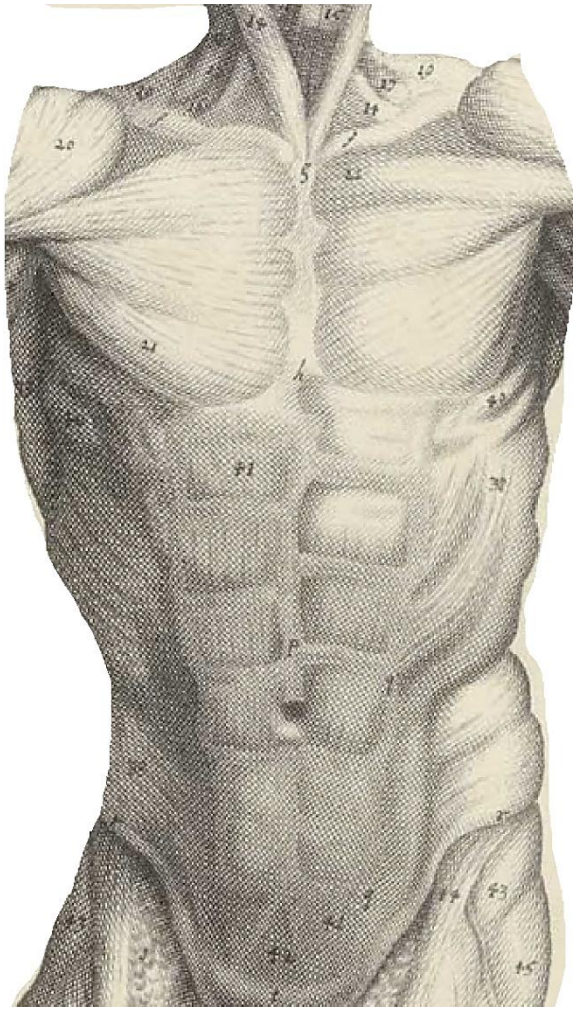
DIGESTION

There are many parts of the digestive system, all of which is specialized for a certain function. By now you should have a grasp of tissue and many of the gross anatomical parts of this system as it involves, the Skeletal, muscular, circulatory, lymphatics and to a degree respiratory. The digestive system is how you get foodstuff into your body and how nutrients enter the circulation.

We will be referring to the abdominal quadrants a lot so it is important to know their divisions. Make a horizontal line through the umbilicus (belly button) and a vertical like through the umbilicus and your will divide the abdominal region into four quadrants: right upper, left upper, right lower, and left lower.



Another division of the abdomen is into nine regions made by two midclavicular lines, a subcostal plane, and an interspinous plane. All of these can be felt on yourself or a partner. They divide the abdominal area into right and left hypochondrium both are next to the Epigastric region. A right and left flank both next to a periumbilical region. A right and left inguinal region that are separated by a pubic region.

1. On the image provided draw two perpendicular lines intersecting at the umbilicus and label the quadrants.

2. In a different color draw in where the ribs would be then draw and label the nine regions mentioned above.

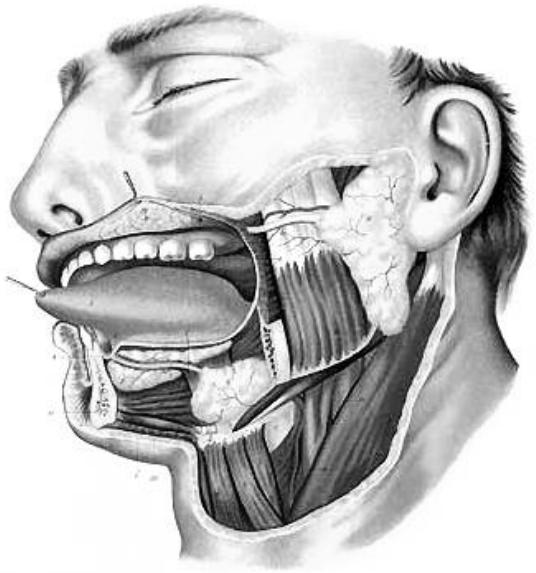
In this lab, we will start with the oral cavity, return to the muscle section to determine which are the muscles of mastication which are composed of striated skeletal muscle tissue. These can be divided by their functions. The ones that help close the mouth are the Temporalis, Masseter, and the Medial Pterygoid Muscles.

