Anatomy 101

naadayoga

500 hr Teacher Training

Anatomy101

Moving From The Inside Out

OVERVIEW

Don't ask yourself what the world needs. Ask yourself what makes you alive, and then go and do that. Because what the world needs is people who have come alive. – Howard Thurman

This course will provide an introduction to the basic anatomical and physiological principles essential for yoga training and teaching. We will deepen our understanding of the harmonious way the body functions anatomically at all levels (anatomical, physiological, organic, and pranic). We will also explore the body's "energetic" anatomy from a yoga perspective and how the subtle body helps us better understand alignment, support and movement in the broader perspective of our lives.

Topics include:

- Osteology: study of the structure of bones and skeletal system, including the spinal column from both a structural and energetic perspective.
- Myology: the muscular system, which consists of skeletal muscles that move or position parts of the body (e.g., the bones that articulate at joints), and smooth and cardiac muscle that propel, expel, or control the flow of fluids in the body.
- Other body systems: including: circulatory, nervous, and endocrine systems.
- The diaphragms and respiration will also be discussed as preparation for pranayama practice and instruction.
- Energetic Anatomy principles: koshas, chakras, nadis, etc.

Objectives

Upon completion of this module you should be able to:

- Have an understanding of anatomy and physiology within the context of yoga practice.
- See the body as a living and evolving system, and view the yoga poses and practice from this perspective.
- Make adjustments in poses from this internal perspective.
- Touch on your personal experience of these systems by focusing on an area where you have been injured or experience/have experienced difficulty in your own body or practice.

Table of Contents

INTRODUCTION

The practice of Hatha Yoga works with the human body as a vehicle for self-transformation. Practitioners seek to balance their bodies in both gross and subtle ways. In yoga anatomy, the body is divided into Five Koshas, or "sheaths", layers of mind and body. The Koshas work interdependently, in much the same way that the various limbs of the yoga system work together, creating structure, form, awareness, insight - none separate from the other. In this module, we will look at the places where Eastern and Western views of the body converge, and this manual is divided into sections based on a yoga anatomy viewpoint. It's important to remember that these viewpoints - Eastern and Western, scientific and esoteric - are simply ways of describing the experience of being in this body and in this life. Different texts, schools and teachers will interpret these experiences differently.

What we offer in this manual is a template of how Eastern and Western views of the body and the experience of the body can meet. We have divided this into categories and sections for study purposes only, but please keep in mind that - much in the same way as asana, meditation, pranayama and other aspects of yoga intertwine and inform one another in your practice and in your life - so too, can the kosha system inter-relate with our Western view of the body and its structures and functions.

BODY ORIENTATION

GENERAL TERMS

Anatomy: description of structure and place of body parts and position with respect to one another.

Physiology: function of body parts and interaction between anatomical structures; study of how structure functions (organs, tissues, all body systems: circulatory, endocrine, respiratory, etc.).

Anatomy and Physiology are studied in conjunction, since the shape and place of a structure defines its function. Structure determines what functions can occur; if structure changes, function also changes.

Pathology: study of disease and dis-ease processes; disfunction of body parts and systems reflects a dis-harmony in body = dis-ease.

Homeostatis: body's ability to maintain an inner balance with respect to outer conditions. All systems of the body contribute to maintaining homeostatic conditions; to maintaining a dynamic state of balance (i.e. balance is not a static state; it is ever-changing, depending on inner and outer environment). Different mechanisms regulate functions (temperature, blood volume, electrolytes, etc.). Homeostasis is not only a physiological concept, but can also be equated with emotional balance and integrity at all levels of our being. It is that state that allows us to respond to life in a healthy way.

Five Body Divisions:
1) Head: Face, Cranium (Skull)
2) Neck: Throat, Back of Neck
3) Trunk: Thorax (upper torso), Abdomen, Pelvis (lower torso)
4) Upper Limb: Shoulder, Arm, Elbow, Forearm, Hand, Fingers
5) Lower Limb: Thigh, Knee, Shin, Calf, Foot, Toes

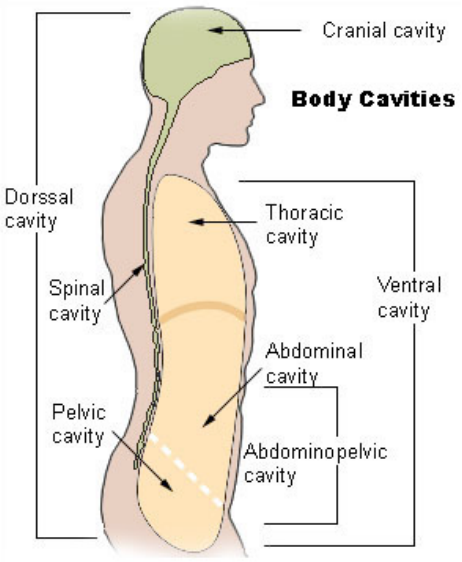
Five Body Cavities:

Dorsal:

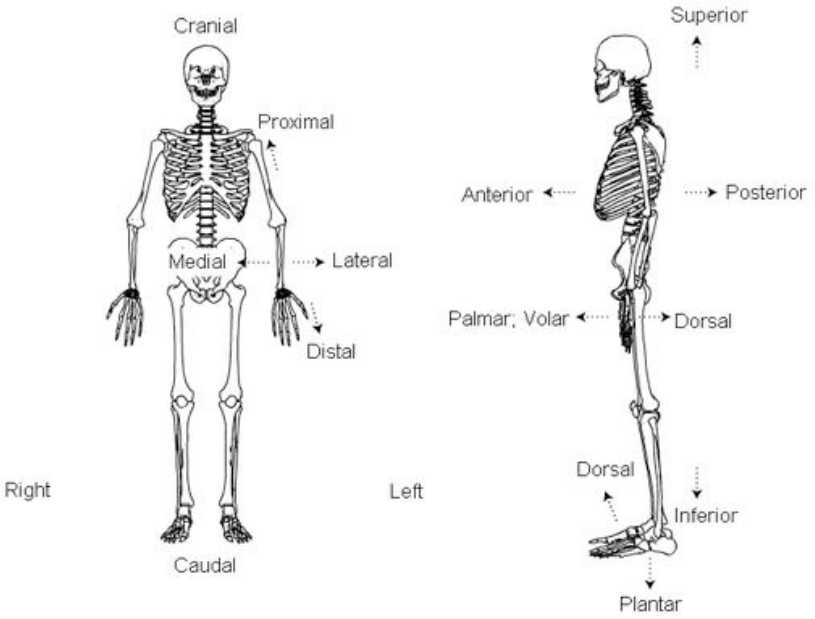
1) Cranial – brain (skull)
2) Spinal – spinal cord (vertebrae)

Ventral:

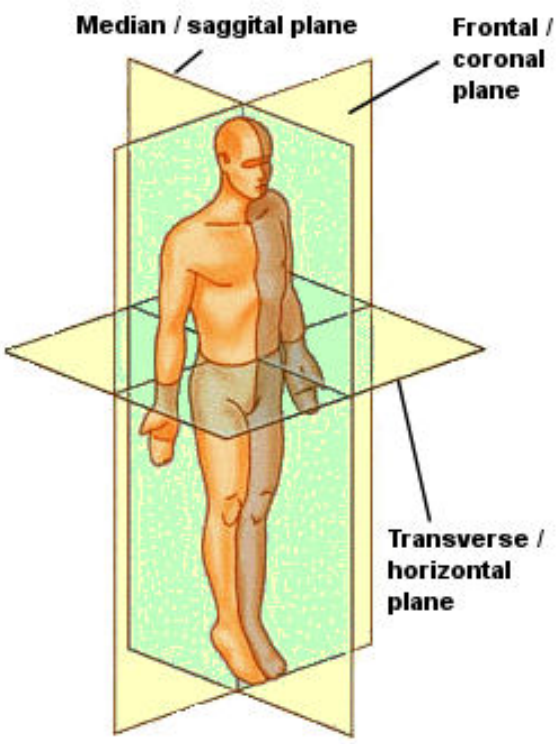
3) Thoracic – lungs, heart (rib cage)
4) Abdominal – stomach, kidneys, spleen, gallbladder, pancreas, liver, appendix, intestines (abdominal wall)
5) Pelvic – uterus, ovaries, bladder, intestines, colon, rectum (pelvis)



Anatomical Position:
Body erect. Feet facing forwards, palms facing front (thumbs turned out, away from body). This is the medical anatomical position, regardless of how the body is placed: standing, seated, lying.



Body Planes/Sections
1) Medial/Saggital – front to back/ vertical
2) Frontal/Coronal – left to right/vertical
3) Transverse/Cross – left to right/ horizontal



Directional Terms
In general, maximum 3 terms are used to describe a structure and its location with reference to the correct anatomical position

Superior – higher/above
Inferior – lower/below

Anterior/Frontal – in front of
Posterior/Dorsal – in back of

Medial – near mid-line
Lateral – away from mid-line
Intermediate – between medial and lateral
(e.g. clavicle is intermediate between sternum and shoulder)

Distal – farther from origin of body part; limb attachment to trunk or pelvis
Proximal – closer to origin of body part; limb attachment to trunk or pelvis

Superficial – toward body surface
Deep – away from body surface; surrounded by other structures

THE FIVE KOSHAS

According to the Kosha system in yoga philosophy, the nature of being human encompasses physical and psychological aspects that function as one holistic system. The Kosha system refers to these different aspects as layers of subjective experience. Layers range from the dense physical body to the more subtle levels of emotions, mind and spirit. Psychology refers to the emotional, mental and spiritual aspects of our being. Together, all these aspects interconnect and influence one another, creating and recreating our subjective experience of being alive. Note that although each kosha is said to comprise certain elements, all the koshas, as well as the gross and subtle body elements, do inter-relate and so some elements can be "classified" under more than one category.

1) ***Anamaya Kosha:*** the musculo-skeletal body (tissues, bones, etc.). This is the sheath of the physical self.

2) ***Pranamaya Kosha***: the physiological body, consisting of the various systems (respiratory, nervous, circulatory, endocrine, etc.).

3) ***Manomaya Kosha*****:** the psychological body (emotions, feelings, reactions to experience).

4) ***Vijnanamaya Kosha*****:** the wisdom body, where we understand and know deeply what is.

5) ***Anandamaya Kosha*****:** the "bliss" body, where one is at-one, with all that is, without conflict.

I. ANAMAYA KOSHA: THE MUSCULOSKELETAL BODY

Anamaya Kosha: This is the musculo-skeletal body (tissues, bones, etc.). It is the sheath of the gross physical body, composed of the basic anatomical body structures:
1) cells
2) tissues
3) organs
4) body systems

BODY STRUCTURE
The human body is a single structure, made up of billions of smaller structures, each highly specialized and complex yet working together to form a whole. There are four main kinds of structures in the body:

1) Cells
Cells have long been recognized as the simplest units of living matter that can maintain life and reproduce themselves. The human body, which is made up of numerous cells, begins as a single, newly fertilized cell**.** All tissues and organs in the body develop from three basic layers of cells that form the early embryo:

- the endoderm produces the internal organs.
- the mesoderm produces the connective tissue, bones and skeletal muscles.
- the ectoderm produces the skin and nervous system.

2) Tissues
Tissues are somewhat more complex units than cells. By definition, a tissue is an organization of a great many similar cells with varying amounts and kinds of nonliving, intercellular substance between them.

3) Organs
Organs are more complex units than tissues. An organ is an organization of several different kinds of tissues so arranged that together they can perform a special function. For example, the stomach is an organization of muscle, connective, epithelial, and nervous tissues. Muscle and connective tissues form its wall, epithelial and connective tissues form its lining, and nervous tissue extends throughout both its wall and its lining.

4) Systems
Systems are the most complex of the component units of the human body. A system is an organization of varying numbers and kinds of organs so arranged that together they can perform complex functions for the body. Ten major systems compose the human body are:

1) Skeletal
2) Muscular
3) Nervous
4) Endocrine
5) Cardiovascular

6) Lymphatic
7) Respiratory
8) Digestive
9) Urinary
10) Reproductive

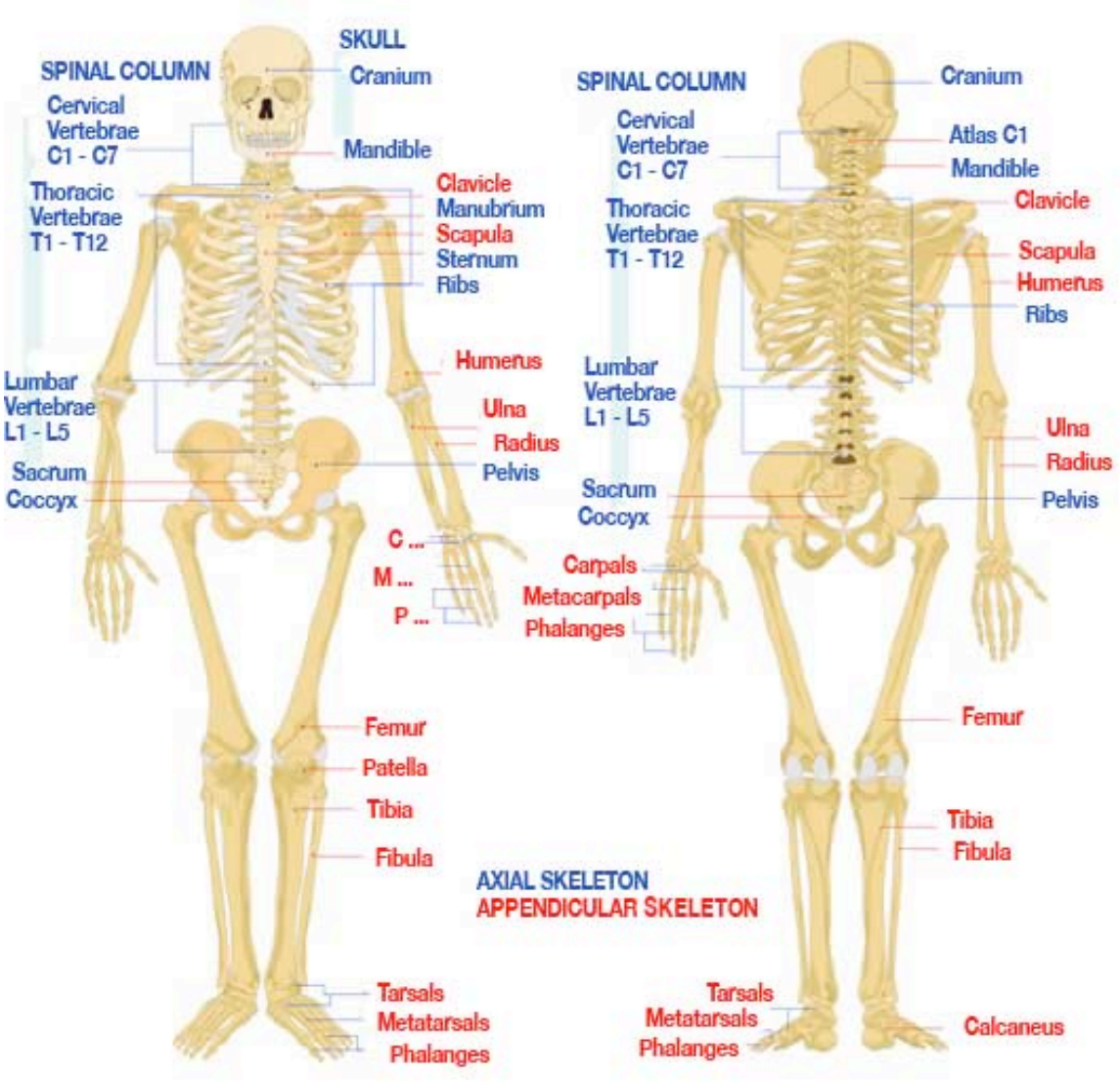
Each of these could comprise years of detailed study, and we are simply providing a brief overview. For the purposes of our yoga training, we will focus on the first eight of these.

Skeletal System

The human skeletal system consists of bones, cartilage, ligaments and tendons and accounts for about 20 percent of the body weight**.**

The skeleton usually consists of 206 bones, grouped in two divisions: appendicular skeleton (126 bones) and axial skeleton (80 bones). The axial skeleton is the central core of the body, where the appendicular skeleton attaches.The axial skeleton and the appendicular skeleton together form the complete skeleton and the sternum. Unlike the axial skeleton, the appendicular skeleton is unfused. This allows for a much greater range of motion. As the skeleton grows older, the bones get weaker with the exception of the

skull. The skull remains strong to protect the brain from injury.

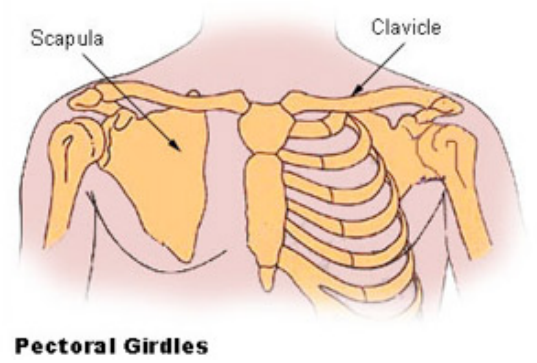


Appendicular Skeleton (126 bones)

The appendicular skeleton is composed of 126 bones. The word appendicular is the adjective of the noun appendage, which itself means a part that is joined to something larger. Functionally it is involved in locomotion (lower limbs) of the axial skeleton and manipulation of objects in the environment (upper limbs). It is divided as follows:

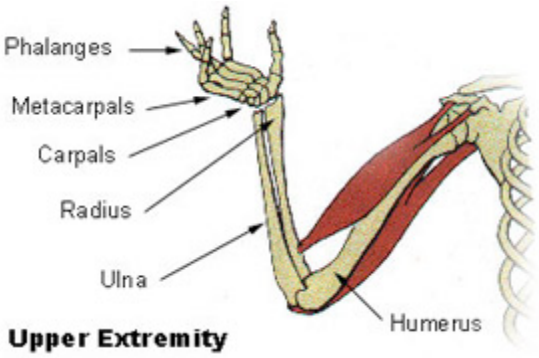
1) Pectoral girdles

- Clavicle (2)
- Scapula (2)



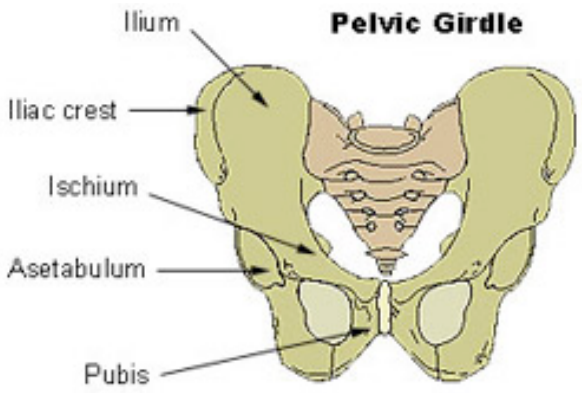
2) Upper Extremity

- Humerus (2)
- Radius (2)
- Ulna (2)
- Carpals (16)
- Metacarpals (10)
- Phalanges (28)



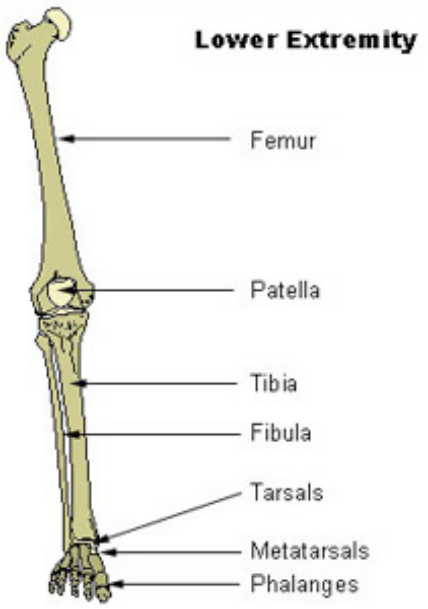
3) Pelvic Girdle

- Coxal, innominate, or hip bones (2)
- Difference between female and male pelvis:
  - female inlet larger and more circular (ischial bones shorter and farther apart, therefore inlet larger)
  - female pelvis is shallower (ilia flare more laterally)
  - bones lighter and thinner
  - sacrum shorter and less curved
  - pubic arch more rounded (angle of pubic arch more than 90 degrees)



4) Lower Extremity

- Femur (2)
- Tibia (2)
- Fibula (2)
- Patella (2)
- Tarsals (14)
- Metatarsals (10)
- Phalanges (28)



