* **Joints**
* Joints: articulations/points where bones meet and connect
	+ Degrees of mobility:
		- Diarthrotic joints: freely moveable
			* Ex: shoulder, knee, wrist, etc.
		- Amphiarthrotic joints: slightly moveable
			* Ex: intervertebral discs
		- Synarthrotic joints: immovable
			* Ex: tooth in socket
	+ Joints change with age
		- Synostosis: 2 bones fused into one by bone tissue
			* Formed at various ages, when bones fuse at joint
			* No mobility
			* Not considered a joint
			* Ex: coxal bone fuses from 3 parts (by adulthood), skull bones fused together (after middle age)
* Joint classification
	+ Fibrous joints:
		- Bones joined by dense regular CT = ligament (connects bone to bone)
		- Mobility: synarthrotic to diarthrotic
		- Types of fibrous joints:
			* Suture:
				+ Ex: between skull bones (synarthrotic)
			* Syndesmosis: length of fibers varies -> determines mobility
				+ Ex: distal tibiofibular joint (synarthrotic), interosseous membrane in forearm (diarthrotic)
			* Gomphosis:
				+ Ex: between tooth and socket (synarthrotic)
	+ Cartilaginous joints:
		- Bones joined by cartilage
		- Types of cartilaginous joints:
			* Synchondrosis: bones joined by hyaline cartilage
				+ Ex: epiphyseal plate (synarthrotic), 1st sternocostal joint (synarthrotic)
			* Symphysis: main cartilage is fibrocartilage, may contain hyaline cartilage as well
				+ Ex: intervertebral disc (amphiarthrotic), pubic symphysis (amphiarthrotic)
	+ Synovial joints:
		- Bones separated by a fluid-containing joint cavity
		- All are freely moveable -> diarthrotic
			* Ex: knee, shoulder, knuckle, wrist, between most ribs and sternum, between ear bones, etc.
		- Anatomy of synovial joint:
			* Joint cavity:
				+ Contains synovial fluid
				+ Blood filtrate
				+ Lubricates
			* Articular capsule:
				+ Inner layer: synovial membrane (produces synovial fluid by filtration
				+ Outer layer: fibrous capsule with dense irregular CT
			* Articular cartilage:
				+ Made of hyaline cartilage
				+ Function: absorbs compression forces -> protects bones
				+ Nourished by weight bearing intermittently
			* Reinforcing ligaments:
				+ Dense regular CT that connects bone to bone
				+ Three kinds:

Capsular: thickened part of the capsule

Extracapsular: outside the capsule

Ex: fibular and tibial collateral ligaments of knee

Intracapsular: inside the capsule

Ex: anterior and posterior cruciate ligaments of knee

* + - * Articular disc (meniscus):
				+ In a few synovial joints
				+ Function:

Evens out the distribution of compression forces

Helps stabilize joint

Allows additional movements

Ex: temporomandibular (jaw) joint

* + - * + Ex: knee
				+ Tissue type: fibrocrtilage
			* Bursae and tendon sheaths
				+ Closed sacs of synovial fluid
				+ Prevent friction among structures
				+ Bursitis: inflammation of a bursa
				+ Tendon sheath: a bursa that wraps around a tendon
* Movements of joints
	+ Terms of orientation in anatomy
		- Axes: infinite line that has a specific orientation
			* Anterior-posterior axis: anterior to/from posterior
			* Superior-inferior axis: superior to/from inferior
			* Left-right axis: left to/from right
	+ Describing movements using planes and axes
		- Movements:
			* Transitional (linear) = move in straight line (not in planes)
				+ Specific directions:

Elevation: move superiorly

Depression: move inferiorly

Protraction: move anteriorly

Retraction: move posteriorly

Feature of temporomandibular joint that is useful for these movements is articular disc

* + - * Around an axis:
				+ Angular movement: change angle between two bones

Flexion: decrease joint angle (sagittal)

Extension: increase joint angle (sagittal)

Abduction: move away from midline of body (frontal)

Adduction: move toward midline of body (frontal)

Circumduction: movement that describes a cone in space (transverse)

Special movements of the feet:

Dorsiflexion: turn foot upward (sagittal)

Plantar flexion: turn foot downward (sagittal)