To open the mouth, you need the Lateral Pterygoids and Digastric muscle.

There is also a group of muscles that raise the hyoid bone to allow for swallowing. These are the Geniohyoid, mylohyoid, and Stylohyoid. Other muscles help elevate the pharynx. These are the Stylopharyngeus, salpingopharyngeus, and the palatopharyngeus.
mastication. The last group of muscles will constrict the pharynx for swallowing which are called the Pharyngeal constrictors. As there are three, we call them the Superior, middle, and inferior pharyngeal constrictors.

In the mouth we also find three important salivary glands for digestion. These are the Sublingual, submandibular and the parotid glands. The basement membrane of this tissue is circular so that it possesses a lumen inside. It has only one cell between the lumen and the basement membrane, and the cells are cube-shaped so it is called simple cuboidal epithelium.

1. List the muscles that help close the mouth?



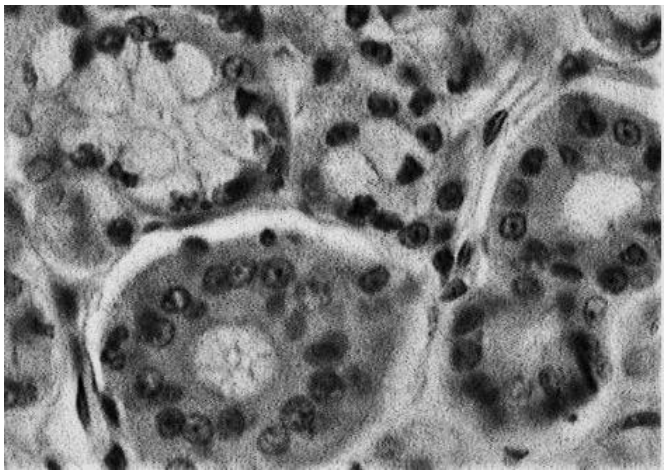
2. What muscles help open the mouth?

3. What muscles aid in swallowing?

4. What tissue type are all these muscles?

5. On the image provided label the three salivary glands and muscles of mastication which are visible.

6. Look at a microscope slide of the salivary glands and compare it to the picture below. draw what you see, what type of tissue is it?



All the facial bones are important to understand digestion which a quick review will aid. There are specialized bony structures such as teeth which are present in both the Maxilla and Mandible which are found in joints within the Alveolar processes. The teeth are held in place by the Periodontal ligaments.

Teeth are much more than bones having specialized structures. We can begin with the three parts of all teeth such as the enamel, the dentin, and the pulp. Enamel is made of the hardest substance in the body called Substansia Adamantia. It is composed of various types of proteins, such as ameloblastins, enamelins, and tuftelins, well as the Hydroxyapatite, a calcium phosphate crystal which by weight is composes 97% of the enamel.

Dentin is the next hardest layer of the tooth. About 45% of dentin consists of the mineral hydroxyapatite and 33% is organic material. Its importance in maintain the strength of the tooth and it contains an odontoblast process from the pulp of the tooth which can produce proteins. The Dentin is also composed of 22% fluid which allows some maintenance of the enamel. The deepest part of the tooth is the

pulp which is composed of connective tissue cells called Odontoblast. It is also the location of the vein, artery, and nerves for each tooth.

The tooth can also be divided into two visible areas. The first it the crown, the exposed portion of the tooth which is covered by the enamel. At the gum-line there is an area with enamel which is called the neck. The other part are the roots, where the blood supply and nerves enter the tooth which is located inside the alveolar process.

