ANATOMY & PHYSIOLOGY

MODULE 4

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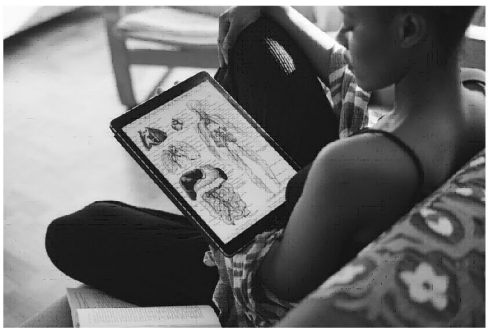
STUDYING & TEACHING YOGA ANATOMY

LESSON OVERVIEW



In this lesson, we introduce best practices for approaching the general subjects of anatomy and physiology as they relate to yoga teaching.

Objective

Become familiar with priorities and guidelines for studying and utilizing knowledge of anatomy and physiology in teaching.

Description

Define "anatomy," "physiology" and "biomechanics." Provide guidelines for effectively utilizing knowledge of anatomy in teaching, and a trick to help you stay conscious of your words. Explain specific ways to help ensure you're being clear when referencing anatomy-related teachings and how developing your understanding of anatomy can make you a stronger teacher. Be aware of common teaching mistakes and of best practices for sharing anatomy teachings with students.

Questions Answered Here

1. Define "anatomy," "physiology" and "biomechanics."
2. What guidelines can help you to effectively utilize knowledge of anatomy in yoga teaching?
3. What trick might you use to help stay conscious of your words?
4. What specific things can you do to help ensure you're being clear when referencing anatomy-related teachings?
5. Continuing to develop your understanding of anatomy and physiology is quite likely to make you a stronger teacher. How?
6. What are some potential teaching mistakes when using anatomical language?
7. Provide five wise tips for effectively sharing anatomy teachings with students.
8. Give an example of a cue that is actually anatomically impossible. What might you say instead?

Terminology

Anatomy = the study of the shape, structure and relationship of parts of living things (source)
Physiology = the study of functions and activities of life forms (at the organ or cellular level) (source)
Biomechanics = as it relates to people, biomechanics often refers to the study of how the skeletal and musculature systems work under different conditions (source)

Terminology related to each topic is contained within the specific sections: Nervous System, Respiratory Anatomy, Musculoskeletal System and so on.

OBJECTIVES & PRIORITIES

This very deep section on Anatomy & Physiology for Yoga Teachers was developed with these objectives in mind:

1. Clearly communicate fundamental and relevant principles of anatomy and physiology — focusing primarily on the application of such principles in teaching. Do not provide mountains of anatomy factoids; instead, focus on teaching concepts with context and relevance.
2. Consult multiple expert sources of different backgrounds, lineages, and approaches. Point out differing approaches for consideration.
3. Provide a progressive curriculum and organized resource library for structured learning and research. Help teachers to efficiently find what they're looking for and to more easily "know what they don't know."
4. Include references and quick links for verification and further study.

Learning Tools Are Not Reality

Learning tools — including the common ways that anatomy is depicted — provide a model only; they are not reality.

A Vital Reminder from the Cadaver Lab

*Once upon a time, I got to attend a one-day cadaver lab… the muscles and nerves look NOTHING like the anatomy books… Let me tell you, after memorizing the four rotator cuff muscl es from a book, you think you've got it and then you go look for them… It was probably the first time I began to understand that we are truly all one, intertwined, connected mix of muscles, tissues, nerves, everything is all together. There's not a perfectly perfect supraspinatus just sitting there waiting to be examined… [And] the sciatic nerve. No wonder it's such a pain in the ***. It's HUGE. Also fascinating, the glutes… Seeing the size of these muscles and knowing they are meant to be strong and utilized for healthy locomotion was really cool. Again, [though,] they were just layers of muscles that were not distinguishable to me. – Terry Littlefield*

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STUDYING & TEACHING YOGA ANATOMY

TEACHING GUIDELINES

Consider these guidelines for effectively utilizing knowledge of anatomy in yoga teaching.

1. Stay conscious of your words: be accurate, precise and clear.
2. Teach only what you know very well.
3. Engage in continuous learning and growth.

#1 Be Accurate, Precise and Clear

1. Whether or not there is a physical therapist or doctor in class, you may wish to imagine that there is in order to stay conscious of your words.
2. While accuracy and precision are of top priority, so is clarity. Although you should feel free to teach concepts as deeply as you think you can do so effectively, endeavor to simplify wherever possible.
3. Define and explain virtually all anatomy terms

#2 Teach Only What You Know Very Well

When learning and growing, teachers are advised to remember this fundamental: teach only that which you know very well. This means teaching only those topics that you have practiced, studied, experienced or otherwise engaged with for a long time.

#3 Engage in Continuous Learning & Growth

Whether you use a significant amount of anatomical language or very little is up to you and often reflects a teacher's personal background and style. There is room for all approaches. However, even for those who use little anatomical language, continuing to develop your understanding of anatomy and physiology is quite likely to make you a stronger teacher. Anatomy teachings help you to:

1. Create particularly focused and effective class objectives.
2. Create safe sequences.
3. Teach asana safely and effectively.
4. Better understand why a student is having a particular experience.

Real-World Teaching Tips

When sharing anatomy teachings with students, consider the following wonderful advice. These excellent suggestions are from Julie Gudmestad's Yoga Journal articles

1. Show, explain and reinforce the body parts you name.
2. Focus on only one anatomical name, principle or movement per class.
3. Do not interchange the name of an injury with a body part. Avoid incorrectly referring to an injury by the name of the body part affected.
4. Use movement terminology correctly.
5. Beware of cues that are actually impossible.

#1 Show, explain and reinforce the body parts you name.

Especially with deeper muscles or organs such as the psoas or kidneys, please help students to identify the location of the body parts you name. Even with such terms as sacrum and scapula, many students will be unclear and need help to locate the parts on their own body. Gudmestad advises that teachers continue referencing the body part throughout class so as to reinforce understanding.

#2 Focus on only one anatomical name, principle or movement.

Avoid overwhelming some students and increase your chances of making a lasting impact by focusing on only one anatomy topic per class.

#3 Do not interchange the name of an injury with a body part.

Be mindful to avoid using names of injuries or body parts incorrectly. For example, TMJ (jaw) is not the same as a TMJ problem and a rotator cuff is not the same as a rotator cuff tear.

#4 Use movement terminology correctly.

Avoid anatomy-based terminology until you are sure you are able to use it correctly. Pay particular attention (as Gudmestad points out) to use of the word "extension" which is often used incorrectly by yoga teachers. If you are knowledgeable about movement terminology, please consider that many students are not. Comprehension will be greater if terms are clearly defined for all students. See Anatomy of Movement: Terminology.

#5 Beware of cues that are actually impossible.

Gudmestad does a great service here in pointing out the mistake of using a general term such as "relax" with a body part that is actually contracting in a pose. She says she's heard teachers advise, for example, "Relax your neck" in Utthita Trikonasana (Extended Triangle Pose) when the neck muscles must contract to hold the head up. This is a key reminder to be mindful of everything you say while teaching. Perhaps in the Triangle Pose case that Gudmestad describes, the teacher meant to suggest, "relax your face and eyes." As an example of precise cues that meet your objectives, consider: give students specific tactics that help avoid excessive tension in the neck, such as keeping the head and gaze neutral vs. looking up; or, bring awareness to the neck with the mind's eye or turn the neck with the breath. We hope these examples spur you to think through your cues for maximum clarity and effect.

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ANATOMY & PHYSIOLOGY

Anatomy & Physiology Module

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RESPIRATORY ANATOMY

The physical process of breathing

NERVOUS SYSTEM

The nervous system and yoga's impact

THE SPINE

Structure and movements of the spine

ANATOMY OF THE CORE

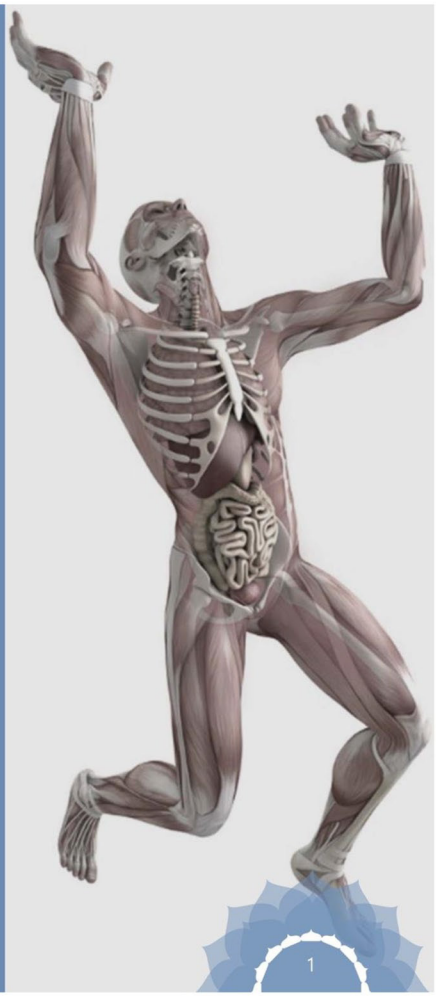
Physical structure of core plus core strengthening benefits & cautions

ANATOMY OF MOVEMENT

Musculoskeletal system & the anatomy of movement

Chapter Highlights

- BONES
- JOINTS
- MUSCLES
- CONNECTIVE TISSUE
- ANATOMY OF MOVEMENT
- MOVEMENT TERMINOLOGY



ANATOMY OF MOVEMENT

MUSCULOSKELETAL SYSTEM & 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

ANATOMY & PHYSIOLOGY

QUESTIONS ANSWERED HERE

- What is included in the musculoskeletal system and what does it do?
- What is a bone?
- What is a joint?
- How does knowing the characteristics of joints apply to teaching *asana* safely?
- How can "muscle" be defined? What is its function?
- Why might a muscle cramp and what might help?
- What is connective tissue?
- What is a ligament? A tendon? Fascia?
- What is meant by the term "myofascia?"
- How does the "myofascial meridian theory" differ from the traditional anatomy model?
- How do muscles create movement?
- What is a muscle contraction?
- What are three types of muscle contraction and an example for each?
- What is meant by origin and insertion points?
- Describe how muscles relate in movement.
- What is reciprocal inhibition?

MORE QUESTIONS ANSWERED HERE

- What is Range of Motion (ROM) and how is it relevant to *asana*?
- How are joints affected by over-stretching?
- How are joints affected when ROM has diminished?
- What is a reason for joints being particularly vulnerable to injury?
- Describe possible joint movements and give examples of each.
- What are the established normal ROM for each joint movement?
- What are the six directions of spinal movement and an *asana* example for each?
- What additional types of movement are we concerned with in Yoga?
- Why is it inaccurate to use the terms spinal extension and backbending interchangeably?
- What does spinal (or axial) extension typically mean in yoga?
- How is the term "extension" being used differently in this case from its typical use in anatomy?
- What is meant by the terms "full" and "mild" inversions and what are examples of each?
- What does flexion mean? Extension? Adduction? Abduction?
- What is internal rotation? External rotation?
- What is meant by lateral? Medial? Anterior? Posterior? Distal? Proximal? Superior? Inferior?
- For what purpose related to asana has Andrey Lappa described movement differently?
- What are the three planes of motion called? What type of movement happens in each?

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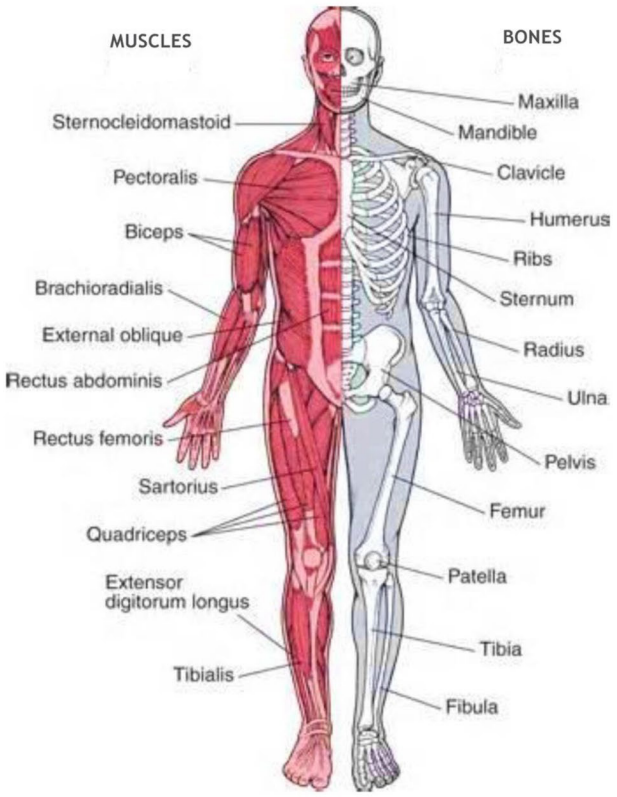
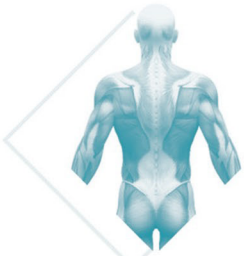
MUSCULOSKELETAL SYSTEM OVERVIEW

- 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.



BONES & JOINTS



MUSCLES

CONNECTIVE TISSUE

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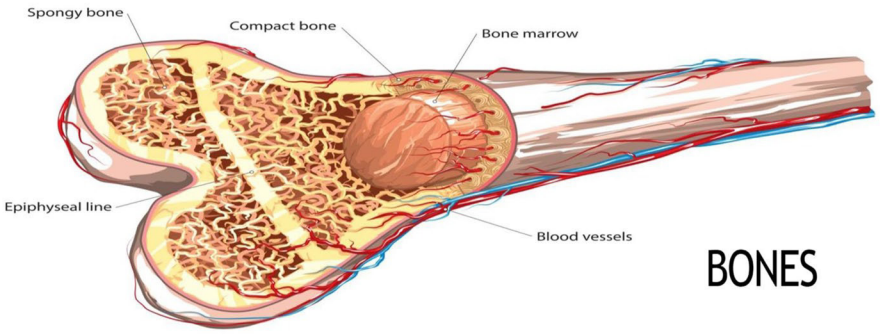

BONES

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.

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).

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

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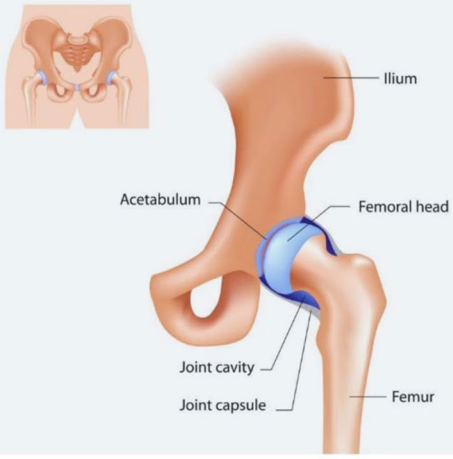
TEACHING APPLICATION

Following is an example of applying knowledge of joints in teaching *asana*:

- 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.



JOINTS

Joints are not things. They are relationships.

– Leslie Kaminoff, YogaAnatomy.net

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, Functional Anatomy of Yoga

KEY POINTS

- Joints are junctions / connecting points between bones.
- Joints are also called "articulations."
- Some joints move a lot; some very little.
- 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.
- The shape of the joints reflects their function.
- 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.
- For information on intervertebral joints, see The Spine:.

