Chapter 8

Anatomy & Physiology

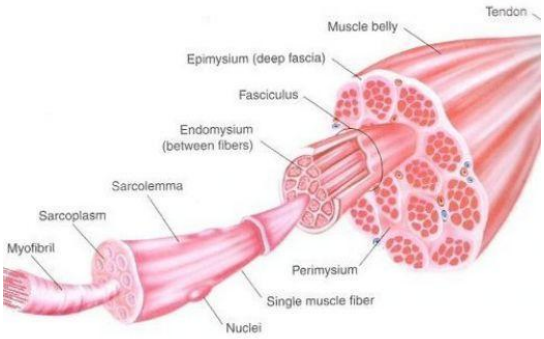


Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

Chapter 8. Anatomy

Part 1. Introduction to Anatomy & Physiology

Definitions

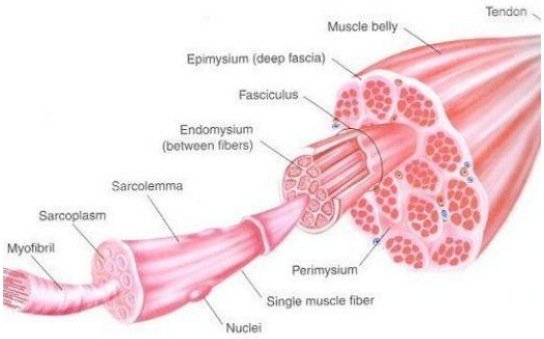
- **Anatomy**: science of body structures and the relationships among them
- **Physiology**: science of body functions; how the body parts work
- **Kinesiology**: the study of the mechanics of body movement

Levels of Structural Organization:

1. **Chemical Level:** atoms and molecules
2. **Cellular Level:** molecules combine to form cells
3. **Tissue Level** (tissue = groups of cells + materials surrounding them that work together to perform a specific function)
4. **Organ Level:** tissues join together to form organs
5. **System Level:** related organs with a common function
6. **Organism Level:** any living individual

Characteristics of the Living Human Organism

- Basic Life Processes
    1. **Metabolism:** sum of all chemical processes in the body
    2. **Responsiveness**: ability to detect and respond to change
    3. **Movement**
    4. **Growth**
    5. **Differentiation**: development of a cell from an unspecialized state to a specialized state (e.g. egg to embryo)
    6. **Reproduction**: new cells for tissue growth, repair, or replacement…or a new person!
- **Homeostasis**: equilibrium in the body's internal environment (*due to the ceaseless interplay of the body's regulatory processes)*



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- Homeostatic imbalances occur frequently!
- The body has regulatory systems that bring it back to balance: **Nervous System** + **Endocrine System**
- **Feedback Loop:** cycle of events where status of a body condition is monitored, evaluated, changed, re-monitored, reevaluated, etc.

Anatomical Directional Terms

Superior: Above, over
Inferior: Below, under

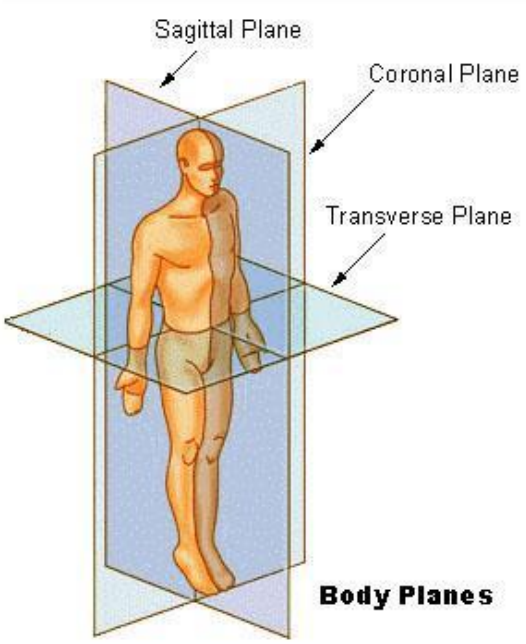
Anterior: In front of, front
Posterior: After, behind, following, toward the rear

Medial: Toward the mid-line, middle, away from the side
Lateral: Toward the side, away from the mid-line

Proximal: Near, closer to the origin
Distal: Away from, farther from the origin

Dorsal: Near the upper surface, toward the back
Ventral: Toward the bottom, toward the belly

Superficial: Closer to the surface/skin
Deep: Farther from the surface/skin



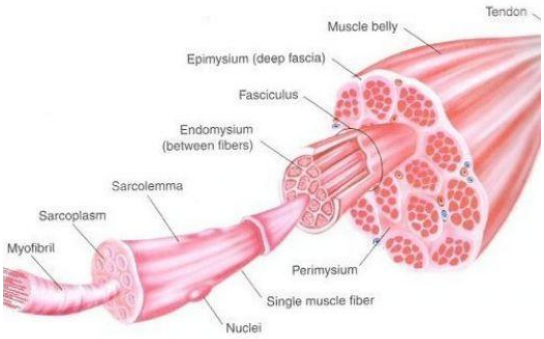
Anatomical Directional Terms Quiz

Your eyes are _____ to your chin.

Your skin is _____ to your heart.

(a) superior

(b) inferior



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Your right shoulder is _____ and _____ from your umbilicus (belly button).

In the anatomical position, your thumb is _____.

Your buttocks are _____.

Your lungs are _____ to your spinal column.

Your breastbone is _____ to your chin.

Your calf is _____ to your heel.

Your hand is _____ to your elbow.

In the anatomical position, your pinky finger is _____.

(c) anterior

(d) posterior

(e) medial

(f) lateral

(g) proximal

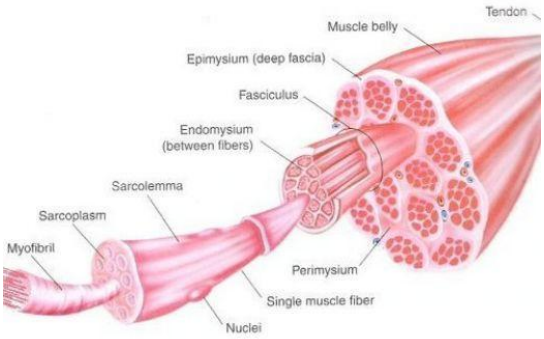
(h) distal

(i) superficial

(j) deep

The 11 Body Systems

System	Components	Functions
Integumentary System	Skin, hair, nails, sweat and oil glands	Protects body; regulate body temperature; eliminates some wastes; helps make Vitamin D; detects sensations such as touch, pain, warmth, and cold.
Skeletal System	Bones and joints, cartilage	Supports and protects the body; provides surface area for muscle attachment; aids body movements; houses cells that produce blood cells; stores minerals and lipids (fats)
Muscular System	Muscles composed of skeletal muscle tissue	Produces body movements; stabilizes body posture; generates heat



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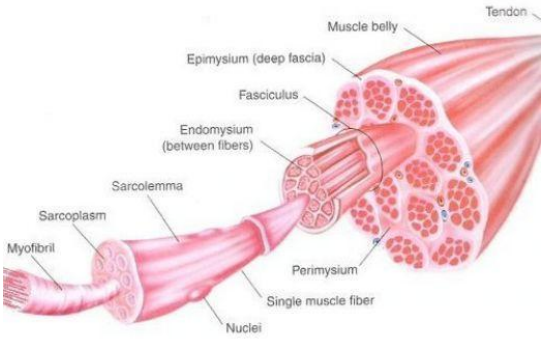
	(because it attaches to bones)	
Nervous System	Brain, spinal cord, nerves, and special sense organs, such as eyes and ears	Generates action potentials (nerve impulses) to regulate body activities; detects changes in body's internal and external environment, interprets the changes, and responds by causing muscular contractions or glandular secretions.
Endocrine System	Hormone-producing glands, such as ● Pineal gland ● Hypothalamus ● Pituitary gland ● Thymus ● Thyroid gland ● Parathyroid gland ● Adrenal glands ● Pancreas, and ● Overies and Testes; Hormone-producing cells in other organs.	Regulates body activity by releasing hormones, which are chemical messengers transported in blood from the gland to an organ.



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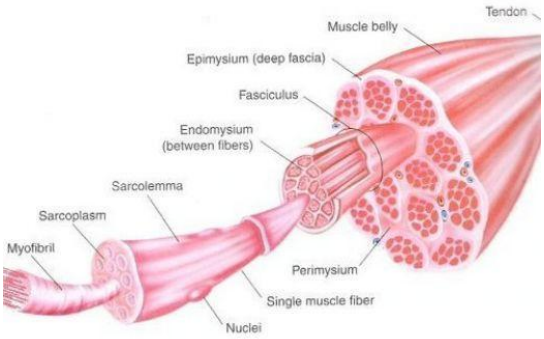
Circulatory (Cardiovascular) System	Blood, heart, and blood vessels	Heart pumps blood through blood vessels; blood (a) carries oxygen and nutrients to cells and, (b) carries CO_2 and wastes away from cells, and (c) regulates acid-base balance, temperature, and water content of body fluids; blood components help defend against disease and mend damaged blood vessels
Lymphatic System + Immunity	Lymphatic fluid and vessels; spleen, thymus, lymph nodes, and tonsils	Returns proteins and fluids to blood; carries lipids from GI Tract to blood; includes structures where lymphocytes that protect against disease-causing microbes mature and proliferate
Respiratory System	Lungs and air passageways (pharynx, larynx, trachea – and bronchial tubes leading in/out)	Transfers oxygen from inhaled air to blood and CO_2 from blood to exhaled air; helps regulate acid-base balance of body fluids; air flowing out of lungs through vocal cords produces sound
Digestive System	Organs of GI Tract (mouth, pharynx, esophagus, stomach, small and large intestines, and anus); Accessory organs such as salivary glands, liver, gallbladder, and pancreas	Achieves physical and chemical breakdown of food; absorbs nutrients; eliminates sold wastes
Reproductive System	Gonads (ovaries or testes) and associated organs (uterine tubes, uterus and vagina OR epididymis, ductus deferens, and penis)	Gonads produce gametes (sperm or oocytes) that unite to form a new organism; Gonads also release hormones that regulate reproduction and other



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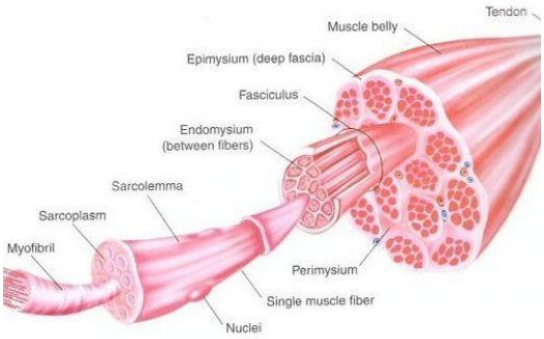
		body processes; associated organs transport and store gametes.
Urinary System	Kidneys, ureters, urinary bladder, and urethra	Produces, stores, and eliminates urine; eliminates wastes and regulates volume and chemical composition of blood; helps maintain the acid-base balance of body fluids; maintains body's mineral balance; helps regulate red blood cell production.

The 11 Body Systems (review)

(a) nervous system	1. regulates body activities through hormones (chemicals) transported in the blood to various target organs of the body	_____
(b) endocrine system	2. produces gametes; releases hormones from gonads	_____
(c) urinary system	3. protects against disease; returns fluids to blood	_____
(d) cardiovascular system	4. protects body by forming a barrier to the outside environment; helps regulate body temperature	_____
(e) muscular system	5. transports oxygen and nutrients to cells; protects against disease; carries wastes away from cells	_____
(f) respiratory system	6. regulates body activities through action potentials (nerve impulses); receives sensory information; interprets and responds to the information	_____
(g) digestive system	7. carries out the physical and chemical breakdown of food and absorption of nutrients	_____
(h) skeletal system	8. transfers oxygen and CO_2 between air and blood	_____
		_____
		_____



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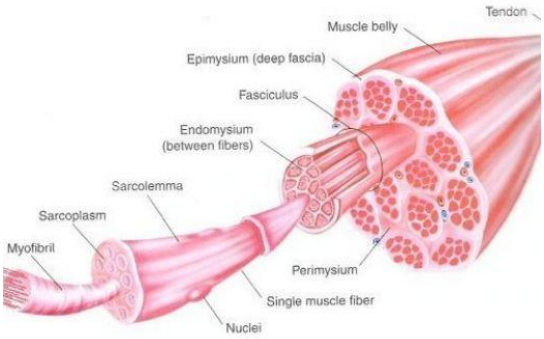
(i) integumentary system	9. supports and protects the body; provides internal framework; provides a place for muscle attachment
(j) lymphatic system and immunity	10. powers movement of the body and stabilizes body position
(k) reproductive system	11. eliminates waste; regulates the volume and chemical composition of blood



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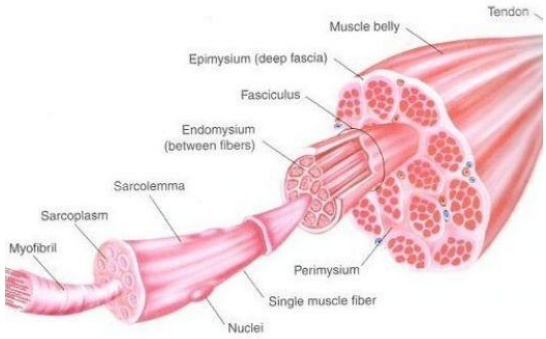
Part 2, Skeletal & Muscular Systems



