Chapter 2: Human Anatomy

ACE Personal Trainer Manual
Third Edition
# Anatomical Terminology

<table>
<thead>
<tr>
<th>Direction</th>
<th>Description</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior (Ventral)</td>
<td>Toward the Front</td>
<td>Medial</td>
<td>Toward the Midline of the Body</td>
</tr>
<tr>
<td>Posterior (Dorsal)</td>
<td>Toward the Back</td>
<td>Lateral</td>
<td>Away from the Midline of the Body</td>
</tr>
<tr>
<td>Superior</td>
<td>Toward the Head</td>
<td>Proximal</td>
<td>Toward the Attached End of the Limb or Midline</td>
</tr>
<tr>
<td>Inferior</td>
<td>Away from the Head</td>
<td>Distal</td>
<td>Away from the Attached End of the Limb or Midline</td>
</tr>
<tr>
<td>Superficial</td>
<td>External; Close to Body Surface</td>
<td>Deep</td>
<td>Internal; Further Beneath the Body Surface</td>
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</tbody>
</table>
## Anatomical Terminology

<table>
<thead>
<tr>
<th>Region</th>
<th>Description</th>
<th>Plane</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar</td>
<td>Regional Term Referring to Between Abdomen &amp; Pelvis</td>
<td>Horizontal Plane</td>
<td>Dividing the Body into Superior &amp; Inferior Parts</td>
</tr>
<tr>
<td>Cervical</td>
<td>Regional Term Referring to the Neck</td>
<td>Transverse Plane</td>
<td>Dividing the Body into Right &amp; Left Sections</td>
</tr>
<tr>
<td>Thoracic</td>
<td>Regional Term Referring to Between Neck &amp; Abdomen</td>
<td>Frontal Plane</td>
<td>Longitudinal Line Dividing the Body into Anterior &amp; Posterior Parts</td>
</tr>
<tr>
<td>Frontal Plane</td>
<td>Longitudinal Line Dividing the Body into Anterior &amp; Posterior Parts</td>
<td>Sagittal Plane</td>
<td>Longitudinal Line Dividing the Body into Right &amp; Left Sections</td>
</tr>
<tr>
<td>Transverse Plane</td>
<td>Horizontal Plane Dividing the Body into Superior &amp; Inferior Parts</td>
<td></td>
<td></td>
</tr>
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## Anatomical Terminology

<table>
<thead>
<tr>
<th>Root</th>
<th>Meaning</th>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>arthro</td>
<td>Joint</td>
<td>Arthritis</td>
<td>Inflammation of a Joint</td>
</tr>
<tr>
<td>bi</td>
<td>Two</td>
<td>Biceps</td>
<td>Two-Headed Muscle</td>
</tr>
<tr>
<td>brachium</td>
<td>Arm</td>
<td>Brachialis</td>
<td>Muscle of the Arm</td>
</tr>
<tr>
<td>cardio</td>
<td>Heart</td>
<td>Cardiology</td>
<td>The Study of the Heart</td>
</tr>
<tr>
<td>cephalo</td>
<td>Head</td>
<td>Cephalic</td>
<td>Pertaining to the Head</td>
</tr>
<tr>
<td>chondro</td>
<td>Cartilage</td>
<td>Chondroectomy</td>
<td>Excision of a Cartilage</td>
</tr>
<tr>
<td>costo</td>
<td>Rib</td>
<td>Costochondral</td>
<td>Pertaining to a Rib &amp; its Cartilage</td>
</tr>
<tr>
<td>dermo</td>
<td>Skin</td>
<td>Dermatitis</td>
<td>Inflammation of the Skin</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>hemo, hemat</td>
<td>Blood</td>
<td>Hemorrhage</td>
<td>Internal or External Bleeding</td>
</tr>
<tr>
<td>ilio</td>
<td>Ilium</td>
<td>Ilium</td>
<td>Wide, Upper Part of Pelvic Bone</td>
</tr>
<tr>
<td>myo</td>
<td>Muscle</td>
<td>Myocitis</td>
<td>Inflammation of a Muscle</td>
</tr>
<tr>
<td>os, osteo</td>
<td>Bone</td>
<td>Osteomalacia</td>
<td>Softening of the Bone</td>
</tr>
<tr>
<td>pulmo</td>
<td>Lung</td>
<td>Pulmonary Artery</td>
<td>Vessel that Brings Blood to Lungs</td>
</tr>
<tr>
<td>thoraco</td>
<td>Chest</td>
<td>Thorax</td>
<td>Chest</td>
</tr>
<tr>
<td>tri</td>
<td>Three</td>
<td>Triceps Brachii</td>
<td>Three-Headed Muscle on Arm</td>
</tr>
</tbody>
</table>
Anatomical Terminology