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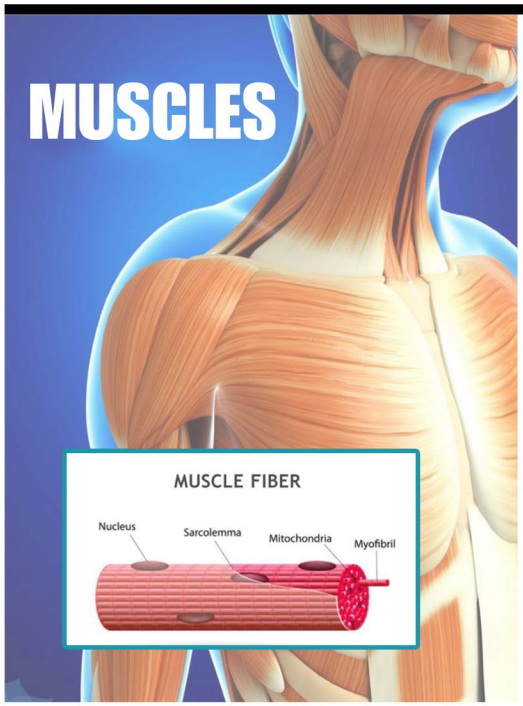
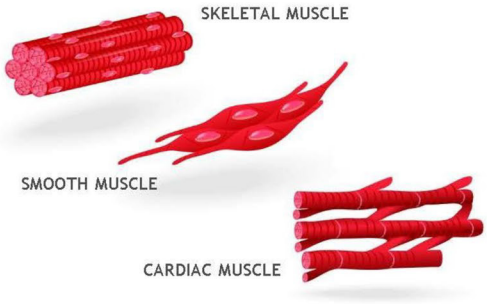


FORM

- 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)
- Please be sure to see the "myofascial approach" vs. "isolated muscle theory" (later in this Course) to get a clear understanding of what a muscle really is.

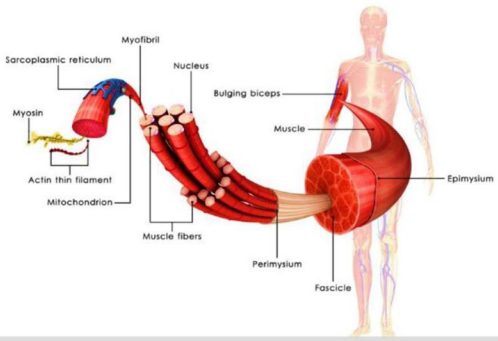
FUNCTION

- 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.



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
- Provides 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



THREE TYPES OF MUSCLES

- **Smooth Muscle** — muscles that line 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, Striated Muscle

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ANATOMY & PHYSIOLOGY

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 TO TISSUES 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, Leg Cramps

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 Cramp

MUSCLE CRAMPS

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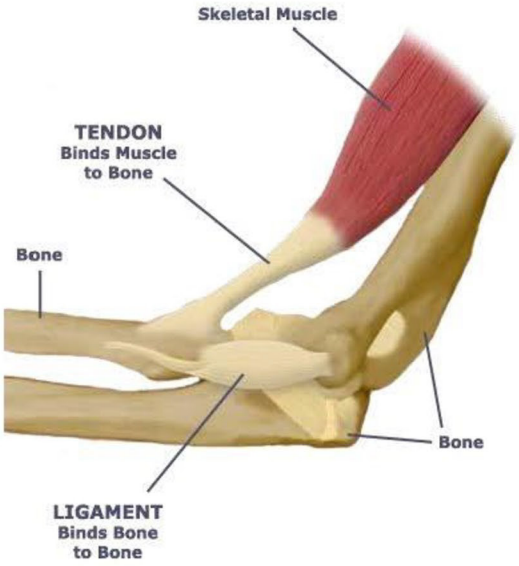
CONNECTIVE TISSUE



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 CAPSULES

- Connective tissue surrounding synovial joints
- Provide container for synovial fluid
- Provide tough covering of tissue where ligaments and tendons can insert
- "And, of special interest to us here, they and their associated ligaments provide about half the total resistance to movement" (David Coulter)

FASCIA

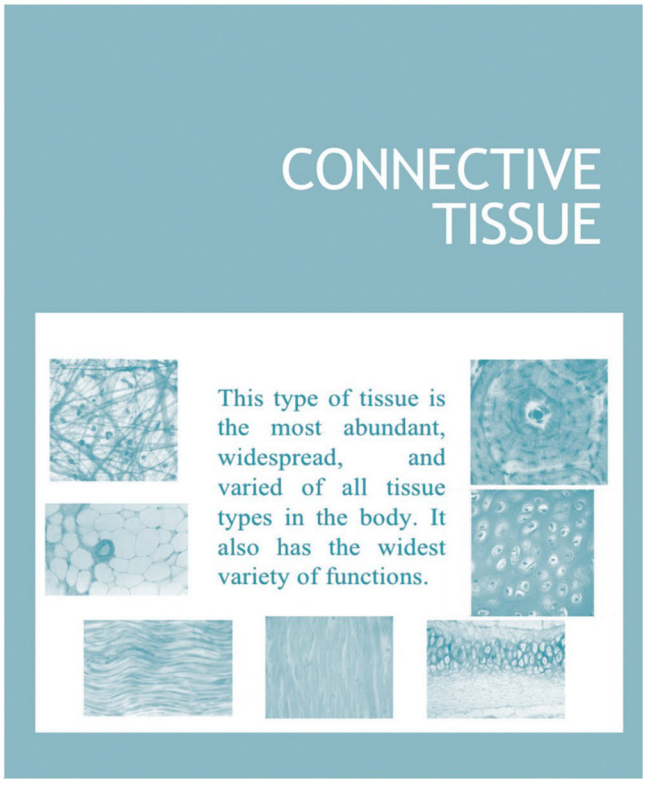
- A sheet or band of fibrous tissue
- Often described as a "body envelope" or "sac" that "permeates through and around every nook of the body."
- Surrounds nerve fibers, surrounds and bundles muscle fibers; lines organs and vessels
- Gives contour and structure to the body

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.
- Compared to other types of tissue, connective tissue has few cells. Fibers contain a protein called collagen.
- Types of connective tissue often referred to in yoga discussions are fascia, tendons, ligaments and joint capsules

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).



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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 organi would fall apart.

– David Coulter, Anatomy of Hatha Yoga

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, Physiology of Stretching

CONNECTS ALL OF OUR PARTS

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

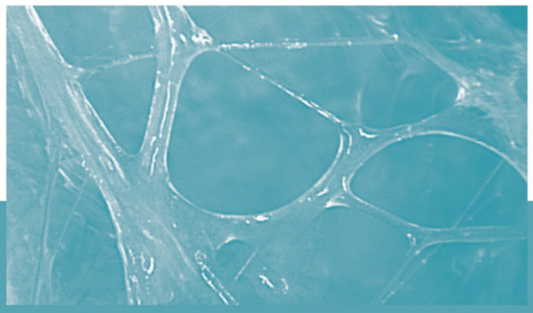
– Susi Hately Aldous, Anatomy and Asana: Preventing Yoga Injuries

A THREE-DIMENSIONAL MATRIX EXTENDING THROUGHOUT THE BODY FROM HEAD TO TOE

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, Trail Guide to the Body

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, The Web of Life

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

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MYOFASCIAL UNDERSTANDING

MYOFASCIAL MERIDIAN VS. ISOLATED MUSCLE THEORY

Image by gilhedley.com

The word myofascia is used to help orient our thinking to the "inseparable nature of muscle tissue (myo) and its accompanying web of connective tissues (fascia).

-Thomas W. Myers

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...

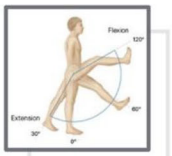
Myofascial meridian theory does not eliminate the value of the many individual muscle-based techniques and analyses, but simply sets them in the context of the system as a whole... It has always been impossible to contact muscle tissue at any time or place without also contacting and affecting the accompanying connective or fascial tissues.

– Thomas W. Myers, Anatomy Trains

ANATOMY OF MOVEMENT

MUSCLE MOVEMENT

RELATIONSHIP BETWEEN MUSCLES



MOVEMENT TERMINOLOGY

SPINAL MOVEMENT

JOINT MOVEMENT

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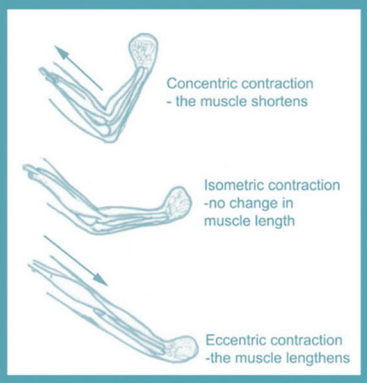
ANATOMY & PHYSIOLOGY

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.

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

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ANATOMY & PHYSIOLOGY

MUSCLE CONTRACTION

Concentric and eccentric are also terms used to describe the phase of a 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.

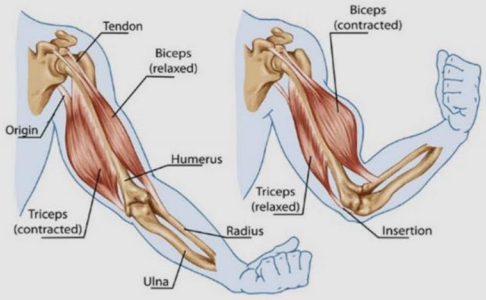
– PT Direct, Muscle Roles & Contraction Types

In Anatomy and Asana, Susi Hately Aldous gives a clear example of contraction types, focusing on the quadriceps muscles. The movement is from Tadasana (Mountain Pose) to Utkatasana (Chair / Fierce Pose)

- Tadasana — Isometric contraction of quads
- Into Utkatasana — Eccentric contraction of quads
- Stay in Utkatasana — Isometric contraction of quads
- Back to Tadasana — Concentric contraction of quads

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.



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

- When looking to determine origin and insertion for biceps and triceps in flexing elbow, note that the arm is fixed and the forearm moves
- Origin: arm and shoulder, Insertion: forearm

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. Here are some sources for lists of origin and insertion points:

- PT Direct, Key Muscle Locations and Movements
- University of Michigan Medical School, Medical Gross Anatomy: Anatomy Tables – Muscles
- University of Arkansas for Medical Sciences, Muscles - Organized by Region
- Quizlet, Muscles: Origin, Insertion, and Action

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ANATOMY & PHYSIOLOGY

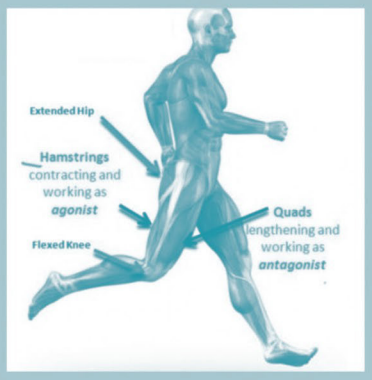
RELATIONSHIP OF MUSCLES IN MOVEMENT

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.gov

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

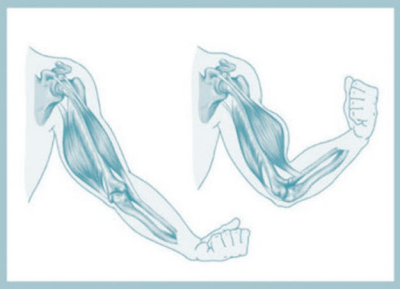


It makes sense that there would be a corresponding physiological Yin/Yang to make biomechanical processes such as flexion and extension of the knee energy efficient, i.e., when the agonist muscle contracts, its antagonist relaxes.

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

RELATIONSHIP OF MUSCLES IN MOVEMENT



To truly 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, Anatomy and Asana

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 agonist, 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. Susi Hately Aldous describes stabilizers as having these characteristics:

- 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)

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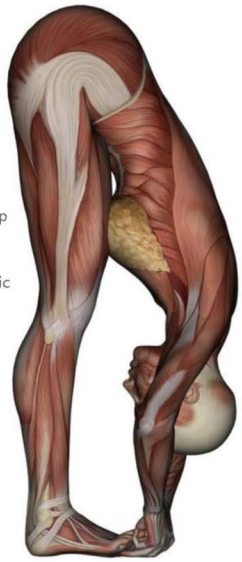
ANATOMY & PHYSIOLOGY

RELATIONSHIP OF MUSCLES IN MOVEMENT



MUSCLE PAIR EXAMPLES

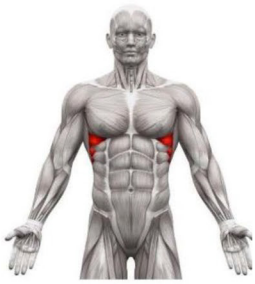
Flexing the elbow (to draw forearm up) contracts the bicep (called the agonist) and stretches the tricep (called the antagonist). Following are pair examples, some of which overlap because we are including both general and specific relationships that may be useful to you.

- 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



MUSCLE PAIRING IN SEQUENCING & TEACHING

- This key relationship among muscles for movement can guide the intention you set to address a problem area.
- For example, as shown in the Yoga International video, Asana Anatomy: Trapezius and Serratus Anterior, if you are considering an approach for rounded shoulders, the muscle pair would be the middle trapezius (middle of shoulder blades) and serratus anterior (side ribs, responsible for pulling scapula forward). In the video, yoga teacher Sarah Guglielmi shows practices for releasing tension in the serratus anterior and learning how to strengthen through the trapezius.
- Being aware of the muscle pairs involved in actions can help a student to deepen her experience of a posture with conscious focus.

TEACHING APPLICATION

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, How to Create a Target Yoga Practice

In the article above, 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 & 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.

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ANATOMY & PHYSIOLOGY

ABOUT JOINT MOVEMENTS

KEY POINTS

- 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.

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

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?

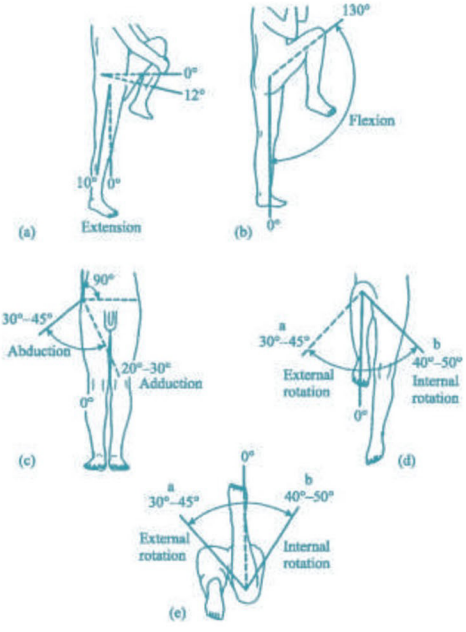
Motions within the optimal range maintain the natural flow of synovial fluid for lubrication of the joints, as well as normal strength and flexibility of the antagonistic muscles on opposite sides of the joint. When this range is exceeded, by overstretching, poor posture, injury or skeletal deformity, 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.

READINGS



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ANATOMY & PHYSIOLOGY

JOINT MOVEMENTS

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

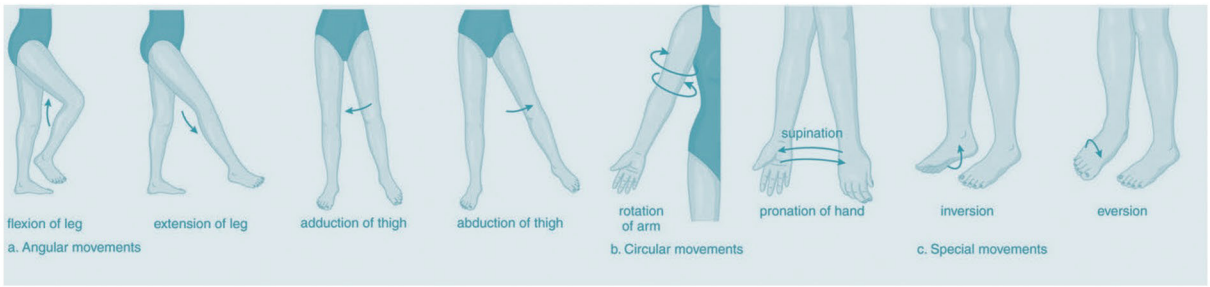
- Abduction – hands to shoulders, open elbows out
- Adduction – hands to shoulders, draw elbows toward one another
- External Rotation – "goal post" arms, palms facing forward
- Internal Rotation – "goal post" arms, rotating palms down and facing back
- Flexion – raise arms upward
- Extension – draw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



RANGE OF MOTION (ROM) FOR JOINTS

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 Dorsiflextion 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

ANATOMY & PHYSIOLOGY

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.

FORWARD BENDING

- Example: Uttanasana (Standing Forward Bend)

BACK BENDING

- Example: Bhujangasana (Cobra)

LATERAL MOVEMENT

- Example: Utthita Parsvakonasana (Extended Side Angle)

TWIST

- Example: 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

- Example: Urdhva Hastasana (Upward Salute)
- Spinal extension means reducing the spinal curves or lengthening the entire spine.
- See here for the definition of extension in anatomy terminology. With the formal definition, spinal extension would mean the return to neutral. But as in Olga Kabel's quote below "spinal extension" in yoga typically refers to lengthening.
- While some people interchange the term "spinal extension" with backbending, the term actually refers to the relationship of the spinal curves to each other. The phrases "forward bending" and "backbending" refer to particular movements through space.
- See also: The Spine

INVERSION

- Example: Salamba Sarvangasana (Supported Shoulderstand)
- The term "inversion" typically refers to poses in which the feet are higher than the heart, as in Sarvangasana (Shoulderstand) and Sirsasana (Headstand).
- The term inversion is also used to mean poses in which the heart is higher than the head such as in Adho Mukha Svanasana (Downward Facing Dog) and Uttanasana (Standing Forward Bend).
- To distinguish between the two meanings, some refer to "full inversions" and "mild inversions."