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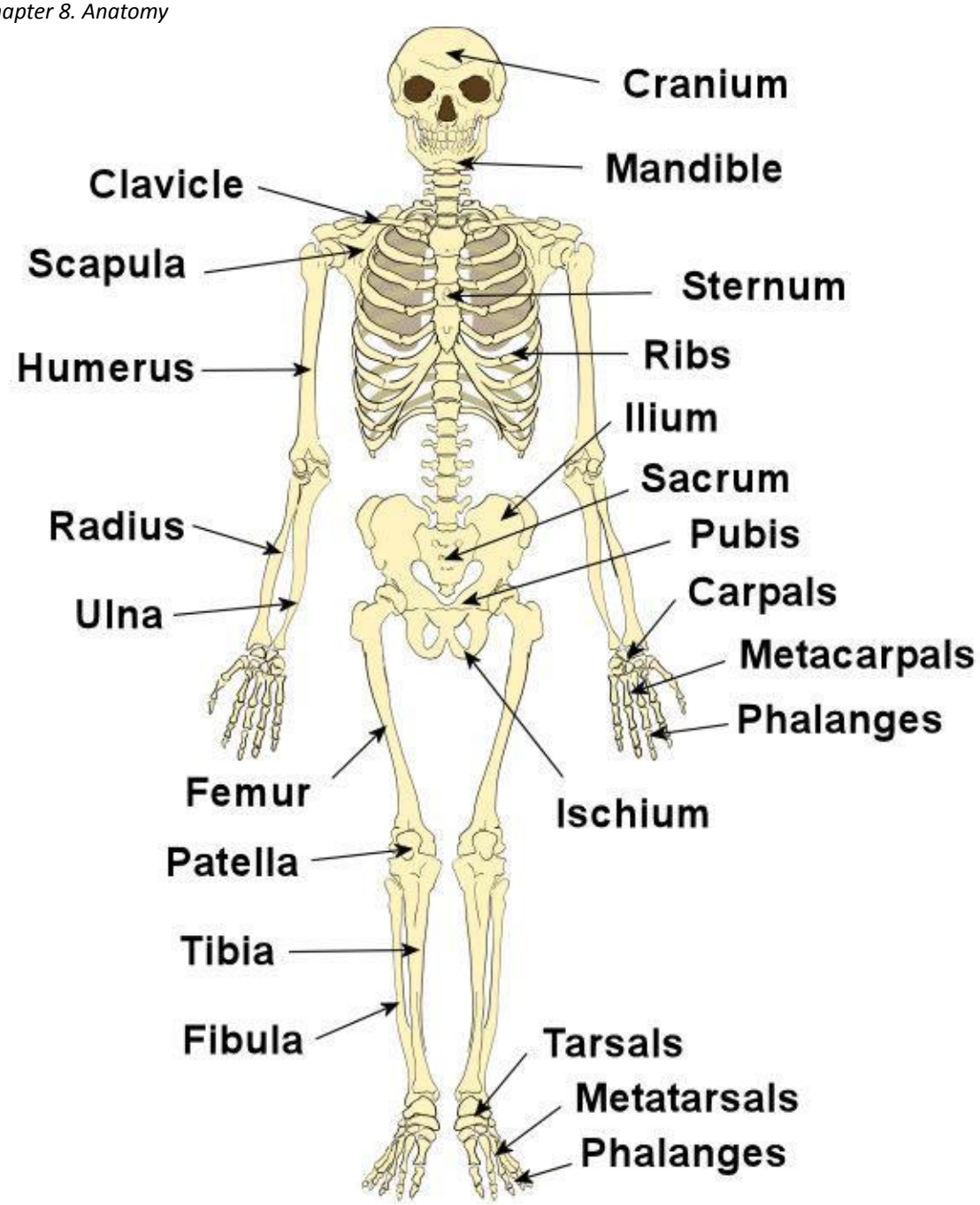

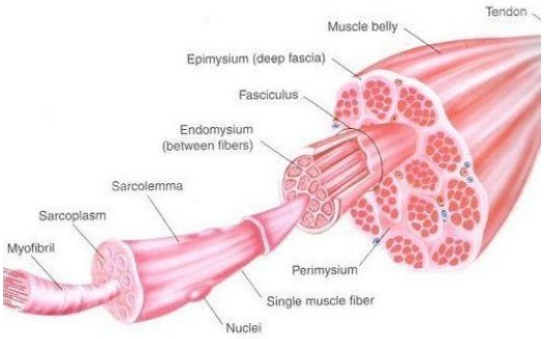

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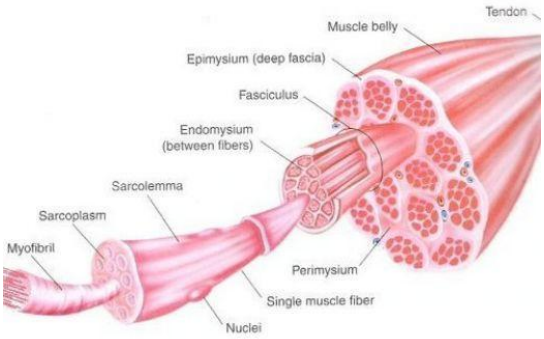
Introduction to Skeletal System:

1. Several tissues make up a bone: bone or osseous tissue, cartilage, dense connective tissue, epithelium, adipose tissue, and nervous tissue.
2. Bones are richly supplied by blood (to get calcium). Nerves accompany the blood vessels that supply the bone (e.g. why we feel pain with fractures).
3. The entire framework of bones and their cartilages constitutes the skeletal system.

The 6 Main Functions of the Bone and Skeletal System:

1. **Support.** *The skeleton is the structural framework for the body. It supports soft tissues and provides attachment points for the tendons of most skeletal muscles.*
2. **Protection.** *The skeleton protects the most important internal organs from injury. (e.g. skull protects brain, vertebrae protect spinal cord, and rib cage protects heart and lungs)*
3. **Assistance in movement.** *Most skeletal muscles attach to bones; when they contract, they pull on bones to produce movement.*
4. **Mineral homeostasis.** *Bone tissue stores several minerals, such as calcium and phosphorous. On demand, bone releases minerals into the blood to maintain homeostasis and to distribute minerals to other parts of body.*
5. **Blood cell production.** *Within certain bones,* ***red bone marrow*** *produces red blood cells, white blood cells, and platelets. In adults it is present in the pelvis, ribs, breastbone, vertebrae, skull, and ends of the bones of the arm and thigh.*
6. **Triglyceride storage.** ***Yellow bone marrow*** *consists mainly of adipose cells, which store triglycerides – a potential energy reserve.*

Exercise and Bone Tissue:



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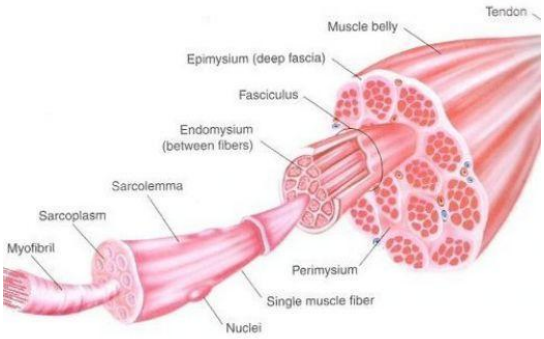
- When placed under mechanical stress (pull of skeletal muscles and pull of gravity), bone tissue becomes stronger through:
    - Increased deposition of mineral salts, and
    - Production of collagen fibers.
- Removal of mechanical stress weakens bones through demineralization and collagen fiber reduction.
- Bones of athletes, which are repetitively and highly stressed, become notably thicker and stronger than those of non athletes.

Aging and Bone Tissue:

- Two principle effects of aging on bone tissue:
    1. Loss of bone mass from demineralization (the loss of calcium and other minerals)
        - **Females:** Begins after age 30, accelerates greatly around age 45, and as much as 70% of calcium in bones is gone by age 70
        - **Males:** Begins around age 60, losing about 3% every 10 years
        - *Women's bones are generally smaller and less massive then men's, so loss of bone mass has a greater adverse effect in females.*
    2. Brittleness from a decreased rate of protein synthesis.
- Loss of bone mass and brittleness increases susceptibility to fractures, deformity, pain, loss of height, and loss of teeth.

There are 3 types of muscle tissue:

1. _____ muscle moves bones.
2. _____ muscle contracts and relaxes the heart.
3. _____ muscle lines the walls of hollow internal muscle structures (blood vessels, airways, and GI Tract.
4. The main type of muscle we should focus on when studying Anatomy for Yoga is: _____.



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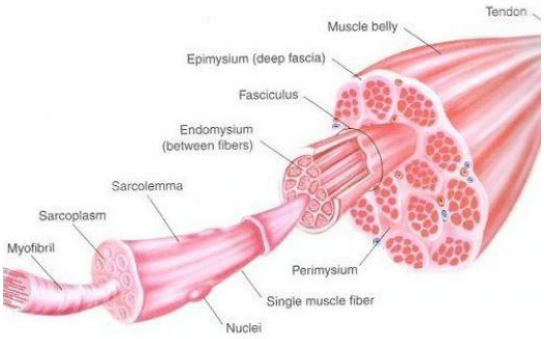
The generalized functions of muscle tissue are:

1. Movement
2. Stabilization
3. Move substances within body
    - *Cardiac muscle* pumps blood through body
    - *Smooth muscle* moves substances through GI tract and regulates blood flow/vessel diameter
    - *Skeletal muscle* moves lymph and aids blood return to the heart
4. Heat generation (thermogenesis = heat produced when muscle tissue contracts)



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Structural Anatomy of a skeletal muscle:

Muscle Metabolism: Energy + Metabolic Activities within the muscle

- Creatine Phosphate: excess ATP in resting muscle forms CP; breaks down quickly
    1. Max contraction = 15 seconds
- Anaerobic Cellular Respiration: no O_2 required; once CP is depleted, glucose breaks down to form ATP
    1. Glucose broken down → pyruvic acid (uses 2 ATP, generates 4 ATP) [*glycolysis*]
    2. Max contraction = 30-40 seconds
- Aerobic Cellular Respiration: CO_2 required; pyruvic acid is oxidized → ATP, CO_2, H_2O + heat
    1. Longer than 30-seconds of muscular activity

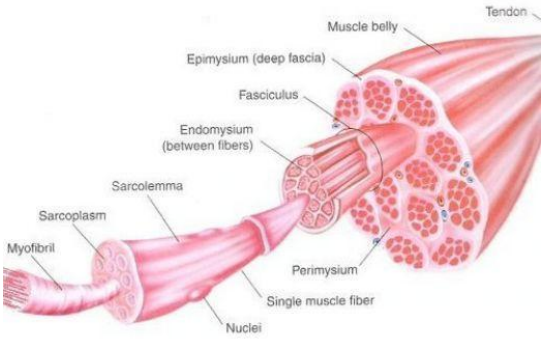
3 Types of Muscle Fibers:

	Slow Oxidative (SO)	**Fast Oxidative-Glycolitic (FOG)**	**Fast Glycolytic (FG)**
Other Name	Slow Twitch		Fast Twitch
Contraction Speed	Slow	Fast	Fast
Fatigue Resistance	High	Intermediate	Low
Energy Method	Aerobic	Both	Anaerobic
Use	Endurance + Posture	Most muscles	Lifting and throwing

- Ratio of SO to FG is genetically determined and varies, depending on exercise behaviors
- Number of fibers does not increase, but characteristics can change
  (e.g. Endurance training could convert FG to FOG or;

Weight training can increase size and strength of FG – hypertrophy)

Tendons vs. Ligaments



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Tendons connect bones to _____.

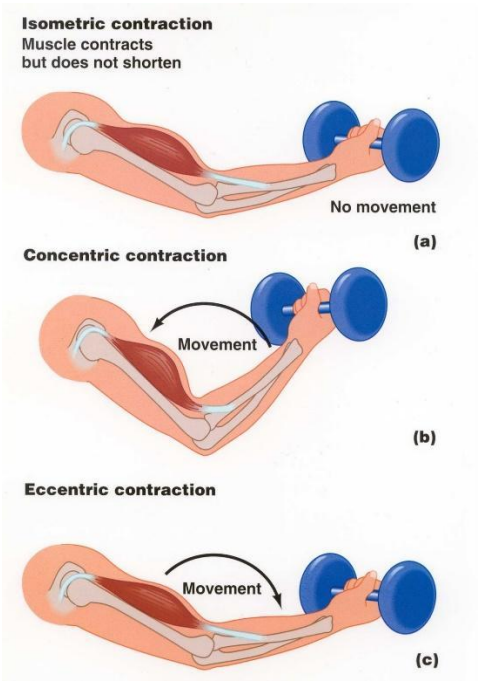
True or False? *Tendons can and will be stretched. This is how we improve flexibility and strength.*

Ligaments connect bones to _____.

They also help _____ the joint and simultaneously allow _____ .

True or False? *Ligaments have sensory nerves that send information about joint position to the spinal cord and brain.*

Muscular Contractions: Isotonic vs. Isometric

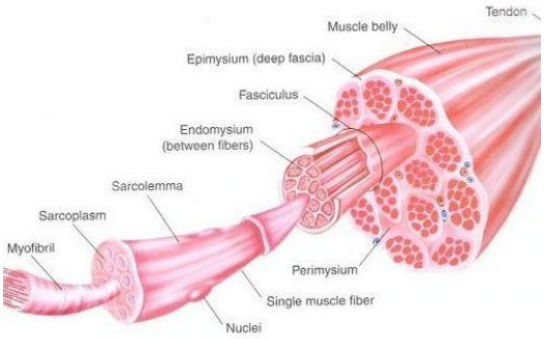


Isometric Contraction: the tension generated is not enough to exceed the resistance of the object to be moved and the muscle does not change in length. Example: biceps and triceps in phalankasana (plank pose).

Isotonic Contraction: the tension developed by the muscle remains almost constant while the muscle changes its length. Used for body movement and moving objects.

Concentric (Isotonic) Contraction: muscle shortens and pulls on another structure (e.g. tendon) to produce movement and reduce angle at a joint. Example: biceps flexing the elbow joint in chaturanga dandasana (four-limbed staff pose) or triceps extending the elbow joint in urdhva mukha svanasana (upward-facing dog).

Eccentric (Isotonic) Contraction: muscle lengthens and resists the movement of the load. Example: triceps opposing the elbow flexion in chaturanga dandasana or biceps opposing the triceps elbow extension in urdhva mukha svanasana.



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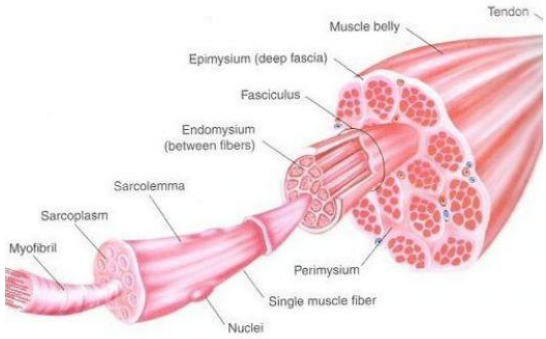
Above sections summarized from Principles of Anatomy and Physiology, 11th Edition, Tortora and Derrickson, Chapter 1 – An Introduction to the Human Body, Chapter 6 – The Skeletal System: Bone Tissue, and Chapter 10 – Muscular Tissue



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Part 3. Kinesiology

1. Classification of Joints

a. Fibrous: *no joint cavity; joint held together by* fibrous connective tissue.

***IMMOVABLE!**

(e.g. joints between the teeth and jaw sockets or the suture joints in the skull)

b. Cartilaginous: *no joint cavity; joint held together* by cartilage.