Most teeth have some variation but there are four basic ones found in the human mouth. The front four (four on top four on the bottom) are the incisors. These teeth are hatchet shaped and slide next to each other in a shearing manner when you bite food. Next to these are the Canines. The Canines are sharp pointy teeth which can be used to hold food in place for tearing or to allow the incisors to cut. Behind the Canines we have the two premoral (per quadrant of mouth) which are sometimes called bicuspids seem to be an intermediate between the canines and molars. The last three back teeth are the molars which are usually broad with four or five cusps. Moral comes from the word to grind.

7. What is the area of this bone that holds the teeth?

8. How many of each tooth type do human have and what is the function of each tooth?
   a. Incisors

   b. Canines

   c. Premoral

   d. Molars

9. Looking back at your skeleton chapter, what is the groove just posterior to the incisors?

10. What holds your teeth in their socket?

11. Draw a generic tooth and label the following:
    a. Crown
    b. Neck
    c. Root
    d. Enamel
    e. Dentin
    f. cementum

Returning to the Skeletal system, look at the inferior aspect of the skull and look at the hard palate. Note that it is formed by two bones.

12. What bones make the hard palate?

13. What makes the soft palate?

14. What part of the Mandible holds the teeth and what is this projection called?

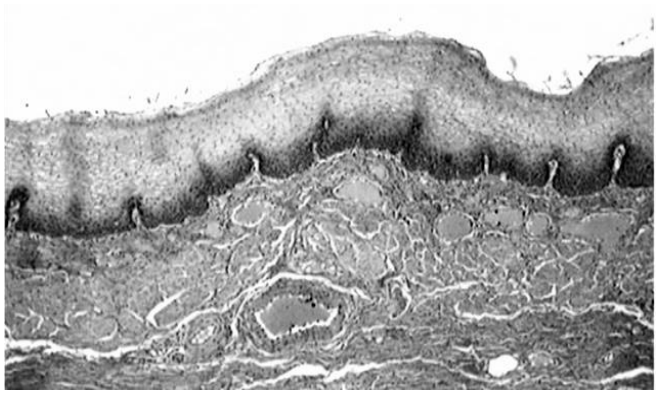
15. What part of the Mandible articulates in the temporo-mandibular joint, what is the process called?

16. What Bone does it articulate with?

As we continue looking at the mouth, we can look at the tissue that lines the lumen under a microscope and see that it is composed of many flat cells in many layers. This tissue is called Stratified squamous epithelium. It is important in the mouth as many of the things we each can damage the outermost lining causing the top cells to come off. As it is layered and thin, the cells below can easily maintain the integrity of the membrane.

Stratified squamous Epithelium is made up of various layers of cells. Starting at the bottom most layer, connected to the basement membrane, we find the Stratum basalis with the largest cells in this tissue. Just over them, we find the Stratum spinosum or spiny layer. These cells are losing cytoplasm so the cell shape changes. You will note that these are attached to the cells surround them. This is followed by the squamous layer which is there you can see the shape of the cell that gives the tissue its shape

17. Draw what you see in a slide of the tissue you find in the mouth and compare it to the image below. label the following:
    a. Basement membrane
    b. Stratum basalis
    c. Stratum spinosum
    d. Squamous cells



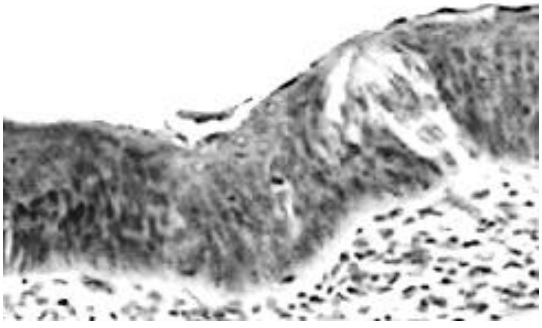
As we move on to the tongue, one can point out all the muscles that allow it to move around these are the genioglossus, the hyoglossus, styloglossus, palatoglossus, and the Myloglossus. It is easy by looking at their names to determine where they will originate from as they all insert at the tongue. These skeletal muscles are covered by a specialized stratified squamous epithelium with bumps called filiform papillae which hold taste buds.

Together the teeth, salivary glands, and tongue work together to form a bolus of food and it is swallowed with the aid of the pharyngeal elevator muscle group and the pharyngeal constrictors.