ADDED NOTE: 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*."

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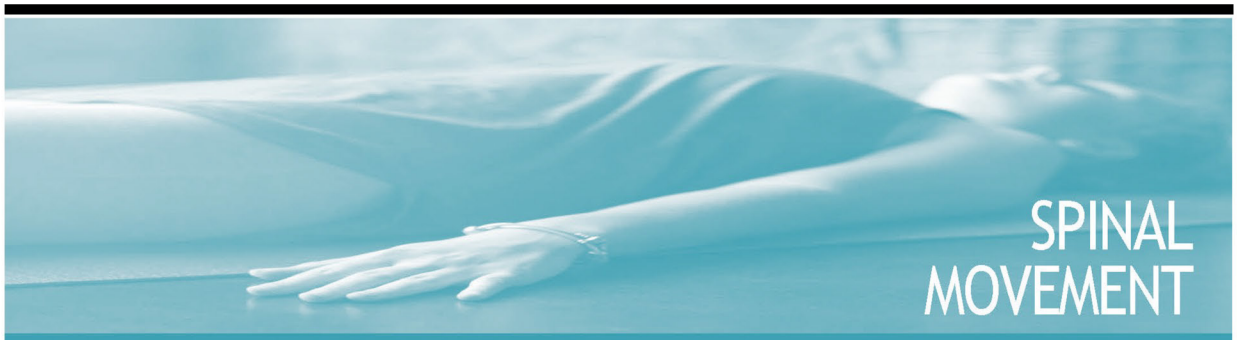
ANATOMY & PHYSIOLOGY



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.

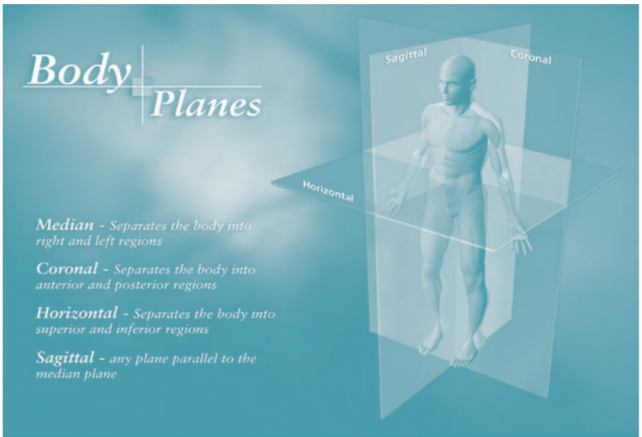
– Olga Kabel, SequenceWiz, Why Do We Lengthen Upward?

PLANES OF MOTION

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

FRONTAL OR CORONAL PLANE
- Divides the body into front and back halves
- Any lateral (side) movement occurs in the coronal plane

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



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.

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ANATOMY & PHYSIOLOGY

MOVEMENTS IN EACH PLANE

SAGITTAL PLANE

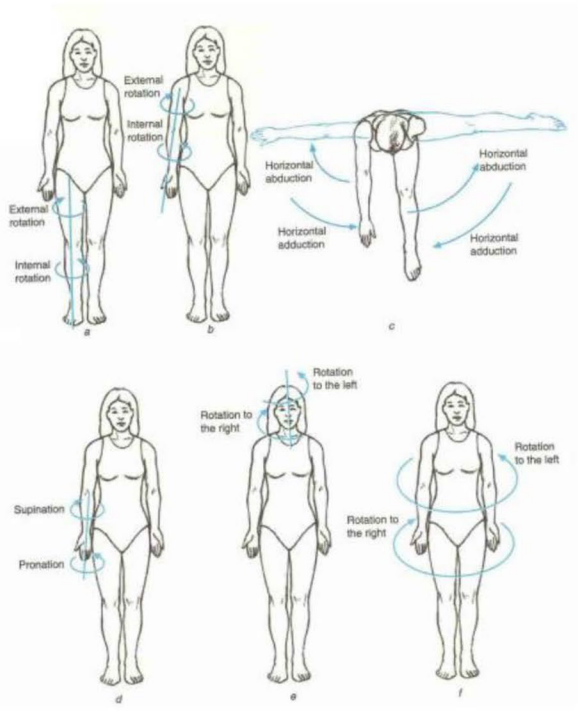
- **Flexion** — Decreasing the angle between two bones
- **Extension** — Increasing the Angle between two bones
- **Dorsiflexion** — Moving the top of the foot toward the shin (only at the ankle)
- **Plantar flexion** — Moving the sole of the foot downward (pointing the toes)
- **Exercise Examples**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

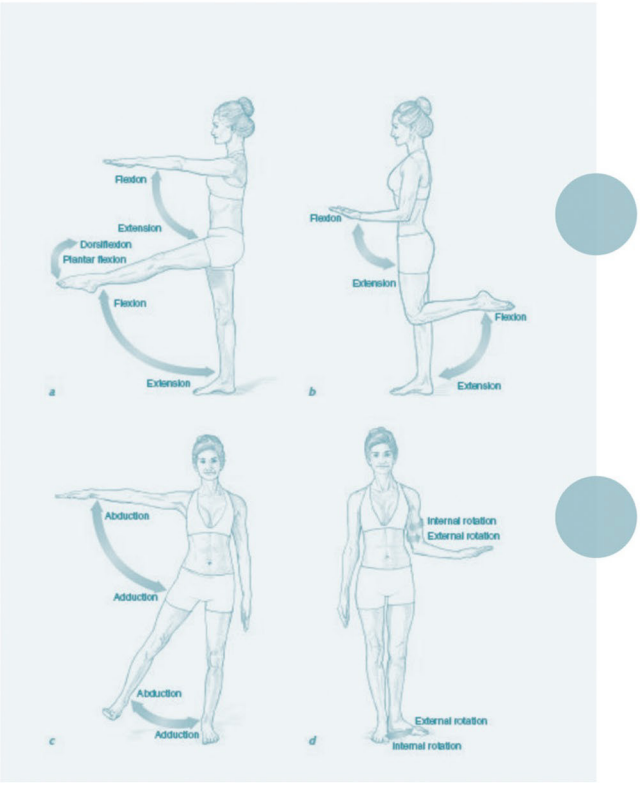
FRONTAL OR CORONAL PLANE

- **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





MOVEMENT TERMINOLOGY

Movements of the body are described in six ways:

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

ADDUCTION / ABDUCTION

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

INTERNAL ROTATION / EXTERNAL ROTATION

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

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ANATOMY & PHYSIOLOGY

LAPPA'S TEACHINGS

WHY DOES ANDREY LAPPA DESCRIBE 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 in "General Movement Types" below), but not the last two.
- Traditional *asanas* 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 strengtl 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: Open Arms and Lappa's website, Universal Yoga.

LAPPA'S CATEGORIZATION

GENERAL MOVEMENT TYPES

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

PASSIVE & ACTIVE

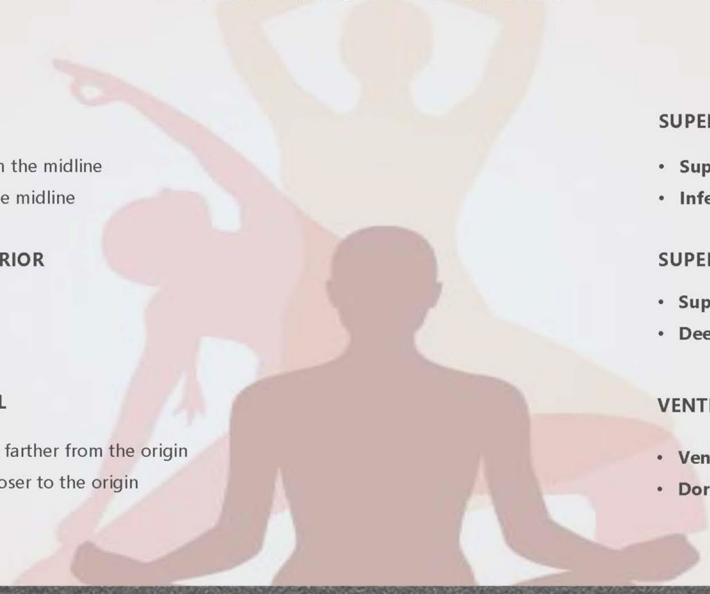
- **Passive** Uses gravity to stretch muscles
- **Active** Stretches one set of muscles by engaging others
- **Equally Passive & Active** Poses that draw equally on passive and active

YOGA-SPECIFIC VERBIAGE

"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.

LOCATION TERMS



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 the body
- **Dorsal** – On back of body

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PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

QUESTIONS ANSWERED HERE

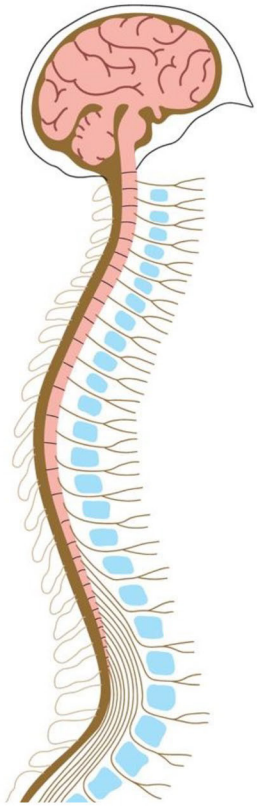
- What is the nervous system and what are its functions?
- What is included in the central nervous system and what is considered the peripheral nervous system?
- What systems make up the peripheral nervous system?
- What is the difference between the somatic and autonomic nervous systems?
- What do the sympathetic and parasympathetic nervous systems trigger?
- What is the vagus nerve and how is it related to stress?
- Where is the Enteric Nervous System (ENS) located?
- Why is the ENS called a "second brain?"
- What is the Stress Response and how is it helpful?
- What is another name for the Stress Response?
- Under what circumstances is the Stress Response harmful?
- What is the Relaxation Response?
- What does research indicate in terms of how Yoga impacts the nervous system?
- How does Yoga work to relieve stress?

NERVOUS SYSTEM

A NETWORK OF INTELLIGENT ENERGY

By communicating through your nerves, your nervous system constantly monitors the internal activities of your body systems, attempting to keep them in a healthy balance called "homeostasis." It also monitors your environment to assess if it is safe or dangerous, and sends messages to your body either to relax and enjoy or act quickly to get to safety.

–Yoga for Healthy Aging



Chapter Highlights

- QUESTIONS ANSWERED HERE
- FORM & FUNCTION
- CNS, PNS, VAGUS NERVE
- ENTERIC NERVOUS SYSTEM
- STRESS & YOGA

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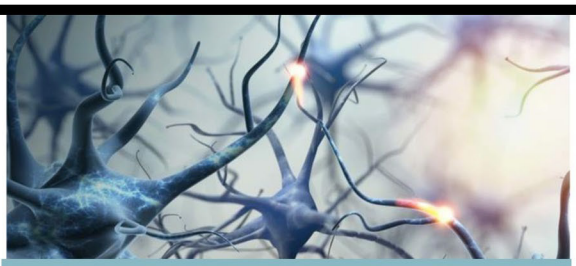
PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA



The human brain contains about 100 billion neurons... The brain is made up of many networks of communicating neurons. In this way, different parts of the brain can "talk" to each other as well as work together to send messages to the rest of the body. — National Institutes of Health

Nervous System Functions
- Sensory
- Integration
- Motor

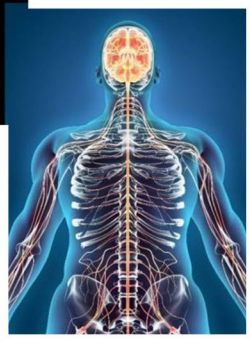
FUNCTION

- The nervous system regulates certain body processes such as blood pressure and the breathing rate, and it connects the brain and spinal cord with muscles and sensory receptors.
- The functions of the nervous system can be categorized as 1) sensory, 2) integration and 3) motor. (InnerBody, *Nervous System*)
- Sensory function: collecting information and passing it on to the central nervous system
- Integration: evaluation of the signals by the brain and spinal cord
- Motor function: carrying of signals from the CNS that can result in, for instance, moving a part of the body.

FORM & FUNCTION

FORM

- The nervous system consists of the brain, spinal cord, neurons, nerves, meninges, cerebrospinal fluid and sensory receptors.
- The nervous system includes a collection of nerves and neurons that transmit signals between different parts of the body.
- The "basic working unit" of the nervous system is a cell called a neuron. Neurons communicate via electrical signals which are converted into chemical messengers called neurotransmitters.



SUMMARY OF ESSENTIAL FUNCTIONS

CONTROLS

Controls background processes that keep the body alive and healthy, such as breathing, maintaining normal temperature, and adjusting blood pressure to match activity.

RESPONDS

Responds to external stimuli (which come in through the senses), such as having a positive reaction to a beautiful smell, a pain response to a burn, or a quick reaction to an oncoming car

OBEYS

Obeys conscious mental instructions, such as to talk, move, or breathe more slowly.

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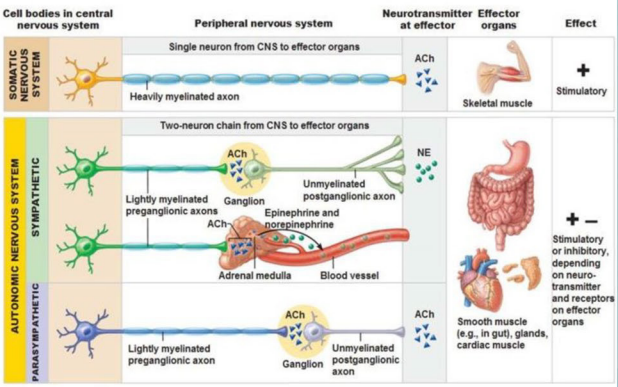
PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

PERIPHERAL NERVOUS SYSTEM

- The somatic nervous system controls conscious bodily activities such as moving the arm.
- The autonomic nervous system (ANS) governs the typically automatic functions including breathing, heart rate and the endocrine (hormone) system.



- While the central nervous system (CNS) is defined as the brain and spinal cord. the peripheral nervous system (PNS) includes all of the other parts of the nervous system which communicate between the CNS and the rest of the body.
- The PNS includes the somatic (voluntary) and autonomic (typically involuntary) nervous systems.
- The autonomic nervous system (ANS) includes the sympathetic and parasympathetic nervous systems.
- The ANS is an area of particular focus for understanding the effects of yoga and breathing practices on reducing negative effects of chronic stress, and improving health and wellness.

[The nervous system] is essentially the body's electrical wiring.

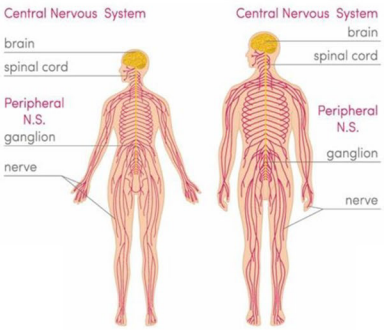
— *Live Science*

THE CNS & PNS

The nervous system is divided into the central nervous system and the peripheral nervous system.

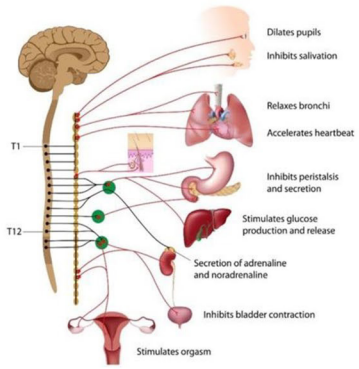
The central nervous system (CNS) is comprised of the brain and spinal cord.

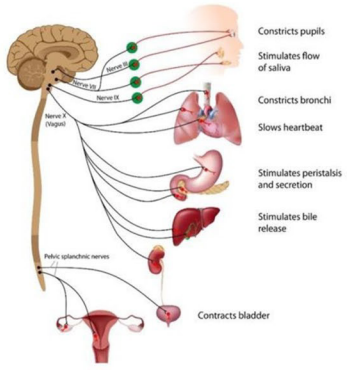
The peripheral nervous system (PNS) includes all other parts of the nervous system that communicate between the CNS and the rest of the body.



