Contents

MUSCULOSKELETAL INTRO

BONES

JOINTS

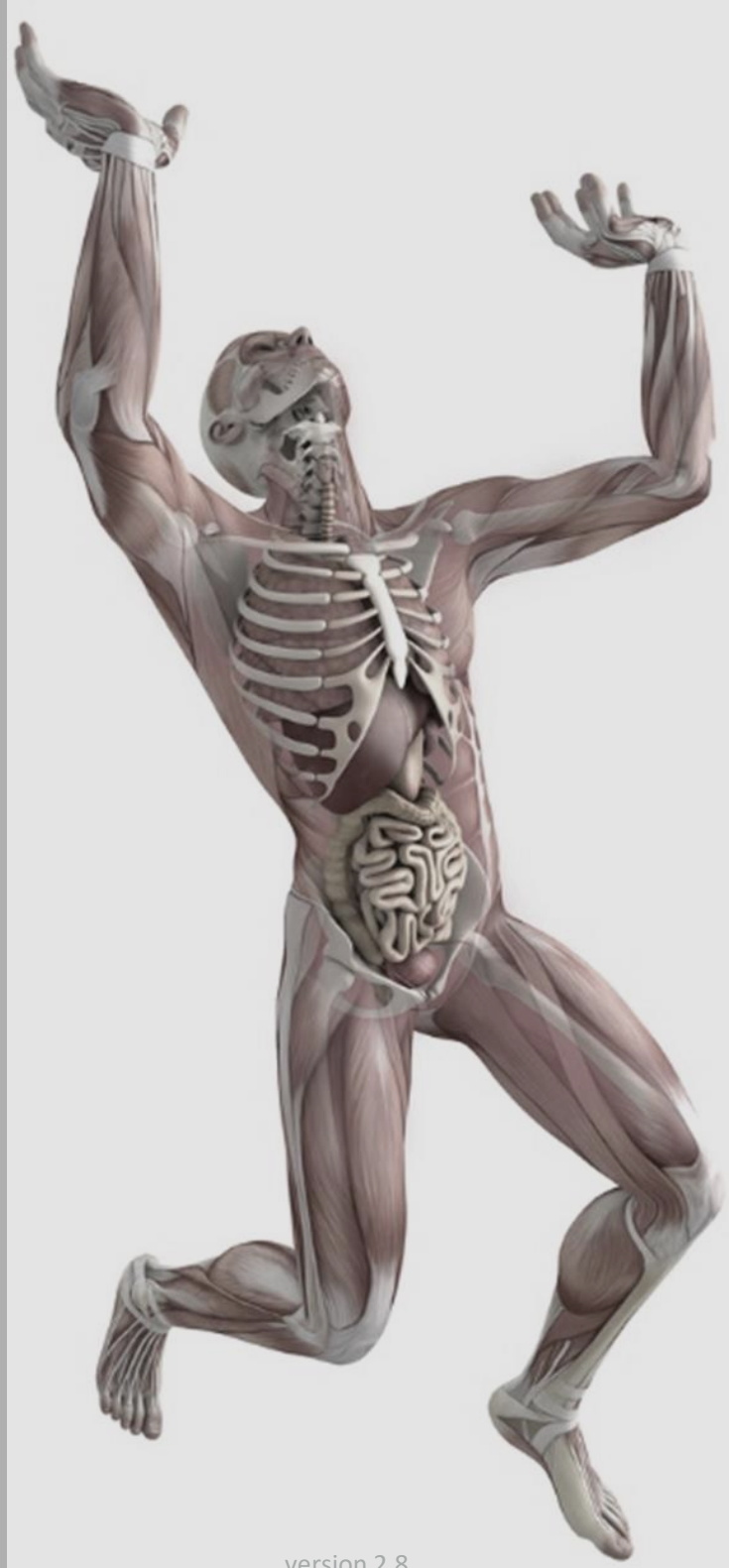
MUSCLES

CONNECTIVE TISSUE

MUSCLE MOVEMENT

MOVEMENT & LOCATION TERMINOLOGY

JOINT MOVEMENTS & ROM



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MUSCULOSKELETAL SYSTEM AND THE ANATOMY OF MOVEMENT

Bodily balance in accord with the principles of mechanics is a poignant means for conservation of nervous energy.

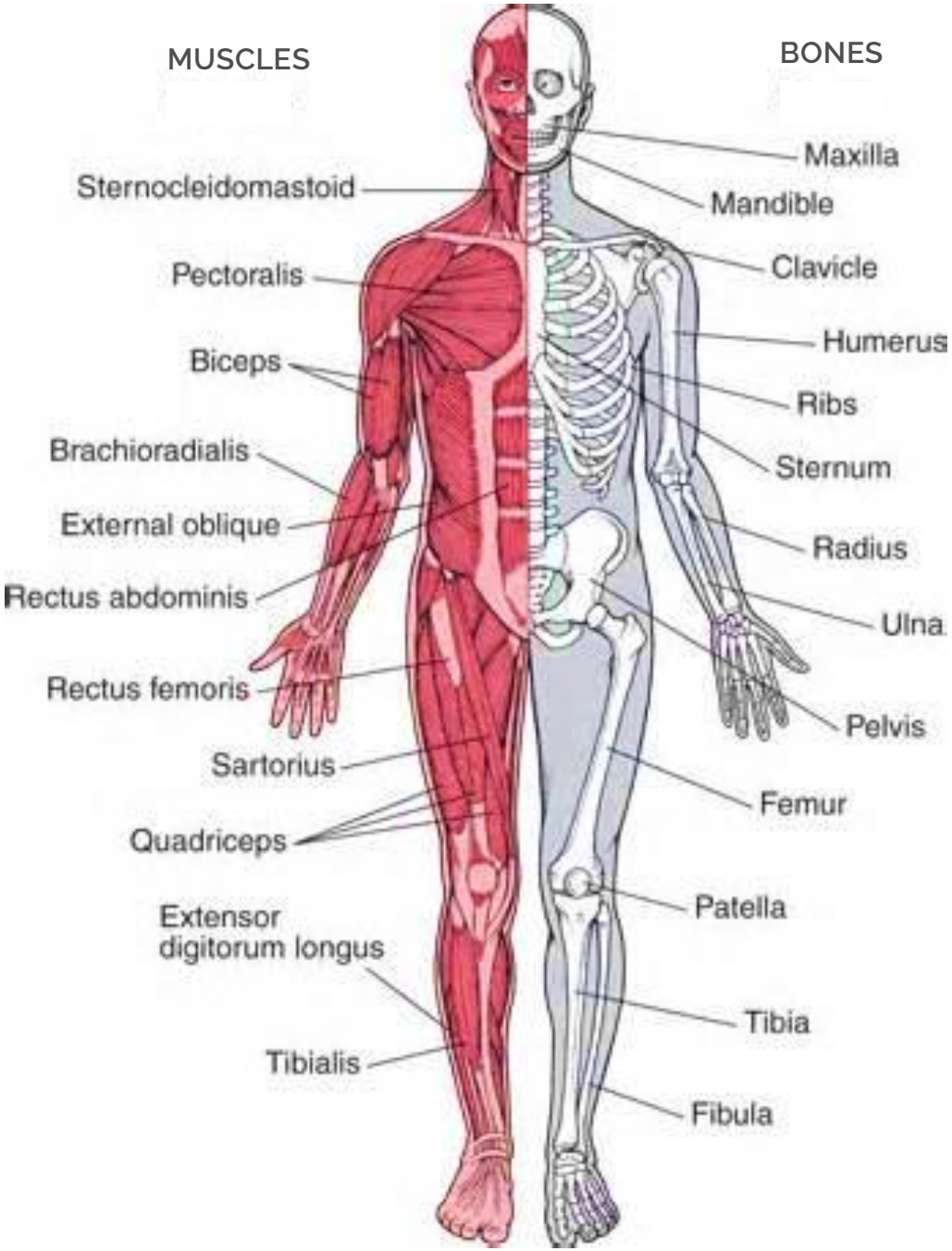
— Mabel E. Todd, 1937, The Thinking Body

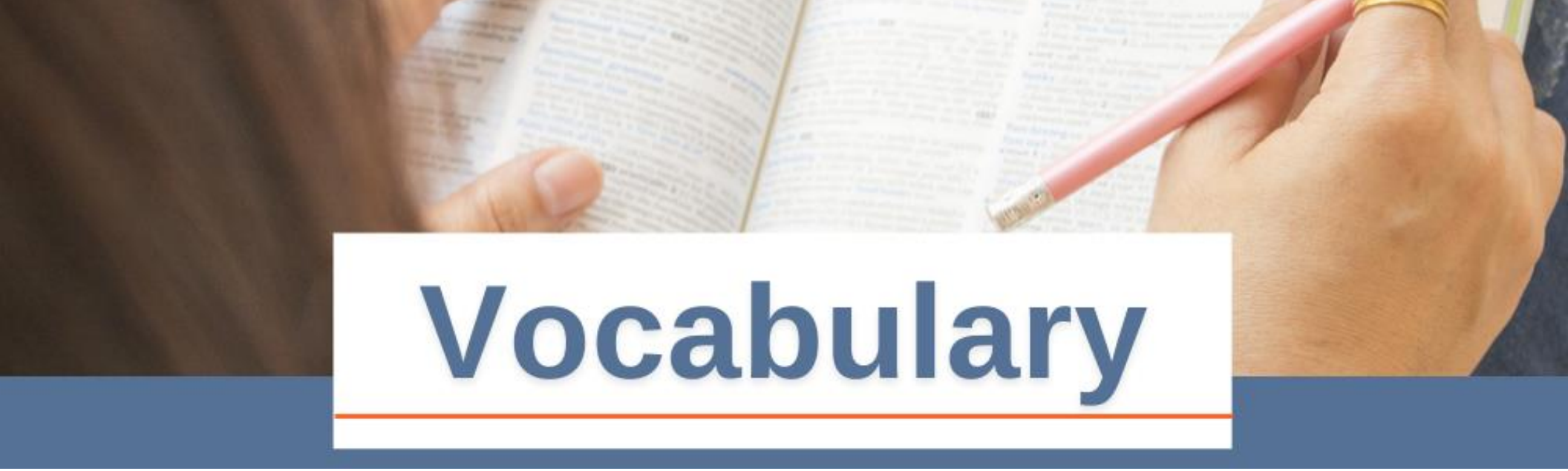
MUSCULOSKELETAL SYSTEM OVERVIEW

- The musculoskeletal system gives humans the ability to move using their muscular and skeletal systems.

- It includes bones, muscles and connective tissue. (While bones and connective tissue are often described separately for learning purposes, expert sources explain that bones are a type of connective tissue.)

- In addition to enabling body movement, the musculoskeletal system provides form, support and stability, protects vital organs, stores minerals such as calcium, produces red blood cells, moves blood and food, and generates body heat.