This will lead the food to the esophagus which is a smooth muscle tube with the lumen covered by stratified squamous epithelium. The tube is located just posterior to the trachea and leads down to the diaphragm. If we look at the esophagus from the lumen going into the body, we find many layers. The one contacting food is called the Mucosa, which is made up of the epithelial layer, a connective tissue layer called the lamina propria made of loose connective tissue, and a smooth muscle layer called the muscularis mucosa.

Going deep to the mucosa, we find the submucosa made up of dense irregular connective tissue. Deep to the Submucosa, we find the muscularis externa which are the two major smooth muscle the one closest to the submucosa is the circular muscle and the next one is the longitudinal muscle layer. Both help propel the food downward by use of peristalsis.

18. Look at a slide of the tongue and label the following
    a. filiform papillae
    b. taste bud
    c. basement membrane
    d. Basal layer



19. What type of tissue is the outer layer of the tongue?

19. What type of tissue is the muscle of the tongue made from?

20. What is food called that has been swallowed as it enters the pharynx?

21. As you have studied in Respiratory system, the pharynx connects the nose and mouth, what are the three parts of the pharynx?

22. What tissue type do you find in the lumen of the pharynx and esophagus (see image below)

23. What muscle type is found lining the esophagus?

24. What are the two layers of muscles in the muscularis externa?

As you continue down the esophagus and pass the diaphragm, you find a valve between the esophagus and the stomach formed from a thickening of smooth muscle. This valve is extremely important as it keeps the acidic stomach contents outside the esophagus. As it is in the cardiac region of the stomach, it is called the cardiac sphincter though sometimes you may read about is as the gastroesophageal sphincter.

In the stomach, we have a different type of tissue as it needs to be protected from the acid. It also needs specialized cells to help produce the acid and proteolytic enzymes as well as a few other chemicals needed for digestion.

The tissue found lining the lumen of the stomach is columnar epithelium which has many folds in its structure. From the lumen, you can find invaginations called Gastric pit. These go in deeper and form many branches called gastric crypts. The gastric crypts many times have the gastric glands which produce hydrochloric acid, proteolytic enzymes, and possibly even intrinsic factor.

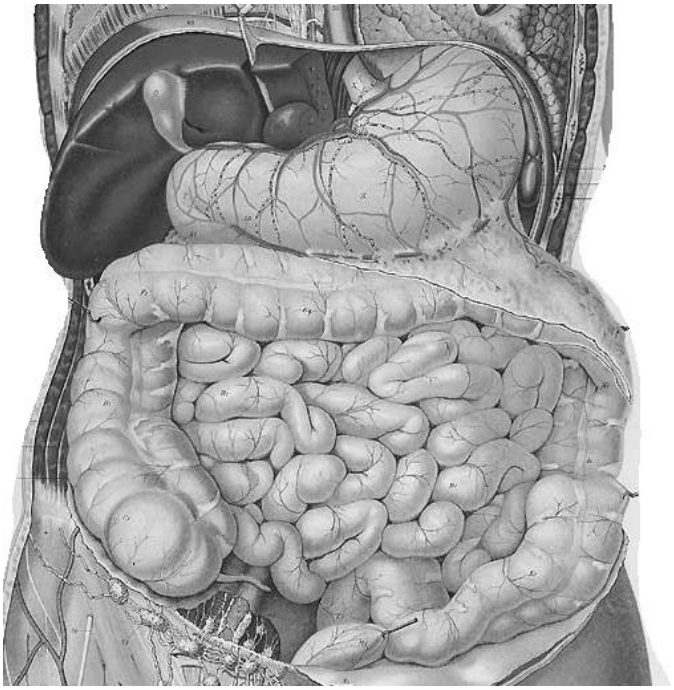
In the top part of the lumen, we find mostly goblet cells, which secrete mucus, and epithelial cells. The mucus helps protect the stomach from auto-digestion as it forms a barrier between the contents and the lining. In the Gastric pits, we find Parietal cells, which produce hydrochloric acid by taking the hydrogen from carbonic acid and combining it with Chloride which entered the body as sodium chloride. It also contains Chief cells which make two proteins named Pepsinogen. In the gastric juices, this is converted to their active forms of Pepsin which is a proteolytic enzyme. The stomach also produces intrinsic factor, a protein needed to absorb vitamin B12.

