# ANATOMY:
# Things to Learn:

## LYMPH SYSTEM

- Lymph is moved
    - by differing osmotic pressure in the capillaries—
        - depends on contraction of skeletal muscles,
        - the presence of valves ,
        - breathing, and
        - gravity
- Lymph nodes have fibrous capsules with phagocytic cortical tissue and is divided by trabeculae.
- Travel of lymph through nodule:
    - Afferent lymphatic vessels enter convex surface
    - Lymph cleared in the cortex by MPG, lymphs and plasma
    - Lymph leaves through concave hilum, there are fewer efferents than afferents, to or right lymphatic duct. efferent collecting vessel to lymph trunk (five in body) which empty into the thoracic duct
    - Thoracic duct drains most of the body and transport lymph to left subclavian vein.
    - Right Lymphatic drain right upper portion of body and transports to right subclavain vein
- Lymph system functions:
    - return fluid to blood,
    - transport absorbed fats (lacteals transport fat products in small intestines away from GI into circulatory system),
    - provide immunologic defense against desease agents.
- Lymph nodes:
    - are filters that remove and destroy antigens with a lot of macrophages.
    - Nodes produce antibodies and store lmphocytes.
    - They occur in clusters particularly in the armpits, the groin, the lower abdomen, and the sides of neck
    - consist of fibrous capsule with internal trabeculae (CT).
    - Outer cortical region: separate masses of lympoid tissue called germinal centers (nodules)→source of lymphocytes, and subscapular and cortical sinuses.
    - Inner meddulary region: in medullary cords which are the source of plasm cells and medullary sinuses
- Deep cervical lymph nodes:
    - collects all lymph of head and neck in chain along internal jugular vein.
    - These join the jugular lymph trunk and then to thoracic duct or right lymphatic
    - Include direct drainiage from mandibular molar teeth???
- Parotid lymph nodes:
    - lymph from strip of scalp above the parotid salivary gland, from anterior wall of external auditory meatus and lateral parts of eye lids and middle ear. To DCLN (deep cervical)
- Submandibular lymph node:
    - front of scalp, the nose and adjacent cheek, upper and lower lips—but not center part--, maxillary and mandibular teeth????, (except the mandibular incisors) anterior two thirds of tongue (except the tip) floor of mouth and vestibule and gingival
- Submental:
    - tip of tongue, floor of mouth beneath the tip of tongue, mandibular incisor teeth and associated gingiva, center part of lower lip and skin over the chin,. Drains into the submandibular and dcln
- Thoracic duct: conveys the blood from, lower limbs, pelvic cavity, abdominal cavity, left side of thorax, and left side of head and neck and left arm

    - begins below the abdomen as dilated sac, the cisterna chili,
    - ascends through aortic opening in the diaphragm, on the right side of the descending aorta,
    - I 8 (IVC) TEN EGSS Esophagus and vegus) at 12 (azygous, thoracic, aorta)
    - empties into the junction of the left internal jugular vein and the left subclavian vein (beginning of the left brachiocephalic vein),
    - contains valves and ascends between the aorta and the azygos vein in the thorax,
- Right lymphatic duct: drains the right side of head and neck, rt upper limb, and right side of thorax. Empties into the junction of the right internal jugular and right subclavain vein
- Lymph contains liquid portion similar to plasma and white blood cells, transparent and slightly yellow
- Bone marrow is part of lymph system
- Chief characteristic of lymphatic organ is presence of lymphocyte
- Spleen, thymus, palatine and pharyngeal tonsils DO NOT have numerous afferent vessels entering them as do lymph nodes
- Spleen:
    - largest single mass of lymphoid tissue in body and is an important blood reservoir,
    - phagocytosis of undesirable blood particles, and manufactures mononuclear leukocytes
    - Spleen contains
        - white pulp: lymphatic nodules and lymphocytes,
        - red pulp surrounding branches of the splenic artery: lymphocytes, macrophages, plasma cells, monocytes, and red blood cells
    - Travel of blood through spleen
        - Blood enters spleen at the hilum through the splenic artery and is drained by the splenic vein→ joins lesser mesenteric vein to form the hepatic portal vein to the liver with greater messenteric.
        - Nerves to spleen accompany the splenic artery and are derived from the celiac plexus
    - Spleen develops from mesenchymal cells of the mesentery attached to primitive stomach,--DOES NOT develop from the primitive gut, as lungs, liver, pancreas, gallbladder, stomach, esophagus, and intestines.
    - site of erythropeoiesis in fetus and infant NOT ADULTS
    - Spleen lies in the left hypochondrium of the abdominal cavity btw the stomach and the diaphragm, is an ovoid organ size of fist
- Thymus:
    - located in the superior mediastinum and has no lymphatics.
    - It develops immunocompetent T cells.
    - Thymus large in newborn, grows until puberty and then regresses
    - Adult thymus is isolated from parenchyma→blood thymus barrier. Barrier non-existant in child
    - Hassels corpuscle are characteristic of this
- Pharyngeal tonsils→adenoids when enlarged located in the posterior wall and roof of the nasopharynx.
    - NO LYMPH, SINUSES OR CRYPTs.
    - Pharyngeal tonsils are characteristically covered by ciliated pseudostratified columnar
    - This is the distinguishing feature Histologically from the palatine tonsils
    -
- Palatine tonsils:
    - reach max size during childhood, but after puberty diminish
    - NO SINUSES
- Lingual tonsils: smaller more numerous on posterior dorsum of tongue each has single crypt.
- Peyer's Patches:
    - intestinal tonsils, similar in structur and function to tonsils,
    - located in the small intestines (specifically the ileum)
    - Destroy bacteria
- Pe**yers and tonsils considered SUBEPITHELIAL AND NONENCAPSULATED lymphoid tissue**

**VEINS**

- Veins vs arteries:
    - less muscle, lower pressure, less elastic tissue, same general structure, larger diameter,
    - valves in neck and arms, legs prevent backflow
- Brachiocephalic veins meet in the superior mediastinum to form superior vena cava
    - (azygos vein—on the left side; also joins the posterior aspect of the SVC just before it pierces the pericardium)
    - Infection of lower lip would enter bloodstream via the brachiocephalic vein
- Axillary vein:
    - begins at the lower border of the teres major muscle as the continuation of the basilic vein.
    - Axillary is really the union of the cephalic (which is on the radial side) and the basilica (which is on the medial side and is formed after the median cubital vein shoots off of the cephalic)
        - Brachial vein: drains venous blood from deep antebrachial regions and brachial regions to axillary
        - Cephalic: drains venous from radial side to the antebrachium and brachium into axillary
    - As it ascends to the inferior margin of the first rib it becomes the subclavian.
      basilic→axillary→subclavian + internal jugular = brachiocephalic
- Subclavian vein crosses the first rib anterior to the anterior scalene muscle
    - Subclavian tributaries are:
        - external jugular on the left side at the angle of its junction with the internal jugular vein. It receives the thoracic duct.
        - On the right side it receives right lymphatic duct at the same location.
- Brachiocephalic: formed by union of internal jugular and subclavian
- Superior vena cava:
    - union of two brachiocephalic veins, has no valves, blood from head, neck, upper limbs, and chest and empties into the right atrium of the heart
- Inferior vena cava: (larger than the superior vena cava) guarded by redimenatry non functioning valve
- Fetal vessels and their remnants:
    - Ductus venosus→*ligamentum venosum*—only fetal vessel to carry oxygen rich blood and nutrients
    - Umbilical vein: placenta to liver, forms major portion of umbilical cord, nutrient rich blood from placenta to fetus, forms the *round ligament of the liver* after birth, or ligamentum teres
    - Foramen oval: opening btw right and left atria to shunt flood passed the pulmonary circuitry, closes at birth and becomes the *fossa ovalis*, a depression in the ineratrial septum
    - Ductus arteriosum: between pulmonary trunk and aortic arch to bypass pulmonary circuitry, closes shortly after birth, atrophies, and becomes the *ligamentum arteriosum*
    - Umbilical arteries: arise from internal iliac arteries ass/with umbilica cord, transports blood from fetus to placenta, becomes lateral umbilical ligament
- Veins and arteries have pulse present, none in capillaries
- Facial vein communicates with superior ophthalmic via the suprotrochlear and supraorbital allowing infxn from face to the cranial dural sinus
- Facial vein:
    - begins as angular vein by the confluence of the supraorbital and supratrochlear viens.
    - Angular vein continues at the lower border of the orbital margin into the facial vein.
        - Recieves the infraorbital and the deep facial veins.
    - The facial vein drains directly into the internal jugular or by joining the anterior branch of the retromandibular vein to from common facial vein which also enters internal jugular.
- Danger triangle of face:
    - covers the nose and maxilla and goes up to the region of the eye.
    - Superficial veins communicate with the dural sinuses.

    - Face has no valves and backflow of infection can get into the sinues via the deep facial vein (via pterygoid plexus) and superior ophthalmic vein (via cavernous sinus)
- Deep facial vein communicates between facial vein and the pterygoid plexus
- Superoir ophthalmic vein communicates between the facial vein and Cavernous sinus:
    - created by superior and inferior ophthalmic vein, the cerebral veins, and the sphenoparietal sinus.
    - Located on either side of the sella turcica of sphenoid bone in middle crainial fossa.
    - Empty by way of superior petrosal sinuses into the transverse sinuses which become the sigmoid sinuses. Then empty to jugular foramen by becoming the internal jugular vein. These veins do not have valves and so can also drain anteriorly into ophthalmic vein
    - Internal carotid artery and abducens nerve pass through cavernous sinuses. Others are embedded in lateral wall: Ophthalmic nerve CN V1, oculomotor CN III maxillary nerve CN V2, trochlear nerv CN IV
- Pterygoid plexus of veins:
    - surrounds the maxillary artery occupying the infratemporal fossa associated with pterygoid muscles.
    - Receives veins that correspond to the maxillary artery.
    - Terminates posteriorly in the maxillary vein
    - Terminates anteriorly in the deep facial vein, which drains into the facial vein
- Inferior ophthalmic vein divides into two terminal branches.
    - One to the pterygoid plexus and the other to the
    - superior ophthalmic vein to the cavernous sinus
- Veins of vein are direct tributaries to the dural sinuses (cerebral sinuses, or the sinuses of dura mater)
- Veins of the skull:
    - The emissary veins pass from the scalp through the calverium to the dura sinuses. The diploic veins lie within the bone of the calverium and join as triubutaries to the emissary vein.
        - Emissary veins:
            - Valveless, connect the dural sinuses with the veins of scalp.
        - Diploic veins:
            - lie in channels in the diploe of the skull and communicate with the dural sinuses,
            - the veins of the scalp and the meningeal vein
- Internal jugular vein:
    - begins at jugular foramen and as a continuation of the sigmoid sinus.
    - Descends in the carotid sheath and ends in the brachiocephalic vein
    - descends behind sternoclavicular joint with subclavain vein to form brachiocephalic vein
- Retromandibular vein:
    - formed by union of superficial temporal and maxillary vein within parotid.
    - It divides at the angle of mandible into the anterior branch, which joins facial vein to form common facial vein, and posterior branch, which joins the posterior auricular vein (occipital) from behind ear to form external jugular vein
- Veins of Cervical Triangle: retromandibular, external and internal jugular veins.
- Superficial temporal vein: drains the scalp and side of head, descending anterior to the ear and plunges into the substances of the parotid gland.
- External jugular: drains the skin, parotid, and muscles of the face and neck → Subclavian vein
- Internal jugular: drain the venous sinuses→brachiocephalic
- Vertebral vein: drains posterior portion of head
- Portal Vein passes (aka. Hepatic portal vein):
    - anterior to the epiploic foramen in the free edge of the lesser omentum,
    - posterior to the bile duct and the proper hepatic artery.
    - posterior to the neck of the pancreas, ascends in front of inferior vena cava, divides into right and left branches into the liver.
    - formed by the union of the splenic and the superior mesenteric veins. Tributaries are left and right gastric veins and the cystic vein

    - Portal vein carries twice as much blood as the hepatic artery
    - Drains stomach, intestines, spleen, pancreas, and gallbladder
    - Hepatic portal vein: drains into hepatic sinusoids, which then drain into the center vein. After liver to hepatic vein to IVC
- Splenic vein:
    - drains spleen, receives tributaries from stomach (right and left gastroepiploic veins, and right and left gastric veins), pancreatic vain, and cystic vein (gallbladder)
- Superior mesenteric drains:
    - small intestine, cecum, and ascending and transverse colon of the large intestines
    - Joins splenic behind the neck of the pancreas
- Inferior mesenteric:
    - drains rectum, descending colon of the large intestine.
- the cavernous sinus
- Azygos vein:
    - drains posterior abdominal and thoracic body wall.
    - Usually formed by union of the right ascending lumbar and right subcostal vein.
    - Ascends through the aortic orifice of the diaphragm,
    - lies in the posterior mediastinum and empties into the superior vena cava.
    - Azygos leaves an impression on the right lung as it arches over root
    - Right superior intercostal vein drains into azygos vein, the left superior intercostal vein drains into the left brachiocephalic vein at level of
- Hemiazygos vein:
    - formed by union of the left ascending lumbar and the left subcostal vein→empties into the azygos vein
    - ascends on the left side of the vertebral body benind the thoracic aorta, receiving the lower four posterior intercostal veins
- Accessory hemiazygos:
    - formed by union of fourth to eighth intercostal vein, empties into the azygos vein

**Arterial System**

- Internal thoracic:
    - arises from first part of subclavian artery and descends BEHIND the first six costal cartilages just lateral to the sternum
    - Two terminal arteries of internal thoracic artery are superior epigastric artery (enters rectus sheath and supplies the rectus muscle as far as the umbilicus) and the musculophrenic arter ( supplies the diaphragm and lower intercostal spaces anteriorly)
    - Branches of internal thoracic include:
        - upper small anterior intercostal arteries which anastomose with posterior intercostal arteries from thoracic aorta which supply intercostal,
        - serratus anterior, and pectoral muscles.
- External iliac artery→inferior epigastric artery anastomes with the superior epigastric artery in the rectus sheath in the area of umbilicus
- Aorta: a lot of elastic fibers in its tunica media. Has four parts:
    - 1) ascending aorta: beginning and has right and left coronary arteries supplying heart muscle
        - sphyilis annuerysm occurs here
    - 2) arch of aorta: with brachiocephalic, the left common carotid, and the left Subclavian—all blood for head and neck
    - 3) thoracic portion: from T4 to T12 (lies in the posterior mediastinum)
        - All of the arterial branches from this part (posterior intercostal, and subcostal arteries) supply the thorax and the diaphragm

    - 4) Abdominal portion of descending aorta: from T12 to L4 terminates by dividing into the right and left common iliac arteries and a small middle sacral arter. From abdomen and pelvic region and lower limbs syphilis
        - most common location for an atherosclerotic induced aneurysm
- Common hepatic artery (proper hepatic),
    - a) right hepatic—to right lobe of liver, cystic to gallbladder
    - b) left hepatic—to left lobe with right gastric to lesser curvature of stomach and gastroduodenal to pancreas and duodenum
- External carotid artery:
    - supplies most of the head and neck except for brain (which comes from internal carotid and vertebral arteries)
    - ECA passes through the parotid gland and terminates as maxillary and superficial temporal arteries
- Sphenopalatine artery:
    - is terminal branch of maxillary artery and
    - primary artery of nasal cavity entering through sphenopalatine foramen along with nasopalatine branch of maxillary nerve
- Anterior ethmoidal:
    - branch of ophthalmic artery
    - is another main supply of the nasal cavity.
    - Other smalls suppliers to the nose include: descending palatine of maxillary, superior labial of facial, and posterior ethmoidal of ophthalmic
- Ophthalmic artery is branch of internal carotid
- Maxillary and superficial temporal arteries are two terminal arteries of external carotid
- Branches of abdominal aorta are:
    - 1)celiac trunk—
        - a)hepatic artery: liver, upper pancreas, duodenum, and gallbladder;
        - b)left gastric: stomach and esophagus;
        - c) splenic: spleen, stomach, and omentum
    - 2) superior mesenteric: small intestines (duodenum and jejunum) pancreas, cecum, ascending and transverse colon
    - 3) inferior mesenteric: transverse, descending, sigmoid colons, rectum
- Brachiocephalic artery (innominate artery):
    - a branch of the arch of aorta giving rise to right subclavain.
    - Other two are left common carotid and the left Subclavian.
    - Brachiocephalic is extremely short. It divides to right common carotid and Subclavian.
- Subclavian artery supplies upper limbs
- Common carotid:
    - supply head and neck branching at superior border of thyroid cartilage.
    - Carotid sinus located at junction and has baroreceptors for pressure and chemoreceptors in carotid body, which is innervated by vagus nerve
        - Carotid sinus: spindle shaped dilation at bifurcation and inervated by the glossopharyngeal
            - Carotid sinus syndrome: temporary loss of consciousness that accompanies convulsive seizures because of intensity of carotid sinus reflex when pressure builds in one or both carotid sinuses
        - Carotid body: lies posterior to the bifurcation and innervated by glossopharyngeal and vegas sensitive to excess CO2 and reduced oxygen tension in blood
    - Internal carotid: inside the cranial cavity.
        - Ophthalmic: orbit and eye through optic foramen
        - anterior and middle cerebral artery→great cerebral circle of willis
    - External carotid:
        - Anterior branches:

- Superior thyroid: supplies thyroid gland, gives oof a branch to the sternocleidomastoid muscle and superior laryngeal artery
- Lingual: supplies tongue
    - Lingual artery does not follow the lingual nerve.
        - It passes deep to the hyoglossus muscle and has branches of: suprahyoid, dosal lingual, sublingual, deep lingual (the terminal branch that supplies the tip of the tongue) which ascends between the genioglossus and the inferior longitudinal muschels.
- Facial: supplies face and submandibular gland
    - Branches of facial artery:
        - Cervical: a) tonsillar b) ascending pharyngeal c) glandular—to submandibular gland d) submental—to areal below chin
        - Facial portion: a) inferior labial b) superior labial c) lateral nasal—outer side of later nose c) angular—medial side of eye, termal branch of facial artery and anastomeses with the doral nasal branch of ophthalmic
- Maxillary artery: supplies mand and max teeth, muscles of mastication, the palate and most of nasal cavity,terminal branch of external carotid to region of temple and sclap
    - Lateral pterygoid muscle divides maxillary nerve into three parts.
        - Mandibular portion before muscle
            - Deep auricular—to external auditory meatus
            - Anterior tympanic to eardrum
            - Middle meningeal—to cranial cavity, damage to this artery results in epidural hematoma
            - Accessory meningeal to cranial cavity
            - Inferior alveolar—chin and lower teeth
        - Pterygoid portion passing over/under muscle
            - Anterior and posterior deep temporal
            - Pterygoid—medial and lateral
            - Massteric
            - buccal
        - Pterygopalatine portion corssing muscle
            - Posterior-superior alveolar—maxillary molars and premolar
            - Infraorbital—canine and incisor
            - Descending palatine—greater and lesser palatine
            - Artery of the pterygoid canal
            - Pharyngeal
            - Sphenopalatine is terminal branch of maxillary artery, damage results in epitaxis

    - 2. Posterior:
        - ascending pharyngeal,
        - occipital,
        - posterior auricular,
        - superficial temporal

- Stomach supplied by: right and left gastric and gastroepiploic arteries and short gastric artery
- Splenic artery: left gastroepiploic to greater curvature of stomach, short gastric—to curvature of stomach
- Less gastric artery: to lesser curvature of stomach, inferior part of esophagus
- External carotid lies within the substance of the parotid gland from upper border of thyroid to the neck of the mandible. Supplies muschels of neck and face, thyroid, salivary gland, scalp, tongue, jaws, and teeth Branches:
- Mandibular teeth receive blood from inferior alveolar artery, branch of maxillary artery. Max posterior teeth from posterior superior alveolar artery, and anterior teeth from anterior and middle superior alveolar arteries

- Occipital—phaarynx and suboccipital triangle
- Posterior auricular—back of scalp
- Two vertebral→basilar artery the posterior brain
- two carotid→internal carotid→ anterior and middle cerebral arteries supply the middle brain
- Circle of Willis:
    - formed by the posterior cerebral (branch of basilar), posterior communicating (branch of internal carotid), internal carotid, anterior cerebral and anterior communicating (branch of internal carotid) arteries
    - forms an important means of collateral circulation in case of obstruction
- Ophthalmic artery: follows optic nerve through the optic forament to enter the orbit
- Linticulostriate arteries: "arteries of stroke" penetrate basal nuclei and are branches of middle cerebral (largest of internal carotid arteries.
- Sinusoids:
    - are wider and more irregular than capillaries,
    - have walls consisting of phagocytic cells, form part of reticuloendothelial system—concerned with phagocytosis and antibody formation
    - Sinusoids found in: liver, spleen, pituitatry gland, adrenal gland, carotid body, pancreas, parathyroid
- Tunica media known for high % of smooth muscle, large arteries have elastic fibers
- Vasa vasorum: "vessels of the vessles", that nourisn more external tissue of the large blood vessels
- Exchange through capillaries is mostly diffusion
- 3 main Hepatic vein → IVC
- Liver has mixture of arterial (hepatic) and venous blood (portal)
- Inferior alveolar vein, artery and nerve and the lingual nerve are found in space between the medial pterygoid muscle and the ramus of the mandible
- Tongue receives blood from: lingual, tonsillar, and ascending pharyngeal arteries.
- The tongue:
    - motor innervation: hypoglossal nerve, CN XII,
    - sensory innervation: lingual branch of trigeminal CN V3 supplies the anterior two thirds, glossopharyngeal (CNIX) supplies the posterior one third (including the vallate papillae, vagus CN X through the internal laryngeal nerve supplies the area near the epiglottis,
    - taste—facial (CN VII) via chorda tympanie supplies the anterior two thirds and glossopharyngeal CN IX the posterior one third

**GastroIntestinal System**

- Esophagus:
    - 10 inches, behind trachea in thorax, emptying in cardiac portion of stomach through cardiac orifice.
    - Esophagus has upper third with skeletal and smooth muscle and lower 2/3 with smooth muscle only
    - Esophagus receives blood from inferior thyroid artery, branches of descending thoracic aorta, and left gastric art
    - PS from esophageal branches of vagus nerve.
    - Motor fibers from recurrent laryngeal of vagus nerve and S innervation from esophageal plexus of nerves.
- Abdomen is divided into nine regions by four imaginary planes:
    - Umbilical—located centrally, surrounds the umbilicus
    - Lumbar—areas to the right and left of umbilical region
    - Epigastric—midline region above umbilical region (contains most of stomach)
    - Hypochondriac—region to the right and left of epigastric region. Located beneath the cartilage of the rib cage (spleen here)
    - Hypogastric (pubic)—midline region directly below the umbilical region
    - Iliac (inguinal)—regions on the right and left of the hypogstric region

- Stomach:
    - upper part of abdomen extending beneath the left costal margin region into epigastric and umbilical regions, protected by lower ribs.
    - Connects with esophagus via cardiac orifice and to small intestine via pyloric sphincter.
    - 1.0 liter is capacity of stomach, receives blood from all three branches of celiac artery (left and right gastric, short gastric, and right and left gastroepiploic arteries
    - Stomach regions
        - Cardia—lies near the junction of stomach and esophagus
        - Fundus—enlarged portion above and left of esophageal opening into stomach
        - Body—middle or main portion of stomach
        - Pyloris—lower portion, lying near small intestines
    - Gastric glands of stomach:
        - Parietal (oxyntic)—in fundus and body secretes HCl
        - Zymogenic (chief)—fundus and body, secretes pepsin
        - Enteroendocrine—present throughout stomach, produces gastrin
    - The lesser and greater omenta are mesenteris that connect the stomach to other visera (lesser—liver; greater—small intestines)
- Duodenum:
    - one foot long—shortest but widest in small intestine, horseshoe-shaped that curves around head of pancreas with
    - BRUNNER's GLANDS (submucosal glands) which secret mucus
        - Brunners glands (duodenal glands) small, branched, coiled, tubular glands in submucosa that secrete alkaline mucus to neutralize gastric acid (histologically differentiates stomach and duod.)
    - Duodenum—is retroperitoneal in the latter parts 3/4 and receives the common bile duct and pancreatic ducts at the ampulla of Vater (small rounded elevation in wall of duod.)
        - Duct of Wirsung—main excretory duct of pancreas, begins at the tail and joins the common bile duct to form hepatopacreatic ampulla (ampulla of Vater) before opening into duodenum→opens into the descending portion ($2^{nd}$ part) of duodenum
        - Accessory pancreatic duct (Santorini's duct)—when present opens separately into duodenum
    - Duod—receives blood from superior pancreaticoduodenal artery arising from gastroduodenal artery and inferior pancreaticoduodenal arising from superior mesenteric.
    - Pregang. PS are in dorsal motor nucleas of vagus nerve
- Jejunum: VALVES of KERCKRING or PLICAE CIRCULARES and more vili for greater resorption
- Ileum:
    - more fat and
    - lymphoid tisse (PEYERS PATCHES—MALT for antigen presentation and secretory IgA) to handle waste, preferred site for Vit B12 absorb
- Ileocecal valve joins small and large intestines
- Small intestines secrete:
    - malatase, sucrase, lactase→disaccs to monosaccs;
    - aminopeptidase and dipeptidase→individual a.a.;
    - enterokinase→converts trypsinogen to trypsin
- Small intestines mucosal:
    - plicae circulares: tranverse folds of mucous membrane increasing surface area found in Jejunum, also called valves of kerckring.
    - Villi are numerous in entire intestins and absorp via microvilli which are projections on the free survace of the cells lining vilii.
    - Epithelial cells lining villi:
        - Goblet cells—mostly in the ileum
        - Absorptive cells—simple colunar cells with microvilli

- Enteroendocrine cells (argentaffic cells)—secrete enterogastrones (secretin and cholecystokinin) into blood stream. Found in duodenum

| Hormone | Major activities | Stimuli for release |
|---|---|---|
| Gastrin | *Stimulates gastric acid secretion* | Presence of peptides and amino acids in gastric lumen. Distension of stomach |
| **Cholecystokinin** | *Stimulating secretion of pancreatic enzymes, and* ***contraction and emptying of the gall bladder*** | Presence of fatty acids and amino acids in the small intestine |
| **Secretin** | ***Stimulates secretion of water and bicarbonate from the pancreas and bile ducts*** | **Acidic pH in the lumen of the small intestine** |
| Gastric inhibitory polypeptide | Inhibits *gastric acid secretion (HCl) and motility* and potentiates release of insulin form beta cells in response to elevated blood glucose concentrations | Presence of fat and glucose in the small intestine |

- Comparison of jejunum and ileum:
    - Jejunum: thicker muscular wall for more active peristalisis, mucosal inner lining of greater diameter for absorption, has more plicae circulares (valves of Kerckring) and more villi for absorption
    - Ileum: more mesenteric fat, more lymphoid tissue (Peyer's patches) more complex blood supply, more globlet cells, which secret mucus
- Large intestines (Colon):
    - TENIAE COLI: thick longitudinal bands of smooth muscle fibers that extend the entire length of colon.
    - Shorter the large intestine therefore cause it to form small pouches called haustra
    - Function of Large int (colon):
        - remove water from material entering it. Water removed by absorption, large intestines does not secrete enzymes into lumen
    - Colon epithelium:
        - simple columnar with microvillous border to increase surface area for absorption of water from lumen.
        - Goblet cells mucus lubricates dehydrating fecal mass. CRYPTS OF LIEBERKUHN (intestinal glands—in the stomach they are called rugae) invade lamina propria (not the same as goblet cells). No villa formed in large intestines.
            - Paneth cells—(stain red)found at bases of villi of tubular intestinal glands (crypts of Lieberkuhn) and secrete digestive enzymes, lysosymes
    - Colon muscularis externa: inner circle smooth muscle layer. Outer three banded layer of longitudinal smooth muscle (teniae coli) for peristalsis
    - Vagus nerve supplies PS to ascending and transverse colon. Descending and sigmoid colon with rectum and anus supplies by pelvic splanchnic nerves.
- Gallbladder:
    - pouch like organ that stores and concentrates bile by absorbing water and salts (bile continuously produces in liver).
    - When small intestines are empty, sphincter of ampulla (Oddi) constricts forcing bile up the cystic duct to glallbladder.
        - With food (particularly fats) cholecystokinin relaxes ampulla for bile to mix with chime
    - Bile emulsifies neutral fats and absorbs fatty acids, cholesterol and certain vitamins
    - Gallbladder does not contain a submucosa,
    - receives blood from cystic artery of right hepatic origin, and is innervated by vagal fibers from celiac plexus.