SYMPATHETIC NERVOUS SYSTEM

The sympathetic nervous system triggers the "fight-flight-or-freeze" or "stress response."





PARASYMPATHETIC NERVOUS SYSTEM

The parasympathetic nervous system controls the "rest-and-digest" or "relaxation response."

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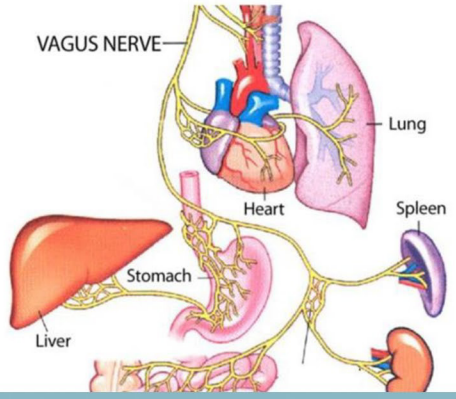
PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

THE VAGUS NERVE

Since the vagus nerve innervates the chest, any kind of practices or activities that influence the energy flow through the vagus nerve will have a profound effect on respiration and circulation.

— Yoga for Healthy Aging, Yoga Practices to Optimize Vagal Tone



- An element of the parasympathetic nervous system, the vagus nerve is one of 12 pairs of cranial nerves that originate in the brain.
- The vagus nerve is considered the largest and most complex nerve in the body. It originates in the brain stem and passes through the neck, spreading nerve fibers through the body.
- The vagus nerve has been called the "air traffic controller" because it helps (among other things) to regulate major bodily functions. It is said to also be related to mood because our state of mind is related to the calming parasympathetic effects of the nervous system.
- Breathing practices such as diaphragmatic breathing stimulate the vagus nerve and this link is coming to be known as the explanation for how yoga practice brings peace of mind.
- High vagal tone relates to an ability to move from more active and stressful states to more relaxed states, whereas low vagal tone is associated with a sense of depletion and such conditions as depression, post-traumatic stress disorder, chronic pain and epilepsy. (Yoga International, Scientific Research: How Yoga Works)

THE "SECOND BRAIN"

The ENS can work all on its own, without any input from the brain... The newest mind-body connection to be revealed —and sometimes considered a branch of the autonomic nervous system—it does much more than control itself. It also sends signals north to the brain that directly affect feelings of sadness or stress, even influence memory, learning, and decision-making.

– Psychology Today

ENTERIC NERVOUS SYSTEM

- The Enteric Nervous System (ENS) is a system of nerves located in the abdomen.
- The ENS communicates with the brain and can act independently of it.

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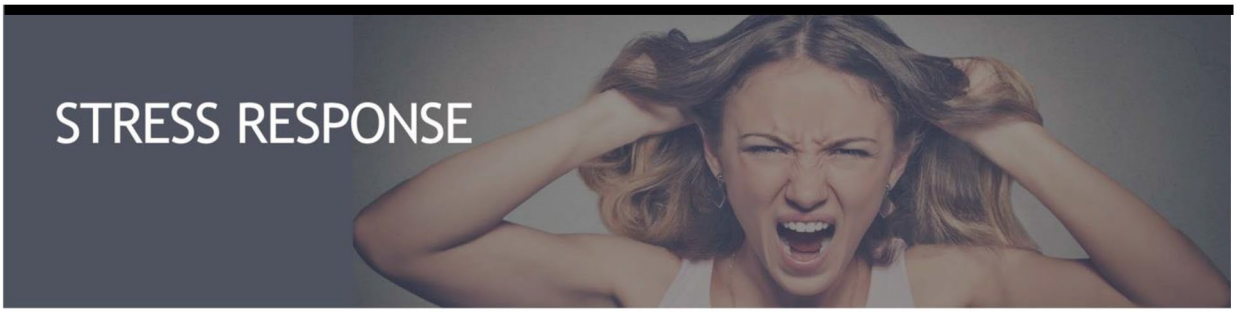
PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA



KEY POINTS

- The stress response is also commonly called the "fight or flight" or "fight, flight or freeze" response.
- The stress response is useful as a short-term reaction because it evokes physical and emotional actions to deal with an immediate threat.
- If the stress response is chronically triggered, the physiological responses that are helpful in the short-term become harmful in the long-term.
- In 2014, the Society for Neuroscience reported that that 60% of Americans feel they are under a great deal of stress at least once per week.
- Stress is known to both cause disease and exacerbate existing ones.

GOING DEEPER

Stress is a biological and psychological response experienced on encountering a threat that we feel we do not have the resources to deal with... Sudden and severe stress generally produces an increase in heart rate, an increase in breathing (lungs dilate), a decrease in digestive activity (don't feel hungry), and the liver releases glucose for energy.

Firstly, our body judges a situation and decides whether or not it is stressful. This decision is made based on sensory input and processing (i.e. the things we see and hear in the situation) and also on stored memories (i.e. what happened the last time we were in a similar situation). If the situation is judged as being stressful, the hypothalamus (at the base of the brain) is activated. The hypothalamus in the brain is in charge of the stress response. When a stress response is triggered, it sends signals to two other structures: the pituitary gland, and the adrenal medulla. These short term responses are produced by The Fight or Flight Response via the Sympathomedullary Pathway (SAM). Long term stress is regulated by the Hypothalamic Pituitary-Adrenal (HPA) system. – SimplyPychology.org, What Is the Stress Response?

RELAXATION RESPONSE

In stressful times, we typically breathe too rapidly. This leads to a buildup of oxygen in the bloodstream and a corresponding decrease in the relative amount of carbon dioxide, which in turn upsets the ideal acid-alkaline balance—the pH level—of the blood. This condition, known as respiratory alkalosis, can result in muscle twitching, nausea, irritability, lightheadedness, confusion, and anxiety. In contrast, slowing the breath raises the carbon dioxide level in the blood, which nudges the pH level back to a less alkaline state. As the blood's pH changes, the parasympathetic nervous system calms us in a variety of ways.

– Richard Rosen

Dr. Herbert Benson, M.D. published research in 1975 documenting what he termed the Relaxation Response, " a physical state of deep rest that changes the physical and emotional response to stress... the opposite of the fight or flight response."

- Initiating the relaxation response switches off the stress response and its associated increase in heart rate, blood pressure, mental alertness and muscle tension.
- When the relaxation response is activated, so too are the bodily systems that were shut down from the fight-or-flight response, including digestion, elimination, growth, repair and reproduction.
- Meditation and relaxation exercises have been shown to initiate the relaxation response and often the positive effects of yoga are a result of affecting the nervous system in this way.

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PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

DIFFERENT TYPES OF STRESS: ONE RESPONSE

Interestingly, despite all the types of stressful situations a person can be in (standing on your head, running away from a lion, finishing those reports by 5 o'clock) the nervous system has just one stress response. The specific thoughts you have may differ, but the brain regions involved, and the physiological response will be the same. The physiological stress response means an increase in heart rate, breathing rate, muscle tension and elevation of cortisol and other stress hormones.

– Alex Korb, Psychology Today

BODIES ARE SLOW TO RECOVER

Effects from a fight-or-flight response take a long time to wear off. Muscles that have tensed are left shortened and do not automatically go back to their former length. They remain relatively short and tense until the reflex is reset by a relaxing experience, like the gentle, conscious stretching that occurs during a massage or a yoga session. Muscles aren't the only part of the body slow to recover from a fight-or-flight reaction. Stress hormones remain in the bloodstream for quite a long time, and more may be released in response to memories of the danger.

YOGA'S IMPACT

Multiple articles have been written to share findings from research. Often these articles highlight findings from studies authored by Chris Streeter, MD, associate professor of psychiatry at Boston University School of Medicine and Boston Medical Center. Streeter's research is published in Medical Hypotheses Journal.

INCREASED VAGAL TONE

In 2012, Yoga International highlighted the following study results:

- Chris Streeter's study hypothesized that yoga works to increase the body's ability to successfully respond to stress by increasing vagal tone and thereby regulating the nervous system.
- Ujjayi Pranayama was shown to increase the relaxation response and heart rate variability (a function of stress resilience)
- Chanting OM out loud increased vagal tone and the relaxation response more than chanting it silently.

GABA LEVELS INCREASE

Psychology Today commented on Streeter's research, noting the increase in GABA levels: Recent research on the neurochemistry of yoga provides some clues about how yoga might exert anxiolytic effects: two fascinating randomized controlled Magnetic Resonance Spectroscopy studies by Streeter and colleagues demonstrate that regular practice of gentle yoga, but not walking, releases a chemical called GABA in the thalamus. GABA is sort of the "grand inhibitor" in the brain, and plays a central role in suppressing neural activity. Classical anti-anxiety medications, such as benzodiazepines, work by encouraging the release of GABA in the central nervous system. GABA was shown to be significantly higher in the brains of those subjects who had been doing yoga. The study also compared GABA levels directly before an after an hour of yoga, and showed a 27% increase! GABA is what alcohol mimics, by temporarily binding to the same chemical receptors.

– Rachael Grazioplene, Psychology Today

KEEPS BRAIN FROM SHRINKING WITH AGE

Psychology Today also shares results from another study conducted in 2015:

A new, May 2015 study published in the Frontiers in Human Neuroscience uses magnetic resonance imaging (MRI) of the brain to show that yoga protects the brain from the decline in gray matter brain volume as we age. People with more yoga experience had brain volumes on par with much younger people... This finding has also been true in brain imaging studies of people who meditate. In other words, yoga could protect your brain from shrinking as you get older.

– Marlynn Wei MD, JD, Psychology Today,
Why Does Anyone Do Yoga, Anyway?

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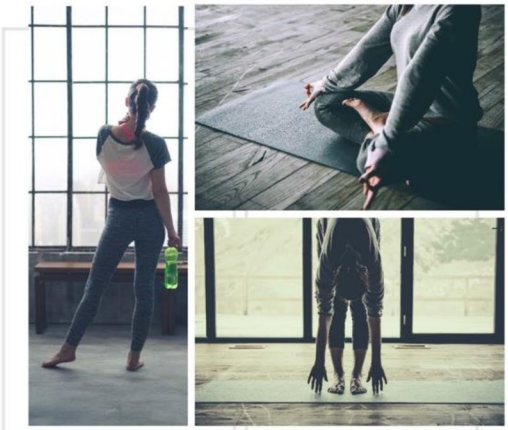


RELAXATION & YOGA

How does Yoga work to relieve stress?

UNDOING THE STRESS RESPONSE IN FLEXORS

Part of the stress response hardwired into our nervous system is the contraction of the major flexors of the torso—somewhat like the response of a caterpillar if you poke it with a twig. A verbal jab from a co-worker, the close call on the freeway, a long-standing argument with your spouse, free-floating anxiety—all of these elicit a contraction in the flexors. This is the tightening in the gut, the hunching of the shoulders, the sinking of the heart. As with all responses to stress, the problem is that the response becomes habitual, resulting in chronic tension and contraction, which we then experience as our "normal" state. Our yoga practice is an opportunity to undo this chronic tension, and establish a deep and abiding sense of harmony in the body and mind.

– Sandra Anderson, Yoga International, Release Tension in the Psoas

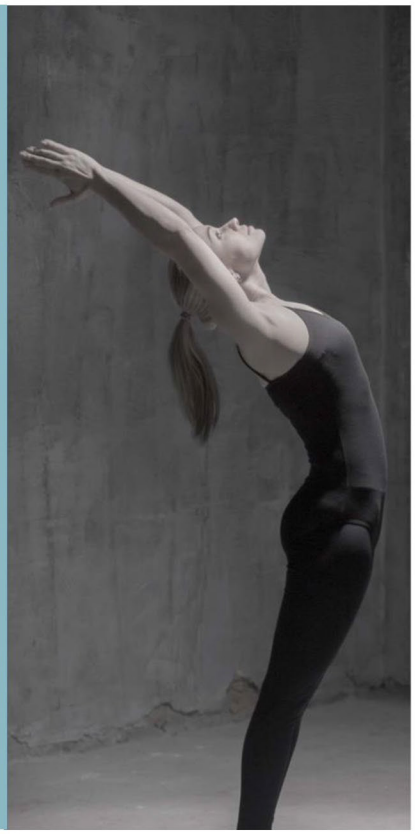
DIAPHRAGMATIC BREATHING STIMULATES THE VAGUS NERVE

Diaphragmatic breathing activates the relax-and-digest response by stimulating the primary mediator of the parasympathetic nervous system, the vagus nerve. This nerve travels from the brain to nearly all the thoracic and abdominal organs... and triggers a cascade of calming effects. As you develop the skill of breathing from the diaphragm in the course of your daily activities, you will begin to experience your breath as a barometer for the nervous system. As long as you are breathing deeply and from the diaphragm, you will find that you can access a feeling of calm and balance even when you are confronted with an unpleasant situation. And you will also notice that if you allow your breath to become shallow by breathing from your chest, anxiety creeps in, your muscles tighten, and your mind begins to race and spin.

– Carrie Demers, MD, medical director for health and healing at the Himalayan Institue, How to Change Your Stress Response

Chapter Highlights

- QUESTIONS ANSWERED HERE
- BREATHING DEFINED
- ANATOMY OF BREATHING



RESPIRATORY ANATOMY

THE PHYSICAL PROCESS OF BREATHING

Respiration is essential for sustaining all forms of animal life—from the single-celled amoeba to man. It is possible to live without food or water for a few days, but when respiration ceases, so does life... Breathing starts with independent life outside the mother and ends when life ceases.

— B.K.S. Iyengar, Light on Prānāyāma

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PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

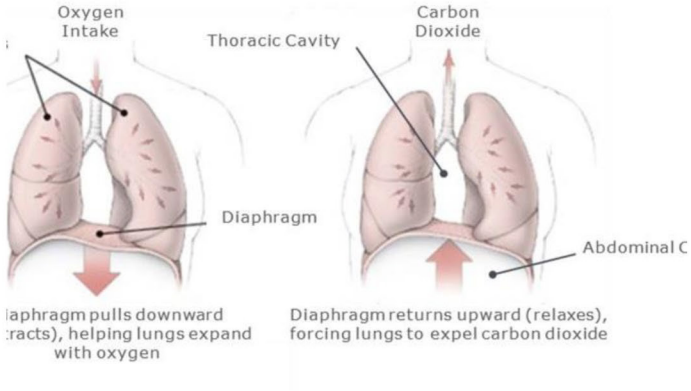
QUESTIONS ANSWERED HERE

- What happens during breathing?
- What is the purpose of breathing?
- What are the contents of the thoracic and abdominal cavities?
- How do the thoracic and abdominal cavities change during breathing?
- What is the diaphragm's role in breathing?
- What is the function of the nose in breathing?
- What is the nasal cycle?
- What are the primary respiratory muscles and what are the accessory?
- What problems can a person have with their diaphragm and what is the effect?
- Why is the fill capacity of the upper lungs less than the lower?
- What is the role of the intercostal muscles and abdominals in breathing?

BREATHING DEFINED

Breathing is the process of taking air into and expelling it from the lungs. The passage of air into and out of the lungs is movement, one of the fundamental activities of living things.

— Leslie Kaminoff



Respiration—the action of breathing—is the process of taking air in and out of the lungs.

Breathing involves the thoracic and abdominal cavities changing shape.

The primary purpose of breathing is to supply fresh oxygen to the blood and cells, and to discharge carbon dioxide.

PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

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THORACIC & ABDOMINAL CAVITIES

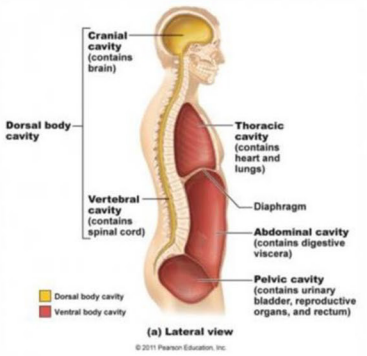
The torso is divided into the thoracic and abdominal cavities, which change shape during breathing.

The **thoracic cavity** contains the heart and lungs.

- When breathing, it changes shape and volume.
- Respiratory muscles increase the dimension of the thoracic cavity, lowering air pressure in the lungs (i.e. creating a vacuum) to facilitate the receiving of air.
- When the muscles relax and the diaphragm billows back up, the air in the chest is compressed, allowing it to move out.

