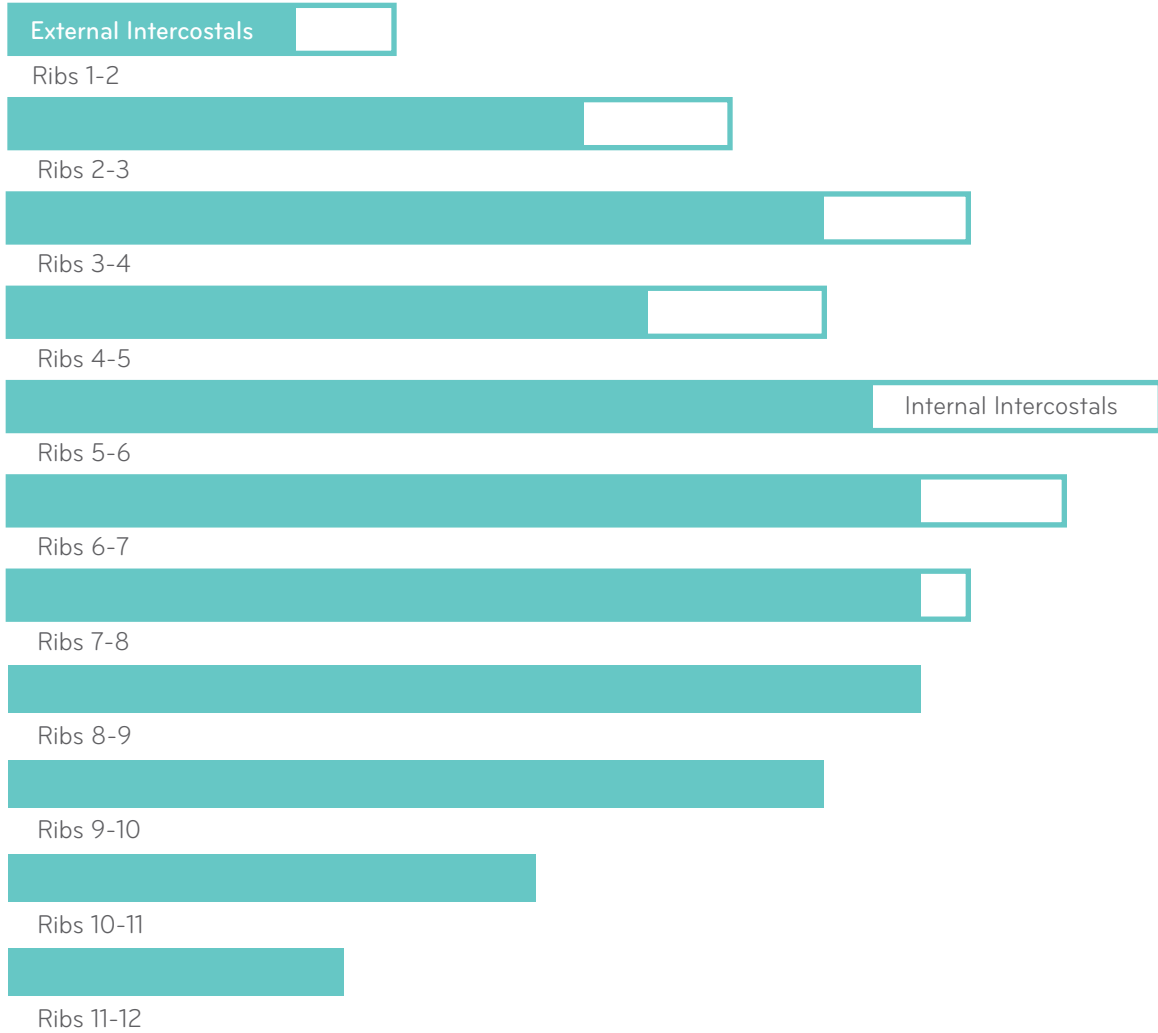


Intercostals

T E M P L A T E

Diaphragm - S

T E M P L A T E



The solid bars represent the external intercostals while the outlined bars represent the inner intercostals.

MUSCLES OF BREATHING

DIAPHRAGM

DIAPHRAGM

The diaphragm is the primary muscle of respiration. It contracts to expand the volume of the thoracic cavity and create inhalation. When it relaxes, it decreases the volume of the lungs and pushes the air out causing exhalation. It also supports the inside of the torso by connecting the bottom ring of the rib cage.

Origin

The diaphragm attaches along the inside of the inferior border of the rib cage. It creates arches over the origin of the quadratus lumborum and the psoas major.

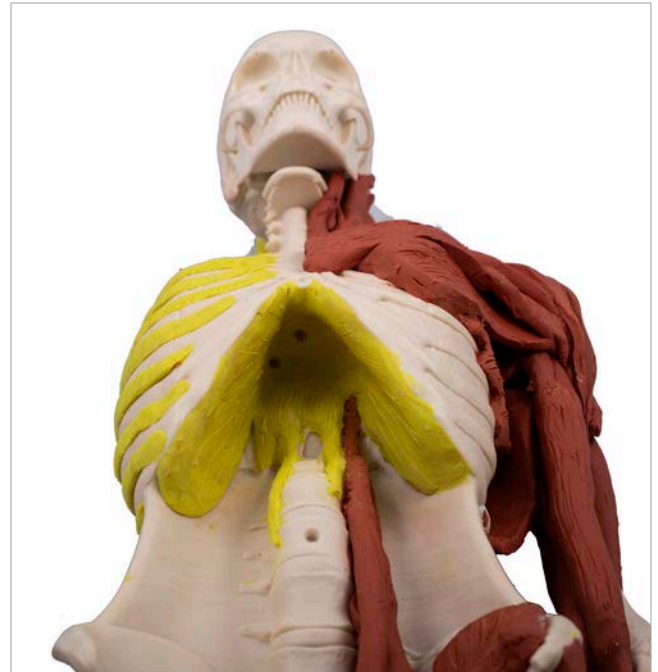
The diaphragm has two anchors called crura that extend onto the bodies of the lumbar vertebrae just medial to the psoas major. The right crus extends to L3, the left crus extends to L2.

Insertion

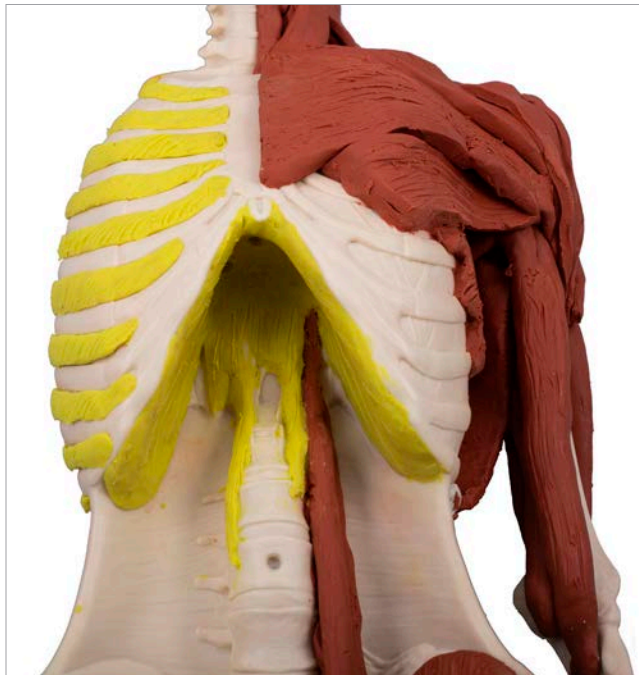
Central tendon of the diaphragm. The central tendon has three holes in it for the esophagus, vena cava and aorta to let food and blood move between the thoracic and abdominal cavity.

Action

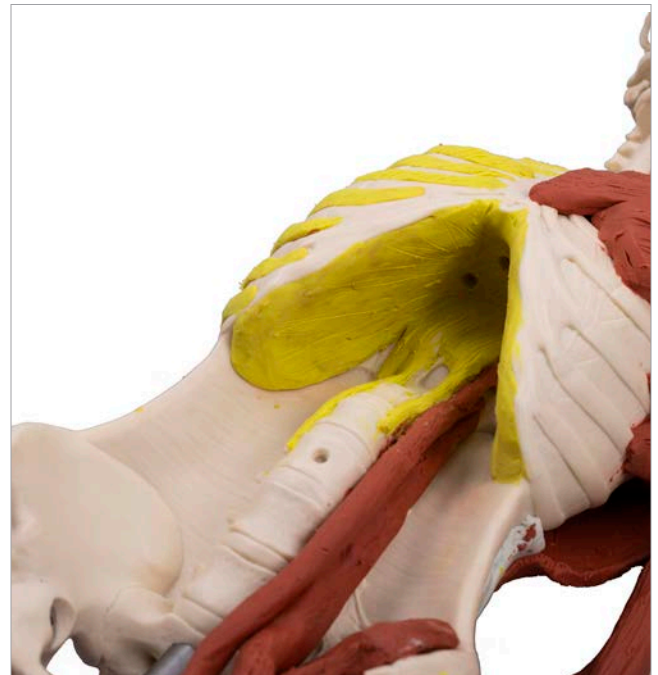
- ▶ Draws central tendon down increasing the volume of thoracic cavity during inhalation.
- ▶ Supports the ribs, chest wall and spine.



Diaphragm, inferior view



Diaphragm, anterior view



Diaphragm, lateral view

INTERCOSTALS

INTERCOSTALS

The intercostals (literally between the ribs) run from the top of one rib to the bottom of the rib above filling in the spaces between the ribs and forming the walls of the thoracic cavity.

Internal Intercostals

Origin and insertion

Inferior border of ribs 1 - 11 to superior border of ribs 2 - 12. These muscles fill the space from the sternum to the edge of the erector spinae. The fiber angle runs from high anterior to low posterior (mountain fibers).

Action

- ▶ Draws the ribs together causing exhalation.
- ▶ Supports the ribs and the chest wall.

External Intercostals

Origin and insertion

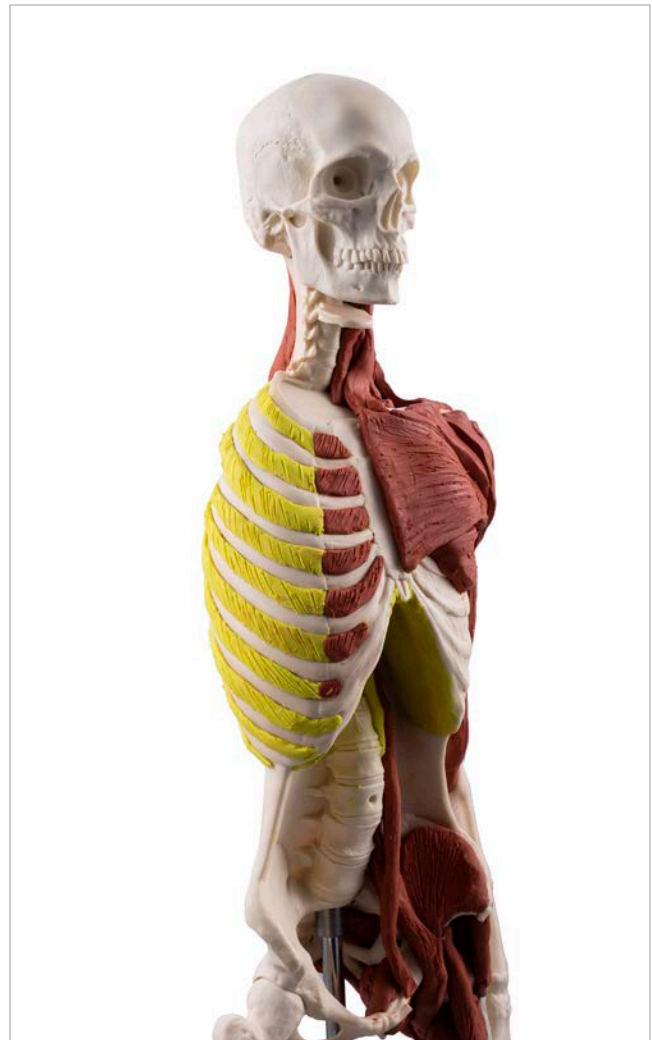
Inferior border of ribs 1 - 11 to superior border of ribs 2 - 12. The fibers begin at the costochondral junction and run posteriorly to the edge of the erector spinae. The fiber angle runs from high posterior to low anterior (valley fibers).

Action

- ▶ Expands the space between the ribs causing inhalation.
- ▶ Supports the ribs and the chest wall.



Internal Intercostals



External Intercostals

MUSCLES OF BREATHING

SCALENES

SCALENES

The scalenes are accessory muscles of breathing connecting the cervical spine to the top two ribs. They can act to lift the ribs up to assist with inhalation.

Anterior Scalenes

Origin and Insertion

Transverse processes of C3 – C6 to rib 1.

Middle Scalenes

Origin and Insertion

Transverse processes of C2 –C7 to rib 1 posterior to anterior scalenes on rib 1

Posterior Scalenes

Origin and Insertion

Transverse processes of C6 –C7 to rib 2 posterior to middle scalenes.

Action

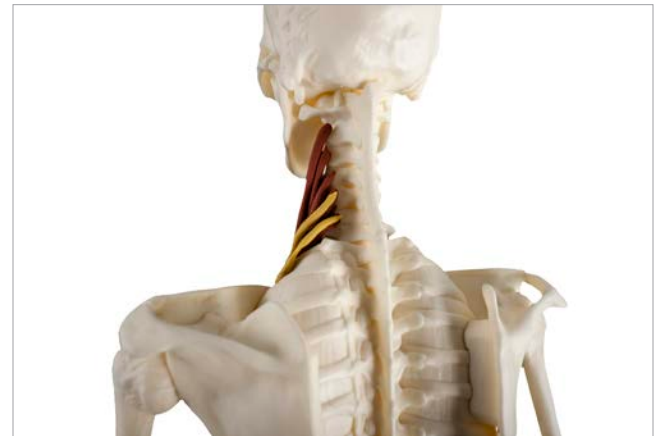
- ▶ Bilaterally: Elevates ribs during inhalation, flexes the neck and head.
- ▶ Unilaterally: Laterally flex head and neck to same side and rotate head and neck to opposite side.



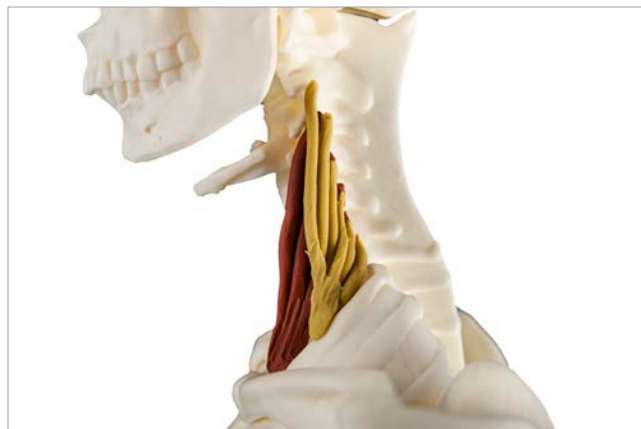
Posterior Scalenes, lateral view



Anterior Scalenes, lateral view



Posterior Scalenes, posterior view



Middle Scalenes, lateral view



Middle Scalenes, anterolateral view

BREATHING MUSCLES IN ACTION

MUSCLE GROUP	Inhale	Exhale	Head and neck flexion	Head and neck lateral flexion	Head and neck contralateral rotation	Supports ribs and chest	Stabilizes lumbar vertebrae
Diaphragm	X					X	X
External intercostals	X					X	
Serratus posterior superior	X						
Scalenes	X		X	X	X		
Internal intercostals		X				X	
Serratus posterior inferior		X					



Inhalation

- ▶ Diaphragm
- ▶ External intercostals
- ▶ Serratus posterior superior
- ▶ Scalenes



Exhalation

- ▶ Internal intercostals
- ▶ Serratus posterior inferior

MUSCLES OF THE SPINE

QUADRATUS LUMBORUM

QUADRATUS LUMBORUM

The quadratus lumborum connects the rib cage, lumbar spine and pelvis and is a critical postural muscle for maintaining the relationship between the three segments. In walking and running it helps create a balanced gait by coordinating the action of the pelvis and rib cage.

Origin

Inferior border of 12th rib, transverse processes of L1 – L5.

Insertion

Superior border of iliac crest.

Action

► Spinal extension, lateral spinal flexion and pelvic upslip

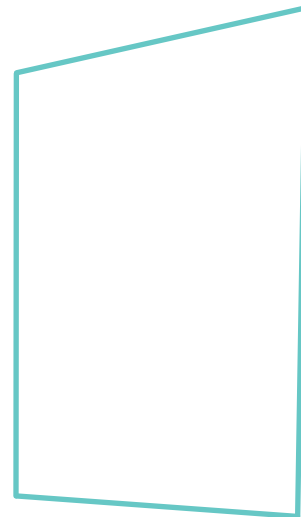


Quadratus Lumborum



Quadratus Lumborum, posterior view

T E M P L A T E



Quadratus
Lumborum (L) - S

DEEP SPINAL MUSCLES

SUBOCCIPITALS

Deep Muscles of the Spine

The spine is held together by a complex series of muscles connecting each segment to provide stability and mobility in appropriate planes. These muscles are responsible for spinal stabilization and spinal extension, when contracted bilaterally and for spinal lateral flexion (Intertransversarii and multifidi) and contralateral rotation (rotatores and multifidi), when contracted unilaterally. In addition to muscles spanning large sections of the spine, a smaller set of deep muscles, the sub-occipital (under the occiput) muscles control the small movements of the head.

SUBOCCIPITAL MUSCLES

This group of 4 paired muscles connects the skull to the upper cervical vertebrae. Their action is closely tied to the movement of the eyes.

Rectus Capitis Posterior Major

Origin and Insertion

Spinous process of C2 to middle third of inferior nuchal line of the occiput.

Rectus Capitis Posterior Minor

Origin and Insertion

Spinous process (posterior tubercle) of C1 to medial third of inferior nuchal line of occiput.

Action

- ▶ Bilaterally: Extends the head
- ▶ Unilaterally: Rotates the head to the same side

Obliquus Capitis Superior

Origin and Insertion

Transverse process of C1 to middle third of inferior nuchal line of occiput. Superior to rectus capitis posterior major.

Action

- ▶ Bilaterally: Extends the head
- ▶ Unilaterally: Laterally flexes head to same side, rotation to opposite side.

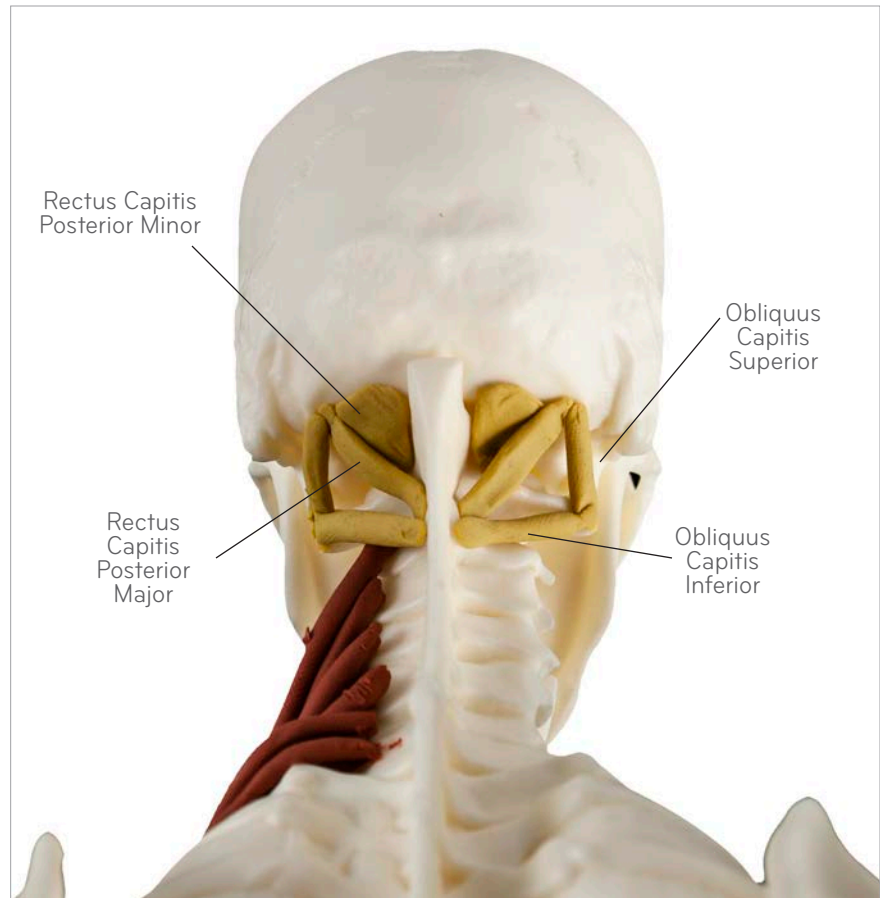
Obliquus Capitis Inferior

Origin and Insertion

Spinous process of C2 to transverse process of C1.