- Cystic duct joins with the common hepatic to form the common bile duct which later joins with the pancreatic duct  the common bile duct which joins the pancreatic to form hepatopancreatic duct
- Lymph from gallbladder drains into a cystic lymph node, then into a hepatic nodes and then into celiac nodes.

- Liver:
  - largest and most active organ,
  - blood from hepatic artery and portal vein,
  - autonomic nerve fibers from celiac plexus,
  - divided into large right lobe and small left lobe by attachment of peritoneum of falciform ligament,
    - Right lobe of liver is further subdivided into quadrate lobe and caudate lobe by presence of gallbladder, fissure for ligamentum teres (from umbilical vein), and IFC, and fissure for ligamentum venosum
  - Liver cells (hepatocytes): produce and excrete bile, are most versatile cells in body.
    - Bile to common hepatic duct, joined by short cystic duct of gallbladder to form common bile duct
  - Kupffer cells: line sinusoids of liver and function to filter bacteria and small foreign particles out of blood
  - Liver lies under the right side of diaphragm.
  - Blood eventually drains via the three hepatic veins into the inferior vena cava which is transported to heart
  - What about the composition of the portal triad

## Endocrine System

- Exocrine glands classified according: to
  - type of secretion:
    - mucous (water and mucin) buccal glands, glands of esophagus, cardiac and pyloric glands of stomach
    - serous (enzymes)—parotid, pancrease and uterin glands
    - mixed (mucus and serous)—submandibular and sublingual salivary –glands of nasal cavity, paranasal sinuses, nasopharynx, larynx, trachea, and bronchi
  - Mode of secretion
    - Merocrine—only cell secretory product released from membrane bound secretory granules—pancreatic acinar cells (glucagons)
    - Apocrine—secretion of product plus small portion of cytoplasm—fat droplet secretion by mammary gland
    - Holocrine—entire cell with secretory product—sebaceous glands of skin and nose
  - Structure of duct system
    - Unbranched—simple glands—sweat glands
    - Branched—compound glands--pancreas
  - Shape of secretory unit
    - Tubular—cylindrical lumen surrounded by secretory cells—sweat glands
    - Acinar (alveolar)—dilated sac-like secretory unit—sebaceous and mammary glands
    - Tubuloacinar (tubuloalveolar)—intermediate in shape or having both tubular and alveolar secretory units—major salivary glands
- Pituitary (hypophysis cerebri): master endocrine gland bc controls many other glands through release of tropic hormones (hormones that effect the activity of another endocrine gland)—are vital to life
  - Origin:
    - Upgrowth from ectoderm of the stomadeum--roof of mouth (anterior pituitary—adenohypophysis, glandular portion from oral ectoderm) and

        - downgrowth from the neuroectoderm of diencephalons—floor of brain (posterior pit—neurohypophysis, nervous portion). Two totally different tissue types
        - Rathke's pouch—diverticulum developing at 3 week embryo from the roof of stomodeum (primitive mouth) grows towards brain
    - Structure:
        - Adenohypophysis include: pars tuberalis, pars distalis, and pars intermedia
        - Neurohypophysis include: median eminence, infundibulum and pars nervosa.
        - Infundibulum—carries important nerve tracts and substances to act on pituitary
        - Pars intermedia is an avascular zone that lies between two lobes but is considered part of anterior pituitary
        - Pars intermedia and tuberalis have no proven function in mammals
    - Synthesized peptide hormes:
        - Anterior Pituitary Hormones: GPA B-Flat = Gh, Prolactin from alpha cells, Beta cells: Fsh.Lh, Acth, Tsh Tropics are FSH, LH, ACTH, and TSH. Regular Hormones are: GH and prolactin
            - Growth hormone (somatotropin): growth in general particularly skeletal system by stimulating uptake of aa, protein synthesis, and carb and fat breakdown. Mo*st plentiful of AP hormones*
            - Corticotrophin (ACTH): secretion of adrenacortical hormones, which in turn effect the metabolism of glucose, proteins, and fat
            - Thyroid stim horm: controls secretion of thyroixine by thyroid, uptake of iodine, and synthesis
            - Prolactin: promotes mammary gland development and mild production, breast development, triggered by rising levels of estrogen
            - Follicle stimulate: development of graafian follicles and estrogens in the ovary and promotes spermatogenesis in the male
            - Lh: estrogen by ovarian cells to result in ovulation and stimulates formation of the corups luteum and secretion of progesterone, interstitial cells of testes to secrete testosterone
        - Posterior Pit: synthesized in hypothalamus and transported in axons to the poster lobe for storage and secretion
            - ADH (antidiuretic hormone or vasopressin): controls the rate of water excretion into the urine;
            - Oxytocin: helps to deliver milk from the glands of breast to nipples during nursing. Both
    - Pituitary positioned in the sella turcica of the sphenoid bone (Turkish saddle) and is directly above the sphenoid sinuses
    - Posterior Pit lobe: unmyelinated nerve fibers, secretes ADH and oxytocin. Consists of 100,000 axons of the supraoptic and paraventricular nuclei of hypothalamus.
    - Hypothalamo-hypophyseal portal tract—refers to
    - Blood supply to pituitary gland is from the right and left superior hypophyseal arteries and the right and left inferior hyposphyseal arters. Form rich vascular portal system.
    - Portal has two capillary beds, three in body: hepatic portal system's fist capillary bed is in the intestines and the second is in the sinusoids of liver. The reanl portal systems first capillary bed is in the glomerulus.
- Parathyroid
    - four superior (superior thyroid artery from external carotid) and inferior (inferior thyroid artery from thryocervical trunk) pairs on posterior of thyroid.
    - PTH regulates calcium and phosphate metabolism of body. ESSENTIAL for LIFE. Innervention by superior cervical ganglion (sympathetic)
    - Cell types:
        - Principal cells (chief cells): PTH, have clear cytoplasm

        - Oxyntic cells (acid secreting cells) granules in cytoplasm, fxn unkown
    - Low PTH leads to tetany, muscle weakness duel to lack of calcium
    - Parathyroid—develop from THIRD AND FOURTH pharyngeal POUCHES.
- Pineal gland:
    - located in the epithalamus of brain and releases the hormone melatonin.
    - Thought to play role in regulation of sleep-wake cycle, body temperature regulation and appetite
- Adrenal gland—(suprarenal gland)
    - Adrenal medulla:
        - secretes epi and norepi, NOT ESSENTIAL FOR LIFE.
        - From neuroectorderm (neural crest cells which differentiate into medullary cells called chromaffin cells)
    - Adrenal cortex: inside to out; zona reticularis→zona fasiculata→zona glomerulosa. Each has endocrine cells:
        - Zona glomerulosa—thin layer, clusters of cells beneath CT capsule. Secrete mineralocorticoids, primarily aldosterone
        - Zona fasiculata—thick middle layer, cells arranged in parallel colunns that run at right angles to surface. Secrete glucocorticoids, primarily cortisol. Small amounts of estrogenic and androgenic-like substances are also produced
        - Zona reticularis—inner layer, cells arranged in interconnectin cords. Secrete small amounts of cortisol and Dehydoropiandrosterone (DHEA)
- Adrenal gland is embedded in adipose tissue above kidneys
        - Derived fromthe mesoderm
- Hormones that are ESSENTIAL FOR LIFE: parathyroid, adrenal cortex, anterior pituitary, pancreatic islets (Langerham)
- Thymus:
    - major gland of the immune system, two soft, pinkish-gray lobes lying in bib-like fashion below the thyroid gland and above heart.
    - Requires zinc: most critical, involved in all aspects of immunity, vit B6, Vit C, carbonic anhydrase, and others to functions
    - no afferent lymphatics of lymphatic nodules
    - blood from the internal thoracic and inferior thyroid arteries,
    - innervated by vagus and phrenic nerves.
    - Has double embryologic origin: lymphocytes derived from hematopoietic stem cells, while Hassall's corpuscle epithelium derived from endoderm of THIRD pharyngeal POUCH
    - produces thymopoietin and thymosin,
        - both are thymic lymphopoeitic factor: confers immunological competence on thymus-dependent cell and induces lymphopoiesis.
        - Also Thymic humoral factor THF and thymic factor TF which are important in normal development of the immune system→proliferation and maturation of T lymphocytes (cell mediated immunity)
    - thin layer of CT (just like (spleen, tonsils, lymph nodes, and Peyer's Patches).
    - Outer cortex of thymus is primarily lymphocytes,
    - the inner medulla contains lymphocytes and Hassall's corpuscles which are thought to be vestiges of epithelium with unknown function
    - master organ in immunogenesis in the young, some believe it monitors total lymphoid system throughout life
- Pancrease: both exocrine and endocrine—posterior to abdominal wall.
    - Retroperitoneal organ, except for small portion of tail which lies in the lienorenal ligament. Head and neck neslt in the curve of the duodenum, body is behind stomach tail extends to spleen.
    - Endocrine (Islets of Langerhans—cells of pancreas)
        - Alpha cells—glucagon
        - Beta—insulin, carb metabs, most abundant (80% of cells)

        - Degeneration of islets of Langerhans leads to diabetes mellitus
    - Delta—somatostatin which acts locally within the islets of Langerhans to depress the secretion of both insulin and glucagon
  - Exocrine
    - Centro acinar cells: pancreatic juices including lipases, carbohydrases and proteases to digest fats, carbs, and proteins
- Goblet cells: female Reproductive tract, respiratory tract, and intestines
- Mucus-functions to protect and to lubricate for transportation. Characterized by large, clear secretory granules that occupy most of the cell and a flattened nucleus-containing, condensed chromatin at cell base.
- Serous demilune cells: associated with the mucous acini of the sublingual and submandibular glands
- Serous cells:
  - rounded euchromatic nucleus surrounded by rough ER in the basal third of the cell with zymogen granules (clearly visible and easily stained secretory granules) at cell apex.
  - Serous cells found in acinar cells of pancreas, parotid, gastric chief cells and intestinal paneth cells (found at base of vili in intestines)
- Thyroid gland:
  - is H-shaped structure. Two parts are joined by thin band called the isthmus.
  - Blood from superior and inferior thyroid arteries,
  - nerve from glandular branches of cervical ganglia of symp trunk.
  - Cell types:
    - Follicle cells: sythesize tyrosine to thryoglubulin, which is stored in colloid of each follicle. Precursors are triiodothyronine and thryoxine.
      - lobules separated by trabeculae and intralobular CT. When pituitary gland secrets thyrotropin, the colloid becomes active and the throglobulin molecues are released and taken back into the follicular cells where they become T4 and T3.
      - Follicular cells remain inactive at times of low throid homrone and can be activated when it is necessary for the mobilization of colloid found in thryroid. Will stain ACIDOPHILIC
      - Metabolically active follicular colloid stains basophil
    - Parafollicular cells: produce calcitonin, lowers blood-calcium and phosphate levels
    - Throglossal duct is a narrow canal that connects the thyroid gland to the tongue during development. Disappears but persists as the foramen cecum
- Fusion of epiphyses of long bones determines if excess GH secreted will result in Gigantism (children) or acromegaly (adults)
- Exocrine glands secrete products into ducts
- Endocrine glands secret their products (hormones) into the interstial fluid surrounding the secretory cells from which they diffuse into capillaries to be carried in blood
- Sublingual gland:
  - contains mostly mucous with some serous demilunes,
  - located in the floor of mouth beneath tongue close to midline.
  - Mylohydoi muscle supports the glands inferiorly.
  - Innervated by PS of facial nerve with chorda tympani from submandibular ganglion.
  - Blood from sublingual artery from lingual from external carotid.
- Submandibular and sublingual lymph drainage is to the deep cervical lymph nodes
- Joining of numerous sublingual ducts to form single main duct is Bartholin's duct, accompanies submandibular duct
- Von Ebner's glands:
  - located around the circumvallate papilla of tongue.
  - Function is to rinse the food away from papilla after it has been tasted by the taste buds.
  - PURELY SEROUS
- Major salivary glands are tubuloalveolar glands

- Sublingual gland secretes through Rivian ducts
- Parotid and Von Ebner's and the only adult salivary glands that are purely serous
- Duct of Wirsung:
    - main excretory duct of pancreas, begins at the tail and joins the common bile duct to form hepatopacreatic ampulla (ampulla of Vater) before opening into duodenum→opens into the descending portion (2nd part) of duodenum
- Accessory pancreatic duct (Santorini's duct): when present opens separately into duodenum
- Bartholin's Duct: major sublingual duct that drains the sublingual salivary gland and opens on the sublingual papilla in floor of mouth
- Wolffian duct: (mesonephric duct) embryonic duct that develops in the male into the deferent duct, in the female it is obliterated
- Submandibular gland: (formerly called submaxillary gland)
    - locate in the submandibular triangle (digastric triangle). Superficial part rests on mylohyoid muscle curves around the posterior border of mylohyoid to the deep part located btw the mylohyoid and the hyoglossus.
    - Whartons ducts:
        - drains submandibular gland,
        - arises from deep portion of gland and crosses the lingual nerve in the region of the sublingual gland to terminate on the sublingual caruncle (papilla) adjacent to the base to the base of the sublingual frenulum.
    - Facial artery enters submandibular triangle deep to the posterior belly of digastric and passes under and nourishes the submandibular gland. Gives of submental branch as it emerges beneath the gland.
    - PS secretomotor leave facial nerve in chorda tympani.
        - Carries pre-gangl to lingual nerve from which the submandibular gangl is suspended.
        - Fibers leave lingual nerve and synapse in the ganglion with post glang.
        - Also supply sublingual, lingual (von Ebners') and glands of inferior portion of buccal mucosa and inferior labial glands.
    - Post gang Sympathetic are from superior cervical ganglion gain access via the adventitia of the facial and lingual arteries
- Parotid gland:
    - largest salivary gland, purely serous.
    - Divided into deep and superficial lobes, superficial to mandibular ramus another portion deep.
    - PS secretomotor from glossopharyngeal by way of lesser petrosl nerve, the otic ganglion, and the auriculotemporal nerve (branch of V-3).
    - Supplied by maxillary and superficial temporal.
- Stensons duct:
    - crosses massster muscle, pierces the buccinator to open into the vestibule of mouth opposite the max second molar,
    - drains parotid
- Lymphatic of parotidis the superior deep cervical nodes
- Adenomere: part of developing salivary gland destined to become responsible for functioning.
    - Composed of intercalated ducts: transport saliva to larger ducts;
    - striated ducts: contain mitochondria for electrolyte and water transport and are simple, low columnar epithelium;
    - glandular cells: synthesize glycoproteins
- Von Ebner's glands: associated with circumvallate papilla
- Serous demilunes:
    - (name is misleading because they secrete mucus) not found in adult parotid as they are in the submandibular and sublingual.
    - It is a mucous tubuloalveolar secretory unit that contain the enzyme lysozyme that decrades the cell walls of bacteria.

- Compound tubuloalveolar glands: classification of all secretory glands, small sacs at end are either called alveoli or acini

## Cardiac

- Thrombosis in coronary sinus might cause dilation in small, great, oblique, and middle cardiac veins, but NOT THE ANTERIOR cardiac vein
- Anterior cardiac vein drains directly into the right atrium whereas all others drain into the coronary sinus.
- Coronary sinus:
    - drains most of blood from the heart wall, opens into the right atrium between the inferior vena cava and the atrioventricular orifice.
    - It is a continuation of the great cardiac vein.
    - Small and middle cardiac vein are tributaries to coronary sinus
- Anterior interventricular artery accompanies the great cardiac vein. The posterior interventricular artery accompanies the middle cardiac vein
- Cardiac muscle:
    - makes up myocardium,
    - intercalated disks to form a functional network,
    - DOES NOT contract voluntarily,
    - fibers are separate cellular units, which don't contain many nuclei,
    - respond to increase demands by increasing fiber size (compensatory hypertrophy)
- Impulse-conducting system of heart:
    - consists of specialized cardiac musle (which contain modified cardiac muscle fibers) present in the SA node, the AV node, and the bundle of his (including the Purkinje fibers)/
    - Fibers capable of depolarizing more rapidly than regular fibers, but are weakly contracting.
- The sinoatrial node (SA node):
    - at the junction of the superior vena cava and the right auricle is the most rapidly depolarizing.
    - The conduction system of heart is all modified cardiac muscle fibers and NOT NERVES
- Left Ventricle:
    - assocated with the apex of heart, and is
    - at the level of the fifth left intercostal space, medial to the nipple line, about 9 cm from midline
    - The left ventricle enlarges briefly in response to coarctation (constriction) of aorta
- Fossa ovalis and anulis ovalis lie on the Atrial (interatrial) septum—previous site of foramen ovale in the fetus. The anulis ovalis forms the upper margin of the fossa
- Layers of the heart:
    - Internal endocardium:
        - homologous with the tunica intima of the blood vessles.
        - Lines the surface with simple squamous endothelium and underlying loose CT with small blood vessels
    - Myocardium:
        - homologous to the tunica media.
        - Bulk of heart mass with cardiac muscle cells arranged in the spiral configuration.
        - Allows heart to wring blood from the bentricls toward aortic and semilunar valves
        - Right and left coronary arteries supply myocardium, come from ascending aorta
    - Epicardium or pericardium:
        - serous membrane.
        - Externally, it is covered by simple squamous epithelium supported by thin layer of CT.
        - The adipose tissue that surrounds the heart accumulates in this layer
- Heart is located in middle mediastinum
- Right and left coronary arteries supply myocardium, coming from aorta.

- Cardiac veins lie superficial to the arteries
- Valves:
    - Mitral valve (bicuspid) best heard over apex of heart,
    - Tricuspid best heard over the right half of the lower end of the body of the sternum
    - Pulmonary valve best heard over the second left intercostal space
    - Aortic valve best heard over the second right intercostal space
- Chordae tenineae attach the cups of the valve to the papillary muscles
- Pectinate muscles:
    - are located on the inner surface of the right atrium.
    - They are prominent ridges of atrial myocardium in right atrium and both auricles (which are small conical pouches projecting from the upper anterior portion of each atrium)
- Crista terminalis:
    - vetical muscular ridge that runs along the right atrial wall from the opening of the SVC to the IVC.
    - Provides origin of the pectinate muscle.
    - Represents junction btw the sinus venosus and the heart in the developing embryo.
    - Also represented on the external surface of heart by the vertical groove called the sulcus terminalis
    - SA node is located in the crista terminalis near opening of SVC
- Papillary muscles:
    - are cone-shaped muscles that terminate in tendinous cords (chordae tendineae that attach to the cusps of the AV valves.
    - Papillary muscles do not help the valves to close.
    - Help prevent the cusps from being everted or blown out into the atrium during ventricular contraction
- Two thirds of hearts mass is to the left of body midline
- Pericardium:
    - tough, double walled fibrous membrane.  T
    - The outer sac is called the parietal pericardium, the inner wall is called visceral pericardium (epicardium).
    - In between walls is the pericardial cavity, which contains serous fluid that minimized friction as heart beats.  Apex of heart fits into a depression on the diaphragm

**Joints**

- Synovial fluid-produced by synovial membrane
- Synovial joints feely move (diarthrodial), and are limited by one joint surface, ligaments, muscles, or tendos.  They are:
    - Articular cartilage: thin layer of hyaline cartilage that covers the smooth articular bone surfaces.  No blood vessels or nerves (TMJ CONTAINS FIBROU-CARTILATE NOT HYALINE CARTILAGE)
    - Synovial cavity: small fluid filled space separation the ends of adjoining bones
    - Articular capsule: double-layers; outer layer of fibrous CT that encloses the joint.  The inner layer is a thin vascular synovial membrane
    - Synovial fluid: clear, thick flid *secreted by synovial membrane*, which fills the joint capsule and lubricates the articular cartilage at the ends of the articulating bones
    - Supporting ligaments: has capsular, extracapsular, and intracapsular ligaments, that mainat the normal position of the bones
- Most joints in body are synovial joints and classified as:
    - diarthroses (freely movable)
    - syarthroses: immovable joints, where bones connect (sutures)
    - Amphiarthroses: slightly movable joint (cartilaginous joint) one example is the symphysis of pubis,
- These disc consit of fibrocartilage and divide cavity into tow separate cavities
- Joints by CT:

    - Fibrous—joined by fribrous CT—
        - Sutures of skull
        - Syndesmoses—between radius and ulna
        - Gomphoses—tooth socket
    - Cartilaginous—joined by fibrocartilage or hyaline cartilage
        - Synchondroses—epiphyseal plates within long bones
        - Symphysis—mental symphsis
    - Synovial—joint capsule containg a synovial membrane that secretes a synovial fluid
        - Most joints such as TMJ
- Some synovial joints have articular discs (TMJ and sternoclavicular joint)
- Busa:
    - fluid filled sac that is lined with a synovial membrane.
    - Functions to reduce friction.
    - May be located between tendon or a bone.
    - Inflammation of lining of bursa is referred to as bursitis
- Atlanto-axial joint:
    - allows for maximum movement of head around vertical axis.
    - It is a synovial articulation between the inferior and articulating facets of the atlas and the superior articulating facets of the axis (second cervical vertebra)—movements of head as saying NO
- Atlanto-occipital joint:
    - pemits rocking and nodding, saying Yes.
    - It is a synovial articulation between the superior articulating facets of the atlas and the occipital condyls of skull

**Blood**

- Red bone :
    - marrow is responsible for producing white and red blood cells and platelets in process of hemopoiesis
    - cranial bone, vertebrae, ribs, sternum, and ends of long bones (proximal epiphyses of humeri and femora), portion of ossa coxae.
    - Red bone marrow found in cancellous (spongy) tissue
- Formed blood elements prior to birth: Liver, spleen, lymph nodes
- Hemacytoblasts = pluripotent stem cells:
    - precursors to red bone marrow→give rise to progenitor cells→proerythroblasts, megakaryocytes, and myeloid and leukoid lines
- Yellow marrow: used for very minor location of fat storage, found in center of long bones of adults
- Flagellum:
    - are present in the human body only in the spermatozoa,
    - and are much longer than cilia and move with an undulating snake-like motion from contraction of the tubular protein
    - nine sets of doublets, two singlets in center
    - basal body is essential to the functioning of the cilia and flagella. Fro the basal body, fibers project into the cytoplasm, possibley to anchor the basal body to the cll
- Cilium:
    - short, hair-like projection from the cell membrane.
    - The coordinated beating of many cilia produce organized movements in coordinated waves from contraction of the tubular protein
    - nine sets of doublets, two singlets in center
    - basal body: is essential to the functioning of the cilia and flagella. Fro the basal body, fibers project into the cytoplasm, possibley to anchor the basal body to the cll

- Centrioles:
  - Nine sets of triplets
- Erythrocytes:
  - are biconcave discs without nuclei,
  - formation process called erythropoiesis which is stimulated by erythropoietin from kidney.
  - Average life span is 120 days. Principle function is to transport oxygen and carbon dioxide
- Oxyhemoglobin = hemo with O2;
- Carbaminohemoglobi = hemo with CO2, 70% of CO2 transported as bicarbonate
- Hematocrit:
  - proportion of erythrocytes (and other formed elements?) in a sample of blood,
  - 46%, for males, 40% for females
- Blood accounts for 8% of body weight, 4 – 6 liters, at 38 C, with pH of 7.35 – 7.45
- Leukocytes by percentage:
  - neutrophils, 60 -70%;
  - lymphocytes, 20 -30%;
  - monocytes 2 – 6%;
  - esoinophils, 1 – 4 %;
  - basophils 0 – 1%.
- Formed elements by # per cubic mm:
  - leukocytes 5- 10 thousand;
  - platelets 250 – 400 thousand;
  - erythrocytes 4.3 – 5.8 million
- Plasma:
  - 91% water,
  - 7 % protein—
    - albumins—55%,
    - globulins 38%, and
    - fibrinogen 7%,
  - 2% other solutes including metabolic end products, food materials, respiratory gases, hormones, ions.
- Platelets are:
  - minute cytoplasmic fragments of cells,
  - irregularly shaped, disk-like cytoplasmic bodies found in blood plasma
  - with no nucleus, DNA or hemoglobin.
  - Life span is 5 – 9 days,
  - removed in spleen and liver.
  - Thrombopoietin stimulates megakaryocytes to give rise to platelets
  - Form platelet plug to stop initial bleeding
  - Contain secretory vesicles (granules) and when adhere to collagen release ADP and others chemicals inducing changes in platelet surface that make them sticky.
  - Thromboxane A directly promotes platelet aggregation

## Bone

- Infratemporal fossa: lies below the infratemporat crest of the greater wing of the sphenoid bone
  - Ethmoid bone: sieve-like bone at base of skull, behind bridge of nose that straddles the mid-sagittal plan and aids to connect the cranial skeleton to the facial skeleton, one of four unpaired bones. Each sinus divided into the anterior, middle and posterior air ethmoidal cells
    - Horizontal plate = cribriform plate—olfactory nerves pass through. The crista galli is the midline for the attachment of the falx cerebri