The **abdominal cavity** contains the stomach, liver, gall bladder, spleen, pancreas, small and large intestines, kidneys, and bladder.

- During breathing, it changes shape but not volume.



To be precise when speaking of abdominal changes during breathing, anatomy experts use terms such as "bulge," "swell" or "puff out."

This is because the belly is not actually "expanding." (Note that the abdominal cavity changes shape but not volume.)

ANATOMY OF BREATHING

PRIMARY VS. ACCESSORY

- Some sources, including Donna Farhi in *The Breathing Book*, classify the abdominals as primary muscles of respiration.
- In the *Anatomy of Breathing*, Calais-Germain describes the diaphragm as the "primary inspiratory muscle," but doesn't distinguish between primary and accessory muscles of expiration.
- In *Anatomy of Hatha Yoga*, David Coulter doesn't use the terms primary and accessory but includes abdominals in the "main sets of muscles" along with intercostals and the diaphragm.

PRIMARY MUSCLES

- Diaphragm – responsible for 75% of all respiratory effort
- Intercostals (muscles between the ribs)
- Abdominals (according to some sources; see note)

ACCESSORY MUSCLES

The accessory muscles for inhalation are helpers intended to be used for short periods of time. These muscles tire more easily.

- Sternocleidomastoid (SCM) – prominent muscle at front of neck; moves rib cage by pulling it upward at top of sternum
- Scalenes – muscles in neck attached to cervical vertebrae; can raise top ribs
- Pectoralis Minor – when it contracts, it lifts ribs forward; moves when inhaling and raising top part of chest
- Pectoralis Major – lifts ribs mostly via lower muscle fibers at ribs four through eight; raises sternum by opening lower ribs outward
- Serratus Anterior – pulls ribs back and out, raising ribs in larger, lateral movement

EXPIRATION MUSCLES

Whether Termed Primary or Accessory

- Rectus Abdominis
- Transversus Abdominis
- Internal Obliques
- External Obliques
- Pelvic Floor
- Quadratus Lumborum

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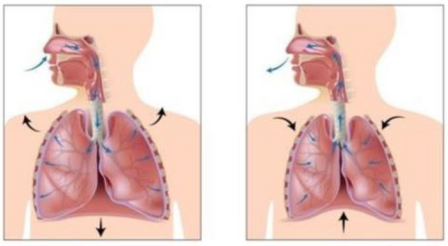
PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

THE DIAPHRAGM

When the diaphragm moves fully with the breath, Donna Farhi notes in The Breathing Book that nearby organs are "massaged, rolled, churned, and bathed in new blood, fluids, and oxygen."

These organs that move with the diaphragm include the heart, lungs, stomach, pancreas, gallbladder, small intestine, liver and spleen.



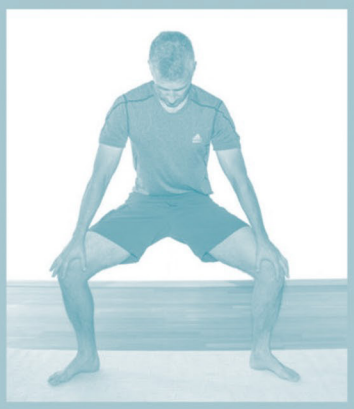
Inspiration Expiration

- The diaphragm is a dome-shaped muscle located at the base of the lungs, separating the thoracic and abdominal cavities.
- It acts as a pump causing the lungs to inflate.
- As with other muscles, the diaphragm can become tight or weak.
- Like the heart, the diaphragm works without break.
- On the in-breath, the diaphragm moves down to give the lungs more room to fill up. The abdominal organs are compressed and the abdomen typically puffs out.
- On the out-breath, the diaphragm relaxes and moves back up; the belly typically moves back in.

PROBLEMS & ISSUES

- When the abdomen is chronically tightened, the diaphragm is unable to move downward and secondary muscles are recruited.
- Using the secondary muscles – designed for short-term use – for regular deep breathing is tiring and ineffective.
- If the diaphragm is tight, weak, or unable to move freely, it can affect stress level, circulation, emotions, digestion & spinal stability. (Yoga Tune Up)

THE DIAPHRAGM



Uddiyana bandha, shown here, uses the musculature of the abdomen to stretch the diaphragm and compress the abdominal cavity to lift the abdominal organs up.

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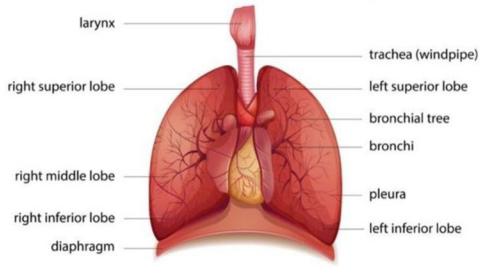
PHYSIOLOGY
THE NERVOUS SYSTEM & YOGA

BREATHING & THE NASAL CYCLE

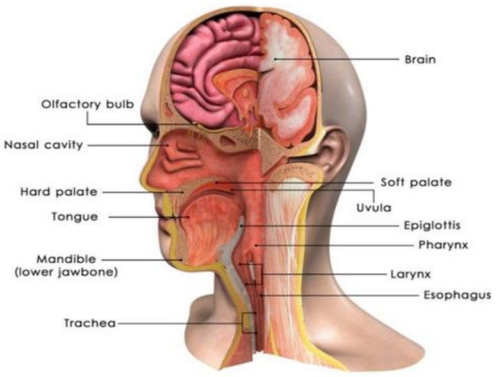
Ancient yogis detected what scientists now refer to as the nasal cycle. Humans (and other animals) cycle alternately from breathing through one nostril to breathing through the other, for periods ranging from a few minutes to a few hours. This pattern continues even during sleep... More and more scientific research is supporting the notion that breathing through different nostrils has very different effects on the body.

– Timothy McCall, Yoga as Medicine



- Lungs have five lobes: three in the right lung (upper, middle and lower lobes) and two in the left (upper and lower lobes).
- Because lungs are pear-shaped, the fill capacity of the upper lungs is less than the lower.
- With a full inhalation, air reaches the lower lungs where, according to one source, there is more blood available for oxygen exchange. (source: Mukunda Stiles quoting John Douillard)

- Tubes in the nose moisten air from the in-breath and fine hairs filter the air.
- Due to the relationship between a nose's form and its function, people in different climates show a different nose structure.
- The Nasal Cycle refers to how humans and other animals breathe in patterns, alternating their breathing through one nostril and then the other.
- The right nostril corresponds to the left side of the brain (which governs thinking, intellect, and reason). It is connected to the sympathetic nervous system.
- The left nostril corresponds to the right side of the brain (responsible for feelings and intuition) and triggers the parasympathetic nervous system.
- See also Nadi Sodana Pranayama.



THE NOSE WARMS, HUMIDIFIES & CLEANS AIR

Both ways of breathing—through the nose and through the mouth—are possible, and each has its advantages and disadvantages. When you breathe through the nose, the air is warmed up and humidified; cleaned of dust particles; and cleaned of bacteria. Thus, the air that reaches the lungs is warm, purified, and of good quality. From this point of view, it is better to breathe through the nose... [However,] it's easier to do deeper breathing through the mouth... When inhaling or exhaling through the mouth, you can also vary the airflow more easily than when you breathe through the nose.

– Blandine Calais-Germain, Anatomy of Breathing

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PHYSIOLOGY
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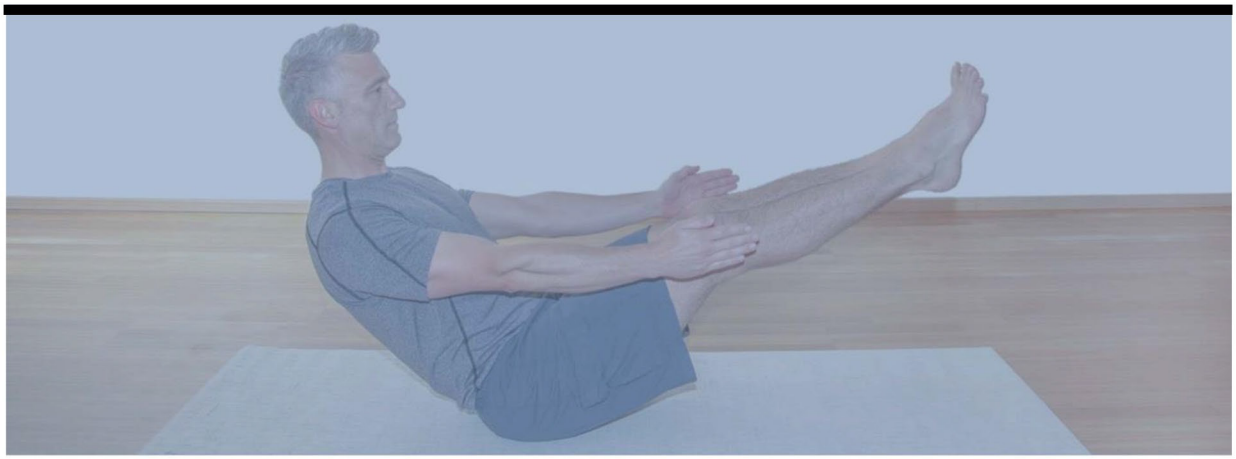
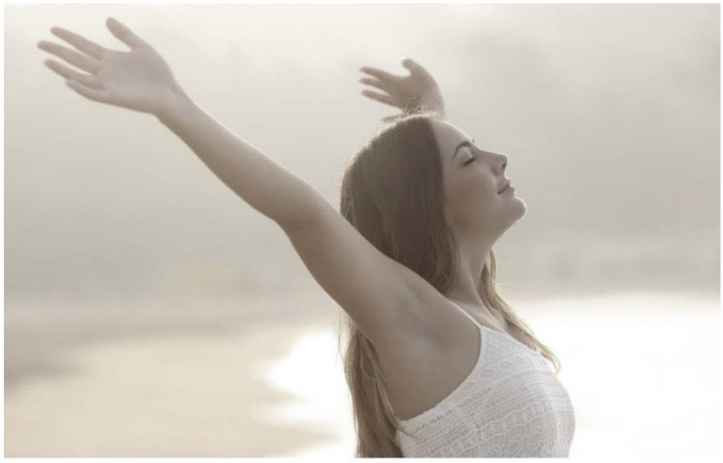


THE ABDOMINALS IN BREATHING

The [abdominal] muscles shorten concentrically, pressing the abdominal wall inward, which in turn pushes the abdominal organs up against the relaxed (or relaxing) diaphragm. In combination with the action of the internal intercostal muscles, this forcibly decreases the size of the chest cavity and pushes air out of the lungs... In yoga the abdominal muscles are important for what yogis refer to as even breathing, and they are also key elements for many breathing exercises.

– David Coulter, Anatomy of Hatha Yoga

THE INTERCOSTALS



- Rib movement is caused by muscles between the ribs, called the internal and external intercostals.
- With an inhalation, the intercostals open to expand the ribs and increase space for the lungs.
- They contract during an exhalation.
- When these muscles are tight, movement of the rib cage is restricted, and therefore so is the breath. Elongating the intercostal muscles improves breathing.

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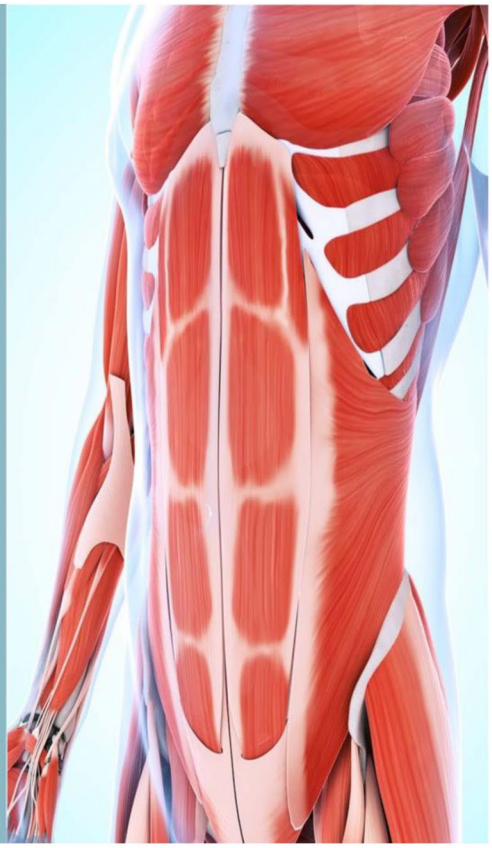
ANATOMY & PHYSIOLOGY

Chapter Highlights

- QUESTIONS ANSWERED HERE
- OVERVIEW
- COMPONENTS OF THE CORE
- TEACHING CONSIDERATIONS
- TRANSVERSUS ABDOMINIS
- STRENGTHENING BENEFITS & CAUTIONS



ANATOMY OF THE CORE

PHYSICAL STRUCTURE OF CORE AND SUBTLE BODY CONSIDERATIONS

The source of our vitality, the abdomen is a sacred space in our bodies, so we would do well to shift from criticizing how it looks to respecting how it feels.

— Fernando Pages Ruiz

QUESTIONS ANSWERED HERE

- What comprises the core?
- What is the primary role of the core?
- Describe and give an example of as *asana* that works each of the following: rectus abdominis, obliques, erector spinae, multifidus muscles.
- What is the difference between a sit-up and a crunch?
- What muscles are targeted in crunches? What is the role of these muscles?
- Crunches flex the trunk; why is this not optimum for most people?
- What is meant by stabilizers and prime movers?
- In the context of stabilization, why are crunches not effective for core health?
- Where is the transversus abdominis (TA) located? What is its function?
- What is the effect from engaging / contracting the TA?
- How can identifying the sensation of contracting the TA benefit students?
- What are some exercises that can help to identify the TA?
- When performing a lower abdominal exercise such as a leg lift, what clue can indicate the TA is not engaged?
- How is true core strengthening different from how popular culture promotes strong abdominals?
- What benefits are associated with a strong and healthy core?
- What type of movement is needed to bring balance after core strengthening work?
- How might a weak TA impact the psoas in some core work?

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ANATOMY & PHYSIOLOGY

OVERVIEW

- The core includes many different muscles that stabilize the spine and pelvis.
- The term "core" often refers to the abdominal muscles (outer and deep) and back muscles including the erector spinae and multifidus muscles.
- Many more refined definitions also include the diaphragm and pelvic floor.
- Some definitions include the inner thighs and/or more muscles.

READINGS

MUSCLES THAT STABILIZE SPINE & PELVIS, AND RUN ENTIRE LENGTH OF TORSO

The abs have very limited and specific action, and what experts refer to as the "core" actually consists of many different muscles that stabilize the spine and pelvis, and run the entire length of the torso. When these muscles contract, they stabilize the spine, pelvis and shoulder girdle and create a solid base of support. When this happens, we are able to generate powerful movements of the extremities.

– About.com

MOST OFTEN ACTS AS A STABILIZER

Your core most often acts as a stabilizer and force transfer center rather than a prime mover. Yet consistently people focus on training their core as a prime mover and in isolation. This would be doing crunches or back extensions versus functional movements.

– BreakingMuscle, Do You Know What Your Core Really Is?

LEARN MORE ABOUT STABILIZATION

See Teaching Considerations for more on "stabilizers" vs. "prime movers."

MANY PEOPLE, MANY MEANINGS

Depending on who you ask, the "core" can refer simply to the muscles of the midsection/trunk of the body, or specifically, to the muscles that support and stabilize the spine (especially the lower back). Some teachers and experts even include the shoulders, upper arms, hips, and thighs when referring to "core muscles." As far as I know, none of these definitions are wrong. "Core" is simply a very appealing yoga and fitness buzzword, and teachers and practitioners (myself included) often use it to describe the centrally located muscles that we believe are important to work with.

Perhaps my personal favorite definition of "core" might be..."the muscles that stabilize the spine, and the muscles that move the spine." That definition, coupled with a practice goal... to "stabilize what's too mobile and mobilize what's too 'stable' (or 'stuck'/'tight')," is, I think, a pretty good framework when it comes to selecting yoga-related "core" exercises.