Action

- ▶ Bilaterally: Extends the head
- ▶ Unilaterally: Rotates head and neck to same side.



Suboccipitals, posteroinferior view

DEEP SPINAL MUSCLES

INTERSPINALES AND INTERTRANSVERSARI

These small muscles are shown on a life size skeleton for clarity.

INTERTRANSVERSARI

The intertransversarii connect the transverse processes at the deepest level. They are also often lacking in the thoracic region because of the attachment of the ribs to the thoracic vertebrae.

Origin and Insertion

Connect one transverse process to the one above. These run in pairs on either side of the spine in the region of C1 - C7 and L1 - L5.

Action

► Bilateral: Support the vertebrae and extend the spine.



Intertransversarii

INTERSPINALES

The interspinales connect the spinous processes at the deepest level. Note they aren't present in the thoracic region because the space between the spinous processes is very limited.

Origin and Insertion

Connect one spinous process to the one above. These run in pairs on either side of the spinous processes in the region of C1 - C7 and L1 - L5.

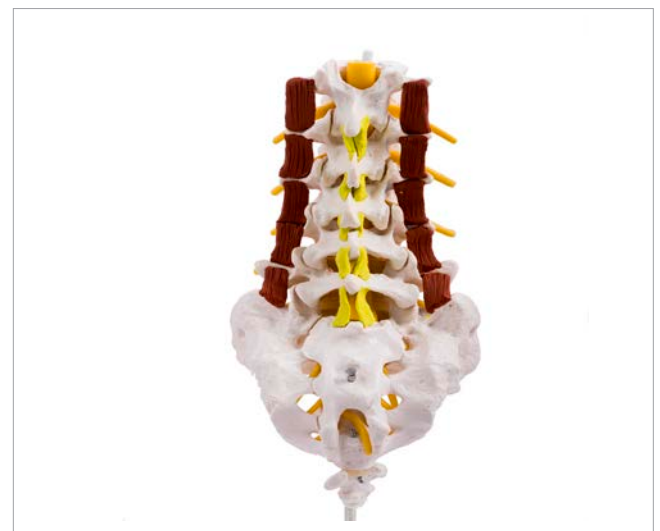
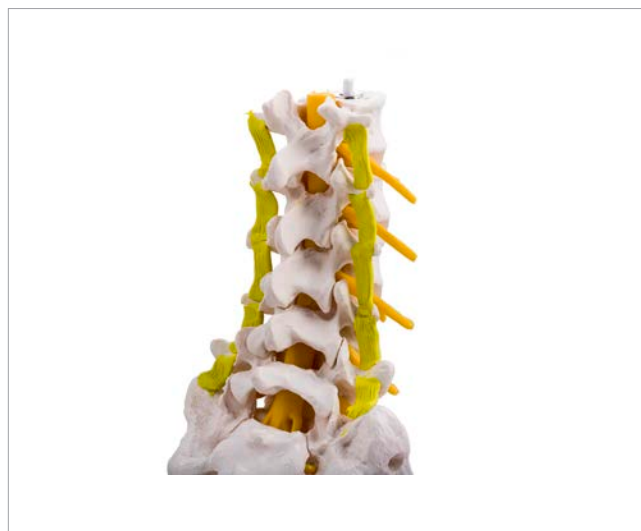
Action

► Bilateral: Support the vertebrae and extend the spine.

► Unilateral: Laterally flex the spine.



Interspinalis



ROTATORES BREVIS AND LONGUS

ROTATORES

The rotatores and multifidi tie the spine together by connecting the transverse processes and spinous processes at the deepest level. They are present in the thoracic spine to facilitate rotation of the rib cage.

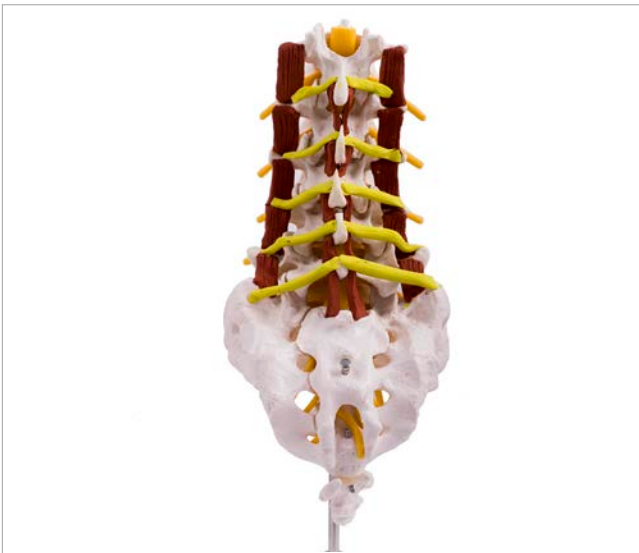
Origin and Insertion

Rotatores brevis - Transverse processes of T1 - T12 to the spinous process of the vertebra one level above.

Rotatores longi - Transverse process of T1 - T12 to the spinous process of the vertebrae 2 levels above.

Action

- ▶ Bilateral: Support the vertebrae and extend the spine.
- ▶ Unilateral: Rotate the spine to the opposite side.



Rotatores Brevis

Rotatores Longus

DEEP SPINAL MUSCLES

MULTIFIDI

MULTIFIDI

The multifidi are important spinal stabilizers and balanced development is crucial to a healthy spine.

Origin and insertion

Connects the transverse process of the sacrum through C2 to the spinous process 3 to 5 vertebrae above.

Action

- ▶ Bilateral: Support the vertebrae and extend the spine.
- ▶ Unilateral: Rotate the spine to the opposite side and laterally flex the spine to the same side.



Multifidi, posterior view on skeleton



Multifidi, 3 spinal segments

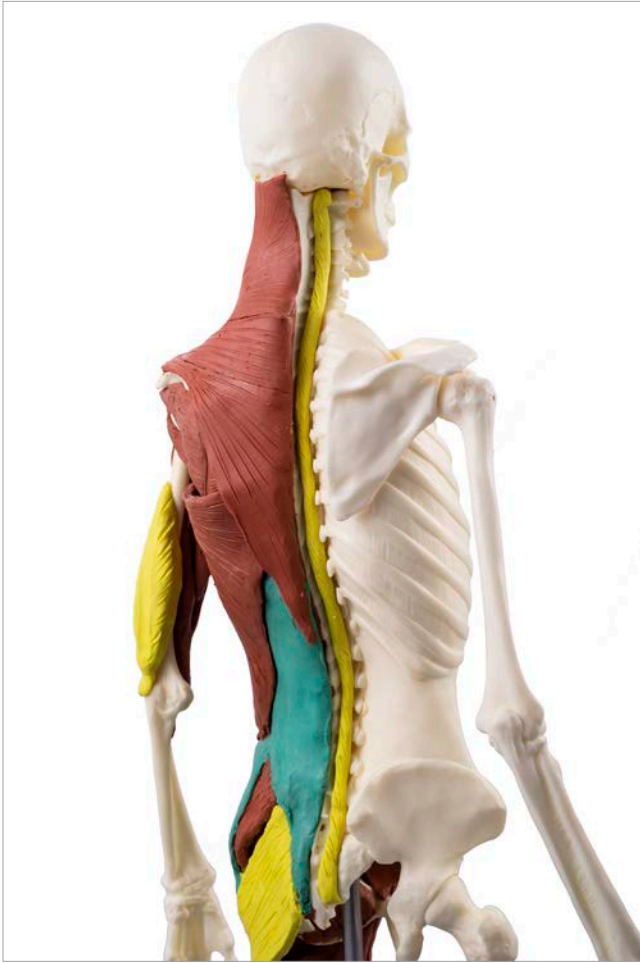


Multifidi, 4 spinal segments

ALL THE DEEP SPINAL MUSCLES AND SEMISPINALIS

DEEP SPINAL MUSCLES ON THE SKELETON

To represent all of the deep spinal muscles on the skeleton, a long thin tube of clay from the coccyx to C2 is placed between the spinous processes and the transverse processes.



Deep Spinal Muscles

SEMISPINALIS

The semispinalis are a group of primarily cervical muscles related to the multifidi. They control the head and neck and connect the transverse processes to the spinous processes to the head.

Semispinalis capitis

Origin and insertion

Transverse processes of C4 - T7 to the occiput between superior and inferior nuchal lines.

Semispinalis cervicis

Origin and insertion

Transverse process of T1 - T6 to the spinous processes of C2 -C5.

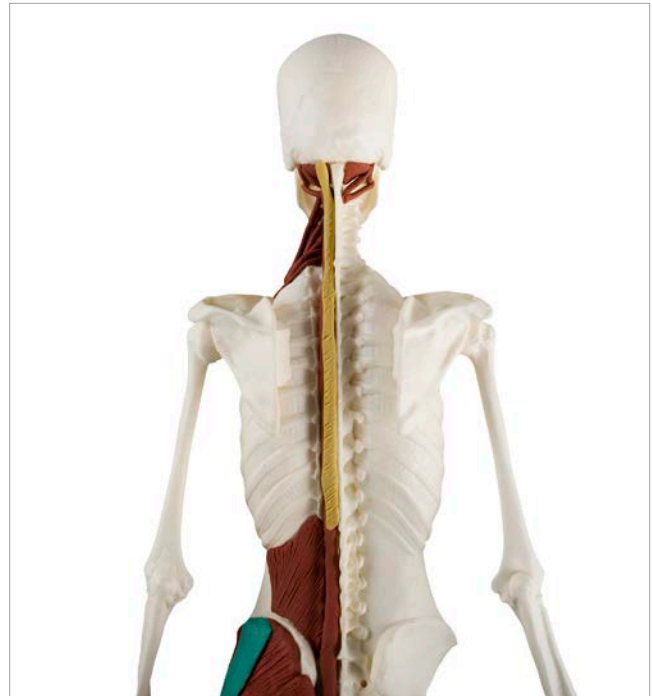
Semispinalis thoracis

Origin and insertion

Transverse process of T6 - T12 to the spinous processes of C6 - T4.

Action

- ▶ Bilateral: Stabilizes the neck and head and extends cervical and thoracic spine.
- ▶ Unilateral: Laterally flexes head, cervical and thoracic spine and rotates head, cervical and thoracic spine to the opposite side.



Semispinalis

DEEP SPINAL MUSCLES

DEEP SPINAL MUSCLES IN ACTION

MUSCLE GROUP	Extension	Lateral Flexion	Contralateral rotation	Ipsilateral rotation	Spinal stability
Interspinales	X				X
Intertransversarii	X	X			X
Rotatores	X		X		X
Multifidi	X	X	X		X
Semispinalis	X	X	X		X



Spinal Extension

- ▶ Interspinales (bilateral)
- ▶ Intertransversarii (bilateral)
- ▶ Rotatores (bilateral)
- ▶ Multifidi (bilateral)



Lateral Spinal Flexion

- ▶ Intertransversarii (unilateral)
- ▶ Multifidi (unilateral)



Spinal Rotation

- ▶ Rotatores (contralateral rotation)
- ▶ Multifidi (contralateral rotation)

ERECTOR SPINAE

SPINALS, LONGISSIMUS AND ILIOCOSTALIS

Erector Spinae

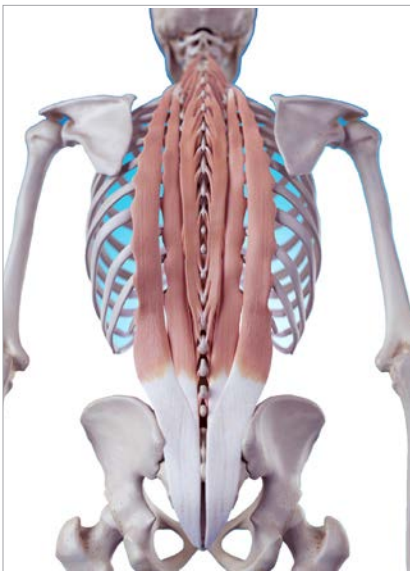
The erector spinae or erectors of the spine, run superficial to the deep spinal muscles in three columns.

- ▶ The spinalis group connects spinous process to spinous process
- ▶ The longissimus group connects the transverse processes to the skull
- ▶ The iliocostalis connects the ribs to the pelvis.

All of the erector spinae feed into the thoracolumbar fascia to connect to the sacrum and thus tie the head, neck, spine and pelvis together.

Erector Spinae

- Spinalis
- Longissimus
- Iliocostalis



Erector Spinae

T
E
M
P
L
A
T
E

Spinalis - T

Longissimus - T

Iliocostalis - T

LONGISSIMUS AND ILIOCOSTALIS

LONGISSIMUS

Longissimus connects the head to the transverse processes and is the middle band of the erector spinae.

Longissimus Capitis

Origin

Transverse processes of upper thoracic and lower cervical vertebra.

Insertion

Mastoid process of temporal bone.

Longissimus Cervicis

Origin

Transverse processes of upper thoracic vertebra.

Insertion

Transverse processes of C2-C6.

Longissimus Thoracis

Origin

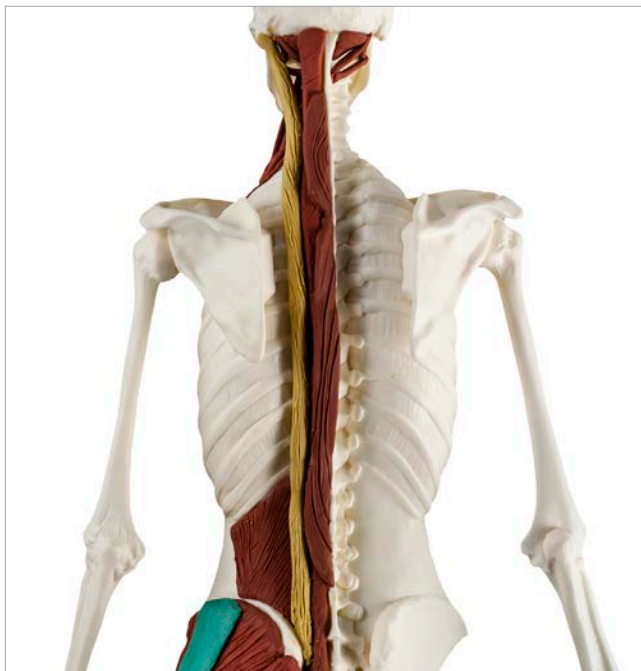
Lumbar transverse processes.

Insertion

Thoracic transverse processes and ribs 9 and 10.

Action

- ▶ Bilaterally: Spinal extension
- ▶ Unilaterally: Spinal lateral flexion and spinal rotation to same side.



Longissimus, posterior view

ILIOCOSTALIS

Iliocostalis connects the ribs to the ilium and is the most lateral erector spinae.

Iliocostalis Cervicis

Origin

Ribs 3-7.

Insertion

Transverse process of C5-7.

Iliocostalis Thoracis

Origin

Ribs 7-12.

Insertion

Ribs 1-6.

Iliocostalis Lumborum

Origin

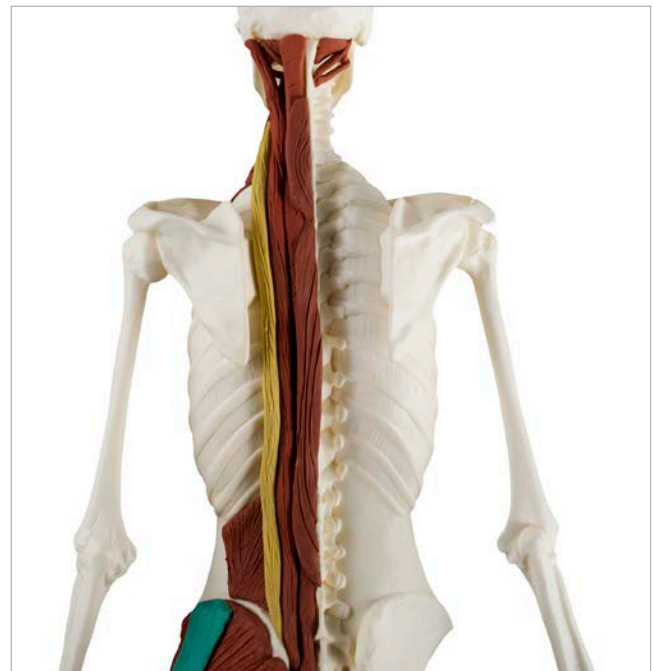
Iliac crest via lumbar fascia.

Insertion

Ribs 6-12, thoracolumbar fascia, transverse processes of upper lumbar vertebrae.

Action

- ▶ Bilaterally: Spinal extension.
- ▶ Unilaterally: Spinal lateral flexion and spinal rotation to same side.