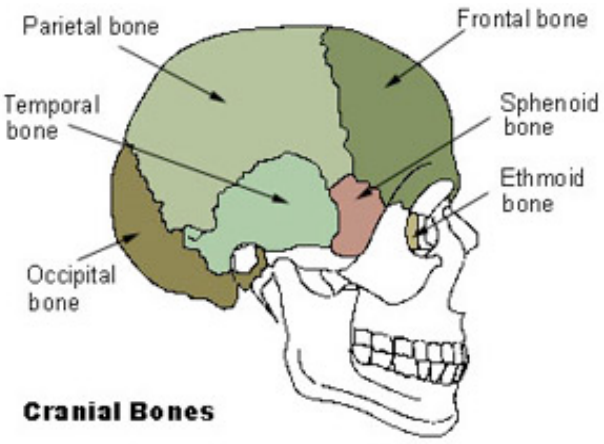
Axial Skeleton (80 bones)

The axial skeleton consists of the 80 bones in the head and trunk of the human body. The word "axial" comes from the word "axis" and refers to the fact that the bones are located close to or along the central axis of the body. The axial skeleton is composed of:

1) Skull (28)

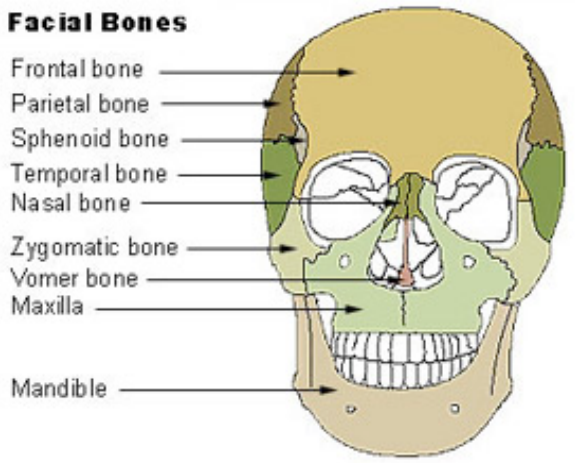
2) Cranial Bones

- Parietal (2)
- Temporal (2)
- Frontal (1)
- Occipital (1)
- Ethmoid (1)
- Sphenoid (1)



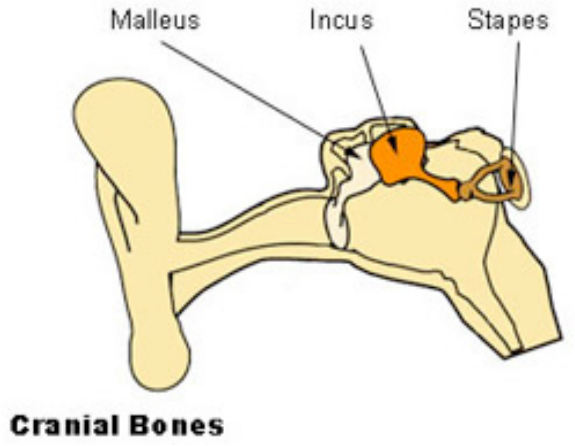
3) Facial Bones

- Maxilla (2)
- Zygomatic (2)
- Mandible (1)
- Nasal (2)
- Platine (2)
- Inferior nasal concha (2)
- Lacrimal (2)
- Vomer (1)



5) Auditory Ossicles (middle-ear bones)

- Malleus (2)
- Incus (2)
- Stapes (2)

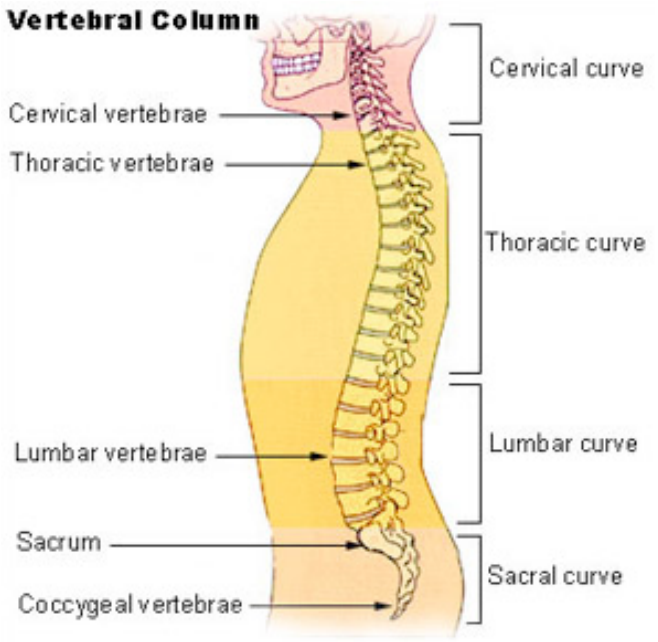


6) Hyoid (1)

- only bone in body not articulated to any other bone.
- held in place by ligaments.
- located in anterior midline of neck, between chin and thyroid cartilage.
- at rest: posterior, it lies at base of mandible; anterior, it lies at third cervical vertebrae.

7) Vertebral Column (26)

- Cervical vertebrae (7)
  (C1 is called the Atlas)
- Thoracic vertebrae (12)
- Lumbar vertebrae (5)
- Sacrum (5 fused bones= 1)
- Coccyx (4 fused bones=1)



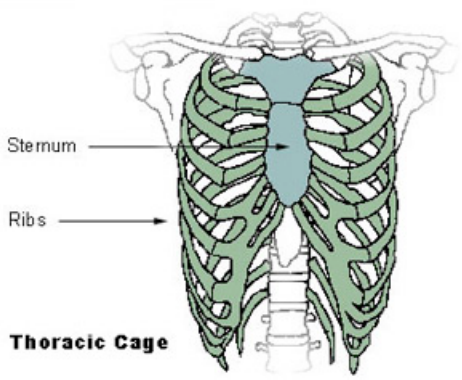
- before birth the vertebral column consists of 33 separate vertebrae.
- after birth, 9 fuse and form the sacrum (5 bones) and the coccyx (4 bones).
- the primary curvatures are present at birth in thoracic and sacral regions.
- the secondary curvatures begins to appear after birth.
- cervical curvature begins when child begins to raise head.
- lumbar curvature begins when child begins to walk.

Intervertebral disks: - absorb shocks
- high water content (90%)
- as person ages, less water between disks, so disks become harder and less able to absorb shocks

Herniated disk: - protruding disk pressing on spinal cord or nerves extending from cord
- also called a "slipped" or "ruptured" disk

8) Thoracic Cage

- Sternum (1)
- Ribs (24)



BONES

Bones are living structures, which use oxygen and give off waste products in metabolism. They contain active tissues that consume nutrients, require a blood supply and change shape or remodel in response to variations in mechanical stress.

All bones have surface markings and characteristics that make a specific bone unique. There are holes, depressions, smooth facets, lines, projections and other markings. These usually represent passageways for vessels and nerves, points of articulation with other bones or points of attachment for tendons and ligaments.

The skeleton supports the body against the pull of gravity. The large bones of the lower limbs support the trunk when standing. The skeleton also protects the soft body parts. The fused bones of the cranium surround the brain to make it less vulnerable to injury. Vertebrae surround and protect the spinal cord and bones of the rib cage help protect the heart and lungs of the thorax.

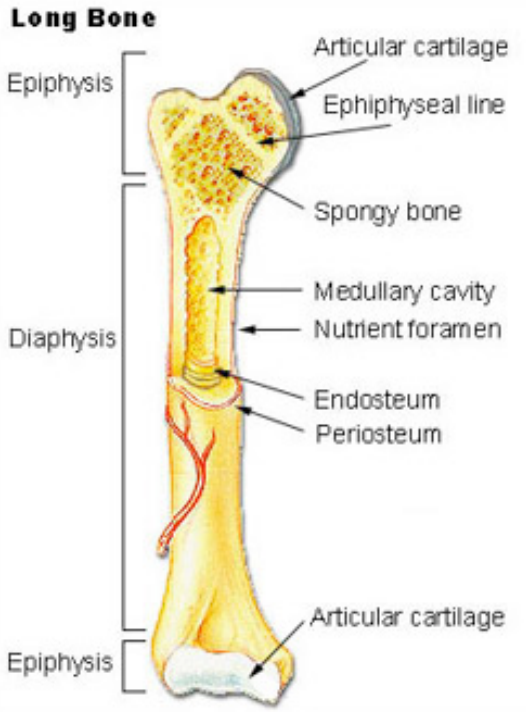
Bones work together with muscles as simple mechanical lever systems to produce body movement. Bones contain more calcium than any other organ. The intercellular matrix of bone contains large amounts of calcium salts, the most important being calcium phosphate.

When blood calcium levels decrease below normal, calcium is released from the bones so that there will be an adequate supply for metabolic needs. When blood calcium levels are increased, the excess calcium is stored in the bone matrix. The dynamic process of releasing and storing calcium goes on almost continuously.

Classification of Bones

Long Bones

Bones that are longer than they are wide are called long bones. They consist of a long shaft with two bulky ends or extremities. They are primarily compact bone, but may have a large amount of spongy bone at the ends or extremities. E.g. bones of the thigh, leg, arm, and forearm.



Short Bones

Short bones are roughly cube shaped with vertical and horizontal dimensions approximately equal. They consist primarily of spongy bone, which is covered by a thin layer of compact bone. E.g. wrist and ankle bones.

Flat Bones

Flat bones are thin, flattened, and usually curved. E.g. most bones of the cranium.

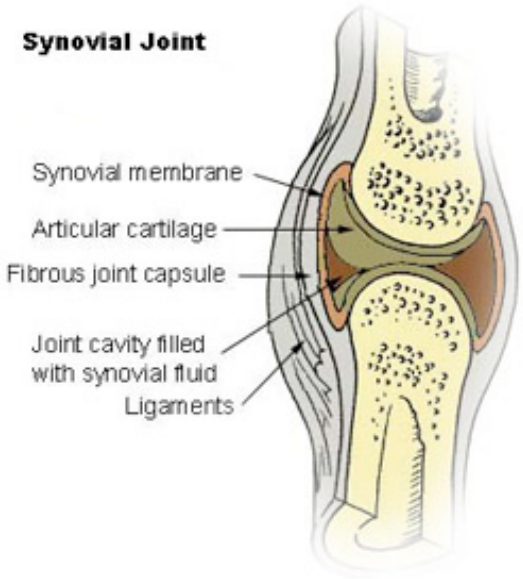
Irregular Bones

Bones that are not in any of the above three categories are classified as irregular bones. They are primarily spongy bone that is covered with a thin layer of compact bone. E.g. vertebrae and some cranial bones.

JOINTS

An articulation, or joint, is where two bones come together. There are three types of joints, classified by the amount of movement they allow:

1) Synarthroses - Immovable joints. In these joints, the bones come in very close contact and are separated only by a thin layer of fibrous connective tissue. E.g. sutures in the skull.



2) Amphiarthroses - Slightly movable joints. In this type of joint, the bones are connected by hyaline cartilage or fibro-cartilage. E.g. the ribs connected to the sternum by costal cartilages; the pubic symphysis, which is a slightly movable joint with a fibrocartilage pad between two bones, the joints between the vertebrae and the intervertebral disks**.**

3) Diarthroses - Freely moveable joints. Most joints in the adult body are diarthroses. In this type of joint, the ends of the opposing bones are covered with hyaline cartilage, the articular cartilage, and they are separated by a space called the joint cavity. The components of the joints are enclosed in a dense fibrous joint capsule. The outer layer of the capsule consists of the ligaments that hold the bones together. The inner layer is the synovial membrane that secretes synovial fluid into the joint cavity for lubrication. Because all of these joints have a synovial membrane, they are sometimes called synovial joints. There are six types of diarthroses joints:

1) Ball-and-Socket: The ball-shaped end of one bone fits into a cup shaped socket on the other bone allowing the widest range of motion including rotation. E.g. shoulder and hip.

2) Condyloid: Oval shaped condyle fits into elliptical cavity of another allowing angular motion, but not rotation. This occurs between the metacarpals (bones in the palm of the hand) and phalanges (fingers) and between the metatarsals (foot bones excluding heel) and phalanges (toes).

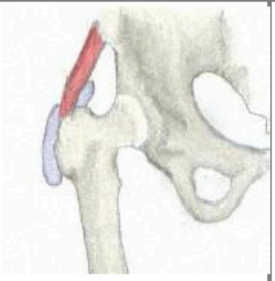
3) Saddle: This type of joint occurs when the touching surfaces of two bones have both concave and convex regions with the shapes of the two bones complementing one other and allowing a wide range of movement. The only saddle joint in the body is in the thumb.

4) Pivot: Rounded or conical surfaces of one bone fit into a ring of one or tendon allowing rotation. E.g. joint between the axis and atlas in the neck.

5) Hinge: A convex projection on one bone fits into a concave depression in another permitting only flexion and extension. E.g. elbow joints**.**

6) Gliding: Flat or slightly flat surfaces move against each other allowing sliding or twisting without any circular movement. E.g. carpals in the wrist and the tarsals in the ankle.

People who are "double-jointed" have extra long ligaments, which allow for a greater range of motion in the joint.

oint Type	Movement at joint	Examples	Structure
Hinge	Flexion/Extension	 Elbow/Knee	 Hinge joint
Pivot	Rotation of one bone around another	 Top of the neck (atlas and axis bones)	 Pivot Joint
Ball and Socket	Flexion/Extension/Adduction/ Abduction/Internal & External Rotation	 Shoulder/Hip	 Ball and socket joint
Saddle	Flexion/Extension/Adduction/ Abduction/Circumduction	 CMC joint of the thumb	 Saddle joint
Condyloid	Flexion/Extension/Adduction/ Abduction/Circumduction	 Wrist/MCP & MTP joints	 Condyloid joint
Gliding	Gliding movements	 Intercarpal joints	 Gliding joint

Joint Disorders
Below are some common joint disorders:

- ***Bursitis:*** - "water on the knee".
  - inflammation of the bursa or synovial membrane.
- ***Sprain: -*** ligaments or tendons reinforcing joints are damaged by over-stretching or are torn from bone.
- ***Arthritis***: - ***Osteo-arthritis*** (degenerative)- caused by breakdown of joint cartilage, causing bone to rub on bone. Usually begins in only one joint.

- ***Rheumatoid arthritis*** (inflammatory) - autoimmune disease (i.e., immune cells attack the body's own healthy tissues). The synovium (lining of the joint) is primarily, but organs also can be affected. Multiple joints are usually involved.

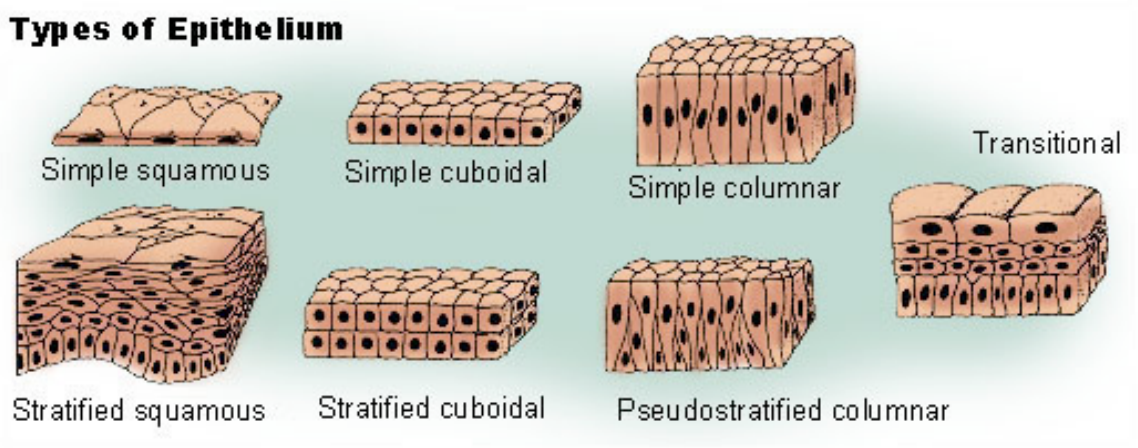
TISSUES

Tissues are simple cells that combine to do a job that's too complex for individual cells to do. Every cell works harmoniously with other cells to maintain overall integrity in the body. When this balance is compromised, deep illness results. The sense of community actually begins at a cellular level (cancer cells are an example of cells which function independently, with one single purpose, and without regard for the body as a whole inter-dependent system).

There are 4 kinds of tissues:

1) Epithelial
2) Muscle
3) Nervous
4) Connective

1) Epithelial
- all external covering (i.e. skin)
- inner lining of all cavities, hollow organs, tubes
- comprised of closely-joined cells which form "sheets"
- different shapes of cells (squamous, cubodial, columnar)
- different densities (simple, stratified)
- used and repaired quickly
- 3 functions:
  - protection (of underlying tissue)
  - secretion (sweat, hormones)
  - absorption (moisture, nutrients)



2) Muscle

- 2 kinds:
  1) voluntary – involved in movement; connected to skeleton.
  2) involuntary - involved in body function within organs.
- comprised of long, cylindrical cells in parallel formation.
- has ability to contract/shorten and lengthen.
- contraction creates movement by:
  - pulling on bone
  - and pushing substances along (e.g. peristalsis in intestines)
- does not reproduce but can repair itself.

3) Nerves

- in brain, spinal cord, nerve endings -> central (brain and spinal column) and peripheral nervous system (nerve branches).
- "star"-shaped cells linked by axon, end-to-end, to create long fibers.
- capacity to transmit energy via electrical impulses (400 km/hr).
- from external/internal sources; to and from brain.
- so highly specialized that they have lost basic functions (i.e. can't reproduce or repair).

4) Connective

- most widely-distributed tissue in body.
- matrix-like construction.
- connects all body parts and is continuous through body - e.g. bones, cartilage, adipose (fat), joints, ligaments (link bones), tendons (link muscle to bone), fascia, dermis.
- can be hard, flexible, elastic, soft.
- consistency of tissue depends on alignment and number of fibres:
  - all aligned -> increased strength (e.g. ligament)
  - different directions -> less "solid" (e.g. blood)
- less fibres -> less dense; "softer" (e.g. adipose matrix).

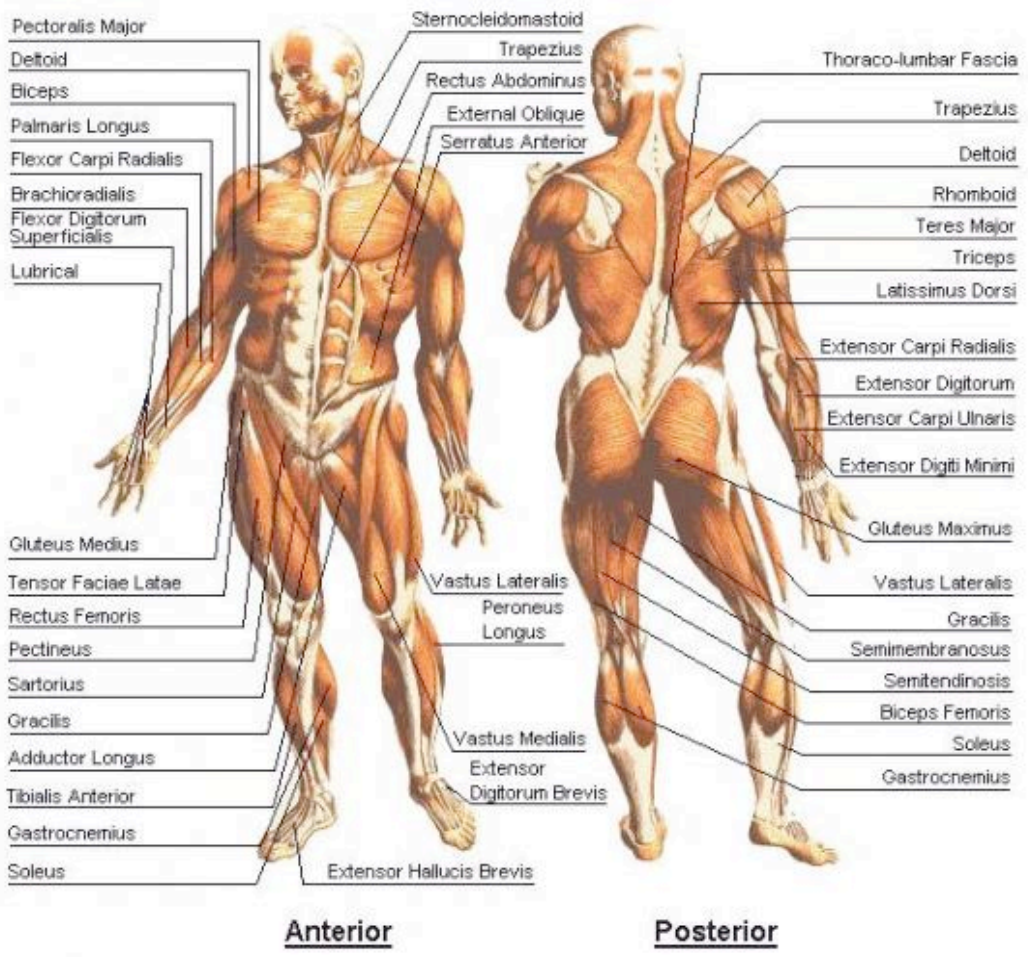
- **3 functions:**
    1) provides consistency – gives shape to different structures
    2) provides support – holds structures in place
    3) provides connection – links
- action on one area affects all.
- fascia – thin connective tissue; clear; envelopes around muscles, organs, different body areas; secures structures in place.
- dermis – skin lies on this large layer of connective tissue.
- **3 elements:**
    1) cells – widely dispersed
    2) liquid/interstitial fluid – between cells; pH similar to salt
    3) fibres – between cells; fibrous proteins; building material
        - 3 kinds of fibres:
            1) collagen – the main component of connective tissue
            - the most abundant protein in mammals, comprising 25-35% of the whole-body protein content. Mostly found in fibrous tissues (e.g. tendons, ligaments, skin; also abundant in cornea, cartilage, bone, blood vessels, gut, and intervertebral discs).
            - constitutes 1- 2% of muscle tissue, and accounts for 6% of the weight of strong, tendinous muscles.
            2) elastin – a protein in connective tissue that is elastic and allows many tissues in the body to resume their shape after stretching or contracting.
            3) reticulum – an extensive, interconnected network of cisternae (sac-like structures) consisting of tubules, vesicles, and cisternae within cells which transport synthesized proteins.
        - synthesizes proteins, lipids and steroids; metabolize carbohydrates; regulate calcium concentration, drug detoxification.

