Yoga Anatomy & Physiology
Anatomy & Physiology

• Anatomy-
  One of the basic essential sciences of medicine that studies the structure of an organism.

• Physiology-
  The biological study of the functions of living organisms and their parts.
Why is knowledge of anatomy & physiology important for yoga instructors?
• Knowledge of anatomy & physiology is the foundation of physical safety for both student & instructor

• Yoga has the potential to heal & prevent injury

• Instructors will be asked by students about various injuries & conditions using the common language of medical terminology

• As instructors, we are ambassadors of Yoga and therefore will be educated, knowledgeable, & compassionate
Physiological Systems of the Human Body
<table>
<thead>
<tr>
<th>System</th>
<th>Major structures</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory</td>
<td>Heart, blood vessels, blood (cardiovascular), lymph nodes and vessels, lymph (lymphatic)</td>
<td>Transports nutrients, wastes, hormones, and gases</td>
</tr>
<tr>
<td>Digestive</td>
<td>Mouth, throat, esophagus, stomach, liver, pancreas, small and large intestines</td>
<td>Extracts and absorbs nutrients from food; removes wastes; maintains water and chemical balances</td>
</tr>
<tr>
<td>Endocrine</td>
<td>Hypothalamus, pituitary, pancreas and many other endocrine glands</td>
<td>Regulates body temperature, metabolism, development, and reproduction; maintains homeostasis; regulates other organ systems</td>
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<tr>
<td>Excretory</td>
<td>Kidneys, urinary bladder, ureters, urethra, skin, lungs</td>
<td>Removes wastes from blood; regulates concentration of body fluids</td>
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<tr>
<td>Immune</td>
<td>White blood cells, lymph nodes and vessels, skin</td>
<td>Defends against pathogens and disease</td>
</tr>
<tr>
<td>Integumentary</td>
<td>Skin, nails, hair</td>
<td>Protects against injury, infection, and fluid loss; helps regulate body temperature</td>
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<tr>
<td>Muscular</td>
<td>Skeletal, smooth, and cardiac muscle tissues</td>
<td>Moves limbs and trunk; moves substances through body; provides structure and support</td>
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<tr>
<td>Nervous</td>
<td>Brain, spinal cord, nerves, sense organs</td>
<td>Regulates behavior; maintains homeostasis; regulates other organ systems; controls sensory and motor functions</td>
</tr>
<tr>
<td>Reproductive</td>
<td>Testes, penis (in males); ovaries, uterus, breasts (in females)</td>
<td>Produces gametes and offspring</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Lungs, nose, mouth, trachea</td>
<td>Moves air into and out of lungs; controls gas exchange between blood and lungs</td>
</tr>
<tr>
<td>Skeletal</td>
<td>Bones and joints</td>
<td>Protects and supports the body and organs; interacts with skeletal muscles, produces red blood cells, white blood cells, and platelets</td>
</tr>
</tbody>
</table>
The Skeletal System

- The structural framework of the body
- Made of living tissues called bone
- Protects organs, spinal cord, & brain
- Attachment site for muscles
- Red Blood Cell production
- Calcium, magnesium, phosphorus, and other minerals stored in bones
- Bone has the strength of steel - at the same time, it has elasticity
- Yoga asana strengthens bone density by applying healthy stress
The axial skeleton consists of the spinal column, cranium (skull), and rib cage. The spinal column surrounds and protects the spinal cord, which is the central energy channel, or Sushumna Nadis. It is the axis around which the poses of Yoga revolve. The appendicular skeleton connects us with the worlds: the lower extremities form our connection to the earth, and the upper extremities, in association with our senses, connect us with each other.
Fundamental Bones

- clavicle
- scapula
- sternum
- humerus
- radius
- ulna
- ilium
- sacrum
- pubis
- femur
- patella
- fibula
- tibia
Shoulder and Hip

The hips and shoulders are ball and socket joints. Their form reflects their function, in that the deep socket (acetabulum) of the hip is designed to support weight, while the shallow socket (glenoid) of the shoulder is designed to provide maximum range of motion for the arms. Yoga postures balance mobility and stability by increasing the range of motion of the hips and stabilizing the shoulder.
The Shoulder Girdle

The shoulder girdle is the yoke that connects the upper extremities to the axial skeleton. It is the seat of the brachial plexus, a collection of nerves that, in association with the heart, forms the basis for the fourth and fifth Chakras. The shoulder girdle is comprised of the following structures:

- Scapula (shoulder blade)
- Scapulothoracic joint
- Clavicle
- Sternoclavicular and Acromioclavicular joints
- Humerus (upper-arm bone)
- Glenohumeral joint

The Pelvic Girdle

The pelvic girdle is the yoke that connects the lower extremities to the axial skeleton. It is the seat of the sacral plexus, a collection of nerves that forms the basis for the first and second Chakras. The pelvic girdle is comprised of the following structures:

- Iliac bones
- Sacroiliac joint
- Femur (thigh bone)
- Hip joint
The Vertebral Column