Looking at the stomach grossly, one can find that it has many regions. On top, near the esophagus is the cardiac region. To the side of the cardiac region, we find a big bulge on top called the fundus. The main portion is known as the body. On one side of the stomach you find a small curve called the lesser curvature of the stomach and on the other side you find a larger one called the greater curvature. The best way to determine the body is to connect the ends of both curves with two line. As we come to the end of the stomach, we find the pyloric region. This area has a sphincter called the pyloric sphincter which separates the stomach from the small intestine.

Besides the tissue of the lumen there are other things that make the stomach different than the esophagus. First are the visible folds called Rugae. These allow the stomach to stretch when people eat, especially in buffets and eating contests. The other variation is in the Muscularis Externa, which has the circular and longitudinal muscles as are found in the esophagus, but deep to those is a third muscle layer which pulls on its sides called oblique muscles.

As the stomach contains acids and other secretions, it makes it difficult for various infectious agents to affect the body. It also changes the composition of the bolus that has entered. The change in composition and acidity leads us to call the foodstuff to be called chime. One vital thing to know is that very little is absorbed in the stomach, mostly medications such as caffeine, alcohol, and NSAIDs can be taken up.

25. What is the function of the cardiac sphincter?
26. On the image, draw a line from the xyphoid process to the pubic bone and intersect if at where the umbilicus would be then, label the following:
    a. Esophagus
    b. Cardiac sphincter
    c. Stomach
        i. Fundus
        ii. Cardiac region
        iii. Body
        iv. Pyloric regions
        v. Pyloric sphincter
    d. Diaphragm



27. What are Rugae and what do they allow?

28. What are the three muscles layers of the stomach called?

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29. Describe the stomachs position in the abdomen in anatomical terms using the quadrants then in regions.

30. Look at a slide of the lumen of the stomach, draw it and labeling the tissue type, the gastric pits, a goblet cell, the lamina propria, the muscularis mucosa, the submucosa, the muscularis externa, and a solitary lymph nodule.

31. What are the four cells found in the lining of the stomach and what is their function?

32. What separated the stomach from the small intestine?

When people talk about the upper Gastrointestinal tract can be described in a few ways. In endoscopy, it will include the first part of the small intestine called the Duodenum. The duodenum, in fact the large and small intestine are made up of almost the same layers of the stomach, but the Oblique muscle layer is missing. Instead of rugae, the intestines will have projections into the lumen called Plica circularis. These projections increase the surface area which is further increased by finger like projections called villi. Within the villi are lacteals and blood capillaries which are where nutrients are absorbed into the body.

The Duodenum is also a place where secretions from the liver and pancreas will enter the intestinal tract. The opening where the ducts with the secretions come in is called the sphincter of Oddi and around the opening of the sphincter are special glands called Brunner's glands which secrete bicarbonate. This bicarbonate, as well as bicarbonate from the pancreas prevents the chyme from digesting the small intestine. When one looks at a slide, you can also see invaginations called Crypts of Lieberkühn which contain a variety of cells but most important would be the stem cells and the Paneth Cells which produce an anti-microbial protein.

The Duodenum is only about 30 cm long and it attaches to the second part of the small intestine named the Jejunum. Besides the Brunner's glands the tissue of the small intestine is similar though out being made of a simple columnar lumen. The jejunum is the main part of the small intestine, composing two third of the entire small intestine. Usually the Jejunum measures about six meters.

As the Jejunum ends, we reach the Ilium the last part measuring about 3 meters which itself ends at the Iliocecal valve. The main function of the Ilium is to absorb what was missed by the Jejunum. Its role in most important in uptake of vitamin B12. Once we pass the ilium, we enter the large intestine.