MUSCULAR SYSTEM

The muscular system allows movement. It is controlled through the nervous system, although some muscles (e.g. cardiac muscle) can be completely autonomous. Muscles provide strength, balance, posture, movement and heat.There are three distinct types of muscles: skeletal muscles, cardiac or heart muscles, and smooth (non-striated) muscles. There are approximately 639 skeletal muscles in the human body, which together account for about 40% of a person's weight. The chart below shows some major muscles and their basic features:

Muscle Chart

Muscle	Origin	Insertion	Function	Location
For images of the muscle, click on each link under location.				
Abductors (tensor fasciae latae, gluteus medius, gluteus minimus)	Ilium	Femur	Brings hip away from body.	**Upper leg**
Adductors(includes madductor longus, adductor brevis, adductor magnus muscles	Pubis	Femu	Brings leg back to and across body.	**Upper leg**
Biceps brachi	Scapula	Radius and ulna	Flexes elbow and moves forearm.	**Arm**
Brachialis	Humerus and septa	Coronoid process and ulna	Flexes elbow.	**Arm**
Brachioradialis	Humerus and septum	Radius	Flexes and rotates elbow.	**Arm**
Deltoid	Clavicle, deltoid tuberosity, acromion and scapula	Deltoid tuberosity (humerus)	Raises and rotates arm in all directions.	**Arm**
Erector spinae	Sacrum and ilium	Upper thoracic vertebrae	Extends spine and trunk back.	**Back**
Gastrocnemius (calf muscle)	Femur Lower leg - back	Calcaneum (by achilles tendon)	Raises heal when leg is straight.	**Lower leg-Back**
Gluteus maximus	Ilium	Femur	Moves hips forward.	**Upper leg**
Hamstrings (made of 3 muscles): 1. Biceps femoris 2. Semitendinosus 3.Semimembranosus	1. Ischium 2. Ischium 3. Ischium	1. Fibula and femur 2. Tibia 3. Tibia	1. Bends knee. 2. Bends knee. 3. Bends knee.	**Upper leg-Back**
Iliopsoas	Ilium, sacrum, thoracic and lumbar vertebrae	Femur	Moves hips backwards.	**Upper leg**
Latisimus dorsi	Lower thoracic, lumbar vertebrae and sacrum	Humerus	Brings shoulders and arms back to body.	**Back**
Pectoralis major and minor	Sternum	Humerus	Moves humerus (arm) to chest.	**Front**
Quadriceps (made of 4 muscles): 1. Rectus femoris 2. Vastus lateralis 3. Vastus medialis 4. Vastus intermediu	1. Ilium 2. Femur 3. Femur 4. Femur	1. Tibia (patella tendon) 2. Tibia (patella tendon) 3. Tibia (patella tendon) 4. Tibia (patella tendon)	1. Extends leg out. 2. Extends knee. 3. Extends knee. 4. Extends knee.	**Upper Leg - Front**
Rectus abdominis	Costal cartilages, medial inferiorcostal	Margin and xiphoid	Brings trunk forward, and aids expiration.	**Front**
Rhomboids	Upper thoracic vertebrae	Scapula	Pulls back scapula (shoulder blades).	**Back**
Soleus (calf muscles)	Tibia and fibula	Calcaneum (by Achilles tendon)	Raises heal when leg is bent.	**Lower leg-Back**
Tibialis anterior	Tibia	Metatarsal # 1 (big toe)	Raises front of foot.	**Lower leg-Front**
Trapezius	Starts at base of skull. Ends at last thoracic vertebra.	Scapula and clavicle elevation.	Elevates and lowers pectoral girdle. Also moves scapula towards the spine.	**Back**
Triceps	Brachi, scapula and Humerus	Olecranon process (elbow)	Extends forearm.	**Arm**



The muscular system is composed of specialized cells called muscle fibers. Their predominant function is contractibility. Muscles, attached to bones or internal organs and blood vessels, are responsible for movement. Nearly all movement in the body is the result of muscle contraction. Exceptions to this are the action of cilia, the flagellum on sperm cells, and amoeboid movement of some white blood cells.

The integrated action of joints, bones, and skeletal muscles produces obvious movements such as walking and running. Skeletal muscles also produce more subtle movements that result in various facial expressions, eye movements, and respiration.

In addition to movement, muscle contraction also fulfills some other important functions in the body, such as posture, joint stability, and heat production. Posture, such as sitting and standing, is maintained as a result of muscle contraction. The skeletal muscles are continually making fine adjustments that hold the body in stationary positions. The tendons of many muscles extend over joints and in this way contribute to joint stability.

This is particularly evident in the knee and shoulder joints, where muscle tendons are a major factor in stabilizing the joint. Heat production, to maintain body temperature, is an important by-product of muscle metabolism. Nearly 85% of the heat produced in the body is the result of muscle contraction.

Structure of Skeletal Muscle
A whole skeletal muscle is considered an organ of the muscular system. Each organ or muscle consists of skeletal muscle tissue, connective tissue, nerve tissue, and blood or vascular tissue.

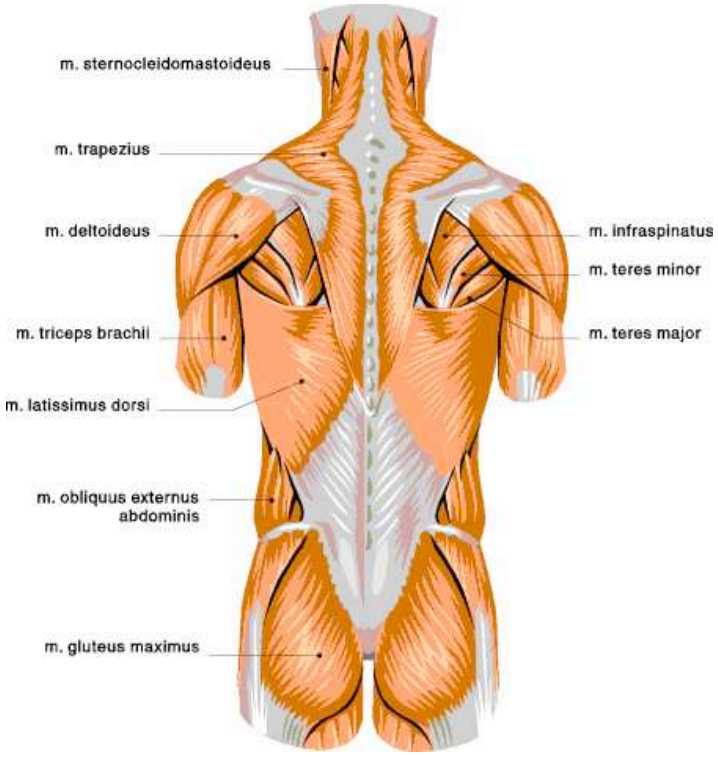
Skeletal muscles vary considerably in size, shape, and arrangement of fibers. They range from extremely tiny strands (e.g. the stapedium muscle of the middle ear) to large masses (e.g. the thigh muscles). Some skeletal muscles are broad in shape and some narrow. In some muscles, the fibers are parallel to the long axis of the muscle; in some, they converge to a narrow attachment; and in others, they are oblique.

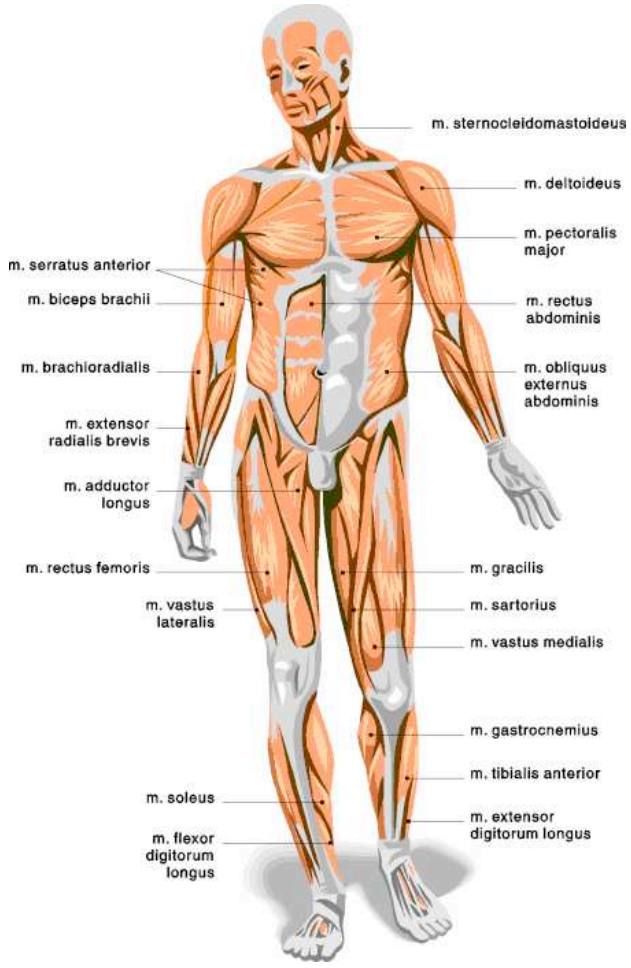
Each skeletal muscle fiber is a single cylindrical muscle cell. An individual skeletal muscle may be made up of hundreds, or even thousands, of muscle fibers bundled together and wrapped in a connective tissue covering. Each individual muscle cell, called a muscle fiber, is surrounded by connective tissue called the endomysium.

Skeletal muscle cells (fibers), like other body cells, are soft and fragile. The connective tissue covering furnishes support and protection for the delicate cells and allows them to withstand the forces of contraction. The coverings also provide pathways for the passage of blood vessels and nerves.

Commonly, the connective tissue surrounding the muscle fibers extends beyond the fleshy part of the muscle, the belly or gaster, to form a thick rope-like tendon or a broad, flat sheet-like aponeurosis. The tendon and aponeurosis form indirect attachments from muscles to the periosteum of bones or to the connective tissue of other muscles. Typically a muscle spans a joint and is attached to bones by tendons at both ends. One of the bones remains relatively fixed or stable while the other end moves as a result of muscle contraction.

Skeletal muscles have an abundant supply of blood vessels and nerves. This is directly related to the primary function of skeletal muscle: contraction. Before a skeletal muscle fiber can contract, it has to receive an impulse from a nerve cell. Generally, an artery and at least one vein accompany each nerve that penetrates into skeletal muscle. Branches of the nerve and blood vessels follow the connective tissue components of the muscle of a nerve cell and with one or more minute blood vessels called capillaries.


m. sternocleidomastoideus
m. trapezius
m. deltoideus
m. infraspinatus
m. teres minor
m. triceps brachii
m. teres major
m. latissimus dorsi
m. obliquus externus abdominis
m. gluteus maximus


m. sternocleidomastoideus
m. deltoideus
m. pectoralis major
m. serratus anterior
m. biceps brachii
m. rectus abdominis
m. brachioradialis
m. obliquus externus abdominis
m. extensor radialis brevis
m. adductor longus
m. rectus femoris
m. gracilis
m. vastus lateralis
m. sartorius
m. vastus medialis
m. gastrocnemius
m. tibialis anterior
m. soleus
m. extensor digitorum longus
m. flexor digitorum longus

Muscle Types

1) Skeletal Muscle
Skeletal muscle, attached to bones, is responsible for skeletal movements. The peripheral portion of the central nervous system (CNS) controls the skeletal muscles. So, these muscles are under conscious, or voluntary, control. The basic unit is the muscle fiber with many nuclei. These muscle fibers are striated (having transverse streaks) and each acts independently of neighboring muscle fibers.

2) Smooth Muscle
Smooth muscle is found in the walls of the hollow internal organs such as blood vessels, the gastrointestinal tract, bladder, and uterus. Smooth muscles are controlled directly by the autonomic nervous system and are involuntary, meaning that they are incapable of being moved by conscious thought. The non-striated (smooth) muscle cell is spindle-shaped and has one central nucleus. Smooth muscle contracts slowly and rhythmically.

3) Cardiac Muscle
Cardiac muscle, found in the walls of the heart, is under control of the autonomic nervous system. The cardiac muscle cell has one central nucleus, like smooth muscle, but it also is striated, like skeletal muscle. The cardiac muscle cell is rectangular in shape. The contraction of cardiac muscle is involuntary, strong, and rhythmical.

Muscle Groups
Most skeletal muscles have names that describe some feature of the muscle. Often several criteria are combined into one name. Associating the muscle's characteristics with its name will help you learn and remember them. The following are some terms relating to muscle features that are used in naming muscles:

• **Size:** vastus (huge); maximus (large); longus (long); minimus (small); brevis (short).

• **Shape:** deltoid (triangular); rhomboid (like a rhombus with equal and parallel sides); latissimus (wide); teres (round); trapezius (like a trapezoid, a four-sided figure with two sides parallel).

• **Direction of fibers:** rectus (straight); transverse (across); oblique (diagonally); orbicularis (circular).

• **Location:** pectoralis (chest); gluteus (buttock or rump); brachii (arm); supra- (above); infra- (below); sub- (under or beneath); lateralis (lateral).

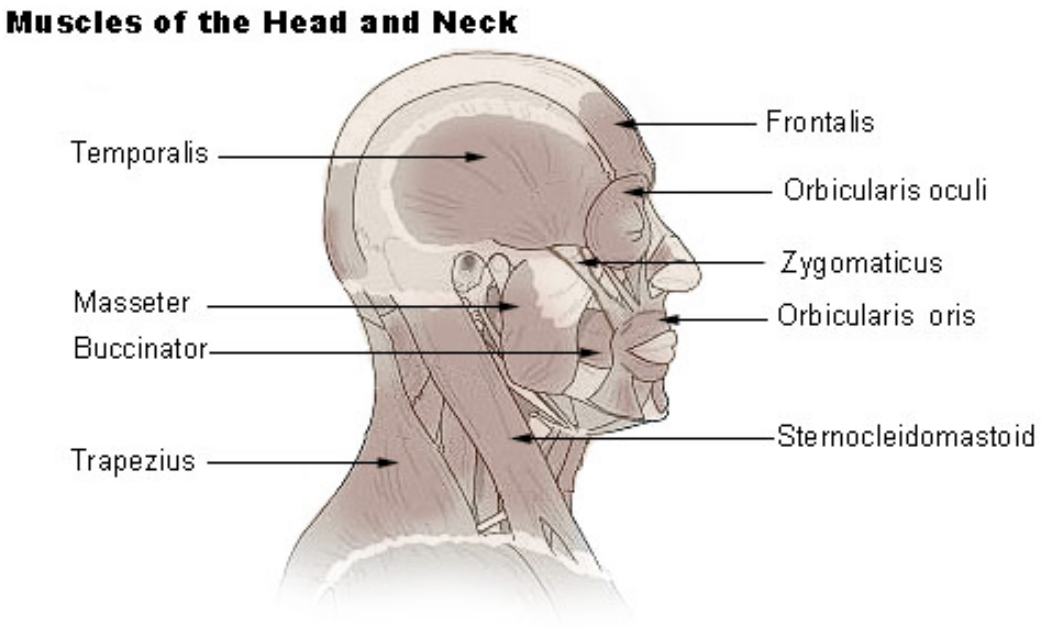
• **Number of origins:** biceps (two heads); triceps (three heads); quadriceps (four heads).

• **Origin and insertion**: sternocleidomastoideus (origin on the sternum and clavicle, insertion on the mastoid process); brachioradialis (origin on the brachium or arm, insertion on the radius).

• **Action**: abductor (to abduct a structure); adductor (to adduct a structure); flexor (to flex a structure); extensor (to extend a structure); levator (to lift or elevate a structure); masseter (a chewer).

Muscles of the Head & Neck
Humans have well-developed muscles in the face that permit a large variety of facial expressions. Because the muscles are used to show surprise, disgust, anger, fear, and other emotions, they are an important means of nonverbal communication. Muscles of facial expression include: the frontalis, orbicularis oris, laris oculi, buccinator, and zygomaticus.

There are four pairs of muscles that are responsible for chewing movements or mastication. All of these muscles connect to the mandible (jaw bone) and they are some of the strongest muscles in the body (when contracting, the uterus in women is stronger than the mandible). There are also numerous muscles associated with the throat, the hyoid bone and the vertebral column.



Muscles of the Trunk
The muscles of the trunk include those that move the vertebral column, the muscles that form the thoracic and abdominal walls, and those that cover the pelvic outlet.

The erector spinae group of muscles on each side of the vertebral column is a large muscle mass that extends from the sacrum to the skull. These muscles are primarily responsible for extending the vertebral column to maintain erect posture. The deep back muscles occupy the space between the spinous and transverse processes of adjacent vertebrae.

The vertebral bones are connected together by spinous, transverse and articular processes and by pads of fibro-cartilage between the bones. The arches of the vertebrae form a hollow cylinder or a bony covering or a passage for the spinal cord.

The muscles of the thoracic wall are involved primarily in the process of breathing. The intercostal muscles are located in spaces between the ribs. They contract during forced expiration. External intercostal muscles contract to elevate the ribs during the inspiration phase of breathing. The diaphragm is a dome-shaped muscle that forms a partition between the thorax and the abdomen. It has three openings in it for structures that have to pass from the thorax to the abdomen.

The abdomen, unlike the thorax and pelvis, has no bony reinforcements or protection. The wall consists entirely of four muscle pairs, arranged in layers, and the fascia that envelops them.

Muscles of Respiration
The various muscles of respiration aid in both inspiration and expiration, which require changes in the pressure within the thoracic cavity. The respiratory muscles do this by changing the dimensions of the thoracic cavity.

The primary respiratory muscles are: the diaphragm and the intercostal muscles. Both the external intercostal muscles and the intercondral elevate the ribs, thus increasing the width of the thoracic cavity, while the diaphragm contracts to increase the vertical dimensions of the thoracic cavity, and also aids in the elevation of the lower ribs.

Accessory muscles are: the sternocleidomastoid and the scalene muscles. However. the following muscles have also been observed to contribute to breathing: serratus anterior, pectoralis major and minor, upper trapezius, latissimus dorsi, erector spinae (thoracic), iliocostalis lumborum, quadratus lumborum, serratus posterior superior and inferior, levatores costarum, transversus thoracis, subclavius. Scalene muscle activation coincides with the diaphragm even at rest, suggesting it could be considered a primary muscle of respiration.