        - Crista Galli: sharp upward projection of the ethmoid bone in the midline for the attachment of the falx cerebri
        - Cririform plate: perforated on either side of crista galli for olfactory bundles
    - Lateral masses (right and left)—project downward from the horizontal plate. Contain the ethmoid sinuses and the lamina orbitalis (lamina papracea) Conchae—curved plates of bone that form the medial surfaces of the lateral masses
    - Perpendicular plate: downward projection from the midline on the undersurface of horizontal plate. Forms the upper portion of the nasal septum
- Unpaired bones: ethmoid, frontal, occipital, and sphenoid
- Sphenoid bone:
    - Greater wing forms lateral wall of the orbit and roof of the infratemporal fossa with foramen rotundum transmitting V-2, foramen oval—transmitting V-3, and foramen spinosum—transmits middle meningeal vessels and nerves to the tissue covering brain
    - Lesser wing contains optic canal (optic foramen) helps form superior orbital fissure and roof of orbit
    - Foramina in greater wing provide access to both pterygopalatine and infratemporatl fossa
    - Body contains sella turcica and sphenoidal sinuses
    - Lateral pterygoid plate provides the origin for both the lateral and medial pterygoid muscle
    - Aids in connecting cranial skeleton to facial skeleton.
    - Consists of hallow body—sella turcica and sphenoid sinuses
- Endochondral ossification:
    - bone formation from preexisting cartilage.
    - Most bones are endochondral derived beginning as hyaline cartilage, accounting for formation of short and long bones.
    - Osteocytes replace chondrocytes.
    - Bones of extremities and weight bearing bones develop by endochondral oss.
- First evidence of bone ossification around 8 weeks of prenatal development
- Intramembranouse:
    - bone formed directly.
    - Flat bones of skull and face, the mandible, and clavicle.
    - Takes place within membranes of CT (ex: mandible and maxilla).
    - Contributes to growth of short bones and thickening of long bones.
    - involves transformation of osteoblasts to osteocytes.
- Once formed bone grows by apposition, or layering
- Osteoblasts:
    - synthesize collagenous fibers, bone matrix and promote mineralization during ossification
    - Become trapped in own matrix and develop into osteocytes, maintaining bone tissue.
    - Derived from mesenchyme (fibroblasts),
    - have high RNA content and stain intensely.
- Osteoclasts: large, *multinucleated* which contain lysosomes and phagocytic vacuoles
- Osteoid: newly formed organic bone matrix that has not undergone calcification, in this way it differs from bone (no mineralized matrix)
- Osteocytes: maintain the bone tissue
- Bone is hard due to calcification of extracellular matrix. *Elastic* due to presence of *organic* fibers
- Function of bone:
    - support, protection, body movement, hemopoiesis, mineral storage, but NOT fat storage
- Bone used for mineral storage:
    - give bone its rigidity and account for 2/3 of weight of bone.
    - 95% of calcium and 90% of phosphorous in body is in bone
- Forms of bone:
    - 1) compact—appears as solid mass
    - 2) spongy or cancellous bone—branching network of trabeculae

- *Collagenous fibrils* of bone give bone its *tensile strength*.
- Mineralization: inorganic increases, water content decreases, LITLE CHANGE IN THE COLLAGEN
- Temporal bone:
  - has mandibular fossa—an oval depression in inferior surface of the base of the zygomatic process (which is an anterior projection from the squamous portion of temporal bone).
  - The posterior slope of eminence is lined by fibrous connective tissue
- TMJ compartments:
  - 1) upper—disc glides forward on articular tubercle.
  - 2) lower—compartment in which the condyle rotates beneath the disc like a hinge
- Alveolar bone increases in height and length to accommodate developing dentition.
  - It exists only to support teeth. If tooth never erupts the bone never forms, if extracted alveolus resorbs.
  - Position of tooth, not the functional load placed on it, determines the shape of the alveolar ridge
- Space for erupting molars provided by growth of mandibular condyles, which is a major site of growth
- Soft tissue development carries the mandible forward and downward while condylar growth fills in the resultant space to maintain contact with the base of the skull.
- Long axes of mandibular condyles intersect at foramen magnum, which indicates that axes are directed *posteromedially*
- Nasal cavity:
  - Bridge of nose is formed by two nasal bones
  - Lateral walls formed by superior, middle, and inferior conchae
  - Floor is formed by the palatine process of the maxilla and the horizontal plate of the palatine bone
  - Roof is formed by the nasal, frontal, sphenoid (body of) and ethmoid (the cribriform plate of) bones
  - Medial wall or nasal septum is formed by the perpendicular plate of the ethmoid bone, the vomer bone, and the septal cartilage
  - Rest of the framework for bone consists of several cartilage plates, specifically the lateral nasal cartilage and the greater and lesser ala cartilage. These are held together by fibrous CT
- Choanae: posterior opening of nasal cavity to nasopharynx
- Meatus: area below each conchae
- Blood supply to nose is from
  - sphenopalatine branch of maxillary artery,
  - anterior ethmoid branch of ophthalmic artery and
  - septal branch of superior labial branch of facial artery
- Fissure—a sharp, deep groove, narrow, cleft-like opening between the parts of bone that allow for passage of blood vessels and nerves
- Sulcus (a groove, but shallower and less abrupt cleft than a fissure—a shallower, wide groove on the surface of a bone that allows for the passage of vessels, nerves, tendons
- Incisure (notch)—a deep indentation on the border of a bone
- Fovea—small, very shallow depression
- Fossa—shallow depression—may or may not be an articulationg surface
- Foramen—opening through which blood vessls pass
- Meatus (canal)—tube loke passage running through bone
- Process—bone projection that serves fro attachment of other structure
- Epicondyle—projection of swelling on condyleex: medial and lateral epicondyles of femur
- Spine—sharp, slenter projecting process ex:spinous process of vertebra and scapula
- Tubercle—small, rounded process; ex: greater and lesser tubercles of humerus
- Tuberosity—large, rounded, roughened process; ex: ischial tuberosity of ischium
- Trochanter—large blunt projection for muscle attachment on femur
- Crest—a prominent elevated right or border of a bone; ex: iliac crest
- Linea (line)—a small crest, usually somewhat straighter than a crest; ex: linea aspera of femur
- Ramus—major branch or division of the main body of a bone. ex: coronoid
- Neck—slight narrowing of the body of bone that supports the head; ex: neck of humers

- Lamina—very thin layer of bone; ex: laminae of the vertebrae
- Periosteum—dense regular CT covering surface of bone; site for ligament and tendon-muslce attachment and responsible for diametric bone growth
- Diaphysis = bone shaft; consists of a cylindrical tube of durable compact bone
- Epiphysis = caps diaphysis; spongy bone surrounded by compact bone; contains red bone marrow
- Epiphyseal plate: between the epiphysis and the diaphysis, region of mitotic activity responsible for elongation of bone
- Medullary cavity—within diaphysis, contains fatty yellow bone marrow
- Nutriet foramen—opening into diaphysis
- Articular cartilage—caps each epiphysis; composed of hyaline cartilage; facilitates joint movment
- Endosteum—lines meddulary cavity; consist of supportive dens regular CT
- Compact bone—hard, outer layer of bone tissue; covered by periosteum, serves for attachment of muscles, provides protection, gives durable strength to the bone
- Cancellous (spongy)—porous, highly vascular, inner layer of bone tissue; make the bone lighter and provides spaces for marrow
- Compact bone would most likely be found directly underneath the periosteium, both are a type of CT. The matrix of compact bone is collagen plus salts of calcium and phosphorus
- Compact bone consists of
    - Osteocytes—bone cells
    - Lacunae—a depression in the matrix where an osteocyte is located
    - Lamellae—a circular layer of osteocytes located in lacunae
    - Canaliculi—processes connecting the lacunae ¾ each canaliculus resembles a miniature canal
    - Haversian canal—central canal around which the concentric lamellae are located. Contains blood vessels and nerves that serve the osteocytes. Exchange of substances between the central canals and osteocytes occurs along the canaliculi connectin th lacunae to the Haversion canals
- Haversian system—surrounding structures of Haversion canal. Repeating system is found in the compact bone of the diaphysis of long bone
- Anterior cranial fossa: formed by frontal and ethmoid bones
    - Frontal lobes of cerebrum
    - Cribriform plate
    - Formaen cecum
    - Crista galli
- Middle cranial fossa: formed by sphenoid, temporal, and parietal bones
    - Temporal lobes of cerebrum
    - Hypophysis cerebri (pituitary gland)
    - Optic and carotid canal
    - Superior orbital fissure
    - Trigeminal impression for trigeminal ganglion
    - Separate the middle ear cavity and sphenoid sinus
- Posterior cranial foss: formed by occipital and temporal bones
    - Occipital lobe,
    - Cerebellum, pons, and medulla oblongata
    - Internal auditory meatus
    - Jubular conyloid, and mastoid foramen
    - Foramen magnum
    - Hypoglossal canal
- Petrous portion of the temporal bone forms the floor of the middle cranial fossa and separates the middle and posterior cranial fossae
- Zygomatic bone = cheekbone, malar bone or zygoma. Forms prominence of cheek and part of the lateal wall and floor of the orbital cavity. Anteriorly—articulates with maxilla; posteriorly it articulates with zygomatic process of temporal bone to form the zygomatic arch.

- Temporal fossa—area above zygomatic arch, filled with temporalis muscle. Lower margin is masseter muscle
- Temporalis muscle passes medial to the zygomatic arch before insetin into coronoid process of mandible
- Temporal fossa—shallow depression on side of cranium bounded by temporal lines and terminating below the level of the zygomatic arch
- Infratermporal crest—of the greater wing of the sphenoid bone separates the temporal fossa from the infratemporal fossa below it
- Temporal and infratemporal fossae communicate with each other deep to zygomatic arch
- Infratemporal fossa communicates with the pterygopalatine fossa via the pterygomaxillary fissure
- Boundaries of Infratemporal fossa:
    - Anterior wall: posterior surface of maxilla
    - Posterior wall: tympanic part and styloid process of temporal bone
    - Medial wall: lateral pterygoid plate of the sphenoid bone
    - Lateral wall: ramus of the mandible
    - Roof: infratemporal surface of the greater wing of the sphenoid bone. contains foramen ovale—transmits V-3
    - Floor: point where the medial pterygoid muscle inserts into the medial aspect of the mandible near the angle
- Contents of infratemporal fossa:
    - Lower portion of temporalis muscle
    - Medial and lateral pterygoid
    - Maxillary artery and most branches
    - Pterygoid plexus of veins
    - Mandibular nerve and branches
    - Chorda typani
    - Otic ganglion (PS ganglion associated with glossopharyngeal nerve)
- Pterygopalatine fossa communicates laterally with infratemporal fossa by way of pterygopalatine fissure
- pterygopalatine fissure—communicates
    - medially with nasal cavity through sphenopalatine foramen,
    - posteriorly through sphenopalaitne foramen,
    - posteriorly with the cranial cavity through the foramen rotundum,
- Hip bone (ox coax) formed by: ileum, ischium, pubis. Articulates with the sacrum at sacroiliac joint to form pelvid girdle. Two hop bones articulate with one another anteriorly at the symphsysis pubis
- Ilium:
    - upper flattened part of hipbone; possesses iliac crest, which ends in front at the anterior superior iliac spine and behind at the posterior superior ilac spoine.
    - The ilium possesses a large notch call the greater sciatic notch
- Ischiu:
    - Lshaped with upper thicker part (body) and lower thinner part (ramus)—bears weight of body when person is upright and seated. Includes ischial spoine and ischial tubersosity.
    - The obturator foramen is formed by ramus together with pubis
- Pubis:
    - body, a superior ramus, and inferior ramus.
    - Bodies articulate in the midline at symphysis pubis. Medial to symphsysi is pubic tubercle. The inguinal ligaments connects the puc tubercle to anterior superior iliac spine
- Acetabulum:
    - cup shaped cavity on later side of hipbone that receives the head of the femure.
    - Formed superiorly by ilium, posterinferiorly by ischium and anteromedially by pubis
- Nasal conchae are three pairs of scroll like delicate shelves or projections, from the lateral walls. They increase the surface area within the nasal cavity and expose the brachiating olfactory nerve to inhaled odors.
    - Superior and middle conchae are part of the ethmoid bone
    - The inferior conchae are separate bones (also called the inferior turbinates)

- Meatus of the Conchae:
    - Superior meatus: lies below and lateral to superior conchae, receives the *openings of the posterior ethmoidal sinuses*
    - Middle meatus receives the openings of:
        - the *frontal sinus* which *drains into the infundibulum* of the middle meatus, also the
        - drainings from the *midle ethmoidal sinuses* which drain onto the ethmoidal bulla (rounded prominence on the lateral wall of the middle meatus)
        - Openings of the *anterior ethmoidal sinuses and maxillary sinus* which drain into the middle meatus via the hiatus semilunares (groove on the lateral wall of the middle meatus that is continuous with the infundibulum)
    - Inferior meatus: receives the opening of the *nasolacrimal duct which drains lacrimal fluid* from the surface of the eye into the meatus for evaporation during respiration
- Left and right pterygoid processes project downward from near the junction of each of the greater wings within the body of the sphenoid bone. Run along posterior portion of nasal passage. Process consists of medial and lateal pterygoid plate
- Lateral pterygoid plate provides orgin for both the lateral and medial pterygoid muscles and forms medial wall of infratemporal fossa.
- The medial pterygoid plate forms the posterior limit of the lateral wall of the nasal cavity and ends inferiorly as a hamulus. A small, slender hook that acts as a pully for the tensor veli palatine tendon to change its dirction of pull from vertical to horizontal therby tensing the soft palate
- Roof of the oral cavity formed by the maxilla and the palatine bones; specifically the palatine processes of the maxilla and horizontal plates of the palatine bones. Same as the floor of the nasal cavity
- Anterior 2/3 of hard palate formed by the palatine processes of maxilla, and posterior 1/3 by the horizontal plates of palatine bone.

- Genetic activity of both X chromosines is essential only during the first weeks after conception; later development only requires one functional X.
- Barr body:
    - inactivated X chromosome appearing in dense chromatin mass attached to nuclear membrane of normal female.
    - Not present in normal male
- Sex of embryo determined by barr body presence as early as eight weeks
- Golgi apparatus: packages secretory material and forms lysosomes. Is flat, membranous sace or cisternae arranged in stacks with two poles the cis face which receives material and the trans face for transportation Fxn:
    - Package, store, and modify products
    - Procollagen filaments formed here from amino cell
    - Glyoprotiens
    - Lysosomes are cytoplasmic membrane bound vesicles containing glycopretoine hydrolytic enzymes that digest and destroy exogenous material
- Axoneme:
    - 9 peripheral pairs of doublets share common wall of 2-3 protofilaments.
    - Central pair of tubules are separated from one antoher and are enclosed within a central (single) sheath. Doublets and central sheath linked by nexins
- Microtubules:
    - Speicalized type of filament composed of polymerized tubulin (protein).
    - Cylindrical hallow structures that are distributed throughout the cytoplasm of eukaryotic cells.
    - Provide support and assist in cellular locomotion
- Centrosomes contain centrioles, the microtubule organizing center of the cell

- Peroxisomes: contain oxidases, enzymes capable of reducing oxygen to hydrogen perioxid and hydrogen peroxide to water
- Ribosomes: site of protein synthesis
- Mitochochondria: threadlike structures within the cytoplasm that provide ATP, contains inner and outer membrane and has cyclic DNA
- Vacuoles: store and excrete various substances within the cytoplasm
- Lysosomes: digestive bodies formed in the Golgi apparatus (they bleb off of it) that break down foereign or damaged material, contain hydrolytic enzymes
- Cytoskeletal elements: form network of protein structures
- Bacterial infections: macrophages are go to cells
- Important Cells:
    - Plasma—antibody synthesis
    - Mast—mediators of inflammation on contact with antige
    - Schwann—form myelin sheath around axons of PNS
    - Sertoli—produce testicular fluid
    - Leydig—produce testosterone
    - Fibroblast—produces collagen and reticular fibers
    - Osteoblast—forms bone matrix and gives rise to osteocytes
    - Neutrophils: contain alkaline phosphatase
    - Eosinophils: contain histinamase, acid phosphatase, and aurosulfurnimase
    - T cells—cell-mediate immunity
    - B cells—differentiated into plasma cells
    - Sustantacular—internal ear (organ of Corti), taste buds, olfactory epithelium
    - Pyramidal—cerebral cortex (cerebrum)
    - Endothelial—lining blood and lymph vessels, endocardium inner layer
    - Ependymal—lining brain ventricles and spinal cord
    - Clara—terminal bronchioles
    - Ganglionic—in the ganglion of peripheral to CNS
    - Globular—transitional epithelium (kidney, ureter, bladder)
    - Prickle—statum spinosum of epidermis
    - Fibroblast—most common cell of CT
    - Chromaffin—adrenal medulla and paraganglia of SNS
    - Purkinje—cerebellar cortex (cerebellum)
    - Goblet--mucous membranes of respiratory and intestinal tracts
    - Interstitial—CT of ovary and testis
    - Islet—pancreas
    - Juxtaglomerulare—renal corpuscle of kidney
- Mesenchymal: between ectoderm and endoderm of embryos
- Metaplasm:
    - collective name given to lifeless material stored in cytoplasm.
    - Ex: glycogen, fat deposits, pigment granules—including lipfuscin—yellowish brown substance that increases in quantity as cells age, and melanin—abundant in epidermis of skin and retina
- Protoplasm:
    - viscous, translucent, water material that is primary component of animal cells.
    - Contains large percentage of water inorganic ions (potassium, calciu, magnesiu, and sodium) and naturall occurring organic compounds such as proteins.
- Nucloplasm: the protoplasm of the cell nucleus, plays part in reproduction.
- Cytoplasm:
    - the protoplasm of the cell body that surrounds the nucleus, converst raw material into energy.
    - Site of most synthesizing activities and contains cytosol (viscous, semitransparent fluid that is 70 – 90% water) organelles, and inclusions (metaplasm

- Mitoses:
  - Interphase
    - G1—first growth phase
    - S phase—when DNA is replicated
    - G2 phase—second growth phase
  - M phase—mitosis (karyokinesis) division of the nuclear parts of cell (no protein synthesis)
- Cytokinesis: division of the cytoplasm
- Mesenchymal = mesoblastic cells. Potential to proliferate and differentiate into diverse types of cells. Form a loosely woven tissue called mesenchyme or embryonic CT
- Mesenchymal cell in dental papilla adjacent to the IEE differentiate into odontoblasts.
- Mesectoderm (ectomesenchym)—part of the mesenchyme derived from ectoderm, especially from the neural crest in the very young embryo.
- Neural crest cells:
  - give rise to spinal ganglia (dorsal root ganglia) and the ganglia of the autonomic nervous system.
  - Also give rise to neurolemma cells (Schwann cells) cells of the meninges that cover the brain and spinal cord, pigment cells (Melanocyts), chromaffin cells of AM and several skeletal and muscular components of head
- Basophils:
  - similar to mast cells with coarse cytoplasmic granules containing heparin (anticoagulant), histamine (vasodilator) and bradykinin, and serotonin.other substances.
  - Occur in most loose CT, especially along the path of blood vessels.
- Heparin can prevent blood coagulation as well as speed the removal of fat particles from blood after a fatty meal.
- IgE type allergic reaction:
  - caused by mast cells and basophils because of propensity to attach to these cells.
  - Cause rupture and release of large quantities of histamine, bradykinin, serotonin, heparin, SRS-A (slow-reacting substance of anaphylaxis) and lysosomal enzymes→local vascular and tissue reactions
- Chromosomes = DNA and protein (histones)
- Euchromatic: loose fibrils and active form of chromatics/DNA and heterochromatin (dense fibrils)
- Chromatids attached to centromeres when replicating
- Plasma cells:
  - from B cells, produce antibodies, found in bone marrow, CT and sometimes blood.
  - Short 8 – 10 day life.
- T cells:
  - produce cell-mediated immunity.
  - Account fro 70 -80% of circulating lymphocytes.
  - Interact with specific antigen, they become sensitized and differentiate into several types of daughter cells including
  - memory T cells—remain inactive until future exposure to same antigen
  - killer T cells—combine with antige on surface of foreign cell causing lysis of foreign cell and the release of cytokines
  - helper T cells—help activate other T lymphocytes
- B cells:
  - antibody-immunity. 20 – 30% of circulating lymphocytes.
  - Becomes sensitized to an antigen, proliferate and differentiate to for clones of daughter cells that either produce antibodies against that antigen or become memory B cells\
- Hepatocyte most versatile cell in body:
  - encircle a central vein and radiate outward.
  - Produce bile, excrete bilirubin, contain large number of mitochondria and smooth ER, responsible for process of conjugation
- Kupffer cells:

- reticuloendothelial macrophages which line sinusoids.
- Remove bacteria and toxins entering blood through the intestinal capillaries.
- Have vacuoles, lysosomes, and granular ER

- Nucleus: site of rRNA synthesis
- Smooth ER (ribosomes are absent)—steroid synthesis; intercellular transport; detoxification
- Rough ER (ribosomes are attached)—synthesis of proteins for use outside a cell.
- Feulgen Reaction: test to distinguish beween DNA and RNA
- Active cells are characterized by an abundance of rough ER (fibroblasts, osteoblasts)
- Four active phases:
  - Prophase—gradual coiling up of chromatin in nucleus. Individualization of chromosomes, initiation of mitotic spindle with centriolar duplication
  - Metaphase-disappearance of the nuclear envelope and nucleoli. Chromosomes arranged in equatorial plane. Spindle is complete
  - Anaphase—the chromosomes split longitudinally and migrate to poles. Beginning of cell division
  - Telophase—nucleolar restitution with nuclear envelope formation. End of cell division

## Embryology

- Stomodeum gives first indication of tongue development in embryo
- Tuberculum impar: (median tongue bud):
  - median, triangular elevation which appears in the floor of pharynx just rostral to foramen cecum.
  - Gives the first indication of tongue development at four weeks.
- Lateral lingual swellings (two distal tongue buds):
  - develop on each side of median tongue bud.
  - Elevations are the result of the proliferation of mesenchym of the first, second, and third branchial arches
  - Swellings fuse to form the anterior two thirds of tongue.
- Posterior one-third of tongue is formed by two elevations: the copula (from second arch) and the hypobranchial eminence (from the third arch)
- Bifid tongue:
  - result of the lack of fusion of the distal tongue buds (or lateral swellings).
  - Common in South American infants
- Branchial arches = pharyngeal arches: series of rounded mesodermal ridges on each side of head and neck of 4 week old embryo.
  - First three play part in formation of face and oral cavity.
  - First arch develops into the mandible and large part of the maxilla.
  - Second and third, along with first, also plays part in development of the tongue
- Meckel's cartilage = mandibular cartilage: cartilagenous bar of first branchial arch.
- Branchial arch contains an artery, a cartilaginous bar or rod, a muscular component, and a nerve
- First arch cartilage (Meckel;s cartilage)—
  - closely related to the developing middle ear;
  - becomes ossified to form the malleus and incus of middle ear
  - Meckel's cartilage characterized by being amodel for the mandible but not participating in the formation of any part of the mandible
  - Fate is dissolution with minor contributions to ossification
- Second arch cartilage (Reichert's cartilage)—
  - closely related to the development of the middle ear,
  - becomes ossified to form the stapes of the middle ear and
  - the styloid process of the temporal bone
- Third arch cartilage: ossifies to form part of the hyoid bone

- Fourth and sixth arch cartilages: fuse to form the laryngeal cartilages, except for the epiglottis
- Fifth arch is absent
- The mandible forms before the maxilla:
    - merging of the medial ends of the two large mandibular processes (prominences) of the first branchial arch during the fourth week of embryonic development.
- Mandible (except the condyles) and maxilla are mostly formed by intramembranous ossification
- Maxilla is formed by merging of the two smaller maxillary processes of the first branchial arch. These processes also form the upper cheek regions and most of the upper lip
- Frontal nasal process (prominence): produced by the growth of the forebrain. Develops the forehead and nose.
- Nasal placodes = thickened areas of specialized ectoderm, form on each side of the frontal nasal process. Elevatios form at the margin of these placodes:
    - Two lateral nasal processes (prominences) will form the sides (alae) of the nose
    - Two medial nasal processes (prominences)—will form the bridge of the nose, the nostrils, and the philtrum of the upper lip.
- Vestibular lamina separates the lips and cheeks externally and the jaw structures internally in the developing embryo
- First Branchial arch divides at four weeks of embryonic development to form mandibular and maxillary process
- Branchial arches (pharyngeal visceral arches):
    - develop in the fourth week as neural crest cells migrate into the future head and neck region.
    - By end of fourth week, four well-defined pairs of branchial arches are visible externally;
    - the fifth and sixth are small and cannot be seen on the surface of the embryo.
    - It is the proliferative activity of neural crest cells that produce the discrete swellings or branchial arches
- The first branchial arch develops two prominences or processes:
    - The larger mandibular process→forms the mandible
    - The smaller maxillary process→forms the maxilla, zygomatic bone, and the squamous part of the temporal bone
    - First branchial arch also gives rise to the tuberculum impar (median tongue bud) and two lateral lingual swellings (distal tongue buds) which help form the tongue.
- Third lingual arch contributes to the hypobranchial eminence to form the root of the tongue (posterior third)
- The corner of the mouth is formed by fusion of the maxillary and mandibular processes
- Inferior parathyroid gland and the thymus gland arise from third pharyngeal pouches
- Pharyngeal pouches are paired evaginations of pharyngeal endocerm that line the inner aspects of the branchial arches in the neck region:
    - $1^{st}$: contributes to the formation of the tympanic membrane, audtitory tube, and cavities of middle ear
    - $2^{nd}$: lymphatic nodules and palatine tonsils
    - $3^{rd}$: inferior parathyroid gland, thymus gland
    - $4^{th}$: Superior parathyroid gland, ultimobranchial body which gives rise to para follicular cells or C cells of the thyroid gland (produce calcitonin)
    - $5^{th}$: rudimentary structure, becomes part of the fourth pouch

## Respiratory System

- The respiratory System:
    - Has two major parts—a branching, tree-like set of hollow tubes (the conducting airways) and very thin-walled pouches (the alveoli) at the ends of these tubes
    - Cartilaginous rings found in the main bronchi
    - Left lung has a smaller capacity than the right
    - Alveolus is form the functional unit of the lung