Vocabulary

APPENDICULAR SKELETON — The bones attached or appended to the axial skeleton (spine, skull and rib cage); bones of the upper and lower limbs plus the shoulder and pelvic girdles

AXIAL SKELETON — Spine, skull and rib cage

BALL AND SOCKET JOINT — A type of joint that allows for a wide range of movement, including rotation

BONES — Living tissues that form the body's structural framework

HINGE JOINT — A type of joint that provides greater stability than other types

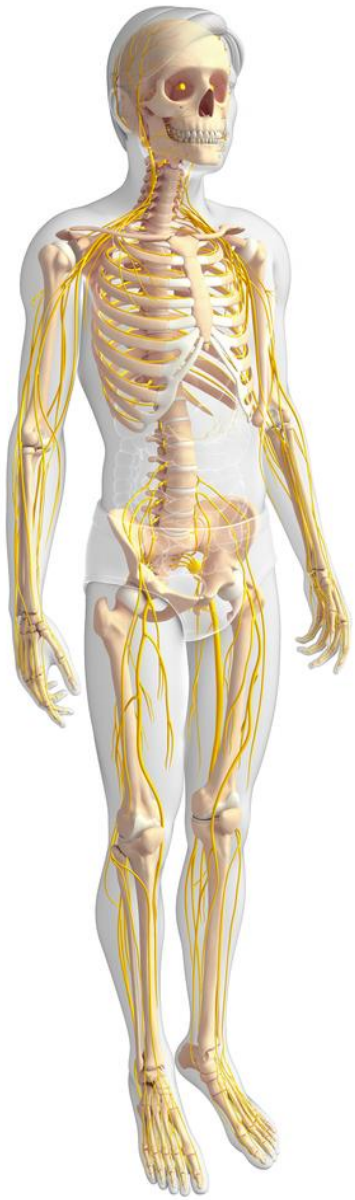
JOINT — Junction / connecting point between bones

MUSCLE — A band or bundle of fibrous tissue that has the ability to contract; attached to bone by tendons

MUSCULOSKELETAL SYSTEM — Gives humans the ability to move via bones, muscles and connective tissue

SYNOVIAL JOINT — The most common type of joint in the body; freely movable

BONES

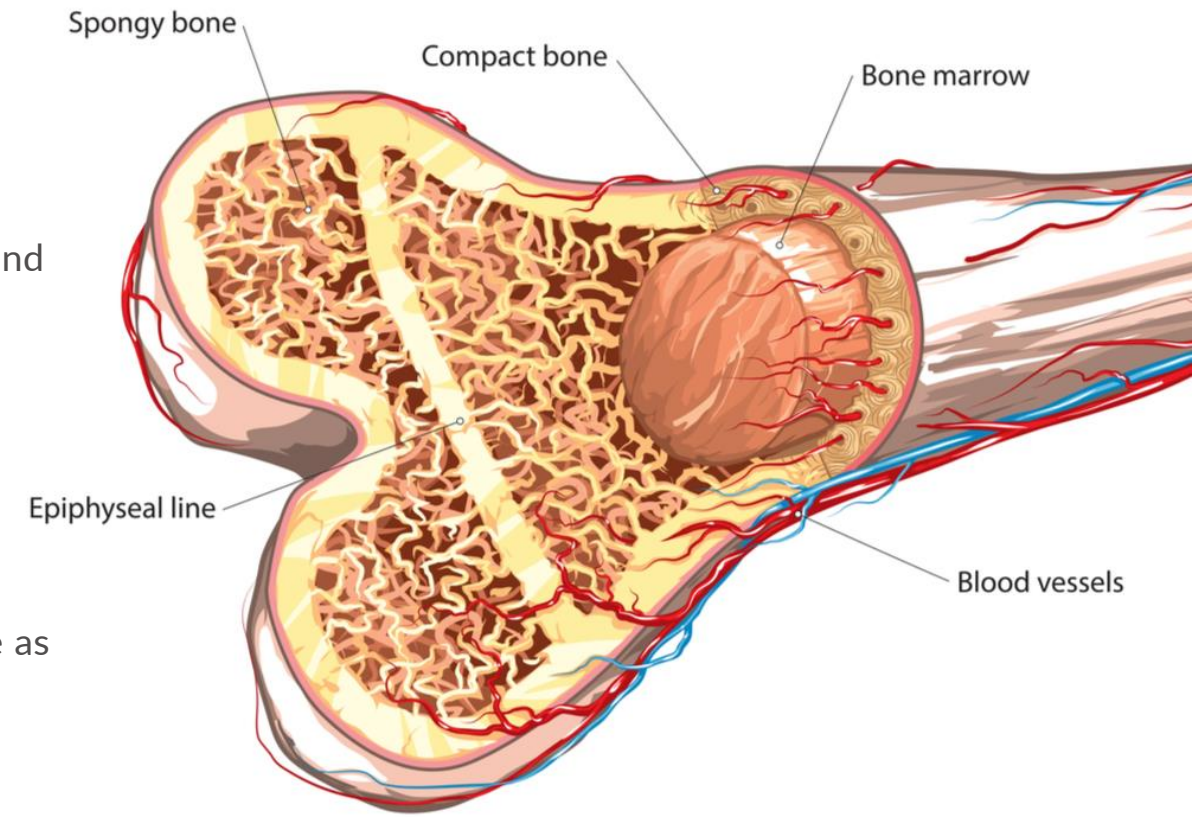


FORM

- The skeleton has 206 individual bones.
- Bones are living tissues that form the body's structural framework.
- Bones are defined as “the hard, rigid form of connective tissue constituting most of the skeleton of vertebrates, composed chiefly of calcium salts." (Medical Dictionary)
- Bones are comprised of calcium salts, connective tissues, cells and blood vessels.
- **Axial Skeleton** refers to spine, skull and rib cage.
- **Appendicular Skeleton** refers to upper and lower extremities.
- Two particularly relevant areas for Yoga are the shoulder girdle (includes scapula and humerus plus associated joints) and pelvic girdle (includes iliac bones and femur plus SI and hip joints).

BONES

FUNCTION



- Bones provide a framework for muscles and other tissues.
- Bones protect internal organs.
- Bones enable body movements.
- Bones store essential minerals such as calcium. And bones store lipids that serve as an energy reservoir.
- Marrow at the center of large bones produces red blood cells.
- Various shapes of bones reflect their function.
- "Long bones provide leverage, flat bones provide protection and a place for broad muscles to attach, and short bones provide for weight bearing functions." (Ray Long)
- Bearing weight on bones helps to strengthen them; gravity thus stimulates bone health. Extended weightlessness in space, for example, causes bones and muscles to weaken.

BONES

BONES ARE ALIVE

The skeletal system is often understood by the layperson as some type of hard, dead, sort of "thing" that is nothing but the framework of our body. In fact, it is a complex, ever-changing system that deals with and reacts to stresses placed on it... Bones are alive. They have a blood supply. They have nerves running in and out them... Bone is yet another varied formation of connective tissue in the body.

– David Keil, Functional Anatomy of Yoga

YOGA STRENGTHENS BONES

Regular practice of Yoga is beneficial for your bones because healthy stresses are applied in a variety of unusual directions. This strengthens bones, which remodel in response to stress by depositing layers of calcium into the bone matrix.

– Ray Long, The Key Muscles of Yoga

JOINTS

Each joint is a world of its own, with its own problems, specific functions, and structures that make it unique, relative to other joints. Each can be classified in one of six categories according to their function, shape, or both. Each joint is in in its own world, but at the same time it lives in a galaxy of joints that exist within the universe of the body.

– David Keil

OVERVIEW

- Joints are junctions / connecting points between bones. For example, the knee joint is the point of connection between the thigh bone and the shin bone.
- Joints are also called "articulation.“
- Joints contain a variety of fibrous connective tissue.
  Ligaments connect the bones to each other; tendons connect muscle to bone and cartilage covers the ends of bones and provides cushioning.
- Some joints move a lot; some very little.
- The shape of the joints reflects their function.

MOVEMENT & JOINT TYPE

- Movable joints are also called synovial joints.
- Synovial joints have a joint capsule within which synovial fluid is produced to keep the joint moist and healthy.
- Movement of joints nourishes and helps to keep the joint capsule healthy.
- A ball and socket joint (such as the hip and shoulder joints) provides the greatest mobility.
- A hinge joint (such as the knee joint) provides greater stability.

TEACHING APPLICATION

Joints are not things. They are relationships.

– Leslie Kaminoff

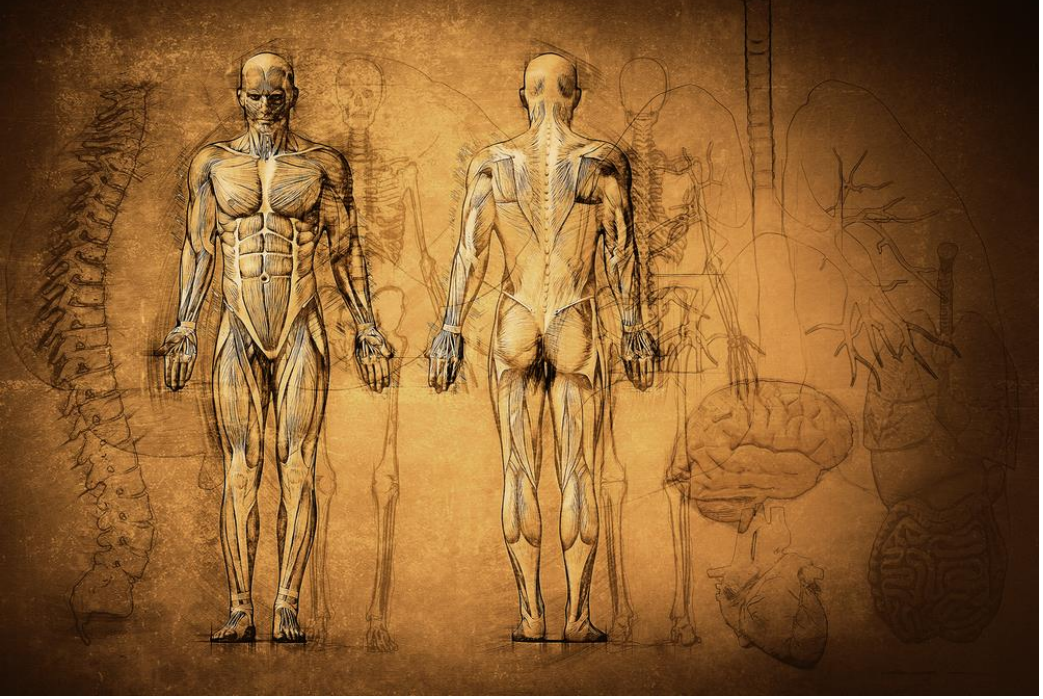
Applying knowledge of joints in teaching *asana* – example:

- Both the hip and knee joints are involved in Padmasana (Lotus Posture).
- As a hinge joint, the knee has limited rotational capability.
- Safe practice of the pose requires the hips (the ball and socket joints) to have adequate range of motion.
- If they do not, the force may be transferred to the knee which is not designed for such movement, thereby causing injury.

MUSCLES

MULTIPLE DEFINITIONS

- Biological units built from various specialized tissues that are integrated to perform a single function
- A band or bundle of fibrous tissues in a human or animal body that has the ability to contract, producing movement in or maintaining the position of parts of the body
- Provide the force behind movement; composed of layers and layers of fibers
- Voluntary contractile tissue that moves the skeleton, is composed of muscle cells (fibers), layers of connective tissue (fascia) and numerous nerves and blood vessels



MUSCLES

FORM

- A muscle is a band or bundle of fibrous tissue that has the ability to contract.
- Skeletal muscles are composed of muscle cells, fascia, nerves and blood vessels. (Andrew Biel)
- Muscle is attached to bone by tendons.
- Please see Connective Tissue for an understanding of "myofascial approach" vs. "isolated muscle theory" and to get a clear understanding of what a muscle really is.

FUNCTION

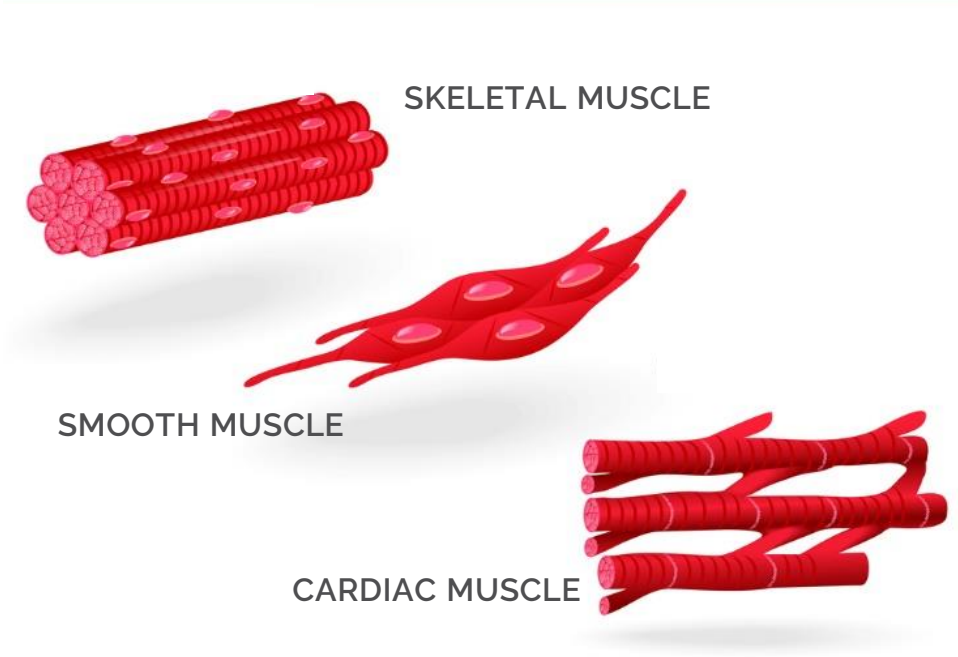
- The main function of the muscular system is movement.
- Muscles maintain posture and body position. This includes contraction to hold the body still.
- Muscles are responsible for breathing, heart function and much of the circulatory system.
- Muscles move substances such as blood and food from one part of the body to another.
- Muscles generate body heat.