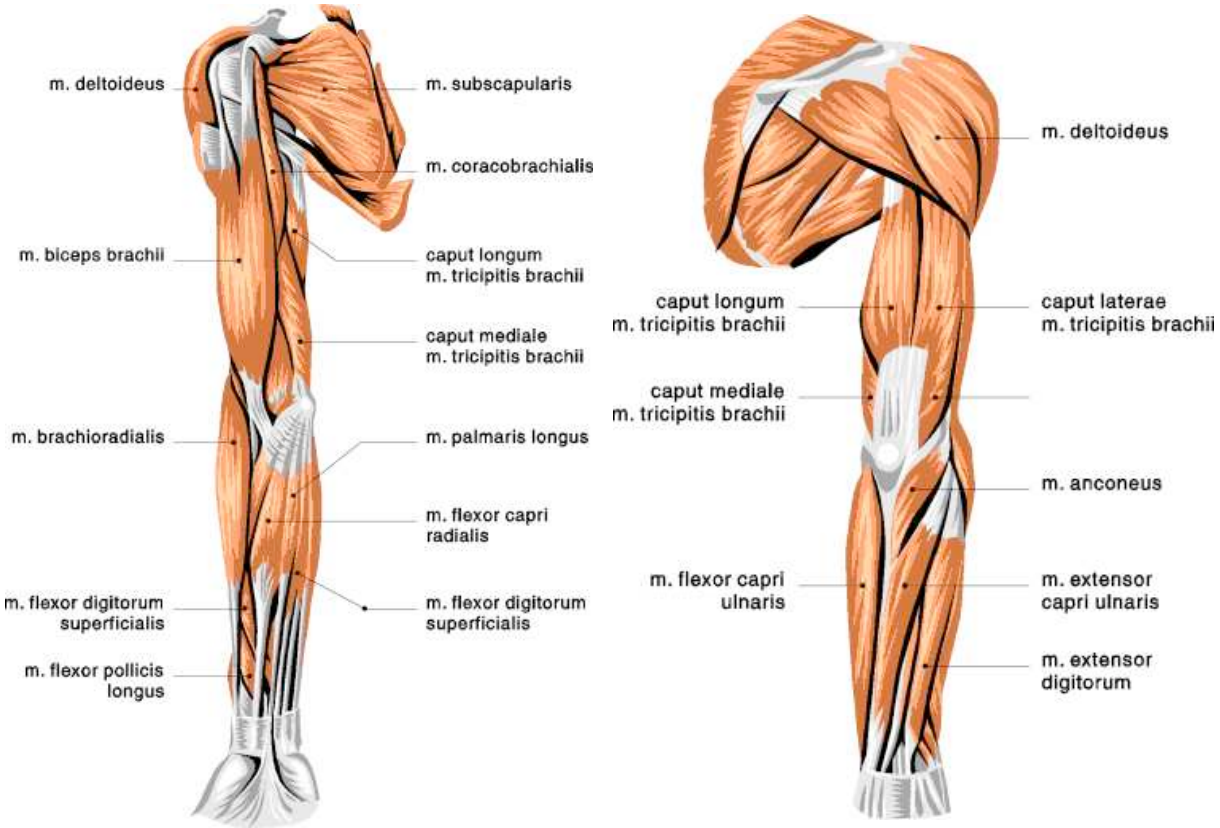
If a breathing pattern disorder exists, the accessory muscles of inspiration may become overused. typically only used when the body needs to process energy quickly (e.g. during heavy exercise, during stress, or during an asthma attack). The accessory muscles of inspiration can also become engaged in everyday breathing when a breathing pattern disorder exists.

Muscles of the Upper Extremity

The muscles of the upper extremity include those that attach the scapula to the thorax and generally move the scapula, those that attach the humerus to the scapula and generally move the arm, and those that are located in the arm or forearm that move the forearm, wrist, and hand.

Muscles that move the shoulder and arm include the trapezius and serratus anterior. The pectoralis major, latissimus dorsi, deltoid, and rotator cuff muscles (supraspinatus, infraspinatus, teres minor, subscapularis) connect to the humerus and move the arm.

The muscles that move the forearm are located along the humerus, which include the triceps brachii, biceps brachii, brachialis, and brachioradialis. The 20 or more muscles that cause most wrist, hand, and finger movements are located along the forearm.

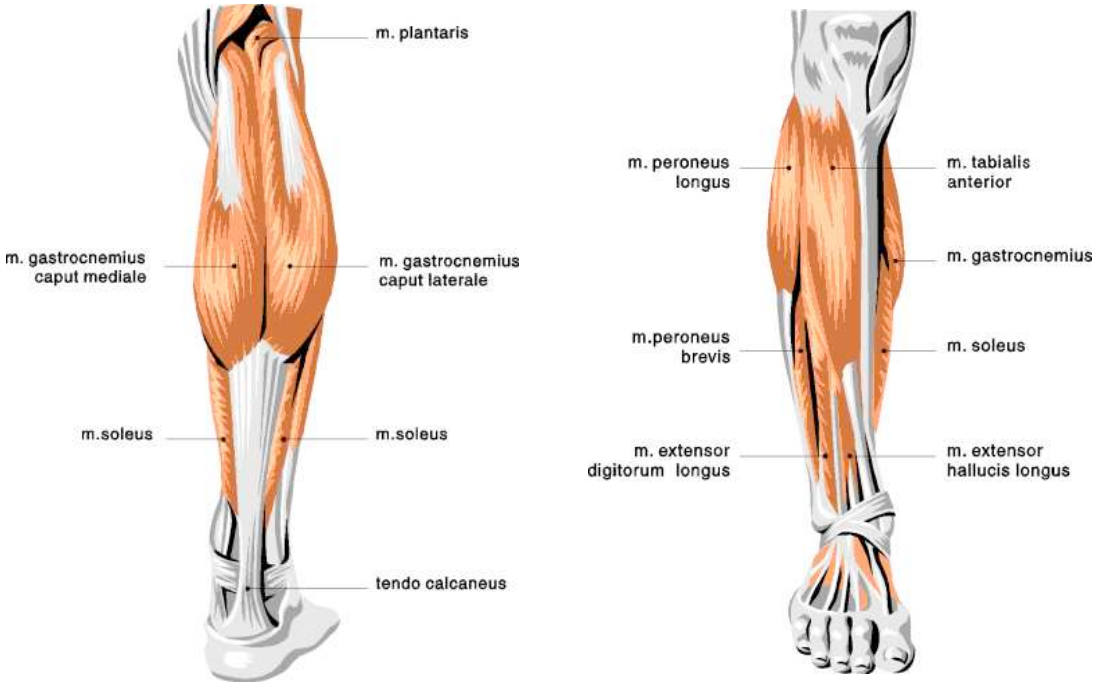


Muscles of the Lower Extremity

The muscles that move the thigh have their origins on some part of the pelvic girdle and their insertions on the femur. The largest muscle mass belongs to the posterior group, the gluteal muscles, which, as a group, adduct the thigh. The iliopsoas (illium and psoas), an anterior muscle, flexes the thigh. The muscles in the medial compartment adduct the thigh.

Muscles that move the leg are located in the thigh region. The quadriceps femoris muscle group (vastus medialis, vastus intermedius, vastus lateralis, rectus femoris) straightens the leg at the knee. The hamstrings (biceps femoris, semitendinosus, semimembranosus) are antagonists to the quadriceps, which are used to flex the leg at the knee.

The muscles located in the leg that move the ankle and foot are divided into anterior, posterior, and lateral compartments. The tibialis anterior, which dorsiflexes the foot, is antagonistic to the gastrocnemius and soleus muscles, which plantar flex the foot.

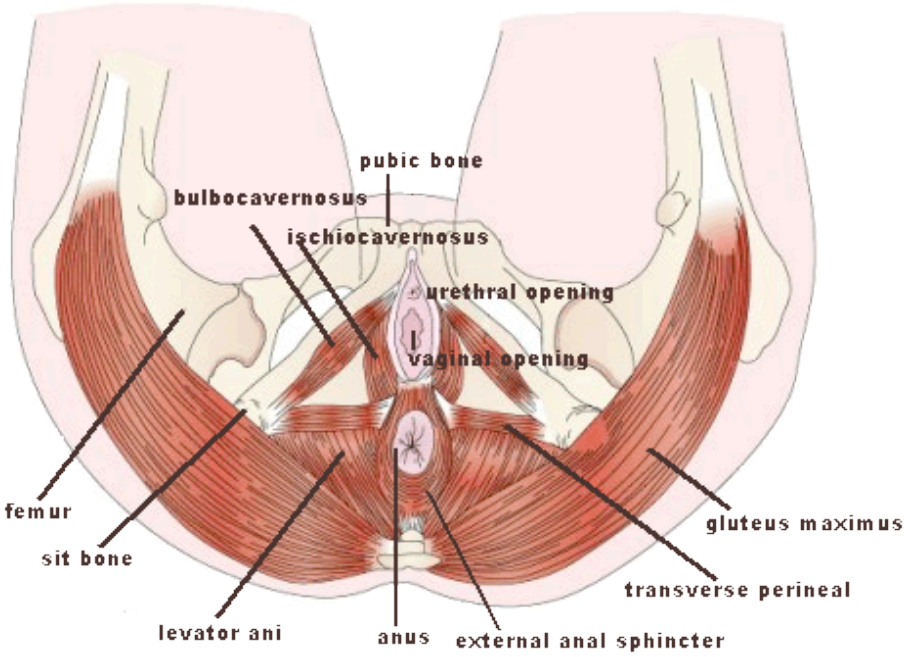


Muscles of the Pelvic Floor

The pelvic floor muscles are a group of several small muscles that form a large sling (or hammock) of muscles stretching from side to side across the floor of the pelvis. They attach to the pubic bone in front, and to the coccyx behind. The openings from bladder (urethra), bowels (rectum), and, in women, womb (vagina) all pass through the pelvic floor.

The pelvic floor or pelvic diaphragm is composed of muscle fibers of the levator ani, the coccygeus, and associated connective tissue which span the area underneath the pelvis. The pelvic diaphragm is a muscular partition formed by the levatores ani and coccygei, with which may be included the parietal pelvic fascia on their upper and lower aspects. The pelvic floor separates the pelvic cavity above from the perineal region (including perineum) below.

Inferior View of Selected Pelvic Floor Muscles (Female Perineum)



The right and left levator ani lie almost horizontally in the floor of the pelvis, separated by a narrow gap that transmits the urethra, vagina, and anal canal. The levator ani is usually considered in three parts: pubococcygeus, puborectalis, and iliococcygeus. The pubococcygeus, the main part of the levator, runs backward from the body of the pubis toward the coccyx and may be damaged during parturition. Some fibers are inserted into the prostate, urethra, and vagina. The right and left puborectalis unite behind the anorectal junction to form a muscular sling . Some regard them as a part of the sphincter ani externus. The iliococcygeus, the most posterior part of the levator ani, is often poorly developed. The coccygeus, situated behind the levator ani and frequently tendinous as much as muscular, extends from the ischial spine to the lateral margin of the sacrum and coccyx. Posteriorly, the pelvic floor extends into the anal triangle.

The pelvic floor is important in providing support for pelvic viscera (organs), e.g. the bladder, intestines, the uterus (in women), and in maintenance of continence as part of the

urinary and anal sphincters. It facilitates birth by resisting the descent of the presenting part, causing the fetus to rotate forwards to navigate through the pelvic girdle.

In women, the levator muscles or their supplying nerves can be damaged in pregnancy or childbirth. This occurs more commonly after a vaginal delivery, but can also occur following a C-section. These muscles may also be damaged during a hysterectomy.

Damage to the pelvic floor not only contributes to urinary incontinence but can lead to pelvic organ prolapse. Pelvic organ prolapse occurs in women when pelvic organs (e.g. the vagina, bladder, rectum, or uterus) protrude into or outside of the vagina. The causes of pelvic organ prolapse are similar to those that contribute to urinary incontinence. These include inappropriate (asymmetrical, excessive, insufficient) muscle tone and asymmetries caused by trauma to the pelvis. Age, childbirth, family history, and hormonal status can all be causes.

Some sources do not consider "pelvic floor" and "pelvic diaphragm" to be identical, with the "diaphragm" consisting of only the levator ani and coccygeus, while the "floor" also includes the perineal membrane and deep perineal pouch. However, other sources include the fascia as part of the diaphragm. In practice, the two terms are often used interchangeably.

In yoga, the pelvic floor responds to (but does not create) the action of mula bandha.

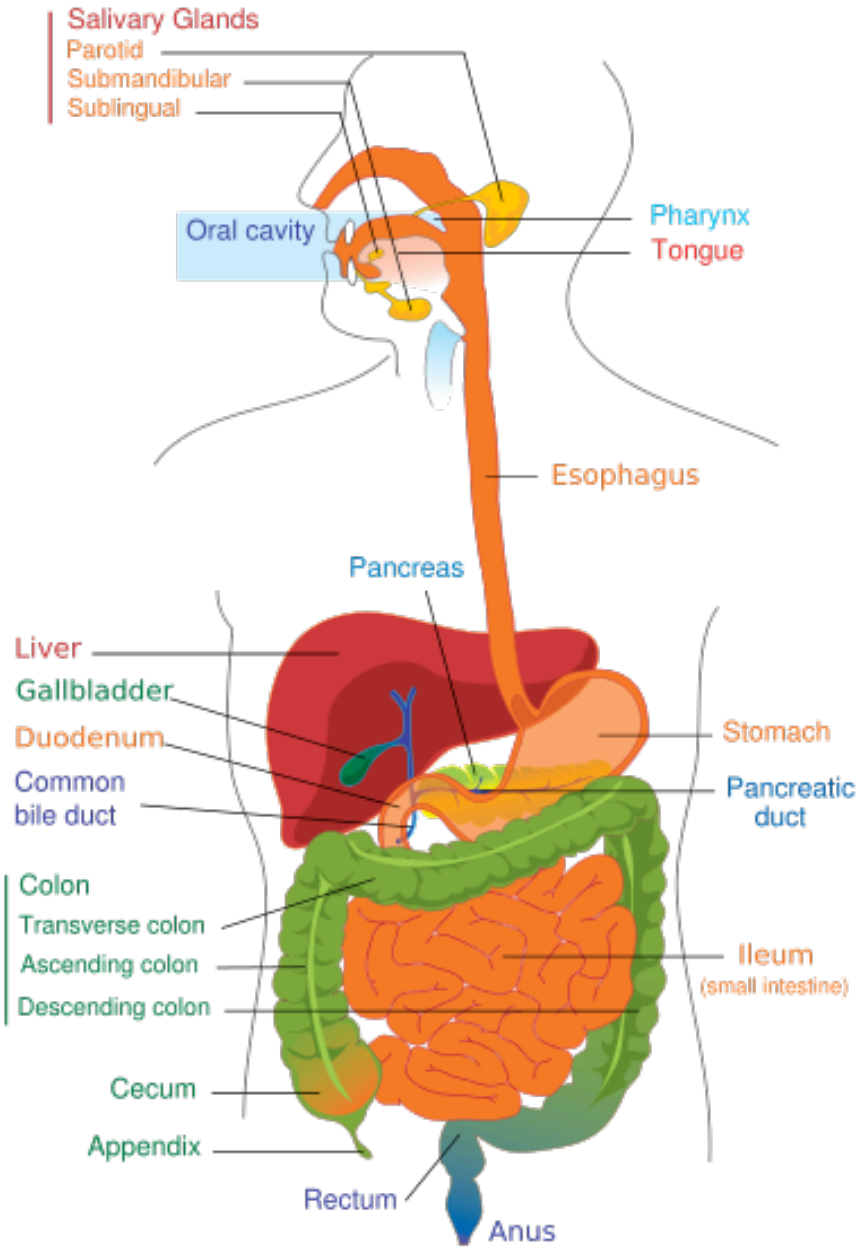
II. PRANAMAYA KOSHA: THE PHYSIOLOGY BODY

Pranamaya Kosha: This is the physiological body, consisting of the various body systems (respiratory, nervous, circulatory, endocrine, etc.). It is composed of prana, the vital principle, the force that vitalizes and supports body and mind. It pervades the whole organism. As long as this vital principle exists in the organism, life continues. Coupled with the five sense organs, Pranamaya Kosha forms the vital sheath, and it is here that the vayus (the “winds”), which carry prana into and through the body, function by way of the different body systems. So, each of the body’s systems can be seen as both carrying prana into and out of the body, and each system can be seen as being supported by the movement of prana itself: from inner to outer, core to periphery and periphery to core.

DIGESTIVE SYSTEM

Digestion is the mechanical and chemical breaking down of food into smaller components that can be absorbed into the blood stream. Digestion is a form of catabolism: a break-down of larger food molecules to smaller ones.

The chemical process of digestions begins with the saliva from the salivary glands as the food is being chewed. The food then travels down the esophagus into the stomach, where hydrochloric acid kills most contaminating microorganisms and begins mechanical break down of some food and chemical alteration of some. The upper and lower gastrointestinal (GI) tract is approx. 9 meters long. In a healthy adult digestion can take between 24-72 hours.



Tongue
The tongue is skeletal muscle on the floor of the mouth that manipulates food for chewing (mastication) and swallowing (deglutition). It is sensitive and kept moist by saliva. The underside of the tongue is covered with a smooth mucous membrane, and underlain by a plexus of veins.

Teeth
Teeth are not made of bone, but rather of tissues of varying density and hardness.

Digestion Process
1) Ingestion: placing food into the mouth (entry of food in the digestive system).

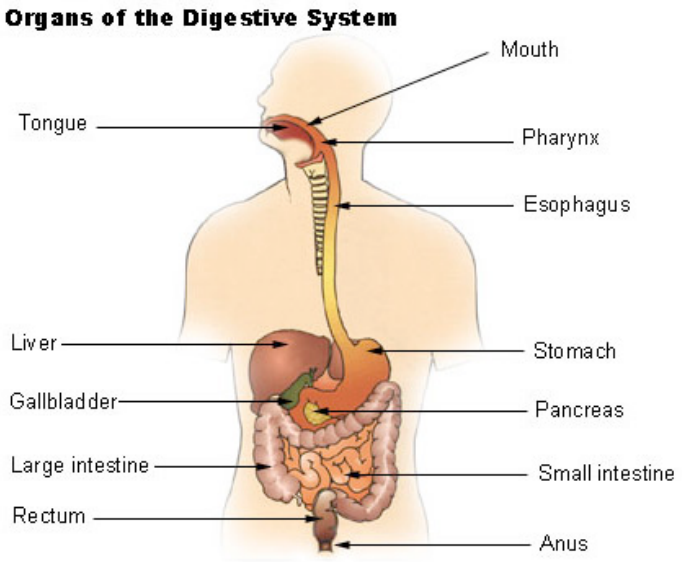
2) Mechanical and chemical breakdown: mastication and the mixing of the resulting bolus with water, acids, bile and enzymes in the stomach and intestine to break down complex molecules into simple structures.

3) Absorption: of nutrients from the digestive system to the circulatory and lymphatic capillaries through osmosis, active transport, and diffusion.

4) Excretion: Removal of undigested materials from the digestive tract through defecation.

The major part of digestion takes place in the small intestine. The large intestine primarily serves as a site for fermentation of indigestible matter by gut bacteria and for resorption of water from digestion before excretion.

Digestion Process: Organs



Mouth
Digestion begins as food is chewed and saliva is produced. Saliva is secreted in large amounts (1-1.5 liters/day) by three pairs of salivary glands (parotid, submandibular, and sublingual), and is mixed with the chewed food by the tongue. There are two types of saliva: (1) a thin, watery secretion, and its purpose is to wet the food; (2) a thick, mucous secretion, which acts as a lubricant and causes food particles to stick together and form a bolus. The saliva serves to clean the mouth, moisten the food, and contains digestive enzymes, which aid in the chemical breakdown of the food.

Swallowing transports the chewed food into the esophagus, passing through the pharynx. Swallowing is coordinated by the brain. The reflex is initiated by touch receptors in the pharynx as the food is pushed to the back of the mouth.

Pharynx
The pharynx is the part of the neck and throat situated immediately posterior to (behind) the mouth and nasal cavity, and cranial, or superior, to the esophagus. It is part of the digestive system and respiratory system. Because both food and air pass through the pharynx, a flap of connective tissue, the epiglottis closes over the trachea when food is swallowed to prevent choking or asphyxiation.

The oropharynx is the part of the pharynx behind the oral cavity and is lined by stratified squamous epithelium. The nasopharynx lies behind the nasal cavity, and like the nasal passages, is lined with ciliated epithelium.

Like the oropharynx above it the hypopharynx (laryngopharynx) serves as a passageway for food and air and is lined with a stratified squamous epithelium. It lies inferior to the upright epiglottis and extends to the larynx, where the respiratory and digestive pathways diverge. At that point, the laryngopharynx is continuous with the esophagus. During swallowing, food has the "right of way", and air passage temporarily stops.

Esophagus
The esophagus is a narrow muscular tube approx. 20-30 cm long. It starts at pharynx at the back of the mouth, passes through the thoracic diaphragm, and ends at the cardiac orifice of the stomach. The wall of the esophagus is made up of two layers of smooth muscles, which form a continuous layer from the esophagus to the open and contract slowly, over long periods of time. The inner layer of muscles is arranged circularly in a series of descending rings, while the outer layer is arranged longitudinally. At the top of the esophagus, is a flap of tissue called the epiglottis that closes during swallowing to prevent food from entering the trachea (windpipe). The chewed food is pushed down the esophagus to the stomach through peristaltic contraction of these muscles. It takes only about seven seconds for food to pass through the esophagus and no digestion takes place.