    - Consists of the nasal cavity , pharynx, larynx, trache, and the bronchi, bronchioles, and alveoli within the lungs
- Nasal cavities lined with specialized columnar epithelium (called olfactory epithelium)
- Nose:
    - Air enters through nostrils (external nares) lead to the vestibules of the nose.
    - the bony roof of the nasal cavity is formed by the cribriform plate of the ethmoid bone.
    - The lateral walls have bony projections called conchae. Conchae form shelves which have spaces beneath them called meatuses.
    - The paranasal sinuses (maxillary, frontal, ethmoidal, and sphenoidal) drain into the nasal cavity by way of these meatuses.
    - The nasolacrimal duct—drains tears from surface of eyes, also empties into the nasal cavity by way of the inferior meatus.
    - Epithelium:
        - Vestiubules are lined with nonkeratinized stratified squamous epithelium
        - Choncae of the nasal fossae are lined with pseudostratified ciliated columnar epithelium
        - The specialized columnar epithelium is very prominent in the upper medial portion of the nasal cavity
    - The nasal cavity receives sensory innervation from the olfactory nerve for smell and from the trigeminal nerve for other sensations.
    - Blood supply is from the branches of the ophthalmic and maxillary arties.
- Pharynx (throat) tube that serves as passageway for respiratory and digestive tracts. Extends from mouth and nasal cavities to the larynx and esophagus. Has three regions:
    - Nasopharynx contains the Eustachian canal—connects the nasopharyx to middle ear, salpingopharygeal fold, pharyngeal recess, and pharyngeal tonsils (adenoids). Lies above the soft palate and is continuous with the nasal passage. The tensor veli palatine and the levator veli palatine muscles prevent food from entering the nasopharynx
    - Oropharynx: extends from the plane passing through the anterior pillars to the beginnings of the laryngopharynx. It is a food and air passageway. It communicates with the oral cavity through tht isthmus of the fauces. Receives food from mouth and air from nasopharynx. Contains palatin and ligual tonsils
    - Laryngopharynx—extends from the oropharynx above the the laryx and esophagus below. Serves as a passageway for food and air. Air entering the laryngopharynx goes to the larynx while food goes to the esophagus
- Food entering the laryx would be expelled by violent coughing
- Emergency tracheotyomy: most easily made by an incision through the median cricoid cartilage to the thyroid cartilage and is inferior to the space between the vocal cords (rima glottides) where aspirated objects usually get lodged. Tracheotomy allows fro air to pass between the lungs and the outside air
- Right lung:
    - Has *three lobes* (superior, middle, and inferior) and *three secondary* (lobar) bronchi
    - Contains *ten* bronchial segments (tertiary bronchi)
    - Usually receives *one bronchial artery*
    - *Slightly larger capacity* than the left lung
- Left Lung:
    - Has *two lobes* (superior and inferior) and *two secondary* (lobar) bronchi
    - Contains *eight* bronchial segments (tertiary bronchi)
    - Contains a *cardiac notch* on its superior lobe
    - Usually receives *two bronchial arteries*
    - Contains a *lingula*—a tongue-shaped portion of its superior lobe that corresponds to the middle lobe of the right lung.
- Structure of the Lung:

- Each lung is enclosed in a double-layers sac called the *pleura*. One layer is called the *visceral pleura*, the other is called the *parietal pleura*. Between the two layers is the *pleural cavity*, which is filled with *serous fluid*
- Trachea: tube that begins below the *cricoid cartilage (C6) of larynx* and ends at the level of the *sternal angle (T5)* where it divides at the carina into *primary bronchi (right and left primary or mainstem bronchus.*
- Two main bronchi branches divide into five lobar bronchi (secondary bronchi): right main bronchus divides into three lobar bronchi and left main bronchus divides into two lobar bronchi.
- Each secondary or lobar bronchus serves one of the five lobes of the two lunges
- Secondary bronchi branch into tertiary bronchi (segmental bronchi) continue to divide deeper in the lungs into tiny bronchioles, which subdivide many times, forming *terminal bronchioles*. Each of these terminal bronchioles gives rise to several *respiratory bronchioles*.
- Each respiratory bronchiole subdivides into several *alveolar ducts*, which end in clusters of small, thin-walled air sacs called *alveoli*. These alveoli open into a common chamber called *alveolar sacs*, which forms the functional unit of the lung.
- *Conduction bronchioles* are smaller extensions of bronchi (little bronchi). Those devoid of alveoli in their walls are nearer the hilum of the lung.
- *Respiratory bronchioles*—continuing from terminal bronchioles, branch nearer the alveolar ducts and sacs and have occasionally alveoli in their walls. These bronchioles capable of respiring are the *first generation of passageways of the respiratory portion of the bronchial tree*
- Bronchiols are characterized by:
  - *Diameter* of one millimeter or less
  - *Epithelium* that progresses from ciliated pseudostratified columnar to simple cuboidal (respiratory bronchioles)
  - *Small bronchioles* have non-ciliated bronchiolar epithelial cells (*Clara cells*) that secrete a surface active lipoprotein
  - *Devoid of glands* in their underlying connective tissue
  - Woven bundles of smooth muscle to regulate the bronchiolar diameter
  - Walls *devoid of cartilage* (smaller diameter prevents them from collapsing at end of expiration)

- Exchange of oxygen and carbon dioxide between the air and the blood occurs in the lungs.
- Each lung is shaped like a cone. It has a *blunt apex, a concave base* (that sits on the diaphragm), a *convex costal surface*, and a *concave mediastinal surface*. At the middle of the mediastinal surface, the *hilum* is located, which is a depression in which the *bronchi, vessels, and nerves* that form the *root* enter and leave the lung.
- The small bronchial arteries also enter the hilum of each lung and deliver oxygen rich blood to the tissues. They tend to follow the bronchial tree to the respiratory bronchioles where they anastomose with the pulmonary vessles
- Branches of the vagus nerve also pass the hilum of each lung
- The right primary or mainstem bronchus is straighter, shorter, and larger than the left primary bronchus. It is also in a more direct line with the trachea (important in dental chair because if patient swallows an object it tends to lodge in the right bronchus
- Major structures found in the root of the lung
  - *Primary bronchus*—arise from trachea and carry air to the hilum
  - *Pulmonary artery*—enters the hilum of each lung carrying *oxygen poor* blood
  - *Pulmonary veins*—superior and inferior pair for each lung leave the hilum carrying *oxygen rich* blood
- Mediastinum Contains
  - Heart, trachea, esophagus, thymus gland, and thoracic duct
  - Thoracic aorta, pulmonary artery and veins, venae cavae, and azygos veins
  - Vagus and phrenic nerves
- Mediastinum: area between the lungs in the thorax.

- Consists of the superior mediastinum above an imaginary plane drawn between the fourth thoracic vertebra and the sternal angel and the
- inferior mediastinum below this plane which is subdivided into an anterior, middle and posterior mediastinum the boundaries of which are provided by the pericardium. Thus the heart is in the middle mediastinum.

## Reproductive System

- Ovaries are almond shaped organs located on either side of the uterus, but vary with age.
  - Round, smooth, and pink at birth
  - Grow larger, flatten and turn grayish by puberty
  - During childbearing years tak on almond shap and rough, pitted surface
  - After menopause, they shrink and turn white
- Ovaries—produce ova and steroid hormones:
  - Estrogen—stimulates the development of the female sex organs, the breast, and various secondary sexual characteristics
  - Progesterone—stimulates secretion of uterine milk by the uterine endometrial glands; also promote development of the secretory apparatus of the breasts
- Corpus luteum—endocrine body that secretes progesterone and is formed in the ovary at the site of a ruptured ovarian (Graafian) follicle immediately after ovulation.
  - If pregnancy does not occur, the corpus luteum regresses to a mass of scar tissue (corpus albicans) which eventually disappears.
  - If pregnancy does occur—corpus luteum persists for several months until the placenta matures enough to produce the hormones
- Purpose of ovaries is to produce *mature ova*. They also produce estrogen and progesterone in their maturing follicles
- *Oogonia*—serve as source of oocytes
- *Primordal follicles*—containing oocytes in their sexually mature ovary are stimulated to develop by secretion of FSH from the anterior lobe of the pituitary. Primary follicles (in first meiotic division) become secondary follicles with the formation of the antrum (cavity) Fully mature Graafian follicles containing secondary oocytes (in second eiotic division) relese the egg into the abdominal cavity under the influence of LH to be swept into the ostium of the Fallopian tube (unterine tube, oviduct) to be fertilized and subsequently implanted in the uterus or discarded if not fertilized
- During maturation of the egg, four daughter cells are produces, one of which is the large *fertilizable ovum*, while the others are small, rudimentary ova known as *polar bodies* or *polocytes*.
- Mammary gland:
  - *Lie in the superficial facia*
  - *Are actually a modified sweat gland*
  - Contain *myoepithelial cells*(star-shaped)—have processes that spiral around some of the secretory cells of these glands. Contraction forces the secretion of the glands toward the ducts
- The breast receives arterial blood through branches of the *lateral thoracic* (branch of the axillary artery) and *internal thoracic arteries*
- *Fibrous Coopers' ligaments* support breasts—are strong, fibrous processes that run from the dermis of the skin to the deep layer of superficial fascia through the breast
- *Nipple* usually lies at the level of the *fourth intercostal space*
- *Breast cancer* causes *dimpling* of the overlying skin and nipple retraction
- Most of the *lymph* from the mammary glands goes to the lymph nodes in the *axilla*
- *Urethra*—passageway for urine between the urinary bladder and the outside of the body
- Female urethra, 4 cm, males is 20 cm because it travels in the penis-->females have more frequent bladder infections

- *Female* urethra opens into the vestibule between the clitoris and the vagina
- *Ureter* is a paired passageway which transports the urine from the kidney to the urinary bladder for concentration and storage until voided
- Organs that produce semen:
    - *Seminal vesicles*—paired sacs at the base of the bladder
    - *Bulbourethral gland* (Cowper's gland)—paired located inferior to the prostate
    - *Prostate gland*—under the bladder and surrounds the urethra. Continually secreates prostatic fluid, a thin, milky, alkaline fluid. *Copora amylacea* are present in the alveoli of this gland
- Round ligament of the uterus normally found in the inguinal canal of the female. It is a fribromusuclar band attached to the uterus on either side in front of and below the openings of the fallopian tube. It passes through the inguial canal to the labia majora
- Inguinal canal:
    - It transmits the spermatic cord in males and the round ligment of the uterus in females; as well as the ilioinguinal nerve in both sexes
    - It begins at the deep inguinal ring and extends to the *superficial inguinal ring*
    - It is much larger in males than in females: the spermatic cord in the male is a collection of structures that tranvers the canal to pass from the testes, which are suspended from the spermatic cord
    - The anterior wall is formed by aponeuroses of the external oblique and partially by the internal oblique muscle
    -
- Testes:
    - Sperm are produced in the seminiferous tubules and stored outside the testis in the epididymis until ejaculated.
    - Androgens, the most important one being testosterone, are synthesized and secreted into the blood stream by interstitial cell (of Leydig) found in the interstitium of the testis between the seminiferous tubules. Testosterone is required for development of the testes and secondary sex characteristics and initiation and maintenance of sperm production and secondary sex characterisitics.
- Testis produce spermatozoa and secret sex hormones. They are firm, mobile organ lying within the scrotum. Each develops *retroperitoneally* and descends into the scrotum about time of birth
- Epididymis displays stereocilia, one on each testi.
    - It is a tortuous, C-shaped, cordlike tube located in the scrotum.
    - Tube emerges from the tail as the vas deferens, which enters the spermatic cord.
    - Provides *storage space for the spermatozoa* and allows them to mature.
    - Carries sperm from the seminiferous tubules of the testis to the vas deferens
- The spermatic cord in the male is a collection of structures that tranverse the canal to pass from the testes, which are suspended from the spermatic cord. It is covered with *three concentric layers* of fascia derived from the layers of the anterior abdominal wall: the internal and external spermatic fascia as well as the cremasteric fascia (cremaster muscle and fascia)
- Spermatic cord contents:
    - *Ductus deferens*: cordlike structure; *it conveys sperm from the epididymis to the ejaculatory duct,* which is a passageway fromed by the *union of the deferent duct and the excretory duct of the seminal vesicle* The ejaculatory duct opens inot the *postatic urethra*
    - *Testicular artery*: branch of the abdominal aorta; supplies mainly the testis and cremaster muscle
    - *Testicular veins: pampiniform plexus* forms testicular veins; drains into the left renal vein on the left side and into the inferior vena cava on the right side.
- Ejaculatory ducst—receive spermatozoa and additives to produce seminal fluid
- Seminal vesicles—secrete alkaline fluid containing nutriets and prostaglandins
- Prostate gland—secretes alkaline fluid that helps neutralize acidic seminal fluid and enhance motility of spermatozoa
- *Stereocilia*—

    - long, nonmotile microvilli that cover the free surface of some of the pseudostratified columnar epithelium which line the inside of the epididymis.
    - Serve to facilitate the passage of nutrients from the epithelium to the sperm by increasing the epitheliums surface area
    - Also present in the ductus (vas) deferens, which is also lined with pseudostratified epithelium
- *Cardiac notch* is a deep indentation on the *superior lobe of the left lung*
- Lungs—lie in thoracic cavity and are separated by the mediastinum. Contain pulmonary vessels and bronchial trees for gaseous exchange

**Central Nervous System**

- Internal acoustic meatus
    - transmits the vestibulocochlear nerve (CNVIII)—remains within the temporal bone, to the cochlear duct (hearing), semicircular ducts and maculae (balance)
    - facial nerve (CN VII)—enters meatus, then the facial canal in the temporal bone, and emerges from the stylomastoid foramen, which lies between the styloid and the mastoid processes of the temporal bone. Gives off five branches in the parotid gland to supply muscles of facial expression
        - anesthetic in parotid will result in paralysis of facial muscles
    - is a canal running through the petrous portion of the temporal bone
- Fracture of optic canal results in injury to optic nerve and ophthalmic artery
- Cribriform plate perforations are in the ethmoid and carry the olfactory nerve
- Hypoglossal canal is in the occipital bone and carries the hypoglossal nerve and meningeal artery
- Carotid canal is in the temporal bone and carries the internal carotid artery and sympathetic nerves (carotid plexus)
- Nasolacrimal canal is in the lacrimal/maxilla bone and carries the nasolacrimal (tear) duct
- Mandibular foramen:
    - located at *or slightly above the occlusal plane and posterior to the molars* on the medial surface of the ramus of the mandible just below the *lingual*, midway between the anterior and posterior borders of the ramus.
    - *Mandibular foramen* leads into the *mandibular canal* which opens into the mental foramen below PM2.
    - The *incisive canal* is a continuation forward of the mandibular canal beyond the mental foramen and below incisor teeth
- *Lingula* is tongue shaped projection of bone that serves as the attachment for the *sphenomandibular ligament*
- Rotundum foramen is in the sphenoid and carries the maxillary nerver (V2)
- Ovale is in the sphenoid and carries the mandibular nerve (V3) and the *lesser petrosal nerve*
- Magnum is in the occipital bone and contains the medulla oblongata, vertebral arteries, and spinal accessory nerve
- Spinosum is in the sphenoid bone and carries the middle meningeal artery and vein
- Mental foramen is in the mandible and carries the mental nerve, artery and vein
- Foreman cecum is in the frontal and ethmoid ones and has the emissary vein in fetal life
- Greater palatine foremen is in the palatine and carries the greater palatine nerve, artery and vein
- Lesser palatine foramen caries the lesser palatine nerve artery and vein
- Superior orbital fissure:
    - is between the slit light openings between the lesser and the greater wings of the sphenoid bone.
    - It transmits the lacrimal, the frontal , the nasociliary, the trochlear, the oculomotor, (all branches of V1) and the abducens nerves, together with the superior ophthalmic vein.
- Petrotympanic fissure is in the temporal bone and carries the chorda tympani, and the anterior tympanic artery
- Foramen lacerum is in the temporal and sphenoid bones and carries the greater and deep petrosal nerves
- The supraorbital is in the frontal bone and carries the supraobrital nerve artery and vein

- The Infraorbital foramen is in the sphenoid and maxilla and caries the infraorbital nerve, artery, and vein
- The Stylomastoid is in the temporal and carries the facial nerve
- Incisive foramen is in the maxilla and carries the nasopalatine nerve
- Dermatome: area of skin supplied by a single nerve.
    - They are supplied by both cranial nerves and spinal nerves. All three divisions of trigeminal supply the skin on the face, anterior scalp V1) and ear (V3).
    - The ear receives additional innervation from CN VII, IX, and X.
    - all but one of the spinal nerves anterior and posterior primary divisions innervate the remaining dermatomes of the body.
    - The greater occipital nerve (C2) supplies the posterior scalp because the *first cervical nerve* usually *does not supply a dermatome*
    - No overlapping innervation of cranial dermatomes
- Peripheral nerve innervation of the skin (cutaneous innervation) usually forms different pattern from spinal nerve skin innervation because of synapses of spinal nerves in periphery. Ex: C5 C6, C7 form musculocutaenous nerve→different dermotaome pattern by overlapping 50%. Must anesthetize three adjacent dermatomes to block feeling to middle
- Cerebral cortex: extensive outer layer of gray matter of cerebral hemispheres. The cerebral lobes function primarily in voluntary movement, higher intellectual processes and personality (with the limbic system)

| Area of the cerebral Corte | Function |
|---|---|
| *Precentral gyrus* of frontal lobe | *Primary motor area* (initiates voluntary contractions of skeletal muscle |
| *Postcentral gyrus* of parietal lobe | *Primary sensory area* (receives sensory information concerning temperature, touch, pain, and proprioception |
| Medal surface of the *occipital lobe* | *Visual* area |
| *Parietal lobe* (near bottom of postcentral gyrus) | *Taste* area |
| *Temporal lobe* (transverse tempral gyri | *Hearing* |
| *Frontal lobe* | *Higher intellectual functions* |
| *Parietal lobe* | Somatic associated area (*Integration and interpretation center)* |
| Temporal lobe (Medial surface) | *smell* |

- Basal nuclei are gray matter structures deep within each cerebral hemisphere which help to control muscle activity
- Neuron or nerve cell: basic unit of the nervous system because it is at the neuron level that the activites of the system are carried out
- Nervous tissue has two classes
    - Neurons: transmit nerve impulses
    - Neuroglial cells (glial cells): provide support and nourishment for theneurons
- Structure of a neuron:
    - Cell body = perikaryon: contains nucleus and most of the cytoplasm. Located mostly in the CNS as clusters called nuclei, some found in periphery as ganglion
    - Dendrites: process that send the impulse towards cell body. One or many. Some neurons lack dendrits
    - Axon (nerve fiber)Only one axon per neuron
- Neurons are classified by number of processes. Multipolar is most common. Can also be motor or sensory or mixed
- Myelin formed by *Schwann cells* in periphery and *oligodendrocytes* in CNS
- *Node of Ranvier* is junction between two Schwann cells
- Neural crest is a band of neuroectodermal cells that lie dorsolateral to the developing spinal cord, where they separate into clusters of cells (neural crest cells) that develop into dorsal root ganglion cells, *authonomica*

*ganglion cells, chromaffin cesll, neurolemma cells (Scwann cells) integumetnary pigment cells (melanocytes, and meningeal* covering of the brain and spinal cord

- Spinal cord:
    - Cylindrical, occupies approximately the upper two-thirds of the vertebral canal, and is enveloped by the meninges
    - In contrast to the cerebral hemispheres (brain), it has centrally located gray matter and peripherally located white matter
    - It ends at about the level of L1 in adults and at the level of L3 in young children
- Main areas of spinal cord:
    - Gray matter: H shaped, centrall located, consists of nerve cell bodies and unmyelinated nerve fibers. The center of H is called the gray commissure and connects the two paired posterior or dorsal horns and the anterior or ventral
    - Central canal: within gray commissure and filled with CSF
    - White matter: surrounds gray matter and composed of primarily myelinated axons
- Cell bodies of somatic motor system lie within the anterior or ventral horn.
- Cell bodies of the somatic sensory system lie within the posterior or dorsal horn
- All spinal nerves are mixed:
    - Ventral roots contain motor neurons. Cell bodies are located in the spinal cord
    - Dorsal root contains axons of sensory neurons. Cell bodies are located outside the spinal cord in dorsal root ganglia.
    - The roots join to form mixed spinal nerves
        - *Posterior rami*—pass posteriorly to supply the skin and dep muscles of the back
        - *Anterior rami* supply the rest of the body wall and the limbs
        - Both are mixed nerves
- *Cervical, brachial, lumbar, and sacral regions the anterior rami* of the spinal nerves unit to form *plexuses*. These plexuses then give rise to other nerves for distribution to muscle skin etc.Fa
- Most organs are innervated by both PS and S Nervous systems
- CNS is *brain and spinal cord*
- PNS is *located outside* CNS: includes cranial nerves, arising from inferior aspect of brain, and the spinal nerves arising from the spinal cord. PNS divided into afferent and efferent divisions
- *Afferent* division of PNS
    - *Somatic sensory neurosn*—cary impulses to the CNS from the skin fascia dn joints
    - *Visceral sensory neurons*—carry impulses from viscera of body (hunger pangs, blood pressure) to the CNS
- *Efferent* division:
    - *Somatic* (voluntary): consists of somatic motor neurons that carry impulses to skeletal muscles
    - *Autonomic* (involuntary): consists of visceral motor neurons transmitting impulses to smooth and cardiac muscles as well as glands
        - *Sympathetic*
        - *Parasympathetic*
- Meninges are three protective tissue layers covering CNS, all three are involved in meningitis—inflamation of meninges, which if severe can become encephalitis—inflammation of brain:
    - Dura mater: outermost, two layers of fibrous CT that separate to form venous sinuses in the cranial cavity. *Endosteal* layer adheres tightly to the inner surface of the cranium and the *meningeal layer* forms partitions fold that extend between regions of the brain
    - Arachnoid: delicate middle membrane, it adheres to the dura mater but is separated from the pia mater by the subarachnoid space. Contains cerebrospinal fluid
    - Pia mater—innermost membrane, delicate vascular membrane of loose CT. adheres closely to brain and spinal cord.
- Subarachnoid space entered for spinal taps. Spinal cord works in adult around *L1 (L1 – L2*). Dura and arachnoid continue to S2 where the arachnoids fuses with the *filum terminale*. The needles is inserted between the spines at L2 and L3 entering the *subarachnoid* space which is fill with cerebrospinal fluid.

- In ventricles of brain, pia mater and ependymal cells contribut to the formation of the choroids plexuses which regulat the intraventricular pressure by secretion and absorption of CSF
- *Cerebrospinal fluid* is clear, colorless fluid formed by *choroid plexuses* within the later, third and fourth ventricles of the brain. Produces by filtration primarily from tufts of capillaries that protrude into all four ventricles  Fluid enters the subarachnoid space through the three foramina of the fourth ventricle.  These plexuses regulate the intraventricular pressure by secretion and absorption of cerebrospinal fluid
- CSF along with ligamentous walls of the vertebral canal protect the spinal cord from injury
- Brainstem is the lower extension of brain where it connect to spinal cord.  Most cranial nerves come from brainstem.  It is the pathway for all fibert racts passing up and down
    - Medulla oblongata: relay station for the crossing of motor tracts between the spinal cord and the brain.  Also contans respiratory, vasomotor, and cardiac centers as well as many mechanisms for controlling reflex activities such as coughing, gaggin, swolling and vomiting
    - Midbrain: nerve pathway of cerebral hemispheres and contains auditory and visual reflex centers
    - Pons: bridg-like structure which links different parts of brain and serves as a relay staion from medulla to higher cortical structures of brain. Also contains respiratory centers
- Neuroglia: non-neuronal tissue of CNS that performs supportive and other ancillary functions.  Contains various types of cells

| **Cells that support neurons** | **Structure** | **Function** |
|---|---|---|
| **CNS** | | |
| Astrocytes | Stellate with numerous processes | Form structure support between capillaries and neurons within the *CNS* |
| Oligodendrocytes | Similar to astrocytes but with shorter and fewer processes | Form myeolin in *CNS*, guide development of neurons within *CNS* |
| Microglia | Minutes cells with few short processes | Phagocytize pathogens and cellular debris within *CNS* |
| Ependymal | Colunar cells that may have ciliated free surface | Line ventricles and central canal within *CNS* where CSF is circulated by ciliary motion |
| PNS | | |
| Satellite cells | Small, flattened cells | *Support ganglia within PNS* |
| Schwann cells | Flattened cells arranged in series around axons or dendrites | *Form myelin within the PNS* |

With the *exception of the microglia*, which derives *from mesoderm, all other neuroglia cells form from ectoderm*

- Pre and postganglionic neurons of PSNS release acetylcholine
- Pre SNS is acetylcholine and postganglionic is NE (except for blood vessles in skeletal muscles and sweat glands)
- Synapses between neurons are made in autonomic ganglia
    - PSNS—ganglia are located in or near the effector organs
    - SNS—ganglia are located in the paravertebral chain
- Parasympathetic:
    - Conserve energy (rest and digest)
    - Decrease HR
    - Papillary and bronchiolar constriction
    - NO EFFECT on adrenal medulla
    - Prepare body to resist stress
    - Lead to acceleration of boady activity
    - Cause rage and emotional reactions
    - Maintain normality of body functions

- Sympathetic division: prepares body for intense physical activity in emergencies (fight or flight) through adrenergic effects.
    - HR blood glucose rises,
    - blood diverted to skeletal mushcles.
    - Pupils dilate, bronchioles dilate,
    - and the adrenal *medulla releases Epi and NE*
- Most authors consider ANS to be motor system only.
- Preganglionic neurosn have their cell bodies in the CNS and synapse in the autonomic ganglia. Symp: cranial sacral (S2 – S4). Parasymp: thoracolumbar (T1 – L3)
- Postganglionic neurons synapse on effector organs
- Peripheral nervous system consists of: 12 cranial nerves, 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal
- Vertical folds in Dura mata
    - *Falx cerebelli* separates the hemispheres of the cerebellum. Contains *occipital sinus*
    - *Falx cerebri*—separates the cerebral hemispheres. Contains *inferior and superior sagittal sinuses*
- Horizontal folds in dura mater
    - *Tentorium cerebelli*: separates the occipital lobes from the cerebellum. Contains the *straight, transverse, and superior petrosal sinuses*
    - *Diaphragma sellae*: forms roof of sella turcica. Small opening in the center allows passage of the infundibular stalk of the *pituitary gland*
- Spinal Cord tracts are columns of *white matter* within the spinal cord that conduct impulses to the C?NS (ascending) and away from the CNS (descending

| **Ascending tracts** | **Function** |
|---|---|
| Anterior spinothalamic | Conducts sensory impulses for *touch and pressure* |
| Lateral spinothalamic | Conducts *pain and temperature* impulses |
| Fasciculus gracilis and fasciculus cuneatus | Conducts sensory impulses from skin, muscle, tendons, and joins; also touch localization (conscious proprioception |
| Posterior spinocerebellar | Conducts sensory impulses from one side of body to same side of cerebellum for *subconscious proprioception* |
| Descending Tracts | |
| Anterior corticospinal | Conducts motor impulses from cerebrum to spinal nerves and outward through anterior horn for *coordinated movement* |
| Lateral corticospinal | Conducts motor impulses from hemisphere to spinal nerves through anterior horns for *coordinated movments* |
| Tectospinal | Conducts motor impulses to cells of anterior horns and eventually to muscles that *move the head* |
| Rubrospinal | Conduct motor impulses concerned with *muscle tone and posture* |
| Vestibulospinal | Regulate body tone and posture (*equilibrium*) in response to movements of head |
| Anterior and medial reticulospinal and lateral reticuloalspinal | Control *muscle tone and sweat gland activity* |

- Brain consist of several regions:
    - Hindbrain (rhombencephalon
    - Midbrain (mesencephalon)
    - Forebrain (prosencephalong