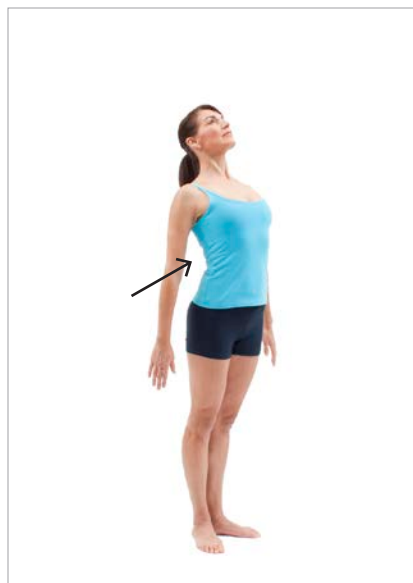


Iliocostalis, posterior view

ERECTOR SPINAE

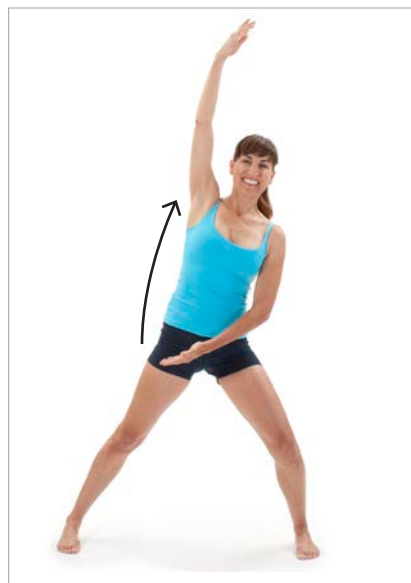
QUADRATUS AND ERECTOR SPINAE IN ACTION

MUSCLE GROUP	Extension	Lateral Flexion	Ipsilateral Rotation
Quadratus lumborum	X	X	
Spinalis	X	X	
Longissimus	X	X	X
Iliocostalis	X	X	X



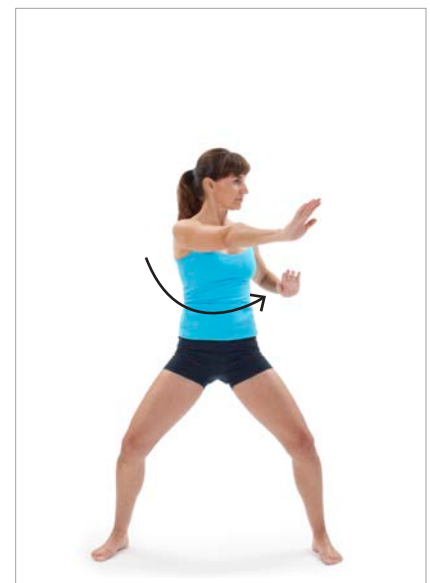
Spinal Extension

- Quadratus lumborum (bilateral)
- Spinalis (bilateral)
- Longissimus (bilateral)
- Iliocostalis (bilateral)



Lateral Spinal Flexion

- Quadratus lumborum (unilateral)
- Spinalis (unilateral)
- Longissimus (unilateral)
- Iliocostalis (unilateral)



Spinal Rotation

- Longissimus (ipsilateral rotation)
- Iliocostalis (ipsilateral rotation)

MUSCLES OF THE HEAD AND NECK

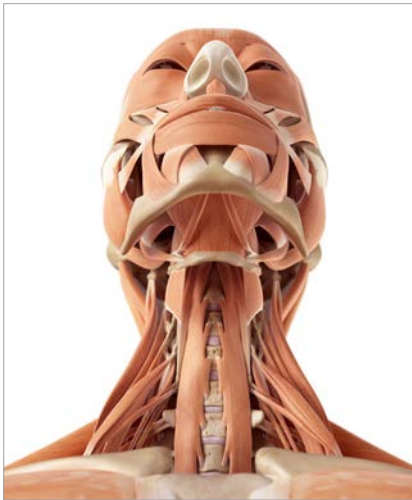
SPLenius, LONGUS CAPITIS, LONGUS COLLI AND STERNOCLEIDOMASTOID

MUSCLES OF THE NECK

- Splenius
- Longus Capitis
- Longus Colli
- Sternocleidomastoid



Splenius

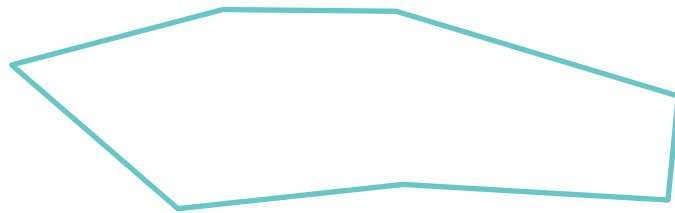


Longus Colli and Capitis

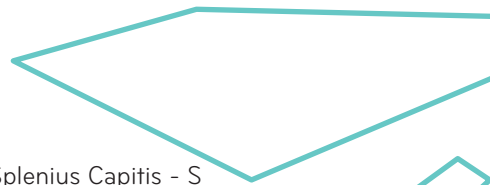


Sternocleidomastoid

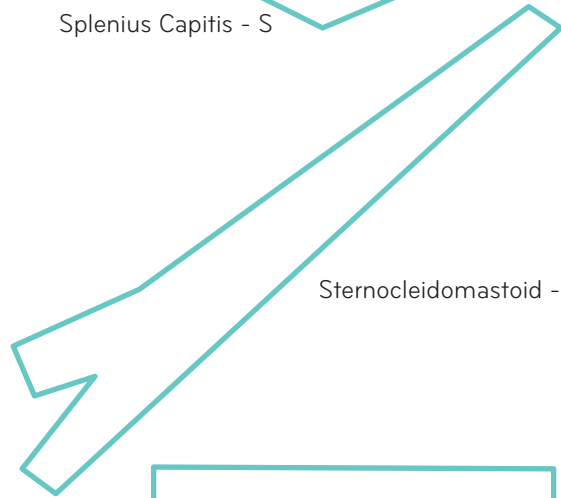
T E M P L A T E



Splenius Cervicis - S



Splenius Capitis - S



Sternocleidomastoid - T



Longus Capitis - T



Longus Colli - T

LONGUS CAPITIS, LONGUS COLLI AND STERNOCLEIDOMASTOID

LONGUS CAPITIS AND LONGUS COLLI

The longus capitis and longus colli connect the anterior face of the cervical and upper thoracic vertebrae to the head. These are considered essential for nodding the head and flexing the cervical spine.

Longus Capitis

Origin

Anterior transverse process of C3 - C6.

Insertion

Basilar part of occipital bone anterior to vertebral column.

Longus Colli

Origin and Insertion

Vertical section: Anterior face of vertebral bodies of C5 - T3 to anterior surface of C2 - C4.

Superior section: Anterior surfaces of transverse processes of C3 - C5 to anterior surface of C1.

Inferior section: Anterior face of vertebral bodies of T1 - T3 to anterior transverse processes of C5 - C6.

Action

- ▶ Bilaterally: Cervical flexion.
- ▶ Unilaterally: Cervical lateral flexion and rotation to opposite side.

STERNOCLEIDOMASTOID (SCM)

Sternocleidomastoid (sternum-clavicle-mastoid) is a superficial anterior neck muscle connecting the head (mastoid process) to the sternum and clavicle. If the deep neck flexors are not strong enough, the SCM can overpower them leading to lack of support and stability in the neck and head.

Sternal Head

Origin

Superior lateral sternum.

Insertion

Mastoid process of temporal bone and lateral occiput.

Clavicular Head

Origin

Medial one third of clavicle.

Insertion

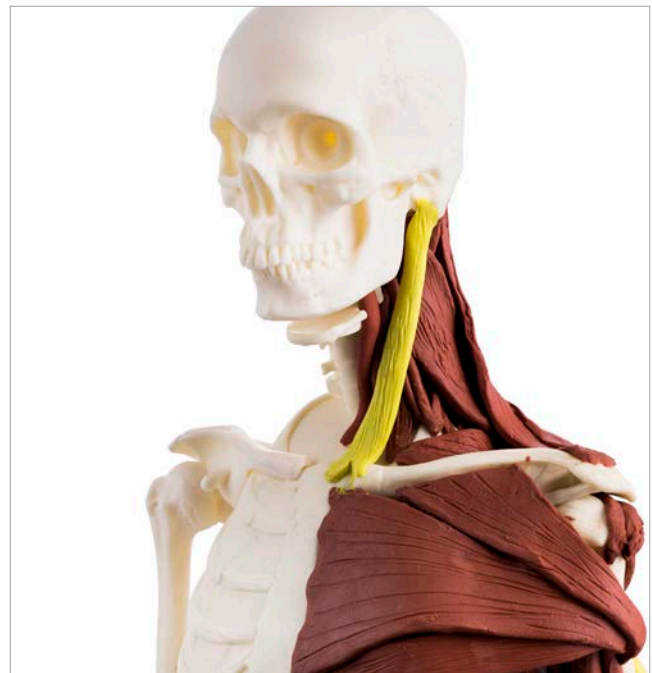
Mastoid process of temporal bone and lateral occiput.

Action

- ▶ Bilaterally: Spinal extension or flexion depending on the position of the head.
- ▶ Unilaterally: Cervical lateral flexion and rotation to opposite side.



Longus Capitis and Colli

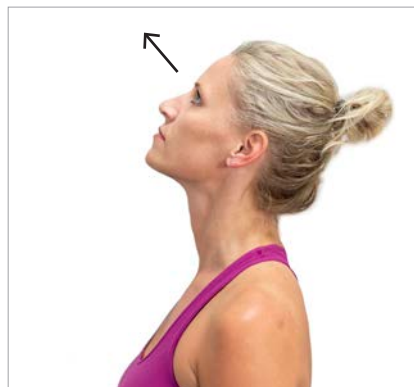


Sternocleidomastoid

MUSCLES OF THE HEAD AND NECK

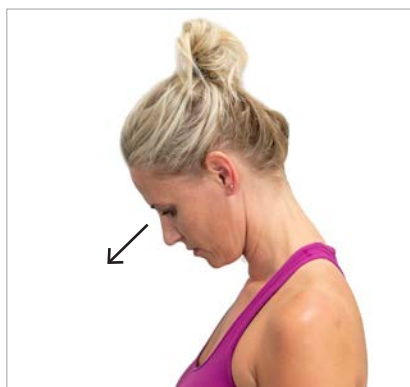
MUSCLES OF THE HEAD AND NECK IN ACTION

MUSCLE GROUP	Head and neck extension	Head and neck flexion	Head and neck lateral flexion	Head and neck same side rotation	Head and neck opposite side rotation	Stabilizes head and cervical vertebrae
Scalenes		X	X		X	X
Rectus capitis posterior major and minor	X			X		X
Obliquus capitis inferior	X		X	X		
Obliquus capitis superior	X		X		X	
Semispinalis	X		X		X	X
Splenius	X		X	X		
Longus capitis and Longus colli		X	X		X	
Sternocleidomastoid	X	X	X		X	



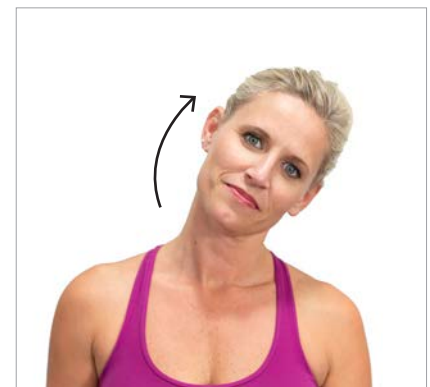
Head and neck extension

- ▶ Rectus capitis posterior major and minor
- ▶ Obliquus capitis inferior and superior
- ▶ Semispinalis
- ▶ Splenius
- ▶ Sternocleidomastoid



Head and neck flexion

- ▶ Scalenes
- ▶ Longus capitis and colli
- ▶ Sternocleidomastoid



Head and neck lateral flexion

- ▶ Scalenes
- ▶ Obliquus capitis inferior and superior
- ▶ Semispinalis
- ▶ Splenius
- ▶ Longus capitis and colli
- ▶ Sternocleidomastoid

MUSCLES AND FASCIA OF THE BACK

SERRATUS POSTERIOR SUPERIOR AND INFERIOR

SERRATUS POSTERIOR SUPERIOR

Serratus posterior superior connects the upper ribs to the spine. It lies superficial to the erector spinae and is an accessory muscle in breathing.

Origin

Spinous processes of C7 – T3.

Insertion

Posterior surface of 2nd – 5th ribs.

Action

- ▶ Elevate ribs during inhalation.



Serratus Posterior Superior

SERRATUS POSTERIOR INFERIOR

Serratus posterior inferior connects the lower ribs to the spine. It lies superficial to the erector spinae and moves the ribs to enhance breathing.

Origin

Spinous processes of T12 – L3.

Insertion

Posterior surface of 9th – 12th ribs.

Action

- ▶ Depress ribs during exhalation.
- ▶ Assists in rotation and extension of the trunk.



Serratus Posterior Inferior

THORACOLUMBAR FASCIA

THORACOLUMBAR FASCIA

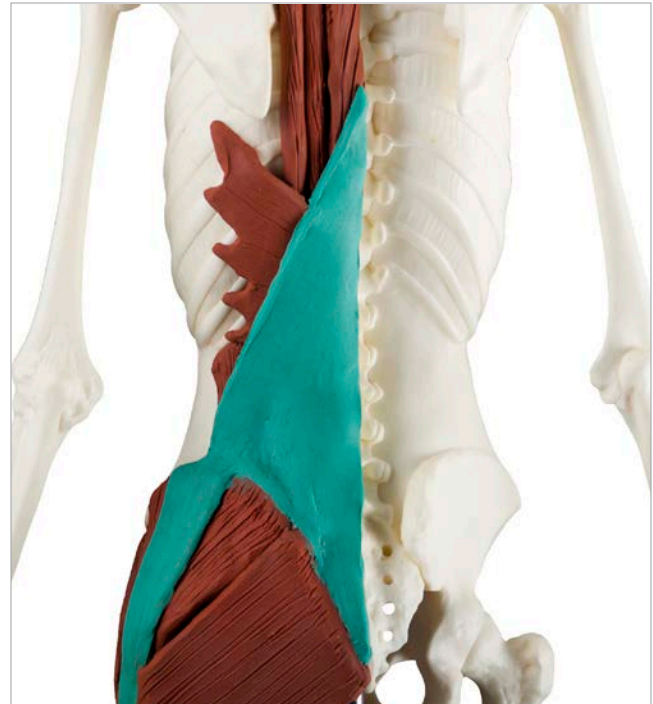
This is not a muscle. The thoracolumbar fascia is a connective tissue structure connecting the ribs, spine and pelvis to the deep abdominals, spinal muscles and latissimus dorsi. We build the superficial part of the fascia but in reality it connects all the layers of the lower back from the psoas major in the front of the spine through the quadratus lumborum, deep spinal muscles and erector spinae to the abdominals and hip muscles.

Origin

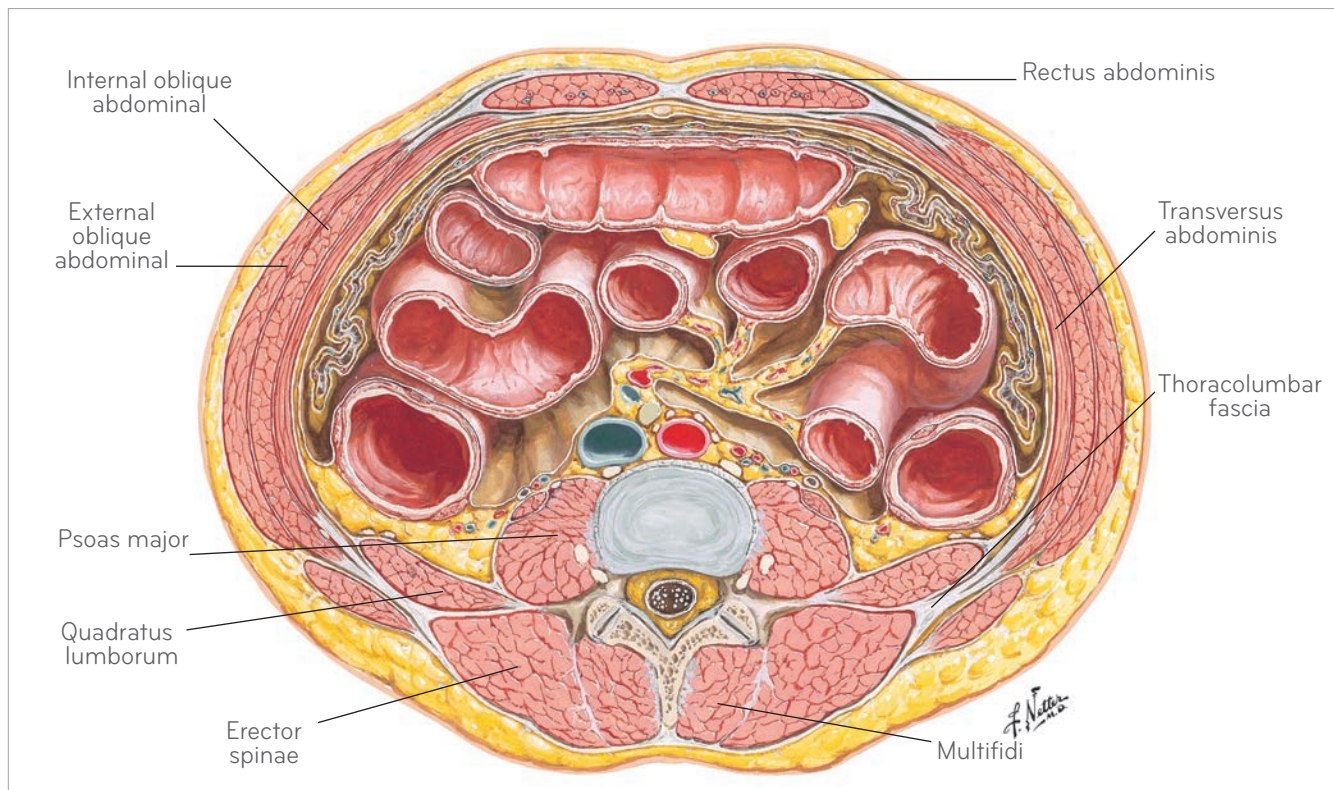
Spinous processes of T7 - S5

Insertion

Posterior iliac crest to the high point. Fibers should cover the Quadratus lumborum.



Thoracolumbar Fascia



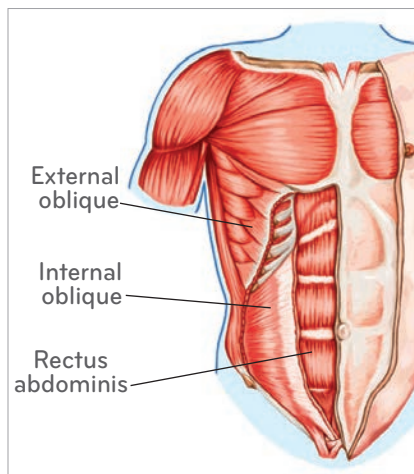
Cross section through the torso at the level of L3 showing the relationships and fascial connections of the torso.

ABDOMINAL MUSCLES

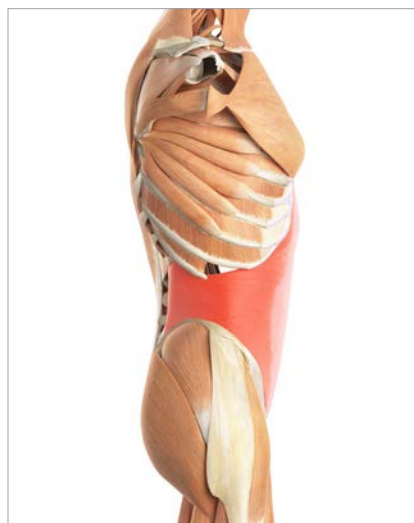
TRANSVERSUS ABDOMINIS, RECTUS ABDOMINIS, INTERNAL OBLIQUE, EXTERNAL OBLIQUE

The abdominal muscles are a critical element of trunk integration. The transversus abdominis forms the deepest layer of the abdominals and is critical to the stabilizing action of the inner unit or core. The three outer layers, the internal oblique, external oblique and rectus abdominis, create movement of the torso and integrate the trunk with the limbs..