Stomach
The stomach is a small, "J"-shaped pouch with walls made of thick, elastic muscles, which stores and helps break down food. Food which has been reduced to very small particles is more likely to be fully digested in the small intestine, and stomach churning has the effect of assisting the physical disassembly begun in the mouth.

Food enters the stomach through the cardiac orifice where it is further broken apart and thoroughly mixed with gastric acid, pepsin and other digestive enzymes to break down proteins. The enzymes in the stomach also have an optimum, meaning that they work at a specific pH and temperature better than any others. The acid itself does not break down food molecules, rather it provides an optimum pH for the reaction of the enzyme pepsin and kills many microorganisms that are ingested with the food. Other small molecules such as alcohol are absorbed in the stomach, passing through the membrane of the stomach and entering the circulatory system directly. Food in the stomach is in semi-liquid form, which upon completion is known as chyme.

Small intestine
After being processed in the stomach, food is passed to the small intestine via the pyloric sphincter. The majority of digestion and absorption occurs here after the milky chyme enters the duodenum. Here it is further mixed with three different liquids:

1) Bile- emulsifies fats to allow absorption, neutralizes the chyme and is used to excrete waste products such as bilin and bile acids. Bile is produced by the liver and then stored in the gallbladder. The bile in the gallbladder is much more concentrated.

2) Pancreatic juice - made by the pancreas.

3) Intestinal enzymes of the alkaline mucosal membranes – these include maltase, lactase and sucrase (all three of which process only sugars), trypsin and chymotrypsin.

As the pH level changes in the small intestines and gradually becomes basic, more enzymes are activated further that chemically break down various nutrients into smaller molecules to allow absorption into the circulatory or lymphatic systems. Small, finger-like structures called villi, each of which is covered with even smaller hair-like structures called microvilli improve the absorption of nutrients by increasing the surface area of the intestine and enhancing speed at which nutrients are absorbed. Blood containing the absorbed nutrients is carried away from the small intestine via the hepatic portal vein and goes to the liver for filtering, removal of toxins, and nutrient processing.

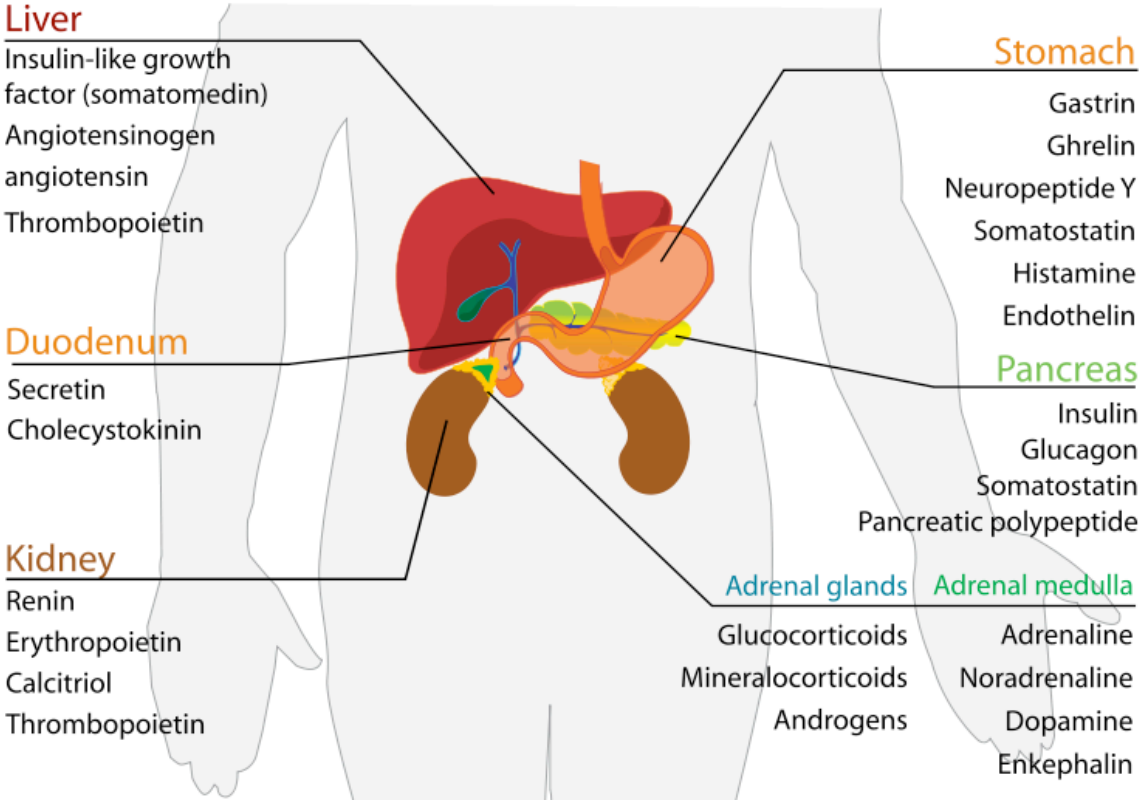
The small intestine and remainder of the digestive tract undergoes peristalsis to transport food from the stomach to the rectum and allow food to be mixed with the digestive juices and absorbed. The circular muscles and longitudinal muscles are antagonistic muscles,

with one contracting as the other relaxes. When the circular muscles contract, the lumen becomes narrower and longer and the food is squeezed and pushed forward. When the longitudinal muscles contract, the circular muscles relax and the gut dilates to become wider and shorter to allow food to enter.

Large intestine

After the food has been passed through the small intestine, the food enters the large intestine. Within it, digestion is retained long enough to allow fermentation due to the action of gut bacteria, which breaks down some of the substances which remain after processing in the small intestine; some of the breakdown products are absorbed.

The large intestine is approx. 1.5 meters long, with three parts: the cecum at the junction with the small intestine, the colon, and the rectum. The colon itself has four parts: the ascending colon, the transverse colon, the descending colon, and the sigmoid colon. The large intestine absorbs water from the bolus and stores feces until it can be egested. Food products that cannot go through the villi, such as cellulose (dietary fiber), are mixed with other waste products from the body and become hard and concentrated feces. The feces is stored in the rectum for a certain period and then the stored feces is eliminated from the body due to the contraction and relaxation through the anus. The exit of this waste material is regulated by the anal sphincter.



CIRCULATORY SYSTEM

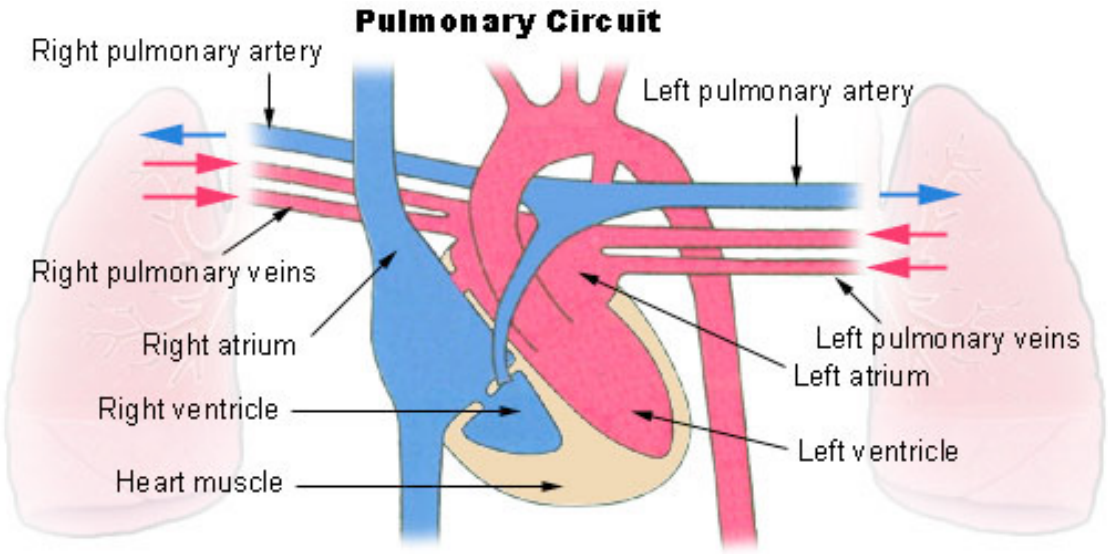
The circulatory system is an organ system that passes nutrients (e.g., amino acids and electrolytes), gases, hormones, blood cells, etc. to and from cells in the body to help fight diseases and help stabilize body temperature and pH to maintain homeostasis.

This system may be seen strictly as a blood distribution network, but some consider the circulatory system as composed of the cardiovascular system, which distributes blood, and the lymphatic system, which distributes lymph.

Two types of fluids move through the circulatory system: blood and lymph. The blood, heart, and blood vessels form the cardiovascular system. The lymph, lymph nodes, and lymph vessels form the lymphatic system. The cardiovascular system and the lymphatic system collectively make up the circulatory system. The digestive system also works with the circulatory system to provide the nutrients the system needs to keep the heart pumping.

Cardiovascular system
The main components of the human cardiovascular system are the heart and the blood vessels. It includes: (1) the pulmonary circulation, a "loop" through the lungs where blood is oxygenated; and (2) the systemic circulation, a "loop" through the rest of the body to provide oxygenated blood.

An average adult contains approx. 5 liters of blood, which consists of plasma, red blood cells, white blood cells, and platelets.

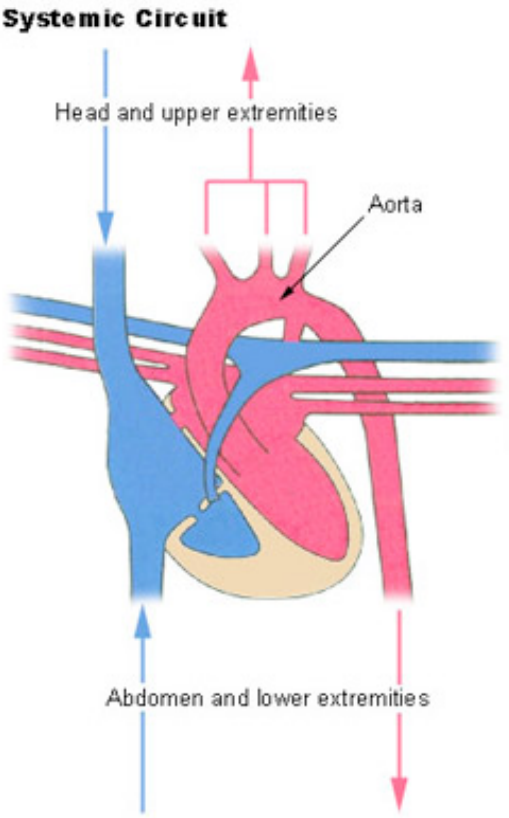


Pulmonary circulation
The pulmonary circulation is the portion of the cardiovascular system that transports oxygen-depleted blood away from the heart, to the lungs, and returns oxygenated blood back to the heart.

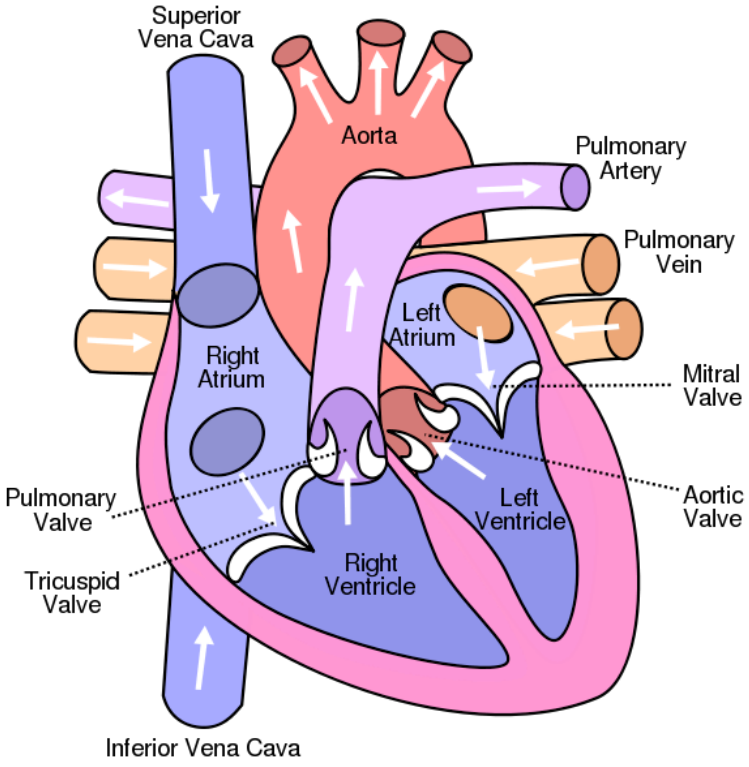
De-oxygenated blood from the vena cava enters the right atrium of the heart and flows through the tricuspid valve into the right ventricle, from which it is pumped through the pulmonary semilunar valve into the pulmonary arteries which go to the lungs. Pulmonary veins return the now oxygen-rich blood to the heart, where it enters the left atrium before flowing through the mitral valve into the left ventricle. Then, oxygen-rich blood from the left ventricle is pumped out via the aorta, and on to the rest of the body.

Systemic circulation

Systemic circulation is the portion of the cardiovascular system which transports oxygenated blood away from the heart, to the rest of the body, and returns oxygen-depleted blood back to the heart. Systemic circulation is, distance-wise, much longer than pulmonary circulation, transporting blood to every part of the body.



Coronary circulation



The coronary circulatory system provides a blood supply to the heart. As it provides oxygenated blood to the heart, it is by definition, a part of the systemic circulatory system.

The heart pumps oxygenated blood to the body and deoxygenated blood to the lungs. In the heart there is one atrium and one ventricle for each circulation, and with both a systemic and a pulmonary circulation there are four chambers in total: left atrium, left ventricle, right atrium and right ventricle. The right atrium is the upper chamber of the right side of the heart. The blood that is returned to the right atrium is deoxygenated and passed into the right ventricle to be pumped through the pulmonary artery to the lungs for re-oxygenation and removal of carbon dioxide. The left atrium receives newly oxygenated blood from the lungs as well as the pulmonary vein which is passed into the strong left ventricle to be pumped through the aorta to the different organs of the body.

LYMPHATIC SYSTEM

The lymphatic system is part of the immune system, made up of a network of conduits that carry a clear fluid called lymph (from Latin lympha "water"). It also includes the lymphoid tissue and lymphatic vessels through which the lymph travels in a one-way direction, flowing only toward the heart. The lymph is moved along the lymphatic vessel network by either intrinsic contractions of the lymphatic vessels or by extrinsic compression of the lymphatic vessels via external tissue forces (e.g. the contractions of skeletal muscles).

Lymphoid tissue is found in many organs, particularly the lymph nodes, and in the lymphoid follicles associated with the digestive system such as the tonsils. The system

also includes all the structures dedicated to the circulation and production of lymphocytes, which includes the spleen, thymus, bone marrow and the lymphoid tissue associated with the digestive system.

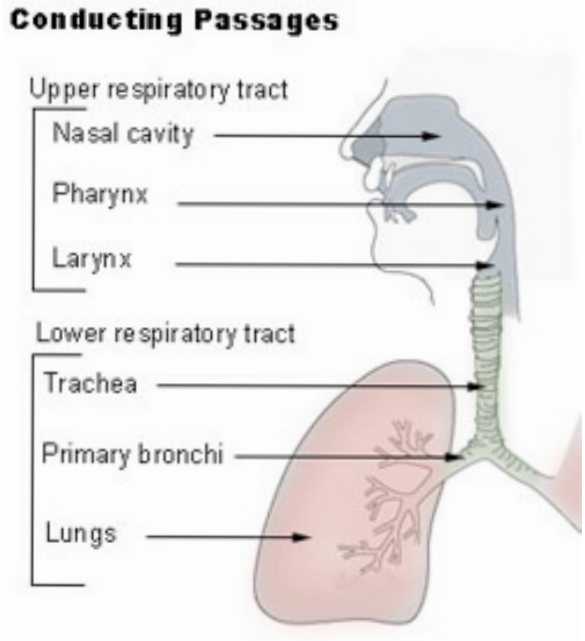
A lymph node is an organized collection of lymphoid tissue, through which the lymph passes on its way to returning to the blood. Lymph nodes are located at intervals along the lymphatic system. Lymph nodes are particularly numerous in the chest/sternum, neck, pelvis, axilla (armpit), inguinal (groin) region, and in association with the blood vessels of the intestines.

RESPIRATORY SYSTEM

The respiratory system includes airways, lungs, and the respiratory muscles. Molecules of oxygen and carbon dioxide are passively exchanged, by diffusion, between the gaseous external environment and the blood. This exchange process occurs in the alveolar region of the lungs. In general, inhalation causes nerve cells to be excited (activated) and exhalation quiets brain and nerve activity, creating a calming response in the body-mind.

Bridging Pranamaya & Manomaya Koshas

In most yoga texts, breathing is considered the bridge between mind and body. Breathing connects us to the world and the body to the mind. In our bodies, where the breath goes the mind goes and where the mind goes, the breath follows. The second line of *Patanjalis's Yoga Sutras*, reminds us of this: *Yoga citta-vriti nirodah*, Yoga is the practice of stilling the fluctuation of the mind – and movement of the mind can, in fact easily be considered movement of the breath. It is at this level that the Pranamaya Kosha (physiological body) bridges into the Manomaya Kosha (the psychological body). The practice of Pranayama, refined this to create very precise ways of working with breath, body and mind as inseparable elements of practice. In the *Yoga Sutras of Patanjali,* the breath practices associated with Pranayama were done as preparation for meditation. In later Hatha Yoga texts, pranayama was used as a "transformative" process, to awaken the body's dormant spiritual energy.



Inhalation
Inhalation is initiated by the diaphragm and supported by the external intercostal muscles. Normal resting respirations are 10-18 breaths per minute, with a time period of 2 seconds. During vigorous inhalation (at rates exceeding 35 breaths per minute), or in approaching respiratory failure, accessory muscles of respiration are recruited for support. These secondary muscles consist of: the sternocleidomastoid, platysma, and the scalenes, the pectoral muscles and latissimus dorsi.

Under normal conditions, the diaphragm is the primary driver of inhalation. On inhalation, the diaphragm contracts, the ribcage expands and the contents of the abdomen are moved downward. This results in a larger thoracic volume and negative pressure (with respect to atmospheric pressure) inside the thorax. As the pressure in the chest falls, air moves into the conducting zone. Here, the air is filtered, warmed, and humidified as it flows to the lungs. During forced inhalation, as when taking a deep breath, the external intercostal muscles and accessory muscles aid in further expanding the thoracic cavity.

Exhalation
Exhalation is generally a passive process; however, active or forced exhalation is achieved by the abdominal and the internal intercostal muscles. During this process, air is forced or exhaled out. The lungs have a natural elasticity; as they recoil from the stretch of inhalation, air flows back out until the pressures in the chest and the atmosphere equalizes. During forced exhalation, as when blowing out a candle, expiratory muscles, including the abdominal muscles and internal intercostal muscles, generate abdominal and thoracic pressure, which forces air out of the lungs.

Gas exchange
The major function of the respiratory system is gas exchange between the external environment and the circulatory system. This exchange facilitates oxygenation of the blood with a concomitant removal of carbon dioxide and other gaseous metabolic wastes from the circulation. As gas exchange occurs, the acid-base (pH) balance of the body is maintained as part of homeostasis.

Non-respiratory functions

Lung Defense Mechanisms
Airway epithelial cells can secrete a variety of molecules that aid in lung defense. These secretions can act directly as antimicrobials to help keep the airway free of infection. Airway epithelial cells also secrete substances that can signal the immune cells to go to other sites of infection.

Metabolic & Endocrine Functions of the Lungs
In addition to their functions in gas exchange, the lungs have a number of metabolic functions. They release a variety of substances that enter the systemic arterial blood and

they remove other substances from the systemic venous blood that reach them via the pulmonary artery.

Vocalization
The movement of gas through the larynx, pharynx and mouth allows speech to occur. The vibration of air flowing across the larynx (vocal chords) results in sound.

Coughing & sneezing
Irritation of nerves within the nasal passages or airways, can induce coughing and sneezing. These responses cause air to be expelled forcefully from the trachea or nose. In this manner, irritants caught in the mucus which lines the respiratory tract are expelled or moved to the mouth where they can be swallowed and eliminated by other means.

III. MANOMAYA KOSHA: THE MIND-BODY BRIDGE

***Manomaya Kosha*:** This is the psychological body (emotions, feelings, reactions to experience). It is composed of manas or mind, along with the five sensory organs. It is the cause of diversity, of self-identification of I, me and mine. Sankara likens it to clouds that are brought in by the wind and again driven away by it. Similarly, our experience of struggle, confusion and suffering (samsara) is caused by the mind, and liberation (nirvana) can also be found through this.