THREE TYPES OF MUSCLES

- **SMOOTH MUSCLE** — lines organs, blood vessels and the digestive tract
- **CARDIAC MUSCLE** — specialized muscles within the heart for pushing blood through the arteries and veins
- **SKELETAL MUSCLE** — muscles for moving bones

SKELETAL & CARDIAC MUSCLES HAVE STRIATIONS

Striations are a key attribute to identify skeletal and cardiac muscle types. In contrast to smooth muscle, cardiac and skeletal muscle types possess an internal ultrastructure of highly organized contractile myofilaments. Actin and myosin myofilaments are stacked and overlapped in regular repeating arrays to form sarcomeres. – McGraw-Hill



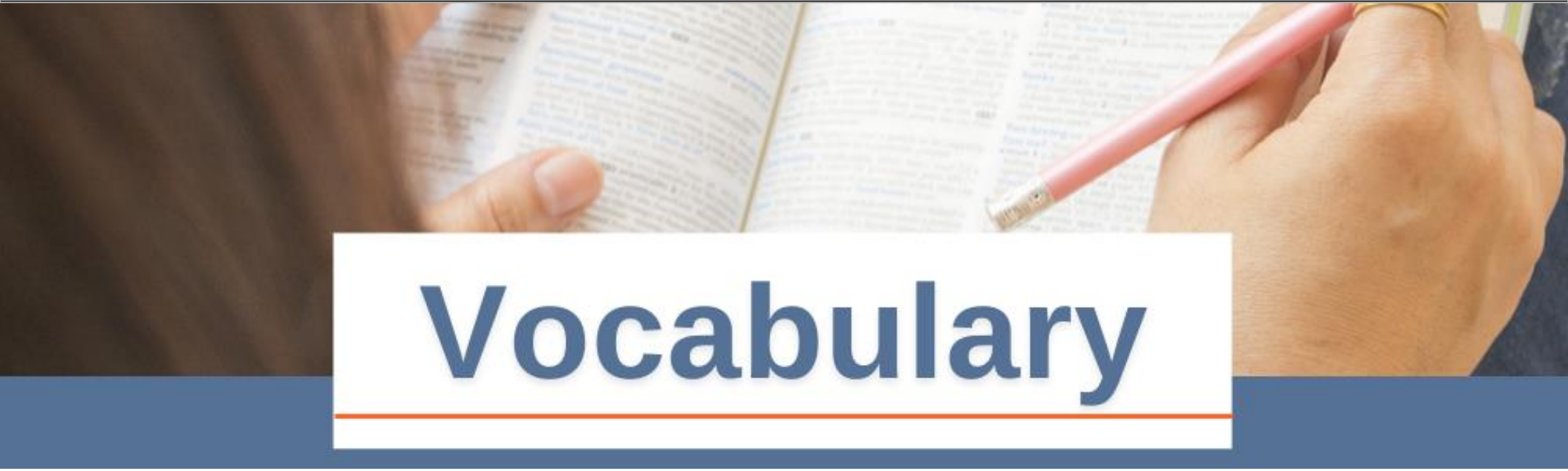
FORM

- Connective tissue is a fibrous type of body tissue that connects, supports, binds, or separates other tissues or organs.
- Some connective tissues are soft and rubbery; some are hard and rigid.
- Connective tissue fibers contain a protein called collagen. Collagen can be stretched “like a really, really, really stiff rubber band.” (Jules Mitchell)
- Types of connective tissue include tendons, ligaments, joint capsules and fascia.

FUNCTION

- Connective tissue supports and connects internal organs.
- It forms bones and the walls of blood vessels.
- It attaches muscles to bones.
- Connective tissue replaces tissues following injury (e.g. scar tissue).
- Fascia helps the body sense itself.
- Energy Medicine experts explain fascia as the connection between the physical and energetic body.

CONNECTIVE TISSUE



Vocabulary

CONNECTIVE TISSUE – A fibrous type of body tissue that connects, supports, binds, or separates other tissues or organs

FASCIA – A type of connective tissue that is a sheet or band of fibrous tissue, giving contour and structure to the body

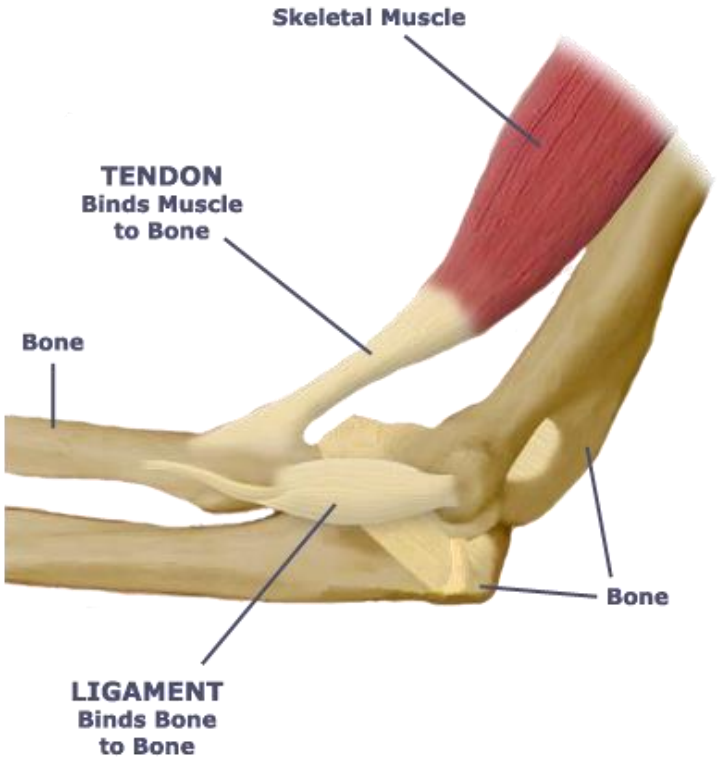
JOINT CAPSULE – A type of connective tissue that surrounds synovial joints

LIGAMENT – A type of connective tissue that connects bones together at the joint

MYOFASCIA – Muscles and surrounding tissues

TENDON – A type of connective tissue that attaches muscle to bone

CONNECTIVE TISSUE



TENDONS

- Attach muscle to bone
- "More accurately, they connect muscles to the periosteum—the connective tissue which surrounds the bone" (Andrew Biel)
- Variety of shapes and sizes
- Fibers of tendons are arranged in long, straight lines
- "Smooth, tough, almost resilient feel to them" (Andrew Biel)

LIGAMENTS

- Connect bones together at the joint
- Strengthen and stabilize joints
- Unlike a tendon's parallel fibers, a ligament's fibers are more unevenly arranged
- Can be stretched but are not very elastic

JOINT CAPSULE

- Connective tissue surrounding synovial joints is called a joint capsule
- Serves as a container for synovial fluid (the slippery fluid that fills most joints)
- Provides a tough covering of tissue where ligaments and tendons can insert
- “They and their associated ligaments provide about half the total resistance to movement" (David Coulter)

FASCIA

- A sheet or band of fibrous tissue; varies in thickness and density
- Described as a "body envelope" or "sac" that "permeates through and around every nook of the body"
- Gives contour and structure to the body
- It “surrounds, connects and supports muscles, organs, bones, tendons, ligaments and other structures of the body. Similar to the membrane around each section of an orange, fascia both separates and connects body parts at the same time. Containing nerves, these tissues also serve as a layer of protection and body awareness.” (Allison Candelaria)

CONNECTIVE TISSUE

A VISUAL

Connective tissue... binds all the other [types of tissues] together. If you were able to remove all the connective tissue from the body, what was left would flatten down on the floor like a hairy, lumpy pancake. You would have no bones, cartilage, joints, fat, or blood, and nothing would be left of your skin except the epidermis, hair and sweat glands. Muscles and nerves, without connective tissue, would have the consistency of mush. Internal organd would fall apart.

– David Coulter

MORE INFORMATION

Located all around the muscle and its fibers are connective tissues. Connective tissue is composed of a base substance and two kinds of protein based fiber... Collagenous connective tissue consists mostly of collagen... and provides tensile strength. Elastic connective tissue consists mostly of elastin and... provides elasticity. The base substance is called mucopolysaccharide and acts as both a lubricant (allowing the fibers to easily slide over one another), and as a glue (holding the fibers of the tissue together into bundles). The more elastic connective tissue there is around a joint, the greater the range of motion in that joint. Connective tissues are made up of tendons, ligaments, and the fascial sheaths that envelop, or bind down, muscles into separate groups... These connective tissues help provide suppleness and tone to the muscles.

– Russell Bradford, University of Bath

CONNECTS ALL OUR PARTS

Fascia connects all of our parts and organizes them into a vibrant whole.

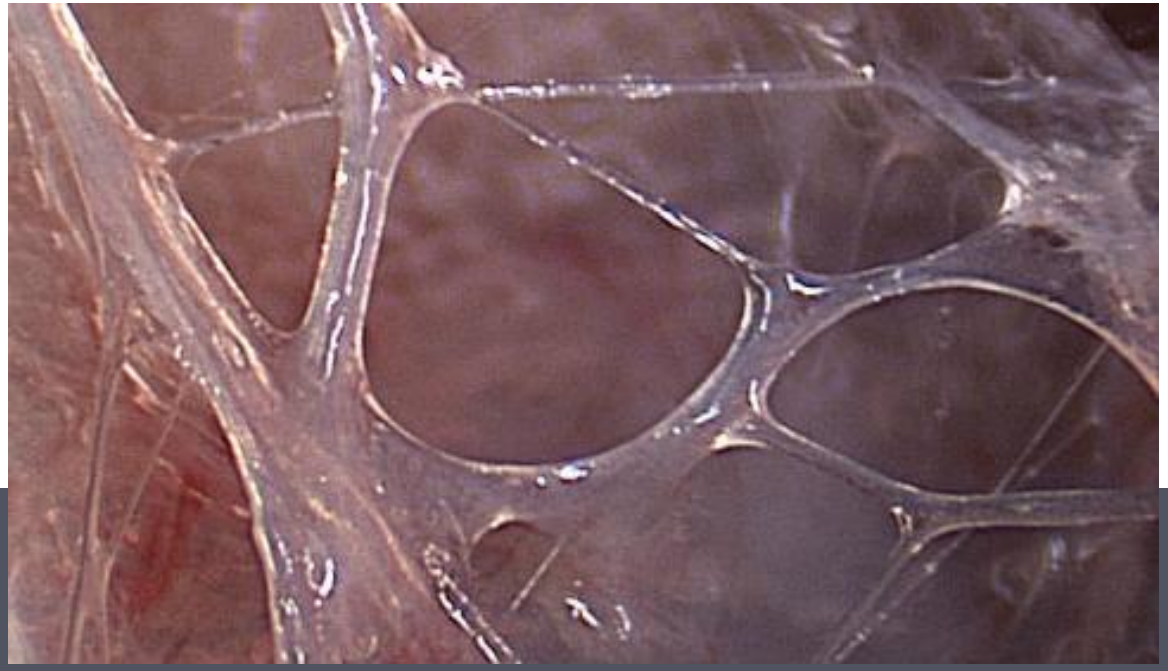
– Susi Hately Aldous

A THREE-DIMENSIONAL MATRIX

Like tendons and ligaments, fascia is a form of dense connective tissue. It is a continuous sheet of fibrous membrane located beneath the skin and around muscles and organs. This fascial system forms a three-dimensional matrix of connective tissue extending throughout the body from head to toe... Superficial fascia... covers the entire body... Deep fascia... surrounds muscles bellies, holding them together and separating them into functional groups. It also fills in the spaces between muscles.

– Andrew Biel

FASCIA



A 3-D SPIDER WEB HOLDING 70 TRILLION CELLS ALL TOGETHER

Fascia is the biological fabric that holds us together. You are about 70 trillion cells all humming in relative harmony; fascia is the 3-D spider web of fibrous, gluey, and wet proteins that hold them all together in their proper placement.

– Tom Myers, YogaUOnline

CAN BE FLEXIBLE OR CAN RESTRICT OUR MOVEMENTS

Fascia is flexible if we keep moving, stretching, and breathing, but if we allow any part of the body to remain immobile, its fasciae become less flexible and eventually restrict our movements, like gloves that fit so tightly that you can't bend your fingers.