***IMMOVABLE!**

(e.g. rib to cartilage joint or the intervertebral discs)

c. Synovial: **EASILY MOVEABLE JOINTS!**

- Always have a joint cavity, articular cartilage, articular capsule, fibrous capsule, synovial membrane, and synovial fluid
- Usually have accessory ligaments
- Sometimes have articular discs, labrum, and bursae

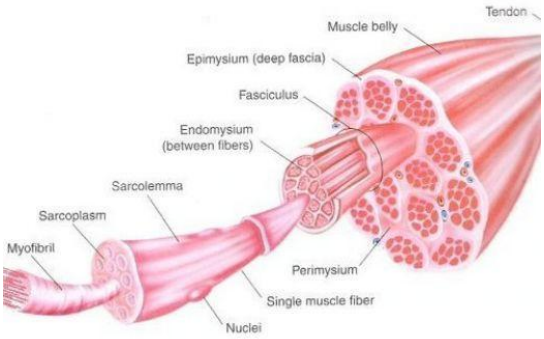
2. Synovial Joints: the most common and functionally important types of joints in the body – especially when dealing with movement, exercise, and yoga!

a. Function

1. Permit mobility of one bone against another
2. Provide stability of the articulation between bones

b. Features

1. Always Have:
   - a joint cavity between the articulating surfaces, which is filled with synovial fluid
   - articular cartilage, which covers and protects the surface of the articulating bones
   - an articular capsule that consists of a
     - joint capsule, which is lined with a



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- synovial membrane, which secretes , which secretes new synovial fluid, absorbs old , absorbs old synovial fluid, and is susceptible to inflammation.

2. Usually Have:
   - Accessory ligaments, which function in strengthening the articular capsules.
3. Sometimes Have:
   - Articular discs, which are usually fibrocartilaginous pads that protect and hold the bones together where the joits are incongruous, e.g. meniscus of the knee
   - Labrum: a fibrocartilaginous ring, which deepens the articular surface of one of the bones, e.g. the glenoid labrum of the shoulder joint complex

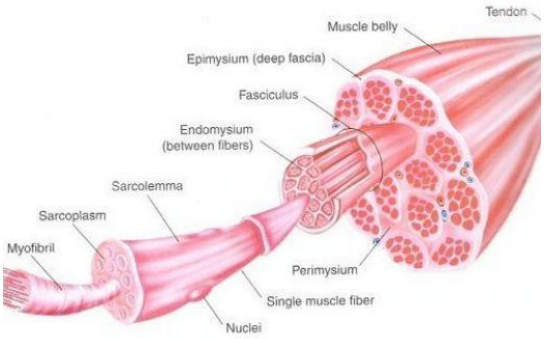
c. Synovial Fluid fills the joint or synovial cavity.

- Provides lubricant for joint motion
- Is a nutritive source for the articular cartilage
- Aids in removal of metabolic waste products from articular cartilage
- Is susceptible to inflammation
- The viscosity of the synovial fluid varies with the environmental conditions (heat = less viscous/more thin and runny; cold = more viscous/thicker and less runny)

JOINTS ARE MORE FLEXIBLE WHEN THEY ARE WARM AND/OR ARE IN AN ALKALINE STATE.

What is the implication for a yoga practice?

d. Types of Synovial Joints



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1. **Gliding (Planar) Joints** (carpals of wrist)
   gliding or sliding movements — *gliding movements*
2. **Hinge** (elbow)
   like a door hinge — *flexion & extension*
3. **Pivot** (atlanto-axial joint)
   one bone rotates around the other — *rotation*
4. **Condyloid** (wrist)
   irregular / concave & convex — *flexion & extension*, *abduction & adduction*
5. **Saddle** (carpals & metacarpals)
   resemble a saddle — *same as above*
6. **Ball & Socket** (shoulder & hip)
   — *all movements except gliding*
7. **Compound** (knee)
   condyloid & saddle — *flexion & extension*

e. Movements around a Synovial Joint:

1. Flexion and Extension

Flexion: decrease in angle between articulating bones
Extension: increase in angle between articulating bones

2. Abduction and Adduction

Abduction: movement of bone away from midline
Adduction: movement of bone toward the midline

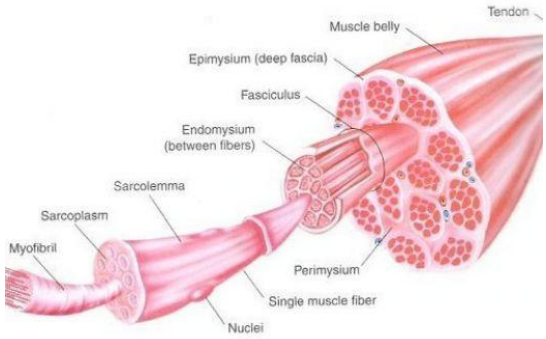
3. Circumduction

Circumduction: movement of the distal end of a body part in a circle

4. Rotation (Lateral/External and Medial/Internal)

Lateral Rotation: anterior surface of bone is turned toward the midline
Medial Rotation: anterior surface of bone is turned away from the midline

5. Elevation and Depression (shoulder blade & TM joint)



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Elevation: upward movement of a part of body (closing mouth, shrugging shoulders)
Depression: downward movement of a part of body (opening mouth, returning shrugged shoulders back to anatomical position)

6. Protraction and Retraction

Protraction: movement of body part anteriorly in the transverse plain (jutting jaw forward, protraction of clavicle when arms are crossed)
Retraction: movement of protracted body part back to anatomical position (squeeze shoulder blades together)

7. Inversion and Eversion (ankle)

Inversion: sole of foot moving medially, so the soles face each other
Eversion: sole of foot moving laterally, so the soles face away from each other

8. Dorsiflexion and Plantarflexion (ankle)

Dorsiflexion: flexing ankle joint – moving dorsal (top) part of foot closer to shin
Plantarflexion: pointing foot – or flexing the plantar portion of your foot – or moving dorsal (top) part of foot away from shin

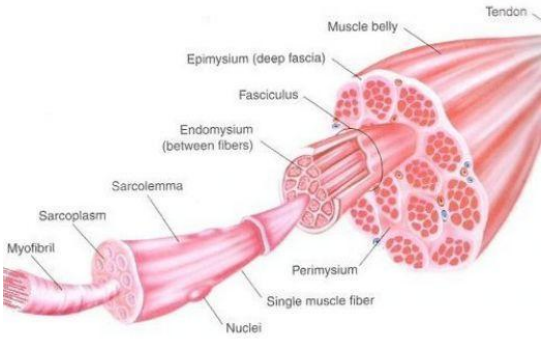
9. Supination and Pronation (elbow)

Supination: movement in forearm to turn palm anteriorly
Pronation: movement in forearm to turn palm posteriorly

10. Anterior Pelvic Tilt and Posterior Pelvic Tilt (pelvis)

Anterior Tilt: forward and downward movement of pelvic bone
Posterior Tilt: backward and upward movement of pelvic bone

Flexion, Extension, Hyperextension and Lateral Flexion



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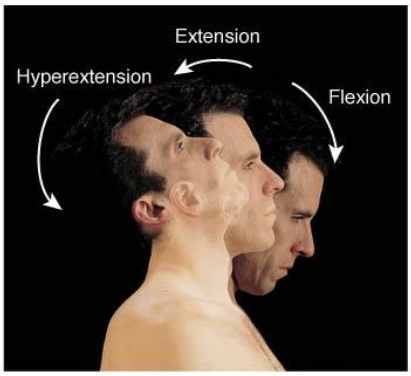
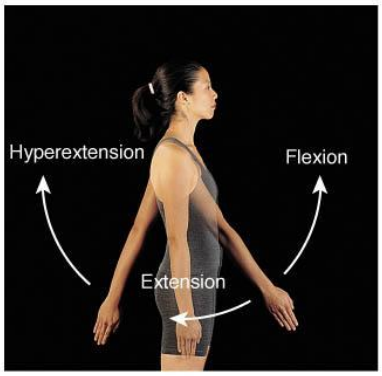
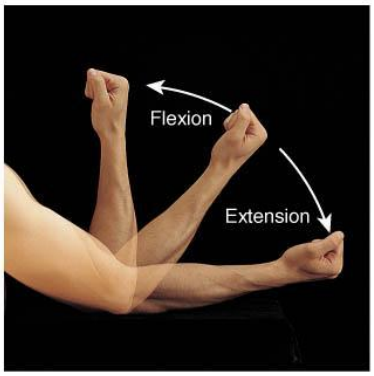


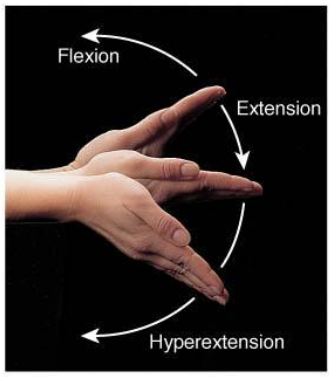
(a) Joints between atlas and occipital bone and between cervical vertebrae



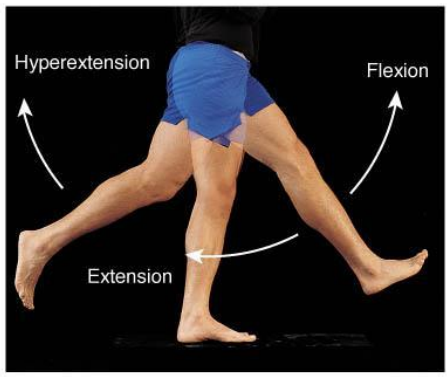
(b) Shoulder joint



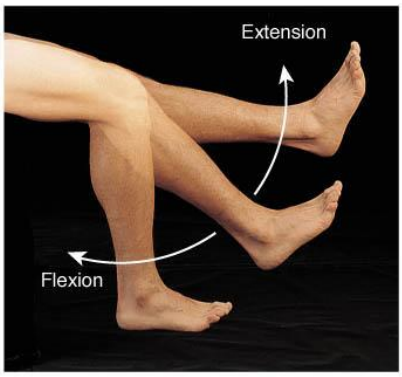
(c) Elbow joint



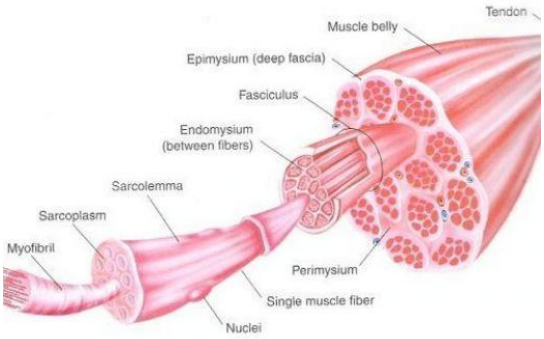
(d) Wrist joint



(e) Hip joint



(f) Knee joint



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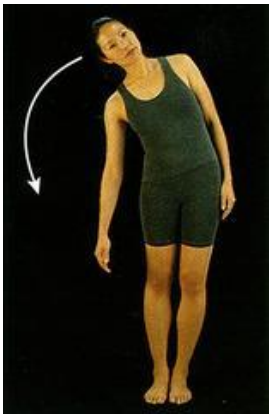
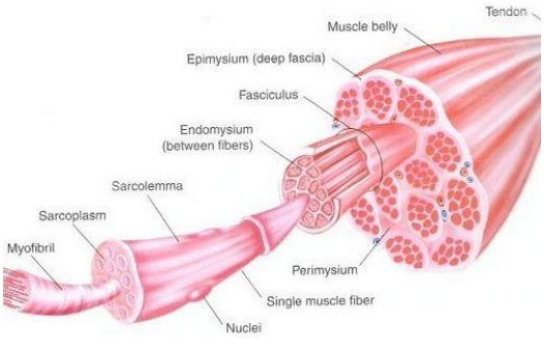


← Lateral Flexion

(g) Intervertebral joints



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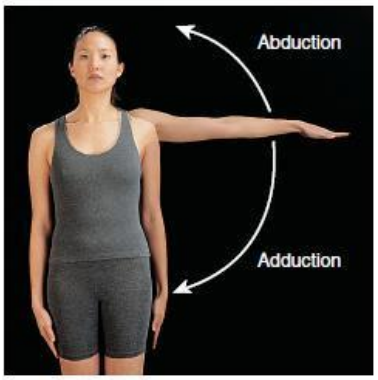
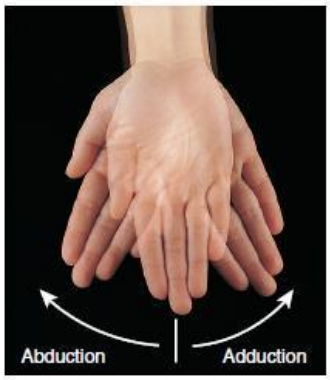
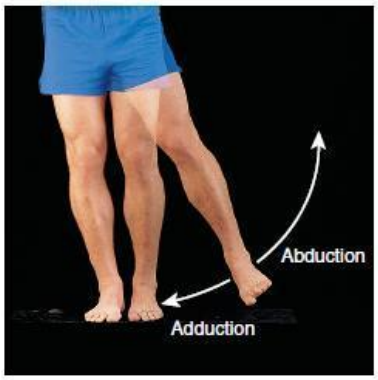
Abduction and Adduction



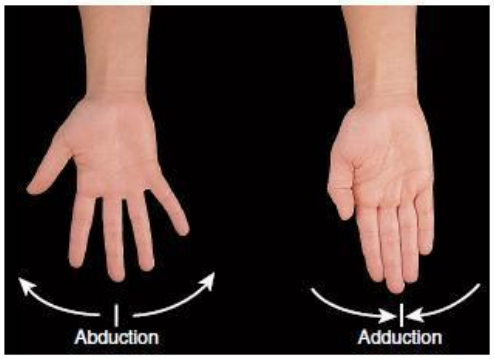
(a) Shoulder joint



(b) Wrist joint



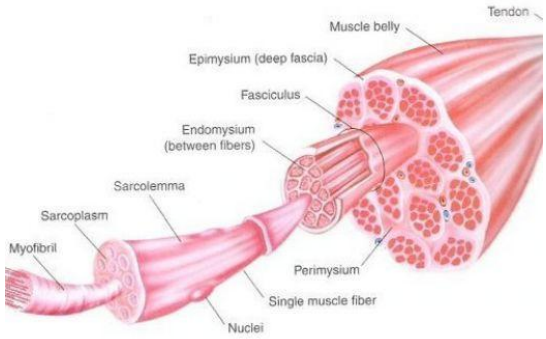
(c) Hip joint



(d) Metacarpophalangeal joints of the fingers (not the thumb)

