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BIOL 244L HUMAN ANATOMY AND PHYSIOLOGY II LABORATORY
DIGESTION I

I. ENZYMATIC DIGESTION

Start this portion of the laboratory exercise first, because it takes 1 hr for the reactions to incubate to completion.

The process of digestion involves chemically breaking large biological molecules (i.e. the food) down into their small component monomers. Most of this chemical processing is done with protein enzymes. Enzymes are a kind of catalyst or substance that increases the speed of chemical reactions. In biological systems, enzymes are usually highly specific and will function in one particular kind of chemical reaction and also under specific chemical conditions of acidity. Chemical conditions change along the digestive tract, and together with different enzymes produced in digestive gland secretions, a precise and controlled sequence of chemical breakdown is accomplished. The names of enzymes typically have the name of the chemical compound they act upon and end with the suffix "ase". Lactose or "milk sugar" is a disaccharide composed of the monosaccharides, glucose and galactose. Lactase is the protein enzyme required to split lactose into glucose and galactose.

A. Working in groups, obtain 3 test tubes and also one beaker to stand the test tubes in. Label the tubes as #1, #2, & #3 with a colored marking pencil.

B. Tube # 1: Fill 1/2 full with 5% lactose solution
Tube # 2: Fill 1/2 full with 5% lactose solution; add 2 drops of lactase.
Tube # 3: Fill 1/2 full with 5% lactose solution; add 2 drops of acetic acid; add 2 drops of lactase.

Mix the contents by inverting each tube (with a different finger over the mouth of each tube) to mix the contents. Allow the tubes to sit for 15 minutes. When manipulating the tubes, take care not to smear the numbers.

C. 1. Add a 7% yeast suspension to the material in all three tubes, so that they are filled within about 1 cm from the top. Mix the contents by inverting each tube (with a different finger over the mouth of each tube) to mix the contents.

2. Cover and seal each tube with a piece of parafilm folding the parafilm down around the neck of each tube. Try to avoid having a large bubble of air sealed into the tube.

3. To the BEAKER, add rather warm tap water from the sink at the back of the laboratory (hot, but not enough to burn your fingers) filling the beaker to about 3/4 full. This beaker will be a miniature incubator for the test tubes.

Then stand the test tubes plugged-end down (upside-down) in the water in the beaker.

4. Check the tubes at one-half hour, and again at one hour.

5. Did the contents of any of the tubes produce bubbles?

Bubbles of carbon dioxide indicate that yeast can use the sugar in the tube for its life processes.)

What sugar(s) should be present in tube # 1
What sugar(s) should be present in tube # 2 & # 3?
Is there indication that yeast cells can digest and use lactose?
What was the effect of acid pH on the rate of carbon dioxide production?

E. Clean your glassware, and invert it to drain in the rack on the table.

II. CAT DIGESTIVE TRACT

Learn the structures in boldface.

Our study of the circulatory system last semester introduced many of the structures of the abdominal cavity, and hopefully the digestive tract structures remain intact. Refer to the figures at the end of this handout as you work.

The **salivary glands** may be exposed on the same side of the head dissected last semester. However, if the damage we did exposing the upper respiratory tract was too severe, use the other side of the head. Remove the skin and superficial platysma muscle posterior to the angle of the mouth and ventral to the auricle (ear). Just ventral to the auricle is the large **parotid gland**. This and other salivary glands are lobular and can be distinguished from the smooth surfaces of lymph nodes in the head and neck. Inferior to the parotid gland is the **mandibular gland**. There are additional smaller salivary glands near the angle of the mouth, and salivary secretions are transported to the mouth via ducts. Take care in dissecting away connective tissue here so as not to cut through and remove the salivary ducts you seek. You can find the parotid duct crossing the surface of the masseter muscle. The **oral cavity** lies between the teeth and the epiglottis. The teeth show a characteristic **dental formula** which is a list for the upper and lower jaws of the numbers of **incisors** (in front for cutting food), then **canines** for tearing and shredding, then **premolars** for crushing and tearing and finally **molars** for crushing and grinding. Cats are carnivores and their dental formulas emphasize tearing actions, while herbivorous horses and cows have lots of molars, and omnivorous humans are intermediate.

If the abdominal cavity is not yet open on your specimen, make a longitudinal incision through the abdominal wall just to the right of the mid ventral line. Extend the cut from the diaphragm to the pelvis, and then cut laterally and dorsally and reflect the flaps of the abdominal wall. As you expose the various organs, do not break the major blood vessels. The abdominal cavity is also known as the **peritoneal cavity**. Its walls are lined with a serous membrane, the **parietal peritoneum**, and the visceral organs are covered with **visceral peritoneum**. The **liver** with several lobes, is shaped to fit against the domed curvature of the diaphragm. Pull the liver and diaphragm apart slightly, and find the **falciform ligament**, which extends between the diaphragm, liver and ventral abdominal wall. Lift the lobes of the liver, and find the **gall bladder** underneath the liver. The gall bladder will appear as a collapsed bag and is usually (but not always) stained green by bile pigments it contained.