– David Coulter, Anatomy of Hatha Yoga

MYOFASCIAL UNDERSTANDING

Image by gilhedley.com

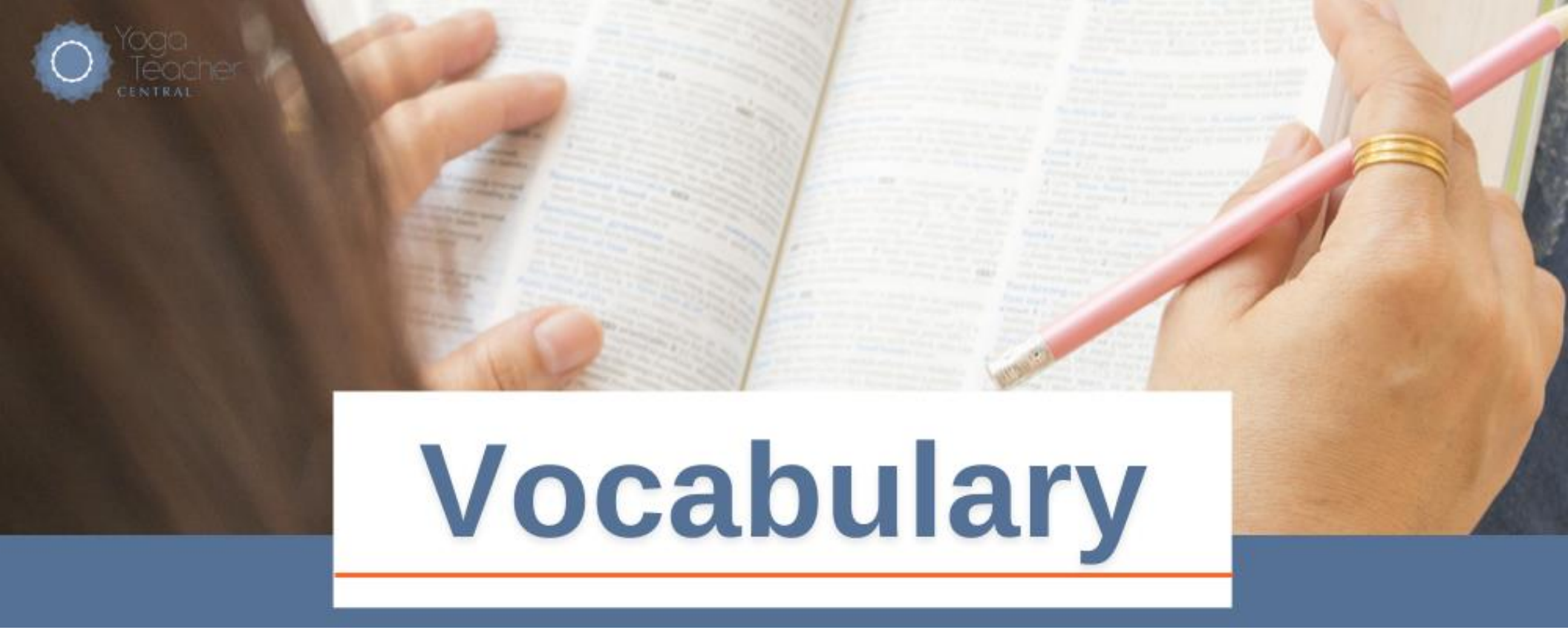
- The word “myofascia” refers to muscles (myo) and surrounding tissues (fascia).
- The word is used to help orient our thinking to the “inseparable nature” of muscle tissue and its connective tissue.

This teaching highlights the inaccuracy of seeing muscles as isolated units, separate from one another; it helps us to envision the interconnected whole that the body is. Thomas Myers, author of Anatomy Trains, has been a key expert communicating this critical point.

> Almost every text presents muscle function by isolating an individual muscle on the skeleton, divided from its connections above and below... This ubiquitous presentation defines a muscle's function solely by what happens in approximating the proximal and distal attachment points... This form of seeing and defining muscles, however, is simply an artifact of our method of dissection—with a knife in hand, the individual muscles are easy to separate from surrounding fascial planes. This does not mean, however that this is how the body "thinks" or is biologically assembled. One may question whether a "muscle " is even a useful division to the body's own kinesiology...
>
> Myofascial meridian theory does not eliminate the value of the many individual muscle-based techniques and analyses, but simply sets them in the context of the system as a whole... It has always been impossible to contact muscle tissue at any time or place without also contacting and affecting the accompanying connective or fascial tissues.
>
> – Thomas W. Myers

MUSCLE MOVEMENT

- Muscles provide the force behind movement.
- Muscles are the only tissue in the body that have the ability to contract and therefore move other parts of the body.
- Movement is produced by muscle fiber (bundles of specialized cells) that changes shape (contracting or relaxing).
- Muscle fibers contract in response to the Central Nervous System. The force of the contraction is transmitted to the fascial elements surrounding the muscles and eventually on to the bones, moving the joint. (Ray Long)
- As muscles contract, usually one end of the muscle remains fixed and the other end moves.



Vocabulary

AGONIST — The muscle providing the predominant contraction for a movement

AGONIST / ANTAGONIST RELATIONSHIP — When one muscle contracts, another muscle stretches

ANTAGONIST — The muscle that performs motion in the opposite direction of the agonist; it stretches passively

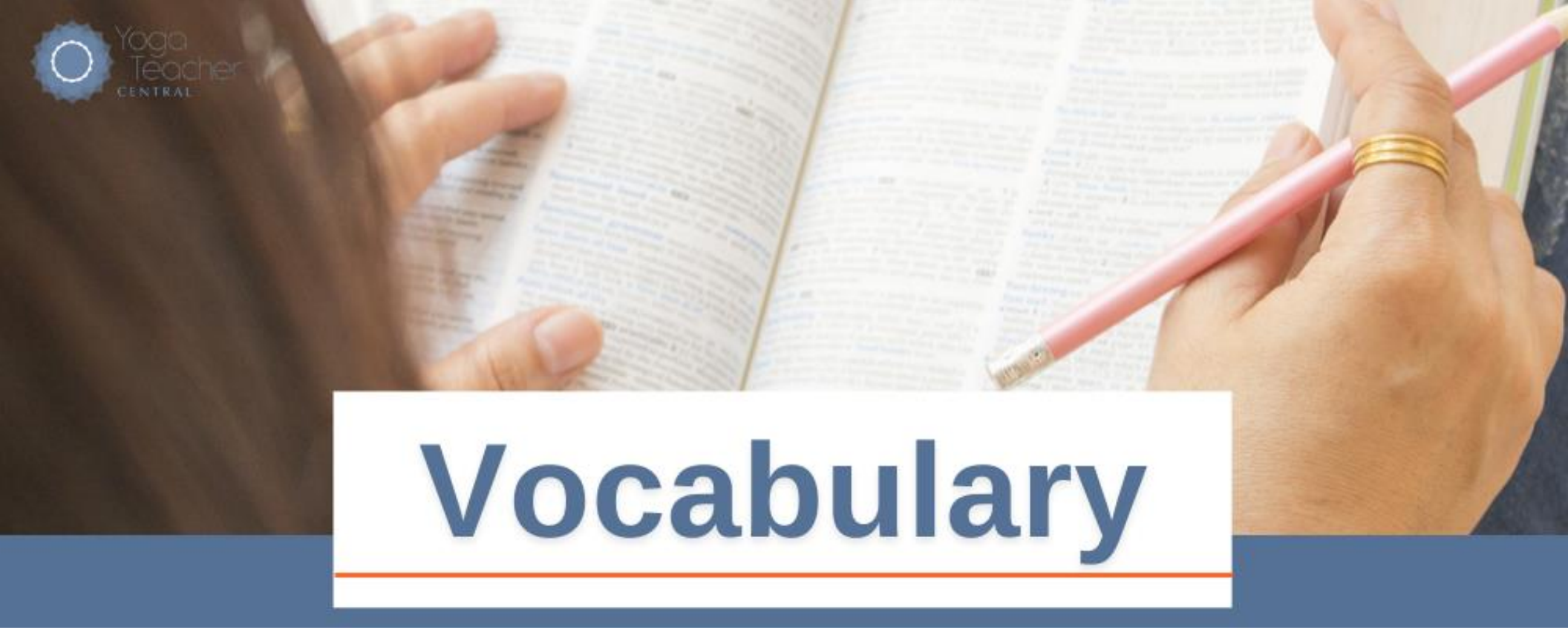
CONCENTRIC CONTRACTION — Muscle contraction causing movement against gravity; muscle actively shortens

ECCENTRIC CONTRACTION — Muscle contraction causing a slowdown of movement with gravity; muscle actively lengthens

FIXATOR MUSCLE — Another name for stabilizer

INSERTION — The distal (away) attachment of muscle to bone; on the bone that is most generally moved

ISOMETRIC CONTRACTION — Muscle contraction with no movement (muscle doesn't change length); also called static contraction



Vocabulary

ISOTONIC CONTRACTION – Muscle contraction with movement

MUSCLE CONTRACTION – The activation of tension in muscle fibers

ORIGIN – The proximal (near) attachment of muscle to bone; on the bone that is relatively stationary

ORIGIN & INSERTION POINTS – The places where muscles are attached to bones in relation to a movement at a joint

PRIME MOVER – Another name for agonist muscle

RECIPROCAL INHIBITION – An unconscious spinal reflex that causes the antagonist muscle to relax when the agonist muscle contracts

STABILIZER MUSCLE – The muscle that fixes part of the body so that movement can occur

SYNERGIST MUSCLES – Muscles that contract along with the prime mover to help carry out a motion

To move a bone at its joint, three things must occur. A set (or two sets) of muscles must contract, another set must release, and a third set must stabilize.

– Susi Hately Aldous

AGONIST / PRIME MOVER

- The agonist muscles are also called the prime movers
- Provide predominant contraction for the movement
- Provide major force
- Synergist – Some define synergists as muscles contracting along with the prime movers to help carry out the motion and some describe synergists as functioning as stabilizers

ANTAGONIST

- Performs motion in the opposite direction of the agonist muscles
- Stretches passively
- Typically relaxes (but not always)
- May slow down or stop a movement; for example: when lowering a very heavy weight from top of bicep curl, the antagonist, the tricep, is controlling movement of weight as it lowers

STABILIZER / FIXATOR

Often, only the terms agonist and antagonist are used. Sometimes, sources discuss synergists and/or stabilizers as well.

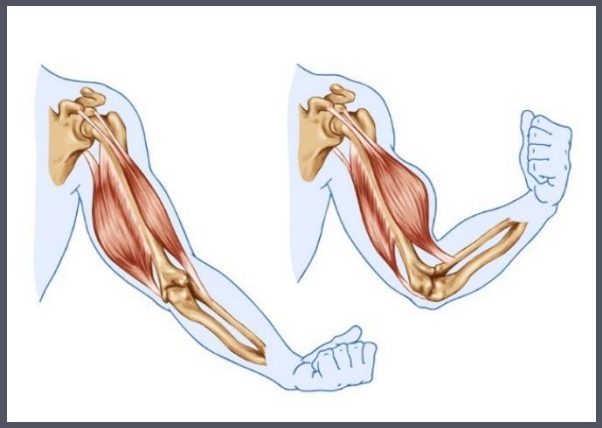
- Performs motion in the opposite direction of the agonist muscles
- Stretches passively
- Typically relaxes (but not always)
- Does not perform movement
- Fixes part of the body so that movement can occur
- Stabilizes origin of agonist and joint that origin spans
- "The better the stabilizers are able to do their job, the more easily the movement will occur and the more fluid the pose." (Susi Hately Aldous)

AGONIST / ANTAGONIST RELATIONSHIP

Agonist / Antagonist Relationship

- When one muscle contracts, another muscle stretches.
- For example, flexing the elbow (to draw forearm up) contracts the bicep and stretches the tricep.

RELATIONSHIP OF MUSCLES IN MOVEMENT



It makes sense that there would be a corresponding physiological Yin/Yang to make biomechanical processes such as flexion and extension of the knee energy efficient, i.e., when the agonist muscle contracts, its antagonist relaxes.

This process occurs unconsciously through a primitive spinal cord reflex arc that scientists call “reciprocal inhibition.” We can consciously access this reflex arc to deepen and improve our poses.