Planes of Motion

• Frontal (Coronal) - separates body into anterior & posterior parts

• Midsagittal (Median) - separates body into right & left parts

• Transverse (Horizontal) - separates body into superior & inferior parts
Anatomical Terminology

- Anatomical Position - standing erect with the feet and palms facing forward.
Anatomical Terminology

- Five (5) Major Human Body Systems (pertinent to physical activity):
  1. Cardiovascular
  2. Respiratory
  3. Nervous
  4. Skeletal
  5. Muscular
Cardiovascular System

- **Components:**
  - Blood
  - Blood Vessels
  - Heart

- **Purposes:**
  - Distribute $O_2$ and nutrients to the cells
  - Carry $CO_2$ and metabolic wastes from the cells
  - Protect against disease
  - Help regulate body temperature
  - Prevent serious blood loss after injury
Cardiovascular System

- Blood is the only fluid tissue in the body and is composed of two (2) parts:
  1. Formed Elements (white & red blood cells & platelets)
  2. Plasma (nonliving liquid portion of blood)

- Two (2) types of blood vessels:
  1. Arteries - carry blood away from the heart
  2. Veins - transport blood toward the heart
Cardiovascular System

- The largest arteries are those nearest the heart.

- Capillaries are microscopic blood vessels that branch to form an extensive network throughout the distal tissues.

- In the capillary beds, the critical exchange of nutrients and metabolic waste products takes place.
Respiratory System

- Respiration is the overall exchange of gases (O₂, CO₂, and N) between the atmosphere, the blood, and the cells.

- There are three (3) general phases of respiration:
  1. External: exchange of O₂ and CO₂ between the atmosphere and the blood within the large capillaries in the lungs.
  2. Internal: exchange of those gases between the blood and the cells of the body.
  3. Cellular: utilization of the O₂ and the production of CO₂ by the metabolic activity within cells.
Respiratory System

- The actual exchange of respiratory gases, such as O$_2$ and CO$_2$, between the lungs and the blood occurs at the bronchioles.
- The lungs are the final component of the respiratory system.
- The lungs are paired, cone-shaped organs lying in the thoracic cavity with three (3) lobes on the right and two (2) lobes on the left.
Nervous System

- The nervous system is divided into two (2) parts according to location:
  1. Central Nervous System (CNS): brain and spinal cord
  2. Peripheral Nervous System (PNS): nerves that connect the extremities of the body with their receptors in the CNS.

- The PNS is comprised of:
  - 12 pairs of cranial nerves
  - 31 pairs of spinal nerves
Nervous System

• There are four (4) main plexus in the human body:
  1. Cervical Plexus: Spinal Nerves C1-C4 - supplying head, neck, upper chest, and shoulders
  2. Brachial Plexus: Spinal Nerves C5-T1 - supplying the shoulder down to the fingers of the hand
  3. Lumbar Plexus: Spinal Nerves L1-L4 - innervating the abdomen, groin, genitalia, and antero-lateral aspect of the thigh
  4. Sacral Plexus: Spinal Nerves L4-S4 - supplies the large muscles of the posterior thigh and the entire lower leg, ankle, and foot
Nervous System

- Receptors are specialized nerve cells located throughout the body that carry messages (nerve impulses).

- Sensory nerve cells carry impulses from the peripheral receptors to the spinal cord and brain.

- Motor nerve cells carry impulses away from the CNS to respond to the perceived changes in the body’s internal or external environment.
Skeletal System

- The human skeletal system consists of 206 bones.

- The skeletal system can be divided into two (2) sections:
  1. Axial Skeleton - 80 bones that make up the head, neck, and trunk
  2. Appendicular Skeleton - 126 bones that form the extremities
Skeletal System

Bones have five (5) basic functions:

1. Protection - serves to protect the vital organs (heart, brain, and spinal cord).
2. Support - serves to support the soft tissue so that erect posture and the form of the body can be maintained.
3. Leverage - provides a framework of levers to which muscles are attached.
4. Blood Cell Production - produces certain blood cells in the red marrow of bone (primarily red blood cells, some white blood cells and platelets).
5. Storage - serves as storage for calcium, phosphorous, potassium, sodium, and other minerals.
Skeletal System

- Bones are classified according to their shape:
  - Long
  - Short
  - Flat
  - Irregular

- Bones are comprised of an organic component made of collagen (complex protein) and an inorganic component composed of mineral salts (calcium and potassium).
Skeletal System

• The bones of persons with sedentary lifestyles will become less dense over time as mineral salts are withdrawn.