The first section of large intestine is called the Cecum which is attached to the vermiform appendix. The large intestine is mostly required for absorbing water and storing fecal matter until it can be evacuated. There are three bands of smooth muscle that run the length of the large intestine called the Tenia Coli which is smaller than the intestine. This leads to the formation of bulges called haustra.

From the lower right quadrant, the colon (large intestine) travels upward until it reaches the liver. From previous readings, you know that hepato- refers to liver so as the colon bends at the upper right quadrant, that bend is called the Hepatic flexure. The colon will then run in a transverse plane to the spleen. On that area between the liver and spleen, it is called the transverse colon. The transverse colon bends at the spleen forming the splenic flexure then descending to an area where the colon is S-shaped giving it the name of Sigmoid colon. Then just passed the Sigmoid is the rectum where fecal matter is stored until it can exit via the anus.

Unlike most of the gastrointestinal tract where the tissue of the lumen is relative uniform, the anus has two tissue types depending on location. The division can best be seen in the pectinate line, superior to the line the tissue is simple columnar (a pseudostratified columnar epithelial) and below it the tissue is stratified squamous epithelium. There are two sphincters that control the movement, the internal anal sphincter is smooth muscle and under involuntary control while the external anal sphincter is formed from striated skeletal muscle.

The tissue remains mostly the same as in the small intestine The Vermiform appendix it is located at McBurney's point, a point on a line from the umbilicus to the anterior superior iliac crest 2/3 from the umbilicus.

In the small intestine you can find finger like projections into its lumen called villi. These are used to increase surface for absorptions. Inside the villi there is a lacteal which is part of the lymphatic system and a capillary bed. These structures are needed to absorb nutrients. The water soluble Amino Acids, dipeptides, monosaccharides and disaccharides will be placed into the capillaries which will come together to form the

mesenteric veins. The Fatty Acids will be transported to the heart via the lacteals which will eventually drain into the thoracic duct.

33. Starting from the end of the stomach, what are the regions of the small intestines?

34. What are the layers of the small intestine?

35. How many muscle layers does it have and what are the names?

36. Look at a slide of the Duodenum draw it and label the crypts of Leiberkuhn, a goblet cell, Brunner's gland, and a duct

37. Draw a villi with the lacteal and capillary bed?

38. What are the lacteals for in the intestines?

39. Looking at the intestine, you find a layer of connective tissue and adipose tissue holding it in place, what is the name of that structure?

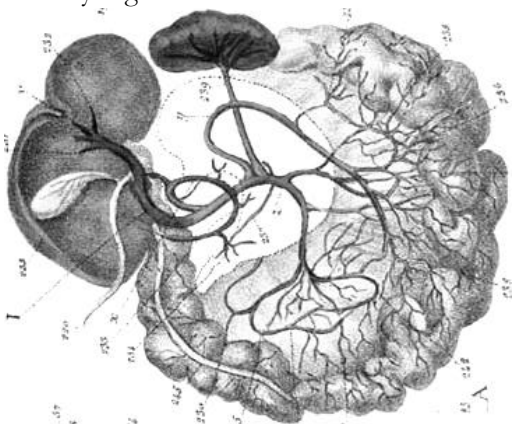
40. What divided the small intestine from the large intestine?

41. On the image provided, label the following:
    a. Cecum
    b. Ascending colon
    c. Hepatic flexure
    d. Transverse colon
    e. Splenic flexure
    f. Descending colon
    g. Sigmoid
    h. Rectum.