- Cerebrum:
    - located within telencephalon and is the higher forebrain.
    - Consists of five paired lobes within two convoluted cerebral hemispheres which are connected by the corups callosum. I
    - accounts for 80% of brain mass,
    - concerned with higher functions, including perception of sensory impulses, instigation of voluntary movment, memory, thought, and reasoning.
    - Two layers of cerebrum:
        - Cerebral cortex: thin, wringled gray matter covering each hemisphere
        - Cerebral medulla: thickned core of white matter
- Diencephalon:
    - a major autonomic region of the forebrain, is almost completely surrounded by the cerebral hemispheres of the telencephalon.
    - Its chief components include the thalamus, hopthalamus epithalamus, and pituitary gland. The third ventricle forms a midplane cavity within the diencephalons
- Each portion of brain consists basically of three areas:
    1. gray matter: coposed primarily of unmyelinated nerve cell bodies
    2. White matter: composed basically of myelinated nerve fibers
    3. Ventricles: spaces filled with cerebrospinal fluid
- Formation of the brain begins with differentiation of the cephalic end of the hollow neural tube
- Four ventricles:
    - Two lateral ventricles are hollow C shaped spaces within the right and left cerebral hemispheres
    - Third ventricle forms a median cavity within the diencephalong (forebrain) the two interventricular *foramina of Monro* are oval openings which provide communication between the third *and lateral ventricles*. The cerebral aqueduct in the midbrain connects the *third and fourth ventricsl*
    - *Fourth ventricle*: located in the metencephalong (hindbrain). Contains two openings in its walls called lateral apertures (foramina of Luschka) and a single opening in its roof called the medial aperuture (foramen of Magendie) These apertures connect the ventricular system with the subarachnoid space. After circulating throughout the subarachnoid space the CSF is returned to the circulatory system by filtration through arachnoid villi that protrude mainly into the venous drainage sinuses of the cranial cavity
- Obstruction of *cerebral aqueduct* cause enlargement of the two lateral and third ventricles (not the fourth) This is referred to as a non-communicating hydrocephalus because the lateral ventricles *are not* in communication with the subarachnoid space
- Growth of neural tissue causes the folding of the embryo during the fourth week of development , giving it the C shaped curvature
    - On 18$^{th}$ day the neural plate invaginates along its central axis to form the neural groove with neural folds on each side.
    - During fourth week the neural fold begins to move together and fuse, converting the neural plate into a meural tube
    - The ectoderm of the neuroplate, called the neuroectoderm, gives rise to the central nervous system, consisting of the brain and spinal cord
- Fourth week of embryonic development
    - Neural tube is closed
    - Four pairs of branchial arches are visible externally
    - Characteristic C shaped curvature of embryo is present due to folding
    - Upper and lower limb buds appear

| Nerve | Site of Exit from Skull | Function |
|---|---|---|
| Olfactory | Cribriform plate of ethmoid bone | S = *smell* |
| Optic | Optic foramen | *S = vision* |

| | | |
|---|---|---|
| Oculomotor | Superior orbital fissure | M = levator palpebrae superioris<br>PS = ciliary muscle of lens and sphincter muscle of pupil |
| Trochlear | Superior orbital fissure | M = *superior oblique muscle of eye* |
| M = motor | S = sensory | PS = parasympathetic |

- Optic disc = optic papilla:
    - small blind spot on the surface of the retina,
    - area where optic nerve exits eye
    - located about 3mm to the nasal side of the macula
    - only part of retina which contains no photoreceptors
    - disc consists of axons of ganglion cells exiting the retina to form the optic nerve
    - axons are accompanies by the central artery and vein of the retina
- From optic chiasm axons that perceive the left visual field from the right optic tract.
    - These optic tract fibers synapse in the *lateral geniculate nuclei with geniculocalcarine* fibers (optic radiations) that terminate on the banks of the calcarine sulcus in the primary visual cortex (Brodmann's area 17) of the occipital lobe.
    - Thus the right visual field is interpreted in the left hemisphere of the brain and visa versa
- Central artery of the retina, a branch of the ophthalmic arter, pierces the optic nerve and gains access to the retina by emerging from the center of the optic disc
- Auriculotemporal nerve
    - Is arises from the posterior division of the mandibular nerve (v3)
    - provides posterior sensory innervation to TMJ. Pain from TMJ is transmitted in the capsule and periphery of the disk by the auriculotemporal nerve. Joint receives only sensory innervation
    - carries some secretory fibers from the otic ganglion to the partid gland
- Nerve to the masseter, also a branch of V-3 carries a few sensory fibers to the anterior portion of the TMJ. Branches of the posterior deep temporal nerve (branch of V3) also supplies the anterior portion of the joint

| Ganglion | Location | PS Fibers | Symp Fibers | Chief Distribution |
|---|---|---|---|---|
| Ciliary | Lateral to optic nerve | Oculomotore nerve and its inferior division | Internal carotid plexus | Ciliary muscle and sphincter pupillae (PS) dilator pupillae and tarsal mm (Smp) |
| Pterygopalatine | In pterygopalatine fossa | Facial nerve, greater petrosal nerve, and nerve of pterygoid canal | Internal carotid plexus | Lacrimal gland and glands in palate and nose |
| Submandibular | On hyoglossus muscle | Facial nerve, chorda tympani, and lingual nerve | Plexus on facial artery | Submandibular and sublingual glands |
| Otic | Below foramen oval | Glossopharyngeal nerve, its tympanic branch, and lesser petrosal nerve | Plexus on middle meningeal artery | Parotid gland |

- Trochlear nerve IV:
    - supplies the superior oblique muscle
    - smallest cranial nerve
    - only cranial nerve that emerges from dorsal aspect of the brainstem
- Abducens VI supplies the lateral rectus of the eye
- Oculomotor nerve

    - supplies: medial, superior, and inferior recti; inferior oblique; and levator palpebrae superioris.
    - Sends pregangl fibers to ciliary ganglion
    - Post gang fibers leave the ganglion in the short ciliary nerves to supply the sphincter pupillae and the ciliary muscle
- Oculomotor nerve (CNIII), trochlear nerve (CNIV) and abducens nerve (CNVI) all exit the cranium through the superior orbital fissure. They innervate the extrinsic ocular muscles, resulting in movement of the eyeball
- A few cardiac branches arise from the vagus and enter the cardiac plexus. These preganglion PS neves that synaps with post ganglionic PS nerves in the heart. They innervate the heart muscle and conducting system (SA node)
- Hypoglossal nerve (CNXII):
    - Motor nerve supplying all the intrinsic and extrinsic muscles of the tongue except the *palatoglossus, which is supplied by the vagus*
    - Leaves the skull through hypoglossal canal medial to the carotid canal and jugular foramen
    - Passes above the hyhoid bone on the lateral surface of the hypoglossus muscle deep to the mylohyoid muscle
    - Loops around the occipital artery and passes between the external carotid artery and internal jugular vein
    - Soon after it leaves the skull through the hypoglossal canal it is joined by C1 fibers from the cervical plexus
- Unilateral lesions: of hypoglossal nerve result in deviation of th protruded tongue towards the affected side. Due to lack of function of the genioglossus muscle on the diseased side
- Injury of the hypoglossal nerve eventually produces paralysis and atrophy of the tongue on the affected side with tongue deviated to the affected side. Dysarthria (inability to articulate) may also be found
- If the genioglossus muscle is paralyzed the tongue has a tendency to fall back and obstruct the oropharyngeal airway with risk of suffocation
- Ophthalmic division (v1)
    - Enters orbit through superior orbital fissure
    - Provides sensory innervation to the eyeball, tip of nose, skin on vace above eye
    - Has thre branches: lacrimal, frontal, and nasociliary
- Maxillary division:
    - Passes through the foramen rotundum
    - Sensory innervation to the midface below eye and above upper lip, palate, paranasal sinuses, and maxillary teeth
- Mandibular division of V-3:
    - Exits cranial cavity through formaent ovale
    - Supplies motor innervation to tensor veli palatine, tensor tympani, muscles of mastication and anterior belly of the digastric and mylohyoid muscles
    - Sensory innervation to skin on cheek, skine of mandible, lower lip and side of head
    - Also sensory innervation to TMJ, mandibular teeth, the mucous membranes of the cheek, the floor of mouth, and the anterior part of the tongue
    - Lingual nerve is a branch of V3 mandibular division of trigeminal nerve.
        - Supplies general sensation for the anterior two-thirds of the tongue, the floor of the mouth, and the mandibular lingual gingival.
        - The submandibular duct has an intimate relation to the lingual nerve, which crosses it twice
        - Lingual nerve descends deep to the lateral pterygoid muscle, where it is joined by the chorda tympani (branch of the facial nerve) which conveys the preganglionic PS fibers to the submandibular ganglion and taste fibers from the anterior thwo thirds of tonge
        - If you cut the lingual nerve after its junction with the chorda tympani, the tongue will loose its taste and tactile sense to the anterior two-thirds of tongue.
- Trigeminal has not PS component in its origin: oculomotor, facial, and glossopharyngeal nerve distribute their preganglionic PS to the PS head ganglia

- Chorda tympani emerges from a small canal in the posterior wall of the tympanice cavity (petrotympanic fissure) and crosses the medial surface of the tympanic membrane. It joins the lingual nerve in the infratemporal fossa
- Sublingual gland is located superior to the mylohyoid muscle
- When placing periapical view of the mandibular molars, it is the mylohyoid muscle that gets in the way if it is not relaxed
- Infrahyoid muscles:
    - depressors of larynx and hyoid after they have been drawn up with pharynx to swallow (deglutition),
    - lie btw deep fascia and visceral fascia over the thyroid gland, trachea, and esophagus,
    - innervated by ansa cervialis from C1,2,3.
- The muscles of the Infrahyoid:
    - Sternothryoid—pulls larynx down
    - Sternohyoid—pulls hyoid downward
    - Thyrohyoid—pulls hyoid down and raises the larynx
    - Omohyoid—pulls the hyoid down
- Suprahyoid muscles:
    - raise the hyoid during swallowing,
    - assist later pterygoid in depressing mandible and
    - assists posterior fibers of temporalis in retraction of mandible
- Suprahyoid muscles:
    - Stylohyoid—
        - pulls hyoid superiorly and posteriorly during swallowing,
        - fixes hydoid bone for infrahyoids
        - innervated by VII
    - Digastric:
        - (anterior) Opens mouth by depressing mandible. Innervated by V#
        - (posterior)fixes hyoid for infrahyoid action. Innervated by VII
    - Mylohyoid
        - elevates hyoid,
        - raises floor of mouth for swallowing,
        - depressed mandible when hyoid is fixed
        - innervated by V3
    - Geniohyoid—
        - elevates tongue,
        - depress mandible, works with mylohyoid
        - innervated by ansa cervicalis, which is a loop formed by branches from the cervical plexus (C1, C2, C3)
- Optic chiasm—uniting of the two optic nerves in the diencephalons
- Optic nerve arises from the axons of the *ganglion cells of the retina* which converge at the *optic disk*.
- Optic foramen = optic canal—area where nerve enters the cranial cavity through the sphenoid bone.
- After forming the optic chiasma, the nerve fibers that arise from the nasal hemiretinas decussate and contribute to the contralateral optic tract whereas those arising from the temporal hemiretinas remain ipsilateral
- Sympathetic and afferent—principle type of nerve in dental pulp. Pulp contains both myelinated and unmyelinated
- Tooth pulp consists of loose CT of thin collagen fibers arranged asymmetrically puls a ground substance containing glycosaminoglycans. It is highly innervated and vascularized tissue. Numerous fibroblasts are present
- Pain in pulp originates from free nerve endings (afferent fibers) about the odontoblastic cells. Regardless of the source of stimulation (heat, cold, pressure) the only response will be pain.
- Vasomotor sympathetic fibers are thought to end on blood vessels
- External laryngeal branch of superior laryngeal nerve innervates the cricothyroid

- Vagus nerve possesses two sensory ganglia:
    - Superior ganglion: lies on nerve *within* the jugular foramen
        - Meningeal: supplies *dura mater*
        - Auricular: supplies auricle, *external auditory meatus*
    - Inferior ganglion: lies on nerve just *below* the jugular foramen
        - Pharyngeal: forms *pharyngeal plexus*, supplies all of the *muscles of the pharynx, except the stylopharyngeus muscle* (innervated by glossopharyngeal nerv) and all of the *muscles of the soft palate*, except the tensor veli palatine (innervated by mandibular nerve, V3)
        - Superior laryngeal
            - Internal laryngeal: travels with *superior laryngeal artery* and pierces the thyrohyoid membrane. Supplies mucous membranes of the larynx *above the vocal folds*
            - External laryngeal: travels with *superior thyroid artery* and supplies the *cricothyroid muscle*
- Vagus nerve:
    - Leaves the brain from the medulla dn passes out of the cranial cavity through jugular foramen
    - Descends in neck in the carotid sheath behind the internal and common carotid arteries and the internal jugular vein.
    - Both right and left vagal trunks pass through the posterior mediastinum on the esophagus and enter the abdominal cavity with the esophagus
    - Supply the viscera of the neck, thorax, and abdomen to the left colic (splenic) flexure of the large intestines
- Vegas nerve Sensory Portion
    - Somatic sensory: fibers to the skin of the ear (ex touch) Cell bodies in the superior ganglion of X (somatic sensory nucleus). Axons enter spinal tract and nucleus of V
    - Visceral sensory: fibers to the pharynx, larynx, and thoracic and abdominal visceral to the left colic flexure (hunger pangs). Cell bodies in inferior ganglion of X visceral sensory nucleus) Axons etner tractus and nucleus solitarius
    - Visceroa sensory fibers to the epiglottis (tast) Cell bodies in inferior ganglion. Axons enter tractus and nucleus solitarius.
- Vagus nerve: motor portion:
    - Branchiomeric: motor fibers to skeletal muscle derived from visceral (gill) arch muscle in larynx upper esophagus and pharyx. Cell bodies of these motor neurons are in nucleus ambguus
    - Visceral motor fibers to smooth muscles and glands of the organx of the neck, thorax, and abdomen. These are the PS preglanglionic fibers that have cell bodies in the dorsal motor nucleus of the vagus (DMX)
- Vagus nerve:
    - Can be cut on the lower part of esophagus to reduce gastric secretions (termed a vagotomy)
    - Forms the anterior vagal trunk at the lower part of the esophagus
    - Passes in front of the left Subclavian artery as it enters thorax
    - Containts PS pre ganglionic fibers
    - Contributes to the anterior esophageal plexus
- Left vagus nerve:
    - enters the thorax in front of the left subclavain artery and *behind* the left brachiocephalic vein.
    - Then crosses the left side of the aortic arch and is itself crossed by the left phrenic nerve.
    - It passes behind the left lung, forms the pulmonary plexus, and continues to form the esophageal plexus.
    - It enters the abdomen in front of the *esophagus* through the esophageal hiatus of the diaphragm as the *anterior vagal trunk (reaches the anterior surface of the stomach*)
- Right vagus nerve:
    - crosses the anterior surface of the right Subclavian artery and enters the thorax *posterolateral* to the brachiocephalic trunk, *lateral to the trachea, and medial to the azygos vein*.
    - It passes posterior to the root of the lung, contributing to the pulmonary plexus.

- It also contributes to eth esophageal plexus. It enters the abdomen behind the esophagus through the esophageal hiatus of the diaphragm as the *posterior vagal trunk (reaches the posterior surface of the stomach)*

- Vagus nerve: lose their identity in the esophageal plexus. At the lower end of the esophagus, branches of the plexus reunite to form the anterior vagal trunk (anterior gastric nerve) which can be cut (vagotomy ) to reduce gastric secretion)
- Abdominal viscera below the left colic flexure and pelvic and genitalia are supplied with PS preganglionic from the pelvic splanchinc nerves
- Right (recurrent???) laryngeal
  - Arises from right vagus nerve in neck—
    - it hooks around the first part of the Subclavian artery and passes backwards and upwards behind the artery ascending in the groove between the trachea and esophagus
    - innervates:
      - all muscles of the larynx, except the cricothyroid, which is supplied by the external laryngeal branch of the superior laryngeal nerve
      - the mucous membrane of the larynx below the vocal folds
      - the mucous membrane of the upper part of the trachea
      - contacts the thyroid gland and comes into close relationship with the inferior thyroid artery
- Left recurrent laryngeal nerve
  - crosses the arch of the aorta, hooks around the ligamentum arteriosum, and ascends in the groove between the trachea and esophagus
  - arises from the left vagus
  - innervates same muscles as right but on left side

| **Nerve** | **Site of exit from skull** | **Functions** |
|---|---|---|
| Trigeminal | | |
| V1 ophthalmic | Superior orbital fissure | S = cornea, skin of nose, forehead, scalp |
| V2 Maxillary | Formane rotundum | S = nasal cavity, palate, max. teeth, skin of cheek, upper lip |
| V3 Mandibular | Foramen ovale | S = tongue, mand. Teeth, mandibule, skin of chin, floor of mouth, TMJ<br>M = muscles of mastication |
| Abducens | Superior orbital fissure | M = lateral rectus muscle of the eye |
| Oculomotor | Superior orbital fissure | M = levator palpebrae superioris and most of the external eye muscles<br>PS = ciliary muscle of the lens and sphincter muscle of the pupil |
| Trochlear | Superior orbital fissure | M = superior oblique muscle of the eye |
| M = Motor | S = sensory | PS = parasympathetic |

- *Geniculate ganglion*:
  - located within the facial canal (petrous portion of the temporal bones) and
  - contains sensory neurons via the *chorda typani of the facial nerve* that
  - innervate taste buds on the anterior two-thirds of the tongue
  - *Greater petrosal nerve*
    - (branch of the facial) arises from the geniculat ganglion,
    - is *parasympathetic root of the pterygopalatine ganglion*.

        - Carries pregangl PS to Ptergopalatine ganglion (for lacrimal glands as well as glands of the palate and nasal cavity)
- *Glossopharyngeal* nerve provide taste fibers to *posterior one-third of tongue*
- Facial nerve also contains PS fibers to the sublingual and submandibular glands (via submandibular ganglion)
- Facial nerve:
    - Innervates the facial muscles with motor fibers
    - Lacrimal gland and salivary glands with PS fibers
    - Anterior tongue with sensory fibers
    - Originates in the pons
    - Traverses the facial canal of the temporal bone and exits the stylomastoid foramen
- Facial nerve functions
    - Motor innervation: muscles of facial expression, posterior belly of digastric muscel and the stylohyoid muscle, and stapedius muscle within the middle ear (lower motor neurons lesions of the faical nerve will cause an ipsilateral flaccid paralysis of facial musculature)
    - Sensory: proprioceptive innervation: from the same muscles listed for motor innervation
    - Secretomotor: PS innervation. Secretion of tears from the lacrimal gland and salivation from the sublingual and submandibular glands
    - Special sensory: taste impulses (sweet sensation) from the taste buds on the anterior two thirds of tongue, the floor of mouth, and the palate
- PS innervation controlling salivation originate in facial and glossopharyngeal nerves
- Semilunar ganglion = gasserian ganglion: large, flattened, sensory ganglion of the trigeminal nerve, lying close to the cavernous sinus in the middle cranial fossa.
- *Trigeminal, facial, glossopharyngeal, and vagus* nerves are *branchiomeric (nonsomitic*) in origin because they originate from the *branchial arches*

| **Arch** | **Muscle** | **Nerve** |
|---|---|---|
| First | *Muscle of mastication*:<br>mylohyoid and anterior belly of digastric<br>Tensor tympani<br>Tensorveli palatine | *Trigeminal* |
| Second | *Muscles of facial expression*<br>Stepedius<br>Stylohyoid<br>Posterior belly of digastric | *Facial* VII |
| Third | Stylopharyngesu | *Glossopharygeal* |
| Fourth and Sixth | Cricothyroid<br>Levator veli palatine<br>Constrictors of pharynx<br>Instrinsic muscles of larynx | External laryngeal branch of *vagus* X<br>Recurrent laryngeal branch of *vagus* |

- Otic ganglion:
    - Small PS ganglion that functionally associated with the glossopharyngeal nerve
    - Situated below foramen ovale and is medial to the mandibular nerve
    - Tympanic and lesser petrosal branches of the glossopharyneal nerve supply pre-ganglionic parasympathetic secretomotor fibers
    - Postganglionic fibers leave the ganglion and join the auriculotemporal nerve → parotid
- Glossopharyngeal nerve:
    - Originates from the anterior surface of the medulla oblongata along with the vagus nerve and spinal accessory nerve.
    - Passes laterally in the posterior cranial fossa and leaves skull through the jugular foramen
    - Supply sensation to the pharynx and posterior third of tonge

    - Cell bodies of these sensory neurons are located in the superior and inferior ganglia of this nerve
    - Descends through the upper part of nex along with the internal jugular vein and internal carotid artery to reach posterior border of the stylogpharyngeus muscle to which it supplies somatic motor fibers
    - Causes the gag reflex (innervates mucous membranes of the fauces
- Trigeminal:
    - Exits inferolateral pons as a sensory and motor root.
    - Largest of 12 cranial nerves
    - Larger sensory root enters the trigeminal (semilunar, gasserian) ganglion in the idle cranial foss)
    - Three sensory divisions of the nerve aris from the ganglion and leave the cranial cavity through formina in the sphenoid bone.
    - Smaller motor root passes under the ganglion and joins the mandibular division as it exists through the foramen ovale
- Somatic sensory cell bodies of the glanglion's sensory fibers enter the :
    - Ophthalmic division: supply gneerla sensation to the orbit and skin of face above eyes
    - Maxillary division: to supply general sensation to the nasal cavity, maxillary teeth, palate, and skin over maxilla
    - Mandibular division: supply general sensation ot the mandible, TMJ, mandibular teeth, floor of mouth, tongue, and skin of mandible
- Axons of the neurons enter the pons through the sensory root and terminate in one of the three nuclein of the trigeminal sensory nuclear complex:
    - Mesencephalic nucleus: mediates proprioception (ex. Muscle spindle)
    - Main sensory nucleus: mediates general sensation (ex. Touch)
    - Spinal nucleus: mediats pain and temperature from head and neck
- Cell bodies of the proprioceptive first order neurons are found in the mesencephalic nucleus, not the trigeminal ganglion.
- TMJ, as with all joints, receives no motor innervation. The muscles that move the joint receive the motor innervations
- Branchiometric motor fibers innervate the temporalis, medial and laterl pterygoid, anterior belly of the digastric, mylohyoid, tensor tympani, and tensor veli palatine
- Sympathitic trunks: two long chains of symp ganglia on either side of the vertebral column that extend from bas of skull to the coccyx.
- Two trunks lie close to the vertebral column and end below by joining to form a single ganglion, the *ganglion impar (unpaired)*. There are sympathetic ganglia located at intervals on each symp trunk alongise the vertebral column. Generally there are *3 cervical, 12 thoracic, 4 lumbar, and 4 sacral*
- Three cervical ganglia:
    - Superior cervical ganglion: uppermost and largest lies between the *internal carotid artery* and the *internal jugular vein*. Most of the postganglionic sympathetic fibers that go to the *head region* have their cell bodies located here
    - Middle cervical ganglion: small, located at the *level of the cricoid cartilage*. It is related to the loop of the inferior thyroid artery
    - Inferior cervical ganglion: occurs at the *C-7 vertebral level*. Most commonly is fused to the first thoracic sympathetic ganglion to form a *stellate ganglion*
- *Gray rami* connect the sympathetic trunk to every *spinal nerve*. *White rami* are limited to the spinal cord segments between *T1 and T2*
- *Cell bodies of the visceral efferent fibers* in the visceral branches of the sympathetic trunk are located in the *intermediolateral cell colulmn* (or lateral horn) of spinal cord; the *cell bodies of visceral afferent fibers* are located in the *dorsal root ganglia*
- Sympathetic ganglia located at intervals on each sympathetic trunk alongside the vertebral column. Nervers arise from *thoracic ganglia (T5 – T12).* They all pass through the diaphragm
- Preganglionic sympathetic fibers may pass through the ganglia on the thoracic part of the sympathetic trunk without synapsing. These myelinated fibers form the splanchnic nerves:

    - Greater: sympathetic fibers from *T5 - T9* pierce the diaphragm and synapse with the excitor cells in the ganlia of the celiac plexus
    - Lesser: symp fibers from *T 10 – T 11* pierce the diaphragm and synapse with excitor cells in the aorticorenal ganglion
    - Least: symp fibers fro *T12* pierce the diaphragm and synapse with excitor cells in the ganglia of the renal plexus
- Thoracic splanchnic nerves (specifically the greater splanchnic nerve) to the celiac plexus consist primarily of preganglionic visceral efferent fibers. The postganglionic fibers arise from the excitor cells in the celiac plexus and are distributed to the smooth muscle and glands of the viscera
- Glossopharyngeal nerve inervates the stylopharyngeus muscle.
    - It is the only muscle that is supplied by this nerve.
    - The muscle is a landmark for locating the nerve because as the nerve enters the pharyngeal wall, it curves posterior around the alteral margin of this muscle
    - Supplies PS pre-ganglionic motor fibers to the otic ganglion → parotid
        - Preganglionic nerve leave the glossopharyneal nerve as the tympanic nerve that enters the middle ear cavity and participates in the formation of the tympanic plexus.
        - It reforms as the lesser petrosal nerve, leaves the cranial cavity through the foramen ovale, and enters the otic glanglion. Postganglionics are carried by the auriculotemporal nerve V# to the parotid
- Visceral sensrory branches of the glossopharyngeal nerve:
    - Lingual: terminal branch of the glossopharyngeal to the posterior one-third of the tongue conveying general sensation and taste to the circum vallate papillae. (also carries some secretomotor fibers to the glands)
    - Pharyngeal: distributed to the mucous membrane of the pharynx. Is the sensory limb of the gag reflex
    - Carotid sinus nerve: to carotid sinus (baroreceptor) and carotid body (chemoreceptor)
- Cervical plexus:
    - Motor nerves fo most of the infrahyoid muscles are branches of the ansa cervicalis (loop formed by C1, C2, and C3
    - Cervical nerves C1 – C4 contribute to plexus
    - It is positioned deep on the side of the neck, lateral to the first four cervical vertebrae
    - An important branch of each cervical plexus is the phrenic nerve which supplies the diaphragm
    - The supraclivicular nerves innervated the skin over the shoulder
    - The transverse cervical nerve provide sensory innervation to the anterior and lateral parts of the neck
    - Provides innervation for the genoihyoid muslce
- Brachial plexus (C5 – C8 and T1)
    - Formed in the posterior triangle of the neck
    - Extends into the axilla supplying nerves to the upper limbe
    - *Has three cords*:
        - Posterior (axillary and radil nerves are main branches)
        - Lateral (musculocutaneous nerve is main branch)
        - Medial (ulnar nerve is main branch)
            - *Median nerve* forms its two heads (*medial and lateral from the medial and lateral cords)*
- *Lumbar plexus: L1 – L4*
    - Formed in the psoas muscle,
    - Supplies lower abdomen and *parts of the lower limb*
    - *Main branches are the femoral and obturator nerves*
- *Sacral plexus: L4 – L5 and S1 – S4*
    - Lies in the posterior pelvic wall in front of the piriformis muscle.
    - Supplies the lower back, pelvic, and parts of the thigh, leg, and foot
    - Main branches are the *sciatic* (largest nerve in the body), gluteal, and pelvic splanchnic nerves

| Nerve | Site of Exit from Skull | Function |
|---|---|---|
| Glossopharyneal | Jugular foramen | M = stylopharyngeus muscle<br>S = Taste (posterior third of tongue, vallate papillae) pharynx, middle ear, cartid sinuses |
| Vagus | Jugular foramen | M = muscles of pharynx and larynx<br>S = taste (epiglottis)<br>S = thoracic and abdominal organs (viscera)<br>PS = thoracic and abdominal organs (smooth muscles) |
| Accessory | Jugular foramen | M = trapezius and sternocleidomastoid muscles |
| Hypoglossal | Hypoglossal canal | M = intrinsic and extrinsic tongue muscles |
| M = motor | S = sensor | PS = parasymphathetic |