Circumduction

Anterior & Posterior Pelvic Tilt



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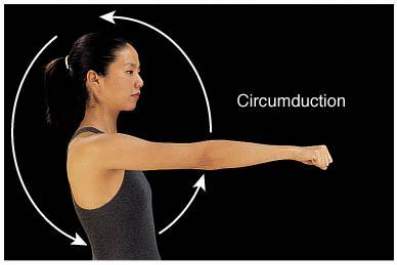
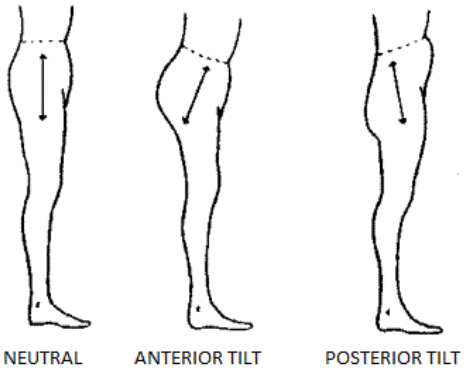
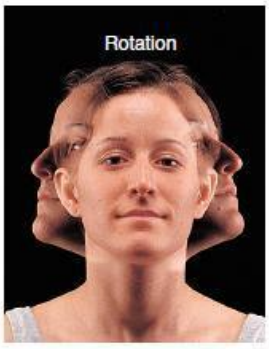


(a) Shoulder joint

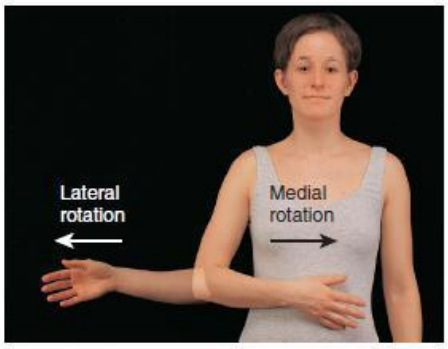
(b) Hip joint



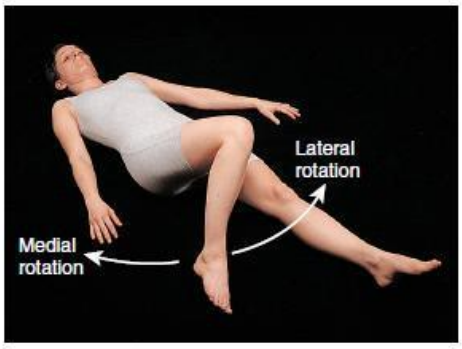
Rotation



(a) Atlanto-axial joint

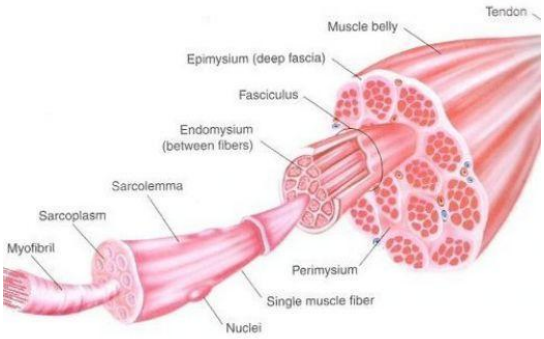


(b) Shoulder joint



(c) Hip joint

Special Movements



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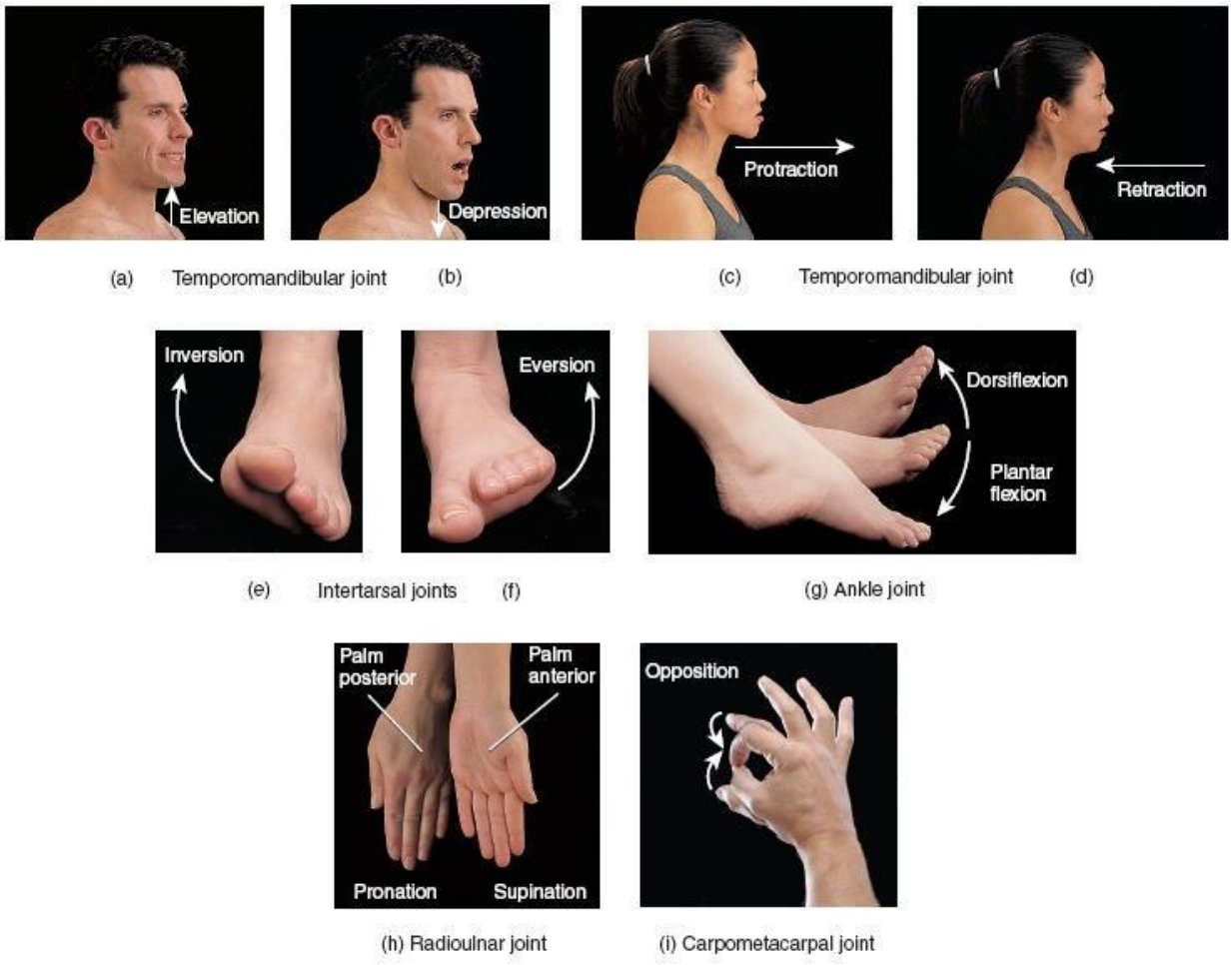

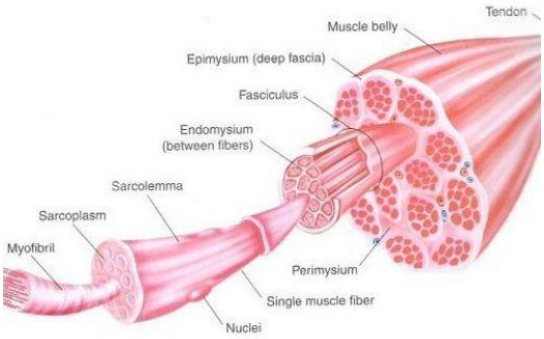

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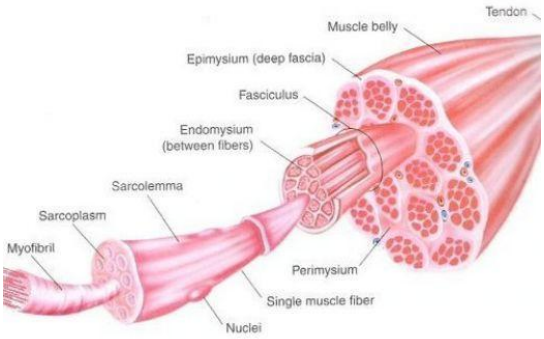
Joint Complexes

1. Cervical Spine (Neck) Joint Complex
2. Thoracic Spine (Upper Back) Joint Complex
3. Lumbar Spine (Lower Back)Joint Complex
4. Shoulder Joint Complex
5. Elbow Joint Complex
6. Wrist Joint Complex
7. Ankle Joint Complex
8. Hip Joint Complex
9. Knee Joint Complex

- **Joint Diseases**
  a. **<u>Inflammatory Joint Diseases</u>**: conditions of the synovial membrane due to systemic diseases, infections, and/or unknown causes
     1. **Rheumatoid Arthritis:** the SF becomes thinner and increases in amount, causing the joint to swell and become painful with a loss of movement and stability
        - Synovial membrane becomes more vascular, more permeable, and accumulates inflammatory cells and debris
        - The cartilage may get completely eroded, which is usually followed by fibrous connective tissues joining the bony ends together. (*the joint may then ossify and become immovable*)

  b. **<u>Degenerative Joint Diseases</u>**: involve localized wearing or deterioration of articular cartilage
     2. **Osteoarthritis:** results from a combination of aging, irritation of the joints, and wear and abrasion – commonly called “wear and tear arthritis”
        - Non-inflammatory progressive disorder of moveable joints, especially those bearing weight
        - Slow degeneration of cartilage, but rarely any change in synovial membrane



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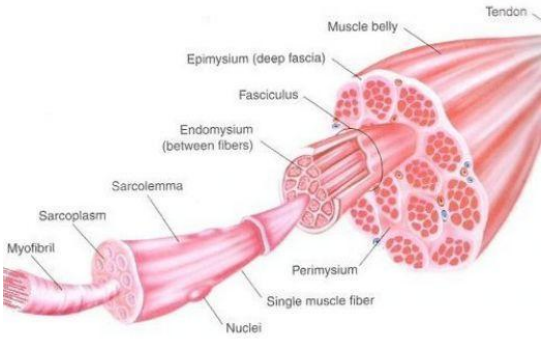
- The bone ends gradually become exposed and small bony bumps or spurs of new bony tissue appear, which reduces the size of the joint cavity and thus limits pain-free movement.



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Muscles Move Bones

Agonist: muscle that concentrically contracts to produce the action around a joint.

Antagonist: muscle that eccentrically contracts while the agonist concentrically contracts.

E.G. Knee Flexion

Which muscle is the agonist? _____

Which is the antagonist? _____

E.G. Knee Extension

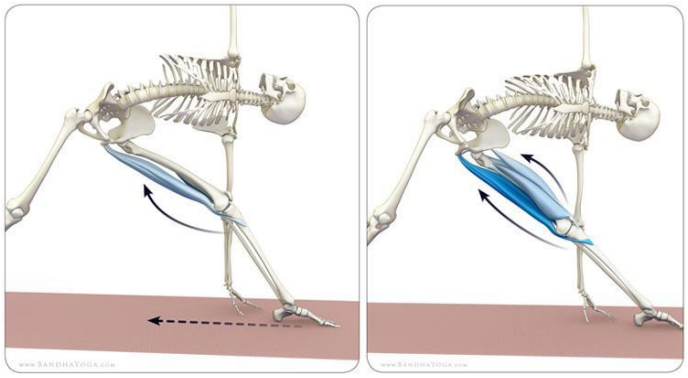
Agonist? _____

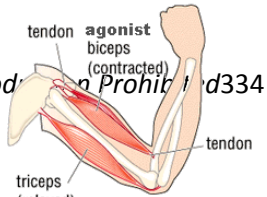
Antagonist? _____

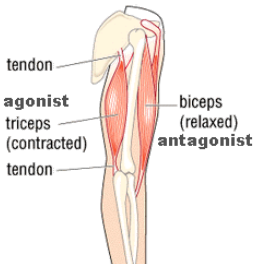
Synergist: muscle that assists the agonist

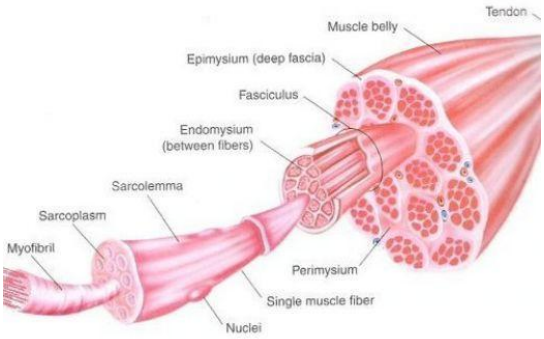
E.G. Knee Flexion

Is there a synergist? If so, which muscle(s)? _____









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The Bandhas and Protecting the Joints

Bandha: *(transl: to lock) a subtle internal energetic lock or grip. Used to control and guide the energy gathered and generated by the internal body pressures created during asana and pranayama.*

On a more physical level, a bandha is the co-activation of opposing muscles around a joint complex that helps stabilize, strengthen, and energize that joint. Depending on the type of agonist/antagonist movement that takes place, a joint will either be expanded or compressed.

- Co-activations of opposing muscles across joint complexes, which forms these bandhas, may also create heat energy (prana) which is pushed and pulled along the *nadis* by different pressure gradients…which helps activate the various *chakras.*
- The bandhas can be used to stiffen weak, yet flexible, parts of the body in order to access stiff parts of the body
- A Safe Approach to Using Bandhas in Asana: ***Sthira Sukham Asanam (PYS 2.46)***

The 3 Central or Spinal Bandhas

1. Jalandhara Bandha (neck joint complex)

2. Uddiyana Bandha (upper back joint complex)

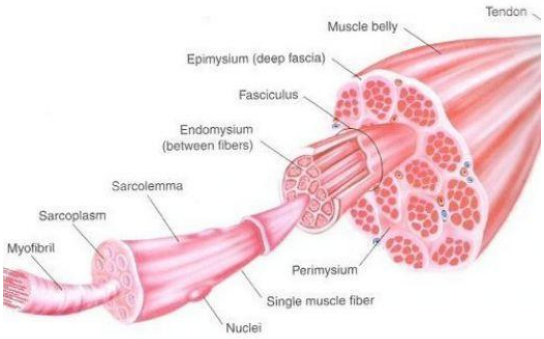
3. Mula Bandha (lower back joint complex – lumbar (T1-L1) through coccyx, and includes sacrum and SI joint)

The 3 Upper Limb Peripheral Bandhas

1. Amsa Bandha (shoulder joint complex)

2. Kurpara Bandha (elbow joint complex)

3. Mani Bandha (wrist joint complex)



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The 3 Lower Limb Peripheral Bandhas

1. Kati Bandha (hip joint complex)

2. Janu Bandha (knee joint complex)

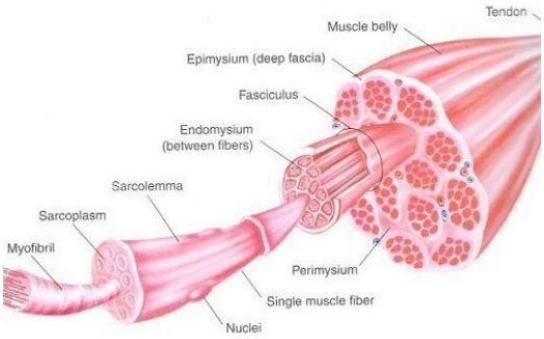
3. Kulpha Bandha (ankle joint complex)

Finding the Balance between Strength, Flexibility, and Relaxation

Hatha Yoga is commonly thought of as a series of static and passive exercises (both stretching and relaxation) that lead to meditation. Because of this, it is not often realized that the flexibility that yoga practitioners often obtain is always balanced with muscular strength!