Inversion: turn sole of foot medially (frontal)

Eversion: turn sole of foot laterally (frontal)

* + - * + Rotation: bone moves around its own longitudinal axis

In axial region (transverse):

Left rotation: turn anterior surface to left

Right rotation: turn anterior surface to right

In appendicular region (transverse):

Medial rotation: turn anterior surface toward midline

Lateral rotation: turn anterior surface away from midline

Special movements of forearm:

Pronation: turn palms posterior (transverse)

Supination: turn palms anterior (transverse)

These are medial/lateral rotation of the forearm

* + - Movement around an axis corresponds to movement within a plane
* Synovial joints classified by shape
	+ Described by:
		- Shape of articulating bone surfaces
		- Number of axes around which movement can occur:
			* Change angle between bones (angular movement)
			* Move bone around its longitudinal axis (rotation)
	+ Plane joint (gliding joint):
		- Only translational (linear) movement
		- Nonaxial (no axes)
		- Ex: intercarpal and intertarsal joints
	+ Hinge joint:
		- Flexion/extension (typically)
		- Uniaxial (1 axis)
		- Ex: elbow
	+ Pivot joint:
		- Rotation
		- Uniaxial (1 axis)
		- Ex: proximal and distal radioulnar joints
	+ Condylar joint:
		- Movements around all axes except axis of rotation (oval so can’t spin)
		- Biaxial (2 axes)
		- Ex: metacarpophalangeal (knuckle) joints
	+ Saddle joint:
		- Movement around all axes except axis of rotation (similar to condylar joint)
		- Biaxial (2 axes)
		- ONLY 2 Ex: 1st carpometacarpal joint (base of thumb) and sternoclavicular joint
	+ Ball-and-socket joint:
		- Most freely moving joint
		- Movements around all axes including rotation (circular so can spin)
		- Multiaxial/triaxial (3 axes)
		- ONLY 2 Ex: shoulder and hip joints
* Joint health and pathology
	+ Injuries
		- Dislocation: bones forced out of normal positions
		- Sprain: ligaments are stretched or torn
			* Has poor blood supply so slow healing
			* Stretched ligaments make joint less stable
		- Cartilage injury: heals even slower
	+ Joint stability: resistance to dislocation
		- Inversely related to range of motion (mobility)
			* Ex: shoulder has large range of motion-> low stability, elbow has small range of motion-> high stability
		- Factors affecting stability:
			* Shape of articular surface
				+ Ex: shoulder vs. elbow
			* Ligaments
				+ Ex: knee, wrist
			* Muscles
				+ Ex: shoulder

Rotator cuff: 4 tendons (= 4 attached muscles) wrapped closely around joint capsule

* + Diseases
		- Arthritis: inflammatory or degenerative joint diseases
			* Osteoarthritis:
				+ Wear and tear from normal aging
				+ Occurs in most elderly people
			* Rheumatoid arthritis:
				+ An autoimmune disease
				+ Begins with inflammation of synovial membrane
			* Gouty arthritis (gout):
				+ Caused by excess uric acid retention -> deposited in synovial membrane
* **Muscle**
* As a tissue and as an organ
* Organs are made of tissues, which are made of cells, not other tissues!
* Examples of tissues that are components of a muscle organ
	+ Muscle tissue
	+ Blood
	+ Other connective tissues
	+ Nervous tissue, etc.
* Functions
	+ Exert force: movement, maintain posture
	+ Stabilize joints
	+ Produce heat
* Special features of muscle tissue
	+ Contractile: exerts force by contracting (shortening) -> pulls things together
	+ Electrically excitable: like nervous tissue, allows rapid stimulation of the whole cell at once
* Types of muscle tissue
	+ Skeletal: voluntary (typically)
	+ Cardiac: heart
	+ Smooth: walls of other hollow organs
* Skeletal muscle
	+ Function: to move bones
	+ Attachments:
		- Origin: the less moveable attachment (proximal)
		- Insertion: the more moveable attachment (distal)
	+ Actions:
		- Must cross a joint to act on that joint
		- Action depends on side bone attachment is on
		- Muscles do work by shortening, not by lengthening
			* Antagonist muscle: different muscle to “undo” another’s action
			* Agonist (prime mover): muscle that has major responsibility for a particular action
			* Synergist: a muscle that helps the agonist
	+ Basic anatomy:
		- Sheaths of connective tissue organize muscle fibers (cells)
			* Epimysium: surrounds entire muscle
			* Perimysium: surrounds each fascicle (bundle of muscle fibers)
			* Endomysium: surrounds muscle fiber (cell)
			* Tendon: extension of the sheaths, connects the muscle to bone
			* Fascia surrounds groups of muscles
	+ Microscopic anatomy:
		- Muscle fiber (cell):
			* Typically nearly as long as whole muscle
			* Contains many myofibrils = long organelles made of actin (thin) and myosin (thick) filaments
				+ In muscle cells, both actin and myosin are organized into myofilaments (a type of microfilament)
				+ Each section of myofibril is called a sarcomere = the basic functional unit of skeletal muscle contraction
			* Multinucleate (has many nuclei)
			* Striations: indicate repeating groups of protein filaments (actin, myosin, etc.)
			* Cells cannot divide after birth
			* In strength training, each muscle fiber thickens by adding more protein filaments
				+ Strength is proportional to total cross-sectional area of fibers attached to tendon