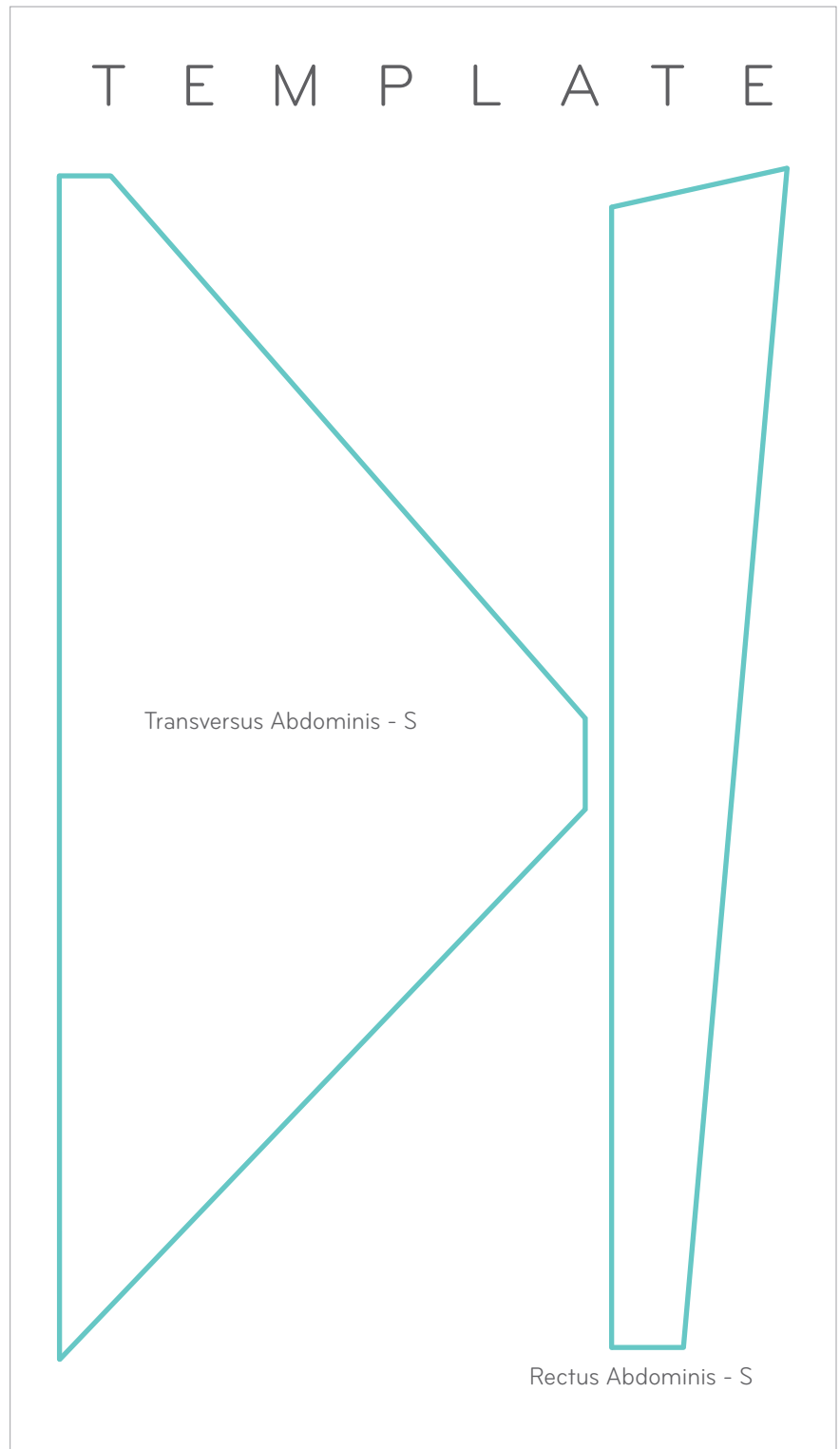
- ▶ Transversus abdominis
- ▶ Rectus abdominis
- ▶ Internal oblique
- ▶ External oblique



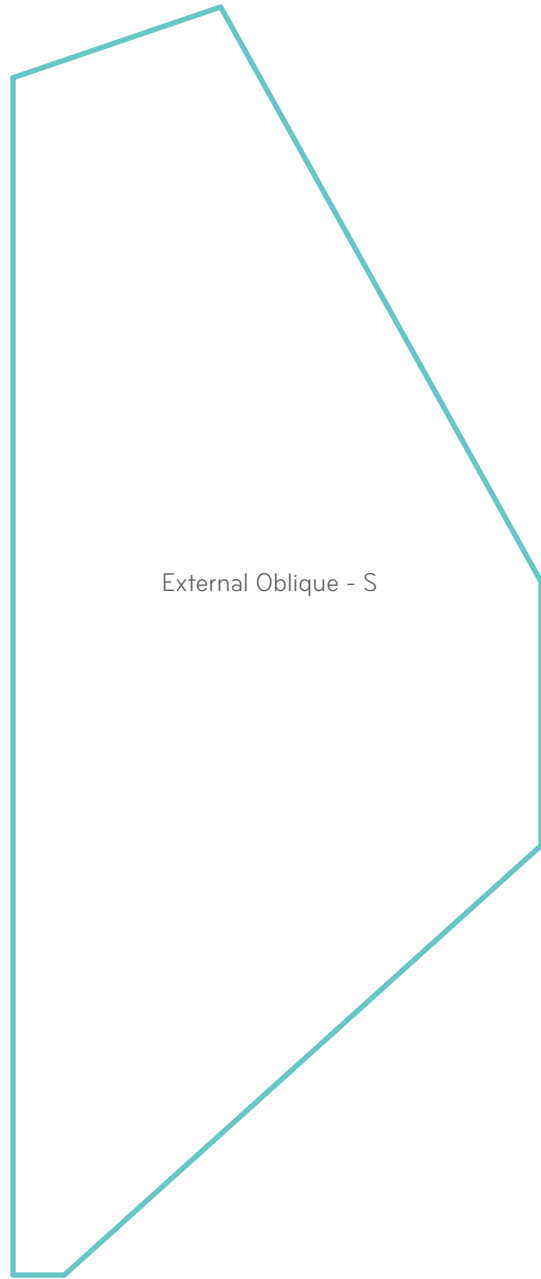
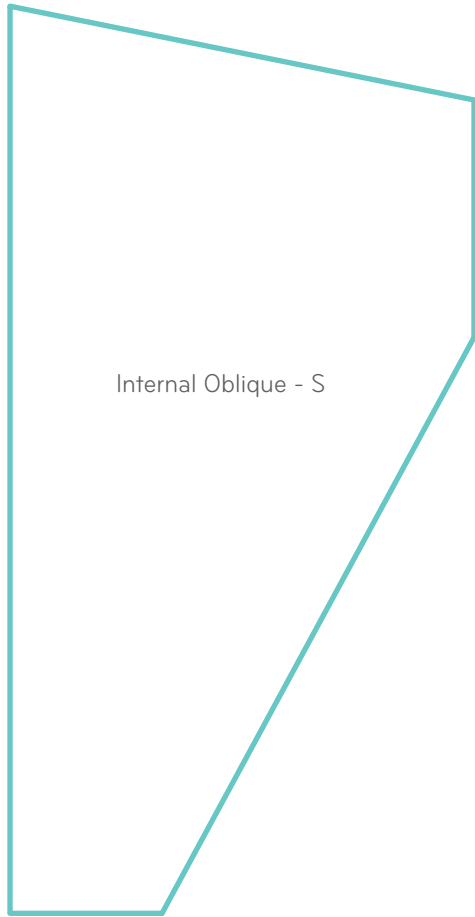
External abdominals



Transverse abdominis



T E M P L A T E



ABDOMINAL MUSCLES

TRANSVERSE ABDOMINIS AND RECTUS ABDOMINIS

TRANSVERSE ABDOMINIS

The transverse abdominis or TA is the deepest abdominal muscle. Its fibers run horizontally around the waist connecting the ribs, spine and pelvis and protecting the internal organs.

Origin

Lateral third of inguinal ligament, iliac crest, thoracolumbar fascia and internal surfaces of lower 6 ribs.

Insertion

Abdominal aponeurosis to linea alba.

Action

► Compresses contents of abdomen and stabilizes lumbar spine.

RECTUS ABDOMINIS

The rectus abdominis (sometimes called the "6-pack") is the most superficial abdominal muscle. It connects the front of the rib cage to the pubic bone.

Origin

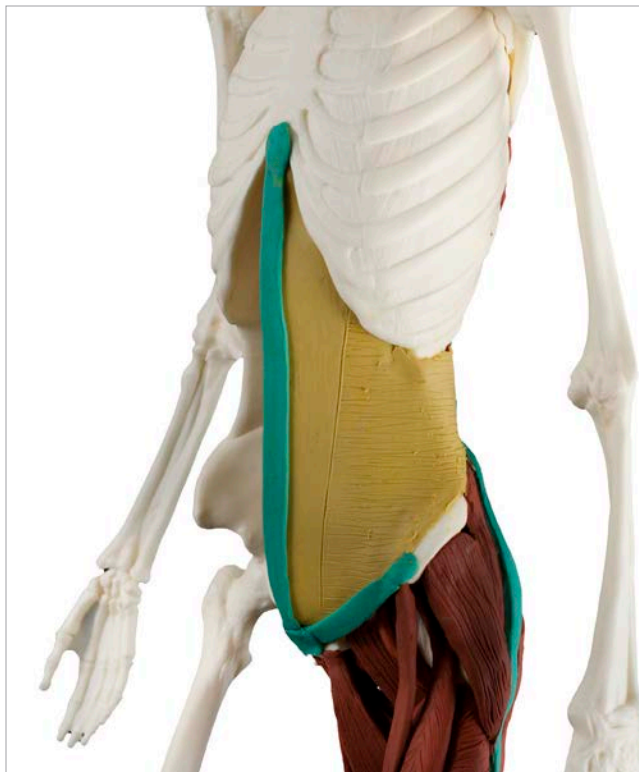
Superior surface of the pubic symphysis.

Insertion

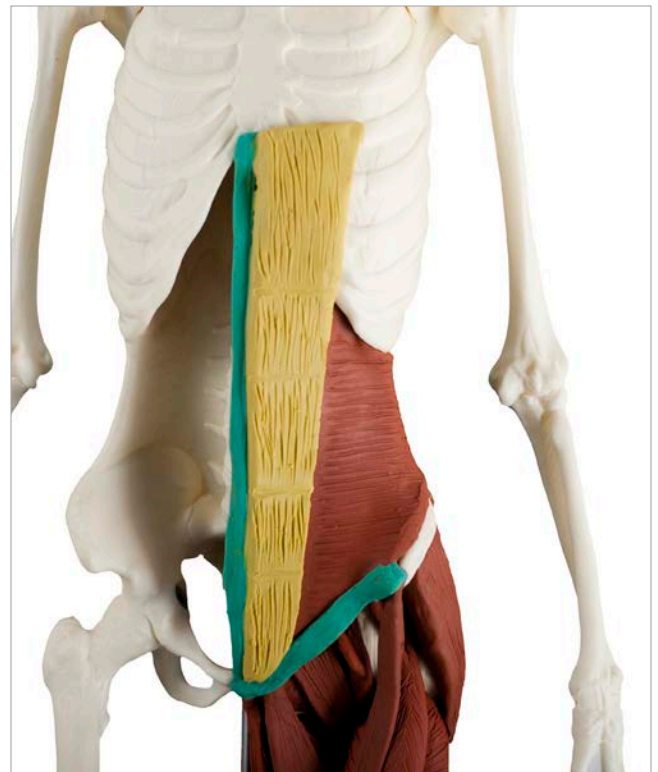
External costal cartilage of ribs 5-7 and xiphoid process.

Action

► Spinal flexion, lateral spinal flexion and posterior pelvic tilt.



Transverse Abdominis



Rectus Abdominis

INTERNAL OBLIQUE ABDOMINAL AND EXTERNAL OBLIQUE ABDOMINAL

INTERNAL OBLIQUE ABDOMINAL

The internal oblique covers the same space as the transverse abdominis but its fibers are oriented up and in toward the midline. This gives the internal oblique the ability to move the torso in flexion, rotation and lateral flexion.

Origin

Lateral third of inguinal ligament, iliac crest and thoracolumbar fascia.

Insertion

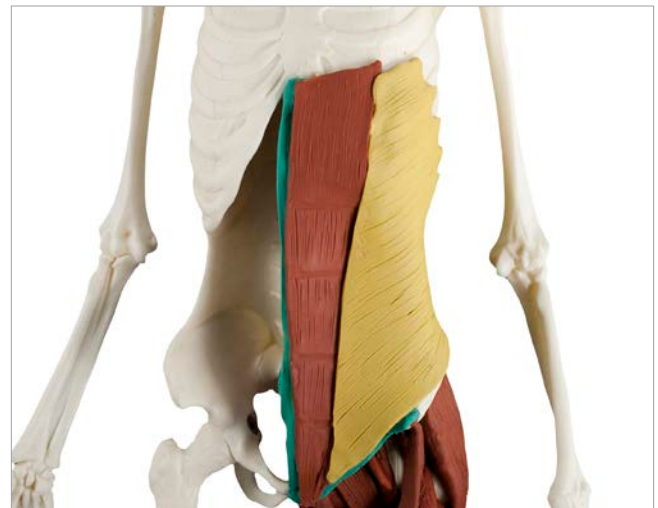
Cartilage of ribs 10-12, abdominal aponeurosis to linea alba.

Action

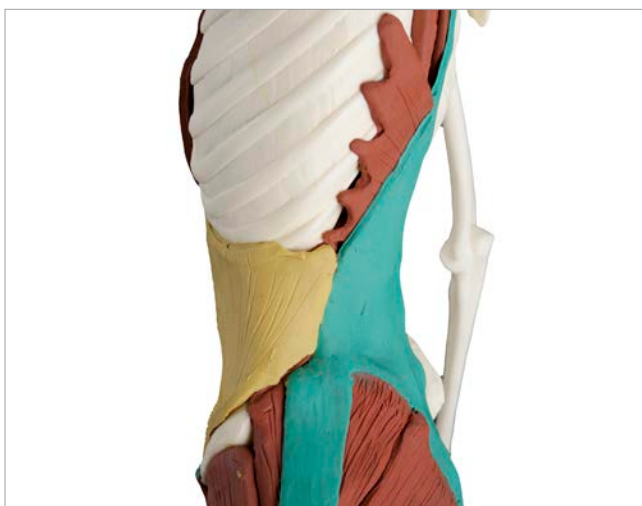
► Spinal flexion, lateral spinal flexion, spinal rotation to same side.



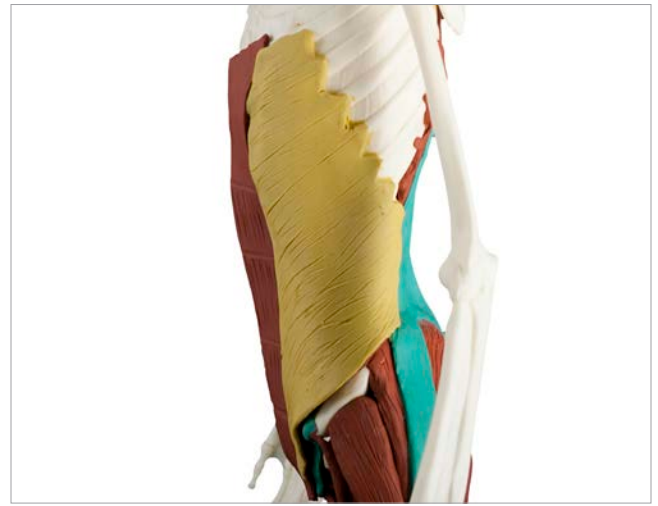
Internal Oblique, anterior view



External Oblique, anterior view



Internal Oblique, side view



External Oblique, side view

ABDOMINAL MUSCLES

ABDOMINAL MUSCLES IN ACTION

MUSCLES	Flexion	Lateral Flexion	Contralateral Rotation	Ipsilateral Rotation	Spinal Stability
Transverse abdominis					X
Internal oblique abdominal	X	X		X	
External oblique abdominal	X	X	X		
Rectus abdominis	X	X			



Torso flexion

- ▶ Internal oblique abdominal (bilateral)
- ▶ External oblique abdominal (bilateral)
- ▶ Rectus abdominis (bilateral)



Torso rotation

- ▶ Internal oblique abdominal (ipsilateral)
- ▶ External oblique abdominal (contralateral)



Torso lateral flexion

- ▶ Internal oblique abdominal (unilateral)
- ▶ External oblique abdominal (unilateral)
- ▶ Rectus abdominis (unilateral)

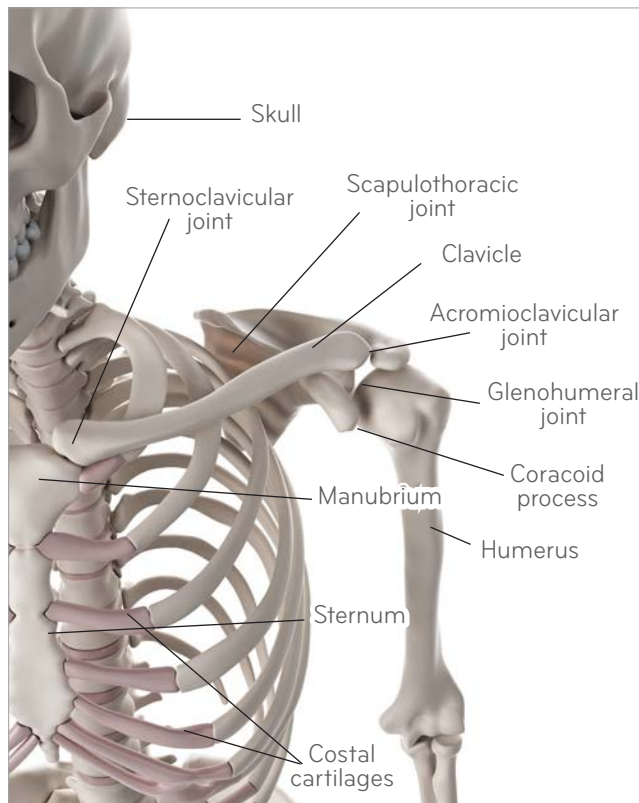
THE SHOULDER GIRDLE AND UPPER LIMB

BONES OF THE SHOULDER GIRDLE

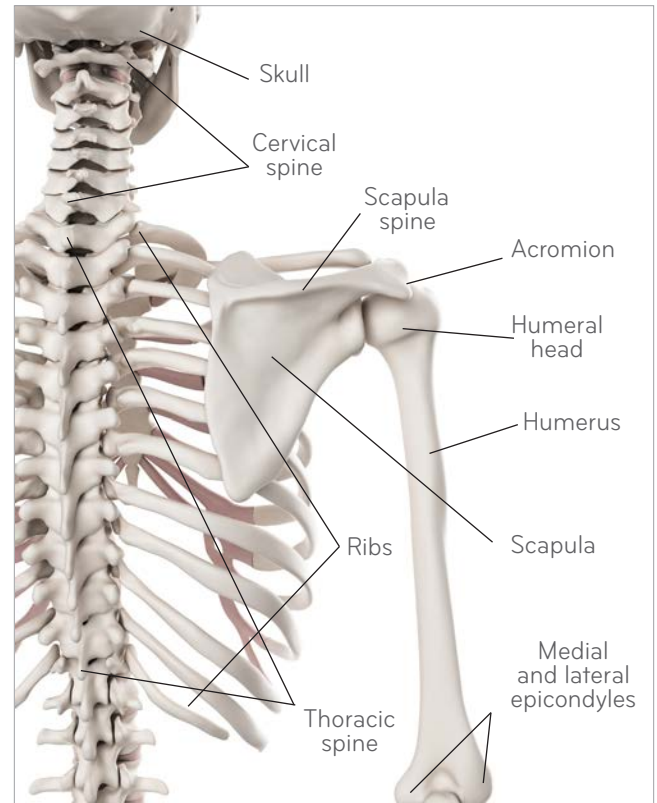
Bones and Joints of the Upper Body

Bones of the upper body are designed for strength and stability while allowing for both large ranges of motion as used in swimming and tremendous manual dexterity for fine work like texting or playing music. The bones include:

- ▶ Clavicle
 - Sternoclavicular joint
 - Acromioclavicular joint
- ▶ Scapula
 - Glenoid fossa
 - Scapular spine
 - Acromion
 - Coracoid process
 - Scapulothoracic joint
- ▶ Humerus
 - Humeral head
 - Medial and lateral epicondyles
 - Glenohumeral joint
- ▶ Lower arm
 - Elbow joint
 - Radius
 - Ulna
 - Wrist joint
 - Carpals
 - Metacarpals
 - Phalanges



Bones of the upper body, anterior.



Bones of the upper body, posterior.

Shoulder Girdle Anatomy

The shoulder girdle consists of three primary bones, the clavicle, scapula and humerus and four primary joints, the sternoclavicular, acromioclavicular and glenohumeral, as well as the muscular rather than bony scapulothoracic joint. These bones and joints all work together to create balanced, functional, pain free shoulder movement.

BONES OF THE SHOULDER GIRDLE

Clavicle

- ▶ The clavicle or collar bone is a long bone which lies between the sternum and its corresponding scapula.
- ▶ It ties the scapula to the axial skeleton and creates the only bone connection between the shoulder girdle and the torso.
- ▶ The clavicle articulates with the sternum to form the sternoclavicular joint. This is a saddle joint allowing movement in all directions.