Thus, the attributes of flexibility, strength, and relaxation are developed concurrently through a practically-applied understanding of the principles of anatomy and physiology.

1) Observation of body symmetry and asymmetry in yoga postures can help identify problems
2) Yoga aimed at one body system can also affect other systems
3) Condition of one's connective tissue affects one's flexibility
4) Ligaments are dense regular connective tissue that join bone to bone. *PROTECT LIGAMENTS FROM OVERSTRETCHING*
5) Tendons are dense regular connective tissue that join muscle to bone. *INCREASE TENDON STRETCHING WITH MUSCLE STRETCHING*
6) Enhance muscle stretching and nerve tensioning with movement and muscle activation to increase body heat
7) Aim to stretch the fascia, not the ligaments or joint capsule
8) Protect cartilage with some muscle tension while stretching
9) Regulate the amount of air you breathe and modify your diet to improve joint flexibility
10) Bone density and shape can change with regular yoga practice
11) Joints are more flexible when they are warm and/or in an alkaline state
12) Muscles, tendons, and ligaments are more flexible when they are warm and/or in an alkaline state
13) Yoga asana uses isometric (static) and istonic (concentric & eccentric) strengthening



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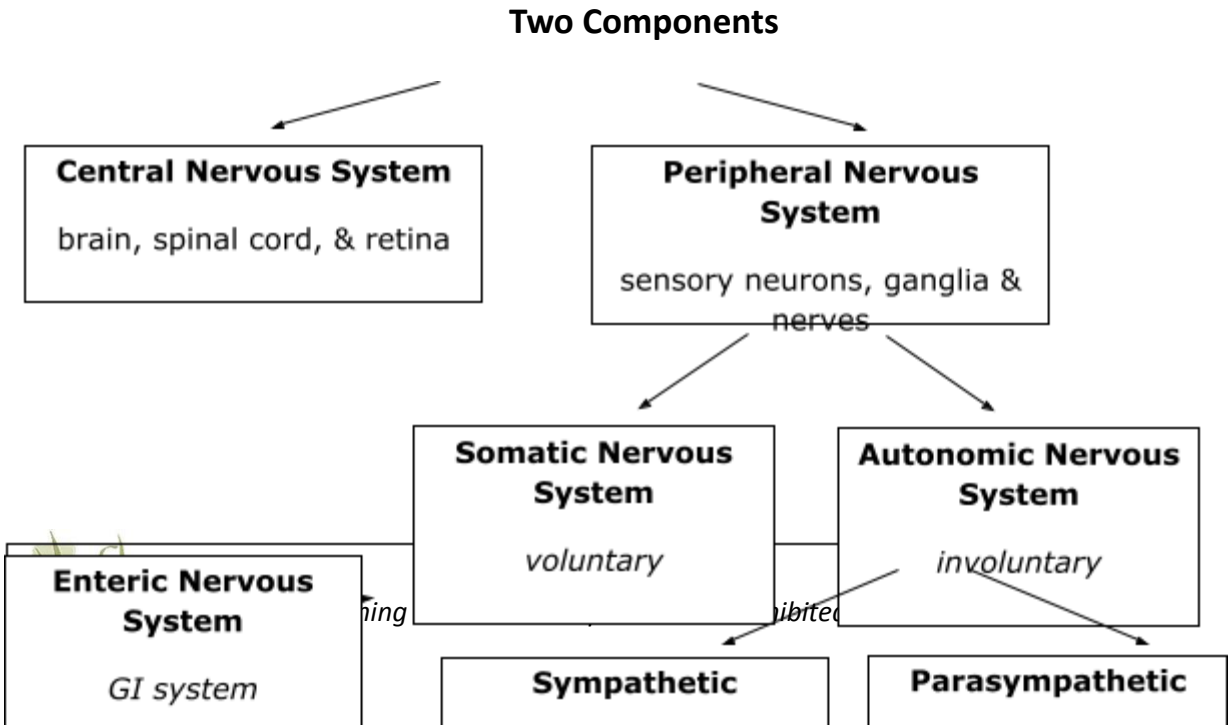
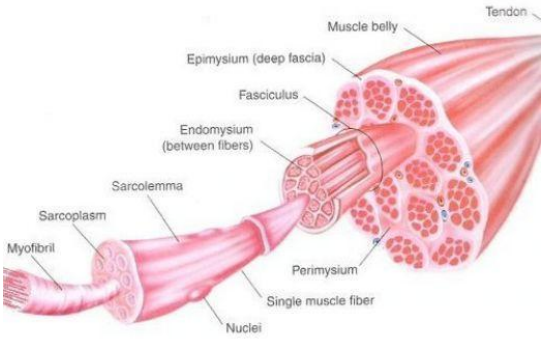
14) Use your muscles to enter a posture
15) Be aware and apply caution when stretching nerves
17) Inhibit the **myotatic stretch reflex** when stretching by generally avoiding **ballistic stretching** (dynamic bouncing in and out of poses). **An experienced yoga practicioner may have the skills to stretch safely with ballistic stretching – but not recommended for most people.*
18) Use the **reciprocal reflex** to relax muscles being stretched (e.g. to relax the hamstrings, activate the quadriceps).
19) Use bandhas to stiffen weak flexible parts of the body in order to access stiff parts of the body
20) Sthira Sukham Asanam: asana should be steady and comfortable….or asana should bring you steadiness and comfort!
21) If you can't breathe, then you probably shouldn't pose!

Summarized from Applied Anatomy & Physiology of Yoga, Simon Borg-Olivier and Bianca Machliss. Yoga Synergy, *Chapter 1 – Introduction to the Applied Anatomy & Physiology of Hatha Yoga*

Part 4, The Other (9) Body Systems

The Nervous System





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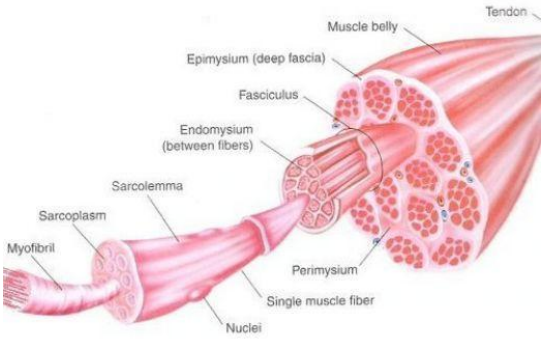
Somatic Nervous System – voluntary control of body movements via nerve signal transmissions

- Sensation = conscious or subconscious awareness of changes in the internal or external environment
    - How does this apply to a yoga class?
- Sensory modalities:
    - General Senses
        - Somatic Senses
            - Tactile (touch, pressure, vibration)
            - Thermal (warm + cold)
            - Pain (incl. visceral pain)
            - Proprioception
    - Special Senses
        - Smell, taste, vision, hearing, equilibrium, and balance

Autonomic Nervous System - responsible for many of the body's involuntary functions

- Beyond our conscious control
- Regulates activity of smooth muscle, cardiac muscle, and certain glands
- Receives input from limbic system and other regions of the cerebrum
- Controlled by the hypothalamus
    - regulates the secretion of hormones
        - key stress hormones



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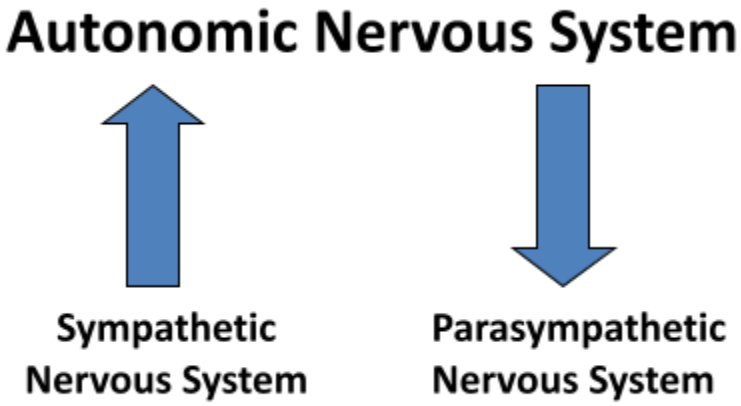
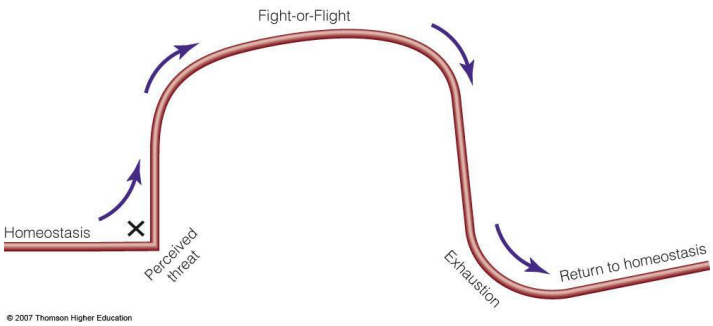
- adrenaline
- Cortisol

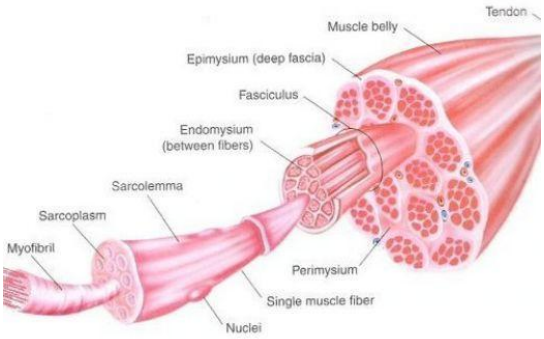
- Sympathetic vs. Parasympathetic



Sympathetic Nervous System (a/k/a the stress response)

- Initiates the fight-or-flight response (big bear example)
- Activated whenever there is a *perception* of potential danger or pain
- Immediately increases power, speed, and strength
- The stress response is a response to threats and danger
- It is a complex interaction between nerves, muscles, hormones and organs
- Homeostasis
    - state in which the body functions efficiently and comfortably
    - disturbed by stress





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The Stress Response in Today's World

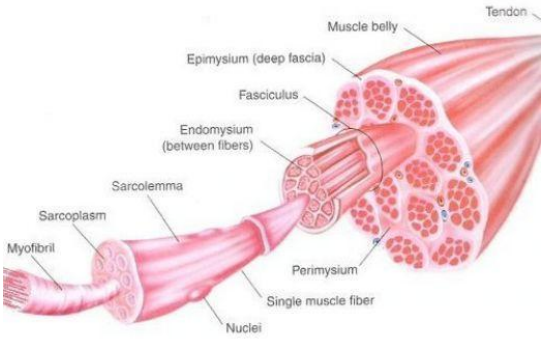
- the fight-or-flight response is inappropriate to today's social stresses
- many situations **other than imminent physical danger** can trigger the stress response
    - Examples?
- our bodies are unable to distinguish between life-threatening dangers and everyday sources of stress

Components of Body & Brain Affected by Stress

- Brain
- Autonomic Nervous System
    - (Sympathetic + Parasympathetic)
- Endocrine System
- Cardiovascular System
- Respiratory System
- Gastrointestinal (digestive) System
- Immune System
- Muscles
- Skin
- And pretty much everything else!

Activation of the Sympathetic Nervous System (Stress Response)

- Increased mental activity
- Increased secretion of adrenaline and cortisol into the bloodstream and to every cell in the body
- Increased heart rate



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- Increased cardiac output
- Increased blood pressure
- Increased breathing rate
- Dilation of breathing airways
- Increased metabolism
- Increased oxygen consumption
- Increased oxygen to the brain
- Shunting of blood away from the digestive tract and directing it into the muscles and limbs
- Increased muscle contraction, which leads to increased strength
- Increased blood coagulation (blood-clotting ability)
- Increased circulation of free fatty acids
- Increased output of blood cholesterol
- Increased blood sugar released by the liver to nourish the muscles
- Release of endorphins from the pituitary gland
- Dilation of the pupils of the eyes
- Hair standing on end
- Blood thinning
- Increased brainwave activity
- Increased secretion by sweat glands
- Increased secretion from apocrine glands, resulting in foul body odor
- Immune system is suppressed
- Blood vessels are constricted, except the vessels that go to the muscles used for running and fighting
- Reproductive and sexual systems stop working normally
- Digestive system stops metabolizing food normally
- Excretory system turns off
- Saliva dries up
- Pain perception decreases
- Kidney output decreases
- Bowel and bladder sphincter close

Activation of the Parasympathetic Nervous System (Relaxation Response)

- returns the body to a state of homeostasis or balance

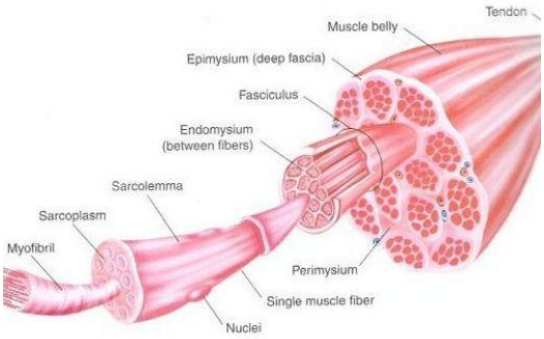


Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

- restores calm and promotes relaxation
    - **S**
    - **L**
    - **U**
    - **D**
    - **D**

The General Adaptation Syndrome to Stress

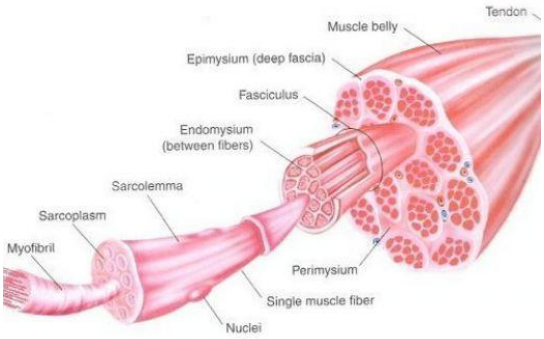
- Phase 1: Alarm Reaction
- Phase 2: Stage of Resistance
- Phase 3: Stage of Exhaustion

Phase 1: Alarm Reaction

- The body's resistance to physical damage drops for a short-time, as it prepares to cope with the stressor
- Some of our defenses against physical damage temporarily drop ⇒
    - blood pressure increases
    - blood-sugar rises
    - muscle tension increases
    - we breathe faster and deeper
    - we get a surge of adrenaline-like substances to give us extra physical capabilities should we need them.
    - If the stressor goes away, the body returns to its normal level of resistance.