Ex: pennate muscles are stronger than parallel muscle (have more cross-sectional area of fibers)

* + - Satellite cells: undifferentiated cells between the muscle fibers
			* Continue dividing through life as needed
			* Growth, strength training, or muscle damage -> satellite cells merge with muscle fibers (adds nucleus)
		- Nerve cells: direct nervous stimulation is the ONLY cause of contraction
			* Motor unit: motor neuron + all the muscle fibers it innervates
				+ Motor neuron: nerve cell that controls muscle fibers
			* Neuromuscular junction: region where motor neuron contacts muscle fiber
	+ Mechanism of contraction: the sliding filament mechanism
		- Myosin (thick) and actin (thin) filaments slide past one another
		- Myosin heads “crawl” along actin and drag
		- Sarcomere shortens by increasing overlap of actin
		- The filaments do NOT shorten (but everything around the does)
* Cardiac muscle
	+ Found in walls of the heart
	+ Involuntary
	+ Muscle anatomy:
		- Branching chains of short cells
			* Stacked end-to-end
		- 1 or 2 nuclei per cell
		- Cells cannot divide after birth
		- Intercalated discs: junctions between cells
		- Gap junctions: ions carry signal between cells
		- Fascia adheres: similar to desmosomes b/c hold adjoining cells together
		- Striated (orderly structure)
			* Sarcomeres
		- Actin and myosin
	+ Causes of contraction:
		- 1. Spontaneously generated (pace-maker cells)
			* Note: the rate of spontaneous contraction is affected by nervous input
		- 2. Via gap junctions from other cardiac muscle cells
* Smooth muscle
	+ Muscle in walls of hollow organs (other than the heart)
	+ Involuntary
	+ Muscle anatomy:
		- Fusiform cells (spindle-shaped)
			* Grouped into sheets of cells having similar orientation
		- Uninucleate (1 nucleus per cell)
		- Can divide after birth
			* Regenerates/heals much better than other muscle tissues
		- Actin and myosin
		- NO striations or sarcomeres
		- Dense bodies: anchor actin to intermediate filaments to transmit force
		- Gap junctions: to coordinate contraction
		- Loose organization allows smooth muscle cells to generate force even when greatly stretched
		- Often arranged in circular and longitudinal layers:
			* Contract circular layer -> narrows the tube
			* Contract longitudinal layer -> shortens the tube
	+ Causes of contraction:
		- 1. By direct nervous control (but involuntary)
		- Other chemical signals (ex: hormones)
		- Stretch
		- Via gap junctions from other smooth muscle cells
		- Spontaneously generated (like pace-maker cells)
* What all 3 muscle tissue types have in common!!!
	+ Actin and myosin
	+ Parts of cytoskeleton (intermediate filaments, microtubules)
	+ Other organelles (mitochondria)
	+ All associated with endomysium
* **Digestive System**
* Function: process food molecules and move them into the blood
* Organs of digestive system
	+ Gastrointestinal (GI) tract (alimentary canal, digestive tract, gut)
		- Mouth
		- Pharynx
		- Esophagus
		- Stomach
		- Small intestine
		- Large intestine
	+ Accessory organs:
		- Salivary glands
		- Liver
		- Gallbladder
		- Pancreas
* Internal/external lining of GI tract and Structure of GI tract wall:
* \*Membrane: 2 layers (epithelium lines space; connective tissue nourishes epithelium)