– Bandha Yoga

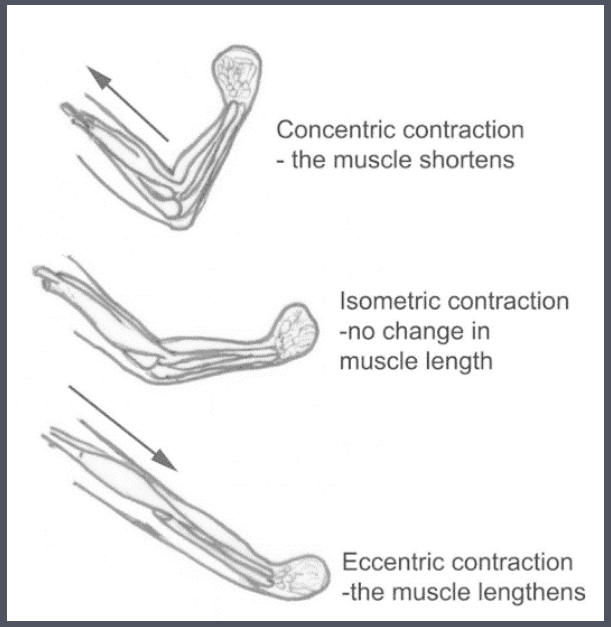
Reciprocal inhibition is the automatic antagonist alpha motor neuron inhibition which is evoked by contraction of the agonist muscle. This so-called natural reciprocal inhibition is a ubiquitous and pronounced phenomenon in man.

- PubMed

RECIPROCAL INHIBITION

- Muscles that move bones work in pairs: when one muscle contracts (called the agonist), another muscle stretches. (called the antagonist).
- Behind the agonist / antagonist relationship is the unconscious spinal reflex called Reciprocal Inhibition.
- Reciprocal Inhibition is “a neuromuscular reflex that inhibits opposing muscles during movement. For example, if you contract your elbow flexors (biceps) than your elbow extensors (triceps) are inhibited.
- This reflex can be used to deepen stretches by first holding a mild stretch until the body has acclimated and then engaging the opposing muscle to go deeper. (Bandha Yoga)
- See also Active Stretching in Flexibility & Stretching

MUSCLE CONTRACTION



Muscle contraction is the activation of tension in muscle fibers.

Some sources incorrectly define muscle contraction as the muscle shortening; in fact, the muscle may lengthen, shorten or stay the same.

ISOMETRIC VS ISOTONIC

If no movement takes place (the muscle doesn't change length), it is called an isometric contraction. When there is movement, it is called an isotonic contraction.

CONCENTRIC CONTRACTION

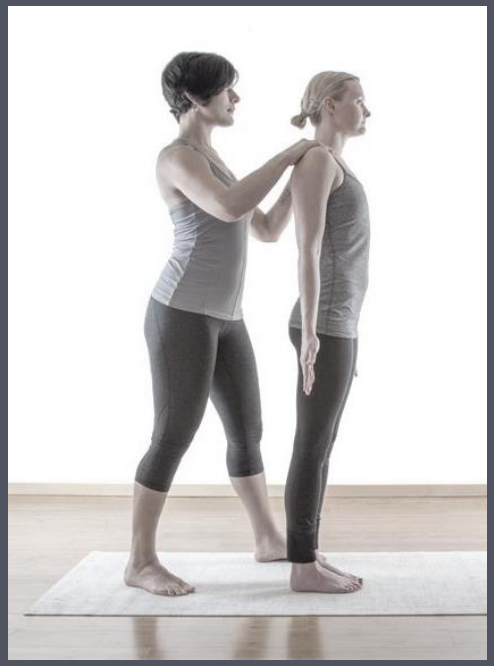
- Causes movement against gravity
- Muscle actively shortens
- Example: raising weight during a bicep curl
- Asana Example: Raising arms forward up—anterior deltoid and biceps contract concentrically

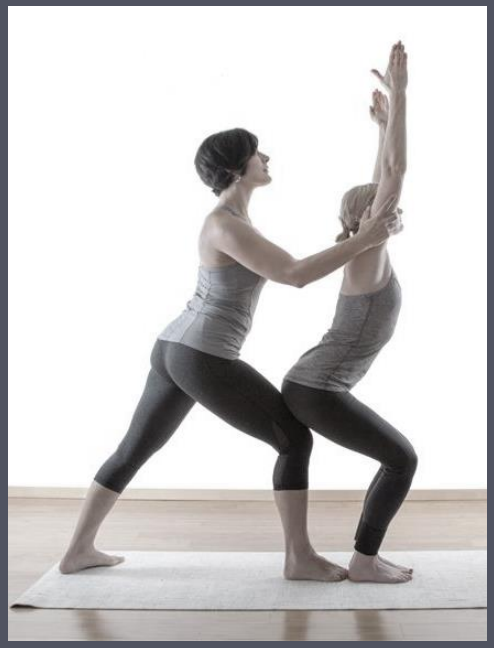
ECCENTRIC CONTRACTION

- Slow down movement with gravity
- Muscle actively lengthens
- Example: walking (quad actively lengthening)
- Asana Example: Controlled lowering of arms from overhead down to sides—biceps and anterior deltoid contract eccentrically

ISOMETRIC CONTRACTION

- "Static contraction"
- Muscle activated but no change in length
- Bones do not move
- Example: Carrying an object in front of you; or muscle attempts to push or pull something immovable
- Asana Example: Tadasana (Mountain Pose) or holding another pose for some time without changing body position





PHASES OF MOVEMENT

The concentric phase is the phase of the movement that is overcoming gravity or load, while the eccentric phase is the phase resisting gravity or load. So for push ups the concentric phase is the up phase where gravity is overcome, and the eccentric phase is the downward phase where gravity is resisted.

– PT Direct

PUSHING UP into PUSH UP

Concentric contraction

DOWNWARD PHASE to LOW PUSH UP

Eccentric contraction

In Anatomy and Asana, Susi Hately Aldous gives an example using movement from Tadasana (Mountain Pose) to Utkatasana (Chair Pose):

TADASANA

Isometric contraction of quads

INTO UTKATASANA

Eccentric contraction of quads

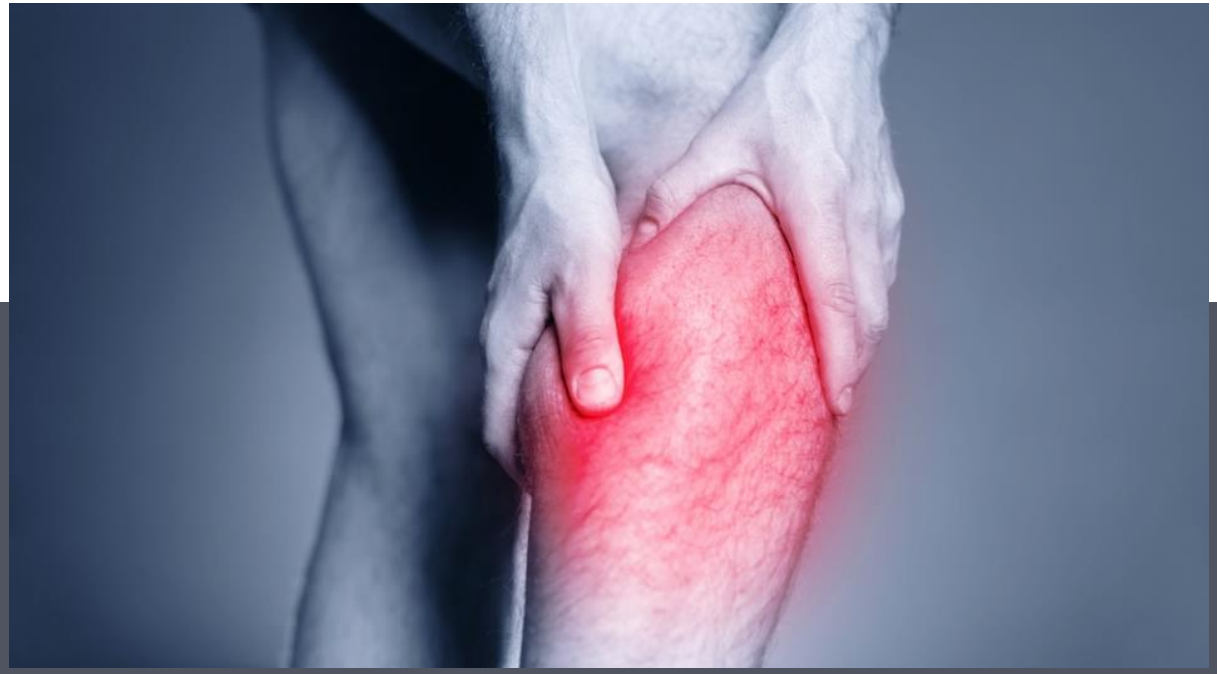
STAY IN UTKATASANA

Isometric contraction of quads

RISE TO TADASANA

Concentric contraction of quads

WHY DO MUSCLES CRAMP?



- Muscle cramping is sudden, involuntary muscle contraction which causes pain.
- Causes can include pregnancy, medications, liver disease and exercise.
- In the case of exercise or movement, the ultimate cause of the cramp may be oxygen deprivation.
- Deep breathing and bringing circulation to the area may help to prevent or resolve cramping.

INCREASING OXYGEN & CIRCULATION MAY HELP

Muscle cramping can be related to pregnancy, medications or liver disease. In many instances, it may be the result of exercise or movement and in these cases, the cause may be as Leslie Kaminoff explains in this 1-minute video. He explains that the sensation of a muscle cramping is a result of oxygen deprivation—which is associated with muscles that are weak. He explains that breathing delivers oxygen to the tissues and suggests that if there is cramping, to first "wake up" the muscles and bring more circulation to them.

MUSCLES CONTRACT, CAUSING PAIN

During a cramp, your muscles suddenly contract (shorten), causing pain in your leg. This is known as a spasm, and you cannot control the affected muscle. The cramp can last from a few seconds to 10 minutes. When the spasm passes, you will be able to control the affected muscle again.

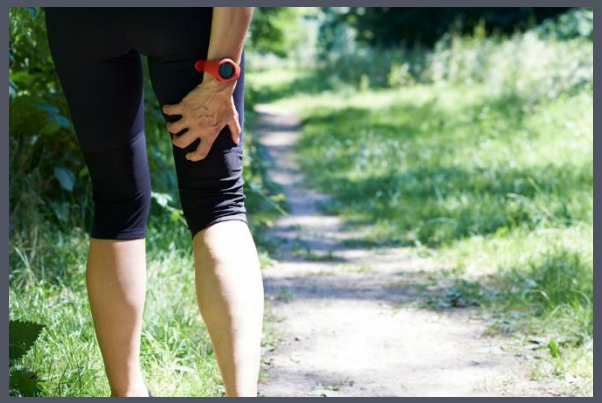
– NHS

CRAMPING CAN AFFECT ANY SKELETAL MUSCLE

A cramp is an involuntary and forcibly contracted muscle that does not relax. Cramps can affect any muscle under your voluntary control (skeletal muscle). Muscles that span two joints are most prone to cramping. Cramps can involve part or all of a muscle, or several muscles in a group.... Although the exact cause of muscle cramps is unknown (idiopathic), some researchers believe inadequate stretching and muscle fatigue leads to abnormalities in mechanisms that control muscle contraction. Other factors may also be involved, including poor conditioning, exercising or working in intense heat, dehydration and depletion of salt and minerals (electrolytes).

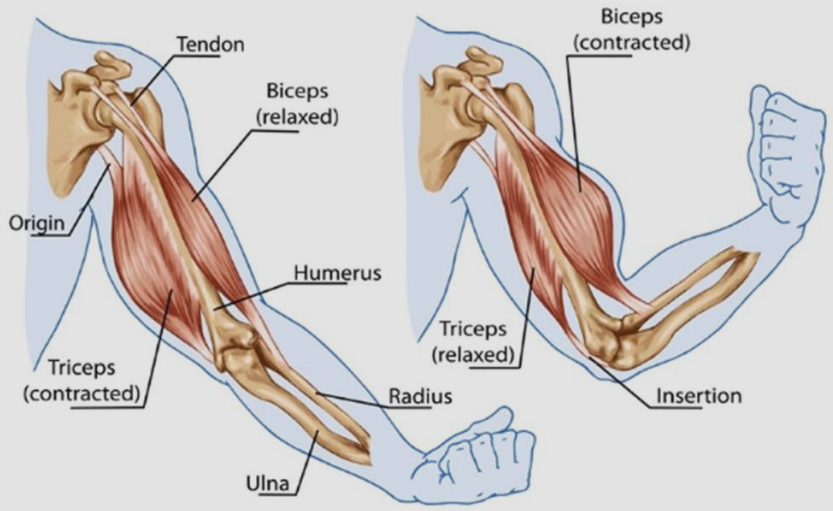
– Ortho Info

MUSCLE CRAMPS



ORIGIN & INSERTION POINTS

In Yogabody, Judith Lasater explains that knowing where a muscle arises and ends will help us in understanding the action that a muscle can make and what might be going wrong if that muscle is not doing its job.