Phase 2: Stage of Resistance

- If the stressor persists, (we do not fight or fly…or we don't apply stress management techniques) our level of resistance increases beyond normal, relaxed levels.
- Our bodies start to run in **higher gear**.
- High levels of stress hormones continue to help us cope with the stressor.
    - The body can continue for days, weeks, even years until either the stressor is suddenly removed or our body simply collapses, often with more dangerous and extreme physical reactions.



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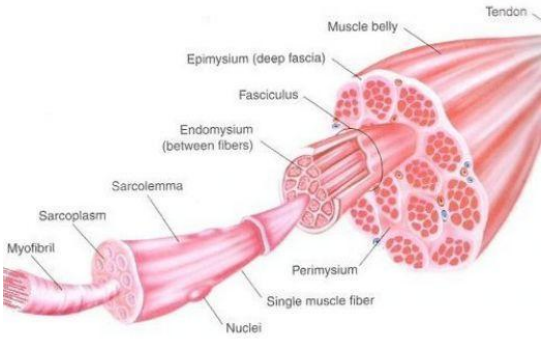
- These extreme physical reactions are usually the same as in the alarm phase only more intense and more relentless.

Phase 3: Stage of Exhaustion

- This is the phase where our health suffers or death can occur.
- Our level of resistance to physical disorder, disease (dis-ease) and psychological pressure is at its lowest.
- Feelings of lethargy, the "weekend headache," illness during the holidays, anxiety, depression, etc.
    - These reactions typically occur AFTER the stressor is removed (b/c we have to *payback our overdrawn stress account!*)



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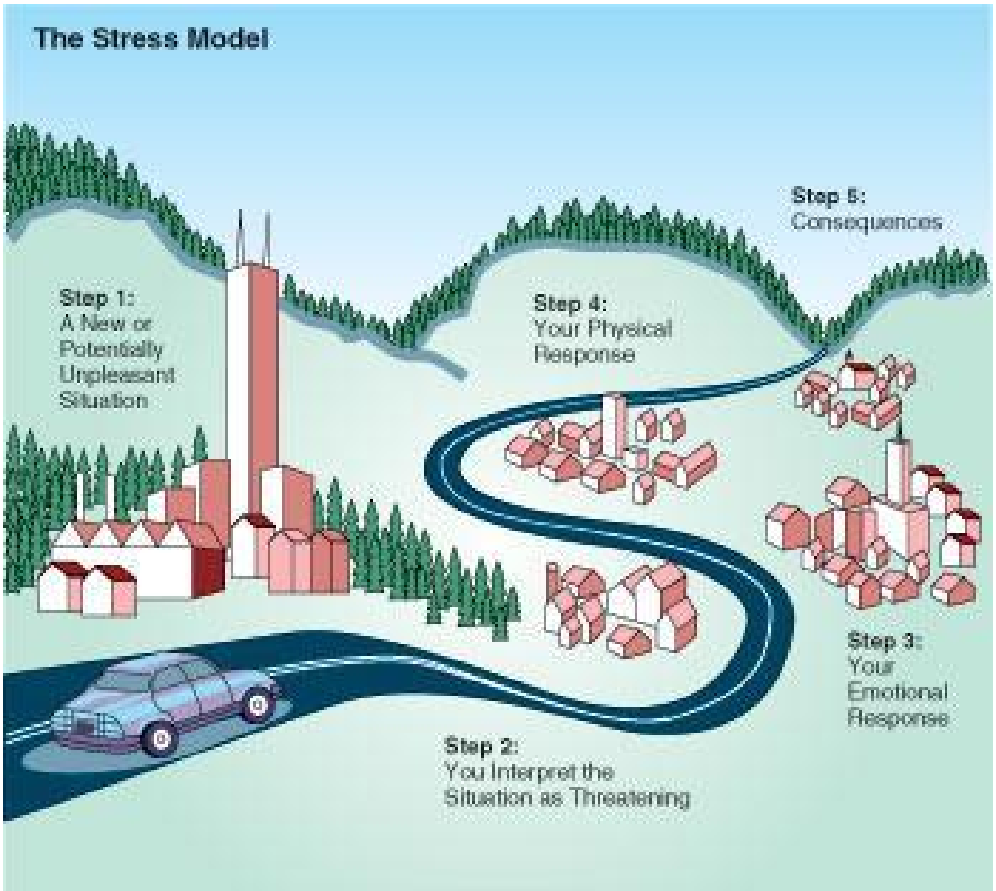
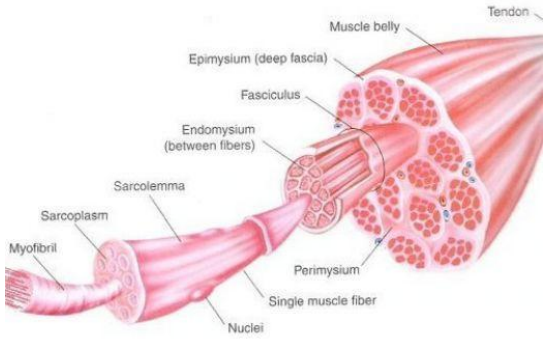
Stress Management

The fitter we are, the better our eating and drinking habits, if we do not smoke and if we are able to listen to our bodies and get periodic relief from otherwise continuing, relentless stress, the less likely we will suffer the ill effects of the exhaustion.

- **TAKEAWAY LESSON**: high levels of stress hormones are meant to be released only briefly; if they continue without enough time to recharge, our resistance is severely lessened.





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- Set up a "road block" between 1 and 2 (e.g. Vitarka Badhane Pratipaksha Bhavanam, or thought stopping, or ask "Am I going to die from this?," or "Will I remember this in 10 years?," or consider the worst-case-scenario…and more!

- Use yogic philosophies (and other emotional management techniques) to manage Step 3.

- Keep your body health (through diet, sleep and exercise) to manage Step 4.

The Endocrine System

Works with the Nervous System

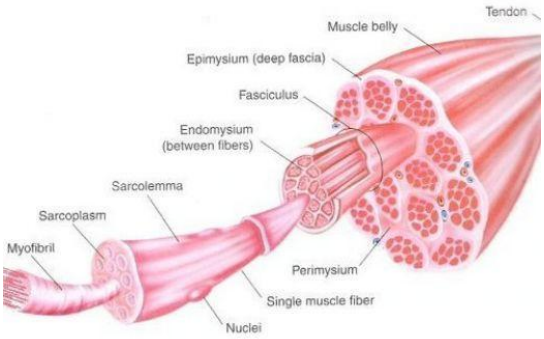
- Endocrine
    - Includes glands that secrete hormones
    - Hormones released into bloodstream and travel through body
    - These hormones change function of bodily tissues
    - Results may take hours, but last longer
- Nervous
    - Certain parts release hormones into blood
    - Rest release NTs, excite or inhibit nerve/muscle/gland cells
    - Results in milliseconds, brief duration of effects

General Function of Hormones

- Help regulate:
    - Extracellular fluid
    - Metabolism
    - Biological clock
    - Contraction of cardiac and smooth muscle
    - Glandular secretion
    - Some immune functions
- Growth & Development
- Reproduction

Endocrine Glands

- Secrete products (hormones) into bloodstream
- Pituitary, thyroid, parathyroid, adrenal, pineal



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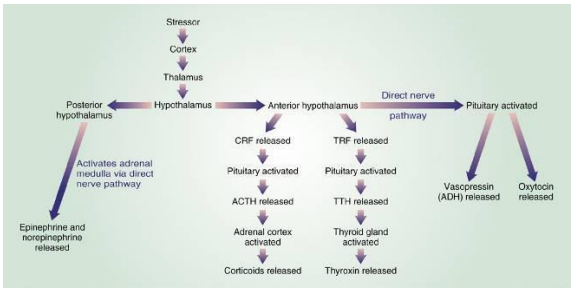
- Other organs secrete hormones as a 2nd function
    - Hypothalamus, thymus, pancreas, ovaries, testes, kidneys, stomach, liver, small intestine, skin, heart, and placenta
- Exocrine glands (counterpart to endocrine)
    - Secretes products (not hormones) into ducts which empty into body cavities or body surface
    - Sweat, oil, mucous, & digestive glands

Which Hormones are Affected by Stress?

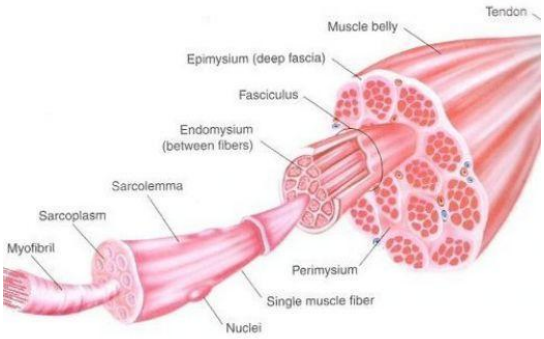
- Adrenal Cortex ⟶ Cortisol + Aldosterone
- Adrenal Medulla ⟶ Catecholamines (Epinephrine + Norepinephrine)
    - Adrenaline + Noradrenaline
- Thyroid Gland ⟶ Thyroxin
- Pituitary Gland ⟶ Vasopressin (ADH) + Oxytocin

Hormones controlled by the Adrenal Cortex



- **Cortisol:** provides fuel for "fight or flight"
    - Increase blood glucose (energy for action!)
    - Mobilizes free fatty acids from fat tissues
    - Breaks down protein
    - Increases arterial blood pressure
    - Decreases lymphocytes
- **Aldosterone:** prepares us for action
    - Increase blood pressure (so food + oxygen can get to the active parts of the body) by increasing blood volume
        - Decrease in urine production
        - Increase in sodium retention
    - What is blood pressure?

Hormones controlled by the Adrenal Medulla



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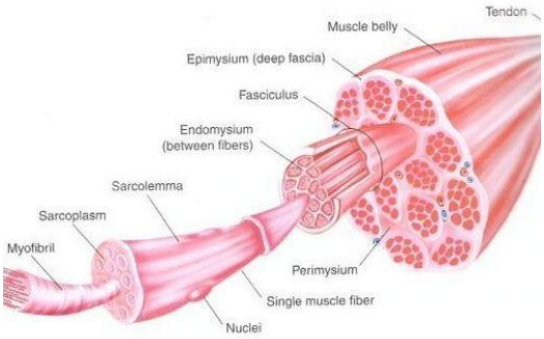
- Epinephrine (Adrenaline) + Norepinephrine (Noradrenaline)
    - Acceleration of heart rate
    - Increase in force at which blood is pumped out of heart
    - Dilation of coronary arteries
    - Dilation of bronchial tubes
    - Increase in basal metabolic rate
    - Constriction of blood vessels in muscles and skin of arms and legs
    - Increase in oxygen consumption
- *Effects remain in body 10x longer than Cortisol + Aldosterone*

Thyroid & Pituitary Glands

- Thyroxin
    - Increases basal metabolic rate, free fatty acids, and the rate of gluconeogenesis
        - Glucose production from amino acids (after no more glycogen is left)
    - Increase GI motility, HR, BP, and anxiety
    - Increase rate + depth of respiration
    - Decrease tiredness
- Vasopressin (ADH): promotes water retention by decreasing urine production (more water stays in blood)
- Oxytocin: contracts blood vessel walls
- What happens when ADH + Oxytocin are released?

Lymphatic System and Immunity

- **Resistance** = ability to ward off disease
- **Susceptibility** = lack of resistance
    - Nonspecific Resistance: general defense mechanisms that are effective on a wide-range of pathogens
    - Specific Resistance: ability to fight a specific pathogen
        - a/k/a “immunology”
            - Cell-mediated
            - Antibody-mediated



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Organs, Vessels & Lymph

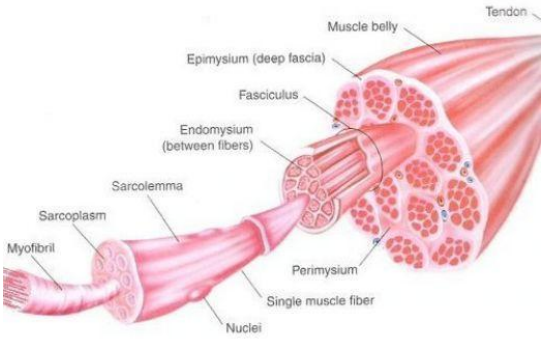
- Red bone marrow
    - Blood cell production (B-Cells: RBCs, WBCs, and platelets)
    - Prevents backflow of lymph
- Thymus
    - Production and education of T-cells
        - Helper
        - Memory
        - Natural Killer
        - Suppressor
    - Lives in front of heart, behind sternum
- Spleen (filters out old, broken-down RBCs)
- Lymph nodes (“war zone”)
- Lymph fluid = fluid that picks up bacteria in the body and brings it to the lymph nodes to be destroyed
    - Interstitial Fluid (solution that bathes and surrounds the cells in the body)
        - (main component of extra-cellular fluid)

Function of Lymphatic System

- Draining excess interstitial fluid and plasma proteins
- Transporting dietary lipids and vitamins from GI tract to the blood
- Facilitating immune responses
    - Recognizing microbes or abnormal cells & responding by killing them directly or secreting antibodies that cause their destruction

Nonspecific Response to Disease

- Immediate protection against wide variety of pathogens & foreign substances
    - Lacks specific responses to specific invaders
- Mechanisms function regardless of the type of invader
    - External mechanical and chemical barriers
        - Skin & mucous membranes
    - Internal “nonspecific” defenses (cellular defenses)
        - Antimicrobial proteins*
        - Natural killer cells & phagocytes
        - Inflammation & fever



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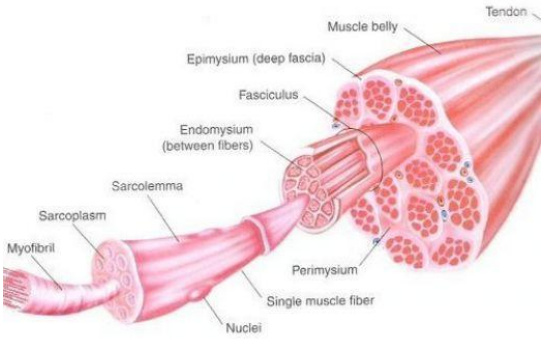
Internal "nonspecific" responses