In yoga anatomy, the endocrine and nervous systems are closely related to the energetic anatomy of the body, and in fact, could be seen as the mind-body bridge – the place where emotions, sensation, feelings merge and where inner and outer experience start to take on a different meaning. Although each of these divisions, is just that: a division from an integrated whole.

NERVOUS SYSTEM

The nervous system is the major controlling, regulatory, and communicating system in the body. It is the center of all mental activity including thought, learning, and memory. Together with the endocrine system, the nervous system is responsible for regulating and maintaining homeostasis. Through its receptors, the nervous system keeps us in touch with our environment, both external and internal.

The nervous system is an organ system containing a network of specialized cells called neurons that coordinate actions and transmit signals to between different parts of its body. Like other systems in the body, the nervous system is composed of organs, principally the brain, spinal cord, nerves, and ganglia. These, in turn, consist of various tissues, including nerve, blood, and connective tissue. Together these carry out the complex activities of the

nervous system. The various activities of the nervous system can be grouped together as three general, overlapping functions:

- Sensory
- Integrative
- Motor

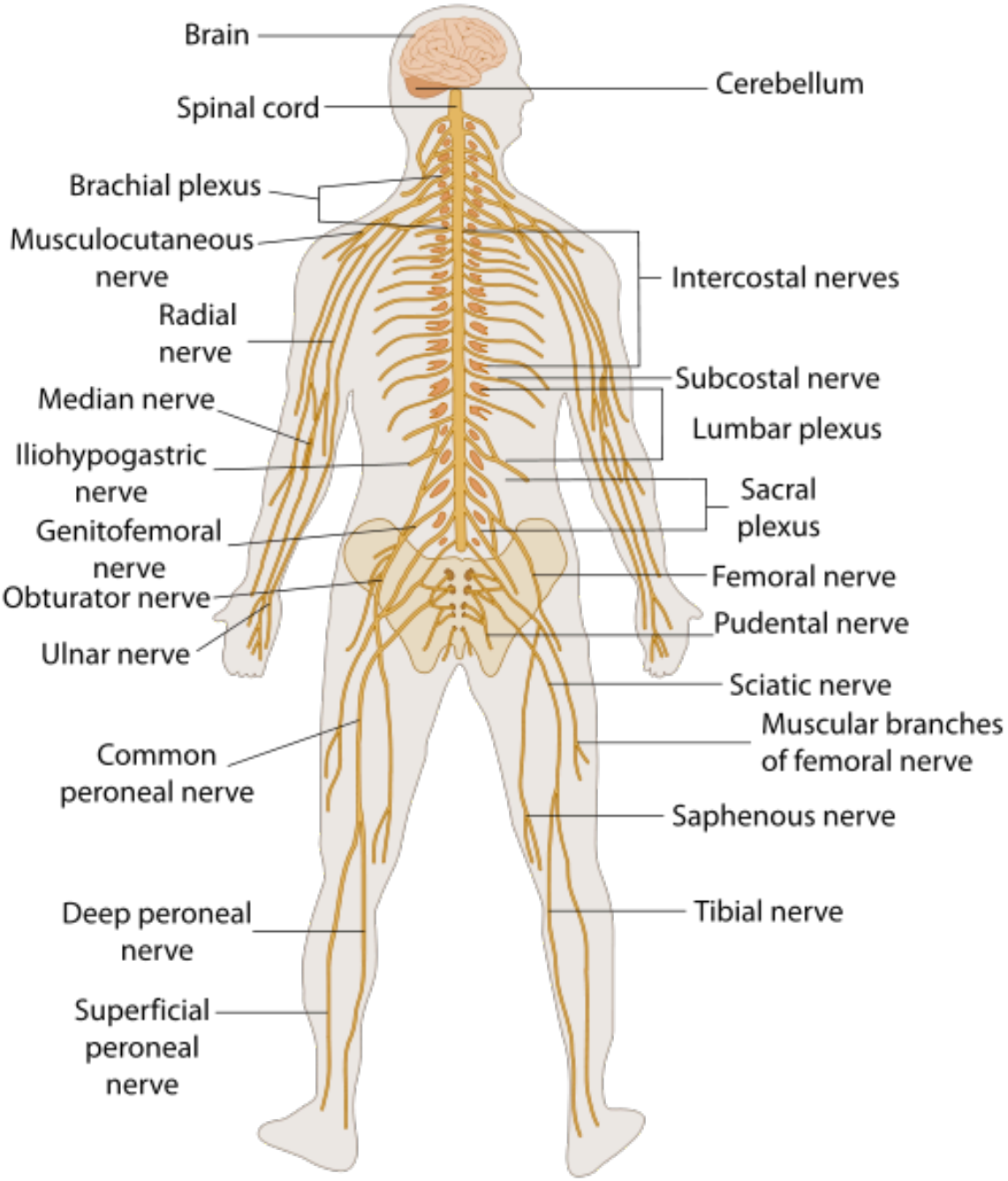
The nervous system consists of two parts: central and peripheral. The central nervous system (CNS) contains the brain, spinal cord, and retina. The peripheral nervous system (PNS) consists of sensory neurons, clusters of neurons called ganglia, and nerves connecting them to each other and to the CNS. These regions are all interconnected by means of complex neural pathways.

The enteric nervous system, a subsystem of the PNS, has the capacity, even when severed from the rest of the nervous system through its primary connection by the vagus nerve, to function independently in controlling the gastrointestinal system.

Millions of sensory receptors detect changes, called stimuli, which occur inside and outside the body. They monitor such things as temperature, light, and sound from the external environment. Inside the body, the internal environment, receptors detect variations in pressure, pH, carbon dioxide concentration, and the levels of various electrolytes. All of this gathered information is called sensory input.

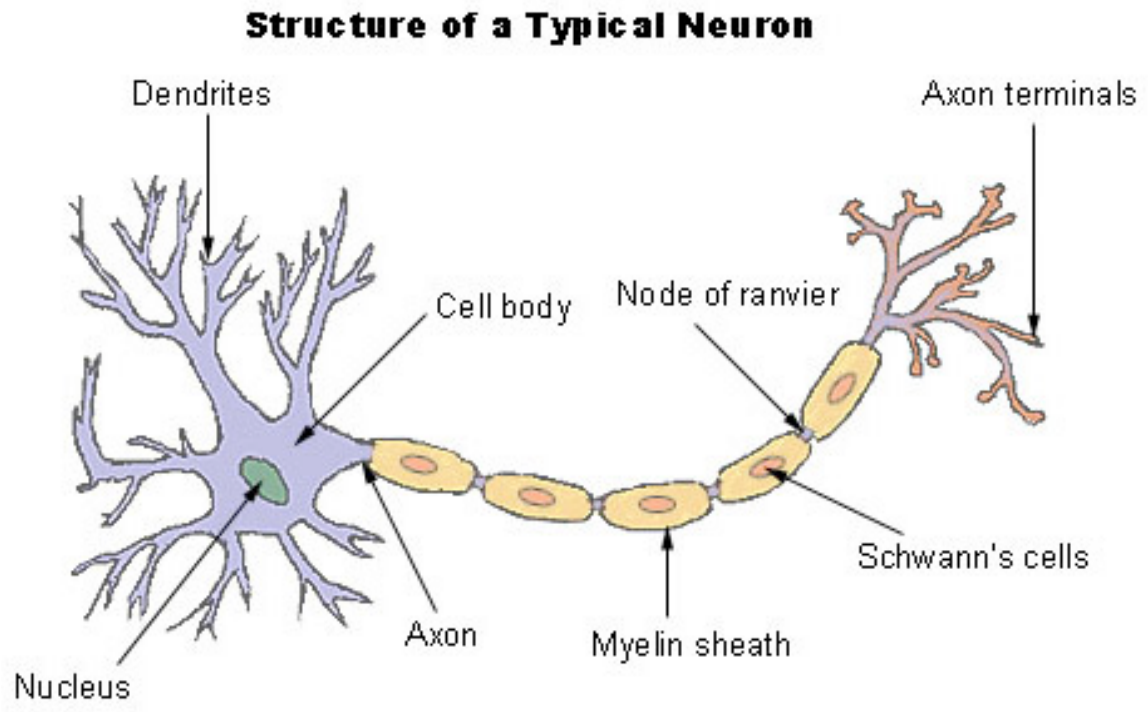
Sensory input is converted into electrical signals called nerve impulses that are transmitted to the brain. There the signals are brought together to create sensations, to produce thoughts, or create memory; Decisions are made each moment based on the sensory input. This is integration.

Based on the sensory input and integration, the nervous system responds by sending signals to muscles, causing them to contract, or to glands, causing them to produce secretions. Muscles and glands are called effectors because they cause an effect in response to directions from the nervous system. This is the motor output or motor function.



Nerve Tissue

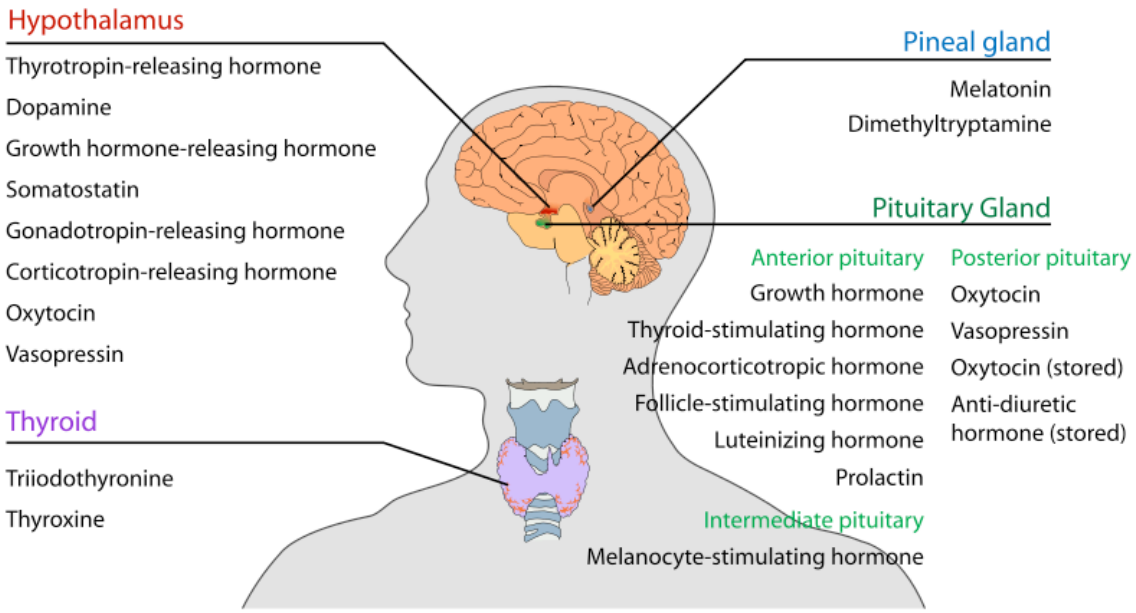
Although the nervous system is very complex, there are only two main types of cells in nerve tissue. The actual nerve cell is the neuron. It is the "conducting" cell that transmits impulses and the structural unit of the nervous system. The other type of cell is neuroglia, or glial, cell. The word "neuroglia" means "nerve glue." These cells are nonconductive and provide a support system for the neurons. They are a special type of "connective tissue" for the nervous system.



Neurons
Neurons, or nerve cells, carry out the functions of the nervous system by conducting nerve impulses. They are highly specialized and amitotic. This means that if a neuron is destroyed, it cannot be replaced because neurons do not go through mitosis (cell division).

Each neuron has three basic parts: cell body (soma), one or more dendrites, and a single axon.

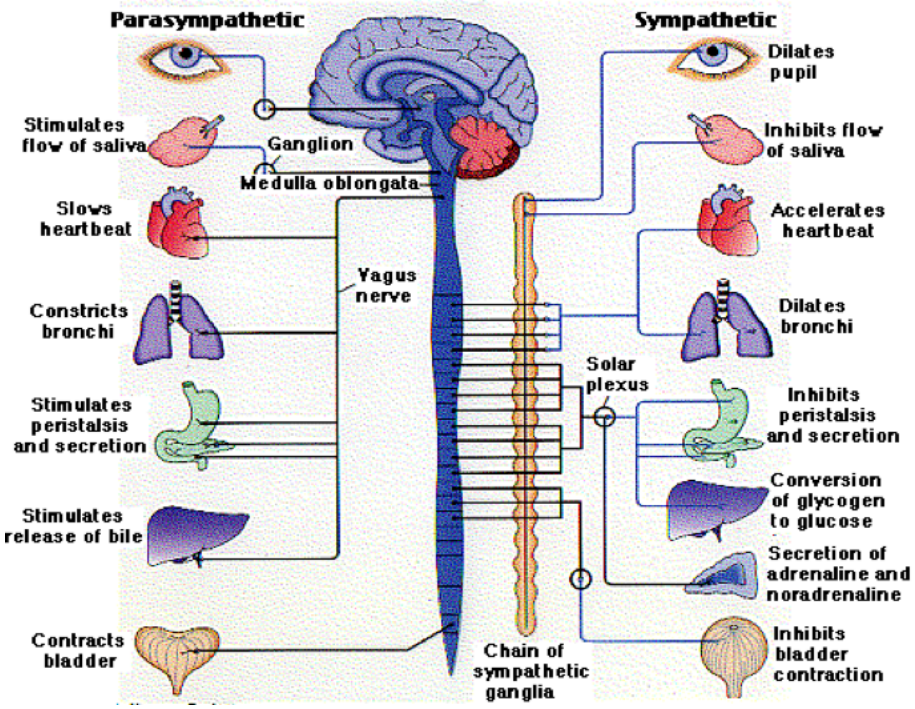
Neurons send signals to other cells as electrochemical waves traveling along thin fibers called axons, which cause chemicals called neurotransmitters to be released at junctions called synapses. A cell that receives a synaptic signal may be excited, inhibited, or otherwise modulated. Sensory neurons are activated by physical stimuli and send signals that inform the CNS of the state of the body and the external environment. Motor neurons, situated either in the CNS or in peripheral ganglia, connect the nervous system to muscles or other organs. Central neurons make all of their input and output connections with other neurons. The interactions of all these types of neurons form neural circuits that generate our perception of the world and determine our behavior.



Nerve Plexus

A plexus is an area where nerves branch and rejoin. The electrical signals do not mix - rather, the fibers travel together with their electrical signals separate. The brachial plexus is an example. It is made up of the spinal nerves which enter the upper limb.

Almost a hundred such plexuses have been described in the human body, but the four primary nerve plexuses are the cervical plexus, brachial plexus, lumbar plexus, and the sacral plexus.

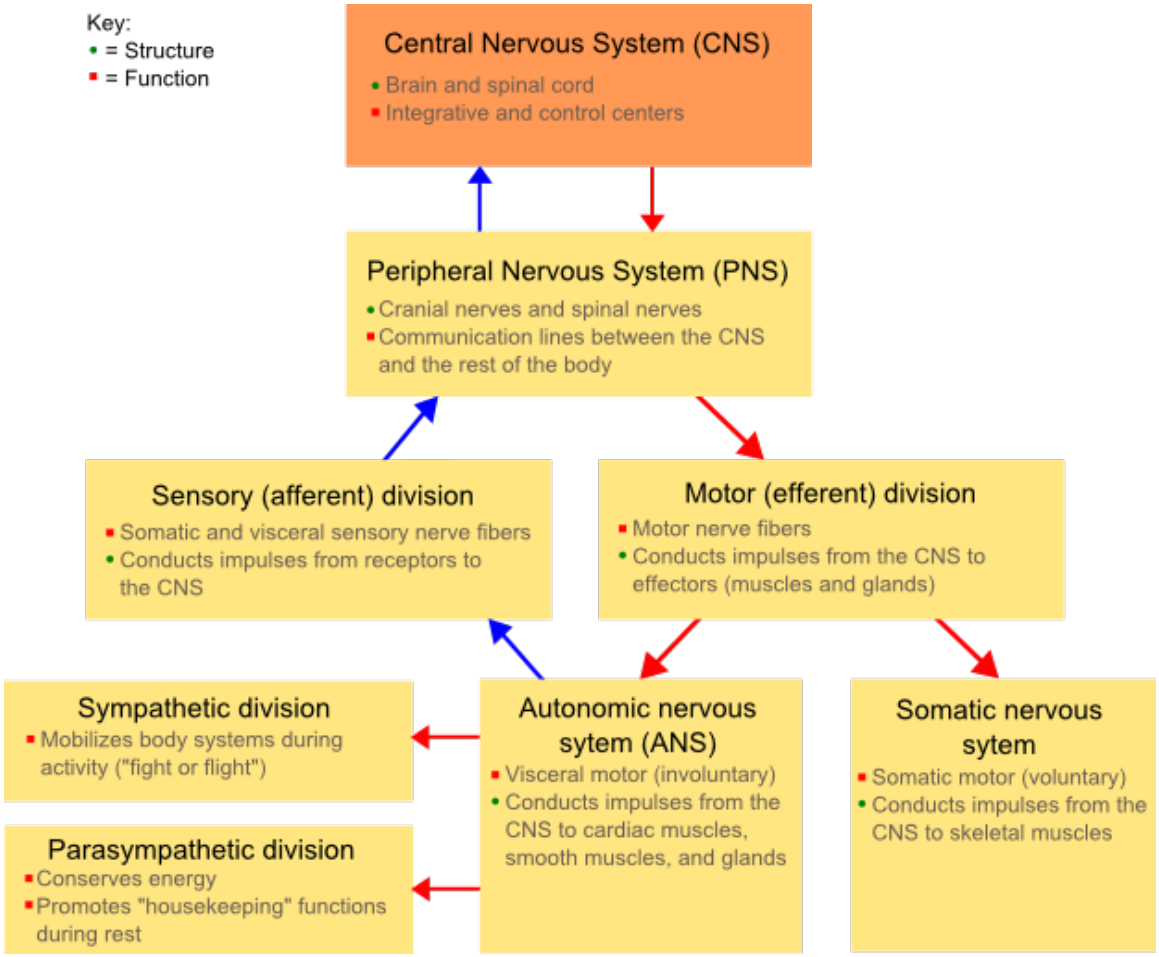


Depth of Touch

There is a very close anatomical and physiological association between the nervous system and the skin. As mentioned at the beginning of this modules, all tissues and organs in the body develop from three basic layers of cells that form the early embryo:

- ***the endoderm*** produces the internal organs.
- ***the mesoderm*** produces the connective tissue, bones and skeletal muscles.
- ***the ectoderm*** produces the skin and nervous system.

So, we can see that the skin and the brain develop from the exact same cells at birth. Deane Juhan, a somatic bodywork practitioner and author *of Job's Body*, states: "Depending on how you look at it, the skin is the outer surface of the brain, or the brain is the deepest layer of the skin. Surface and innermost core spring from the same mother tissue, and throughout the life of the organism they function as a single unit, divisible only by dissection or analytical abstraction." This is a very important factor when considering the mind-body relationship– and an important point to remember in our practice.

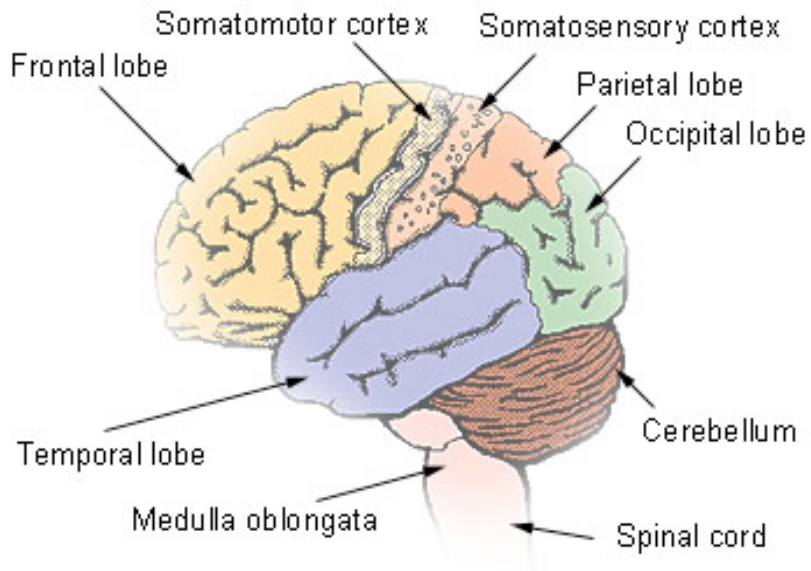


Senses
Senses are the physiological capacities within the body that provide inputs for perception. The nervous system has a specific sensory system or organ, dedicated to each sense. There is no firm agreement among neurologists as to the number of senses because of differing definitions of what constitutes a sense. One definition states that an exteroceptive sense is a faculty by which outside stimuli are perceived.