* Mucosa (mucous membrane):
	+ Line lumen (interior space) of GI tract
	+ Simple columnar epithelium through most of its length
		- Endocrine cells: release product into blood (inside body)
		- Exocrine cells: release product into lumen (outside body)
			* Ex: mucus
		- Has other epithelial cells for absorption
		- Rate of cell turnover is rapid
	+ Lamina propria = CT
		- MALT = mucosa-associated lymphoid tissue (with immune cells)
		- Blood/lymph vessels, nerves
		- Glands (exocrine)
	+ Muscularis mucosae
		- Layer of smooth muscle
		- Unique to digestive system
		- Twitches to dislodge sharp objects
* Submucosa = CT:
	+ Tough but flexible
	+ Submucosal nerve plexus (network of nerves)
		- Part of enteric nervous system
	+ Blood/lymph vessels, nerves
	+ Glands (exocrine)
* Muscularis externa = muscle layer:
	+ Ex: peristalsis = pushing food along the GI tract
		- Circular muscle – contraction narrows tract
		- Longitudinal muscle – contraction shorten tract
		- Myenteric nerve plexus – part of enteric nervous system
* Serosa (serous membrane): called the peritoneum in abdominopelvic cavity
	+ Lines peritoneal cavity (space between organs)
		- Cavity is narrow, crowded by organs
	+ Visceral peritoneum (deep inner lining of cavity/outer layer of organ wall): produces serous fluid by filtration (mostly)
		- CT
		- Visceral Mesothelium: simple squamous
	+ Peritoneal cavity
	+ Parietal peritoneum (superficial outer lining of cavity/inner layer of body wall)
		- Parietal Mesothelium: simple squamous
		- CT
* \*Mesentery: double layer of peritoneum connecting parietal and visceral peritoneum (technically an organ)
	+ Supports GI tract
	+ Carries vessels and nerves
	+ Stores fat
	+ During development, some organs in abdominopelvic cavity become buried in body wall and lose mesentery = secondarily retroperitoneal
		- Still has peritoneum on one side (side not on body wall)
		- Have adventitia (CT between organs on body wall) on other side
		- Ex: pancreas
	+ Organs that keep mesentery = intraperitoneal
		- * Ex: stomach
* Steps in food processing
	+ 1. Ingestion: food taken into the mouth
	+ 2. Mechanical breakdown and mixing -> more surface area exposed to chemical action (no chemical bonds broken!)
	+ 3. Secretion (enzymes, mucus, etc.)
	+ 4. Chemical digestion: breaking down large nutrient molecules (ex: protein) into smaller ones (ex: amino acids)
	+ 5. Absorption: small molecules actively taken up by epithelium -> moves into blood or lymph
	+ 6. Propulsion: move food along tract by swallowing and peristalsis
	+ 7. Defecation: eliminate indigestible material from anus
* Organs of the GI tract
* \*Proximal and distal describe relative positions of organs along the tube from mouth to anus (follow the tube)
* Mouth (oral cavity):
	+ Epithelium type: non-keratinized stratified squamous
	+ Chewing forms bolus of food
	+ Accessory organs:
		- Salivary glands: secrete saliva into the mouth
			* Includes enzyme to initiate carbohydrate digestion in the mouth
* Pharynx:
	+ Sections belonging to GI tract:
		- Oropharynx
		- Laryngopharynx
	+ Epithelium type: non-keratinized stratified squamous
	+ Swallowing: skeletal muscles propel food through pharynx (mostly reflex = involuntary)

Esophagus:

* + Function: delivers food from pharynx to stomach
	+ Location: mediastinum (area between the lungs)
	+ Characteristics:
		- has both smooth and skeletal muscle (all involuntary) -> peristalsis
		- Cardiac sphincter at exit into stomach with thickened smooth muscle
			* Circular muscle layer of muscularis externa is thick
				+ Prevents reflux from stomach
				+ If fails to close (ex: due to hiatal hernia) -> GERD (gastroesophageal reflux disease)
		- Epithelium type: non-keratinized stratified squamous
* Stomach:
	+ Function:
		- Stores food
		- Churns food (for mechanical breakdown and mixing) -> chyme
		- Begin chemical digestion of proteins
		- Secretion:
			* Mucus and bicarbonate (exocrine)
			* Acid (HCl) – sterilizes, separates molecules (exocrine)
			* Digestive enzyme – to break down proteins (exocrine)
			* Gastrin – a hormone (messenger via blood) to stimulate acid secretion (endocrine)
		- Absorption: some water and ions, but no nutrients (molecules that can be broken down for energy)
* \*Stomach is not essential for survival
	+ Gross Anatomy:
		- Pyloric sphincter: circular muscle at distal end of stomach that evens out flow of chyme to small intestine
		- Rugae: folds of mucosa and submucosa, allow distention
	+ Microscopic Anatomy:
		- Muscularis externa: has 3rd muscle layer = oblique (deepest)
		- Mucosa:
			* Simple columnar epithelium
				+ Surface epithelium (includes gastric pits) secretes bicarbonate (alkaline-neutralizes acid) and mucus
			* Gastric glands:
				+ Mucous neck cells: secrete bicarbonate and mucus
				+ Parietal cells: produce HCl
				+ Chief cells: produce pepsinogen (inactive enzyme)
				+ Enteroendocrine cells: produce gastrin (hormone)
				+ Stem cells: at pit/gland boundary, maturing cells migrate
		- No goblet cells in stomach!
* Small intestine:
	+ Function:
		- Chemical digestion
			* Primary site of digestion
		- Absorption
			* Primary site of nutrient absorption
		- Secretion
		- Mixing by segmentation
	+ Gross Anatomy:
		- Duodenum:
			* Shortest part of small intestine
			* Receives secretions from pancreas and gallbladder
			* Duodenal glands (submucosa):
				+ Secretes bicarbonate (neutralizes stomach acid)and mucus
		- Jejunum:
			* Most absorption occurs here
		- Ileum:
			* Has Peyer’s patches (aggregated lymphoid nodules)
				+ An example of MALT
				+ In lamina propria and submucosa
	+ Wall of the small intestine
		- Epithelium type: simple columnar
		- Plicae circulares (“circular folds”): folds of mucosa and submucosa
			* Permanent unlike rugae
			* Slows down passage of chyme
			* Increases surface area
		- Villi: projections of mucosa -> increase surface area
			* Absorption of nutrients (from gut lumen to blood/lymph)
				+ Sugars and amino acids absorbed by blood capillaries
				+ Lipids absorbed by lacteals (special lymph vessels)
		- Microvilli: folding of plasma membrane of enterocytes (absorptive cells)
			* Increase surface area
		- Goblet cells:
			* Function: secrete mucus
		- Intestinal crypts (glands):
			* In mucosa, between villi
			* Secretes intestinal juice
				+ Maintains liquid state of chyme
			* Enteroendocrine cells
			* Stem cells
* Large intestine:
	+ Function:
		- Absorb water, ions, some vitamins, but no nutrients
		- Passageway for materials that cannot be absorbed = feces
	+ Gross Anatomy:
		- Cecum:
			* Ileocecal valve: prevents backflow into small intestine
		- Vermiform appendix:
			* Has lymphoid tissue
			* Appendicitis: inflamed appendix
			* Peritonitis: inflamed peritoneum
				+ Occurs if appendicitis is not treated
		- Colon:
			* Ascending colon
			* Transverse colon
			* Descending colon
			* Sigmoid colon
		- Rectum:
			* Muscular, specialized for defecation
		- Anal canal:
			* Opening guarded by:
				+ Internal anal sphincter (smooth muscle) - involuntary
				+ External anal sphincter (skeletal muscle) - voluntary
	+ Walls of large intestine:
		- Teniae coli: three thickened bands of longitudinal muscle layer
		- Haustra: bulges due to contraction of teniae coli
		- Epithelium type: mostly simple columnar
			* Colonocytes: absorptive cells
			* Goblet cells
			* Distal part of anal canal: non-keratinized stratified squamous
		- Plenty of MALT
		- Intestinal crypts (glands)
			* Goblet cells
			* Stem cells