- Natural Killer Cells
    - Attack!
- Phagocytes
    - Ingest! (pac-man)
- Inflammation
    - Signs of Inflammation:
        - Redness
        - Heat
        - Swelling
        - Pain
    - Stages of Inflammation*
- Fever
- Abscesses and Ulcers*

Specific Response to Disease

- Immunity = Body's ability to defend itself against specific foreign material or organisms
    - Bacteria, toxins, viruses, cat dander, etc.
- Differs from nonspecific defense mechanisms
- Immune system is cells and tissues that produce the immune response…the study of it is "immunology"
    - T and B Cells*
    - Antigens*
- Great video on Immunology - http://www.youtube.com/watch?v=kskFjm1pKEs



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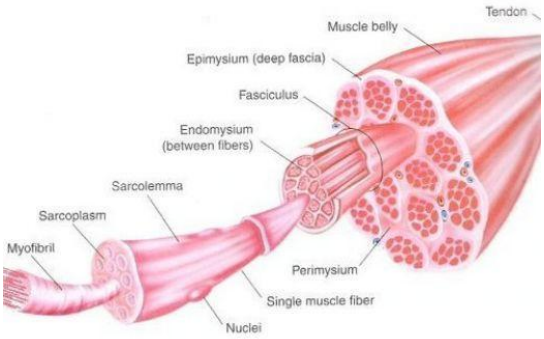
Circulatory (Cardiovascular) System

Part 1. *The Blood.*

- Three Functions of Blood
  a. Transportation
     - O_2 from lungs to cells of body
     - CO_2 from cells to lungs (exhale)
     - Nutrients from GI tract to body cells
     - Hormones from endocrine glands to body cells
     - Heat & waste products to various organs for elimination
  b. Regulation
     - Maintains homeostasis of all body fluids
     - Regulates pH
     - Adjusts body temperature
  c. Protection
     - Clotting properties protect from excessive loss
     - White Blood Cells protect against disease with phagocytosis
- Components of Blood
  a. Plasma: 55 % of blood volume
  b. Formed Elements: 45 % of blood volume
     - Red Blood Cells, White Blood Cells, and Platelets

Part 2. *The Heart.*

- Heart located in Thoracic Cavity
  - Pericardium
  - Layers of Heart Wall
- Anatomy of the Heart: http://www.youtube.com/watch?v=H04d3rJCLCE
  - Atria: the two superior chambers
  - Ventricles: the two inferior chambers
  - AV Valves prevent regurgitation back into the atria



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- Right = tricuspid
- Left = bicuspid

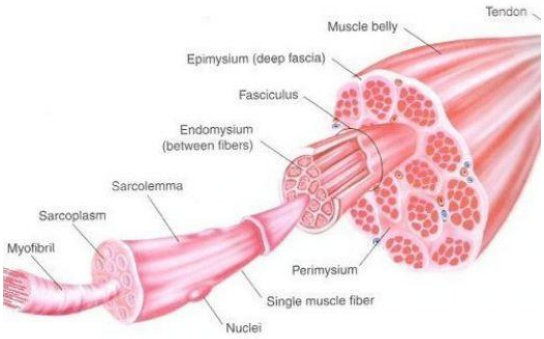
- Semilunar Valves prevent regurgitation back into ventricles
  - Right = Pulmonary
  - Left = Aortic

- Path of blood circulation through Heart and Lungs
  1. Right Atrium
  2. Tricuspid Valve
  3. Right Ventricle
  4. Pulmonary Valve
  5. Pulmonary Trunk
  6. Pulmonary Arteries
  7. Lungs
  8. Pulmonary Veins
  9. Left Atrium
  10. Bicuspid Valve
  11. Left Ventricle
  12. Aortic Valve
  13. Ascending aorta
      - *Some blood from here flows into coronary arteries and the rest goes through the descending aorta, and then to the rest of the body*

Part 3. *Blood Vessels and Movement (hemodynamics).*

- Blood Vessels
  - Veins: blood to heart (unoxidized)
  - Arteries: blood away from heart (oxidized)
- Blood Movement
  - Pressure: moves from high to low
    - What is blood pressure? How does it work?

    - What are the risks if it is too high?



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- How does blood get too thick?

- What happens when it gets too thick?

- General path of blood flow through body
  - Head
  - Upper Extremity
  - Trunk
  - Lower Extremity

The Respiratory System

The Basics

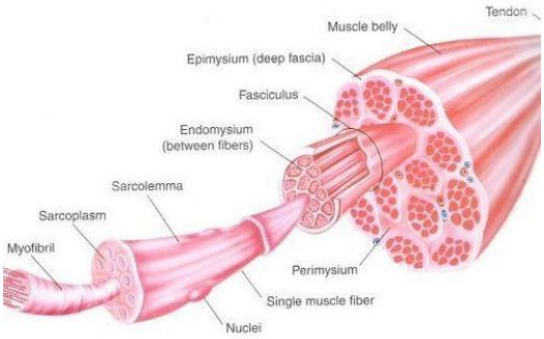
- Cells continually use O_2 and release CO_2
- Respiratory System is designed for gas exchange
- Circulatory System transports gases in the blood
- Failure of either system → Rapid cell death from O_2 starvation

Structural Breakdown

Upper Respiratory System: nose & pharynx

Lower Respiratory System: larynx, trachea, bronchii, and lungs

Functional Breakdown



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Conducting Zone: interconnecting cavities and tubes outside & inside the lungs that filter, warm, and moisten air and conduct it into the lungs

Respiratory Zone: tissues within lungs where gas exchange occurs (main site of gas exchange between air & blood)

How It Works

1. Breathe in.
2. Air moves through nose, pharynx, larynx, and trachea.
3. Goes through the bronchii
4. Lungs and chest wall expand and fill with air
    a. The ease of expansion depends on elasticity of lungs and surface tension
    b. Diaphragm moves down thoracic cavity
5. Breathe out.
    a. Diaphragm moves up thoracic cavity
    b. Chest walls and lungs deflate

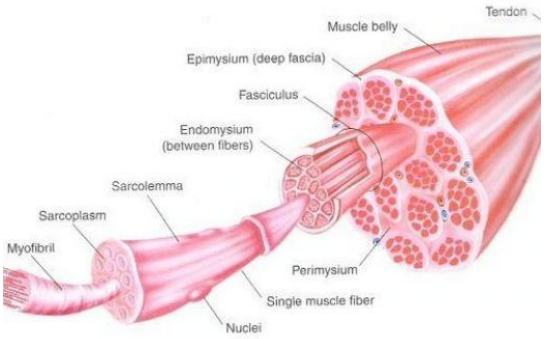
What is air made of?

Air: 21% O_2, 79% N_2, and .04% CO_2
Alveolar Air:* 14% O_2, 79% N_2, and 5.2% CO_2
*has less O_2 because some is absorbed by blood
Expired Air: 16% O_2, 79% N_2, and 4.5% CO_2

The Digestive System

The Basics

1. You chew your food…saliva!
2. You swallow your food…esophagus!
3. You digest your food…stomach!
4. Your body takes the nutrients…small intestine!



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- Pancreas secretes digestives enzymes that pass to the small intestines

5. Your body moves the waste out…large intestine!
6. The liver helps break down toxins and stores glucose, Iron, Liver & Vitamins A, D, B12,.
7. You get rid of the waste…anus!

The Functions

1. Ingestion: taking food into the mouth
2. Secretion: release of water, acid, buffers, and enzymes into the lumen of the GI Tract
3. Mixing and Propulsion: churning and propulsion of food through the GI Tract
4. Digestion: mechanical and chemical breakdown of food
5. Absorption: passage of digested products from the GI tract into the blood and lymph
6. Defecation: the elimination of feces from the GI tract

How Stress Effects the Digestive System

1. Mouth

2. Esophagus

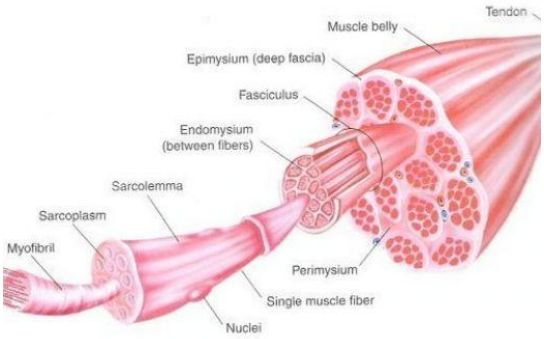
3. Stomach

4. Small and Large Intestines

5. Anus

Yoga and the Digestive System

Using what you've experienced in your own body and what you've learned, how can yoga affect the digestive system?



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Integumentary System

Function

- Protects the body
- Helps maintain a constant body temperature
- Provides sensory information about the surrounding environment

The Skin

The **skin** is the largest organ of the body, in both surface area and weight. It covers the external surface of the body – about 22 square feet and 10-11lb for the average adult.

The skin has two main parts:

Epidermis: the superficial, thinner portion

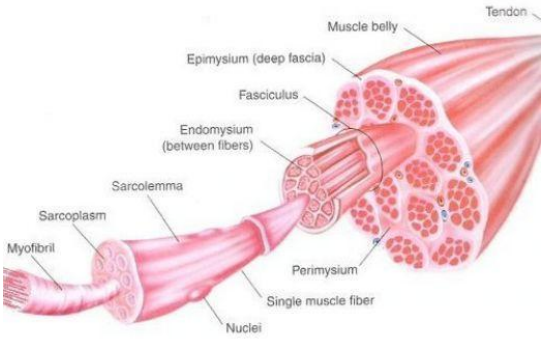
Dermis: the deeper, thicker connective tissue*

**deep to the dermis, but not part of the skin, is a 3rd layer called the subcutaneous layer – areolar and adipose tissue (storage depot for fat and contains large blood vessels that supply the skin). This region also contains nerve endings that are sensitive to pressure.*

Out of all the organs, the skin is the most easily inspected and the most exposed to infection, disease and injury. Due to its location, it makes it vulnerable to damage from trauma, sunlight, microbes, and environmental pollutants. However, the skin's protective features ward off this kind of damage!

The Accessory Structures

- Hair – present on most skin surfaces, except palms, palmar surfaces of fingers, soles, and plantar surfaces of the feet.
    - Hair on head guards scalp from injury and sun's rays. Also decreases heat loss from scalp.



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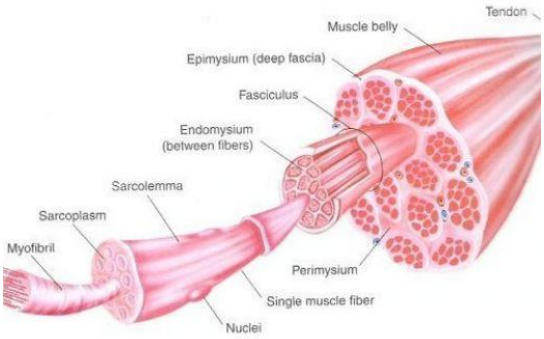
- Eyebrows, eyelashes, nose and ear hair: protect the eyes from foreign particles.
- Touch receptors (roots) are activated with even the slightest movement – so hair can help sense light touch.

- Nails – cover the dorsal surface of the distal portions of all digits
  - Help us grasp and manipulate small objects in various ways
  - Protect against trauma to the end of the digits
  - Allow us to scratch various parts of the body
- Skin glands
  - Sebaceous Glands (oil)
    - Coats the surface of the hairs and keeps them from drying and becoming brittle
    - Prevent excessive evaporation of water from the skin
    - Keep the skin soft and pliable
    - Inhibit the growth of certain bacteria
    - Acne = inflammation of sebaceous glands
  - Sudoriferous Glands (sweat)
    - Regulate body temperature
    - Waste removal
    - Some are specifically stimulated during emotional stress and sexual excitement.
    - Mammary Glands: specialized sudoriferous glands that secrete milk; part of female reproductive system
  - Ceruminous Glands (ear wax)
    - Along with ear hair, provides a sticky barrier that impedes entrance of foreign bodies

The Urinary System

Function of the Kidneys



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- Regulation of blood ionic composition
- Regulation of blood pH
- Regulation of blood volume
- Regulation of blood pressure
- Regulation of blood glucose level
- Production of hormones
- Excretion of wastes and foreign substances
- Kidneys do most of the work. The other parts are mainly passageways and storage areas
    - Ureters transport urine from kidneys to bladder
    - Bladder stores urine
    - Urethra discharges urine from the body

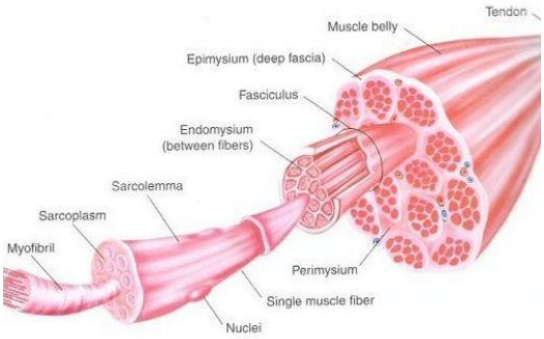
The Reproductive Systems

Organs of the Reproductive Systems

Female	Male
Gonads (ovaries)	Gonads (testes)
Uterine (Fallopian) tubes	System of ducts
Uterus	Accessory sex glands
Vagina	Penis
External Organs (vulva)	Scrotum

Functions of Female Reproductive System

1. The ovaries produce secondary oocytes and hormones, including progesterone, estrogens, inhibin and relaxin.



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2. The uterine tubes transport a secondary oocyte to the uterus and normally are the sites where fertilization occurs.
3. The uterus is the site of implantation of a fertilized ovum, development of the fetus during pregnancy, and labor.
4. The vagina receives the penis during sexual intercourse and is a passageway for childbirth.
5. The mammary glands synthesize, secrete, and eject milk for nourishment of the newborn.

Functions of Male Reproductive System

1. The testes produce sperm and the male sex hormone, testosterone.
2. The ducts transport, store, and assist in maturation of sperm.
3. The accessory sex glands secrete most of the liquid portion of semen.
4. The penis contains the urethra, a passageway for ejaculation of semen and excretion of urine.

Above sections summarized from Principles of Anatomy and Physiology, 11th Edition, Tortora and Derrickson, Chapter 15 – The Autonomic Nervous System, Chapter 18 – The Endocrine System, Chapter 22 – The Lymphatic System & Immunity, Chapter 19 – The Cardiovascular System: The Blood, Chapter 20: The Cardiovascular System: The Heart, Chapter 21 – The Cardiovascular System: Blood Vessels and Hemodynamics, Chapter 23 - The Respiratory System, Chapter 24 – The Digestive System, Chapter 5 – The Integumentary System, Chapter 26 – The Urinary System, Chapter 28 – The Reproductive Systems

Yoga and the 11 Body Systems

Name 3 asanas, kriyas, or other practices that can help each of the body systems. Describe why or how they help.