Scapula

- ▶ The scapula sits on the back of the ribs like a floating island that can be moved in many directions by different groups of muscles.
- ▶ It is connected to the torso through the acromioclavicular joint which connects the scapula to the clavicle and through the scapulothoracic joint which is not a traditional bony joint but is instead composed of muscles which keep the scapula attached to the rib cage.
- ▶ Many muscles attach to the scapula, clavicle and humerus so they can move the scapula in any direction.

Humerus

- ▶ Is a long bone that runs from the shoulder to the elbow.
 - ▶ It articulates with the glenoid fossa of the scapula and at the elbow to the radius and ulna.
-
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JOINTS OF THE SHOULDER GIRDLE

Sternoclavicular joint

- ▶ The sternoclavicular or SC joint connects the manubrium of the sternum and the medial end of the clavicle with a saddle joint.
- ▶ The saddle joint allows movement in all three planes including elevation, depression, protraction, retraction and circumduction at the sternoclavicular joint.
- ▶ Very few muscles attach directly to the sternoclavicular joint but it is moved by any action of the scapula and many movements of the glenohumeral joint.

Acromioclavicular joint

- ▶ The acromioclavicular or AC joint, is where the clavicle meets the acromion process of the scapula.
- ▶ The AC joint is a gliding synovial joint which forms the top of the shoulder.
- ▶ Its small amount of movement support healthy glenohumeral rhythm.

Scapulothoracic joint

- ▶ The scapulothoracic "joint" is formed by the muscles that support the scapula on the rib cage.
- ▶ Through the action of these muscles the scapula moves in elevation, depression, protraction, retraction and upward and downward rotation.

Glenohumeral joint

- ▶ The glenohumeral joint, often referred to as the shoulder joint, is where the glenoid fossa of the scapula and humeral head articulate.
- ▶ The large humeral head and the small glenoid fossa create a large range of motion at the glenohumeral joint.
- ▶ Motions include abduction, adduction, flexion, extension and medial and lateral rotation.
- ▶ Actions of the glenohumeral joint are often combined with actions of the scapula.

THE SHOULDER GIRDLE AND UPPER LIMB

ELBOW, WRIST AND HAND BONES

Lower Arm Anatomy

The lower arm bones consist of the radius, ulna, the irregular carpal bones of the wrist, the metacarpals and phalanges. The joints of the lower arm consist of the hinge like elbow joint, the more complex articulations of the wrist and the metacarpophalangeal joints of the metacarpals and phalanges, or fingers.

BONES OF THE LOWER ARM

Radius

- ▶ The radius or radial bone is one of the two long bones of the forearm.
- ▶ It is on the lateral side of the elbow and extends to the thumb side of the wrist. It runs parallel to the ulna.

Ulna

- ▶ The other long bone of the forearm is the ulna.
- ▶ It is on the medial side and extends to the 5th finger side of the wrist.
- ▶ It is longer than the radius and broader at the elbow but narrows as it approaches the wrist.
- ▶ The olecranon is a bony hook like protrusion on the proximal end of the ulna that forms the most pointed end of the elbow. It fits into the olecranon fossa on the humerus.

Carpals

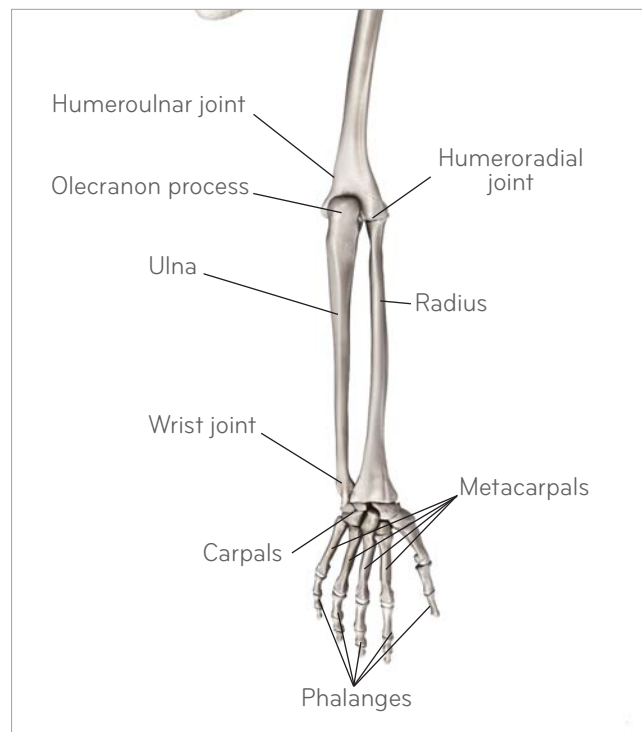
- ▶ The wrist includes eight carpal bones which connect the forearm to the hand.
- ▶ The cobblestone arrangement of these small irregular bones increases mobility at the wrist.

Metacarpals

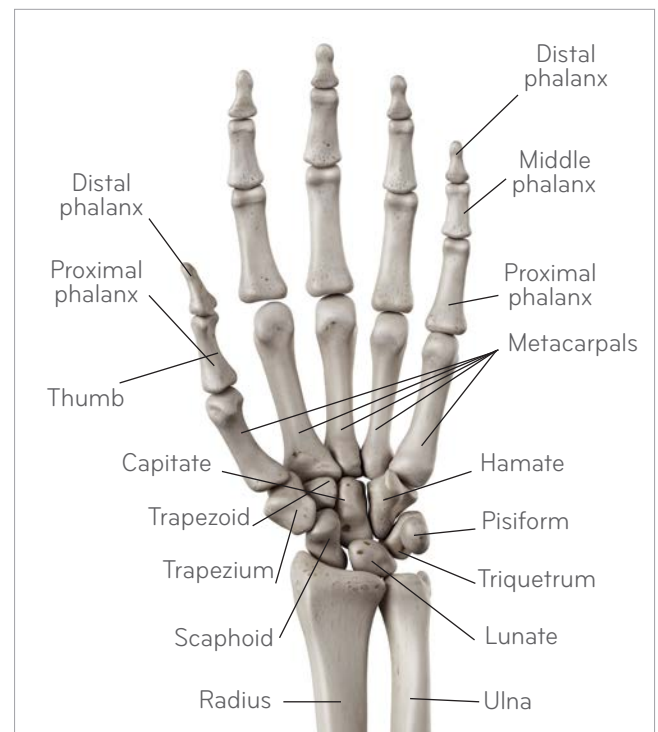
- ▶ The metacarpal bones form much of the palm area of the hand and lie between the carpals of the wrist and the phalanges of the fingers.

Phalanges

- ▶ In the hand, the phalanges make up the fingers.
- ▶ Each finger, with the exception of the thumb, has three phalanx bones. The thumb has two.



Bones of the lower arm



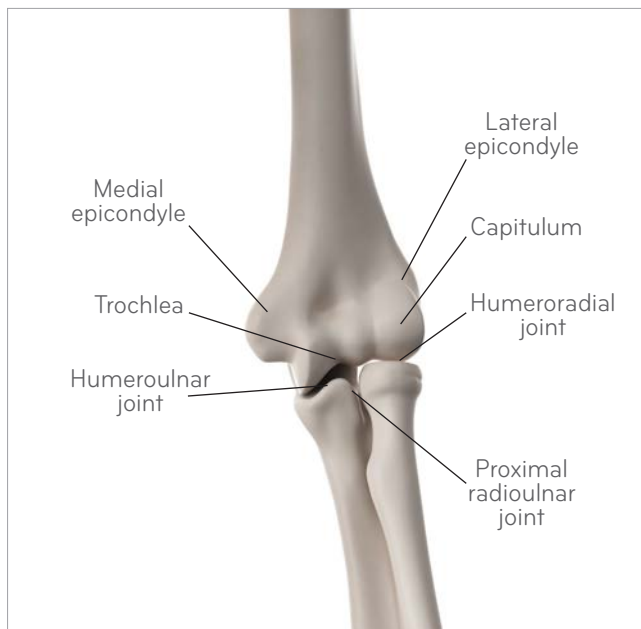
Bones of the wrist and hand

ELBOW, WRIST AND HAND JOINTS

JOINTS OF THE LOWER ARM

Elbow joint

- ▶ Compared to the knee joint the elbow joint has more complexity as it consists of three different joints which are surrounded by a single joint capsule. These three joints include:
 - **Humeroulnar joint:** A simple hinge joint where the hook of the olecranon process hinges around the trochlea of the humerus. This joint creates flexion and extension at the elbow.
 - **Humeroradial joint:** The joint between the disc shaped head of the radius and the capitulum of the humerus. This joint also participates in flexion and extension of the elbow.
 - **Proximal radioulnar joint:** This joint between the top of the radius and ulna allows the radius to rotate over the ulna creating pronation and supination of the forearm.



Elbow joint

Hanging by a process:

The *olecranon process* hooks into the *olecranon fossa* on the distal end of the humerus. This "hook" prevents hyperextension of the elbow, is a lever for the elbow extensor muscles and provides joint stability when swinging from trees!

Wrist including the radiocarpal and midcarpal joints

- ▶ The wrist contains two joints, the **radiocarpal joint** connects the hand and the forearm while the **midcarpal joint** creates motion between the two rows of carpal bones.
- ▶ The **radiocarpal joint** is an ellipsoid joint where the proximal row of carpals, primarily the lunate and scaphoid, glide against the end of the radius. The **radiocarpal joint** is the primary mover in wrist extension and ulnar deviation but participates in all the actions of the wrist including flexion, extension, abduction (radial deviation), adduction (ulnar deviation) and circumduction.
- ▶ The **midcarpal joint**, is formed by the movement between the proximal and distal carpals and amplifies the action of the radioulnar joint. The **midcarpal joint** is dominant in wrist flexion and radial deviation but participates in all actions of the wrist.

Metacarpophalangeal joints (MCP)

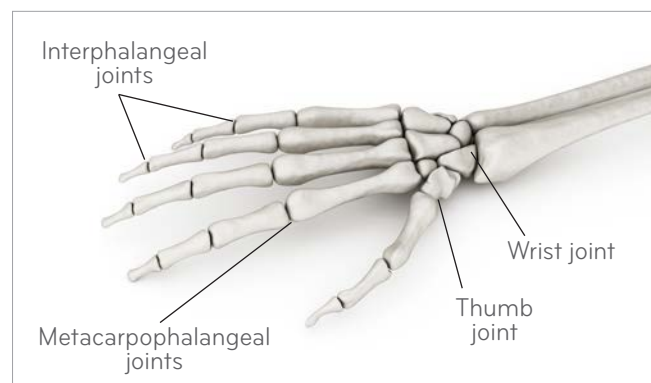
- ▶ The MCP joints between the metacarpal bones of the hand and the phalanges or finger bones create the knuckles at the base of the fingers.
- ▶ The MCP joints create flexion, extension, adduction, abduction, and circumduction at the base of the fingers.

Thumb joint or carpometacarpal joint

- ▶ The joint between the metacarpal of the thumb and the trapezium is a saddle joint. It allows movement in flexion, extension, abduction and adduction as well as opposition or bringing the thumb across the hand creating the ability to grasp and making us human.

Interphalangeal joints

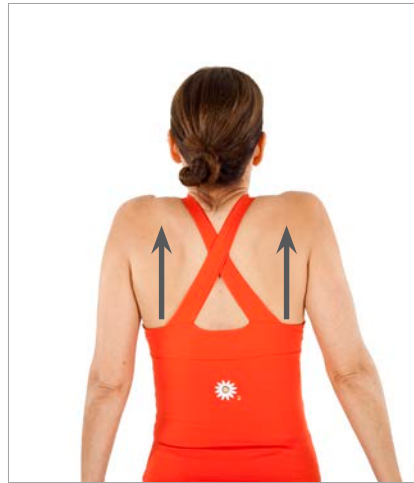
- ▶ These hinges joints between the phalanges create flexion and extension of the fingers.



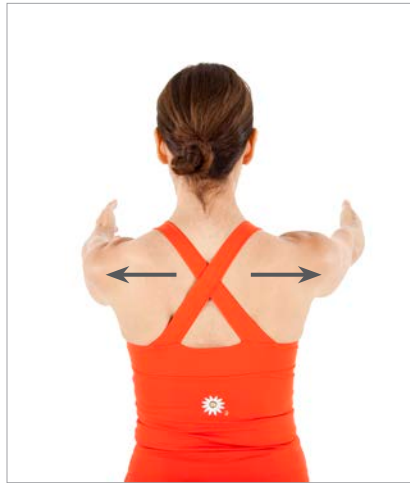
Joints of the wrist, hand and fingers

THE SHOULDER GIRDLE AND UPPER LIMB

MOVEMENTS OF THE SHOULDER GIRDLE AND UPPER LIMB



Scapular elevation



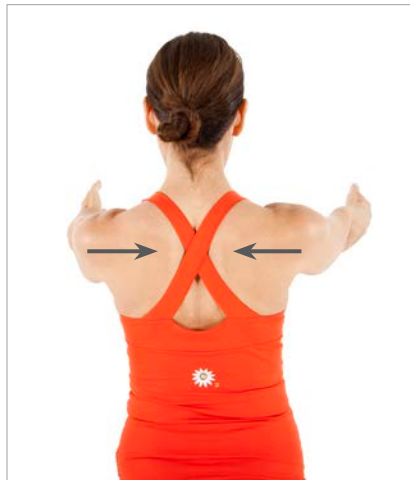
Scapular protraction



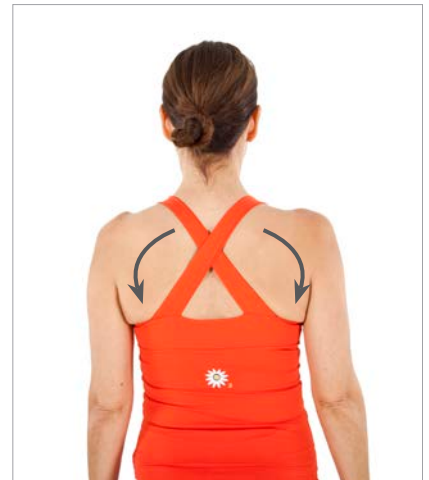
Scapular upward rotation



Scapular depression



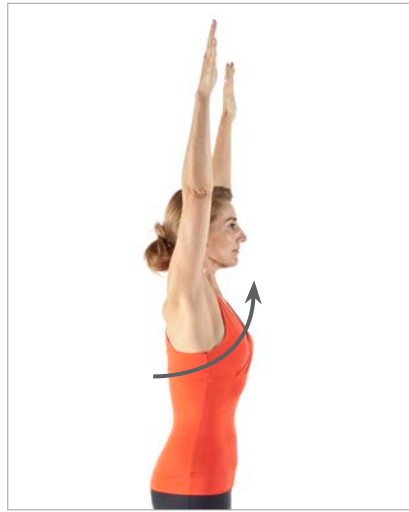
Scapular retraction



Scapular downward rotation



Glenohumeral medial rotation



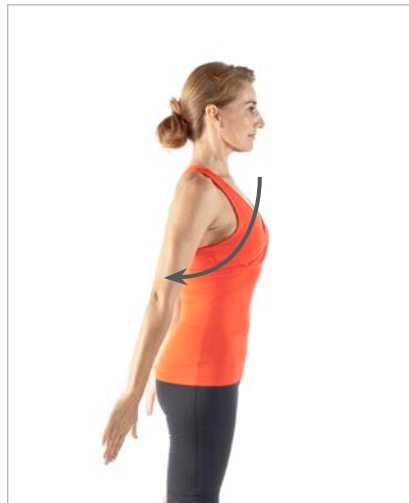
Glenohumeral flexion



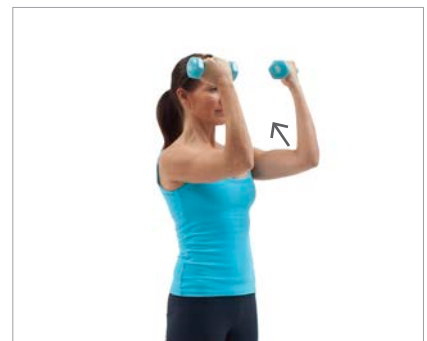
Elbow extension



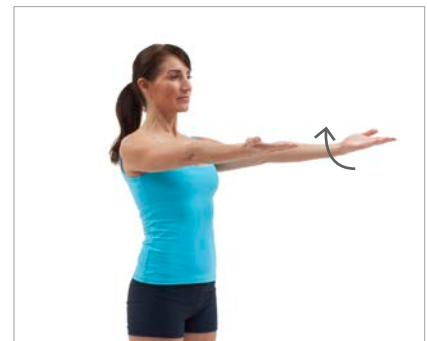
Glenohumeral lateral rotation



Glenohumeral extension



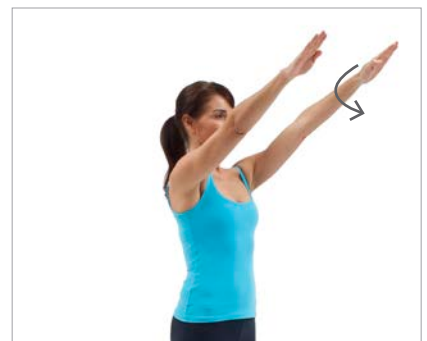
Elbow flexion



Forearm supination



Glenohumeral abduction and adduction



Forearm pronation

ROTATOR CUFF OF THE SHOULDER

SUBSCAPULARIS, SUPRASPINATUS, INFRASPINATUS AND TERES MINOR

The rotator cuff holds the humerus in the glenoid fossa and adjusts the humeral motion within the joint. The rotator cuff is more of an endurance muscle group than a strength muscle group, so training in this area should focus on light resistance and high repetitions.

- ▶ Subscapularis
- ▶ Supraspinatus
- ▶ Infraspinatus
- ▶ Teres Minor



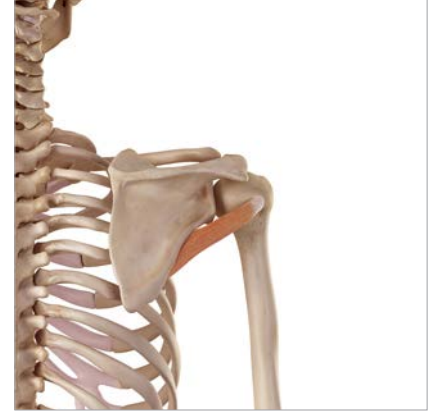
Subscapularis



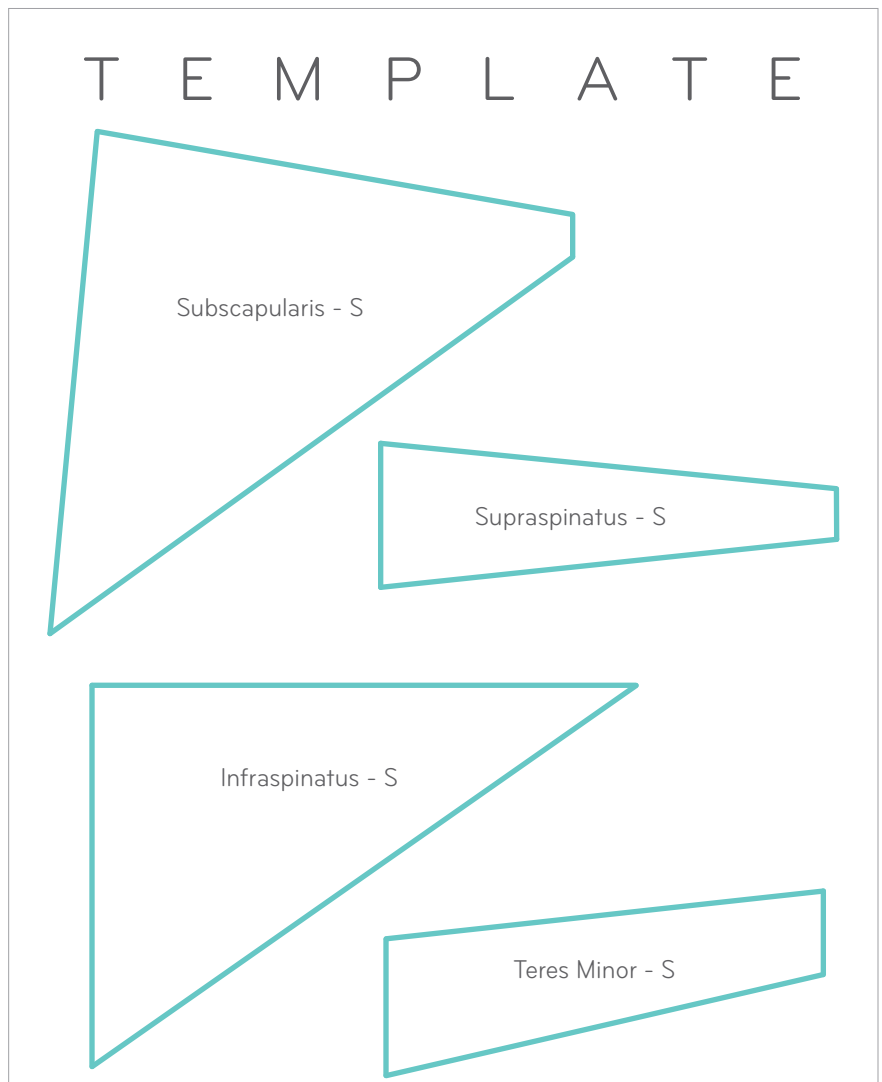
Supraspinatus



Infraspinatus



Teres Minor



SUBSCAPULARIS AND SUPRASPINATUS

SUBSCAPULARIS

The subscapularis fills in the underside of the scapula and connects to the head of the humerus. It lies on top of the serratus anterior and glides over the rib cage.