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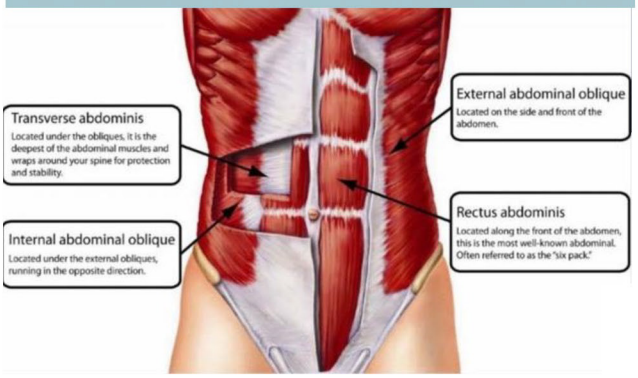
ANATOMY & PHYSIOLOGY

COMPONENTS OF THE CORE



OUTERMOST ABDOMINALS

RECTUS ABDOMINIS

- Bends spine forward
- Worked in Ardha Navasana (Half Boat) and Bakasana / Kakasana (Crane / Crow)

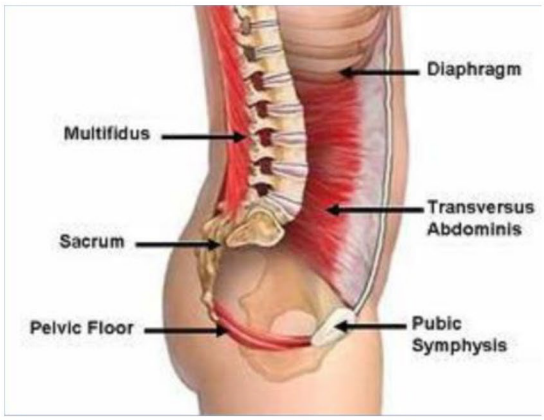
INTERNAL AND EXTERNAL OBLIQUES

- Twists torso & bends it sideways
- Worked in Ardha Matsyendrasana (Half Lord of Fishes) and Utthita Trikonasana (Extended Triangle)

DEEP ABDOMINALS

TRANSVERSUS ABDOMINIS (TA)

- Wraps around torso and supports spine
- Worked in Plank
- See The TA for much more information



ERECTOR SPINAE (SPINAL ERECTORS)

- The erectors consist of three groups of muscles running the length of either side of the spine.
- The spinalis group is most medial (closest to spine); the longissimus is the next group; the iliocostalis is the most lateral group.
- The erectors are deep, located beneath two other layers of muscles and covered by fascia. (Core Walking)
- The erectors help to maintain erect posture; stabilize the spine during flexion; and assist in side bending and spinal rotation.
- The erectors together act as "powerful extensors to promote the return of the back to the erect position... primarily responsible for the extension of the back (straighten the spine) as well as more specific movements such as extension of the neck and sideward movements of the head." (Muscles Used, Erector Spinae)

[Study] results showed that low back pain subjects, especially those with chronic pain, displayed significantly smaller multifidus muscle activity as compared to healthy subjects during the coordination exercises, indicating that over the long term, back pain patients have a reduced ability to voluntarily recruit the multifidus muscles in order to maintain a neutral spine position.... When multifidus function is poor, one will be more susceptible to back injuries.

– Core Concepts, Multifidus

MULTIFIDUS MUSCLES

- Series of deep muscles that run the length of the spine (some sources state only low back)
- They stabilize vertebrae as well as assist in spinal rotation and extension
- They can be key in learning to recruit the core for stabilization in those who have experienced back pain
- See article for more information

The Multifidus... has a unique design that provides support as well as keeps us upright by providing scaffolding for the vertebral column. Unlike most muscles, when the multifidus is on stretch (when we bend forward) it gets stronger. Generally, if a muscle is lengthened it has a tendency to lose strength. Obviously this Multifidus is operating under different rules.

– USA Synchro, Understanding... Core Muscles

DIAPHRAGM

- See Respiratory Anatomy

PELVIC FLOOR

- See Pelvic Floor

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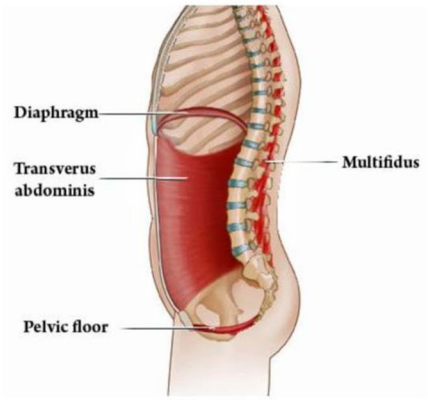
ANATOMY & PHYSIOLOGY

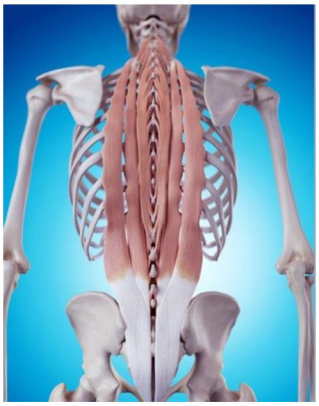
THE TRANSVERSUS ABDOMINIS (TA)



When you laugh until your belly aches, you are feeling your TA. It is also the muscular focus on Kapalabhati Pranayama. When properly toned, this muscles keeps your organs in place while giving support to the lumbar spine. When habitually gripped, it compresses the organs and lends to abdominal hernias, urinary incontinence, and digestive problems.

— Mark Stephens, Teaching Yoga

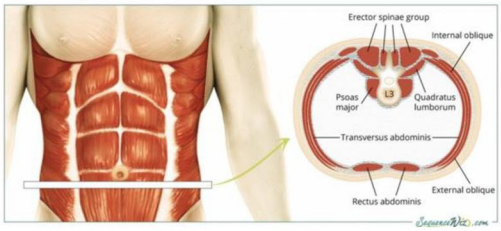
- A significant amount of expert teaching around core recruitment and strengthening is focused on the transversus abdominis (TA).
- It is the deepest of the abdominal muscles.
- "There is one transverse muscle on each side joined by a fascial sheet that connects them and allow them to act as one solid muscle." (Core Walking)
- The TA wraps around the abdomen between the lower ribs and top of the pelvis.
- The TA supports the abdominal wall, aids forced expiration, and stabilizes the spine and pelvis before movement of the limbs.
- It helps with overall core stability.
- When the TA engages / contracts, it has a "corset-like" effect, slightly narrowing the waist and flattening the lower abdomen.
- This video is less than a minute and shows the specific anatomical origin and insertion points for the TA.



MORE STUDY TOOLS

For a clear, 2-minute video showing these muscles being laid upon a skeleton, see What are the Core Muscles?

See also the uniquely helpful image shown here, a top-down view from SequenceWiz.



EXPERIENCING THE ABS AS STABILIZERS

The following exercise (as shared by Judith Lasater in Yoga Abs) is specifically to give students the experience of feeling the abdominal muscles in their role as stabilizers.

1. Lie on back, legs together, knees facing up.
2. Lift one leg off floor, noticing contraction of abdominals. This is an example of the abdominals stabilizing the trunk.
3. Now place thumbs on lower ribs and middle fingers on iliac crests (hip bones).
4. Lift leg about 5 inches off the floor and then outward about 10 inches.
5. If abdominals are stabilizing, there will be no lifting of opposite-side pelvis; the greater the movement experienced, the less stabilization the abs are providing.
6. "Not only is this exercise a good way to become aware of your habit of not stabilizing your abdominals when you move your legs, it can also be a strengthening exercise that you can incorporate into your regular asana practice."

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ANATOMY & PHYSIOLOGY

TEACHING CONSIDERATIONS

This section is concerned with Anatomy-related topics.

For specific asana and other practices, see Core Strengthening.

Consider these key themes, as offered by Fernando Pages Ruiz in What It Means to Have Strong Abdominals:

- Movement comes from the body's center of gravity just below the navel.
- A healthy core acts as a stable base and fluid source of movement.
- Abdominal muscles should be toned but not tense.
- A fundamental step is to learn to sense the core.

This module, Anatomy of the Core, delves into these topics and gives you study and practice tools to support these teachings.

- Sit-ups refer to lifting the entire back off the ground to a sitting position. Crunches lift only head and chest until abdominals engage.
- Sit-ups have a relatively high risk of injury. (healthline)
- Crunches isolate abdominals, but only the outermost abdominals.
- Neither sit-ups nor crunches may be the best choice for core strengthening.
- Sit-ups and crunches flex the trunk forward, a movement most people do in excess.
- The concept of "stabilizers" and "prime movers" can help with understanding core health and choosing effective strengthening movements.
- A balanced approach to core health includes utilizing the abdominals as stabilizers (not prime movers).

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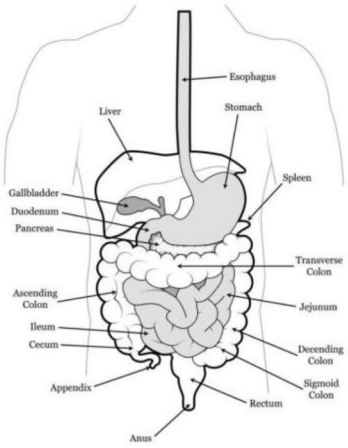
ANATOMY & PHYSIOLOGY

TEACHING VERBIAGE



The abdomen is between the thorax (chest) and pelvis. The abdominal contents include the stomach, small intestine, colon and appendix, liver, gallbladder, pancreas, spleen, kidneys and adrenal glands.

- Do you use such words as belly, abdomen, abdominal muscles ("abs") and core in your teaching? And do you intend to mean different things or do you use them interchangeably?
- If you haven't already examined your language around this area, now might be a time to consider how to be most clear and convey what you want your students to understand. Whatever terminology you choose to use, define the terms throughout your teaching to ensure clarity.
- Teachings in this chapter, The Anatomy of the Core, on can assist you in defining or refining how you choose to use the word core. Consider, also, whether you wish to refer to the abdominal muscles as a whole or refer to the outer abs vs the TA, or the particular muscles themselves.
- In Yoga Abs: Moving from Your Core, Judith Lasater uses the word abdomen "to refer to the anatomical aspects of this area" (the organs and muscles between the diaphragm and pelvic floor) and the word belly "to describe the metaphysical or philosophical aspects of the abdomen."

TEACHING VERBIAGE

The following teachings explain that when students hear the cue, "Engage your core," they are likely to draw in the outer abdominals and round the spine.

EXAMPLE REGARDING FORWARD BENDS

When teachers say, "Engage your core as you enter the forward bend," I wonder: "What will students engage when they hear that? The rectus abdominis?" That would tend to round the spine, which is not what we want at all... If students don't know what that phrase means, they may assume that you're referring to the abdominal muscles. That might lead them to think that a forward bend is about rounding the spine. In reality, the whole trunk should activate harmoniously, although the multifidus muscles on the back may be exerting the most effort in order to maintain a neutral spine and to keep the spine and pelvis together as a unit as we enter into the first phase of the pose.

I prefer to say, "Bend at the hips and keep the spine long and the front part of the body open, as you enter the first phase of your forward bend." This allows us to lead with the heart and have a much fuller breath in the pose.

– Gyandev McCord, The Expanding Light, Engage Your Core?

PULLING ABDOMEN BACK AND ROUNDING SPINE

When I [ask my students] what the instruction "Engage your core" means, they always answer back with, "pull my navel back," or "draw my navel in," or "navel to spine," and that is where the instruction falls very short of what really needs to happen... In yoga asana, we are... either trying to hold [the spine] stable in its well-aligned, neutral position (think Warrior II or Mountain Pose) or we are intentionally trying to manipulate it (think: Wheel Pose, Upward-Facing Dog, or Crow Pose).

In those three poses, we are using the core in the same way as in Warrior II or Tadasana but also asking one or more of the core muscles that moves the spine to intentionally manipulate it from its neutral position to another one required for the posture. If most students think "engage your core" means to pull their belly back, then that cue is really only fully helpful in something like Crow Pose where you are intentionally trying to round your lumbar and thoracic region.

– Alexandria Crow, Yoga Journal, Engage Your Core

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ANATOMY & PHYSIOLOGY

MORE READINGS

HEALTHY ABDOMINALS ARE INTENDED TO WORK AS BACK STABILIZERS, NOT PRIME MOVERS

An abdominal crunch primarily targets your rectus abdominis muscles (the infamous 6-pack), whose job is to flex your trunk forward. Unfortunately, you already flex your trunk forward all day long when you sit, drive, lean forward or stand with your tailbone tucked under. Repetitive spinal flexion over time can mess up your natural lumbar curve, which repositions your spinal disks in relation to one another, creating compression on the discs in places where they are not supposed to be compressed.

Pete Egoscue writes: "Everybody wants a flat stomach, but the worst way to get one is to deliberately contract your abdominal muscles. This holds your hips and spine in flexion, preventing them from achieving neutral positions. Healthy abdominals are intended to work as back stabilizers, not prime movers." So when it comes to the muscles of the core we need to create stability and balanced development between all the different layers.

– Olga Kabel, SequenceWiz, Core Players

WHAT DOES STABILIZATION MEAN?

Stabilization means being able to control the amount of movement of your joints during movement of your body. Stability is not about how much movement you have but about how well you can control it. The activation of specific core muscles allows you to stabilize your joints and control movement.

– Grand River Sports Medicine Centre, Core Stabilization

READINGS

CRUNCHES & SIT-UPS CONSIDERED OUTDATED AND INEFFECTIVE BY SOME

Here's the good news: Core work doesn't have to mean crunches! In fact, crunches and sit-ups are becoming somewhat passé, with many fitness experts considering them outdated, ineffective, and potentially injurious.

– Kat Heagberg, Yoga International, A (Crunch-Free!) Core Sequence

STABILIZERS & PRIME MOVERS

Stabilizers are the muscles that keep your back in alignment. They are also the muscles that hurt when you lift a weight with your back rounded. But which muscles are these, exactly? They are the small muscles of the lower back and the central spine. Prime movers are muscles that aren't attached directly to the lower back or the central spine. They are large, because their job isn't to hold the small bones of the back in place but to provide locomotion... The stabilizers can be misused to move things, but that takes them out of the stabilizer role. The prime movers can be used only to move things.

– SuppleCity.com, Stabilizers vs Prime Movers

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ANATOMY & PHYSIOLOGY

FINDING & STRENGTHENING THE TA

YOU CANNOT STRENGTHEN A MUSCLE YOUR BRAIN CANNOT ACTIVATE

Restoring the recruitment patterns (order in which different muscles contract) of the core is different than most exercises you will have been used to in the past. The first step is to learn to isolate the [TA], to train it to contract. Research has clearly shown that the better you are at isolating this muscle, the faster it will integrate into functional tasks. The second step is to strengthen or teach it to co-contract with the other muscles of the core, the deep multifidus and the pelvic floor as you breathe. The final step is to co-contract the entire core (connect to the entire core) and use this connection in functional activities. You cannot strengthen a muscle your brain cannot activate.

– Diane Lee Physiotherapy, Deep muscles of the core

CONTRACTING THE TA OR SUCKING IN?

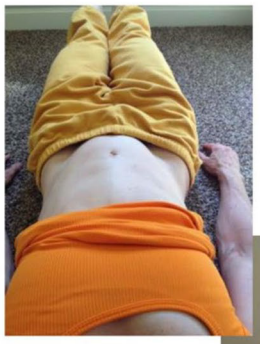
For many people when they are told to contract the abdominals, what they really are doing is sucking in, pulling up their diaphragm and bringing the abdominal contents with it. This is not muscle work.

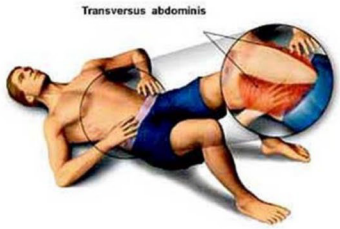
– Align for Health, How to contract the TA

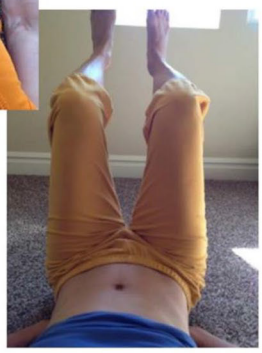
SITTING UP & TIGHTENING THE CORSET

To build awareness of your transversus abdominis try this: Sit tall and take a deep breath. On the exhale hug your waist in from the front, side and back at the same time, as if you were tightening the corset around your torso, on the inhale release. You can do that action in any yoga pose and it will help you develop awareness and stability in your core.