Cervical - 7 Vertebrae
Lordotic Curve

Thoracic - 12 Vertebrae
Kyphotic Curve

Lumbar - 5 Vertebrae
Lordotic Curve

Sacrum - 5 Fused Vertebrae
that create one bone
Kyphotic Curve

Coccyx - Tailbone

Vertebra = Singular
Vertebrae = Plural

“Breakfast, Lunch, & Dinner”
Movements of the Spine

- Flexion
- Extension
- Axial Rotation
- Lateral Flexion
Anatomical Directions

- **Midline**: Center of the body
- **Posterior**: Toward the back of the body
- **Anterior**: Toward the front of the body
- **Lateral**: Away from the midline
- **Medial**: Toward the midline
- **Proximal**: Nearer to the center of the body
- **Distal**: Situated further away from the center of the body
- **Superior**: Above another body part/toward the top of body—head
- **Inferior**: Below another body part/toward the bottom—feet
Movement

Movement Definitions

The six basic movements of the body take place in three planes.

Coronal plane: Divides the body into front and back. Movements along this plane are called adduction and abduction. Adduction moves the extremity toward the midline, abduction moves the extremity away from the midline.

Sagittal plane: Divides the body into right and left. Movements along this plane are called flexion and extension. Flexion usually moves the extremity forward, except at the knee, where it moves backward. Extension moves the extremity backward.

Transverse plane: Divides the body into upper and lower halves. Movement along this plane is called rotation. Rotation is further classified as medial rotation (toward the midline) or lateral rotation (away from the midline). Medial and lateral rotation are also referred to as internal and external rotation, respectively.

All movements of the body are composed of varying contributions of these six elemental movements.

Motion of the musculoskeletal system necessarily involves multiple joints, forces applied in many directions, and movement in many planes. A convention exists to describe the basic movements of the musculoskeletal system that can be useful in analyzing the form and function of the Asanas.
Directions of Movement – Extremities & Joints

- **Flexion** - Bending of a joint so that the bones that form the joint are pulled closer together

- **Extension** - The movement that brings bones in a joint into or toward a straight position/back

- **Abduction** - The movement of a body part away from the midline

- **Adduction** - The movement of a body part toward the midline

- **External Rotation** (Lateral Rotation) - Turning a limb about its axis of rotation away from the midline

- **Internal Rotation** (Medial Rotation) - Turning a limb about its axis of rotation toward the midline
3 Types of Joints:

1. **Fibrous**—Bound together by dense connective tissue—designed for little to no movement
   - Sutures found between the plates of the skull

2. **Cartilaginous**—Unite bones with cartilage—designed for minimal movement
   - Joint at 1st rib and sternum, pubic symphysis, intervertebral joint-disc
3. Synovial Joints

Articular capsule between two joined bones, bone surfaces protected by cartilage, supported by ligaments, nourished & lubricated by synovial fluid

- Wrist, ankle, elbow, shoulder, vertebral facets, hips, knees, knuckles, toes

Types of Synovial Joints

**Hinge Joint** - Allows movement in one axis (Uniaxial)

- Elbow, Knee, Knuckles

**Ball & Socket Joint** - Spherical surface fits into dish shaped depression, designed for maximum mobility, triaxial-capable of circumduction

- Hip Joint, Shoulder Joint
**Pivot** - Surface of one bone spins within the ring shaped surface of another, like a door knob

- **C1-C2 Atlas & Axis**

**Ellipsoid Joint** - modified ball & socket, oval shaped bone articulating in an elliptical basin of another bone, deigned for mobility, Biaxial-moving around two planes

- **Wrist**

**Saddle Joint** - Back and forth & side to side motion

- **Base of thumb**

**Gliding Joint** - Flat or nearly flat articular surfaces, glide past one another forward & back, side to side, slight rotation, designed for minimal movement

- **Carpals in the Wrist, Tarsals in the foot**
What is a Ligament?

Ligaments are bands of dense, fibrous, connective tissue that attach bone to bone. Provides structural integrity for the joints.
Shoulder and Elbow Ligaments

Elbow (posterior)
The collateral ligaments of the elbow limit side-to-side motion and maintain the joint as a hinge. The interosseous membrane stabilizes the bones of the forearm.

Shoulder
Unlike the thick ligaments of the hip, the glenohumeral ligaments of the shoulder are thin structures. Their design allows greater mobility of the joint.
The patellar tendon connects the quadriceps muscle to the tibia for extension of the knee. The collateral ligaments limit side-to-side motion of the knee and maintain its function as a hinge joint. The anterior and posterior cruciate ligaments limit anterior and posterior translation of the tibia on the femur, respectively. The menisci deepen and stabilize the knee joint. The interosseous membrane stabilizes the bones of the lower leg.
Spine Ligaments

LUMBOSACRAL SPINE

VERTEBRAL UNIT
The vertebral unit is comprised of two adjacent vertebral bodies and the intervertebral disc. Movement between the vertebrae is possible in several planes (including small amounts of rotation, flexion, and extension). The combination of motion across multiple vertebral units culminates in spinal movement.
The Muscular System

Composed of 3 types of muscle tissue
- **Smooth**-involuntary-intestines, uterus, bladder...
- **Skeletal**-voluntary-hamstrings, deltoids...
- **Cardiac**-involuntary-Heart

Creates movement of skeleton

Maintains posture

Produces heat

Aides in blood & lymph circulation
Muscles

Movements are determined by the varying forces acting across the joints. These forces are produced by the muscles, and their effects on body position are determined by the muscles’ shape, origin (the attachment of the muscle to a bone at the more fixed or proximal end), and insertion (the attachment of the muscle to a bone at the end toward the part to be moved, or the more distal end).