As muscles contract, usually one end of the muscle remains fixed and the other end moves. Origin and insertion points are where muscles are attached to bones in relation to a movement at a joint. Different movements can cause a "functional reversal" of the origin and insertion points for a muscle.

Different sources use different approaches in how they display muscle actions and their origin and insertion points.

MUSCLE ORIGIN

- Proximal (near) attachment of muscle to bone
- On the bone that is relatively or usually stationary

MUSCLE INSERTION

- Distal (away) attachment of muscle to bone
- On the bone that is most generally moved

EXAMPLE: FLEX ELBOW

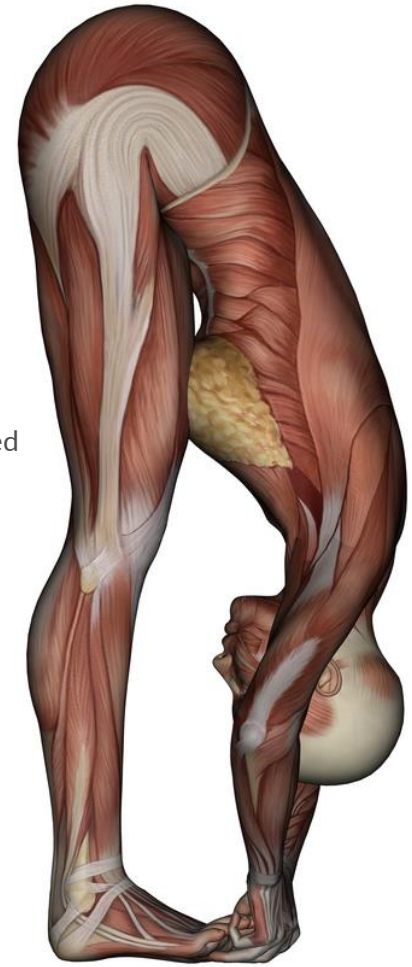
- Origin and insertion for biceps and triceps in flexing elbow; arm is fixed and the forearm moves
- Origin: arm and shoulder
- Insertion: forearm

RELATIONSHIP OF MUSCLES IN MOVEMENT

MUSCLE PAIR EXAMPLES

Flexing the elbow (to draw forearm up) contracts the bicep (called the agonist) and stretches the tricep (called the antagonist). Following are pair examples, some of which overlap because we are including both general and specific relationships that may be useful to you.

- Biceps — Triceps
- Back — Chest
- Middle Trapezius — Serratus Anterior
- Trapezius & Rhomboids — Pectoralis Major
- Posterior Deltoid — Anterior Deltoid
- Abdominals — Lower Back
- Left External Obliques — Right External Obliques
- Rectus Abdominis — Erector Spinae
- Deltoid — Latissimus Dorsi
- Quadriceps — Hamstrings
- Gluteus Maximus — Iliopsoas
- Gluteus Medius — Adductors
- Shin — Calf
- Tibialis Anterior — Soleus & Gastrocnemius



MUSCLE PAIRS BY MOVEMENT

In the following examples (from this source), the first muscle is the agonist and the second, the antagonist:

- Elbow Flexion — Biceps / Triceps
- Elbow Extension — Triceps / Biceps
- Shoulder Flexion — Anterior Deltoid / Posterior Deltoid
- Shoulder Extension — Posterior Deltoid / Anterior Deltoid
- Shoulder Abduction — Middle Deltoid / Latissimus Dorsi
- Shoulder Adduction — Latissimus Dorsi / Middle Deltoid
- Shoulder Medial Rotation: —Subscapularis & Teres Major / Infraspinatus & Teres Minor
- Shoulder Lateral Rotation — Infraspinatus & Teres Minor / Subscapularis & Teres Major
- Spinal Flexion — Rectus Abdominis / Erector Spinae
- Spinal Extension — Erector Spinae / Rectus Abdominus
- Hip Flexion — Iliopsoas / Gluteus Maximus
- Hip Extension — Gluteus Maximus / Iliopsas
- Hip Abduction — Gluteus Medius & Minimus / Adductors
- Hip Adduction — Adductors / Gluteus Medius & Minimus
- Hip Medial Rotation — Gluteus Medius & Minimus / Gluteus Maximus
- Hip Lateral Rotation — Gluteus Maximus / Gluteus Medius & Minimus
- Knee Flexion — Hamstrings / Quadriceps
- Knee Extension — Quadriceps / Hamstrings
- Dorsiflexion — Tibialis Anterior / Gastrocnemius & Soleus
- Plantarflexion — Gastrocnemius & Soleus / Tibialis Anterior
- Wrist Flexion: —Wrist Flexor / Wrist Extensor
- Wrist Extension — Wrist Extensor / Wrist Flexor

WHEN TEACHING POSES

- Being aware of the muscle pairs involved in actions can help a student to deepen her experience of a posture with conscious focus. For example, when the student wishes to lengthen the hamstrings, you can teach active engagement of the quadriceps.
- Reciprocal inhibition is an unconscious spinal reflex that causes the antagonist muscle to relax when the agonist muscle contracts. This reflex can be consciously accessed to deepen stretches by first holding a mild stretch until the body has acclimated and then engaging the opposing muscle to go deeper. (Bandha Yoga)
- See also: Active Stretching in Flexibility & Stretching.

FOR SEQUENCING & CLASS PLANNING

- the muscle relationships in movement can guide the intention you set to address a problem area.

- For example, in the Yoga International video, Asana Anatomy: Trapezius and Serratus Anterior, an approach for rounded shoulders involves the middle trapezius and serratus anterior (side ribs, responsible for pulling scapula forward). In the video, Sarah Guglielmi shows practices for releasing tension in the serratus anterior and strengthening through the trapezius.

- Avoid choosing too many poses that use similar muscular actions.

TEACHING APPLICATIONS

INCLUDE POSES THAT WORK ANTAGONIST MUSCLES

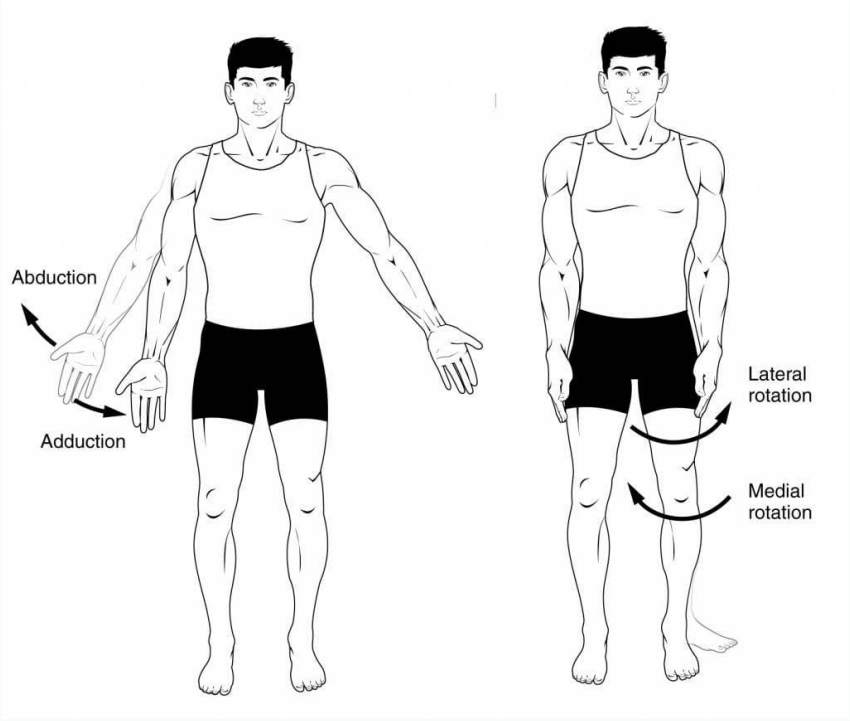
Be sure to include poses that work the antagonist muscles. Do not include too many poses with similar action – that can create cumulative stress.

– Olga Kabel, SequenceWiz

Olga Kabel offers these considerations when targeting a specific body area.

1. Identify target parts of skeleton.
2. Determine the target muscles and the muscle actions; in order to provide integration, plan to involve a more general area of the body—not just the specific muscles.
3. Identify poses and pose adaptations that will stretch and strengthen those muscles.
4. Contract muscles first; then relax them; then stretch them.
5. Take breaks to feel effect of practice on target area.

MOVEMENT TERMINOLOGY



FLEXION / EXTENSION

- **Flexion** — Decreases joint angle (Usually moves a body part forward except in the case of the knee which moves backward)
- **Extension** — Returns joint to resting position
- **Hyperextension** — Moving beyond normal, healthy range of motion

ADDUCTION / ABDUCTION

- **Adduction** — Moves a part of the body **toward** the midline
- **Abduction** — Moves a body part **away from** the midline

INTERNAL / EXTERNAL ROTATION

- **Internal Rotation** — Moves **toward** the midline
- **External Rotation** — Moves **away from** the midline

PRONATION / SUPINATION

- **Pronation** — Moves palms posteriorly or face down
- **Supination** — Moves palms anteriorly or face-up

LOCATION TERMINOLOGY

LATERAL / MEDIAL

- **Lateral** – Away from the midline
- **Medial** – Toward the midline

ANTERIOR / POSTERIOR

- **Anterior** – In front
- **Posterior** – Behind

DISTAL / PROXIMAL

- **Distal** – Away from, farther from the origin
- **Proximal** – Near, closer to the origin

SUPERIOR / INFERIOR

- **Superior** – Above, over
- **Inferior** – Below, under

SUPERFICIAL / DEEP

- **Superficial** – Toward the skin
- **Deep** – Inside body

VENTRAL / DORSAL

- **Ventral** – On front of body
- **Dorsal** – On back of body

LAPPA'S CATEGORIES

GENERAL MOVEMENT TYPES

1. Stretching
2. Static Strengthening
3. Dynamic Strengthening
4. Static Endurance
5. Dynamic Endurance
6. Coordination
7. Reaction

PASSIVE & ACTIVE

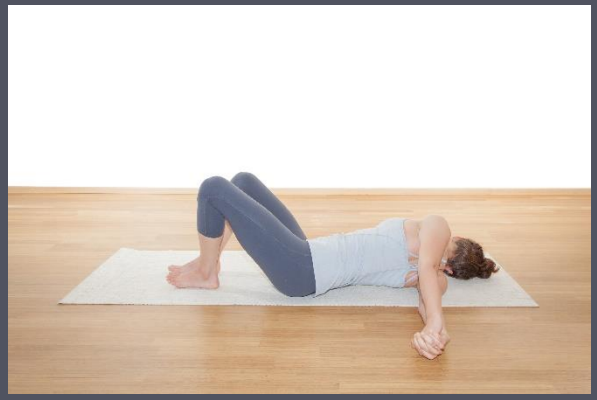
- **Passive** – Uses gravity to stretch muscles
- **Active** – Stretches one set of muscles by engaging others
- **Equally Passive & Active** – Poses that draw equally on passive and active techniques

WHY LAPPA DESCRIBES MOVEMENT TYPES DIFFERENTLY

In the Yoga Journal article Open Arms by Todd Jones, Andrey Lappa teaches the following:

- Traditional *asanas* use the first five types of movements (noted above), but not the last two.
- Traditional *asana*s may utilize an overabundance of active stretches.
- To address his findings, Lappa developed additional practices derived from other movement modalities.
- For instance, Lappa found that most poses that train the arms focus on strength while "of the few poses that focus on arm flexibility, most are active stretches, like Viparita Namaskar, Gomukhasana (Cow Face), and Garudasana (Eagle), which use the strength of one set of muscles to stretch others."
- In response to his analysis, Lappa created passive stretches for arms and shoulders.
- See also: Lappa's website, Universal Yoga

ANDREY LAPPA'S TEACHINGS



MORE

“SCRUB”

- The term "scrub" appears in Ray Long's writing (The Daily Bandha and Yoga Mat Companion series).
- This refers to the action of engaging muscles as if the intention is to drag a body part along the floor, although it does not move.
- For example, in Sphinx Pose shown here, this action can be taught with the forearms. Long teaches to “scrub” backward on the mat toward the pelvis, drawing the chest forward.