42. What part of the large intestine is the Appendix found on, what quadrant is it in?

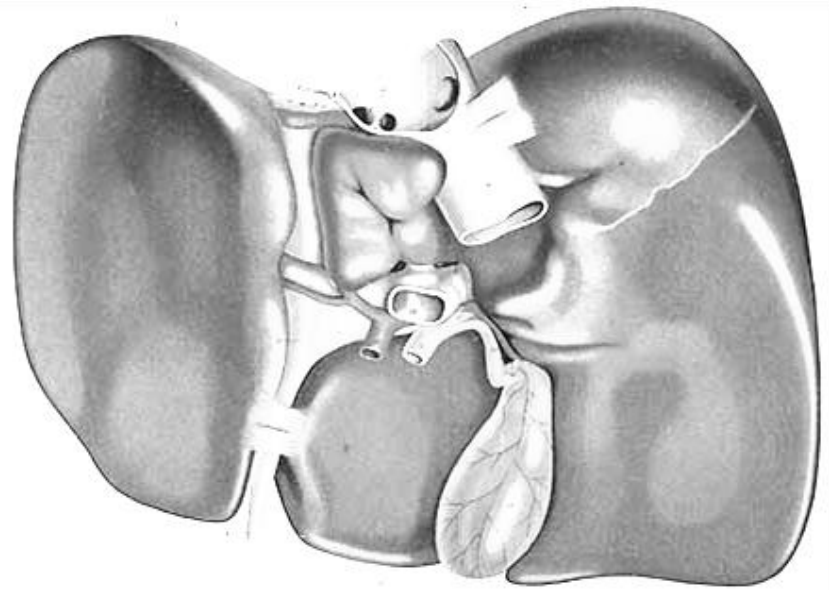
43. What are the two sphincter muscles and what tissue are they made from?

Besides the tube and mouth, our digestive system has many accessory organs that are needed for digestion to take place. These include the Liver, Spleen, Pancreas, Gall bladder, and the Hepatoportal venous system.



44. On the image provided label the following:
    a. Liver
    b. Spleen
    c. Hepatic portal vein.

45. On the image of the posterior of the liver label the following
    a. right lobe
    b. left lobe
    c. quadrate lobe
    d. caudate lobe
    e. Ligamentum Venousum
    f. Round ligament,
    g. gall bladder,
    h. porta Hepatis.



46. In which quadrant would you find the liver?

47. What connects the liver to the stomach?

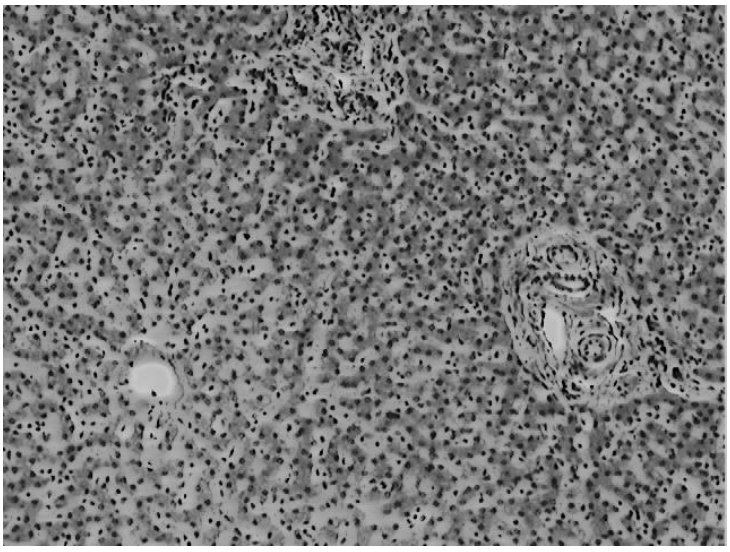
48. What divides the liver into the right and left lobes on the anterior view?

49. What is the green structure embedded within the liver? Is it vital for life?

50. What does the Liver secrete into the intestine?

51. What vein brings blood to the liver from the intestines and spleen?

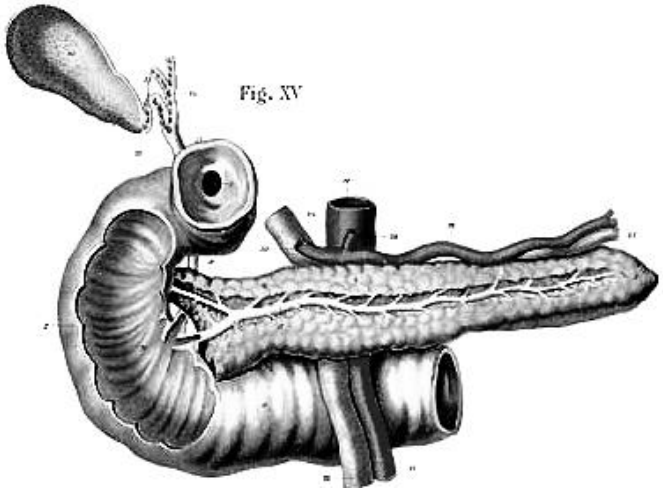
52. Look at a slide of liver draw it near the image provided and label the portal triad, a sinusoid, and a central vein.