The traditional five senses are sight, hearing, touch, smell and taste, a classification attributed to Aristotle. Humans are considered to have at least five additional senses that include: nociception (pain); equilibrioception (balance); proprioception and kinaesthesia (joint motion and acceleration); sense of time; thermoception (temperature differences); and possibly an additional weak magnetoception (direction), and six more if interoceptive senses are also considered. There are specific nerve receptors for pressure, light, temperature, sound, and other sensory experiences.

In yoga and buddhist texts, the traditional five senses are enumerated as the "five material faculties". They appear in allegorical representation as early as in the Katha Upanishad (roughly 6th century BC), as five horses drawing the "chariot" of the body, guided by the mind as "chariot driver".

One commonly recognized categorisation for human senses is as follows: chemoreception; photoreception; mechanoreception; and thermoception. This does not include categories for accepted senses such as the sense of time and sense of pain.



Lobes of the cerebrum

Equiloception: Balance & acceleration
Balance, equilibrioception, or vestibular sense is the sense which allows an organism to sense body movement, direction, and acceleration, and to attain and maintain postural equilibrium and balance. The organ of equilibrioception is found in both of the inner ears. Technically, this organ is responsible for two senses of angular momentum acceleration and linear acceleration (which also senses gravity), but they are known together as equilibrioception**.**

Thermoception:Temperature
Thermoception is the sense of heat and the absence of heat (cold) by the skin and including internal skin passages, or rather, the heat flux (the rate of heat flow) in these areas. There are specialized receptors for cold (declining temperature) and to heat. The thermoceptors in the skin are quite different from the homeostatic thermoceptors in the brain (hypothalamus) which provide feedback on internal body temperature.

Prprioception: Kinesthetic sense
Proprioception (from Latin proprius, meaning "one's own") is the sense of the relative position of neighboring parts of the body. Unlike the exteroceptive senses by which we perceive the outside world, and interoceptive senses, by which we perceive the pain and movement of internal organs, proprioception is a third distinct sensory modality that provides feedback solely on the status of the body internally. It is the sense that indicates whether the body is moving with required effort, as well as where the various parts of the body are located in relation to each other.

The proprioceptive sense is believed to be composed of information from sensory neurons located in the inner ear (motion and orientation) and in the stretch receptors located in the muscles and the joint-supporting ligaments (stance).

Neurologists test this sense by telling patients to close their eyes and touch the tip of a finger to their nose. Assuming proper proprioceptive function, at no time will the person lose awareness of where the hand actually is, even though it is not being detected by any of the other senses. Proprioception and touch are related in subtle ways, and their impairment results in surprising and deep deficits in perception and action.

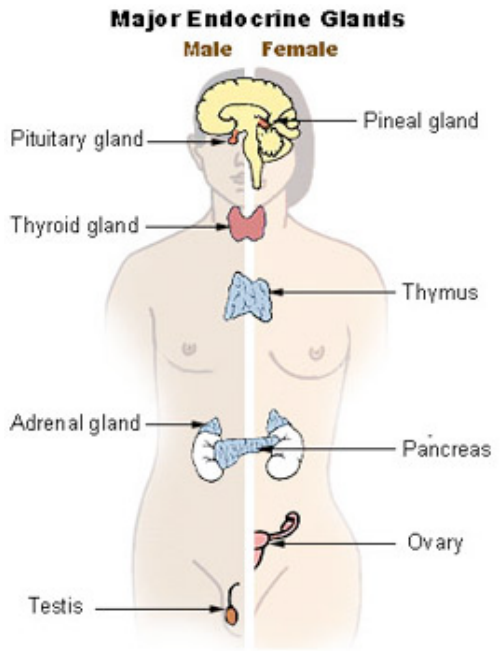
Nociception: Pain
Nociception (physiological pain) signals near-damage or damage to tissue. The three types of pain receptors are cutaneous (skin), somatic (joints and bones) and visceral (body organs). It was previously believed that pain was simply the overloading of pressure receptors, but research has confirmed that pain is a distinct phenomenon that intertwines with all of the other senses, including touch. Pain was once considered an entirely subjective experience, but recent studies show that pain is registered in a specific area of the brain.

Magnetoception: Direction
Magnetoception (or magnetoreception) is the ability to detect the direction one is facing based on the Earth's magnetic field. Directional awareness is most commonly observed in birds, though it is also present to a limited extent in humans. It has also been observed in insects such as bees. One study has found that cattle make use of magnetoception, as they tend to align themselves in a north-south direction. Magnetotactic bacteria build miniature magnets inside themselves and use them to determine their orientation relative to the Earth's magnetic field.

Interoception
An internal sense or interoception is "any sense that is normally stimulated from within the body".These involve numerous sensory receptors in internal organs, such as stretch receptors that are neurologically linked to the brain.
▪ Pulmonary stretch receptors are found in the lungs and control the respiratory rate.
▪ The chemoreceptor trigger zone in the brain receives inputs from blood-borne drugs or hormones, and communicates with the vomiting center.
▪ Cutaneous receptors in the skin not only respond to touch, pressure, and temperature, but also respond to vasodilation in the skin such as blushing.
▪ Stretch receptors in the gastrointestinal tract sense gas distension that may result in colic pain.
▪ Stimulation of sensory receptors in the esophagus result in sensations felt in the throat when swallowing, vomiting, or during acid reflux.
▪ Sensory receptors in pharynx mucosa, similar to touch receptors in the skin, sense foreign objects such as food that may result in a gag reflex and corresponding gagging sensation.
▪ Stimulation of sensory receptors in the urinary bladder and rectum may result in sensations of fullness.
▪ Stimulation of stretch sensors that sense dilation of various blood vessels may result in pain, for example headache caused by vasodilation of brain arteries.

ENDOCRINE SYSTEM

The endocrine system, along with the nervous system, functions in the regulation of body activities. The nervous system acts through electrical impulses and neurotransmitters to cause muscle contraction and glandular secretion. The endocrine system acts through chemical messengers called hormones. Hormones regulate many functions of an organism, including mood, growth and development, tissue function, and metabolism. The action of the endocrine system is measured in minutes, hours, or weeks and is more generalized than the action of the nervous system.



There are two major categories of glands:

1) Exocrine Glands
Exocrine glands are less vascular and have ducts that carry their secretory product to a surface. These glands include the sweat, sebaceous, and mammary glands and, the glands that secrete digestive enzymes.

2) Endocrine Glands
The endocrine glands do not have ducts to carry their product to a surface. They are called ductless glands. The word endocrine is derived from the Greek terms "endo," meaning within, and "krine," meaning to separate or secrete. The secretory products of endocrine glands are called hormones and are secreted directly into the blood and then carried throughout the body where they influence only those cells that have receptor sites for that hormone. Typical endocrine glands are the pituitary, thyroid, and adrenal glands. Features of endocrine glands are, in general, their ductless nature, their vascularity, and usually the presence of intracellular vacuoles or granules storing their hormones.

Although there are eight major endocrine glands scattered throughout the body, they are still considered to be one system because they have similar functions, similar mechanisms of influence, and many important interrelationships. A number of glands that signal each other in sequence is usually referred to as an axis, for example, the hypothalamic-pituitary-adrenal axis.

In addition to the specialized endocrine organs mentioned above, many other organs that are part of other body systems (e.g. the kidney, liver, heart and gonads), have secondary endocrine functions and are involved in regulating all bodily processes. For example, the ovaries and testes secrete hormones and also produce the ova and sperm. Some organs (e.g. stomach, intestines, and heart) produce hormones, but their primary function is not hormone secretion.

Characteristics of Hormones
Chemically, hormones may be classified as either proteins or steroids. All of the hormones in the human body, except the sex hormones and those from the adrenal cortex, are proteins or protein derivatives. Hormones are very potent substances, which means that very small amounts of a hormone may have profound effects on metabolic processes. Because of their potency, hormone secretion must be regulated within very narrow limits in order to maintain homeostasis in the body.

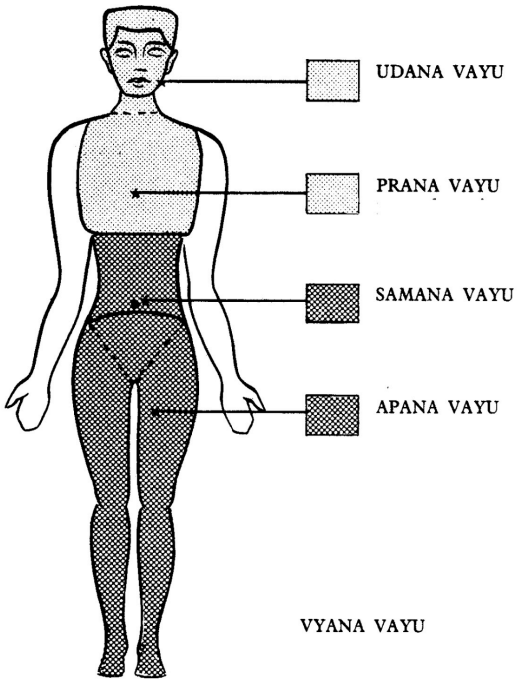
The body compensates for energetic imbalances, which is often regulated at the level of the endocrine system. When there is energetic deficiency, the body attempts to limit further loss by reducing its function. The result might be shallow respiration, constipation, scanty and infrequent urination, sluggish gall bladder, dry skin, cold extremities, reduced sweating, diminished menstrual flow, etc. On the behavioral level, we might see lethargy, fatigue, decreased libido, and general hypo-function.

IV. VIJNAMAYA KOSHA: THE WISDOM BODY - ENERGY ANATOMY

***Vijnanamaya Kosha*:** This is the "wisdom" body, where we understand and know deeply what is. It is composed of vijnana, or intellect, the faculty that discriminates. This is where we start to explore the more subtle aspects of yoga anatomy, or the "energy" anatomy, the vital forces that both form and inform, that define how one moves through life, and how one expresses that movement out in the world. Although the concept of prana and vayus were mentioned earlier in the Pranamaya Kosha section of this manual, these movements of the vital life energies are also predominant in the Vijnamaya Kosha, carrying not only the basic energies that sustain our body through the various body systems, but also processing and carrying a more subtle expression and understanding of these vital pranic forces.

VAYUS

(excerpt from: "The Five Vayus" by Timothy Burgin; Feb, 2006)



The word Prana in Sanskrit can be loosely translated as life force or life energy. Prana allows all activity within our being; mental, emotional as well a physical. Prana can be further subdivided into energetic components they called Vayus (winds). The five Vayus of prana all have very subtle yet distinct energetic qualities, including specific functions and directions of flow. "Vayu" is translated as "wind". The root 'va' means "that which flows". A vayu is a vehicle within our body for activities and experiences. It also means 'a force' that moves in a specific way in a certain area of the body that is overseas.

Both asana and pranayama optimize and utilize the functioning of the Vayus as well as maintaining equanimity of each Vayu, so that their energies are uplifted.

Ancient yogis were able to control and cultivate these Vayus by simply bringing their focus and awareness to them. Through this conscious control and cultivation they were not only able to create optimal health and well-being, but were able to activate the primordial Kundalini energy to obtain states of enlightened Samadhi. Complete mastery over the Vayus is not necessary to benefit from using them to improve our inward focus and the ability to feel the subtleties within the body. Cultivating a basic awareness of one or more of the Vayus will help us deepen our awareness of body and breath to enrich our yoga practice.

The Vayus can be divided into six major ones, with Prana and Apana being the most significant:

1) Prana-Vayu is situated in the head, centered in the third-eye, and its energy pervades the chest region. The flow of Prana-Vayu is inwards and upward. It nourishes the brain and the eyes and governs reception of all things: food, air, senses, and thoughts. This Vayu is the fundamental energy in the body and directs and feeds into the four other Vayus. To experience Prana-Vayu: Close your eyes, sit or stand with a long spine and

relaxed body, and as you inhale feel an energy flowing up the torso from the belly to the third-eye.

2) Apana-Vayu is situated in the pelvic floor and its energy pervades the lower abdomen. The flow of Apana-Vayu is downwards and out and its energy nourishes the organs of digestion, reproduction and elimination. Apana-Vayu governs the elimination of all substances from the body: carbon monoxide, urine, stool, etc. To experience Apana-Vayu: Close your eyes, sit or stand with a long spine and relaxed body, and as you exhale feel an energy flowing down the torso from the top of the head to the tailbone.

3) Vyana-Vayu is situated in the heart and lungs and flows throughout the entire body. The flow of Vyana-Vayu moves from the center of the body to the periphery. It governs circulation of all substances throughout the body, and assists the other Vayus with their functions. Vyana is the distributor of energy. Radiating from the heart where the true self dwells, Vyana moves through the myriad of vital currents. The entire body is the seat of the actions of the Vyana Vayu. It is present in the heart and moves outward circulating prana to the muscles and extremities. It controls functions throughout the entire body by assisting all the other pranas to function. It controls body movement, circulation, heart and aids the function of gross nerves and subtle nadis. It is considered a connecting and cohesive force. It is associated with the Anahata (heart) Chakra and Swadisthana (water) Chakra. Vyana Vayu is strengthened by the interplay of the muscular and organic energy, which coordinate and integrate the mind and body through the actions of asana. To experience Vyana-Vayu: Close your eyes, sit or stand with a long spine and relaxed body, and as you inhale feel the breath radiating outward from the navel to the arms and legs.

4) Udana-Vayu is situated in the throat and it has a circular flow around the neck and head. It functions to "hold us up" and governs speech, self-expression and growth. To experience Udana-Vayu: Close your eyes, sit or stand with a long spine and relaxed body, and as you inhale and exhale feel the breath circulating around and through the head and neck.

5) Samana-Vayu is situated in the abdomen with its energy centered in the navel. The flow of Samana-Vayu moves from the periphery of the body to the center. It governs the digestion and assimilation of all substances: food, air, experiences, emotions and thoughts. To experience Samana-Vayu: Close your eyes, sit or stand with a long spine and relaxed body, and as you inhale and exhale feel the breath rising and falling in the front, sides and back of the torso.

Awareness of one or more Vayu has several applications in yoga, and is most easily illustrated within a yoga posture. The awareness of Prana-Vayu creates a focus to lift, lengthen and open the upper body. The awareness of Apana-Vayu creates a focus to ground and stabilize the lower body. The awareness of Vyana-Vayu creates a focus of strength and fluid movement body. The awareness of Udana-Vayu creates a focus to maintain a long spine and a correct posture. The awareness of Samana-Vayu creates a focus to open and relax the body.

NADIS

The Sanskrit term "Nadi" comes from the root "Nad" which means "motion". *The Hatha Yoga Pradipika* describes a nadi as, “flow. The nadis are energetic pathways or circuits in the subtle body, conducting the flow of prana. The nadis transport pranic energy through both gross and subtle anatomy(i.e. the physical body, chakras and vayus).

Different authors state the number of Nadis ranging from 72,000 to 350,000; the basic notion to grasp is that Nadis are innumerable. It is through these Nadis that the vital force or prana moves or flows. The nadis are neither nerves, arteries nor veins, but are much more subtle energy channels. Some contemporary scholars have suggested that the nadis actually travel along the crystalline matrix of the connective tissue, which has been scientifically shown to function as a semi-conductor, transforming sensation into information into emotion.

There are fourteen major nadis, of which three are said to be important to the process of spiritual development, expounded on in the traditional practice of Hatha Yoga (vs the limited asana-focused most contemporary Hatha Yoga practices): the Ida, Pingala and Sushumna.

The Ida and Pingala Nadis can be related to the parasympathetic and sympathetic nervous systems. The Ida Nadi is associated with the left side of the body and has symbolic feminine associations – the moon, paleness, introspection, intuition, reflection. The Pingala Nadi is associated with the right side of the body and with male associations: the sun, brightness, action, rational thought, manifestation.

With qualities of coolness and intuition, Ida Nadi terminates at the left nostril. Therefore, in pranayama practice, breathing through the left nostril is considered calming and quieting. Pingala Nadi terminates at the right nostril, and its characteristics are heating and energizing. Breathing through the right nostril is energizing and aids in digestion. It is normal for the breath to predominate in one or the other nostril throughout the day - generally in approximately 90-minute cycles. Yoga practice is designed to bring balance between these two energies.

The Sushumna Nadi runs inside the spinal cord from the base of the spine to the center of the brain. Sushumna is also referred to as the ‘Brahman Nadi’, since the progression of prana through the nadi leads to an experience of Brahman, non-separation, or enlightenment. The major chakras are located along the Sushumna.

In the esoteric teachings of Yoga, the goddess Kundalini is described as a snake residing at the base of the spine, coiled three-and-a-half times around a phallus and looking downward. Only once the blockages in the subtle body are cleared away, is this vital force free to flow unimpeded through the Sushumna Nadi, which is in the central channel of the body.

In addition to these three major nadis, there are eleven additional nadis (texts often disagree as to the location and description of minor nadis). The following descriptions are from Maya Tiwari:

- Gandhari and Hastajihva Nadis are companions to the ida. Gandhari originates from the lower corner of the left eye and ends at the big toe of the left foot. Hastajihva nadi begins on the lower corner of the right eye and ends at the big toe of the left foot. These nadis are used to bring psychic energy from the lower body to the ajna chakra.

- Yashasvini and Pusha Nadis are companions to Pingala Nadi. Yashasvini runs from the left ear to the big toe of the left foot; Pusha Nadi runs from the right ear to the big toe of the left foot.

- Alambusha Nadi begins at the anus and ends in the mouth and provides prana for the assimilation and elimination of food. It also is responsible for the assimilation of ideas and thoughts.

- Kuhu Nadi begins in the throat and terminates in the genitals and can be trained to retain sexual secretions.

- Shankhini Nadi originates in the throat and ends in the anus and is activated by cleansing of vata from the colon and anus.

- Saraswati Nadi begins in the tongue and ends in the vocal cord. It is responsible for speech and dissemination of knowledge, and is considered a companion to the sushumna nadi.

- Payasvini Nadi is located in the lobe of the right ear and connects to the cranial nerves.

- Varuni Nadi aids in the purification of bodily wastes. It originates at the throat and left ear and ends at the anus.

- Vishvodara Nadi is located around the umbilical area and stimulates the adrenal glands and pancreas. It also distributes prana throughout the body.

All the Nadis spring from the Kanda. Some say, that this Kanda is 12 inches above the anus, others that it is deep inside the body near the base charka. Kanda is said to be the junction where the Sushumna Nadi is connected with the Muladhara (root) Chakra.

The spinal column is known as Meru Danda. This is the axis of the body just as Mount Meru is the axis of the earth. Hence the spine is called "Meru". The spinal column is also viewed as an axis-staff, with man as the microcosm through which the macrocosm of the universe functions. All things seen in the universe exist in the body also. The major chakras are located along the sushumna, which runs inside the spinal cord from the base of the spine to the center of the brain.

CHAKRAS

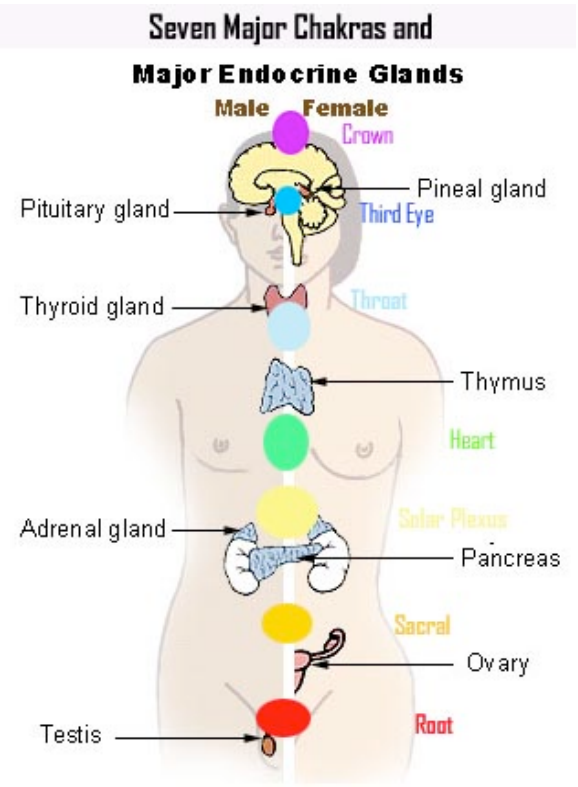
The chakras are energy centres which distribute prana throughout the body. The ancient Yogis discovered these subtle energetic centers through deep practices of breathwork and meditation. *The Hatha Yoga Pradipika* defines chakra as, “circle, wheel or vortex” because it was believed that the energy formed circular swirls in these areas of the body.