• “Form follows function” - the form that bone will take (strong or weak) is in direct response to the recent function of that bone.
Skeletal System

- Amenorrhea - two (2) or less menstrual periods per year

- Menopause - loss of menstrual periods

- Low levels of estrogen (hormone) accompany amenorrhea and menopause; thus, women may have substantial bone mineral loss and need specific attention when developing strength-building programs.
Skeletal System

• The axial skeleton provides the main structural support for the body and also protects the CNS and vital organs of the thorax.
Skeletal System

Vertebrae

- Cervical - 7
- Thoracic - 12
- Lumbar - 5
- Sacrum - 5 (fused)
- Coccyx - 4 (fused)
Skeletal System

- Articulation (Joint) - point of contact or connection between bones, or between bones and cartilage.

- Ligament - dense, fibrous strands of connective tissue that link together the bony segments.
Skeletal System

- Joints can be classified into two (2) general categories according to:
  1. Structure of the joints
  2. Type of movement allowed by the joints

- Two (2) main characteristics differentiate the types of joints:
  1. Type of connective tissue that holds the bones of the joint together
  2. Presence or absence of a joint cavity
Skeletal System

• There are three (3) major structural categories of joints:
  1. Fibrous - Ex., joints between the bones of the skull and between the distal tibia and fibula
  2. Cartilaginous - Ex., joints formed by the hyaline cartilages that connect the ribs to the sternum
  3. Synovial - Ex., knee, shoulder, most joints

• The most predominant type of joint in the body are synovial joints.
Skeletal System

- The primary function of the synovial membrane is the secretion of synovial fluid - a lubricant for the joint and nutrition for the articular cartilage.

- Acute injury to, or overuse of, a synovial joint can stimulate the synovial membrane to secrete excessive fluid, typically producing swelling and decreasing the pain-free range of motion.
Menisci (meniscus) - articular disks made of fibrous cartilage designed to help absorb shock, increase joint stability, aid in joint nutrition, and increase the joint contact area.
Skeletal System

• The functional classification of joints is based on the degree and type of movement they allow:
  – Fibrous (immovable)
    • Between distal tibia & fibula
  – Cartilaginous (slightly moveable)
    • Ribs & sternum
  – Diarthrodial (synovial free-moving joints)
    • Foot, ankle, knee, hip, hand, thumb, wrist, elbow, shoulder
Skeletal System

- For a joint to move in a given plane, there must be an axis of rotation.

- An axis of rotation is an imaginary line perpendicular to (at a right angle to) the plane of movement about which a joint rotates. Many joints have several axes of rotation, enabling bones to move in various planes.
Skeletal System

- **Uniplanar joint** - joint with one (1) axis of rotation; can only move in one (1) plane; also known as “hinge” joints
  
  Ex., ankle and elbow

- **Biplanar joint** - joint with two (2) axes of rotation; can move in two (2) planes that are right angles to one another; “modified hinge” and condyloid joints
  
  Ex., knee (modified hinge); joints of hand & fingers, feet & toes (condyloid)
Skeletal System

- Multiplanar joint - joint with three (3) axes of rotation; can move in three (3) planes; ball-and-socket and saddle joints
  Ex., Hip & shoulder (ball-and-socket); thumb (saddle)

- There are two (2) basic types of movement in the synovial joints:
  - Angular - flexion, extension, abduction, adduction
  - Circular - rotation
Skeletal System

- Flexion and extension occur in the sagittal plane.
- Adduction and abduction occur in the frontal plane.
Skeletal System

- **Supination** - the external rotation of the forearm which causes the palm to face anteriorly.

- **Pronation** - internal rotation of the forearm which causes the palm to face posteriorly.
Muscular System

- The anatomical system most directly affected by exercise is the muscular system.