53. What is a hepatocyte?

54. While it was covered previously, why is the spleen important in the breaking down of fat?

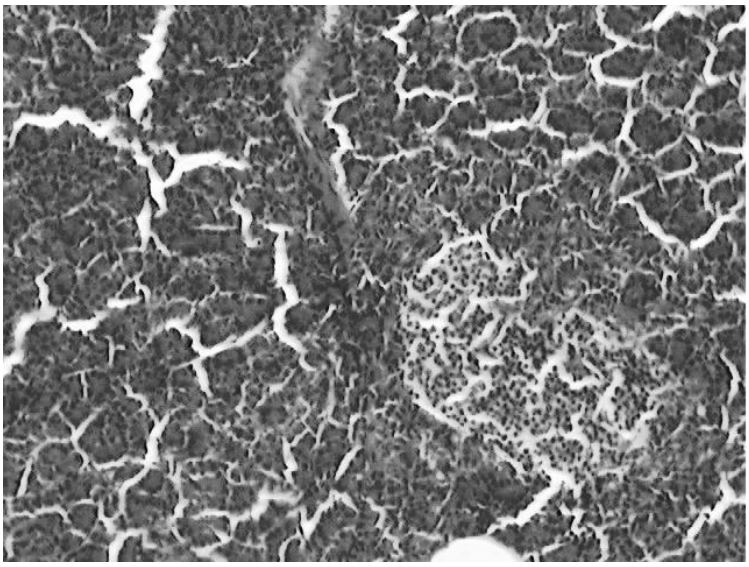
55. Looking at the pancreas. You can see that it has a head and a tail. Label these on the image provided.



56. What organ would the head of the pancreas be next to? What is the tail next to?

57. What does the Pancreas make for digestion?

58. Next to the image provided draw what is seen in a slide of the pancreas label the Islets of Langerhans



59. What are the three cells in the islets of Langerhan and what do they produce?

60. What type of tissue is found in the pancreas?

Embryology of Digestive and respiratory systems

The Embryology of the Digestive and respiratory systems are tied closely together. If we begin at week 3, when we have three germ layers, we can see how the ectoderm, mesoderm, and endoderm line up with the ectoderm in contact with the Amnionic sac and the endoderm in closest to the yolk sac. Then the Mesoderm and ectoderm begin to grow faster than the endoderm causing the embryo to form a tube which will become the gut tube.

Once the endoderm is surrounded by the ectoderm and mesoderm forming a tube. The Mesoderm forms a cavity which will eventually become the ventral body cavity. The cavities then form two membranes, the one in the thoracic region will become the pleura or pleural membrane which will surround the lungs and another membrane around the abdominopelvic cavity called the peritoneal membrane.

The cells that make up the endoderm will form the intestines, and stomach. Two connections develop, one will become the greater on the dorsal side and lesser omentum on the ventral side. Near week 36, the liver begins to develop within the lesser omentum. As it becomes larger, the liver rotates and moves to the right. Within the Greater Omentum, the pancreas develops then forms the greater mesentery, a fatty apron protecting the intestines.

While the gut tube is developing, some gill slits calcify and form the lower jaw as well as some of the muscles of mastication. Near the developing mouth, there is a bulge ventrally which is called the respiratory bulb. The respiratory bulb will continue to grow caudally to form the trachea, bronchi, and alveoli. As the Embryology of the respiratory and digestive system are closely correlated, many malformations will affect both systems.

61. What germ layer does the digestive tract come from?

62. What two major organs of the digestive tract develop from mesoderm?

63. What is the pleura?

64. What is the Peritoneum?