- Greater petrosal nerve is a
    - PS secretomotor branch of facial nerve:
    - Exits cranial cavity through foramen lacerum and enters the pterygoid canal after joining with the deep petrocal nerve carrying post-ganglionic sympathetics from the superior cervical ganglion
    - In pterygoidpalatine fossa nthis nerve of the pterygoid canal terminates in the pterygopalatine ganglion.
    - PS preganglionics from the greater petrosal nerve synapse with the post-ganglionics here whereas the sympathetic (already post-ganglionics) pass through the ganglion without synapsing.
    - These post-ganglionic autonomics are distributed to the lacrimal gland, and glands of the mucous membrane of the nasal cavity, pharynx, and palate
- Greater petrosal nerve also transmits taste centrall from the palate through the palatine nerves. These taste fibers also necessarily pass through the pterygopalaitne g. and nerve of the pterygoid canal to reach the greater petrosal nerve on their way to the tractus and nucleus solitarius in the pons

## Connective Tissue

| Epithelium | Cells | Function |
|---|---|---|
| Simple | Squamous | Diffusion and filtration |
| | Cuboidal | Secretion, excretion, or absorption |
| | Colunar | Absorption, secretion, and protection |
| Pseudostratified | Columnar | Secretion and transport of particles out of air passages |
| Stratified | Squamous | Protection, prevents water loss |
| | Cuboidal | Protection and secretion |
| | Columnar | Protection |
| Special stratified: transitional | Varies between cuboidal and squamous | Permits expansion |

- Keratinocyte: cell type most common in epidermis of skin. Specialized to produce keratin (a protective protein)
- Epidermis: outermost portion of skin. Develops from embryonic ectoderm.:
    - Stratum basal (also called stratum germinativum): leat cytodifferentiated, contain cuboidal or low colunar cells that exhibit large amounts of mitosis and contain tonofibrils in their cytoplasm. Melancytes are located here
    - Stratum spinsoum (also called prickle cell layer): contains ells called Langerhans cells (function is unkonw, perhaps immune response). Malpighian layer denotes the stratum basal and spinosum together
    - Stratum granulosum: contain keratohyalin granules in their cytoplasm
    - Stratum lucidum: clear band, cells contain eleidin which transformed into keratin as this layer becomes part of the stratum corneum. Most prominent in thick skin, absent in the thin skin
    - Statum corneum: composed of closely packed dead cells filled with keratin, also called horny layer
- Oral epithelium is covered with stratified squamous epi
- Areas of oral stratified squamous keratinized: gingival, hard palate (are of mechanical stress)
- Pemeabilities of oral mucosal decrease in the order of sublingual greater than buccal and buccal greater than palatal. Based on the relative thickness and degree of keratinzation of those tissues. With the sublingual mucosa being relatively thin and non keratizined.
- Oral cavity is highly acceptable for systemic drug delivery
    - Mucosa is relative permeable with a rich blood supply
    - Virtual lack of langerhans cells makes the mucosa tolerant to potential allergens.
    - Route also bypasses the first passs effecgt and avoids pre-systmeic elimination in the GI tract. Ex: nitroglycerin tablets are given sublingually for rapid absorption. Note Alveolar mucosa is very similar to sublingual mucosa in that it too appears red due to the numerous blood vessles and thin epithelial covering
- Stratified squamous epithelium: acts as a mechanical barrier and protects the underlying tissue:
    - Keratinized: least frequently present; effective mechanicl protector. Cells are filled with keratin
    - Nonkeratinized: selective barrier, acts as a cushion. Cells do not contain keratin
    - Parakeratinzed: intermediate form that gradually becomes keratinized
- Types of oral epithelilum:
    - Melanocytes: produce melanin
    - Langerhans cells: antigen presenting cells, part of immune system
    - Merkel cells: associated with nerve endings
    - Inflammatory cells: lymphocytes, monocytes, neutrophils
- CT of oral cavity: referred to as lamina propria forms mechanical support and carries nerves and blood vessels Two layers
    - Papillary layer: directly under epithelial layer
    - Reticular layer: dense, fibrous layer located under papillary layer

- Submucosa: present only in areas that require a high degree of compressibility and flexibility (cheekcs, soft palate) Located between connective tissue and muscle tissue
- Basement membrane:
    - thin structure that attaches epithelium to underlying CT in contact with the dividing layer of cells.
    - Consists of glycoprotein from the epithelial cells and a meshwork of collagenous and reticular fibers from the underlying connective tissue
    - Consists of
        - Basal lamina: develops from the epithelial cells
        - Reticular lamina: develops from the connective tissue
- Functions of epithelium: protection, absorption, excretion, and secretion
- Functions of skin:
    - Prevention of body dehydration
    - Synthesis of Vit D
    - Prevention of pathogen entry
    - Regulation of body temperature
- Skin consists of two principle layers:
    - Outer epidermis: consists of strat sq. ep. Develops from embryonic ectoderm. It is avascular. The outer clls are dead, keratinized, and cornified
    - Inner dermis which is deeper, thicker layer of the skin. Consists of dense CT. Develops from embryonic mesoderm. This layer also contains blood and lymphatic vessels, 5 types of nerve endings, sweat and oil glands, and hair follicles
        - Papillary layer: thin and less fibrous; has prejections (papillae) that extend up toward ht epidermal layer. Finely constructed, thin, loose CT. Contains fibroblasts, mast cells, and macrophages. Elastic fibers are abundant and provie the skin tone
        - Reticular layer: thick, fibrous, and dense CT. Continous with the hypodermis. Reticular fibers are abundant, collagenous fibers, along with elastic fibers are also found. More fibers and fewer cells than the papillary layer
- Hypodermis is a subcutaneous layer found beneath the dermis that binds skin to underlying structures. It is composed of loose arealar CT, adipose tissue and blood and lymph vessels
- Characteristics of the hypodermal layer that connects the dermis with the underlying fascia of muscle:
    - Composed primarily of loose CT
    - Major site of fat deposition (50% of body fat)
    - Has a good blood supply
- Epithelial tissue is classified according to the shape of the cell and the number and arrangement of cell layers
- Simple Squamous epithelium:
    - Endothelium lining the cardiovascular system
    - Epithelium lining the alveoli in lungs
    - Mesothelium lining body cavities and coats organs of these cavities
- Simple Cuboidal epithelium
    - Epithelium lining collecting ducts, proximal, and distal tubules of the kidney
    - Epithelium lining thyroid follicles
- Simple columnar epithelium
    - Lining of the small and large intestine, the gallbladder, and the stomach
    - Uterine epithelium
    - Salivary gland striated ducts
- Stratified squamous epi
    - Epidermis of skin
    - Lining of the esophagus (usually not keratinized)
- Stratified cuboidal
    - Ducts of the sweat glands
- Stratified columnar ep

    - Large ducts of salivary glands
    - Male urethra
- Specialized epithelium
    - Pseudostratified columnar epi
        - Lining of the upper respiratory tract
        - Lining of parts of the male reproductive tract
    - Transitional epi
        - Bladder
        - ureter

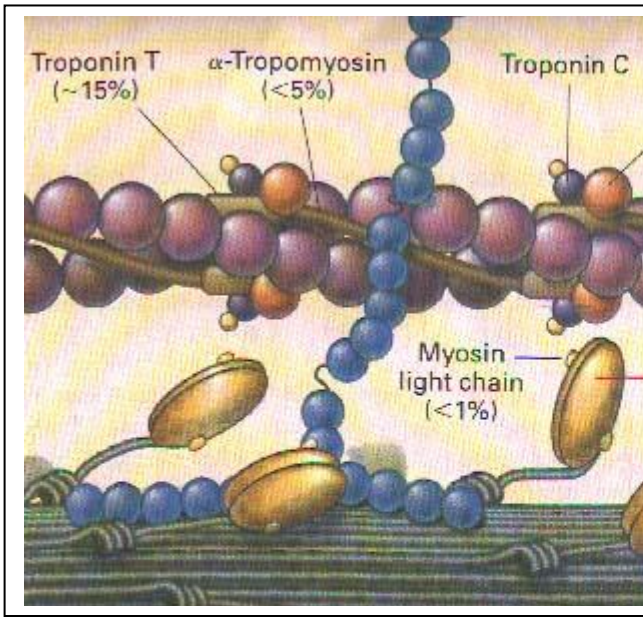
| Types | Description and Function | Example |
|---|---|---|
| Epithelial tissues | May be one or several layers thick; lower surface bound to a supportive basement membrane of glycoprotein, mitotically active tissue; line all body surfaces, cavities, and lumina and are adapted | Outer layer of skin, linings of GI tract, urinary bladder, ducts and vessels; alveoli of lungs; and covering of viscera and body |
| Connective Tissue | Highly vascular (except cartilage); contain considerable intercellular matrix; mitoically active tissue, support or bind other tissues and provide metabolic needs | Tendons and ligaments; cartilage and bone, adipose, blood |
| Muscle | Limited mitotic activity; fibers are adapted to contract in response to stimuli; movment of materials through the body, the movement of one part of the body | Smooth, skeletal, and cardiac muscle |
| Nervous tissue | Limited mitotic activity; respond to impulses to and from all body organs | Neurosn and neuroglia |

- pseudostratified ciliated columnar epi: Surface layer of mucous membrane of the nasopharynx
    - also lines the nasal cavity, the paranasal sinuses, the nsaopharynx, the trachea, and the bronchial tree (except the lining of the respiratory bronchioles, which lose their cilia and change to cuboidal and then to squamous)
- Statified squamous epi usually contains cuboidal cells in the deeper layers and squamous cells in the surface layer. This tissues is well adapted for abrasion and protection. Found on skin, linings of the mouth, oropharynx, laryngeopharynx, esophagus, anus, and vagina
- Simple squamous epi: found where diffusion and filtration occur. It includes endothelium that lines the blood vessels and mesothelium that lines the body cavities. It also lines the air sacs of the lungs
- Transitional ep: is specialized stratified tissue that lines the urinary bladder, ureter, and upper part of the urethra. Contains dome-shaped superficial cells that change form depending on whether the bladder is contracted or expanded
- Cartilage is avascular→ slow to heal after injury.
- Chondrocyte is a cartilage cell:
    - Reside in depressions in the matrix called *lacunae*. The only blood supply is provided by blood vessles that enter the cartilage through the *perichondrium*
- Three subtypes of cartilage:
    - Hyaline: matrix contains fine collagenous fibers
    - Fibrocartilage: matrix has dense collagenous fibers
    - Elastic: matrix has collagenous fibers and elastic fibers

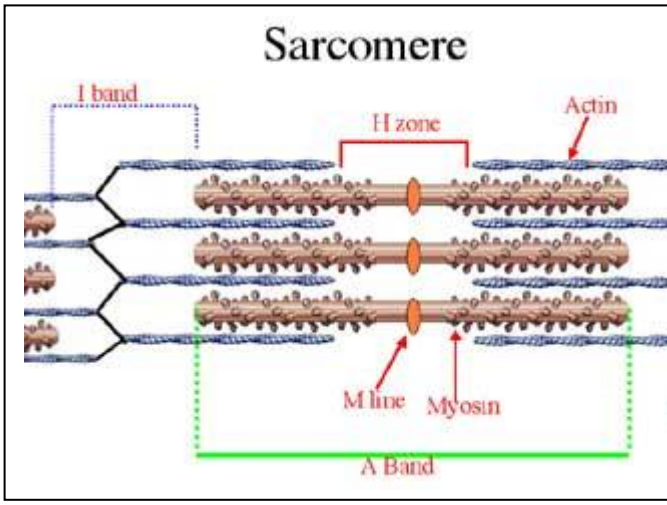
- Perichondrium is a fibrous, CT membrane covering the external surface of cartilaginous structures (it is very important in the growth of cartilage). No calcium salts are present and, therefore, cartilage doesn't appear on x-rays
- Cartilage is precursor to endochondrial bone in length.
    - The cartilage cells of the epiphyseal plate form layers of compact bone tissue, adding to the length of the bone (interstitial growth).
    - The disc becomes inactive in most indivuals by the late teens of early twenties
- Hyaline cartilage has a capsule around the chondrocytes which represents the youngest layer of intercellular substance
- Long bones increase in length during growth and development. The epiphyseal plate (disc) is a wedge of hyaline cartilage occounting for this increase. The plate is found between the epiphysis (bulbous end) and diaphysis (tubular shaft) at each end of the bone.
- Primary ossification center: ossification occurs first near the middle of the diaphysis
- Secondary ossification center: forms later, in the epiphyses
- The region between the secondary and the primary ossification is termed the metaphysic
- Cartilage:
    - Secrete a hard, rubbery matrix around themselves.
    - Can support great weight, yet it is flexible and somewhat elastic
- Growth of cartilage:
    - Interstitial: chondrocytes divide within cartilage
    - Appositional: where surface perichondirum lays down new layers (perichondirum consists of a fibrous outer layer and a chondroblastic inner layer)
- Growth of bone:
    - Appositional: below the covering periosteal layer of bone periosteum consists of a fibrous outer layer and a cellular inner layer of osteoblasts, which lay down bone. Becaues of its rigid structure, interstitial growth is not possible
    - Do not confuse bone growth with bone formation. Bone forms by either endochondral ossification or intramembranous ossification
- Types of Cartilage:
    - Hyaline cartilage (most common): contains many closely packed fine collagenous fibers. Covers and protects bone; precursor to bone and where strong support is needed but some flexibility is desirable. Makes up the costal cartilages, the cartilaginous rings of the trachea, joints, nose, and the main support of the bronchial wall
    - Fibrocartilage: most closely resembles dnse, irregular, CT (consists of dense matrix of collagenous fibers) Withstands tension and compression. Founde in intervertebral discs (vertebra) knee joint, TMJ, and syphysis pubis
    - Elastic cartilage: similar to hyaline cartilage but the ifbers are not as closely packed. More importantly, elastic cartilage contains many elastic fibers (elastin). Forms the external ear and is also found in the epiglottis, the auditory meatus and the larynx
- Ground substance of hyaline cartilage is basophilic because it contains Sulfated proteoglycans which are called glycosaminoglycans
    - GAG: can readily bind and hold water→allows tissue to assume a gelatinous nature that can resist compression and also permit some degree of diffusion
- Hyaline cartilage forms nearly all of fetal skeleton.
- Hyaline cartilage in adults:
    - Articular cartilage: smooth and slippery, it lines movable joints
    - Costal cartilages: at the sternal ends of the ribs
    - Respiratory cartilages: movable external nose and septum, larynx, trachea, and the bronchial walls
    - Auditory cartilages: external auditory meatus and pharyngotympanic tube
- Ligament: band of CT that binds bone to bone
    -

- Tendon: band of CT that attaches bone to muscle
- Fasciculus: bound group of individual muscle fibers.
    - The fasciculi are the bundles of muscle fibers composing the muscle.
    - Each muscle is surrounded by a CT called fascia.
    - Fascia secures the muscle to a tendon. Composed of dense regular CT, tendons are strong, flexible structures that secure muscles to bones.
    - More specifically, a tendon secures the fascia of a muscle to the periostium of bone.
- Aponeurosis: a sheetlike tendon
- When a tendon or ligament is attached to the bone, the attaching fibers are called Sharpey's fibers. They are periosteal collagen fibers that penetrate the bone matrix binding the periosteum to bone
- Dense CT:provides tendons and ligaments strong, flexible support (dense regular). Has greater fiber concentration.
    - Dense regular: CT consist of tightly packed fibers arranged in consistant patter. Includes tendons, ligaments, and aponeuroses
    - Dense irregular: tightly packed fibers arranged in an inconsistent pattern. Found in dermis, submucosa of the GI tract, fibrous capsules, and deep fascia
- CT is derived from mesenchyme (mesoderm) and contains more intercellular material than cells. The most common cells are the firbroblasts and macrophages.
- Loose (areolar) CT: large spaces separating the fibers and the cells and contains much intracellular fluid
- Hemidesmosomes: *half desmosomes* that anchor epithelium to the basal lamina and thus to the underlying CT. Common in stat epi of skin and *juncitonal ep of the epithelial attachment* (also called the epithelial cuff)
- Bullous pemphigoid: involves the disruption of Hemidesmosomes and consequent separation of the epi form the basal lamina
- Adhering junctions are belt-like
- Others are spotlike:
- Intermediate junction: belt-like junction that connects two neighboring cells
- Desmosomes: a spot like junction that connects two neighboring cells
- Hemidesmosomes: a spot-like junction that connects plasma membrane of an epithelial cell to the underlying basal lamina
- Focal contact: spot like junction that connects the plasma membrane of a fibroblast to the surrounding CT
- Gap juctions: specialized areas of cell membrane that connect neighboring cells
    - Communicating junctions.
    - Organized collections of protein channels that allow ions and small molecules to traverse between the connected cells in a passive fashion.
    - Are separate from the components of the junctional complese.
    - Exist in all multicellular organisms and in almost all cell types in these organism.
    - Some exceptions are skeletal muscle, red blld cells, and freestanding cells such as circulating lymphocytes
- Six major types of cell junctions in humans:
    1. tight junctions (zonula occludens)
    2. intermediate junctions (zonula adherens)
    3. desmosomes (macula adherens)
    4. Hemidesmosomes
    5. focal contacts
    6. gap junctions
- Functional classes:
    - Occluding junctions: tight junctions
    - Anchoring or adhering junctions: intermediate junctions, desmosomes, Hemidesmosomes and focal contact
    - Communicating junction: gap junctions

**Muscle**




- When a muscle contracts, tension develops because of the interaction between the actin and myosin filaments
    - Actin filaments (thin myofilaments, 5-8 nm in diameter) are compsed of :
        - Actin: globular actin (G-actin) molecules are arranged into double spherical chains called fibrous actin (F-actin)
        - Tropomyosin: long threadlinke molecules, lie along the surface of F-actine strands and physically cover actin binding sites during the resting state
        - Troponin: small oval-shaped molecule attached to each tropomyosin
    - Mysoin Filaments: (thick myofilaments, 12- 18 nm in diameter are composed of:
        - Light meromyosin (LMM): makes up the rod-like backbone of myosin filaments
        - Heavy meromyosin (HMM): forms the shorter globular lateral cross-bridges, which link to the binding sites on the actin molecules during contraction




- Sarcomeres: myofibrils of skeletal muscle fiber characterized by dark and light striations due to the arrangement of thick (myosin) and think (actin) filaments.
- A bands: A bands (anisotropic) Contain actin and myosin
- Lighter bands: I bands (isotropic), bisected by dark Z lines where the actin filmanets of adjacent sarcomeres join
- Lighter central regions (H bands) of the A bands contain only myosin
- H band represents the central area of the A band where there is no actin/myosin overlap
- *Epimysium* is the CT layer that envelopes the entire muscle
- *Perimysium*:
    - continuation of the outer fascia, dividing the interior of the muscle into bundles of muscle cells.
    - The bundle of cells surrounded by each perimysium is called a *fasciculus*
- *Endomysium*: CT surrounding each muscle fiber
- Each of the three levels of fascia is interconnected, allowing vessels and nerves to reach individual fibers and cells
- Sarcoplasmic reticulum:
    - Network of tubules and sacs in skeletal muscles.
    - Analogous, but not identical to the endoplasmic reticulum of other cells
- Cytoplasm of muscle cells is called sarcoplasm.
    - Sarcoplasm of each muscle fiber contains many parallel, threadlike structures called myofibrils.
- It is mainly a great increase in the numbers of additional myofibrils (which is caused by progressively greater numbers of both actin and myosin filaments in the myofibrils) that causes muscle fibers to hypertrophy. The number of muscle fibers does not increase, the size of each fiber increases
- Skeletal muscle contract when a stimuls from the nervous system excites the individual muscle fibers. This starts a series of events that lead to interactions between the myosin and actin of the sacromeres of the fibers

- Smooth muscle fibers:
    - Composed of uninucleated, spindle shaped cells (fusiform cells)
    - Much smaller than skeletal muscle fibers
    - Nuclei are situated in the widest part of each fiber.
    - Do *NOT possess t-tubules* and their sarcoplasmic reticulum is poorly developed
    - Do not possess regularly ordered myofibrils and are therefore *NOT striated*
    - Contraction process is *slow and not subject to voluntary control*
    - *Single unit smooth* muscle has *numerous gap junctions*
    - Types of Smooth muscle
        - Single unit: have numerous gap junctions (electrical synapses) between adjacent fibers. These fibers contract spontaneously. (Ex. muscular tunica of the GI tract, uterus, ureters, and arterioles)
        - Multi-unit: lacks gap junctions and the individual fibers are autonomically innervated. (Ex: ciliary muscle and the smooth muscle of the iris, ductus deferens and arteries)
- Skelatal muscle fibers:
    - Composed of bundles of very long, cylindric, multinucleated cells that possess regularly ordered myofibrils that are responsible for the striated appearance of the cell
    - Nuclei are either slender ovoid or elongated and are situation peripherally
    - Do contain transverse tubules and the sarcoplasmic reticulum is very well developed.
    - Contraction is quick, forceful, and usually under voluntary control
    - Myofibrils (actin and myosin) are the contractile element
- Cardiac muscle:
    - Make up thick , middle layer of the heart known as the myocardium
    - Have larger t-tubules and less developed sarcoplasmic reticulums as compared to skeletal fibers
    - In contrast to skeletal fibers, cardiac muscle fibers are short, branched, and single or binucleated
    - Fibers have more mitochondria between myofibrils and are richer in myoglobin than most skeletal muscles
    - Fibers contain large, oval *centrally placed nuclei*
    - Their characteris feature is the presence of *intercalated discs:* strong, but thin unions between fibers:
        - *Discs provide low resistance for current flow*
        - Within the intercalated discs, desmosomes attach one cell to another while gap junctions allow electrical impulses to spread from cell to cell
    - **Fibers contract spontaneously without any nerve supply**
    - Respond to increased demand by incrasing the size of the fiber, this is known as compensatory hypertrophy
- Axon of motor unit is highly branched.
    - *One motor neuron innervates numerous muscle fibers*.
    - When a motor neuron transmits an impulse, *all of the fibers it innervates contract simultaneously*
- Cardiac muscle fibers:
    - contain centrally place nuclei as well as
    - intercalated discs, which represent junctions between cardiac muscle cells
- Skeletal and cardiac muscle fibers cannot mitotically divide but certain smooth muscle fibers can under hormonal influences (during pregnancy, the smooth muscle fibers of the myometrium of the uterus increase in length and new cells are formed)

| Muscle | Nerve Innervation | Action |
|---|---|---|
| Pectoris major | Medial and lateral pectoral nerve from brachial plexus | *Flexes, adducts,* and medially rotates arm |
| Pectoris minor | Medial pectoral nerve | *Depresses* the scapula |
| Latissiums dorsi | Thoracodorsal nerve from brachial plexus | *Extends, adducts* and medially rotates the arm |
| Deltoid | Axillary nerve (C5 – C6) | *Abducts* arm, post. Fibers extend and |

| | | |
|---|---|---|
| | | anterior fibers flex |
| Teres major | Lower subscapular nerve from brachial plexus | *Adducts*, extends and medially rotates the arm |
| Teres minor | Branch of axillary nerve | Rotates the arm laterally |

| | **Muscles of the pectoral Girdle** | |
|---|---|---|
| **Muscle** | **Action** | **Innervation** |
| Serratus anterior | Pulls scapula forward and downward | Long thoracic nerve |
| Pectoralis minor | Pulls scapula forward and downward | Medial pectoral nerve |
| Subclavius | Draws clavicle downward | Nerve to subclavius, C5, C6 |
| Trapezius | Elevates scapula, draws head back, adducts scapula, braces shoulder, draws scapula downward | Accessory nerve |
| Levator scapulae | Elevates and draws scapula medially | Dorsal scapular nerve |
| Rhomboideus major | Elevates and retracts scapula | Dorsal scapular nerve |
| Rhomboideus minor | Elevates and retracts scapula | Dorsal scapular nerve |

- The Triangle of auscultation
    - Is bounded by the upper border of the latissimus dorsi, the lower border of the trapezius, and the medial margin of the scapula
    - It is the site where breathing sounds can be heard most clearly
    - Its floor is formed by the rhomboid major
- Quadriceps femoris group
    - Rectus femoris:
        - flexes thigh and extends leg at knee
        - crosses at the hip and knee joints
    - Vastus lateralis, intemedius and medialis: all extend leg at knee
- Muscles of the thigh: posterior group. They all flex the leg and extend the thigh and are all innervated by the tibial nerve
    - Biceps femoris
    - Semitendinousus
    - Semimembranous
- Muscles of the thigh: anterior group
    - Sartorius: flexes leg and thigh; abducts thigh

| | **Muscles of the Anterior Abdominal Wall** | |
|---|---|---|
| **Muscle** | **Action** | **Innervation** |
| External abdominal oblique | Compresses abdomen; lateral rotation | Lower intercostal nerves |
| Internal abdominal oblique | Compresses abdomen; lateral rotation | Lower intercostal, iliohypogastric, and ilioinguinal nerves |
| Transversus abdominis | Compresses abdomen | Lower intercostal, iliohypogastric and ilioinguinal nerves |
| Rectus abdominis | Flexes vertebral column | Lower intercostal nerves |

- Internal oblique:
    - is muscle of anterior abdominal wall and forms the cremaster muscle.
    - As the spermatic cord (or round ligament of the uterus) passes under the lower border of the internal oblique, it carries with it some of the muscle fibers that are called the cremaster muscle
- Posterior abdominal muscles include

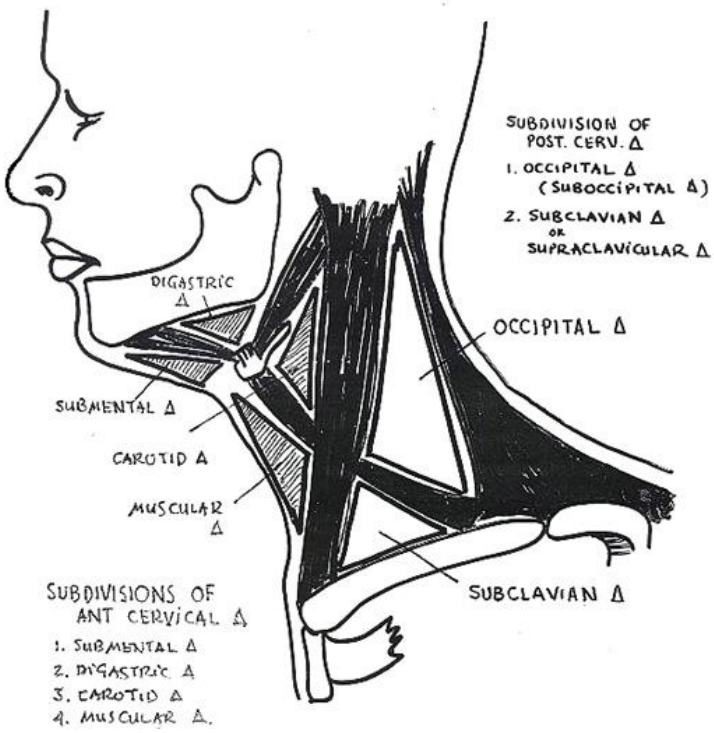
    - psoas major and minor (innervated by the lumbar plexus)
    - quadratus lumborum (innervated by the lumbar plexus)
    - iliacus (innervated by the femoral nerve)
- Intrinsic muscles of the larynx
    - Cricothyroid: stretches the vocal chords
    - Vocalis: shortens vocal cords, is the antagonist of the cricothyroid muscle
    - Lateral cricoarytenoid: adducts the vocal cords
    - Transverse arytenoids: contracts to close the airway posteriorly for speech
    - Posterior cricoarytenoid: maintains wide airways (For breathing)
    - Thyroarytenoid: closes the vestibule
    - Aryepiglottic: closes the vestibule
    - Thyroepiglotticus: helps close vestibule
- The cricothyroid muscle is innervated by the external laryngeal branch of vagus, the reminaing muscles are all innervated by the recurrent laryngeal branch