Origin

Entire anterior surface of subscapular fossa.

Insertion

Lesser tubercle of humerus.

Action

- ▶ Medial rotation, adduction and extension of glenohumeral joint.



Subscapularis

SUPRASPINATUS

The supraspinatus lies on top of the scapula and goes underneath the acromion to attach to the humeral head. Because of its position, it is the most commonly injured rotator cuff muscle.

Origin

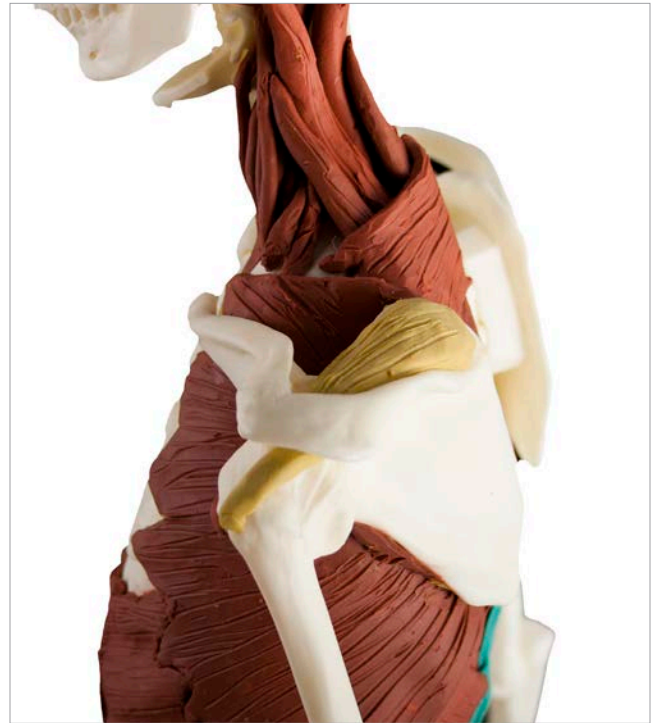
Medial two thirds of supraspinous fossa.

Insertion

Superiorly on greater tubercle of the humerus.

Action

- ▶ Glenohumeral abduction (primarily active in first 30 degrees) and stabilizes humeral head.



Supraspinatus

ROTATOR CUFF OF THE SHOULDER

INFRASPINATUS AND TERES MINOR

The infraspinatus and teres minor connect the back of the scapula to the humerus and are responsible for lateral rotation of the humerus.

INFRASPINATUS

Origin

Medial aspect of infraspinous fossa just below spine of scapula.

Insertion

Posteriorly on greater tubercle of humerus.

Action

► Lateral rotation, extension and horizontal abduction of glenohumeral joint.

TERES MINOR

Origin

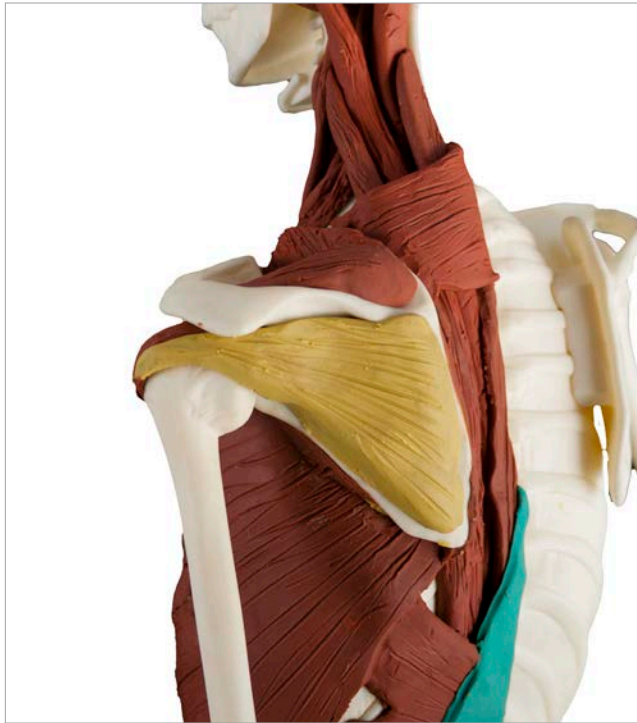
Posteriorly on upper and middle aspect of lateral border of scapula.

Insertion

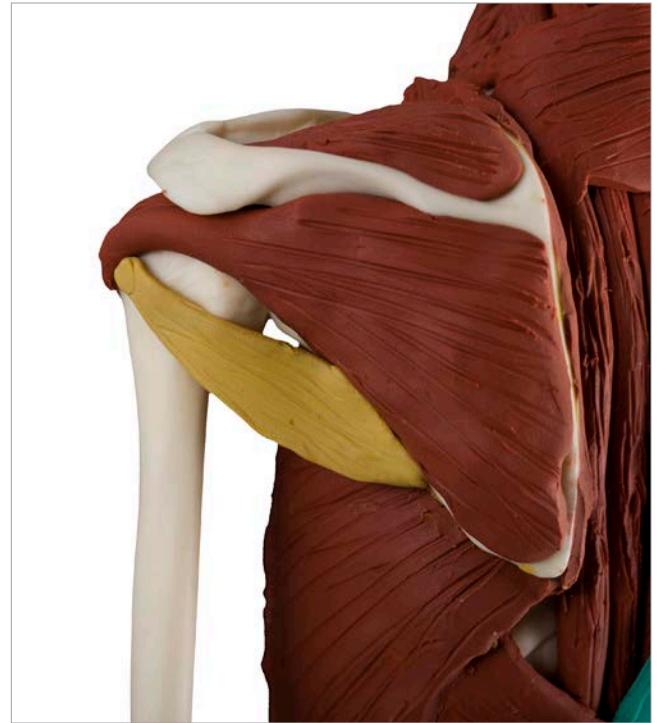
Posteriorly on greater tubercle of humerus.

Action

► Lateral rotation, extension and horizontal abduction of glenohumeral joint.



Infraspinatus



Teres Minor

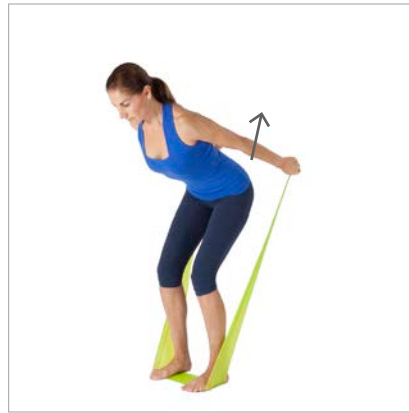
ROTATOR CUFF MUSCLES IN ACTION

MUSCLES	Lateral Rotation	Medial Rotation	Extension	Adduction	Abduction	Horizontal Abduction
Subscapularis		X	X	X		
Supraspinatus					X	
Infraspinatus	X		X			X
Teres minor	X		X			X



Medial rotation

- ▶ Subscapularis



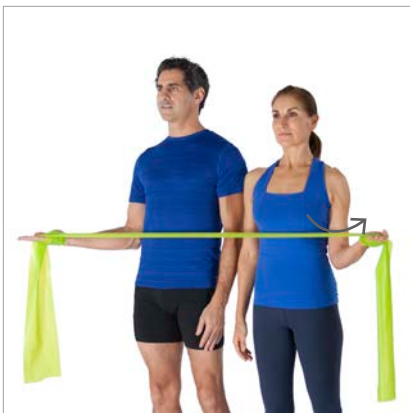
Glenohumeral extension

- ▶ Subscapularis
- ▶ Infraspinatus
- ▶ Teres minor



Horizontal abduction

- ▶ Infraspinatus
- ▶ Teres minor



Lateral rotation

- ▶ Infraspinatus
- ▶ Teres minor

MUSCLES OF THE UPPER ARM

TERES MAJOR, TRICEPS BRACHII, BRACHIALIS, CORACOBRAHIALIS, BICEPS BRACHII

These muscles are responsible for controlling the strength, speed and power of the arm in functional movements. They move the elbow and are accessories of glenohumeral movement.

- ▶ Teres Major
- ▶ Triceps Brachii

- ▶ Brachialis
- ▶ Coracobrachialis

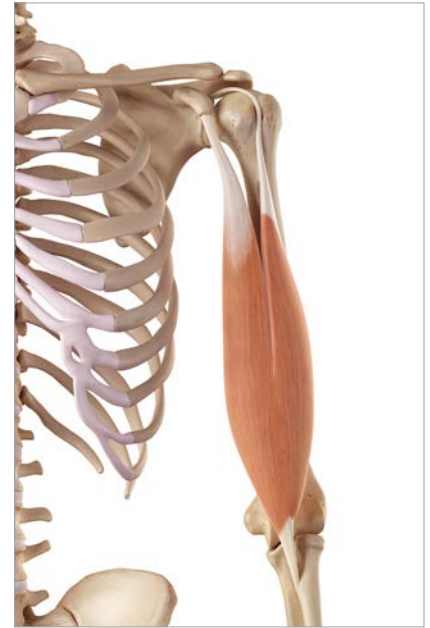
- ▶ Biceps Brachii



Teres Major



Brachialis



Biceps Brachii



Triceps Brachii



Coracobrachialis

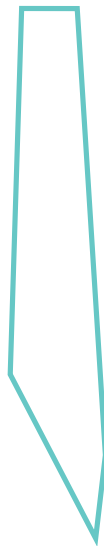
T E M P L A T E



Teres Major - S



Triceps Brachii
Medial Head - T



Triceps Brachii Long
Head - T



Brachialis - FS



Biceps Brachii - T



Triceps Brachii
Lateral Head - T



Coracobrachialis - T

MUSCLES OF THE UPPER ARM

TRICEPS BRACHII

TRICEPS BRACHII

The triceps brachii (three headed muscle of the arm) is the primary elbow extensor. It creates power for throwing and climbing.

Origin

Medial head

Distal two-thirds of posterior surface of humerus.

Lateral head

Upper half of posterior surface of humerus.

Long head

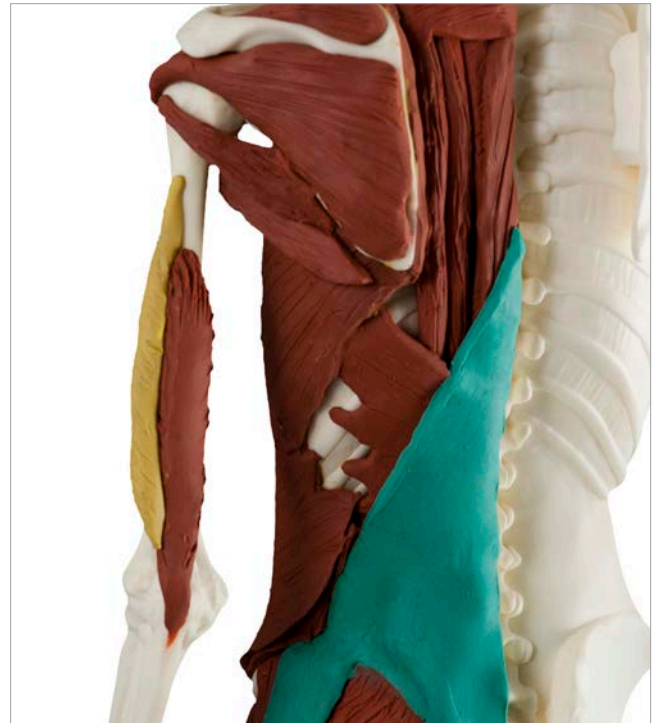
Infraglenoid tubercle below inferior lip of glenoid fossa of scapula.

Insertion

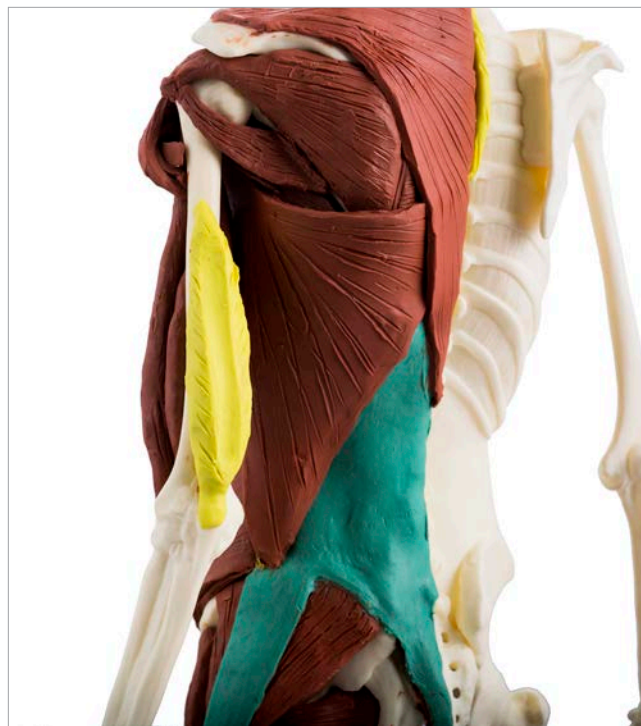
Olecranon process of ulna.

Action

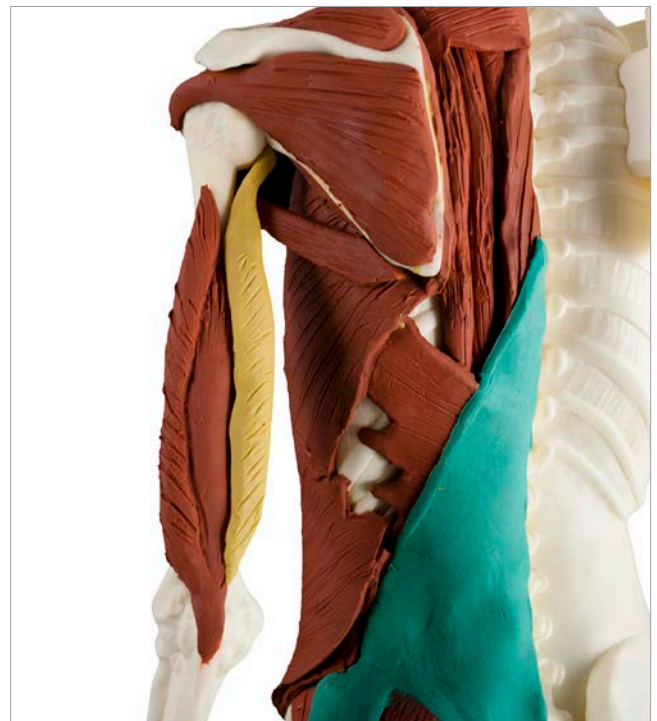
Elbow extension and glenohumeral extension (long head only).



Triceps Brachii, lateral head



Triceps Brachii, medial (deep) head



Triceps Brachii, long head

MUSCLES OF THE UPPER ARM

BRACHIALIS AND CORACOBRACHIALIS

BRACHIALIS

The brachialis covers the anterior aspect of the humerus much like the medial head of the triceps covers the posterior aspect of the humerus. The brachialis is an elbow flexor regardless of the position of the forearm because it attaches to the ulna.

Origin

Distal half of anterior portion of humerus.

Insertion

Coronoid process of ulna.

Action

► Elbow flexion regardless of the position of the forearm.

CORACOBRACHIALIS

The coracobrachialis connects the front of the scapula to the humerus and helps to tie the humerus to the scapula.

Origin

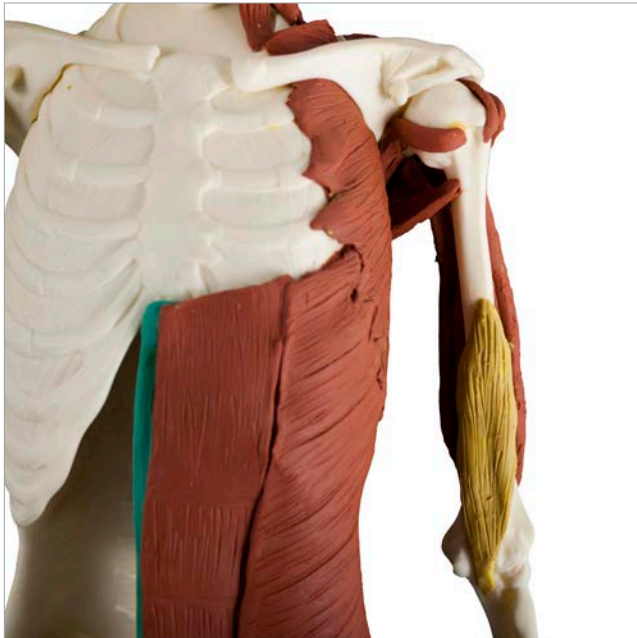
Coracoid process of scapula.

Insertion

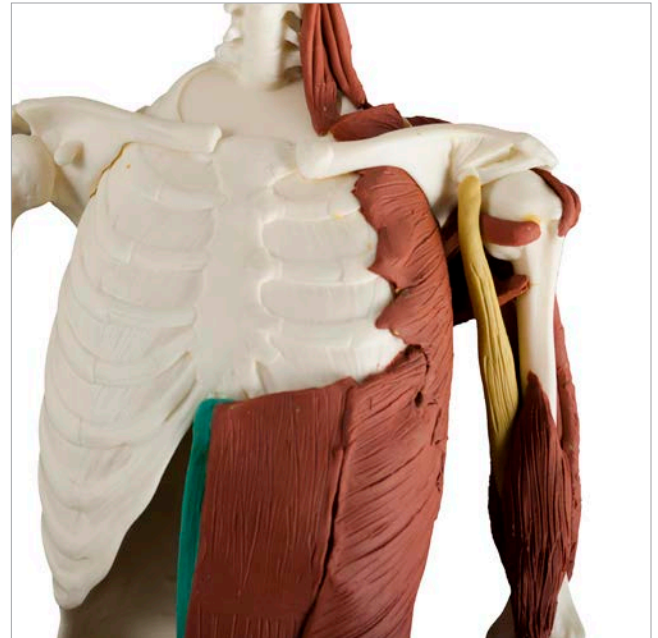
Middle of medial border of humeral shaft.

Action

► Flexion, adduction and horizontal adduction of glenohumeral joint.