There are peritoneal sheets extending from the body wall and enclosing the viscera, and these are called **mesenteries.** The peritoneal cavity is like a closed sac into which the abdominal organs have been pushed from the outside (think of pushing your thumb into a balloon). These sheets of tissue covered with serous membrane suspend the visceral organs and contain blood vessels, nerves, and lymph vessels supplying these organs. Two of these mesentaries are **lesser and greater omenta**. The **lesser omentum** extends from the liver to the **stomach** and **duodenum**. Most of the **stomach** lies on the left side of the peritoneal cavity. By lifting the liver, find where the **esophagus** penetrates the diaphragm and enters the stomach. The stomach both stores food from large meals and begins protein chemical breakdown by secretion of hydrochloric acid and proteolytic enzymes. Chemical breakdown of food actually begins with salivary secretions in the mouth, but chemical and physical breakdown in the stomach can subsequently deliver a fluid material called **chyme** in small and more steady portions to the **duodenum**. The duodenum is the first segment of the small intestine and is a U shaped loop. Entry to and exit from the stomach is controlled by sphincter muscles. The **pyloric sphincter** can be seen if you carefully open the stomach where it connects to the duodenum. Lining the stomach are series of folds called **rugae**. The **greater omentum** is a double sheet of mesentary attached to the greater curvature of the stomach and extending caudally then turning upon itself and extending cranially to attach to the dorsal body wall. It thus forms a sac like structure that drapes over the intestines like an apron. The dorsal layer encloses part of the **pancreas** and **spleen**. Lift the **greater omentum** and observe its relations to the pancreas and spleen.

Returning the duodenum and lesser omentum, carefully dissect away portions of the **lesser omentum** to trace the **common bile duct**, which receives branches from the gall bladder and hepatic ducts from the liver and drains into the duodenum. Note also in this region the **hepatic portal vein** (injected with yellow latex), which brings blood and digested nutrients from capillary beds of the digestive tract and delivers them to the liver. While the hepatic portal vein blood is somewhat depleted in oxygen after traversing the gut tissues, the **hepatic artery** comes from the aorta via the celiac artery and brings fully oxygenated blood to supply the liver. The **pancreas** is an elongate, almost sheet-like organ that lies along the duodenum and can be recognized by its fine lobular structure. There is a small **pancreatic duct** and a very small accessory duct that deliver pancreatic digestive enzymes and $NaHCO_3$ (to neutralize HCl from the stomach) to the duodenum. The **pancreatic duct** is a bit tricky to find; try carefully scraping away the granular pancreatic tissue near the upper portion of the duodenum where the pancreas lies fused to the margin of the duodenum. There may be a large amount of variation in plumbing here: the pancreatic duct may join the common bile duct before they enter the duodenum.

The small intestine downstream of the duodenum is divided into the **jejunum** (proximal half and the **ileum** (distal half). What is the difference between the two sections? There is no gross anatomical difference and no apparent difference in microscopic anatomy either. Jejunum means "empty" and back around the year 280 the greek anatomist, Galen, may have named it because the first half is usually more empty after death when he studied these structures in cadavers. Nevertheless, everyone has had to learn it ever since. The small intestine is supported by a mesentery called simply the **mesentery** or **mesentary proper**. Cut out a piece of the small intestine about a cm long (avoid areas that seem to be full of food - go for the jejunum). Cut the segment open longitudinally, rinse the inside if needed, and look at the inner surface. The large folds in the mucosa are **plicae circulares**. Then look for the small **villi**. These are small finger-like projections from the lining of the intestine that increase the surface area for absorption. The individual villi may at first be hard to see as the whole surface may resemble matted wet fur. A binocular dissecting microscope (at the front of class) should provide the best view of the villi, which you may need to tease free of the matted surface using a dissecting needle.

Find the junction of the ileum with the **ascending colon**. The digestive tract distal to this point is the **large intestine or colon**, and it is supported by a mesentery called the **mesocolon**. There is a short, dead-end pouch where the ileum enters the colon called the **cecum**. In humans, the vermiform appendix is located at the end of the cecum, but the appendix is absent in the cat. These structures are better developed in herbivorous animals which benefit from additional bacterial action on vegetable food spending time here. Trace the **ascending, transverse, and descending colon**. The **rectum** extends from the pelvic canal to the anus, but save the dissection of the pelvic canal for future study of reproductive organs.

WHEN FINISHED:

***Throw small scraps of tissue in the scraps can at the back of the lab.**

***Wash out your dissecting trays and stack by the sink at the back (<u>please do not let tissue scraps go down the drain</u>).**

***Clean your dissecting tools, blot them dry, and check them in their boxes to the front of the classroom. Please leave the lids open to complete drying.**

III. DIGESTIVE TRACT IN THE HUMAN MODEL

Find and Know these parts:

number	
185 stomach	208 vermiform appendix
187 pylorus of stomach	209 ascending colon
188-190 lobes of liver	210 transverse colon
195 gall bladder	211 descending colon
196 pancreas	213 rectum
202 small intestine	207 cecum

IV. CAT DISSECTION ANATOMY ILLUSTRATIONS

Illustrations are from Gilbert, Steven G. Pictorial Anatomy of the Cat. 1975 University of Washington Press.