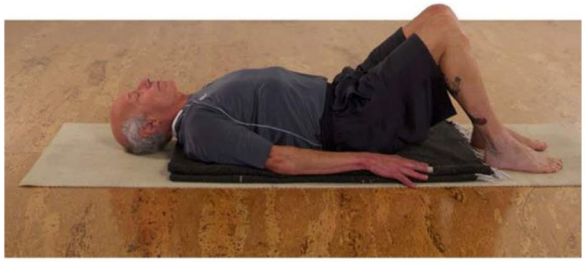
– Olga Kabel, SequenceWiz, Core Players







Images by Align for Health demonstrate the "loaf" vs lower abdominals appearing flat and engaged.



- It can be challenging for students to learn to feel the TA.
- Identifying the TA can be a fundamental step in learning to properly activate the core.
- Learning to contract the TA can be vital for students who—thinking they are engaging their core—are actually just pulling up their diaphragm and abdominal contents.
- Practicing the TA contraction is typically easiest on exhale.
- Laughing and coughing use the TA.

When performing a lower abdominal exercise such as the leg lift, you can tell if you are not using the transversus abdominis if your rectus abdominis (your six pack muscle) pokes out and looks like a bread loaf.

Try contracting the muscle before you lift the legs and see if the "loaf" stays flat and engaged.

– Align for Health, How to contract the TA

ENCOURAGE ACTIVATION OF TA BY DRAWING HIP POINTS TOGETHER

The image here shows this exercise with feet flat on the floor. The following excerpt from Kat Heagberg's teaching here instructs the exercise from Savasana.

1. Start lying on your back in Savasana, heels about as wide apart as they would be in Mountain Pose.
2. Bring hands to the two pelvic points.
3. Exhale, engage the muscle between hands, drawing pelvic points toward each other.
4. You may prefer to gently use your hands to narrow the pelvic points.
5. Try to keep that engagement in deep low belly on inhales and use each exhale to enhance, or reestablish, the engagement.
6. Let this action—the narrowing of your pelvic points—initiate the internal rotation of your thighs as you flex your feet and turn your toes to point up toward the ceiling.
7. Keep your heels on the floor, but imagine that you're going to pick them up off of the floor.

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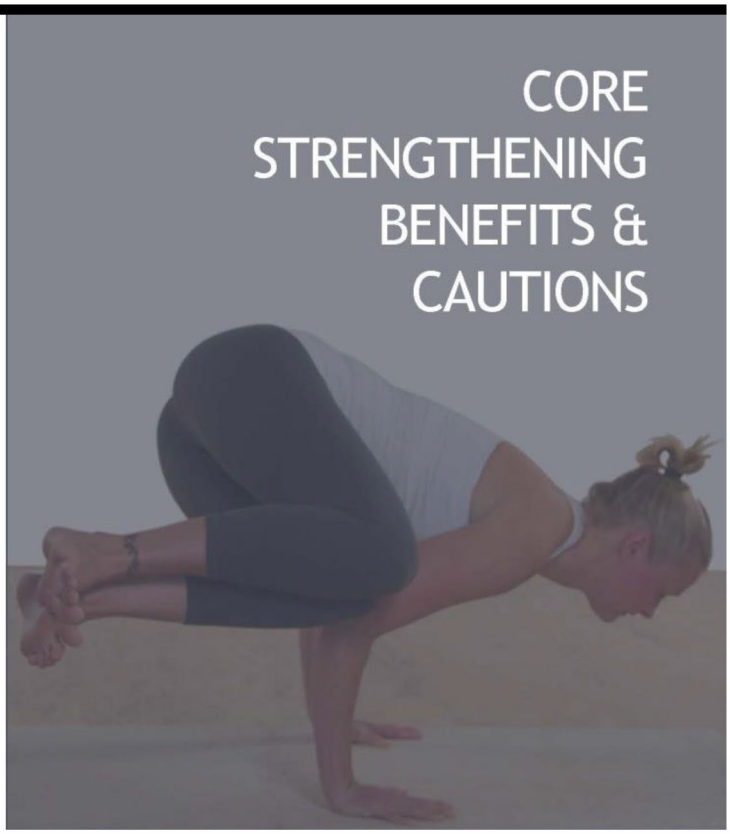
ANATOMY & PHYSIOLOGY

In popular fitness culture, the ideal core is often symbolized by "six-pack abs," the most superficial of the abdominal core muscles. Yet when so overdeveloped and tight, this rectus abdominis muscle is a source of compressed tension as well as spinal and breathing problems, compromising the grace and ease, poise and elegance, comfort and stability that come form a refined core...

Remind students that yoga is largely about creating space; we want to guide students into cultivating a strong yet supple core, learning along the way to radiate outward while drawing awareness deep into the core of the body.

– Mark Stephens, Yoga Sequencing



ABOUT CORE STRENGTHENING

KEY POINTS

- Popular culture presents an overdeveloped rectus abdominis as desirable when in fact this is not representative of core health as a whole and can be a source of "compressed tension."
- True core strengthening involves a balanced integration of the deeper core muscles.
- A strong core can be thought of as "building strength from the inside out" and is often correlated with positive psychological, emotional and spiritual states, including feelings of strength and resilience.
- A healthy core in Yoga is associated with healthy digestive "fire."
- Core strengthening supports the low back and can eliminate back pain. "Weakness in the core can result in "overrotations in the vertebrae of the lower back, which leads to degenerative disk disease and arthritis." In addition, "[weak] abs often contribute to trouble in the sacroiliac joint." (Rachel Brahinsky)
- A strong core improves athletic performance.
- Strong abdominal muscles support abdominal organs.

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ANATOMY & PHYSIOLOGY

BENEFITS OF CORE STRENGTHENING

DEVELOP SPIRITUAL & PHYSICAL SUPPORT; BUILD RESILIENCE

The core, says senior Anusara teacher Desirée Rumbaugh, "is what supports us spiritually in our lives, and physically in our yoga practice. If our core is weak, the ups and downs of life are much harder to take. A strong core makes us more resilient."

– Rachel Brahinsky, Yoga Journal, Core Purpose

INCREASE DIGESTIVE FIRE

"If we're weak in the core, our digestive fire is weak," adds Ana Forrest, founder of the Forrest Yoga Institute in Santa Monica, California. This can cause constipation, which then brings on "chronic exhaustion, because we're not absorbing nutrients," and which pollutes the blood stream and can muddy the mind, leading to unclear thinking and gloomy moods. Core work, on the other hand, "quickens the blood and gets oxygen moving" throughout the body.

– Ana Forrest

CULTIVATING A STRONG & SUPPLE CORE VS COMPRESSED TENSION

In popular fitness culture, the ideal core is often symbolized by "six-pack abs," the most superficial of the abdominal core muscles. Yet when so overdeveloped and tight, this rectus abdominis muscle is a source of compressed tension as well as spinal and breathing problems, compromising the grace and ease, poise and elegance, comfort and stability that come form a refined core. As yoga teacher Ana Forrest has long emphasized, we want to relieve emotional and physical constipation and restriction, to release deep guttural anxiety, not seal it in. Remind students that yoga is largely about creating space; we want to guide students into cultivating a strong yet supple core, learning along the way to radiate outward while drawing awareness deep into the core of the body.

– Mark Stephens, Yoga Sequencing © 2012 p 61

EXPERIENCE BODY AS A WHOLE

When you see yogis doing an arm balance with finesse, they look as light as a feather. They make the pose look so easy that you might forget how much strength it requires... Yoga teaches you to cultivate the strength that results from physical integration and connection. Physical integration is that sense of coordinating different parts of the body so that they work in concert. It's the idea that we become exponentially more powerful when the whole body works in unison rather than when we isolate a muscle or muscle group. When we learn this, and feel it, we have the powerful and beneficial experience of being whole. A key way to learn physical integration is to work the core abdominal muscles.

– Jason Crandell, Yoga Journal, Core Competency

BUILDING STRENGTH FROM THE INSIDE OUT CULTIVATES SELF-UNDERSTANDING AND ACCEPTANCE

Core-focused exercises in particular are fairly "inward focused." They're not generally big, expansive, or showy like impressive backbends or arm balances. Core work requires us to "be with ourselves" in a unique way, and often specifically with parts of ourselves that we've been conditioned by society to reject, "get rid of," or change—and that's not always (or maybe ever) easy. But when we build strength from the inside out (both literally and metaphorically) and approach core work as a practice of cultivating self-understanding, self-acceptance, and even self-love, it has the potential to empower our yoga practices and our lives in ways that trying to "whittle away our waistlines" never could.

– Kat Heagberg, Yoga International, A (Crunch-Free) Core Sequence

"TURN ON INNATE INTELLIGENCE"

And, Forrest adds, core work connects students to their feelings. "Working with the core during the first 15 minutes of class turns on a student's innate intelligence and gets them feeling more accurately," she says. Such intelligence is essential both in class, as your students decide how deeply to move into more challenging poses in ways that avoid injury, and when they step into the world. "If we don't know how to get centered in our core, we're basically doormats for whoever is a stronger personality," Forrest says. "We become susceptible to anyone who wants to push us off balance, whether it's a controlling mother or a government that controls by fear."

– Ana Forrest

ABOUT CORE STRENGTHENING

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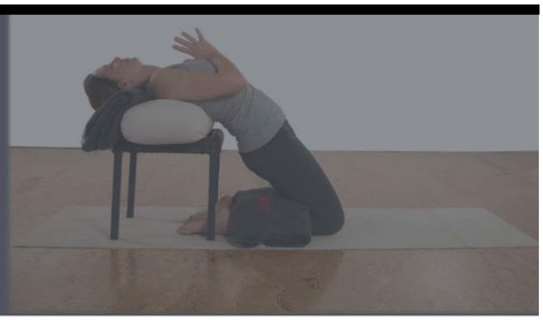
ANATOMY & PHYSIOLOGY

BALANCING STRENGTH WITH FLEXIBILITY



BALANCE STRENGTH WITH FLEXIBILITY BY LENGTHENING ABS AFTER CORE STRENGTHENING WORK

- "To keep your obliques and rectus abdominus in optimal working order, you must train them to relax and lengthen as well as to contract and shorten." (Julie Gudmestad)
- This can include relaxing abs after strengthening, releasing over a bolster and/or practicing traditional backbends such as Ustrasana (Camel) or Setu Bandhasana (Bridge).
- Ana Forrest often teaches Setu Bandhasana (Bridge) after abdominal exercises.

The abdominal muscles need to be strong enough to perform their jobs, but they should not be so short, tight, and rigid that they restrict lung expansion and limit inhalation. The upper abdominals, which are strengthened during curl-ups and crunches, are the guilty gang that can put the squeeze on the diaphragm. These upper abdominals include the upper fibers of the rectus abdominus, which sits lengthwise in the center of the abdomen, running between the pubic bone below and the lower sternum and the rib cartilage above. The external and internal obliques, which cross the abdomen diagonally like a supporting girdle, also have upper fibers that attach to the lower ribs and can restrict rib cage movement.

– Julie Gudmestad, Julie, Yoga Journal, Take a Deep Breath

CAUTIONS

A key muscle at the very center of your core, the psoas, is all too often overworked in ab exercises. You'll benefit most from your core work if you learn the actions that not only tone your tummy, but also tame a tight psoas.

– Doug Keller, Yoga Journal, Beneath the Surface

CAUTION: RELEASE PSOAS

If the TA is weak, the psoas pulls too strongly on spine; see Yoga Journal article, Beneath the Surface for more information.

- Keller explains how in leg lifts, for example, the TA holds the spine steady while the psoas & thighs lift & lower legs
- He notes that it is the effort to maintain a neutral curve in spine that gives abdominals a workout
- The TA tightens to prevent psoas from pulling the back into an exaggerated arch as legs are lifted & lowered
- But if core is weak and not engaged, great pressure is placed on lower back, causing it to overarch, which can lead to pain or injury
- Keller explains that the key actions to avoid low back stress are activating low belly and drawing navel slightly back & up

CAUTION: RECOMMEND SUPPORT FOR EMOTIONAL RELEASE

The belly region is also central for healing emotionally bound problems, such as eating disorders, and core work can dredge up difficult food-related feelings. Forrest emphasizes that when you deal with students with such concerns, be aware that they will need support. "When you start working on the abs and you begin to feel in there, it makes people feel out of balance. This is an important part of the healing process. It's important to be able to accurately assess the damage without drowning in it. Start by teaching how to feel and how to breathe, move, and process those feelings: feel, digest, and move through."

– Rachel Brahinsky, Core Purpose

ANATOMY & PHYSIOLOGY

ANATOMY OF THE SPINE

FORM & FUNCTION OF THE SPINAL COLUMN

Your back is a gateway to the sky.
The celestial dance,
The story of space and time,
Is coded in the spine.

—Lorin Roche, Radiance Sutras

Chapter Highlights

- OVERVIEW
- JOINTS OF THE SPINE
- SPINAL CURVES
- FUNCTION
- ISSUES
- TEACHING CONSIDERATIONS

SPINAL CURVES

CERVICAL SPINAL CURVE (C1-C7)

- Lordotic: convex, curving in toward body
- Most flexible part of spine and therefore often overused

THORACIC SPINAL CURVE (T1 – T12)

- Kyphotic: curves away from body
- If the curve exceeds 50 degrees, medical sources consider it abnormal and call it kyphosis
- "Called the primary curve because it's the curve of the fetal position and it forms in utero" (Joyce Englander Levy)
- Generally can twist fairly easily but not bend forward and back as well

LUMBAR SPINAL CURVE (L1 – L5)

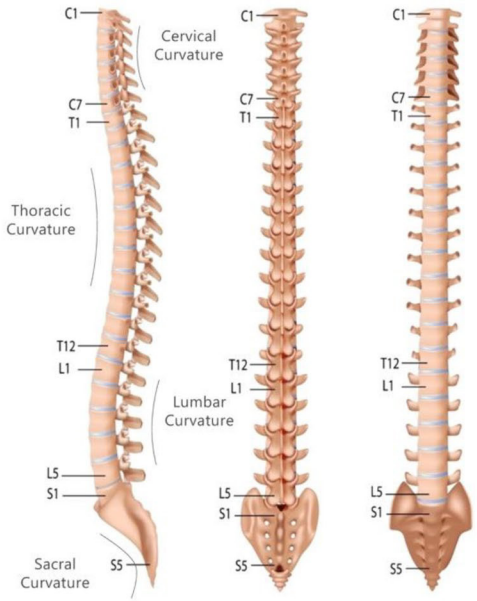
- Lordotic: convex, curving in toward body
- Hyperlodosis is excessive curve; also called swayback
- Generally can bend forward and back well but more challenging to twist
- Tight hip flexors can tilt pelvis forward, creating excessive low back curve

SACRUM (S1 – S5)

- Consists of 5 fused vertebrae
- Kyphotic: curves away from body
- The sacrum is the base of the spine and the back of the pelvis

COCCYX

- Consists of 3 to 5 fused vertebrae with a tip that typically points straight down
- Kyphotic: curves away from body
- Tailbone curves vary
- Unlike rest of spine, it is dense bone only and does not house spinal cord



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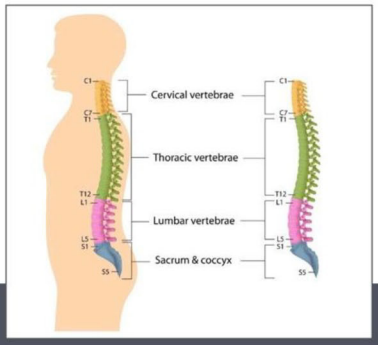
ANATOMY & PHYSIOLOGY

OVERVIEW



- The spinal column consists of 33 bones, some of which are fused. "The sacrum's five bones and the coccyx's four do not fuse together until adolescence. (Inner Body, Spine)
- The spine is labeled according to 5 regions: cervical (7 vertebrae), thoracic (12 vertebrae), lumbar (5 vertebrae), sacral (5 fused vertebrae) and coccyx (3 to 5 fused vertebrae).
- The spine has four "normal curves," a term used by anatomists to underscore their importance.
- The vertebrae are numbered from the top down: C1 to C7, T1 to T12, L1 to L5, and S1 to S5.
- The junctions where the curves of the spine change direction allow the most movement: C7 - T1, T12 - L1, and L5 - S1.
- Spinal curves are affected by genetics & postural habits.