Brachialis

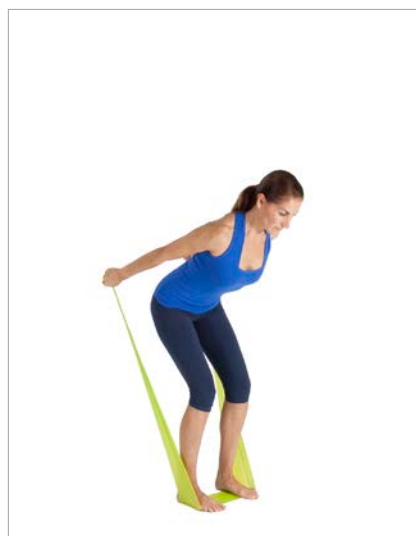


Coracobrachialis

MUSCLES OF THE UPPER ARM

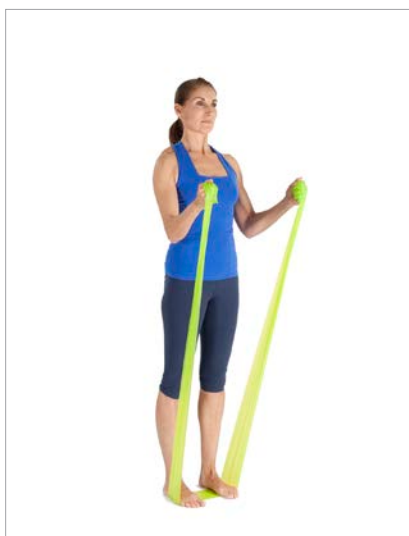
UPPER ARM MUSCLES IN ACTION

MUSCLES	Elbow Flexion	Elbow Extension	Glenohumeral Flexion	Glenohumeral Extension	Glenohumeral Adduction	Glenohumeral Horizontal Adduction
Triceps brachii		X		X		
Brachialis	X					
Coracobrachialis			X		X	X
Biceps brachii	X		X			



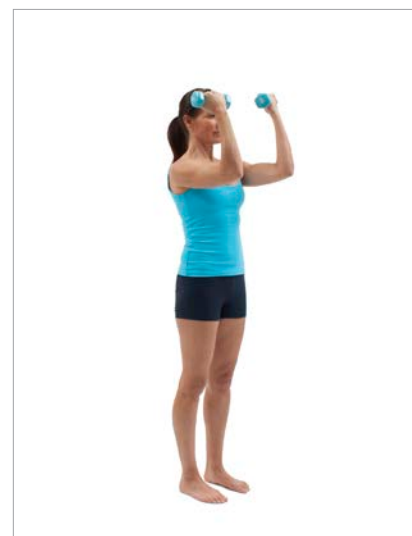
Elbow and glenohumeral extension

- ▶ Triceps brachii



Elbow flexion

- ▶ Brachialis
- ▶ Coracobrachialis
- ▶ Biceps brachii

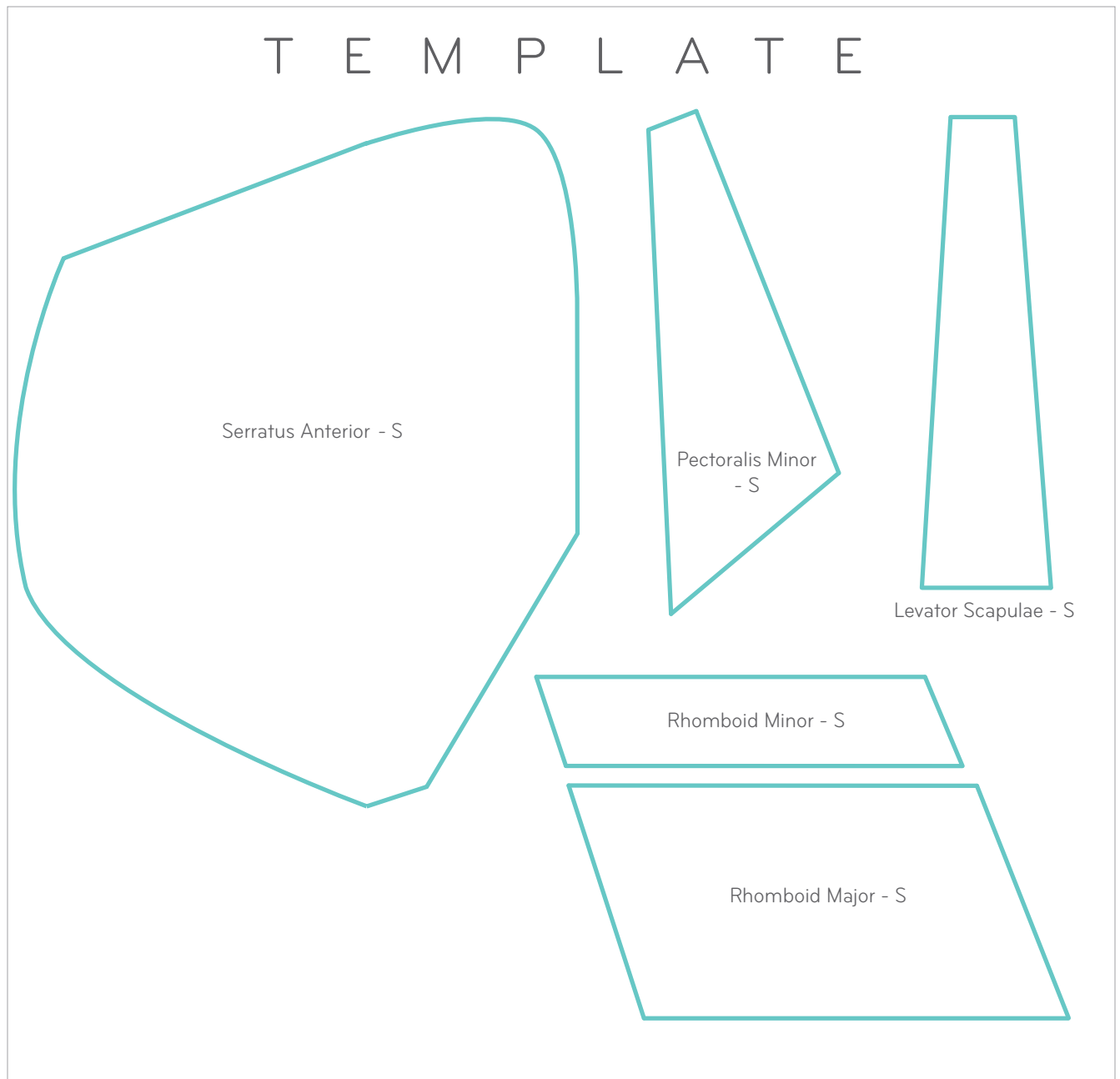


Elbow flexion, glenohumeral flexion, adduction and horizontal adduction

- ▶ Coracobrachialis
- ▶ Biceps brachii

MUSCLES OF THE SCAPULA

SERRATUS ANTERIOR, RHOMBOIDS, PECTORALIS MINOR, LEVATOR SCAPULAE



SERRATUS ANTERIOR

SERRATUS ANTERIOR

The serratus anterior ties the scapula to the ribcage and is a key stabilizer of the scapula. When weak, the scapula may "wing" away from the ribcage.

Origin

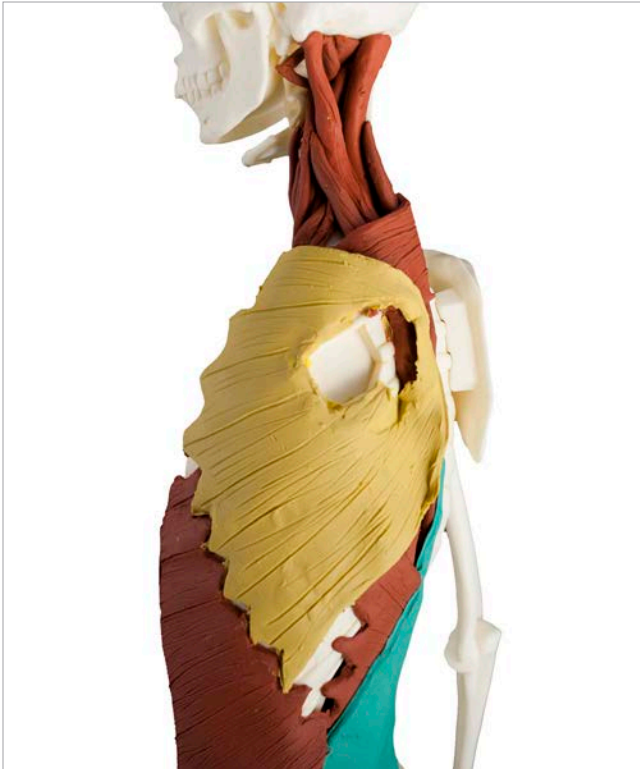
Surface of upper nine ribs at side of chest. The serratus interdigitates with the external oblique.

Insertion

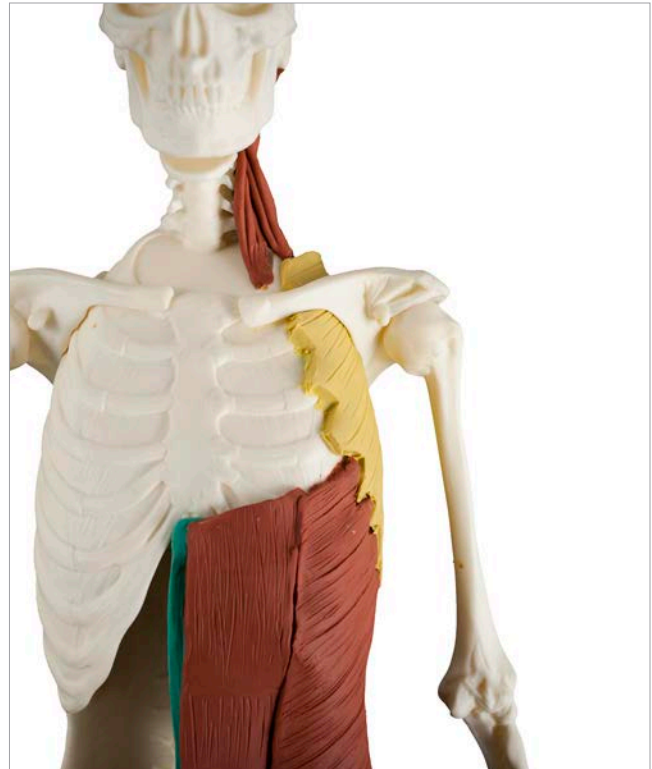
Anterior aspect of entire length of medial border of scapula.

Action

► Protraction, upward rotation and stabilization of scapula.



Serratus Anterior, side view



Serratus Anterior, anterior view

MUSCLES OF THE SCAPULA

RHOMBOIDS

The rhomboids connect the medial border of the scapula to the spine and work as a force couple with the serratus anterior to stabilize the scapula on the rib cage.

RHOMBOID MINOR

Origin

Spinous processes of C7 and T1.

Insertion

Medial border of scapula, level with scapular spine.

Action

► Retraction, elevation and downward rotation of scapula.

RHOMBOID MAJOR

Origin

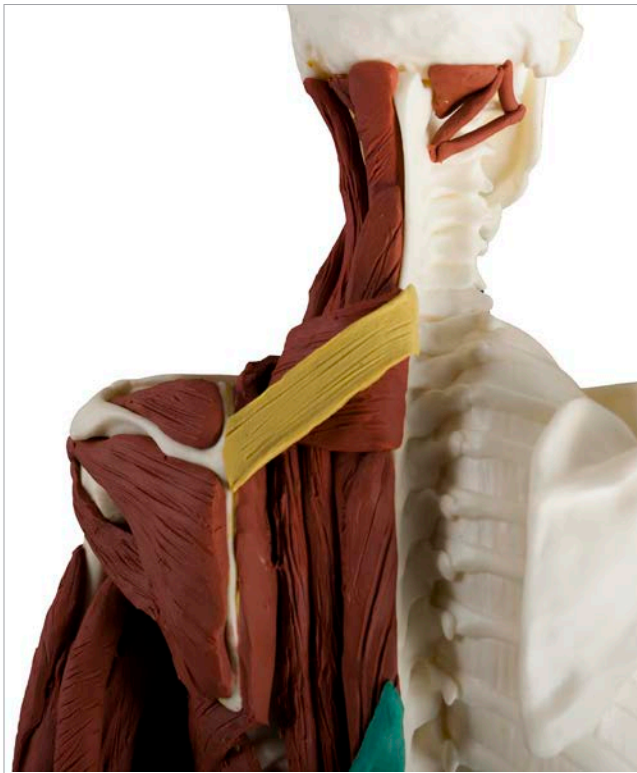
Spinous processes of T2 – T5.

Insertion

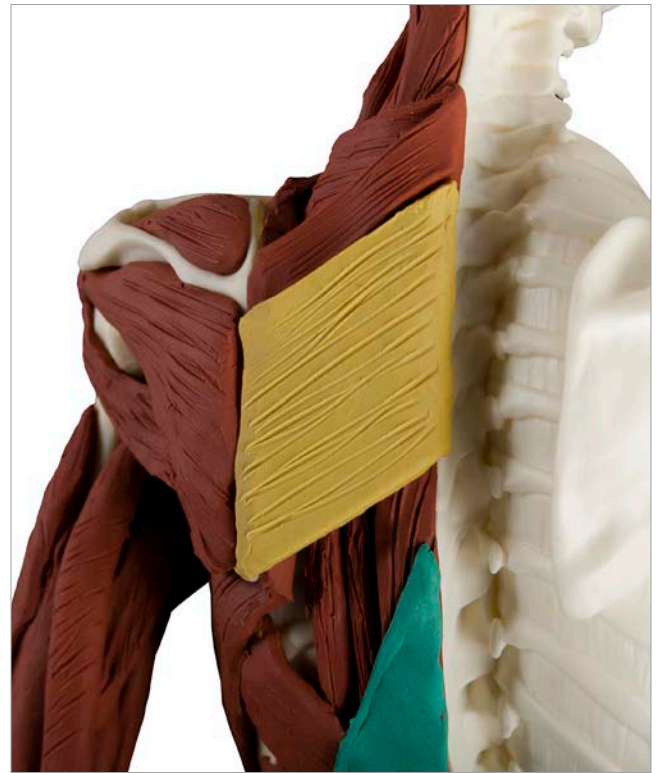
Medial border of scapula, below scapular spine.

Action

► Retraction, elevation and downward rotation of scapula.



Rhomboid Minor, posterior view



Rhomboid Major, posterior view

PECTORALIS MINOR AND LEVATOR SCAPULAE

PECTORALIS MINOR

Pectoralis minor attaches the front of the scapula to the ribs. It lies over the thoracic outlet, an area where nerves, blood supply and lymph move into the arm. When tight, it can pull the shoulders forward into protraction.

Origin

Anterior surfaces of 3rd – 5th ribs.

Insertion

Coracoid process of scapula.

Action

- ▶ Protraction, downward rotation and depression of the scapula.



Pectoralis Minor, anterior view

LEVATOR SCAPULAE

The levator scapulae (elevator of the scapula) connects the top corner of the scapula to the transverse processes of the upper cervical vertebrae. This muscle crosses multiple joints and can be prone to spasms and tension.

Origin

Transverse process of upper four cervical vertebrae.

Insertion

Superior angle of scapula, above scapular spine.

Action

- ▶ Scapula - Elevation, assists in retraction and downward rotation.
- ▶ Neck and head - Lateral flexion, ipsilateral rotation, extension.

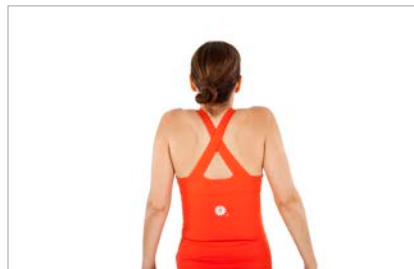


Levator Scapulae, posterior view

MUSCLES OF THE SCAPULA

SCAPULA MUSCLES IN ACTION

MUSCLES	Scapula Elevation	Scapula Depression	Scapula Protraction	Scapula Retraction	Scapula Upward Rotation	Scapular Downward Rotation
Serratus anterior			X		X	
Pectoralis minor		X	X			X
Rhomboid major and minor	X			X		X
Levator scapulae	X			X		X



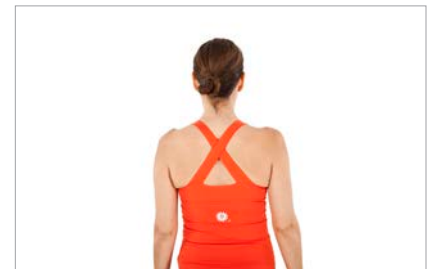
Scapula elevation, retraction and downward rotation

- Rhomboid major and minor
- Levator scapulae



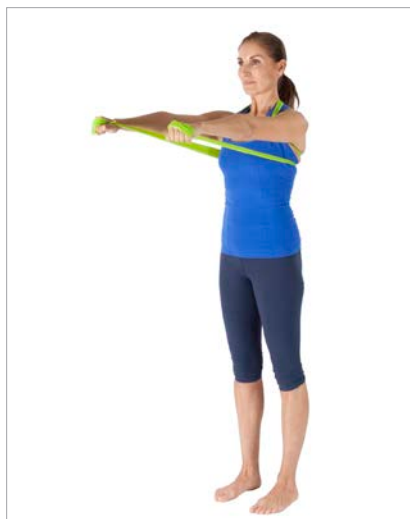
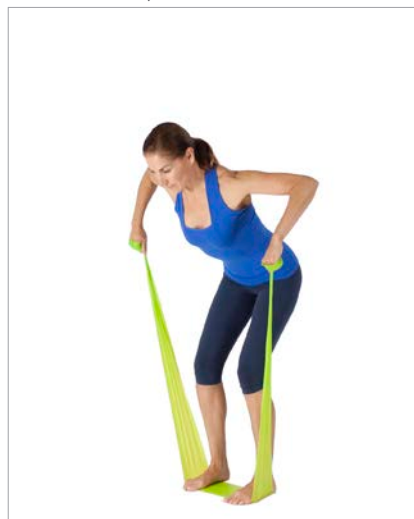
Scapula protraction and upward rotation

- Serratus anterior



Scapula depression, protraction and downward rotation

- Pectoralis minor



POWERFUL MUSCLES OF THE SHOULDER

LATISSIMUS DORSI, PECTORALIS MAJOR, DELTOID, TRAPEZIUS

LATISSIMUS DORSI

Latissimus dorsi (widest muscle of the back) ties the highly mobile humerus into the stability of the thoracolumbar fascia and pelvis. This muscle keeps the arm connected to the torso when hanging from the hands.

Origin

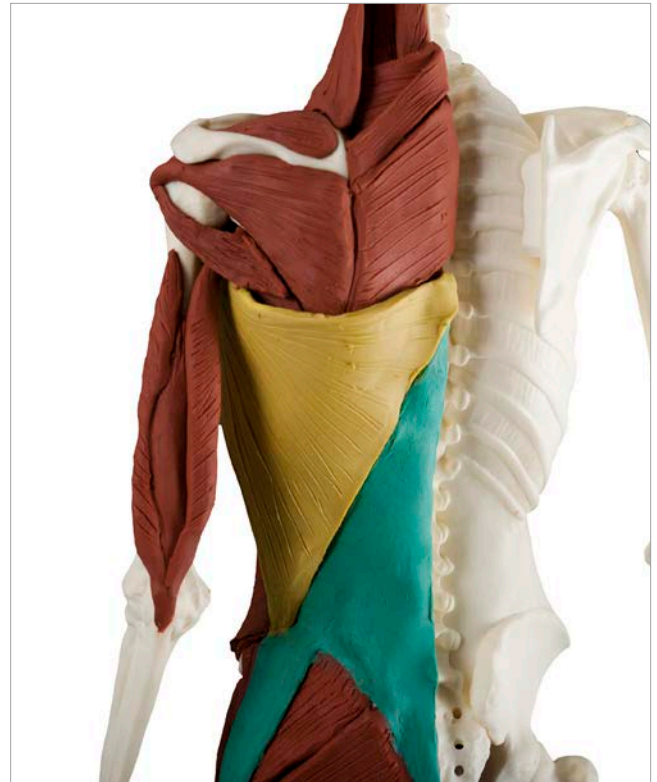
Attaches to the posterior iliac crest, spinous processes of lumbar and lower six thoracic vertebrae through the thoracolumbar fascia. It also has slips to the lower 3 ribs and the bottom of the scapula.