While the body contains many hundreds of chakras, in general there are thought to be seven major chakras, aligned along the spine, starting from the base of the spine and rising above the crown of the head. Among other attributes, the ancient Yogis associated a color, a sound (mantra), a symbol, and a quality (for example, earth, water, etc.) with each chakra.

Between each pair of vertebrae there are apertures through which the spinal nerves pass from the spinal cord to the different portions and organs of the body. These regions of the spine, not including the brow and crown, are believed to correspond with the regions of the chakras.

As the physical body, the energetic body and the mind become harmonized, the creative power of kundalini may be "awakened". This "energy of transformation" is said to open the chakras in more profound ways, facilitating the process of transformation at all levels. That's the theory. In practice, we all encounter obstacles in the form or physical limitations, mental and emotional states, and our reactions to these "hinderances", which can also include our reactions to pleasure. So the process of “awakening” is continual and gradual, and part of our daily practice.

There are six main chakras relating to the physical body, the seventh being located above the crown of the head:



1) Muladhara Chakra - The base chakra, located between the sacrum and coccyx is associated with the color red and relates to our survival instincts and material/physical existence.

2) Svadhistana Chakra - The second chakra, located around the reproductive organs and lumbar region, is associated with the color orange and relates to feelings, desires and sensations.

3) ***Manipura Chakra*** - Located in the navel
4) or solar plexus region and associated with the color yellow. This chakra relates to a sense of personal power and identity.

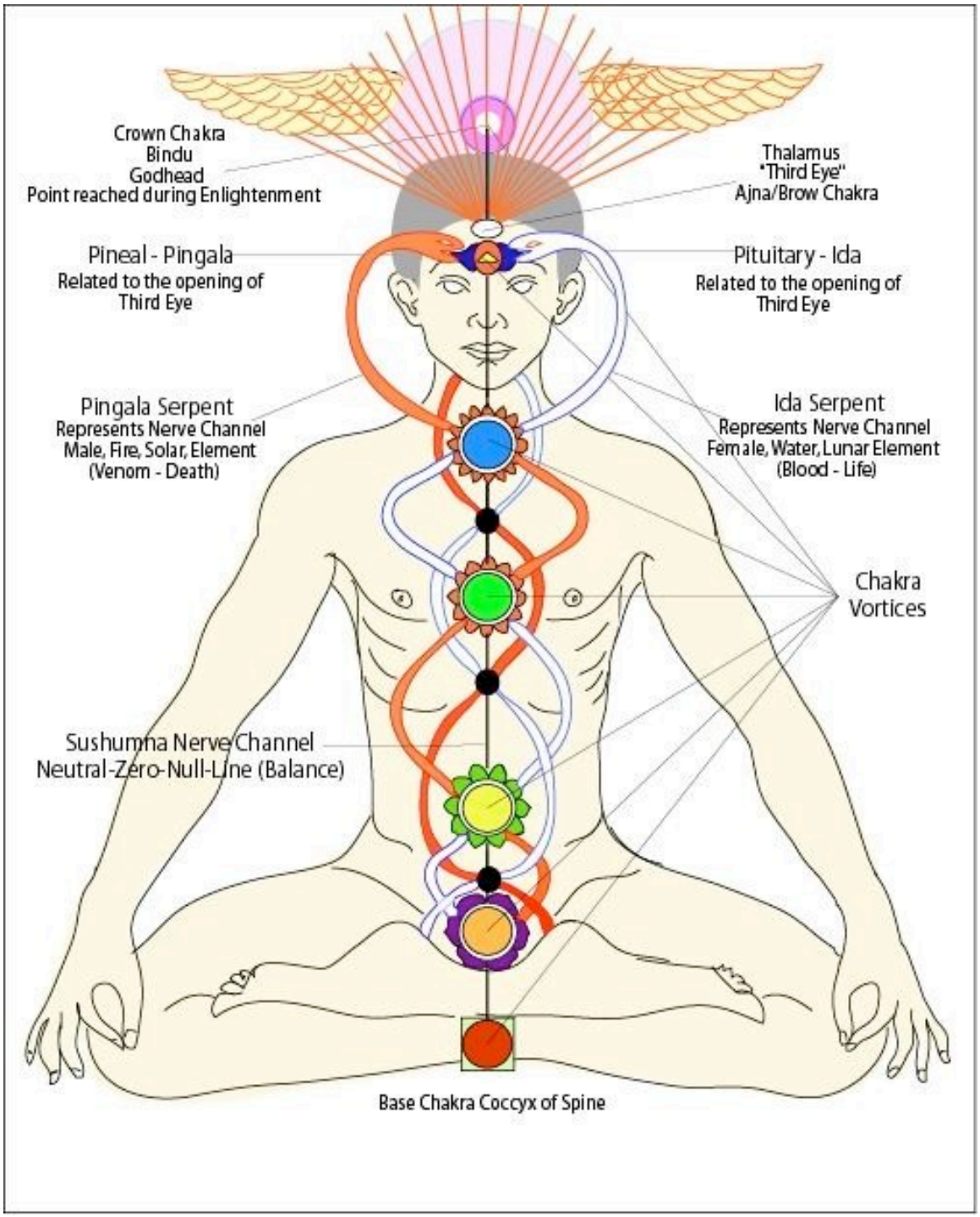
4) Anahata Chakra - Located in the heart region, this chakra relates to one's ability to give and receive love and is associated with the color green.

5) Vishuddi Chakra - The throat chakra is associated with the color blue and relates to one's ability to communication and expression.

6) Ajna Chakra - Associated with the color violet, the third eye chakra relates to intuition, creativity and imagination.

7) Sahasrara Chakra - The crown chakra relates to universal consciousness and inter-connectedness and is associated with the color violet.

The chart on the following page outlines the chakras in more detail.


Crown Chakra
Bindu
Godhead
Point reached during Enlightenment
Thalamus
"Third Eye"
Ajna/Brow Chakra
Pineal - Pingala
Related to the opening of
Third Eye
Pituitary - Ida
Related to the opening of
Third Eye
Pingala Serpent
Represents Nerve Channel
Male, Fire, Solar, Element
(Venom - Death)
Ida Serpent
Represents Nerve Channel
Female, Water, Lunar Element
(Blood - Life)
Chakra
Vortices
Sushumna Nerve Channel
Neutral-Zero-Null-Line (Balance)
Base Chakra Coccyx of Spine

Medical Terminology	Yogic Terminology	
CEREBRUM CEREBELLUM	SAHASRARA	Crown
NASOCILICARY PLEXUS Eye	AJNA	Ajna
Lacrymal Gland Mucous Membrane of Nose and Pharynx Submaxillary and Sublingual Gland Mucous Membrane of Mouth Parotid Gland	VISHUDDHI	Throat Chakra
BRAIN CONE Sphenopalatine Ganglion Subinarillary Ganglion One Ganglion		
SPINAL CORD (BLACK) CARDIAC PLEXUS Heart	ANAHATA	Heart Chakra
SOLAR PLEXUS Trachea, Bronchi, and Lungs Stomach Liver, Gall Bladder and Bile Ducts Blood Vessels of Abdomen Pancreas Adrenal Gland	MANIPURA	Solar Plexus
Superior Mesenderic Ganglion Inferior Mesenderic Ganglion Small Intestine Large Intestine HYPOGASTRIC PLEXUS	SWADHISTHAN	Sacral Chakra
Kidney, Ureter, and Urinary Bladder PELVIC PLEXUS Genitals	MULADHARA	Root Chakra
SPINE		

Sahasrara: The Crown Chakra

Sahasrara, which means 1000 petalled lotus, is generally considered to be the chakra of pure consciousness, within which there is neither object nor subject. When the female kundalini Shakti energy rises to this point, it unites with the male Shiva energy, and a state of liberating samadhi is attained. Symbolized by a lotus with one thousand multi-coloured petals, it is located either at the crown of the head, or above the crown of the head. Sahasrara is represented by the colour white and it involves such issues as inner wisdom and the death of the body.

Its role may be envisioned somewhat similarly to that of the pituitary gland, which secretes hormones to communicate to the rest of the endocrine system and also connects to the central nervous system via the

o have a key role in the physical basis of ures. Sahasrara's inner aspect deals with the release of karma, physical action with meditation, mental action with universal consciousness and unity, and emotional action with "beingness".

In Tibetan buddhism, the point at the crown of the head is represented by a white circle, with 32 downward pointing petals. It is of primary importance in the performance of phowa, or consciousness projection after death, in order to obtain rebirth in a Pure Land. Within this chakra is contained the White drop, or Bodhicitta, which is the essence of masculine energy.

Ajna: The Brow Chakra

Ajna is symbolised by a lotus with two petals, and corresponds to the colors violet, indigo or deep blue. It is at this point that the 2 side nadis Ida and Pingala are said to terminate and merge with the central channel Sushumna, signifying the end of duality. The seed syllable for this chakra is the syllable OM, and the presiding deity is Ardhanarishvara, who is a half male, half female Shiva/Shakti. The Shakti goddess of Ajna is called Hakini.

Ajna (along with Bindu), is known as the third eye chakra and is linked to the pineal gland which may inform a model of its envisioning. The pineal gland is a light sensitive gland that produces the hormone melatonin which regulates sleep and waking up. Ajna's key issues involve balancing the higher & lower selves and trusting inner guidance. Ajna's inner aspect relates to the access of intuition. Mentally, Ajna deals with visual consciousness. Emotionally, Ajna deals with clarity on an intuitive level. Some scholars believe that the pineal and pituitary glands should be exchanged in their relationship to the Crown and Brow chakras.

In Tibetan Buddhism, this point is actually the end of the central channel, since the central channel rises up from the sexual organ to the crown of the head, and then curves over the head and down to the third eye. While the central channel finishes here, the two side channels continue down to the 2 nostrils.

Vishuddha: The Throat Chakra

Vishuddha (also Vishuddhi) is depicted as a silver crescent within a white circle, with 16 light or pale blue, or turquoise petals. The seed mantra is Ham, and the residing deity is Panchavaktra shiva, with 5 heads and 4 arms, and the Shakti is Shakini.

Vishuddha may be understood as relating to communication and growth through expression. This chakra is paralleled to the thyroid, a gland that is also in the throat and which produces thyroid hormone, responsible for growth and maturation. Physically, Vishuddha governs communication, emotionally it governs independence, mentally it governs fluent thought, and spiritually, it governs a sense of security.[27] In Tibetan buddhism, this chakra is red, with 16 upward pointing petals. It plays an important role in Dream Yoga, the art of lucid dreaming.

Anahata: The Heart Chakra

Anahata, or Anahata-puri, or padma-sundara is symbolised by a circular flower with twelve vermilion, or green petals. Within it is a yantra of 2 intersecting triangles, forming a star of David, symbolising a union of the male and female. The seed mantra is Yam, the presiding deity is Ishana Rudra Shiva, and the Shakti is Kakini.

Anahata is related to the thymus, located in the chest. The thymus is an element of the immune system as well as being part of the endocrine system. It is the site of maturation of the T cells responsible for fending off disease and may be adversely affected by stress. Anahata is related to the colours green or pink. Key issues involving Anahata involve complex emotions, compassion, tenderness, unconditional love, equilibrium, rejection and well-being. Physically Anahata governs circulation, emotionally it governs unconditional love for the self and others, mentally it governs passion, and spiritually it governs devotion.

In Tibetan buddhism, this centre is extremely important, as being the home of the indestructible red/white drop, which carries our consciousness to our next lives. It is described as being white, circular, with 8 downward pointing petals, and the seed syllable Hum inside. During mantra recitation in the lower tantras, a flame is imagined inside of the heart, from which the mantra rings out. Within the higher tantras, this chakra is very important for realising the Clear Light.

Manipura: The Solar Plexus Chakra

Manipura or manipuraka is symbolised by a downward pointing triangle with ten petals. The seed syllable is Ram, and the presiding deity is Braddha Rudra, with Lakini as the Shakti.

Manipura is related to the metabolic and digestive systems. Manipura is believed to correspond to Islets of Langerhans,[29] which are groups of cells in the pancreas, as well as the outer adrenal glands and the adrenal cortex. These play a valuable role in digestion, the conversion of food matter into energy for the body. The colour that corresponds to Manipura is yellow. Key issues governed by Manipura are issues of personal power, fear, anxiety, opinion-formation, introversion, and transition from simple or base emotions to complex. Physically, Manipura governs digestion, mentally it governs personal power, emotionally it governs expansiveness, and spiritually, all matters of growth.

In Tibetan buddhism, this wheel is repreeented as a triangle with 64 upward pointing petals. It is the home of the Red drop, or red bodhicitta, which is the essence of feminine energy (as opposed to the Shakta system, where the kundalini energy resides in Muladhara). It contains the seed syllable short-Ah, which is of primary importance in the Tummo inner fire meditation, which is the system by which the energy of the red drop is raised to the white drop in the crown.

Svadhisthana: The Sacral Chakra

Swadhisthana, Svadisthana or adhishthana is symbolized by a white lotus within which is a crescent moon, with six vermillion, or orange petals. The seed mantra is Vam, and the presiding deity is either Vishnu, with the Shakti being Rakini (or Chakini). The animal associated is the crocodile of Varuna.

The Sacral Chakra is located in the sacrum (hence the name) and is considered to correspond to the testes or the ovaries that produce the various sex hormones involved in the reproductive cycle. Svadisthana is also considered to be related to, more generally, the genitourinary system and the adrenals. The key issues involving Svadisthana are relationships, violence, addictions, basic emotional needs, and pleasure. Physically, Svadisthana governs reproduction, mentally it governs creativity, emotionally it governs joy, and spiritually it governs enthusiasm.

In Tibetan buddhism, this is known as the Secret Place wheel. Below this point the Shakta tantra and Vajrayana systems diverge somewhat.

Muladhara: The Base Chakra

Muladhara or root chakra is repreeented as a yellow square, with 4 red petals. The seed syllable is Lam, the deity is Brahma, and the Shakti is Dakini. The associated animal is the elephant Ganesha. This chakra is where the 3 channels are merged, then separate and begin their upward movement. Inside of this chakra is wrapped up the goddess kundalini three times around a black lingam. It is the seat of the red bindu, the female drop (which in Tibetan vajrayana is located at the navel chakra).

It is related to instinct, security, survival and also to basic human potentiality. This center is located in the perineum, which is the region between the genital and the anus. Although no endocrine organ is placed here, it is said to relate to the gonads and the adrenal medulla, responsible for the fight-or-flight response when survival is under threat. There is a muscle located in this region that controls ejaculation in the sexual act of the human male. A parallel is charted between the sperm cell and the ovum where the genetic code lies coiled and the kundalini. Muladhara is symbolized by a lotus with four petals and the colour red. Key issues involve sexuality, lust and obsession. Phyeically, Muladhara governs sexuality, mentally it governs stability, emotionally it governs sensuality, and spiritually it governs a sense of security.

There is no chakra that exists in this position within Tibetan buddhism. Instead, below the secret place wheel, there are 2 other wheels, the jewel wheel, which is located in the middle of the sex organ, and the wheel located at the tip of the sex organ. These wheels are extremely important for the generation of great bliss, and are involved with tantric consort practices.

V. ANANDAMAYA KOSHA: THE BLISS BODY - NON-DUAL EXPERIENCE

***Anandamaya Kosha*:** This is the "bliss" body, where one is at-one, with all that is, without conflict. When we can abide calmly with what is, without desiring it to be otherwise, we are touching the true essence of compassion, which is beyond a sense of "self".

Anandamaya means composed of ananda, or bliss. In the Upanishads the sheath is known also as the causal body. Unlike the next three more outer koshas, it constitutes the karana sarira or causal body. It is associated with the state of dreamless sleep and samadhi. While in the dreaming and wakeful states, it has only a partial manifestation, but in deep sleep, when the mind and senses are still, it is accessible.

In Advaita Vedanta the Anandamaya Kosha is the innermost of the five koshas or "sheaths" that veil the Atman or Supreme Self. Anandamaya is regarded as a reflection of the Atman which is bliss absolute, without a sense of separation into I, me, or mine. The Indian Theosophist T. Subba Row states that the Anandamaya Kosha is associated with the Spiritual Soul or Buddhi principle.

In the teachings of Satguru Sivaya Subramuniyaswami (of the Himalayan Academy), the Anandamaya Kosha is not a sheath in the same sense as the four outer koshas, but rather constitutes the soul itself, a body of light. As well as being the causal body and the repository of karma, it is also the Karana citta, the "causal mind" or superconscious mind. It is said to evolve through all incarnations until finally merging in the Primal Soul, Parameshvara. It then becomes Sivamayakosha, the body of Siva.

Unlike other Vedantic philosophers, Sri Aurobindo did not consider the five selves as koshas, but instead saw them as the evolutionary principles of the Inner or True Divine Self at each plane of existence. This is the physical and energetic expression of compassion, where one is at-one, with all that is, without conflict or struggle.

Integrating Experience
It could be said that at the level of the Anandamaya Kosha, we integrate all experiences from the other koshas and then move back out into the world. This is a fluid and ongoing process, this is our yoga practice. It can be likened to what Donna Farhi calls the "democratic body community", a multiplicity of avenues for accessing our subtle energetic systems and the experience of being truly alive and awake. These are described

below, including what she calls "inquiries" or exercises to open our awareness to what it means to be in this body and of this life.

The Cellular System represents pure potential. Through it, we can access the experience of breathing into the billions of cells in the body. Each cell expands and condenses in a continual process of respiration. When we enter into cellular awareness, we experience a state of undifferentiated form and being. A technique for experiencing the cellular body begins by following the path of the breath into the lungs, into the alveoli, through the transfer of oxygen to the blood, and from the blood to all the body's cells.

The Musculoskeletal System makes up our internal architecture and is our most primary and tangible body mover. As such, it represents support and power and is able to manifest our intentions. Because of its tangible nature, this body tends to dominate our perceptions. A technique for bringing more subtle perception to the musculo-skeletal body can be practiced during yoga asanas by noticing: where in the body the mind is drawn; where the body tires first; and where the body needs support and/or release.

The Fluid System represents flow, transformation, transitions, ease, lubrication, and buoyancy. Our bodily fluids include blood, lymph, cellular fluid, cerebrospinal fluid, and synovial fluid. The quality of water allows us to adapt and change with less resistance and difficulty. We can experience the fluid body by imagining ourselves as a body of water encapsulated by our skin; feeling solid form melting away; letting go of fixed ideas; and feeling our inner pulsation rippling through the inner body.

The Organ System is used for processing and gives us weight, volume, and substance. Experiencing the organ body in yoga practice is accomplished by moving from the core, aligning ourselves from the inner body and moving outward from there. This support of the alignment of the inner body is expressed through the word "organ-ized." Exercises to experience the organ body include imagining: the sensation and path of the brain and spinal cord; the awareness of the digestive tract from the mouth, through the esophagus, the stomach, the small and large intestines, the rectum, and anus; and the sensations of the heart, lungs, liver, spleen, kidneys, etc. Yoga asanas can then be practiced with the intention of moving from the inner organs.

The Neuroendocrine System - is associated with energetic charge. The glands, with their secretion of hormones, are associated with chakras and as such are powerful places for deep transformation, enabling body, mind and spirit to meet experience as it is, without trying to change, manipulate or avoid.

In many ways, the Anandamaya kosha can be seen as the yoga, the meeting place of all experience. And it is here, where the practice flourishes and compassion can flow: as we remain with experience, our hearts open and ananda (bliss) flows in.

REFERENCES

Caldwell, C. Getting Our Bodies Back. Body-Centred Psychotherapy. Shambhala Publishing, 1996.

Coulter, HD. *Anatomy of Hatha Yoga: A Manual for Students, Teachers, and Practitioners.* Body and Breath, 2001.

Deane, J. *Job's Body: A Handbook for Bodywork*. Barrytown/Station Hill, 2002.

Farhi, D. Yoga Mind, Body & Spirit; A Return to Wholeness. Henry Holt & Co., 2000.

Kapit, W & Lawrence ME. *Anatomy Coloring Book*. Benjamin Cummings, 2001.

Kaminoff, L. *Yoga Anatomy: Your Illustrated Guide to Postures, Movements and Breathing Techniques*. Human Kinetics, 2007.

Long R, Macivor C. *The Key Muscles of Yoga: Scientific Keys, Volume I.* BandhaYoga, 2009.

McNamara, JK. *Energy Anatomy*. Montreal Institute of Classical Homeopathy, 2009.

Moyer, D. *Yoga: Awakening the Inner Body*. Rodmell Press, 2006.

Myers, T. *Anatomy Trains: Myofascial Meridians for Manual and Movement Therapists*. Churchill Livingstone, 2008.