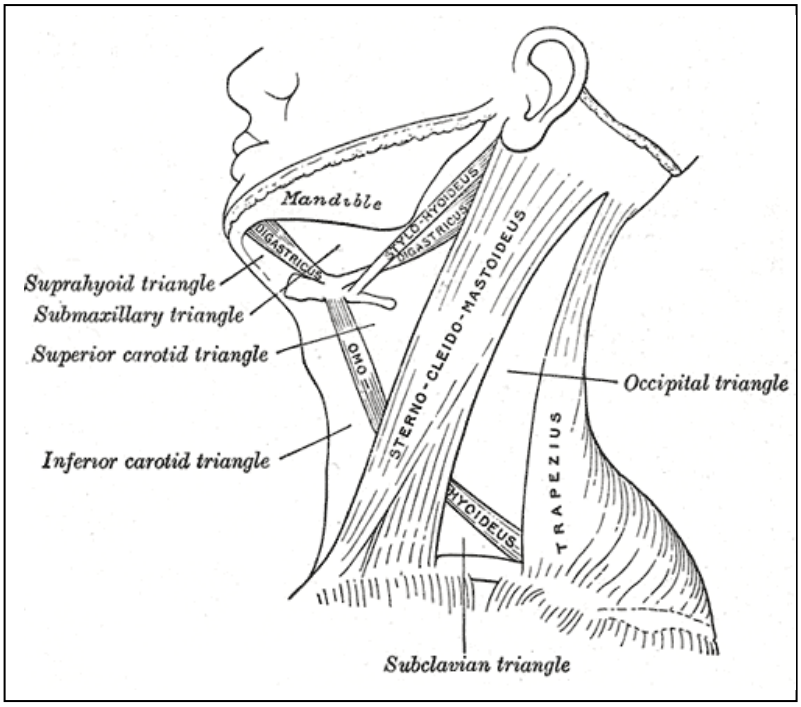
| | | **Muscles of Neck** | | |
|---|---|---|---|---|
| **Muscle** | **Origin** | **Insertion** | **Action** | **Innervation** |
| SCM | Sternum; clavicle | Mastoid process of temporal bone | Turns head to side; flexes neck and head | Accessory nerve |
| Digastric | Inferior border of mandible; mastoid groove | Hyoid bone (sling) | Opens jaw; elevated hyoid bone | Ant belly (V3)<br>Post belly (facial) |
| Mylohyoid | Mylohyoid line of mandible | Median raphe | Elevates hyoid bone and floor of mouth | Trigeminal V3 |
| Stylohyoid | Styloid process of temporal bone | Body of the hyoid | Elevates and retracks hyoid bone | Facial N |
| Hyoglossus | Body of hyoid bone | Side of tongue | Depresses hyoid | Hypglossal n. |
| Sternohyoid | Manubrium | Body of hyoid | Depresses hyoid | Ansa cervicalis |
| Thyrohyoid | Thyroid cartilage | Greater cornu of hyoid bone | Depresses hyoid; elevates thyroid cart. | C1 via hypoglossal n |
| Omohyoid | Superior border of scapula | Clavicle; body of hyoid bone | Depresses hyoid | Ansa cervicalis |

- Sternocleidomastoid separate the anterior and posterior triangles of the neck

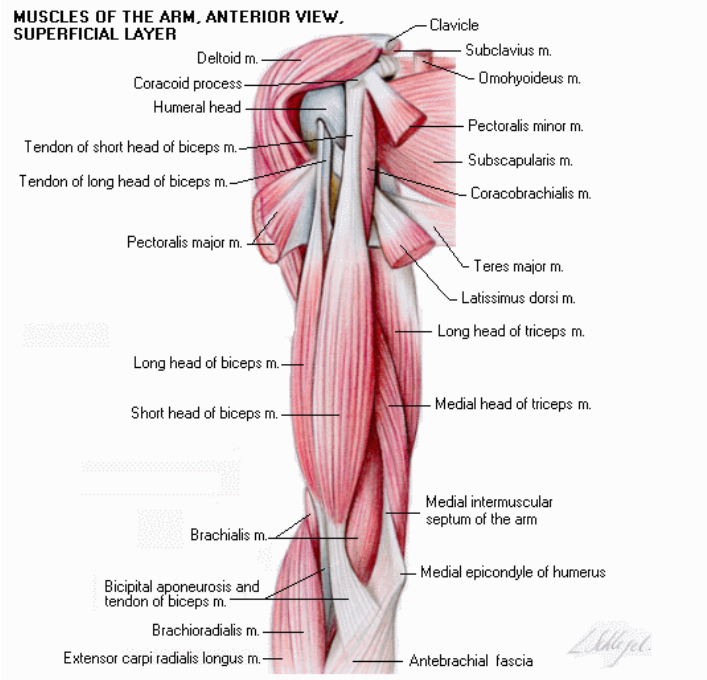
| | **Location and Contents of the Triangles of the Neck** | |
|---|---|---|
| **Triangle** | **Boundaries** | **Contents** |
| Anterior | SCM muscle, medial line of neck, inferior border of mandible | Four lesser triangles, salivary glands, larynx, trachea, thyroid glands, various vessels and nerves. |
| Carotid | SCM, posterior digastric, and omohyoid muscle | Carotid arteries, internal jugular vein, vagus nerv |
| Submandibular (digastric, submaxillary) | Digastric muscle, inferior border of mandible | Salivary glands |
| Submental | Digastric, hyoid bone (only unpaired triangle of neck) | Muslces of the floor of the mouth, salivary glands and ducts |
| Omotracheal | SCM and omohyoid muscles, midline of neck | Larynx, trachea, thyroid gland, carotid sheath |
| Posterior | SCM and trapezius muscles; clavicle | Nerves and vessels |
| Occipital | SCM, trapezius, and omohyoid | Cervical plexus, accessory nerve |

| | | |
|---|---|---|
| | muscles | |
| Omoclavicular (Subclavian) | SCM, and omohyoid muscles, clavicle | Brachial plexus, Subclavian artery |




| Muscle | Origin | Insertion | Nerve Innervation | Action |
|---|---|---|---|---|
| Triceps Brachii | Scapula and humerus | Ulna (olecranon process) | Radial | Extends the forearm |
| Brachialis | Humerus | Ulna (coronoid process | Musculocutaneous | Flexes the forearm |
| Brachioradialis | Humerus | Radius (styloid process) | Radial | Flexes the forearm |
| Biceps Brachii | Scapula (coracoid process and supraglenoid tubercle) | Radius (tuberosity) | Musculocutaneous | Flexes the forearm and arm, supinates the forearm |




- The radial nerve is most commonly injured in a mid-humeral shaft fracture, because it runds in the radial (spiral) groove of the humerus

| | | **Muscle of Mastication** | |
|---|---|---|---|
| **Muscle** | **Origin** | **Insertion** | **Action** |
| Temporalis | Floor of the temporal bone | Coronoid process of mandible | Elevates and retracts mandible |
| Masseter | Zygomatic arch | Lateral ramus of the mandible | Elevates mandible to occlude teeth |
| Medial pterygoid | Lateral pterygoid plate and tuberosity of maxilla | Medial surface of angle of mandible | Elevates mandible and moves mandible laterally |
| Lateral pterygoid | Lateral pterygoid plate and the greater wing of the sphenoid bone | Neck of mandible (condyle) and articular disc | Opens, protrudes, and moves mandible laterally |

- Muscles that close mouth: medial pterygoid, temporalis, and masseter
- Muscles of mastication are innervated by trigeminal nerve (V3)

| | | **Muscles of Tongue** | | |
|---|---|---|---|---|
| **Muscle** | **Origin** | **Insertion** | **Action** | **Innervation** |
| Genioglossus | Superior genial spine of mandible | Dorsum of tongue | Protrudes apex of tongue through mouth | Hypoglossal nerve |
| Styloglossus | Styloid process of temporal bone | Lateral side and dorsum of tongue | Elevates and retracts tongue | |
| Hyoglossus | Hyoid bone | Side of tongue | Depresses side of tongue | |
| Palatoglossus | Palatine aponeurosis | Side of tongue | Pulls roof of tongue upward and backward | Pharyngeal plexus |

- All muscles of tongue (except the palatoglossus muscle—pharyngeal plexus) are innervated by the hypoglossal nerve
- Tongue receives its major blood supply from the lingual artery. Veins drain into the internal jugular vein
- All extrinsic muscles end in →glossus and begin with their site of origin

- Extrinsice muscles of the tongue:
    - Anchor the tongue to the skeleton
    - Control protrusion, retraction, and lateral movements of the tongue
    - Include genioglossus, hyoglossus, styloglossus
- Intrinsic muscles lie entirely within the tongue itself.
    - Named according to spatial plane
    - Longitudinal, transverse, vertical
    - Fibers contract they squeeze, fold, and curl the tongue
- Taste buds:
    - Are associated with peg-like projections on the tongue mucosa called lingual papillae.
    - Contain a cluster of 40 to 60 gustatory cells as well as many more supporting cells
    - Each gustatory cell is innervated by a sensory neuron
    - Kinds of Lingual papilla:
        - Filiform:
            - most numerous, small cones arranged in V shaped rows paralleling the sulcus terminalis on the anterior two thirds of tongue.
            - Characterized by *absence of taste buds* and increased keratinzation
        - Fungiform:
            - knob-like in appearance, they are found on the tip and sides of the tongue.
            - These taste are innervated by the facial nerve VII
        - Circumvallate:
            - largest but fewest in number. Arranged in an inverted V shaped row on the back of tongue.
            - Associated with the ducts of Von Ebner's Glands.
            - Taste buds are inervated by the glossopharyngeal nerve IX
        - Foliate:
            - found on lateral margins as 3-4 vertical folds.
            - These taste buds are innervated by both the facial nerve and the glosspharyngeal nerve
            - They are rudimentary or vestidule in humans

**Longitudinal Muscles of the Pharynx**

| Muscle | Origin | Insertion | Action |
|---|---|---|---|
| Stylopharyngeus (glossopharyngeal nerve) | Styloid process | Thyroid cartilage and muscles of pharynx | Elevates pharynx and larynx |
| Palatopharyngeus (pharyngeal plexus: vegus) | Hard palate; aponeurosis of soft palate | Thyroid cartilage and muscles of pharynx | Elevates pharynx |
| Salpingopharyngeus (pharyngeal plexus: vegus) | Cartilage of auditory tube | Muscles of pharynx | Elevates nasopharynx, opens auditory tube |

- Stylopharyngues is innervated by the glossopharyngeal nerve
- All other longitudinal muscles are innervated by the vagus nerve via the pharyngeal plexus
- Stylopharyngeous, palatopharyngeus and salpingopharyngeus are all considered to be longitudinal muscles of the pharynx

**Circular Muscles of the Pharynx**

| Muscle | Origin | Insertion | Action |
|---|---|---|---|
| Superior constrictor | Medial pterygoid plate, pterygoid hamulus, pterygoimandibular raphe; mylohyoid line of mandible, side of tongue | Median raphe and pharyngeal tubercle of skull | Constricts upper pharynx |
| Middle constrictor | Greater and lesser horns of | Median raphe | Constricts lower pharynx |

| | | | |
|---|---|---|---|
| | hyoid; stylohyoid ligament | | |
| Inferior constrictor | Arch of cricoid and oblique line of thyroid cartilages | Median raphe of pharynx | Constricts lower pharynx |

- All circular muscles are innervated by the vagus nerve via the pharyngeal plexus
- Masseter and medial pterygoid form sling around angle of the mandible.
    - The superificial head of the masseter inserts on the external (lateral) surface of the angle and the medial pterygoid inserts on the internal (medial) surface of the angle.
    - Both of these muscles exert similar forces upon the mandible. They are the primary closing muscles and provide *lateral stabilization of the mandible*
- Medial pterygoid muscle arises from the medial surface of the lateral pterygoid plate and the lateral pterygoid muscle arises from the lateral surface of the lateral pterygoid plate
- Soft palate:
    - Uvula is suspended from the soft palate.
    - Is attached infero-laterlaly to the tongue by the glossopalatine archs and is connected to the lateal wall of the pharynx by the pharyngopalatine arches.
    - Palatal salivary glands found beneath the mucous membrane of the hard and soft palate. Mostly mucous
- Bifid uvula:
    - results from failure of complete fusion of the palatine shelves.
    - A unilaterally damaged pharyngeal plexus of nerves causes the uvula to deviate *to the opposite side*.
        - This is because uvular muscle shortens the uvula when it contracts and the muscle on the intact side pulls the uvula toward that side.
- Mastication muscles grouped into two areas:
    - Elevate the mandible to close the mouth = master, temporalis, medial pterygoid
    - Works to depress the mandible, translate the jaw from side to side and protrude the mandible forward = lateral pterygoid
    - All receive blood supply from pterygoid portion of the maxillary artery, V3 for nerve
- Buccinator muscle:
    - Innervated by the facial nerve:
    - Origin:
        - Maxilla:
        - Mandible
        - Pterygomaxillary ligament
        - Pterygomandibular raphe: a thin, fibrous band running from the hamulus of the medial pterygoid plate down to the mandible
    - Inserts: orbiuclaris oris and skin at the angle of the mouth. It is tranversed by the parotid duct
    - Does not move jaw
    - Proprioceptive fibers are derived from the buccal branch of V3
    - Actions:
        - Move boluses of food out of vestibule of mouth and back towards molar teeth
        - Tense the cheeks during blowing and whistling
        - Assist with closure of mouth
    - Facial and maxillary arteries supply blood
- Damage to the facial nerve or its branches may cause weakness or paralysis of facial muscles called Bell's Palsy
- Temporalis muscle:
    - It is fan-shaped and originates from the bony floor of the temporal fossa and from the deep surface of the temporal fascia
    - The anterior and superior fibers elevate the mandible, the posterior fibers retract the mandible
    - Inserts on the coronoid process of the mandible and the anterior border of the ramus of the mandible
    - Innervated by V3
    - Is a muscle of mastication

    - Passes medially (downward and deep) to the zygomatic ach as a thick tendon before inserting
    - Posterior fibers retract the jaw and also maintain the resting position of closure of the mouth
- All muscles of soft palate are innervated by CN IX, CN X except the tensor veli palate muscle which is innervated by the *nerve to the medial pterygoid*, a branch of V3
- Five paired skeletal muscles of the soft palate:
    - Palatoglossus: closes the oropharyngeal isthmus
    - Palatopharyngesu: elevates the pharynx
    - Levator veli palate: elevates the palate during swallowing and yawning
    - Tensor veli plati: tenses the palate and opens the mouth of the auditory tube during swallowing and yawning. Curves around the pterygoid hamulus. If hamulus was fractured the actions of this muscle would be affected
    - Uvular: raises (and shortens) the uvula to help seal oral from nasal pharynx
- Anterior zone of the palatal submucosa contains fat, while the posterior zone contains mucous glands
- Diaphragm:
    - Muscle responsible for quiet breathing.
    - Is a flat muscle in a dome-like shape that separates your chest cavity from your abdominal cavity
    - Exhaling is done by contracting he muscles of the abdoment to force the diaphragm upward when it is relaxed
    - Esophagus passes through the diaphragm, while the aorta, azygos vein, the thoracic duct pass posterior to it.
    - Phrenic nerve travels through the thorax between the pericardium and the pleura
    - Has three openings:
        - Aoritc opening: transmits the aorta, the thoracic duct, and the azygos vein
        - Esophageal opening: transmits the esophagus and the right and left vagus nerves
        - Caval opening: transmits the IVC and the right phrenic nerve
- Respiratory muscles include:
    - the internal and external intercostals, subcostals, and transverses thorasic
    - These muscles are all inervated by the intercostal nerve while the diaphragm is innervated by the phrenic
- Intenal muscles of thorax involved in breathing: Respiratory muscles:
    - External intercostal:
        - pass from rib to rib and run at right angles to the fibers of the intenal and innermost muscles.
        - Continue toward sternum as the anterior intercostal membrane
    - Internal intercostal muscles:
        - eleven on each side between the ribs.
        - Continue toward the vertebral column as the posterior intercostal membrane.
        - they assist in drawing ribs together or by elevating or depressing the rib cage
    - Innermost intercostals:
        - run is same direction as internal intercostals but are separated from them by nerves and vessels
- Boundaries of the axilla:
    - Medial wall: upper four or five ribs and their intercostal muscles and the serratus anterior muscle
    - Lateral wall: humerus (specifically the coracobrachialis and bicep muscles in the biciptial groove)
    - Posterior wall: subscapularis, teres major, and latissimus dorsi muscles
    - Anterior wall: pectoris major, minor, and subclavius muscles
    - Base: axillary fascia or skin
- Contents of the axilla
    - The axillary vessels
    - Branches of the brachial plexus
    - Both heads of the biceps brachii
    - coracobrachialis

- Palatine tonsils: consists of predominatly lymphoid tissue, found between the two arches in an area referred to as the *isthmus of the fauces*,
- Within the glossopalatine arch is the palatoglossus muscel that elevates the tongue and narrows the isthmus of fauces
- Within the pharyngopalatine arch is the palatopharyngues muscle that *elevates* the pharynx, helps shut the naso pharynx, *narrows* the isthmuse of the fauces, and *aids in swallowing*
- During inferior alveolar nerve block injection, the needle passes through the mucous membrane and the buccinator muscle and lies lateral to the medial pterygoid
    - If needle passes posteriorly at level of mandibular foramen→penetrate parotid and have facial paralysis.
    - If needle tip passes well below the foramen, you will penetrate the medial pterygoid
- Damage to the articular disc of the TMJ would result in paralysis of the lateral pterygoid muscle, which inserts on the articular disc of the TMJ, the joint capsule, and neck of the mandible. The patient would be unable to open his/hermouth
- Condylar fracture or injury to lateral pterygoid will result in deviation toward affected sie

**Miscellaneous**

- Extracellualr fluid (Na-142; K-4) vs intracellular (Na-10 K-140)
- Fluid: 50 – 60% of body weight
    - Intracellular fluid (within cells) → 35 – 40% body weight
    - Extracellular fluid (outside the cells) →15 – 20% of body weight
        - Blood plasma: 4-5% body weight
        - Interstitial fluid: 11 – 15% boby weight
            - Transcellular fluid: cerebrospinal, intraocular, synovial, pericardial, pleural, peritoneal fluids
- Tissue fluid (also called interstitial fluid) contains a small percentage of plasma proteins of low molecular weight that pass through the capillary walls as a consequence of hydrostatic pressure of blood. This fluid bathes the cells
- Retroperitoniea:
    - Organs do not have mesenterie.
    - Structures on posterior abdominal wall are retroperi
    - ascending, descending colon, kidney, and pancreas, suprarenal gland, IFC and abdominal aorta
- Intraperitoneal structures:
    - Usually have a mesentery or peritoneal (ligament)
    - Include: stomach, jejunum, ileum, appendix, transvers colon, sigmoid colon, ileum, spleen, liver, and gallbladder
- Peritoneum: shingle sheet of simple squamous mesothelium that lines the abdominopelvic cavity and covers the abdominal and pelvic organs.
    - Portion on the cavity wall is called the *parietal layer*
    - Part on the organs is called the *visceral layer*
    - Some of the organs are suspended from the body wall by a double fold of pertoneu called mesentery.
    - Rotaion of the gut in the embryo moves some organs to locations behind the parietal peritoneu,
    - Others develop behind the peritoneum. These organs are retroperitoneal:
- Listing the parts of the large intestine in order results in positions that alternate between retroperitoneal and intraperitoneal: ascending colon→retro; transvers→intraperitoneal; descending→retro; sigmoid→intra; rectum→retro (ileum refersto to a part of hip bone)
- Middle ear communicates posteriorly with the mastoid air cells and the mastoid antrum through the aditus and antrum
- Eustachian tube serves to equalize air pressures in the tympanic cavity and the nasopharynx

- Ear consist of:
    - External ear: auricle and the external auditory canal. Receives sound waves
    - Middle ear (tympanic cavity)→contains three small bones or ossicles, the malleus (hammer) stapes (stirrup) and incus (anvil) Also contains two muscles: the stapedius muscle, which is the smallest skeletal muscle in the body, and the tensor tympani muscle
    - Inner ear: consists of the acoustic apparatus, the vestibular apparatus, and the semicircular canals. It is composed of the body and membranous labyrinth
- Middle ear infections (otitis media) are quite prevalent and may become extensive due to connection to both the mastoid air cells and the nasopharynx by way of Eustachian tube
- Principle body cavities:
    - Posterior (dorsal)
        - Cranial cavity: contains brain
        - Spinal cavity: contains spinal cord. Two cavities communicate through the foramen magnum. These cavities are lined by meninges.
    - Anterior (ventral) cavity
        - Thoracic cavity
            - Pericardial cavity: surrounds heart
            - Pleural cavity (righ and left) each surrounds a lung
            - The portion between the two pleural cavities is called the mediastinum (the hear and pericardial cavity are located here
        - Abdominal cavity:
            - Abdominal cavity: contains the stomach, spleen, liver, gallbladder, pancreas, and small and large intestines
            - Pelvic cavity: contains the rectum and urinary bladder. In the male—the paried ductus deferens and seminal vesicle and the unpaired prostate. In the female the paired ovaries and the unpaired uterus
- Superior mediastinum:
    - Aortic arch with its branches, right and left brachiocephalic veins, upper half of the SVC, trachea, esophagus, thoracic duct, thymus, the phrneic nerve, vagus nerve, cardiac nerve, and lerft recurrent laryngeal nerve
- Inferior mediastinum:
    - Anterior mediastinum: part of the thymus gland, some lymph nodes, branches of the internal thoracic artery
    - Middle: pericardium and heart, the phrenic nerve and its accompanying vessels
    - Posterior: descending (thoracic aorta, thoracic duct, esophagus, azygos system of veins, vagus nerves, splancnice nerves, and many lymph nodes

## Urinary System

- Nephron:
    - subunit of kidney that purifies blood and maintains a safe balance of solutes in water.
    - The functional unit of the human excretory system.
    - Over 1 million nephrons per kidney.
    - Made up of a reanl corpuscle plus several regions of tubules
        - Renal corpuscle: consist of a glomerulus (network of parallel capillaries) and a double walled cup, the Bowman's capsule which surrounds the glomerulus. The renal corpuscle is the site of filtration, the passage of plasma substances for the glomerulus into the Bowman's capsule
        - The tubular portion: proximal convoluted tubule in cortex, Loop of Henle in medulla. Distal convoluted tubule in cortex. Collecting duct in medulla
- Ureters pass urine from kidney to bladder. They are long, slender, muscular tubes that transport urine from the pelvis of the kidney to the base of the urinary bladd

- Urethra: fibro muscular tube that carries urine from the urinary bladder to outside the body.
- Urinary bladder is a distensible sac that is situatied in the pelvic cavity posterior to the symphysis pubis. It is slightly lower in the female than in the male. It concentrates and serves as a reservoir for urine.
- Urine:
    - Adults pass about a quart and a half of urine each day,
    - Volume of urine formed as night is about half that formed during daytime
    - Normal urine is steril. Contains fluids, salts, and waste products, but is free of bacteria, viruses and fungi
    - The tissue of the bladder are isolated from urine and toxic substances by a coating that discourages bacterial from attaching and growing on the bladder wall
- Urinary system removes nitrogenous waste as urea from blood
- Urinary system is lined with transitional epi
- Genital and urinary systems are supplied with PS fibers from the pelvic splanchnic nerve
- Kidneys, ureters, and urinary bladder are all located retroperitioneally, they are behind the peritoneum, which is a serous membrane lining the walls of the abdominal and pelvic cavities and enclosing the viscera.
- Kidney:
    - Located retroperitoneally, the right kidney lie slightly lower than the left kidney due to the large size of the right lobe of the liver
    - Surrounded by a fibrous renal capsule and is supported by the adipose capsule
    - Medulla is composed of renal pyramids separated by renal columns
    - Each kidney has an indentation, the hilum, on its medial border through which the ureters, renal vessels, and nerves enter or leave.
    - Each kidney receives blood from renal artery, a branch of the aorta
    - Each kidney is divided into an outer dark-brown renal cortex and an inner light brown renal medulla
- Internal features of kidnes:
    - Cortex: outer layer (glomeruli are located here)
    - Medulla (inner layer, consists of renal pyramids)
    - Renal columns: found between pyramids. Cortical tissue
    - Renal papilla: apex of pyramids, here the collecting ducts pour into minor calyces
    - Minor calyces: unit to form major calyces, which then unit to form renal pelvis

## Tooth Histology

- Dental sac will form the inner cells of cementoblasts, PDL and alveolar bone proper.
- Dental papilla:
    - Peripheral cells of dental papilla differentiate into odontoblasts which produce predentin that calcifies and becomes dentin.
    - Center of dental papilla will become dental pulp
- Cells from the inner enamel epithelium of enamel organ differentiate into ameloblasts which produce enamel
- Inner and outer enamel epithelia of enamel organ come together in the neck region and form Hertwig's erpithelial rooth sheath
- First sign of tooth development seen in histological sections occurs in the sixth week in utero.
    - Tooth development appears to be initiated by the mesenchyme's inductive influence on the overlying ectoderm
    - In sixth week there is a thickening of the oral epithelium (derivative of the surface ectoderm). These thickenings or U shaped bands are called the dental lamina and follow the curve of the primitive jaws
    - At certain point on dental lamina, the ectodermal cells proliferate and produce swellings which become the enamel organ. Inside the depression of the enamel organ an area of condensed mesnchym becomes the dental papilla.