Insertion

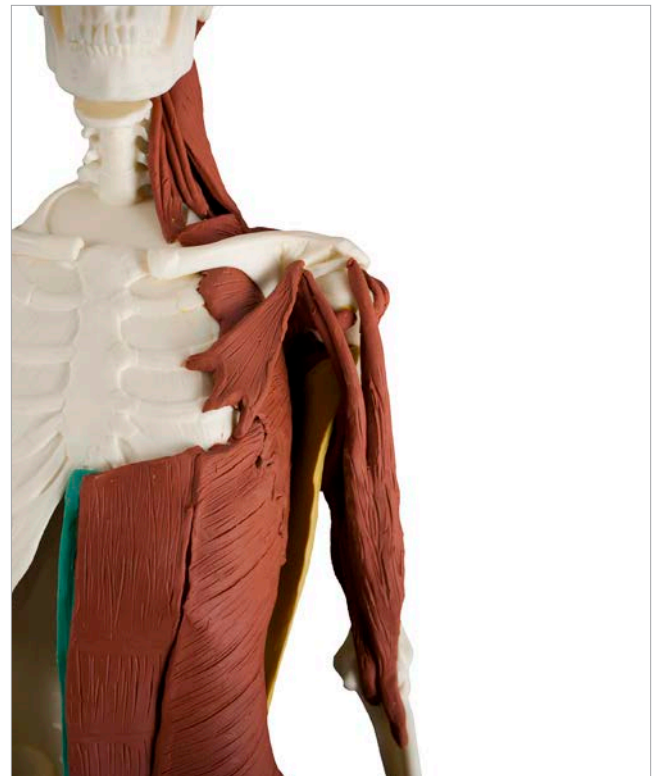
Medial side of intertubercular groove of humerus.

Action

► Extension, adduction, horizontal abduction and medial rotation of glenohumeral joint.



Latissimus Dorsi, posterior view



Latissimus Dorsi, anterior view

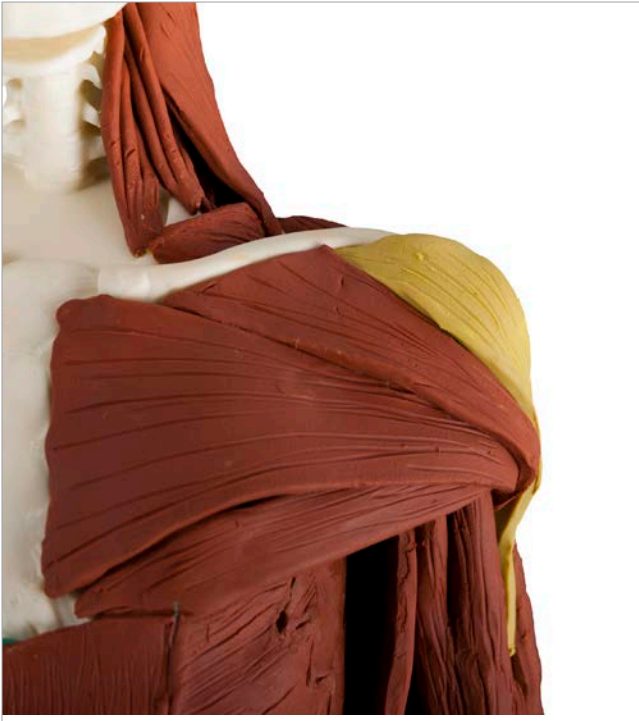
T E M P L A T E



Latissimus Dorsi - S

*This muscle will
need to be shaped

DELTOID



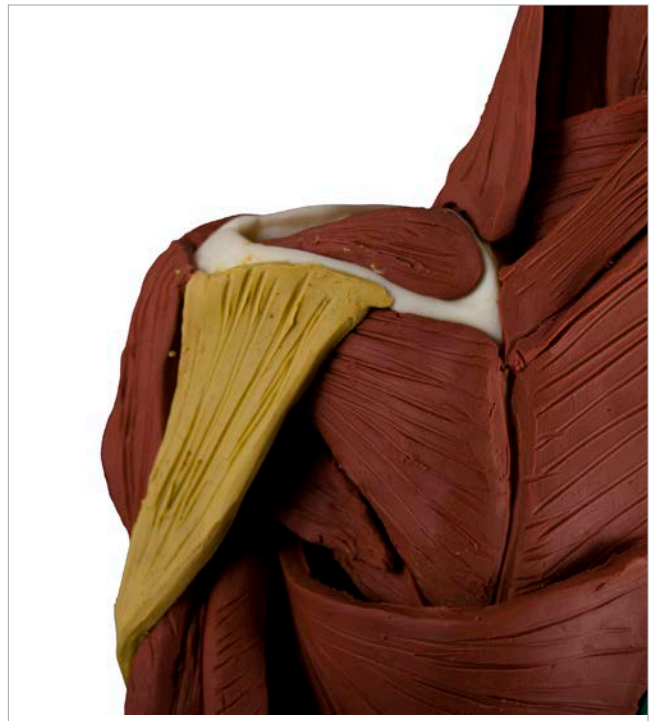
Deltoid, anterior fibers, anterior view



Deltoid, middle fibers



Deltoid, anterior fibers, lateral view



Deltoid, posterior fibers

POWERFUL MUSCLES OF THE SHOULDER

TRAPEZIUS

TRAPEZIUS

The trapezius is the superficial muscle of the upper back attaching from the skull to T12 and filling in the superior border of the clavicle, acromion and scapular spine. It also has 3 parts each with distinct actions

Origin

Upper fibers – Base of skull, occipital protuberance and posterior neck ligaments.

Middle fibers – Spinous processes of 7th cervical and upper three thoracic vertebrae.

Lower fibers – Spinous processes of 4th through 12th thoracic vertebrae.

Insertion

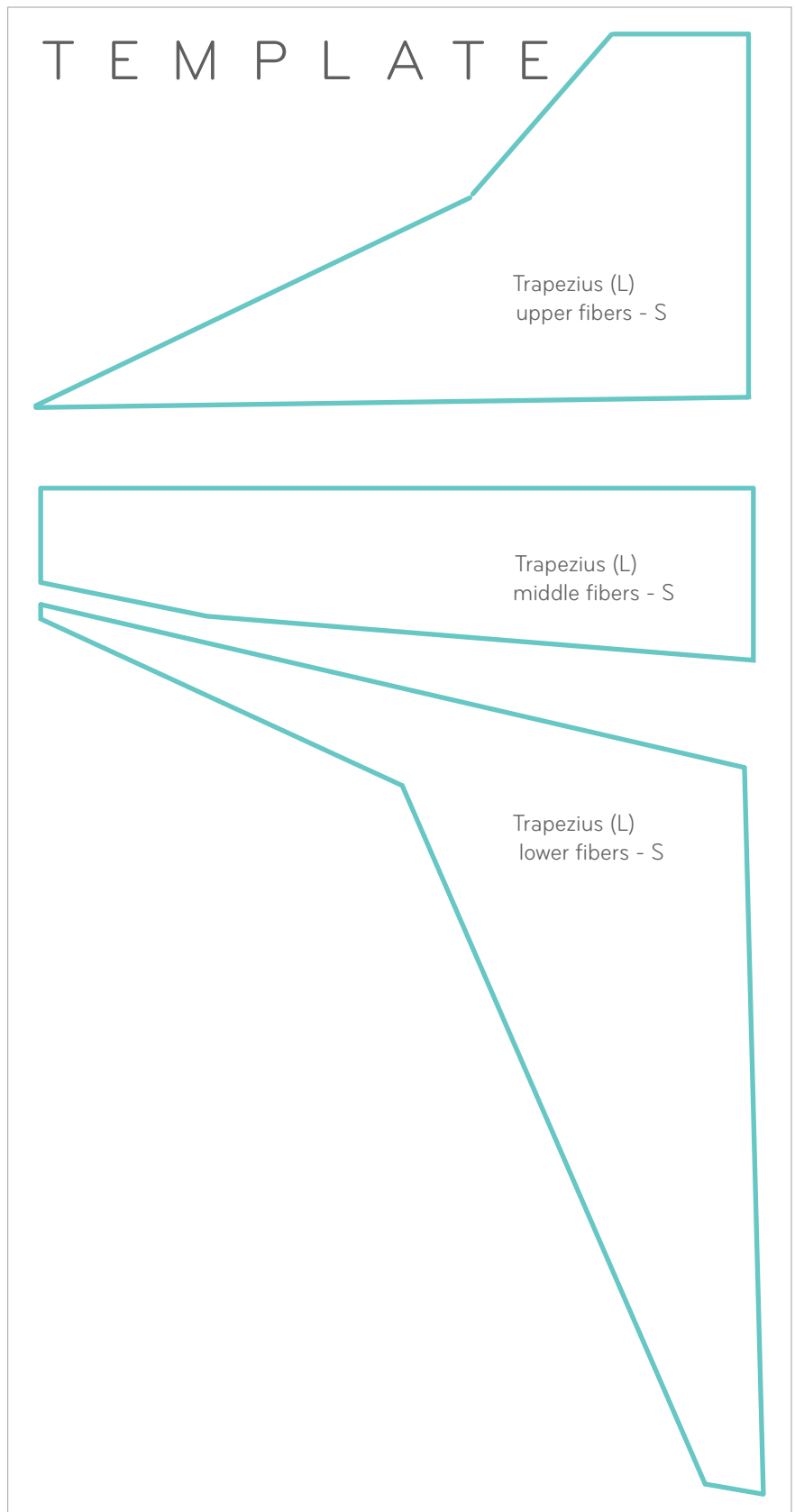
Upper fibers – Posterior aspect of the lateral 3rd of the clavicle.

Middle fibers – Medial border of acromion process and upper border of scapular spine.

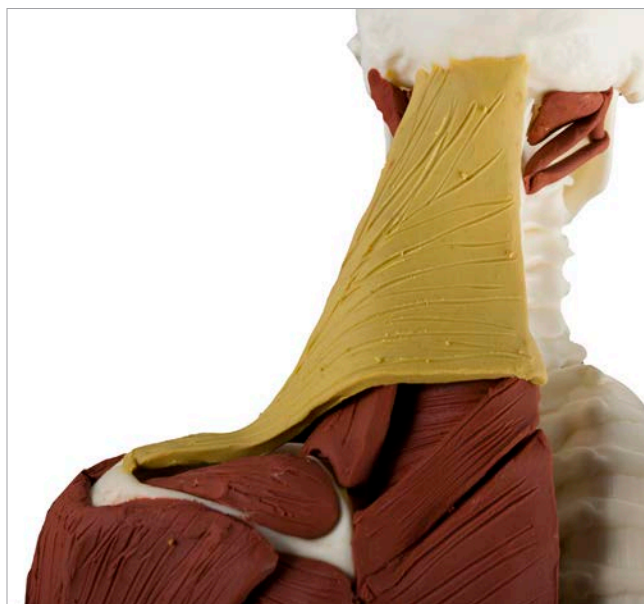
Lower fibers – Triangular space at base of scapular spine.

Action

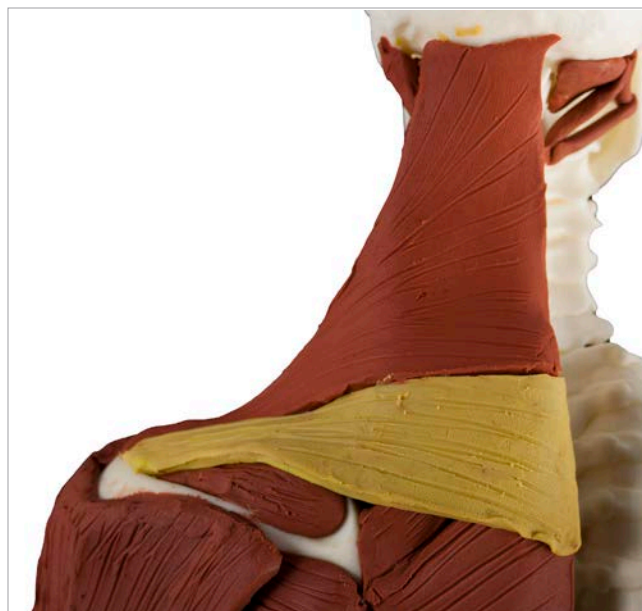
- ▶ Bilaterally: Extend head and neck.
- ▶ Unilaterally: Laterally flex head and neck to same side, rotate head and neck to opposite side, elevate and upwardly rotate scapula.
- ▶ All fibers – Upwardly rotate scapula.
- ▶ Upper fibers – Laterally flex head and neck to same side, rotate head and neck to opposite side, elevate scapula.
- ▶ Middle fibers – Adduct and stabilize scapula.
- ▶ Lower – Depress and upwardly rotate scapula.



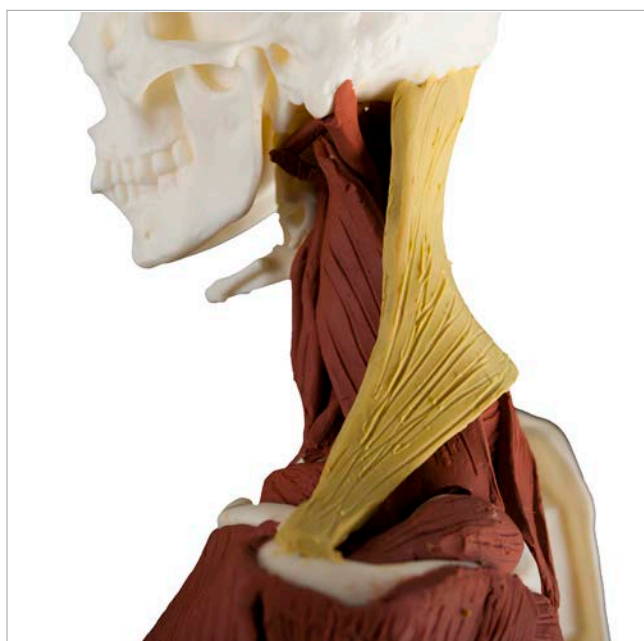
TRAPEZIUS



Trapezius, upper fibers, posterior view



Trapezius, middle fibers



Trapezius, upper fibers, lateral view



Trapezius, lower fibers

POWERFUL MUSCLES OF THE SHOULDER

POWERFUL SHOULDER MUSCLES IN ACTION

MUSCLES	GLENOHUMERAL MOTION							Lateral Rotation
	Flexion	Extension	Adduction	Abduction	Horizontal Adduction	Horizontal Abduction	Medial Rotation	
Latissimus dorsi		X	X			X	X	
Pectoralis major Upper fibers	X		X				X	
Pectoralis major Middle and lower fibers		X	X				X	
Deltoid Anterior fibers	X			X	X		X	
Deltoid Middle fibers				X				
Deltoid Posterior fibers		X		X		X		X

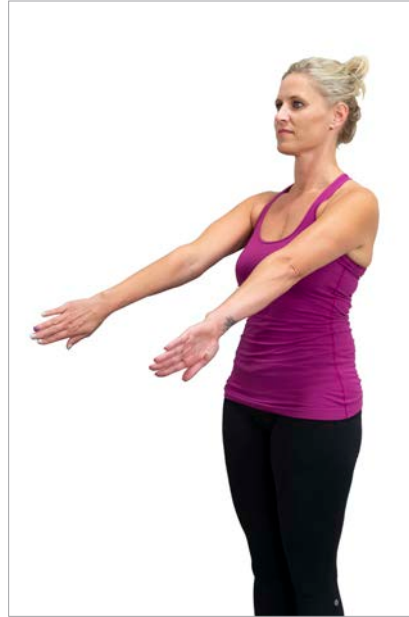
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POWERFUL SHOULDER MUSCLES IN ACTION



Glenohumeral extension, adduction and medial rotation

- ▶ Latissimus dorsi
- ▶ Pectoralis major, middle and lower fibers



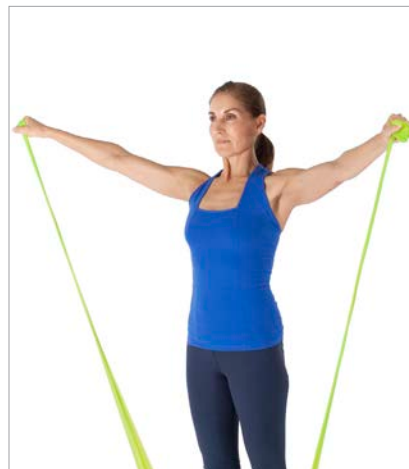
Glenohumeral flexion, adduction and medial rotation

- ▶ Pectoralis major, upper fibers
- ▶ Pectoralis major, middle and lower fibers



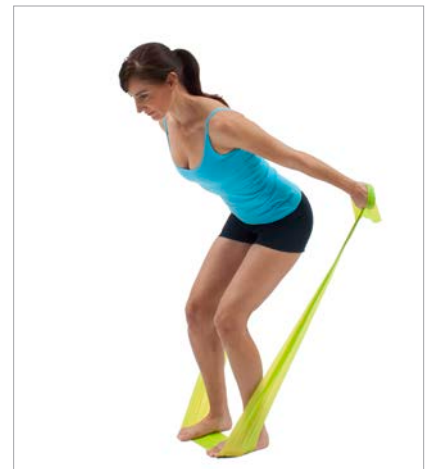
Glenohumeral flexion, horizontal adduction, abduction and medial rotation

- ▶ Deltoid, anterior fibers



Glenohumeral abduction

- ▶ Deltoid, middle fibers



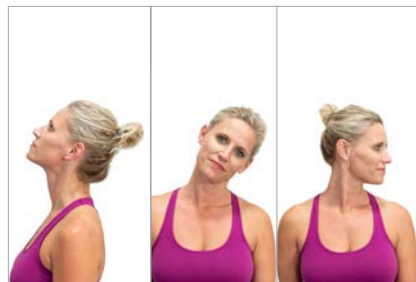
Glenohumeral extension, horizontal abduction, abduction and lateral rotation

- ▶ Deltoid, posterior fibers

POWERFUL MUSCLES OF THE SHOULDER

POWERFUL SHOULDER MUSCLES IN ACTION

MUSCLES	HEAD AND NECK MOTION			SCAPULAR MOTION			
	Extension	Lateral Flexion	Rotation to Opposite Side	Upward Rotation	Elevation	Depression	Retraction
Trapezius Upper fibers	X	X	X	X	X		
Trapezius Middle fibers							X
Trapezius Lower fibers				X		X	
Trapezius All fibers	X			X			



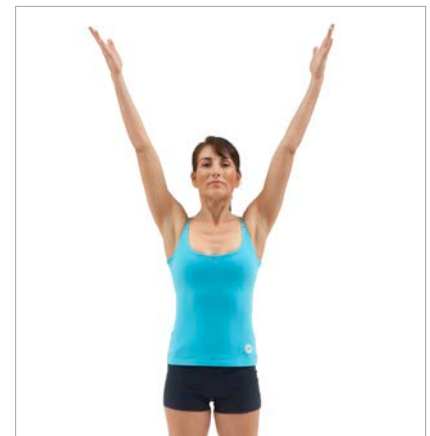
Head and neck extension, lateral flexion and rotation to opposite Side

► Trapezius, upper and all fibers



Scapula retraction

► Trapezius, middle fibers



Scapula upward rotation and depression

► Trapezius, middle and all fibers