PRONE / SUPINE

- To be prone is to life face downward (on the stomach).
- To be supine is to lie on the back.

PLANES OF MOTION

SAGITTAL / MEDIAN PLANE

- Divides the body into left and right
- Any forward and backward movement occurs in the sagittal plane

CORONAL / FRONTAL PLANE

- Divides the body into front (anterior) and back (posterior)
- Any lateral (side) movement occurs in the coronal plane

TRANSVERSE / HORIZONTAL PLANE

- Divides the body into top and bottom
- Rotational movement occurs in the transverse plane

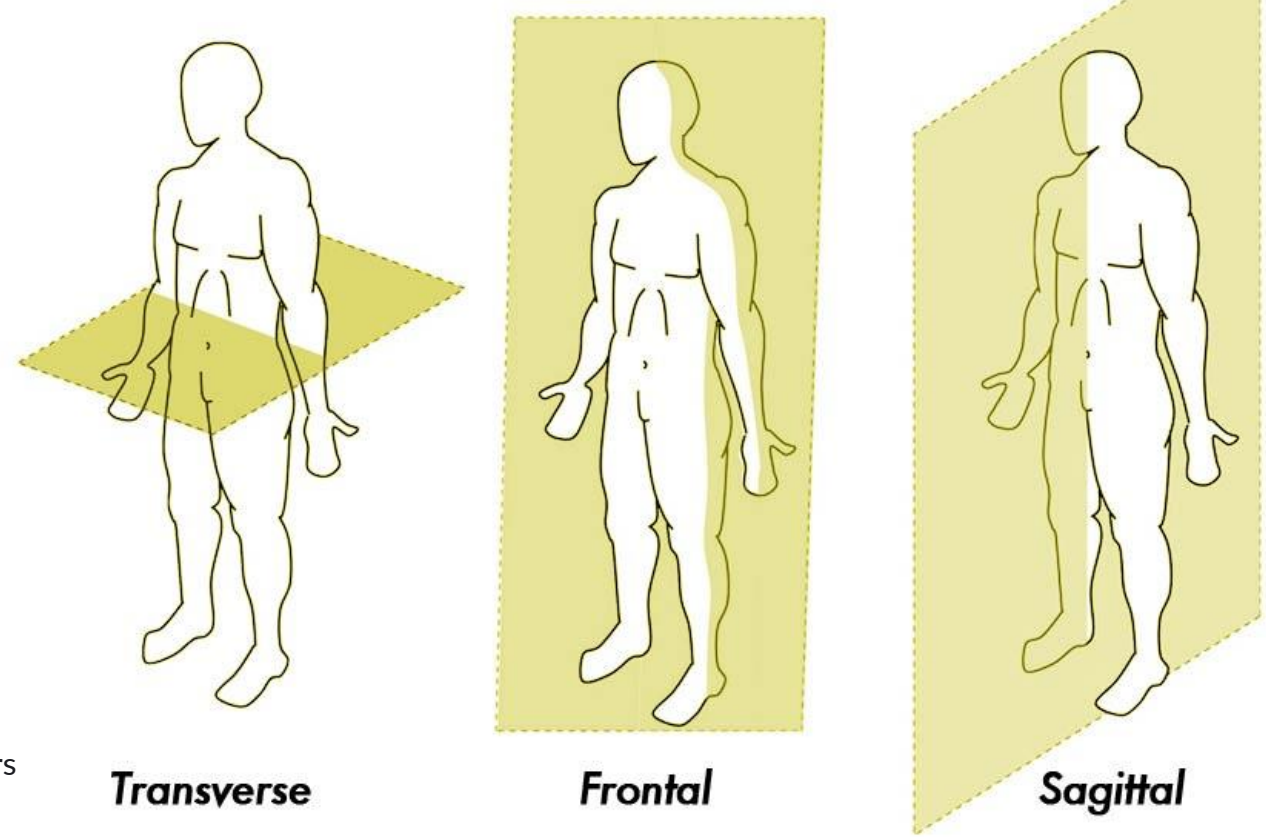


Image source: All Hands On Fitness

WHY DO WE REFER TO PLANES OF MOTION?

Your body doesn't move in one dimension. If it did, you wouldn't be able to move your leg away from you, toward you, in front and behind you. Your body moves in three dimensions... There are three different planes of motion: sagittal, frontal, and transverse. In each plane, several different movements occur at the joints.

– Acefitness.org

MOVEMENTS IN EACH PLANE

SAGITTAL PLANE

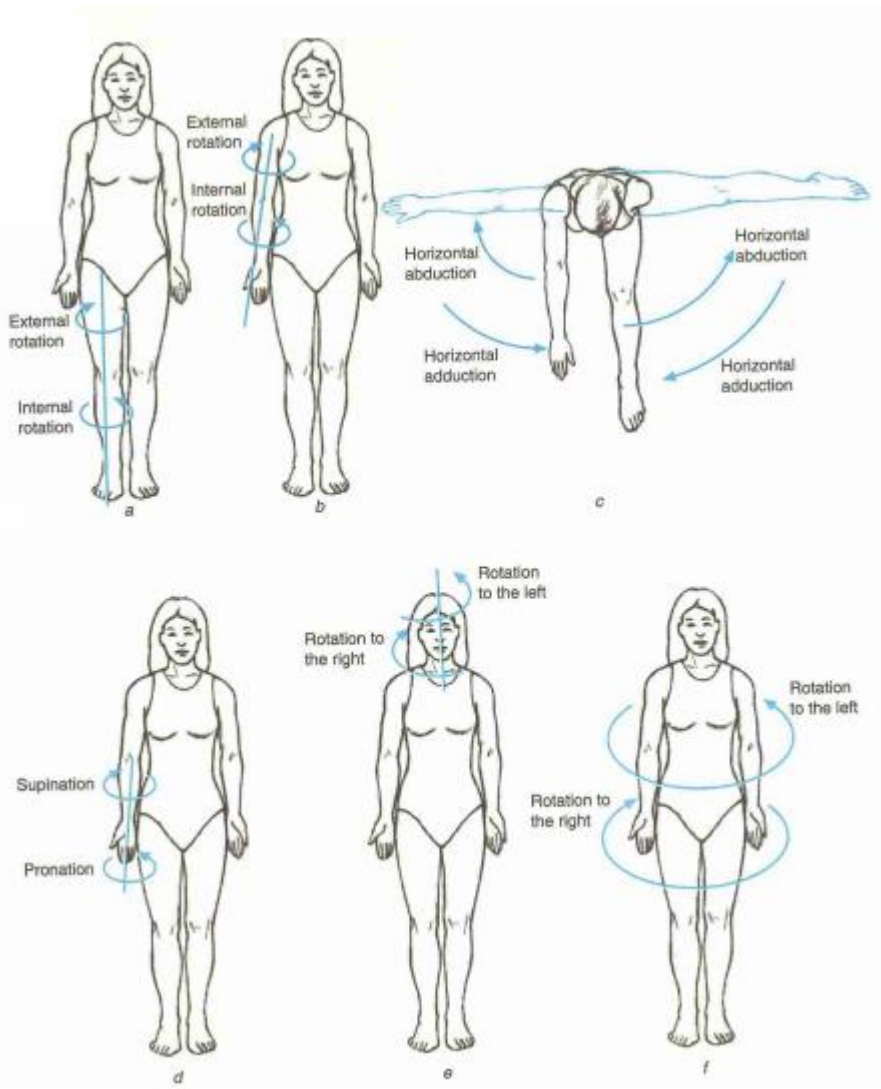
- **Flexion** — Decreasing the angle between two bones
- **Extension** — Increasing the Angle between two bones
- **Dorsiflexion** — Moving the top of the foot toward the shin (only at the ankle)
- **Plantar flexion** — Moving the sole of the foot downward (pointing the toes)
- **Exercise Examples** — Bicep curl and forward or reverse lunges

FRONTAL OR CORONAL PLANE

- **Adduction** — Motion toward the midline
- **Abduction** — Motion away from the midline of the body
- **Elevation** — Moving to a superior position (only at the scapula)
- **Depression** — Moving to an inferior position (only at the scapula)
- **Inversion** — Lifting the medial border of the foot
- **Eversion** — Lifting the lateral border of the foot
- **Exercise Examples** — Dumbbell lateral (side) raise

TRANSVERSE PLANE

- **Rotation** — Internal (inward) or external (outward) turning about the vertical axis of the bone
- **Pronation** — Rotating the hand and wrist medially from the bone
- **Supination** — Rotating the hand and wrist laterally from the bone
- **Adduction** (Horizontal Flexion) — From the 90-degree abducted arm position, the humerus is flexed (adducted) in toward the midline of the body in the transverse plane
- **Abduction (Horizontal Extension)** — Return of the humerus from horizontal flexion
- **Exercise Example** — Horizontal wood chop



JOINT MOVEMENTS

- Joints move because muscles contract and move them.
- Range of motion (ROM) refers to mobility of each joint through its various directions of movement.
- Specialists in orthopedics, physical therapy and related fields often utilize standards that define normal range of motion; the "standards" differ somewhat according to source.
- An objective for *asana* is to move the joints through their range of motion, thereby lubricating the joints as well as developing and maintaining strength and flexibility of muscles around the joint.
- A joint's mobility is affected by the muscles around it.
- Hyperextension can lead to joint instability.
- Diminished ROM places additional stress on body.

WHAT IS JOINT PLAY AND WHY IS IT IMPORTANT?

In order to move, the capsule and the ligaments around the joint must have a certain amount of laxity, or joint play. Joint play means that the structures are loose on one side of the joint to facilitate movement on the opposite side... A certain amount of... joint play is necessary in order to allow for normal movement. If both sides of the joint capsule are taut, movement is greatly impeded.

– Judith Lasater, Yogabody

WHY IS MAINTAINING AN OPTIMAL RANGE OF MOTION (ROM) IMPORTANT?

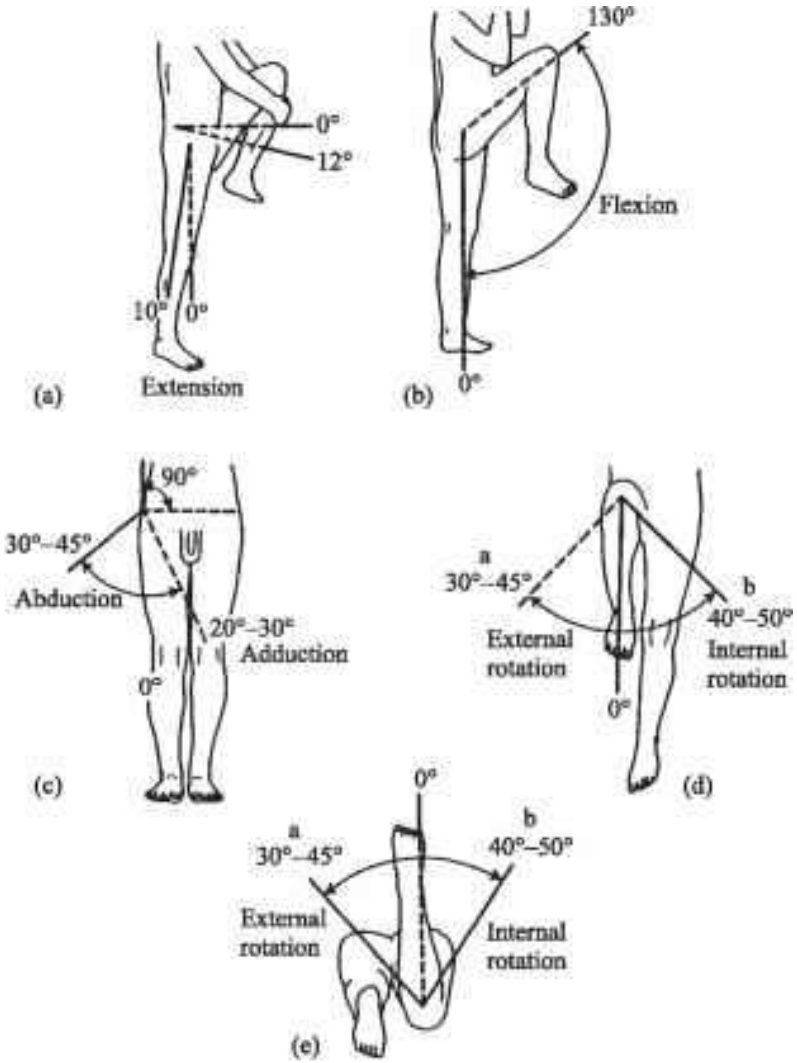
Motions within the optimal range maintain the natural flow of synovial fluid for lubrication of the joints, as well as normal strength and flexibility of the antagonistic muscles on opposite sides of the joint. When this range is exceeded, by overstretching, poor posture, injury or skeletal deformity, the joint becomes hyperextended, less stable and potentially more vulnerable to injury. Conversely, when the range of a joint has been diminished, the resulting rigidity in the joints and postural muscles supporting it places more stress on neighboring joints and muscles.