QUESTIONS ANSWERED HERE

- What regions make up the spinal column and what is the shape of each curve?
- How many vertebrae are in each region? Which are fused?
- Where do we experience the most movement in the spine, and why?
- How can a student use Savasana to identify her spinal curves?
- What is meant by the term "primary curves?"
- What is the function of the spinal cord?
- What are the attributes of a healthy spine?
- What is the purpose of the spinal curves?
- What is kyphosis and hyperlordosis? What are potential causes of each?
- What is the difference between structural scoliosis and functional scoliosis?
- What is a primary objective of *asana* as it relates to spinal curves?
- What is compensation as it relates to spinal curves and why is it important?
- What are two different reasons that a student may present with hyperlordosis, and which cues might be effective for each?
- What might you watch out for in terms of spinal alignment in forward bends, in backbends, and in twists?

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ANATOMY & PHYSIOLOGY

- The vertebral column—also known as the backbone or spine—houses the spinal canal which in turn encloses the spinal cord, meninges (membranes) and cerebrospinal fluid.
- The spinal cord extends from the brain stem to the lower back, relaying information to and from the brain via 31 pairs of spinal nerves (part of the peripheral nervous system) that connect the spinal cord to the rest of the body.
- The cervical spine houses 8 pairs of nerves; the thoracic 12, the lumbar 5, the sacrum 5 and the coccyx 1 pair.

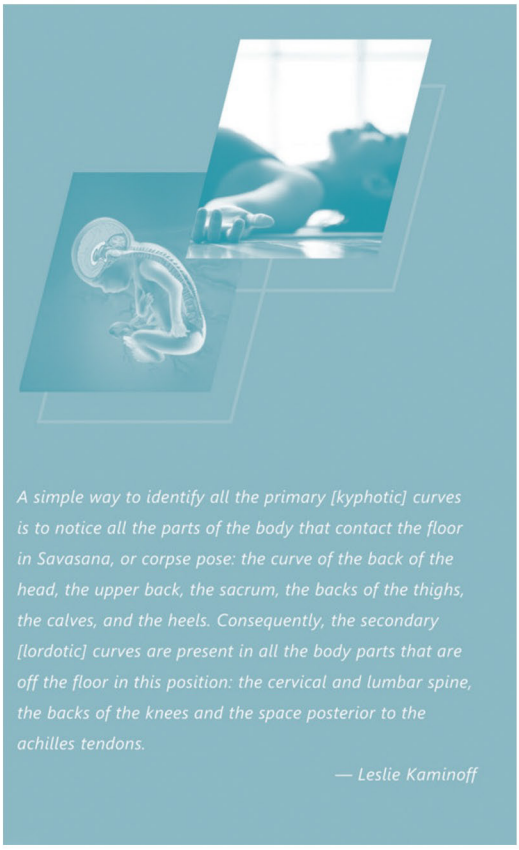
The location of the nerves in the spinal column determine which parts of the body they communicate with. Different sources sometimes indicate slightly different body part connections for the various nerves. The following are common general associations.

- Cervical: head, neck, shoulders, arms, hands and diaphragm
- Thoracic: chest, abdominal muscles, intercostals
- Lumbar & Sacral: low back, buttocks, legs, feet, anal and genital areas

FUNCTION

HOW SPINAL CURVES DEVELOP

- The thoracic and sacral curves—the kyphotic spinal curves—are developed in utero, and are therefore called primary curves.
- The cervical and lumbar curves develop later and are called secondary curves.
- The cervical curve develops during the birthing process and while learning to hold up the weight of the head, forming fully by around nine months of age.
- The lumbar curve is the last curve to develop over time, fully forming by about age ten.
- While the primary curves are supported by surrounding bones, the cervical and lumbar spine are "freestanding sections of the spine" which are therefore more impacted by the surrounding myofascia.



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.

— Leslie Kaminoff

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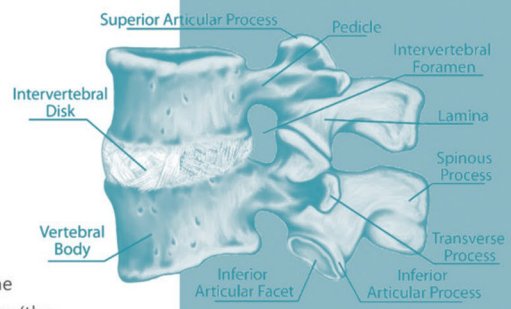
ANATOMY & PHYSIOLOGY

JOINTS OF THE SPINE

VERTEBRAE & INTERVERTEBRAL JOINTS

- Each vertebra has a **body** (thick oval segment of bone forming the front of the vertebra), **vertebral foramen** (the opening through which the spinal cord passes), **spinous process** (bony projection off posterior) and **transverse process** (small bony projection off right and left sides).
- Between the vertebrae is cartilage called intervertebral discs.
- There are joints between the bodies of vertebrae and joints between vertebral arches.
- Intervertebral joints include both synovial and cartilaginous joints.
- Intervertebral joints "allow for limited mobility between individual vertebrae but great stability to protect the spinal cord. Mobility of the spinal column comes from combining the limited movement of individual intervertebral joints as a whole." (Ray Long, *The Key Muscles of Yoga*)

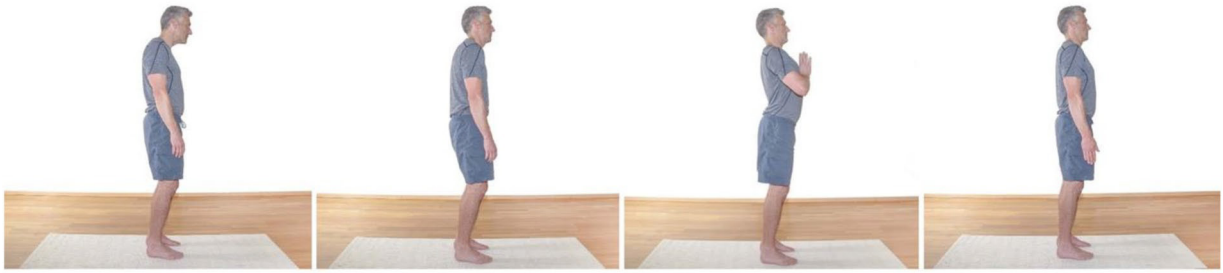


The spine is made up of vertebrae and their joints, each of which can move in six different directions. (That's a lot of movable parts, increasing the odds of something going wrong.) The vertebrae are bound together by two long, thick ligaments running the entire length of the spine as well as by smaller ligaments between each part of vertebrae.

— Larry Payne, PhD

ISSUES

There are a number of causes for spinal misalignment including genetics, lifestyle, physical activity, injury and emotional stress. Here we will describe some of the most common issues related to spinal alignment, plus potential causes and symptoms. Following this section, we will explore a number of teaching considerations for addressing spinal alignment in teaching. The images below demonstrate several examples of common spinal misalignments.



FORWARD HEAD | KYPHOSIS / HYPERKYPHOSIS | LORDOSIS / HYPERLORDOSIS | NORMAL CURVATURE

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ANATOMY & PHYSIOLOGY

KYPHOSIS / HYPERKYPHOSIS / THORACIC KYPHOSIS / HUNCHBACK

- Excessive forward curvature of the thoracic spine (clinically defined as greater than 50 degrees).
- Potential symptoms include an appearance of hunching forward, mild to severe back pain, loss of height, difficulty standing upright, and fatigue.
- Potential causes of kyphosis include vertebral fracture due to osteoporosis, congenital malformation of the spinal column, neuromuscular diseases such as cerebral palsy, Scheuermann's Disease (occurring in adolescents), nutritional deficiencies, degenerative conditions due to wear-and-tear such as spinal arthritis with degeneration of discs, and poor posture and slouching. (*spine-health.com*)

HYPERLORDOSIS / LORDOSIS / SWAYBACK / HOLLOW BACK / SADDLE BACK

- Excessive inward curvature of the lumbar spine
- Forward (anterior) pelvic tilt
- Potential causes of hyperlordosis include structural issues such as flat feet or a short leg, abnormal bone growth, neuromuscular disorders such as cerebral palsy, spondylolisthesis, osteoporosis, hip dislocation, obesity, kyphosis, disc degeneration or inflammation, and weak or imbalanced muscles (*LowerBackPain-Help.com* and *health.cvs.com*)

LORDOSIS CAUSE: LOWER CROSSED SYNDROME

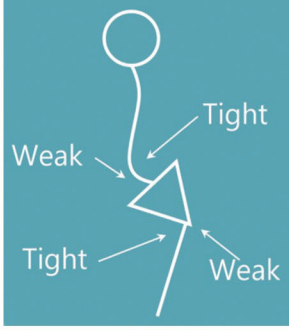
Some muscles around the hip and spine become tight and some become weak and stretched, causing an imbalance. This is often known as a lower crossed syndrome. This is due to the position of the tight and weak muscles. Look at the diagram [here]. If you drew a line from the tight lower back to the tight hip flexors and then another line from the weak abdominals to the weak hamstrings and glutes, the two lines would form a cross shape.

- ***The muscles that are often tight are:*** *Trunk extensors called the erector spinae and quadratus lumborum. Hip flexors, in particular the iliopsoas muscle. These muscles require stretching.*
- ***The muscles that are often weak and stretched are:*** *Abdominal muscles called the rectus abdominus, internal oblique and external oblique muscles. Hip extensors or hamstrings and gluteus maximus.*

— Sportsinjuryclinic.net, Hyperlordosis

RELATED ISSUES

Although yoga teachers may see many students with kyphosis due to postural causes, there are also structural causes unrelated to posture, such as with Scheuermann's Kyphosis.



The idea that a "tucked pelvis" is good for you comes from ballet... A tucked pelvis is necessary for a ballerina to perform her craft, but it is a decidedly unnatural movement to do all the time. Large numbers of ballet dancers end their careers with arthritic hips and sciatica due to this overemphasis on a tucked pelvis... Constantly arching the spine is unhealthy. Constantly tucking the spine is unhealthy.

— Paul Grilley, Yoga Journal
Debunking the Tucked Pelvis

SCOLIOSIS

- Abnormal curve from side-to-side
- Structural Scoliosis: inherited
- Functional Scoliosis: developed from one-sided activities

MORE

- Rounded shoulders
- Forward head
- Rib thrust / Rib shear
- Winging shoulder blades
- Constantly tucking pelvis
- Lack of awareness

WINGING SHOULDER BLADES

In winging of the shoulder blades, the scapulas do not lie smoothly against the posterior rib cage... When standing with your back to the wall, the shoulders will be forward and only a small portion of the inner shoulder blades will touch the wall. The rhomboids and middle trapezius muscles will tend to be weakened... This condition often restricts full respiration in the chest and increases abdominal breathing.

— Mukunda Stiles, Structural Yoga Therapy

PELVIC TILT

MOVING THE PELVIS TO AFFECT THE SPINE

The pelvis and its position relative to the spine influence alignment, posture and the way the body moves. To illustrate the pelvic tilt, consider how the movement of the pelvis changes the alignment and shape of the spine in the often practiced Marjaryasana (Cat Pose) and Bitilasana (Cow Pose).

ANTERIOR PELVIC TILT

When the pelvis is in an anterior tilt, the top of the hip bones lean forward and the sacrum leans backward. The anterior tilt facilitates extension of the lumbar spine and when excessive, can result in lower back pain and front-to-back muscle imbalance, as described in the discussion of lordosis.

POSTERIOR PELVIC TILT

When the pelvis is in a posterior tilt, the top of the hip bones lean back and the sacrum moves into the body. The posterior tilt rounds the spine and produces flexion of the vertebrae. A chronic posterior tilt, or tucking of the tailbone, can inhibit mobility in the pelvis and create postural imbalance.

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ANATOMY & PHYSIOLOGY

RESTORE NATURAL CURVES OF THE SPINE

Your body is like a combination lock—when you find the numbers, it unlocks easily. And one of the numbers is moving toward the natural curves of your spine.

— Rodney Yee
Yoga: The Poetry of the Body

Distorting the curves, either by increasing or decreasing them, can have negative effects for our overall health. Since the back's proper alignment is paramount, one of the primary goals of yoga therapy is to restore and preserve the proper curvature of the spine.

— Larry Payne, PhD
Yoga RX

BE AWARE OF COMPENSATION

Judith Lasater calls the cervical and lumbar curves "sympathetic," indicating that when we move one, we tend to move the other as well. Gary Kraftsow uses the term "compensation" for this tendency which he explains below:

It is important to realize that conditions in the upper back and lower back are interconnected. If one spinal curve increases, the other usually increases to compensate.

— Gary Kraftsow
Yoga for Wellness

SYSTEMATICALLY MOVE THE SPINE

To have a healthy spine, we must systematically move it through its full range of motion. This means sometimes we tuck the pelvis to flatten the spine, sometimes we tilt the pelvis to arch the spine, and sometimes we keep the spine neutral... When practicing backbends... don't try to tuck the pelvis, but let the spine arch. When practicing forward bends... don't try to tilt the pelvis, but let the spine round. These are normal movements for the lumbar spine, and to fight against them is to nullify the effects of the poses...Sooner or later, the goal of all physical rehabilitation is to regain the natural range of motion.

— Paul Grilley, Yoga Journal,

THE SPINE AS A SELF-SUPPORTING STRUCTURE

Debunking the Tucked Pelvis

If you were to remove all the muscles that attach to the spine, it still would not collapse... [that the spine is a self-supporting structure] reveals a deeper truth about how yoga practice appears to liberate potential energy from the body... This built-in support does not depend on muscular effort because it is derived from the relationships between the non-contractile tissues of cartilage, ligament and bone. It takes a lot of energy to fuel our constant, unconscious muscular exertions against gravity, and that is why the release of that effort is associated with a feeling of liberated energy.

— Leslie Kaminoff
Yoga Anatomy

RIBS FORWARD — INDICATING OVER-ARCHED LOWER BACK

The ribcage puffing forward is what most teachers' eyes see first, so they say, "soften your front ribs" in an attempt to get students to drop the front of the ribcage toward the pelvis. But the change actually comes from the front of the pelvis, the hips. To fix over-arched lower backs and pointy, puffy lower ribs, students have to posteriorly tilt their pelvis at the hip joint bringing their pelvis and lower back into neutral alignment. That reduces the lower back's arch and shortens the front body, dropping the ribs down.

— Alexandria Crow, Yoga Journal
Alignment Cues Decoded: "Soften Your Front Ribs"

RIB THRUST OFTEN CAUSING HYPERLORDOSIS — NOT A RESULT OF IT

Alexandria implies in her article that most people have a forward-tilted pelvis (also called an anterior pelvic tilt), which needs to be brought back to neutral with a posterior tilt, or tuck. But the anatomical truth is that the overwhelming majority of us present with a pelvis which is actually tucked under (also called posteriorly-tilted), which is the opposite of forward-tilted. We sit in so many chairs with rounded spines and tucked-under hips for the majority of our time that our body can't help but adapt to this shape.

In addition to having a tucked pelvis, most people also present with a forward translation of their rib cage, also called rib thrust or rib shear. When one's rib cage has moved forward, it creates the overly-arched spine... but the mistake that too many yoga teachers make is in assuming that this excessive arch (also called hyperlordosis) is coming from below – from the pelvis. Yes it's true... that when your pelvis moves, your lumbar spine moves along with it. But it's also true that when your rib cage moves, your lumbar spine moves too. The hyperlordosis that we all-too-often see in our students isn't the result of a pelvis that is anteriorly-tilted from below—it's the result of a rib cage that has sheared forward from above. The fix is therefore not to tuck your pelvis under, or to do any of these other cues that... mean the same thing, like pull the front of your pelvis up, lift your hip points, drop your tailbone... The correct fix is to return the rib cage to neutral, which you could certainly cue as "soften your front ribs" (but there are many other ways to convey this same action).

— Jenni Rawlings, YogaDork,
A Biomechanics-Informed Response

ANATOMY & PHYSIOLOGY

Asana Considerations

FORWARD BENDS

- Consciously extend the spine to maintain natural curves "rather than exploit them"
- See also Forward Bends

BACKBENDS

- Watch out for overarching neck in backbends due to a tight upper back and neck compensating
- Watch out for overarching low back
- See also Backbends

TWISTS

- Watch out for a focus on neck in twisting poses rather than twisting from lower spine
- Begin twists from low back & wait to gently turn neck last
- See also Twists

SPINAL EXTENSION / AXIAL EXTENSION

"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?*

- See Spinal Movements for important clarifying information on the term Spinal or Axial Extension.
- Potential teaching cues include, "Lengthen (or elongate) the spine" or "Extend the spine."