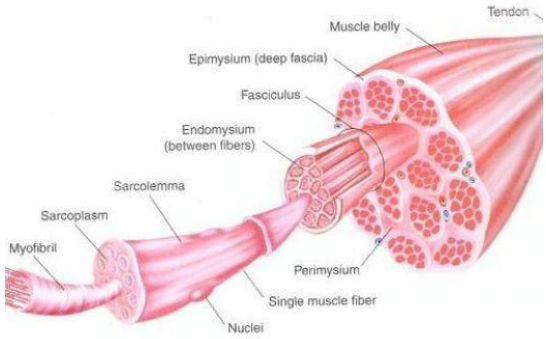

Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

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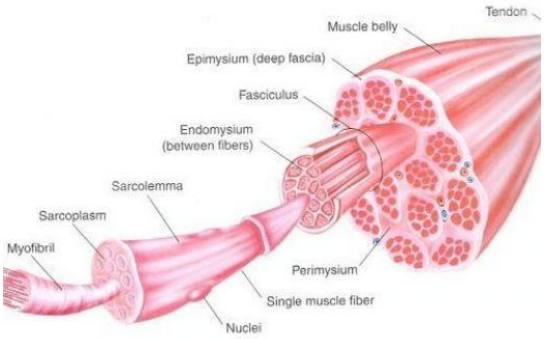
1. Skeletal

2. Muscular

3. Nervous



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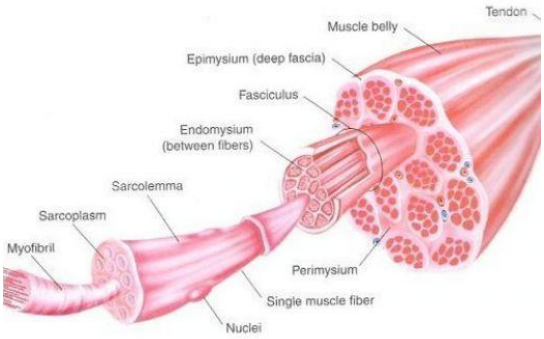
4. Endocrine

5. Lymphatic System & Immunity

6. Circulatory System



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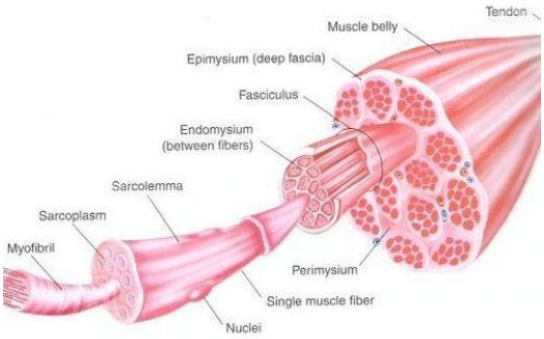
7. Respiratory System

8. Digestive System



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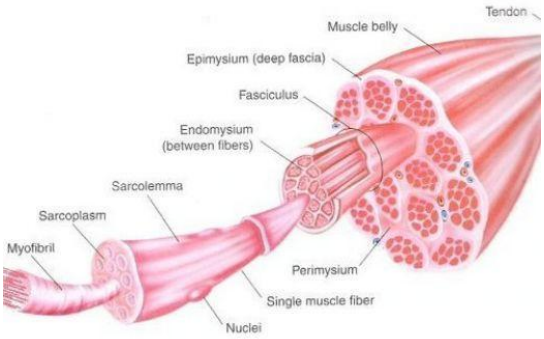
9. Integumentary System

10. Urinary System



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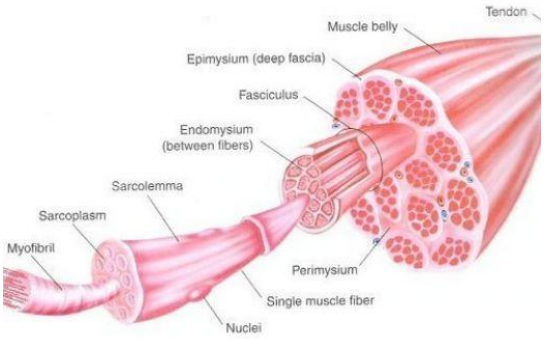
11. Reproductive System



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Exercises to Help learn the Skeletal Muscles

Hip and Knee

1. **Group the muscles into the following categories (separate paper):**
    a. Muscles that flex the thigh at the hip joint
    b. Muscles that extend the thigh at the hip joint
    c. Muscles that laterally rotate the thigh
    d. Muscles that medially rotate the thigh
    e. Muscles that abduct the thigh
    f. Muscles that adduct the thigh
    g. Muscles that flex the knee
    h. Muscles that extend the knee

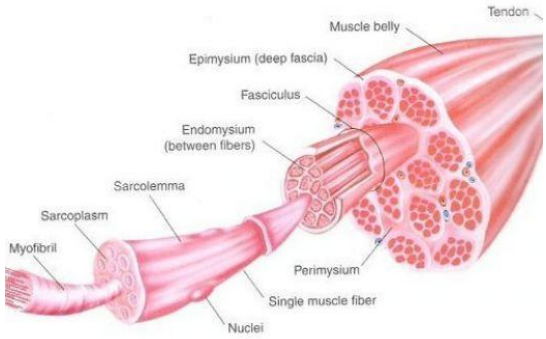
2. **Practice moving the joints!**

Complete the following exercises with 2 people (TT peers, family, friends)

a. Hip Flexion
- Subject: Sit on a table with legs hanging over edge. Flex thigh at hip joint.
- Assistant: Resist movement slightly by pressing down on knee.
- Observer (YOU): Palpate pectineus, TFL, Sartorius, rectus femoris, and adductor longus. Does the gracilis contract?

b. Hip Flexion
- Subject: Lie on one side, rolled toward face. Flex thigh of top leg.
- Assistant: Resist movement by pushing against knee.
- Observer (YOU): Palpate iliopsoas

c. Hip Extension
- Subject: Stand facing table with trunk flexed forward until it rests on table. Grasp sides of table. Extend one thigh by raising one leg, keeping the knee extended.
- Assistant: Resist movement by pushing down on thigh close to knee. Second time, give resistance at the heel.
- Observer (YOU): Palpate gluteus maxiums, adductor magnus, and hamstrings



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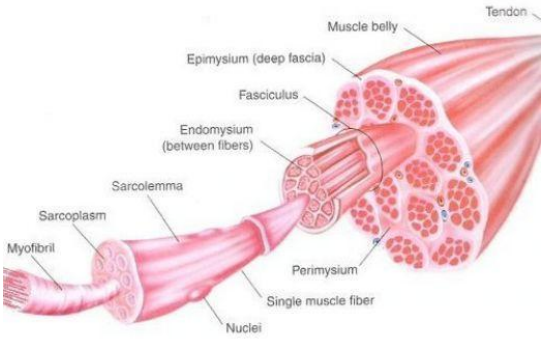
d. Hip Extension
   - Subject: Lie face down on table and extend lower extremity at the hip joint keeping the knees extended.
   - Assistant: resist movement by pushing down on knee
   - Observer (YOU): Palpate same muscles as in A.

e. Hip Abduction
   - Subject: Lie on one side and abduct the top leg at the hip joint.
   - Assistant: Resist movement by pushing down on knee.
   - Observer (YOU): Palpate gluteus maximus, gluteus medius, and TFL.

f. Hip Adduction
   - Subject: Lie on one side with the top leg abducted; then adduct it.
   - Assistant: Resist movement by pressing up against knee. (Unless resistance is applied to the knee, the action will be performed by the eccentric contraction of the abductors)
   - Observer (YOU): Palpate three adductors and name them.

g. Lateral Rotation of thigh
   - Subject: Stand on one foot with the other leg flexed at the knee so that the lower leg extends horizontally backward. Rotate the free thigh outward by swinging the foot medially.
   - Assistant: Steady subject's knee and resist movement of leg at ankle.
   - Observer (YOU): Palpate gluteus maximus.

h. Medial rotation of thigh
   - Subject: Stand on one foot with other leg flexed at the knee so that the lower leg extends horizontally backward. Rotate the free thigh inward by swinging the foot laterally.
   - Assistant: Stead subject's knee and resist movement of leg at ankle.
   - Observer (YOU): Palpate gluteus medius, TFL, and lower adductor magnus.



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i. Flexion of knee
- Subject: Lie face down and flex leg at knee by raising foot.
- Assistant: Steady subject's thigh and resist movement by pushing down on ankle.
- Observer (YOU): Palpate biceps femoris, semitendinosus, gracilis, sartorius, and gastrocnemius (calf).

j. Extension of knee
- Subject: Rise from a squat position
- Observer (YOU): Palpate quadriceps femoris

k. Extension of knee
- Subject: Sit on table with legs hanging over edge. Extend leg.
- Assistant: Steady subject's thigh and resist movementby holding ankle down.
- Observer: Palpate quadriceps femoris.

Shoulder Girdle

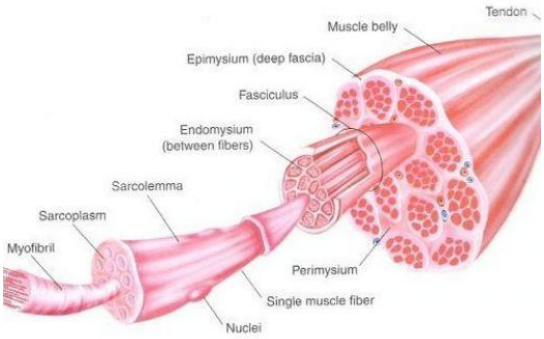
1. Group the muscles into the following categories (separate paper):

a. Elevation of shoulderblades
b. Depression of shoulderblades
c. Abduction (protraction) of arm
d. Adduction (retraction) of arm
e. Internal Rotation of arm
f. External Rotation of arm
g. Flexion of arm
h. Extension of arm

2. Which muscles are used to (separate paper):

a. Raise your shoulders

b. Lower your shoulders



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c. Join your hands behind your back

d. Join your hands in front of your chest

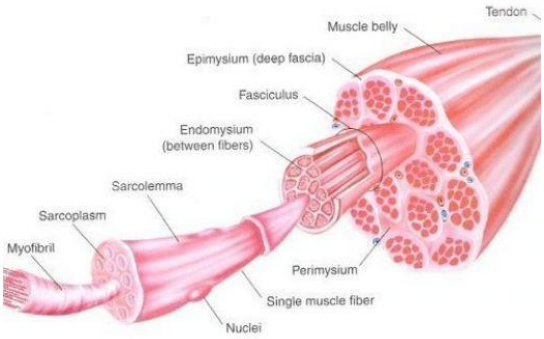
3. Complete the following exercises with 2 people (TT peers, family, friends)

a. Abduction of the arm
Subject: In erect position, abduct arm to shoulder level (keep forearm extended).
Assistant: Resist movement by exerting pressure downward on subject's elbow. See to it that subject does not elevate shoulder.
Observer (YOU): Palpate the 3 portions of the deltoid and tell which portions contract. Did the pec major contract during any part of the movement?

b. Adduction of the arm
Subject: In erect position with arm abducted to shoulder level, lower arm until 45 degrees from side.
Assistant: Place hand under subject's elbow and resist movement.
Observer (YOU): Palpate the latissimus dorsi, teres major, pec major, and posterior deltoid. Do they each contract? If so, during which part of the movement?

c. Flexion of the arm
Subject: In erect position, flex arm to shoulder level, keeping elbow extended.
Assistant: Resist movement by exerting pressure downward on subject's elbow. See to it that the subject does not elevate shoulder.
Observer (YOU): Palpate the anterior deltoid and the pec major. Do both the sterna and clavicular portions of the pec major contract?

d. Extension of the arm
Subject: In erect position with arm flexed to shoulder level, lower it until 45 degrees from side.
Assistant: Resist movement at underside of elbow.



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Observer (YOU): Palpate the latissimus dorsi and the pec major. Do they contract with equal force throughout the movement?

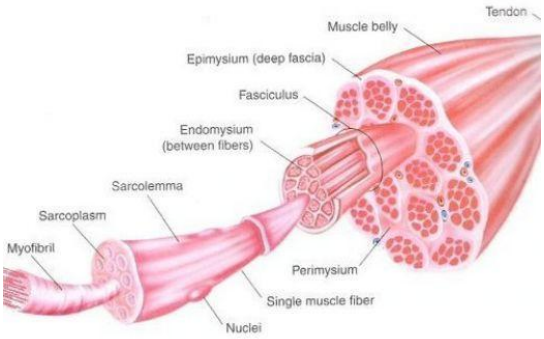
e. Internal rotation of the arm
Subject: Lying face down on a table with upper arm at shoulder level, resting on table and forearm hanging down off edge of table. Keeping forearm at right angles to upper arm, externally rotate arm at the shoulder joint, without allowing upper arm to leave table.
Assistant: Steady upper arm and resist movement of forearm by holding wrist.
Observer (YOU): Palpate teres major and latissimus dorsi

f. External rotation of the arm
Subject: Lying face down on a table with upper arm at shoulder level, resting on table and forearm hanging down off edge of table. Keeping forearm at right angles to upper arm, internally rotate arm at the shoulder joint, without allowing upper arm to leave table.
Assistant: Steady upper arm and resist movement of forearm by holding wrist.
Observer (YOU): Palpate infraspinatus and teres minor.

g. Elevation of shoulder
Subject: In erect position, elevate shoulder girdle, keeping arm muscles relaxed.
Assistant: Resist movement by pressing down on shoulder.
Observer (YOU): Palpate trapezius.

h. Depression of shoulder
Subject: In erect position with shoulder girdle elevated and elbow flexed, push down with elbow, depress shoulder girdle to normal position.
Assistant: Resist movement by holding hand under elbow.
Observer (YOU): Palpate trapezius

Arm



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1. Arrange the muscles in these groups:
    a. Flexion of elbow
    b. Extension of elbow
    c. Supinate forearm
    d. Pronate forearm
2. Flex your elbow. Which group of muscles is contracting? Which group of muscles must relax so that you can flex your arm?

Complete a 10 -15 Minute Class Presentation: Special Conditions & Presentations Ideas

Yoga & Respiration, Scoliosis, Asthma, Sleep, Concussions, Menstruation, Pregnancy, Post Partum, Back Pain & Conditions, Trauma, PTSD, Recovery, TBI, Depression, Anxiety, Knee Injuries, Sciatica, SI issues, Headaches, Insomnia, Diabetes