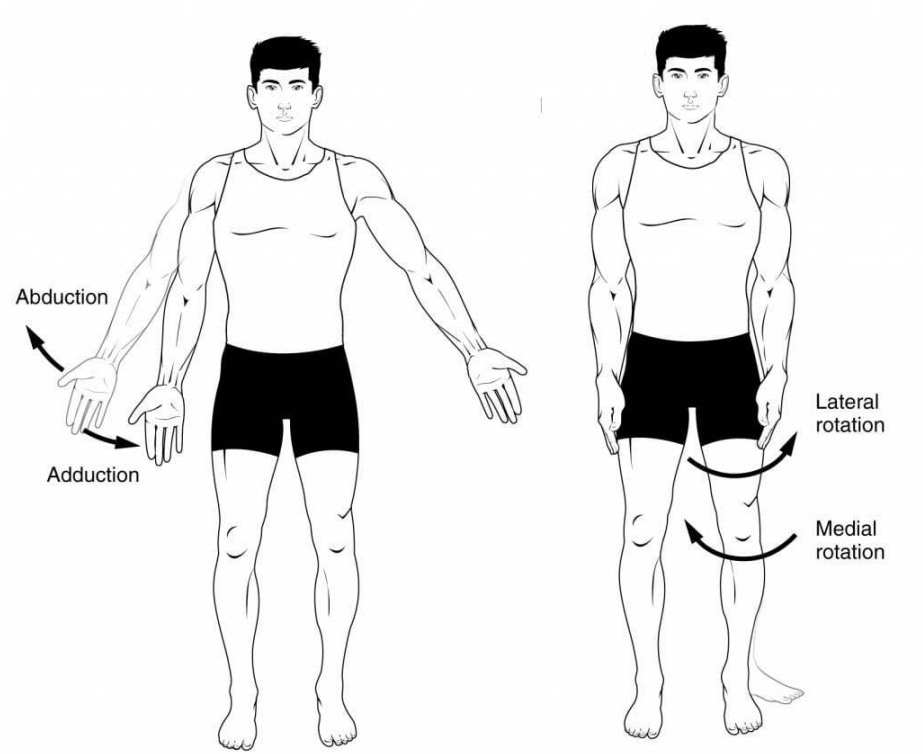
– Mukunda Stiles, Structural Yoga Therapy

A JOINT IS ONLY AS HEALTHY AS THE MUSCLES SURROUNDING IT

While a few joints in the body are immovable or slightly movable, most of the joints are "freely movable" and have elaborate structures. Their complexity is one reason they're particularly vulnerable to injury. A joint is only as healthy as the muscles surrounding it. Relaxed, flexible muscles lead to a more mobile joint.

– Larry Payne, Yoga RX





JOINT MOVEMENTS PART I

ANKLES

- Plantar Flexion – pointing toes
- Dorsiflexion – drawing toes back toward knee
- Eversion – outer edge of foot draws toward head
- Inversion – inner edge of foot draws toward head
- Rotation – circling of ankles

KNEES

- Flexion – bending knee
- Extension – straightening knee

HIPS

- External Rotation – outward rotation of thighbone within hip socket
- Internal Rotation – inward rotation of thigh coming from glutes
- Extension – from hands & knees, back of leg rises toward sky
- Flexion – from hands & knees, rounding to take knee to nose flexes the hip
- Adduction – drawing leg across centerline of body as in Gomukhasana (Cow Face Pose)
- Abduction – taking leg out away from midline of body

JOINT MOVEMENTS PART II

SPINE

- See Spinal Movements

NECK

- Extension – dropping head back
- Flexion – taking chin to chest
- Lateral flexion both directions – drawing ear toward shoulder
- Lateral rotation both directions – turning chin toward shoulder

SCAPULA

- Adduction – squeeze shoulder blades
- Abduction – round thoracic spine

SHOULDERS

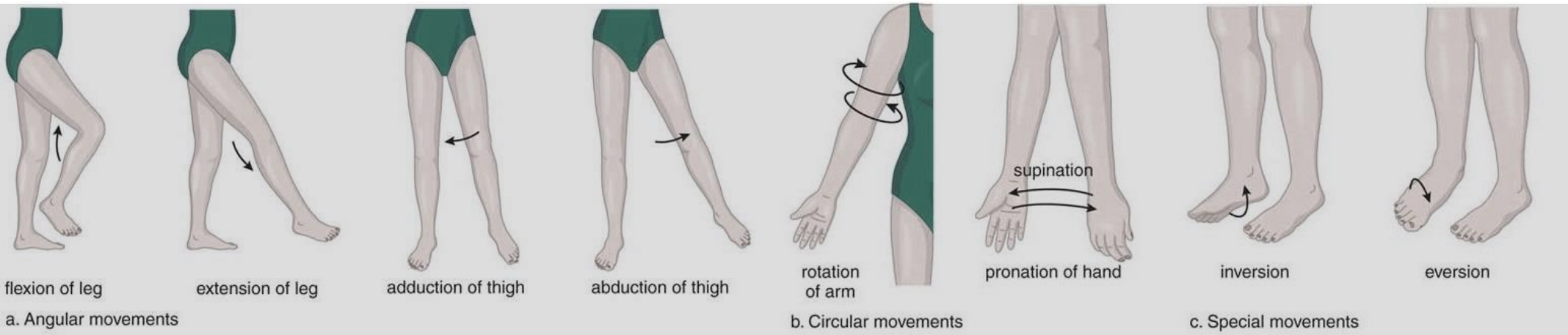
- Abduction – hands to shoulders, open elbows out
- Adduction – hands to shoulders, draw elbows toward one another
- External Rotation – "goal post" arms, palms facing forward
- Internal Rotation – "goal post" arms, rotating palms down and facing back
- Flexion – raise arms upward
- Extension – draw arms back behind body

WRISTS

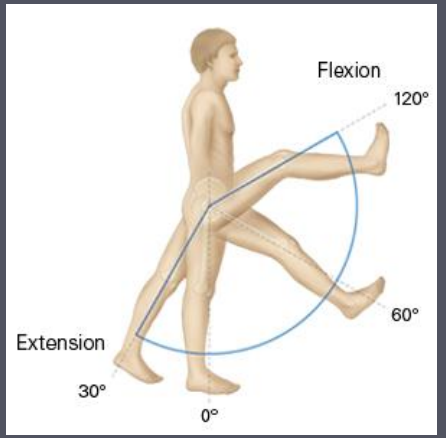
- Flexion – taking palm toward body
- Extension – making the stop motion with the hand
- Radial deviation – from straight wrist, palm up, turning thumb side toward torso
- Ulnar deviation – from straight wrist, palm up, turning pinky side toward torso
- Rotation – circling wrists

ELBOWS

- Extension – straightening arms
- Flexion – bending arms



JOINT RANGE OF MOTION (ROM)



The following range of motion norms are from Structural Yoga Therapy.

SPINE

- Spine Extension - No standard; "from a yogic point of view, we look for symmetry and fullness in backbending and for a lengthening of the spinal column“
- Spine Flexion — No standard; "A yogic view is that, if the tone of the spine flexors is balanced to the opposing muscles, the erector spinae, the spine arcs evenly, creating a symmetrical semicircle.“
- Spine Lateral Flexion not established ("though it appears to be 45°")
- Spine Rotation not established ("shoulder girdle 45°")

NECK

- Neck Extension 55° — Neck Flexion 45°
- Neck Lateral Flexion 45° — Neck Lateral Rotation 70°

HIPS

- Hip External Rotation 45-60° — Hip Internal Rotation 35°
- Hip Extension 30° — Hip Flexion 135°
- Hip Adduction 30-40° — Hip Abduction 45°

KNEES

- Knee Extension 180° — Knee Flexion 150°

ANKLES

- Ankle Dorsiflexion 20° — Plantar Flexion 50°
- Ankle Eversion 20° — Ankle Inversion 45°
- Ankle Rotation — combines previous motions

SHOULDERS

- Shoulder Abduction 40° — Shoulder Adduction 130°
- Shoulder External Rotation 90° — Shoulder Internal rotation 80°
- Shoulder Flexion 180° — Shoulder Extension 50°
- Scapula Adduction not established — Scapula Abduction not established

ELBOWS

- Elbow Extension 0° (straight line) — Elbow Flexion 145°

WRISTS

- Wrist Flexion 90° — Wrist Extension 80°
- Radial Deviation 20° — Ulnar Deviation 30°
- Wrist Rotation - combination of four preceding motions

SPINAL MOVEMENT

It's generally accepted that a balanced yoga practice will move the spine in each of its six directions (forward, backward, both sides and twisting both directions). In addition, the categories of extension and inversion are often included.

SPINAL MOVEMENT EXAMPLES

FORWARD BENDING

- Uttanasana (Standing Forward Bend)

BACK BENDING

- Bhujangasana (Cobra)

LATERAL MOVEMENT

- Utthita Parsvakonasana (Extended Side Angle)

TWIST

- Ardha Matsyendrasana (Half Lord of the Fishes)

For in-depth coverage of characteristics, cautions, and sequencing considerations for each of the different pose categories, see Asana Categories

SPINAL EXTENSION / AXIAL EXTENSION / ELONGATION

- Urdhva Hastasana (Upward Salute)
- "Spinal or Axial Extension" in yoga typically refers to reducing the spinal curves or lengthening the entire spine.
- The objective is to create space between the vertebrae, thus lengthening the spine.
- Spinal extension refers to the relationship of the spinal curves to each other while the phrases "forward bending" and "backbending" refer to particular movements through space.
- From the "root" comes the "rise" which refers to pressing into the earth and noticing how this activation causes a rebounding or lifting effect.
- Once the foundation is set, potential teaching cues might include, "Lengthen (or elongate) the spine" or "Extend the spine" or "Feel a lifting through the top of the head."
- See also: Anatomy of the Spine

INVERSION

- Salamba Sarvangasana (Supported Shoulderstand)
- To "invert" means to turn upside down.
- Yoga inversions invert the body's relationship to space and gravity.
- In some types of inversions, the heart is higher than the head.
- In some types, the pelvis, legs and feet are higher than the heart.
- And in some types of inversions, both conditions are true: the heart is higher than the head and also the pelvis, legs and feet are higher than the heart.

COMPRESSION

Andrey Lappa adds compression (drawing the bones closer together) to the list of types of movement although he notes that "compression is only desirable therapeutically; extension is the normal aim in all *asanas*."

SPINAL MOVEMENT

LESLIE KAMINOFF EXPLAINS SPINAL FLEXION & EXTENSION AS DEFINED BY SPINAL CURVES

A simple way to identify all the primary [kyphotic] curves is to notice all the parts of the body that contact the floor in Savasana, or corpse pose: the curve of the back of the head, the upper back, the sacrum, the backs of the thighs, the calves, and the heels. Consequently, the secondary [lordotic] curves are present in all the body parts that are off the floor in this position: the cervical and lumbar spine, the backs of the knees and the space posterior to the achilles tendons. From this perspective, spinal flexion can be defined as an increase in the primary spinal curves and a decrease in the secondary spinal curves. A reversal of this definition would define spinal extension as an increase in the secondary curves and a decrease in the primary curves.

– Leslie Kaminoff, Yoga Anatomy

OLGA KABEL ON EXTENSION OF THE SPINE

Technically, the term “spinal extension” refers to the spine returning into the neutral position from flexion (1) and bending backwards (2). But the term “extension” also means lengthening. So when we say “axial extension poses”, we mean that the main goal of those poses is to lengthen the spine along its axis... It is NOT our intention to flatten the spine, but rather to create some space between the vertebrae to counteract the effect of gravity... The most important aspect of all axial extension postures is to bring the spine into maximum vertical alignment while integrating all the spinal curves without strain. This type of action builds strength and elasticity in the postural muscles, helps to strengthen the core and promote overall structural integration.

– Olga Kabel, SequenceWiz, Why Do We Lengthen Upward?