**Origin**
Proximal attachment of the muscle to a bone.

**Insertion**
Distal attachment of the muscle to a bone.

**Agonist, or Prime Mover**
The muscle that contracts to produce a certain action about a joint. For example, the hamstrings are agonists when you flex your knee.

**Antagonist**
A muscle that relaxes while the agonist contracts. The antagonist produces the opposite action about a joint. For example, the quadriceps (at the front of the thigh) are the antagonists to the hamstrings when you flex your knee. When you extend your knee, the quadriceps are the agonists and the hamstrings are the antagonists.

**Synergist**
A muscle that assists and fine-tunes the action of the agonist and which can be used to produce the same action, although generally not as efficiently.

The synergists of the psoas assist in flexing the hip.

The quadriceps are the agonists that contract to extend the knees. The hamstrings are the antagonists stretched by this action.

The origin of the rectus femoris is the anterior superior iliac spine. The insertion is the patella.
Muscle fibers are the functional contractile units of each skeletal muscle. Fibers are grouped into fascicles which, in turn, are grouped into bundles, thus forming the individual skeletal muscles.

Skeletal muscles are also composed of non-contractile elements. The non-contractile elements include the connective tissue sheath surrounding the muscle bundles, fascicles, and individual fibers, as well as the myotendon junction.

Muscle fibers contract in response to afferent nerve stimuli (from the central nervous system). This is an active, energy-dependent process involving the release of calcium at the cellular level of the muscle fiber. Calcium then forms cross-bridging between the myofilaments (of the myofibril). This causes a "ratcheting" effect that results in the shortening or contraction of the individual muscle fiber. The net effect of this process is shortening or contraction of the entire muscle.

The force of this contraction is transmitted to the non-contractile fascial elements surrounding the muscle.
What is a Tendon?

- Tendons are made up of fibrous, flexible but non-elastic connective tissue that attach **muscle to bone**
Types of Muscle Contraction

There are three types of muscle contraction:

**Concentric (Isotonic) Contraction:**
The muscle shortens while maintaining constant tension through a range of motion.

**Eccentric Contraction:**
The muscle contracts while lengthening.

**Isometric Contraction:**
The muscle generates tension but does not shorten, and the bones do not move.
Stretching Muscles

Static Stretching

Static stretching is the most common technique used in Hatha Yoga. There are two categories of static stretching. The first is active static stretching. This involves contracting antagonist muscles to stretch a target muscle. Contracting the quadriceps, iliopsoas, and biceps during the forward bend Paschimottanasana is a form of active static stretching of the hamstrings. Contracting antagonist muscles in active static stretching results in a phenomenon called “reciprocal inhibition.” During reciprocal inhibition, the central nervous system signals the target muscle to relax.

Passive static stretching occurs when we relax into a stretch, using only the force of body weight (or an externally applied weight) to stretch muscles. The restorative pose Supported Setu Bandha Sarvangasana is an example of passive static stretching of the iliopsoas muscle.
Facilitated Stretching

Yoga practitioners use facilitated stretching to deepen their postures. This type of stretching involves contracting the muscle being stretched during an active static stretch. This action triggers a reflex arc involving the Golgi tendon organ, resulting in a profound relaxation of the target muscle when the contraction period ends. This is also known as proprioceptive neuromuscular facilitation (PNF). It is extremely important to consider the joint reaction forces when using facilitated stretches, since the force the muscle generates is transmitted to the joints. As a general rule, gently contract the stretched muscle to avoid excessive joint reaction forces. These images demonstrate facilitated stretching of the gluteus medius, gluteus maximus, and tensor fascia lata.

Dynamic Stretching

Yoga practitioners use dynamic stretching during a Vinyasa style of practice. This type of stretching involves repetitive movement of the body into increasingly deeper stretches. Performing dynamic stretching in the morning “resets” the resting muscle length for the day. (Scientific Keys, Volume II, covers the physiology of stretching in detail).
Reciprocal Inhibition:

- Describes the process of muscles on one side of a joint relaxing to accommodate contraction on the other side of the joint
- Agonist-Antagonist relationship

Stretch Reflex:

- A muscle contraction in response to stretching within the muscle. When the muscle spindle is stretched its nerve activity increases. The reflex causes the muscle to contract & thus resist the stretching
- An automatic safety mechanism bringing the muscle to a constant length
"The most creative act you can undertake is the act of creating yourself."
- Deepak Chopra