- There are three (3) types of muscle tissue:
  - Skeletal - voluntary muscle attached to bones by tendons
  - Cardiac - involuntary muscle that forms the walls of the heart
  - Visceral (Smooth) - involuntary muscle found in the walls of internal organs such as the stomach and intestines
Muscular System

- Aponeurosis - a broad, flat type of tendon that sometimes attaches skeletal muscle to bone. Ex., wide flat insertion of the rectus abdominus

- There are more than 600 muscles in the human body.
Muscular System

Muscles are named according to:

1. Location (posterior tibialis, rectus abdominis)
2. Shape (deltoid, trapezius, serratus, anterior, rhomboid)
3. Action (various muscle names include the terms extensor, flexor, abductor, adductor)
4. Number of Divisions (biceps brachii, triceps brachii, quadriceps femoris)
5. Bony Attachments (coracobrachialis, iliocostalis)
6. Size Relationships (pectoralis major, pectoralis minor)

Some muscles also include the terms “longus” (long) and “brevis” (short).
Muscular System

- Agonist - a muscle that is directly engaged in contraction; oppose the action of an antagonist.

- Antagonist - a muscle that acts in opposition to the action produced by an agonist muscle.

- When one muscle (agonist) is contracting to achieve a desired movement, its opposite muscle (antagonist) is being stretched.
Muscular System

- At most joints, several muscles combine to help perform the same anatomical function; these muscles are known as synergists.
Muscular System

The lower extremity (leg) has four (4) compartments:

1. Anterior Tibial Compartment - extend toes & dorsiflex (flex) the ankle
2. Lateral Tibial Compartment - eversion (abduction) of the foot & plantraflexion of the ankle
3. Superficial Posterior Tibial Compartment - largest muscles of calf (soleus and gastrocnemius) responsible for plantarflexion (extension) of the ankle, flexion of the toes, & inversion (adduction of the foot)
4. Deep Posterior Tibial Compartment - popliteus, posterior tibialis, flexor hallucis longus, & flexor digitorum longus also responsible for plantarflexion (extension) of the ankle, flexion of the toes, and inversion (adduction of the foot)
Muscular System

- The largest tendon in the body, the Achilles tendon, is found in the posterior compartment and attaches the gastrocnemius and soleus via one common tendon to the calcaneus (heel bone).
Muscular System

The muscles that cross the knee joint to act on the leg (tibia & fibula) can be divided into three (3) separate groups:

1. Quadriceps femoris (rectus femoris, vastus medialis, vastus intermedius, & vastus lateralis)
2. Hamstrings (biceps femoris, semitendinosus, & semimembranosus)
3. Pes anserine group (semitendinosus, sartorius, & gracilis)

The sartorius is the longest muscle in the body.
Muscular System

Most of the muscles that cross the hip joint and act on the thigh (femur) originate on the pelvis:

- Psoas major
- Psoas minor
- Iliacus
  (This group of three (3) muscles is commonly referred to as the iliopsoas)
- Rectus femoris
  (Only muscle of the quadriceps femoris group that crosses the hip joint)
- Gluteus maximus
- Gluteus minimus
- Hamstring muscles
  (biceps femoris, semitendinosus, semimembranosus)
- Adductor magnus
- Adductor longus
- Adductor brevis
Muscular System

The major muscles that act on the trunk are mostly agonist/antagonist and result in primarily sagittal plane motion (i.e., flexion & extension of the trunk):

- Iliocostalis
- Longissimus
- Spinalis

These three (3) muscles are better known by their functional group name “erector spinae.”

- External oblique
- Internal oblique
- Transverse abdominis
- Rectus abdominis
Muscular System

The three (3) major muscles responsible for movement of the vertebral column are:

1. Iliocostalis
2. Longissimus
3. Spinalis

These three (3) muscles are better known by their functional group name “erector spinae.”
The muscles that act at the wrist are:
- Flexor carpi ulnaris
- Pronator teres
- Pronator quadratus
- Extensor-supinators
- Extensor carpi radialis longus
- Extensor carpi ulnaris
- Supinator muscle
Muscular System

- The muscles that act at the elbow joint are:
  - Biceps brachii
  - Brachialis
  - Brachioradialis
  - Triceps brachii
Muscular System

- The muscles that act at the shoulder joint are:
  - Pectoralis major
  - Latissimus dorsi
  - Deltoid muscles
  - Rotator cuff muscles ("SITS" muscles: supraspinatus, infraspinatus, terres minor, & subscapularis)
Muscular System

- The muscles that act at the scapulothoracic articulation are:
  - Trapezius
  - Rhomboid major
  - Rhomboid minor
  - Levator scapulae