    - Surrounding both the enamel organ and dental papilla is a capsule-like structure of mesenchym called the dental sac
- Enamel organ separates from the dental lamina AFTER the layer of dentin is deposited
- Each tooth is the product of two tissues that interact during tooth development, the oral epithelium and the underlying ectomesenchyme. The epithelium grows down into the underlying ectomesenchyme and forms small areas of condenseded mesenchyme, which become tooth germs
- Attached epithelium is derived from the reduced enamel epithelium
    - After enamel formation is completed, all of the structures of the enamel organ (inner and outer enamel epithelium, stratum intermedium, and stellate reticulum) become one and form the reduced enamel epithelium.
    - This is important in the formation of the dentogingival junction, which is an area where the enamel and oral epithelium come together as the tooth erupts into the mouth
    - This forms the initial junctional epithelium (epithelial attachment), which later migrates down the tooth to assume its normal position.
- Epithelial attachment joins the gingival to the tooth
- Hetwigs epithelial rooth sheath is formed by the joining of the inner and outer enamel epithelium
    - After crown formation the root sheath grows down and shapes the root of the tooth and induces formation of root dentin
    - Uniform growth of this sheath will result in the formation of a single rooted tooth,
    - Medial outgrowths or evaginations of this sheath will produce multi-rooted teeth
- Epithelial rests of Malassez are remnants of Hertwig's epithelial rooth sheath
    - Can be found as groups of epi cells in the PDL
    - Some degenerate and other become calcified
- Continuity of Hertwig's epithelial rooth sheath must be broken in order for cementum to be deposited during tooth development
- Hertwig's epithelial root sheath is characterized by:
    - The formation of cell rests (rests of Malassez) in the PDL when the sheaths functions have been accomplished
    - The absence of stellate reticulum and a stratum intermedium
- Cementogenesis:
    - After first root dentin is deposited, the cervical portion of Herwigs epithelial rooth sheath breaks down and this new dentin comes in contact with the dental sac.
    - This communication stimulates cells to differentiate into cementoblasts which produce cementum.
- Accessory root canals are formed by a break or perforation in the rooth sheath BEFORE the root dentin is deposited
- Histogenesis of tooth:
    - Elongation of inner enamel epithelial cells of the enamel organ; this influences mesenchymal cells on the periphery of the dental papill to differntiate
    - Differentiation of odontoblasts
    - Deposition of the first layer of dentin
    - Deposition of the first layer of enamel
- Tooth development is dependent on a series of sequential cellular interactions between epithelial and mesenchymal components of the tooth germ. Once the ectomesenchyme influnces the oral epithelium to grow down into the ectomesenchym and become a tooth germ, the above events occur
- Some texts include deposition of root dentin and cementum as #5
- Korff's fibers is the name given to the rop-like grouping of fibers in theperiphery of the pulp that seem to have something to do with the formation of dentin matrix
- Histogenesis = formation and development of the tissues of the body.
- Distinct layers of enamel organ:
    - Outer enamel epithelium (OEE): outher cellular layer of the enamel organ (very thin) it outlines the shape of the future developing enamel organ.

    - Inner enamel epithelium (IEE): innermost cellular layer of the enamel organ (very thin) The cells in this layer will become ameloblasts and produce enamel. This layer is essential for the initiation of dentin formation once enamel is formed
    - Stratum intermedium: this area lies immediately lateral to the inner enamel epithelium (thicker than both the OEE and IEE). This layer seems to be essential to enamel formation (prepares nutrients for the ameloblasts of the IEE)
    - Stellage reticulum: this area is the central core and fills the bulk of the enamel organ. It contains a lot of intercellular fluid (mucous type fluid rich in albumin) which is lost just prior to enaml deposition
- Final shaping of the tooth occurs in the differentiation (Bell stage)
- Initial (Bud Stage): initial interaction between oral epithelium and mesenchym (ectomesenchym), formation of dental lamina. Congenital absence of teeth results from an interruption in this phase
- Proliferation (cap stage): shape of tooth becomes evident, enamel organ is formed
- Differentiation (Bell Stage): final shaping of tooth, cells differentiate into specific tissue forming cells (ameloblasts, odontoglasts, cementoblasts, and fibroblasts) in emanel organ. Histodifferentiation and mophodifferentiation occur durin this stage
- Apposition: cells that were differentiated into specific tissue forming cells being to deposit the specific dental tissue
- Calcification: mineralization
- Eruption
- Attrition
- Fused or geminated teeth occur during initiation and proliferation stages of tooth development
- Dentinogenesis imperfecta and amelogenesis imperfecta occur during histodifferntiation
- Dentin of root distinguished readily from dentin in crown by presence of Tomes Granular layer
    - Odontoblasts form this layer by producing an organic matrix
    - Found in the radicular dentin and lies just beneath the cementum
    - Interglobular dentin differs from Tomes granular layer in that interglobular dentin usually occurs a short distance inside the DEJ and represents uncalcified areas
- Dental sac, which is formed from mesenchyme, is derived from neural crest cells. It surrounds the developing tooth germ and will give rise to cementum, the PDL, and the alveolar bone proper.

## TEMPOROMANDIBULAR JOINT

- Magnetic resonance imaging (MRI): Best imaging modality for identifying the position of the articular disc of the TMJ
    - Gold standard for soft tissue, especially th position of the articular disc
    - MRI utilized magnetic field to alter the energy levels of primarily the water molecules of the soft tissue which results in good visualization of the different soft tissues, including articular disc
    - Major advantage of MRI is that there is no exposure of x-ray radiation to patient. No harmful effects have been demonstrated
- Panoramic, CAT, and lateral trnascranial radiographs: used to evaluate the bony structures of the TMJ
- Click: best describes the type of sound associated with a disc displacement with reduction of the articular disc of TMJ
- Crepitation sound: (crepitus) usually associated with a degenerative process (osteoarthritis) of condyl,
- Dull thud is usually assocated with self-reducing subluxation of the condyle
- Tinnitus: ear ringing
- Anteromedial: most common direction in which the articular disc in the TMJ can be displaced
    - A click sound is usually demonstrated when this happends

    - Articular disc seated on condyle and held in place by the collateral ligaments that are attached to the medial and lateral poles of the condyles.
    - Attached to the anterior portion of the articular disc are muscle fibers from the lateral pterygoid muscle
- *Temporomandibular ligament* is the only ligament that *gives direct support* to the capsule of the TMJ
    - Also called the lateral ligament
    - Runs from the articular eminence to the mandibular condyle. It provides lateral reinforcements for the capsule.
    - Prevents posterior and inferior displacement of the condyle
- Sphenomandibular and stylomandibular ligaments are considered accessory ligaments responsible for eht limitation of mandibular movment
- Sphenomandibular ligagment is attached ot the lingual of the mandible
- The stylomandibular ligament is attached at the angle of the mandible.
- Important points about TMJ:
    - It is a diarthrodial joint that has a fibrous connective tissue (fibrocartilage) on its articular surfaces
    - Joint cavity is lined by a synovial membrane and enclosed by a fibrous capsule
    - It is divided into two compartments by an articular disk
- Lateral pterygoid muscle: both heads insert into the
    - Neck of the mandibular condyle
    - Into the capsule and articular disc of the TMJ
- *Articular capsule* sournds the joint:
    - Attached above to the articular eminence (tubercle)
    - Attached at margins of the mandibular fossa nad below the neck of the mandible
    - *Synovial membrane* lines the capsule in the superior and inferior spaces of the joint, it *does not cover* the articular surfaces of articular discs
- Best way to palpate the posterior aspect of the mandibular condyle is through the external auditory meatus
- TMJ should be evaluated for tenderness and noise. The joint is palpated laterally (in front of the external auditory meatus) with the mandible in closed and open position. The joint should also be palpated posteriorly through the external auditory meatus with the mandible in closed and open position
- Tenderness and sensitivity:
    - should be noted as well as joint noises.
    - The mandibular range of motion should also be determined.
    - Normal range of movment of an adults mandible is about 50 mm openins and 10 mm potrusively and laterally
- Posteior aspect of the condyle is rounded and convex, whereas the anterioinferior is concave
- TMJ can only be dislocated anteriorly
- Dislocation (luxation) may occur with one or both condyles. RElaxionat of the supporting gligaments will occasionally allow condy to extend anteriorly beyond normal open position. May be manifested by true luxation that requires assistance for reduction, or it may be merely an overextended excursion anteriorly that is self-reducing
- Reduction of the dislocation is done by standing behind pt with thumbs inside mouth and the index fingers below chin. Thumbs depress the back of the jaw, and the chin is elevated by the index fingers. The head of the condyl of the mandible will then slide back into the articular fossa
- Articular disc (meniscus)
    - Consists of fibrocartilagenous tissue, which resembles dense, irregular connective tissue. It is capable of providing smooth articulating surface
    - Meniscus is a biconcave oval plate and divides the joint into superior and inferior spaces. The superior joint space is bounded by the articular fossa and the articular eminence. The inferior joint space is bounded below by the condyle
        - Meniscus varies in thickness, the thinner, central intermedia zone separate the thicker portions called the anterior and posterior bands.

        - Posteriorly the meniscus is continguous with the posterior attachment tissues called the bilaminar zone which is vascular, innervated tissue that plays an important role in allowing the condyle to move forward
- Nonarticular surfaces of the TMJ are covered with periosteum:

## Tooth

- Cementum:
    - Slightly softer and lighter in color (yellow) than dentin
    - It is formed by cementoblasts from the PDL, as opposed to denitn which is formed from odontoblasts of the pulp.
    - Most closely resembles bone (more so than dentin) except there are no haversian systems or blood vessles→it is avascular
    - It is 50% inorganic *hydroxyapatite, 40% organic and 10% water
    - Organic portion is primarily compsed of collagen and protein
    - Has no nerve innervation
    - Important in orthodontics. It is more resistant to resorption than alveolar bone, permitting orthodontic movement of teeth without root resortpoin
- Two types of cementum→functionally there is no difference
    - Acellular: contains no cells usually predominates in the coronal two-thirds of the root. Thinnest at the CEJ
    - Cellular: contains cementoblasts, inactive cementocytes, fibroblasts from the PDL, and cementoclasts. It occurs more frequently on the apic third of the rooth. It is usually the thickest to compensate for attritional wear of the occlusal/incisal surface and passive eruption of the tooth.
- Mantle dentin is the peripheral portion of the dentin adjacent to the enamel (DEJ) or cementum (CEJ), consisting mostly of course fibers (Korff's fibers). The remaining is called circumpulpan denitn
- Other types of Dentin:
    - Peritubular: lines each denital tubule. It is more mineralized than intertubualr dentin (has greater content of inorganic salts
    - Intertubular dentin: surrounds the peritubular dentin, less inearlized (has lower content of inorganic salts)
    - Interglobular dentin: imperfectly calcified matrix of denitn situated between the calcified globules near the periphery of the dentin
- Each dentinal tubule contains the cytoplasmic cells (Tomes fiber) of an odontoblast
- Dead tracts: groups of dead, coagulated cytoplasmic processes of the dentinal tubules. These tracts have also been attributed to aging, caries, erosion, cavity prep, or odontoblastic crowding
- Morphology of DEJ determined at the bell stage
- Purposes of Dentin:
    - Form dentin
    - Nutritive—keeps organic components of the surround mineralized tissue supplied with moisture and nutrients
    - Sensory: extremes in temperature, pressure, or trauma to the dentin or pulp are perceived as pain
    - Protective: formation of reaparative or secondary dentin
- Pulp capping is more successful in young teeth because:
    - Apical foramen of a young pulp is larg
    - Contains more cells
    - Is very vascular
    - Has less fibrous elements
    - More tissue fluid
    - Does lack collateral circulation

- Main function of cementum is to provide rough surface for attachment of Sharpey's fibers. Others include:
    - Compensate for the loss of tooth surface due to occlusal wear by apical deposition of cementum throughout life
    - Protects the root surface from resorption during vertical eruption and tooth movement
    - Reparative function, allows reattachment of CT following periodontal treatment
- Cementum is different than enamel:
    - Has **collagen fibers**
    - Has cellular components in mature tissue
- Cementoid: is the peripheral layer of developing cementum that is uncalcified

| | | **Comparison of tooth Tissues** | | |
|---|---|---|---|---|
| | **Enamel** | **Dentin** | **Cementum** | **Pulp** |
| **Mineral content** | 96% | 70% | 50% | Non, except denticles or pulp stones |
| **Color** | Translucent yellow | Light yellow | Light yellow | Blood red |
| **Formative cell** | Ameloblasts | Odontoblasts | Cementoblast | Dental papilla |
| **Embryology** | Epithelial | Ectomesenchym | Echomesenchym | Ectomesechyme |
| **Repair** | No replacement, some reminerilazation | Physiologically, reparative secondary dentin | New cementum desposition | Can recover if mild inflammation. But severe→death |
| **Aging** | Wear, staining, dental caries | Increase in secondary and sclerotic dentin | Increasd amount with age (apex) | Reduces size and may be obliterated |
| **Sensitivity** | None | Yes, only as pain | No | Yes |
| **Cells in mature tissue** | None | Cytoplasmic extensions from the odontoblasts | Cementocytes | Odontoblasts and other types |

- Age changes in pulp:
    - Decrease:
        - Intercellular substance, water, and cells
        - Size of pulp cavity due to secondary or tertiary dentin
        - Number of reticulin fibers
    - Increase:
        - Number of collage fibers
        - Calcifications within pulp
- Denticals:
    - True: complete with tubule and processes
    - False: amorphous in structure
    - Free: unattached to outer pulpal wall
    - Attached: attached at dentin-pulp interface
- Cementicels are calcified bodies that are sometimes found lying free within the PDL or fused with the cementum of the tooth
- Enamel:
    - Hardest tissue in body,
    - Richest in calcium
    - Highly mineralized totally acellular
    - 96% inorganic minerals of calcium and phosphorous as hydroxyapatite
    - 1% organic material (protein which is rich in praline), 3% water

    - ectodermal origin.
- Enamel rod or prism: fundamental morphologic unit of enamel
    - Bound together by an interprismatic substance (interred substance.)
    - Each is formed in increments by a single enamel forming cell, the ameloblast
    - Rods begin at DEJ and extend to outer surface
    - 5 to 12 million rods per crown.
    - Rods increase in diameter (4 up to 8 microsn) as they flare outward from DEJ
    - *Oldest enamel in a fully erupted tooth is located at DEJ underlying a cusp or cingulum*
    - Is a good thermal insulator
    - Organic matrix decreases as tooth matures and inorganic increases (fluoride and zinc are minor constituents)
    - Optically clear due to high inorganic content
    - Extremely brittle: can endure crushing pressure of approximately 100,000 pounds per square inch
    - Coupled with dentin has cushioning property
    - Semitransluscent an is yellow to grayish white.
    - Selectively permeamble membrane allowing water and certain ions to pass via osmosis
- Hunter-Shreger bands: refers to the alternating light and dark lines seen in dental enamel that begin at the DEJ and end before they reach the enamel surface. They represent areas of enamel rods cut in cross-section dispersed between areas of rods cut longitudinally
- Lines of Retzius:
    - artifacts in enamel created by incremental steps of ameloblasts
    - have increased organic content and are indicative of the rhythmic variation in the calcification of the enamel matrix.
    - They follow the appositional growth pattern
- Perikymata: where lines of Retzius terminate on the surface of tooth making small valley traveling circumferentially around tooth.
- Neonatoal line:
    - marks the division between enamel formed before birth and that formed after→
    - found in decidous and cusps of permanent first molars
    - most accentuated line of Retzius
- Enamel tufts: fan shaped, hpocalcified structures of enamel rods that proect from the dentinoenaml junction into the enamel proper (unknown function)
- Enamel spindles: elongated odontoblastic processes (hair like) that traverse ht DEJ from the underlying odontoblasts. May sere as pain receptors
- Enamel lamellae: defects in the enamel resembling cracks or fractures which traverse the entire length of crown from surface ot DEJ. Contain mostly organic material and may provie an area for decay (bacteria) to enter
- Incremental lines of von Ebner (sometimes called the contour lines of Owen):
    - Lines in dentin that correspond to the lines of Retzius in enamel
    - Also have a neonatal line which marks the transition between dentin formed before and after birth
- Imbrications Lines of Pickerill: depression or grooves formed when growth rings (lines of Retzius) are incomplete at the enamel surface
- Dentin is much softer than enamel but harder than bone. It is more flexible (lower modulus of elasticity) than enamel. Its compressive strength is much higher than its tensile strength
- During active tooth eruption there is apposition of bone on all surfaces of the alveolar crest and on all walls of the bony socket.
- Permanent teeth move occlusally and buccally when erupting
- Apical abscesses of mandibular second and third molars have a marked tendency to produce cervical spread of infection most rapidly
    - Attachment of muscles may determine the route that an infection will take, channeling the infection into certain tissue spaces

    - Infections perforate below the buccinator: swelling of the lower half of the face→ infection will spread medially from the mandible into the submandibular and masticatory spaces. It will push the tongue forward and upward. Further spread cervically may involve the visceral space and lead to edema of the vocal cords and airway obstruction
    - Of maxillary teeth—perforate the bone above the buccinator attachment will cause swelling of the upper half of the face (which will eventually spread to the entire face)
    - Lingual spread from infected mandibular bicuspids or molar teeth is inot the floor of mouth when perforation is above the level of attachment of the mylohyoid muscle. Below the mylohyoid, it would drain into the submaxillary space
- Alveolar process consists of:
    - Alveolare bone proper: part of alveolar process which immediately surrounds root of tooth to which the fibers of PDL are attached. Has minute openings which provide passage for vascular nerve components Also called cribriform plate or lamina dura. Consists of:
        - Compact lamellar bone
        - Layer of bundle bone
    - Supporting alveolar bone: bone that surrounds the alveolar bone proper and gives support to the socket. Consists of:
        - Cortical plate (compact lamellar bone) forms outer and inner plates of the alveolar processes. It is thicker in the mandible than in the maxilla
        - Spongy bone (cancellated bone): fills in area between cortical plates of bone. this type of bone is not present in the anterior region of the mouth –here the cortical plate is fused to the cribriform plat. This is alos true over the radicular buccal bone of the maxillary posteriors
- Alveolar bone proper is the only essential part of the bone socket. Supporting alveolar bone is not always present
- Nasmyth's membrane = Primary enamel cuticle: delicate membrane covering the crown of a newly erupted tooth
    - Produced by the ameloblast cell after it produces enamel rods
    - Worn away by mastication and cleaning
    - Replaced by an organic deposit called the pellicle, which is formed by salivary glycoproteins
        - This pellicle is invaded by bacteria to form bacterial plque which will cause caries
- Resting lines in cortical bone of mandible are caused by growth of the mandible by appositional growth
    - Deposition of successive layers of bone on those already present
    - Bone can only grow by appositional growth.
    - However, cartilage can grow by both apposition and interstitial growth
- Tomes' Fibers: long slender, cytoplasmic extension arising from each odontoblast
    - Occupy the dentinal tubules
    - Dentin sensitivity is mediated by these fibres
    - Because of these fibers odontoblasts are considered living tissue
- Dentinal tubules are s-shaped in the crown due to overcrowding of the odontoblasts
- Ameloblasts have short extensions towards the denitnoenamel junction DEJ called Tomes' process. They aer in their secretory stage
- Reparative denitn is formed very rapidly in response to irritants such as attrition, abraosion, erosin, moderately advancing dental caries, trauma
- Sclerotic dentin: results from agin and slowly advancing dental caries. The denitn tubules become calcified and obliterated, which blocks access of irritants to the pulp by way of tubules
- Primary dentin: dentin forming the initial shape of the tooth. Deposited before completion of the apical foraemn
- Secondary dentin: formed after completion of the apical foramen. Formed at a slower rate than primary dentin as functional stresses are placed on a tooth. Secondary dentin is a regular and somewhat uniform layer of dentin around the pulp cavity
- Junction between primary and secondary dentin is characterized by sharp change in directions

**Periodontal Ligaments**

- *Dentojunctional epithelium*: gingival epi that faces the tooth and composed of nonkeratinized stratified squamous epithelium divided into :
    - *Sulcular epithelium*: lines the sulcus; it connects directly with the junctional epithelium
    - *Junctional epithelium*:
        - *begins at the base of the sulcus*;
        - it is a collar-like band of stratified squamous epithelium that is firmly attached to the tooth by Hemidesmosomes.
        - At its beginning it is approximately 15 – 30 cell layers thick and at its apical end it is only a few cell layers thick.
        - The junctional epithelium consists of two layers:
            - *Basal*
            - *Suprabasl layer*
- *In ideal gingival health*: the junctional epithelium is located entirely on enamel above the cementoenamel junction
- *Epithelial attachment*: inner layer of cells (specifically the basal lamina and hemidesomosomes) of the junctional epithelium that forms the actual attachment to the tooth surface
- Histologically, best way to distinguish the free gingival from the epithelial attachment is the fact that the epithelium of the epithelial attachment does not contain rete pegs and the free gingival does.
- CT projections that extent into the overlying epi are called connective tissue papillae
- Specialized mucosa covers dorsum of tongue and taste buds and is nonkeratinized
- Masticatory mucosa—all are keratinized, under tissue is lamina propria, a dense thick, firm CT containing collagen
    - composed of free gingival,
    - attached gingiva,
    - interdental gingival, and
    - mucosa of hard palate.
- Lining or reflective mucosa—lining mucosa is thin, movable, nonkeratinized and thin lamina propria:
    - covers lips,
    - cheek,
    - vestibule,
    - lateral surfaces of alveolar process,
    - floor of mouth,
    - soft palate, and
    - inferior surface of tongue.
- Crevicular epi and gingival col are nonkeratinized with **no rete peges**
- Rete pegs in gingival sulcus indicates inflammation inflammation,
- Mucogingival junction where lining of masticatory and lining mucosa meet.
- Gingival fibers area collagen fibers that provide support for the marginal gingival including the interdental papilla
- Even though gingival fibers are found in the free gingival, they are continuous with the CT fibers of the PDL and are often considered to be part of the ligament
- Gingiva fibers are found within the free gingival:
    - Are collagen fibers (CT) that support the gingival and attaché it to the tooth and alveolar bone
    - Continuous with PDL
    - PDL also considered to be CT, it surrounds the root and connect it with the alveolar bone by its principal fibers (also callegenous)
- Gingival apparatus: term used to describe these gingival fibers and the epithelial attachment

- Gingival ligament: includes the dentogingival, alvologingival, and circumferential fibers
- Interdental ligaments: includes transseptal fibers
- Gingival fibers
    - Circumferential (circular) fibers: encircle the tooth around the most cervical part of the rooth and insert into the cementum and lamina propria of the free gingival and the alveolar crest. They *resist rotational forces*
    - Transseptal fibers: extend from tooth to tooth, coronal to the alveolar crest and area embedded in the cementum of adjacent teeth. Not found on the facial aspect, and have no attachmet to alveolar crestal bone. They maintain the integrity of the dental arches (sometimes classified as principal fibers of the PDL)
    - Dentogingival fibers: extend from the cementum apical to the epithelial attachment and course laterally and coronally into the lamina propria of the gingival
    - Dentoperiosteal fibers: extend from the cervical cementum over the alveolar crest to the periosteum of the cortical plates of bone
    - Alveologingival fibers: insert in crest of alveolar process and spread out through the lamina propria into the free gingiva
- Epithelium of oral mucosa:
    - *Stratified squamous epith*: may be keratinized, parakara, or nonkeratinized depending on location
    - *Lamina propria* (CT): supports epithelium: Subdiveded in to *papillary and reticular*. May be attached to the periosteum of the alveolar bone or interposed over the submucosa (the submucosa contains glands, blood vessels, and nerves)
    - *Basement membrane* is located between the oral epithelium and the CT Composed of *basal and reticular lamina*
- PDL is 0.2 mm wide
- Thickness of PDL varies depending on :
    - Person age decreases to .1 mm as a result of deposition of cementum and bone (most notable in region of mandibular canine)
    - Thins when tooth looses function, also with tension, but not compression.
    - Stage of eruption
- Alveolar crest fibers: extend from cervical cementum to the alveolar crest: fxn to counterbalance the occlusal forces on the more apical fibers and resist lateral movement
- Oblique fibers: insertions in cementum and extending apically in alveolus. Compose 1/3 or all fibers. Resist forces along the long axis of tooth, masticatory forces. Found in middle third of tooth.
- Horizontal fibers: run perpendicular from alveolar bone to cemuntum and resist lateral forces
- Interradicular: found only on multirooted teeth, extend from furcation area to bone within the furcation
- Sharpey's fibers—
    - Terminal portions of collagen fibers embedded into cementum and bone .
    - Diameter is considerably greater on bone side than on the cementum side
- PDL is specialized form of CT derived from dental sac and surrounds root of tooth. Fibers are arranged in two groups:
    - Gingival fibers: CT fibers (collagen fibers) that are found in the free gingival, however, they are continuous with the CT fibers of the PDL and are often considered to be part of the ligament
        - Include circumferential, dentogingival, dnetoperiosteal, alveologingival, and transseptal fibers (transseptal sometimes included tieh principal fiber group of PDL
    - Principal fibers (collage fibers) of PDL include alveolar cres, horizontal, oblique, apical, and interradicular fibers. These fibers connect the cementum to alveolar bone. They are distinguied by their location and direction.. The terminal portion of these collagen fibers, are called Sharpey's fibers
- Fibroblasts, osteoblasts, cementoblasts, and macrophages may be found in PDL
- Two types of nerve endings are found in PDL:
    - Free, unmyelinated nerve endings; convey *pain*

    - Encapsulated (myelinated) nerve endings; convey *pressure*
- PDL becomes very thin and loses the regular arrangements of its fibers when a *tooth loses its function*
- PDL derived from *dental sac*

Buccopharyngeal membrane, only from ecto and endo covers the stomatodem. Ruptures at 3 ½ weeks forming max and mand palatal shelves?

- Reticulan: type III the supporting tissue in lymphatics, the fibroblasts of spleen, thymus, in vessels
- Most abundant in cartilage dentin and bone: chondroitin sulfate. They form hard gels. Hyaluronic acid forms soft cells like in joints for synovial fluids, it a fluid.
- Bulbar's fascia, posterior 5/6 of eye
- Spinal nucleus of V: pain and temperature
- Main (chief) sensory nucleus of V: general sensation
- Spinal submucleus caudalis of V: nociception of central incisors
- Spinal subnucleus oralis of V:
- Bowmans glands are in the olfacted
- Stria reticularis is found in the ear and makes endolymph
- Schlems canal in eye draining the anterior chamber.
- Malpigian corpuscles: found in the kidney, renal corpuscles are malpigian corpuscles
- Spiral arteries: found in uterus. Spiral ganglion in ear: ganglion for the vestibule aspect (the hair cells)
- Captain of the carpul tunnel: capatus,
- Three muscles go through it: flexor palmar, digitorum, flexor policis longus, sufercialic, AND the median nerve.
- Corpora amalacia: prostatic concretion of gland, similar to thassyl corpuscle in thymus.
- Perimysium: surround fascilcle
- Sensory ganglion have more satellite cells surrounding them
- Mes axon: point where the shwann cell membranes meet after they first wrapp around the cell
- Emissary vein: connect flat bone to dural sinus
- Diploic vein: run between two layers of flat bones

Questions:

- Villi not in the large intestine?
- Portal triad system and the direction everything flows
- Rugae of the stomach vs that of large and small intestine. Question at the part that talk about colon epithelium
- Are enteroendocrine cells in both the stomach and small intestines?
- Genioglossus to protrude or protract tongue? Dects: protrude, test, protract