ZOO 4377L - VERTEBRATE MORPHOLOGY LAB

LAB 11: DIGESTIVE SYSTEM

Name: _____ SSN: _____

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Next Week's Assignment: Walker & Homberger - Chapter 11 (*Circulatory System*); read the small print and skim the large print sections

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Preparation: Walker & Homberger - Chapter 10 (*Digestive System*); read the small print and skim the large print sections.

Background

The evolution of an active-feeding lifestyle (as opposed to a filter-feeding one) required several changes in what was primitively an uncomplicated digestive system (e.g., amphioxus). Active feeders generally take large food at infrequent intervals. This food is ingested faster than it can be digested, and so must be stored. In most vertebrates, the **stomach** is the major storage organ. In birds, the **crop** also serves to store food. Large food particles have also necessitated the evolution of highly distensible organs which allow the passage of these particles and increase storage volume facultatively. The main role of the digestive system, of course, is to process the nutrients necessary for metabolism. Although this process begins immediately upon ingestion, the **intestines** provide for the majority of digestion and absorption of nutrients. As a result, it is often possible to get a good idea of an animal's diet from the shape and complexity of the gut. In general, guts of carnivores tend to be short, although stomach capacity is huge. Herbivorous animals of all classes have long, convoluted guts that become particularly complex if plant cellulose needs to be fermented for nutritional value. Some herbivores have compartmentalized stomachs designed to harbor the microorganisms responsible for cellulose digestion (no vertebrate can digest cellulose without such microorganisms). The process of anaerobic digestion of cellulose that occurs is called **fermentation,** hence herbivores with complex stomachs are called **'foregut fermenters.'** Other herbivores use a blind diverticulum off the large intestine called the **caecum** for the same function. These are called **'hindgut fermenters.'**

Developmentally, the gut tube, or **archenteron,** becomes apparent early in gastrulation and is lined by embryonic **endoderm.** As development proceeds, it is convenient to identify two basic sections of the gut tube, the **foregut** and **hindgut.** The foregut later differentiates into the **pharynx, esophagus,** and **stomach,** while the hindgut becomes the **intestinal** and **cloacal** (urogenital) regions. Further folds and outpocketings **(diverticula)** of the archenteron become respiratory structures and the associated digestive organs **(liver,** gall **bladder,** and **pancreas).** The bulk of the tissue of the digestive system (muscle and connective tissue) is derived from embryonic **mesoderm;** remember, it is only the *gut* lining that is endodermal in origin. As in the circulatory system, the basic structure of the digestive system is phylogenetically quite consistent; it is the variations on the theme on which you should concentrate.

Generally, most of the terms for which you are responsible should be familiar, so dissection will not be too difficult.

Today's Lab

Cut open your shark and your cat to look at the digestive system. We will not focus on the anterior portion of the digestive tract, but rather on the posterior parts, those termed viscera

(Latin for "guts"). When doing your dissections, be sure to preserve the material of the urogenital system (kidneys, bladder, and reproductive organs) for an upcoming lab. Also be sure to preserve the blood vessels, most of which are injected with colored latex. For today, focus specifically on comparison of the shark and cat digestive tracts. Know the function of each organ.

I. SHARK DIGESTIVE SYSTEM

Material: Our slowly disintegrating friends, the sharks.

Work through pp. 295-301 and 303-306 of your manual. You will be responsible for knowing the following structures identified in **bold**. You may want to make a brief description of the following structures to assist in your learning and identification.

Identify: Figure 10-5, 10-6

pleuroperitoneal cavity
- parietal serosa
- visceral serosa

cloaca
liver

? How many lobes are ther in the shark liver? What are their names? What storage structure is found within the median lobe? What role does the liver play in digestion?

gall bladder
bile duct
esophagus
stomach
- **rugae**

? What role does the stomach play in digestion? How can you tell internally where the esophagus ends the and stomach begins? What is the function of the rugae?

valvular intestine

? What role does the intestine play in digestion?

spleen

? What role does the spleen play in digestion?

pancreas

? What role does the pancreas play in digestion?

mesentery (both meanings)
digital gland

? What is the function of the digital gland?

Internal structure of organs: Figure 10-7

esophageal papillae

cardiac of stomach
body of stomach
pyloric of stomach
pylorus
spiral valve

oral cavity and pharynx: Figure 10-9

primary tongue
gill raker

? What is the function of the gill rakers?

II. CAT DIGESTIVE SYSTEM

Material: Cats

Work through pp. 320-332 of your manual (omitting section (B) The Pericardial Cavity). You will be responsible for knowing the following structures identified in **bold**. You may want to make a brief description of the following structures to assist in your learning and identification.

Identify

Pleural cavity: Figure 10-21
lungs
parietal pleura
visceral pleura
esophagus
diaphragm

Peritoneal cavity: Figures 10-21, 10-22, 10-23, 10-26, 10-27
peritoneal cavity
parietal peritoneum
visceral peritoneum

? In the cat, what divides the peritoneal from the pleural cavities? In the shark?

liver

? How many lobes are there in the cat liver? What are their names? What is the liver's role in digestion?

gallbladder
stomach
cardiac of stomach
fundus
body of stomach
pyloric of stomach
pylorus
rugae
spleen
bile duct
small intestine
duodenum

jejunum
ileum
villi
large intestine
cecum
colon

? Where will you find the vermiform appendix in the cat?

rectum
anus
pancreas

? The amount of nutrient absorbed in the intestines is a function of time. Thus, assuming a constant rate of movement through the gut, the longer the route through the intestine, the greater the absorption will be. Sharks and mammals (cat) have independently evolved different solutions to lengthening the route through the intestine, specifically, the short spiral intestine and the lengthy convoluted small intestine, respectively. For the shark, can you think of any advantage(s) in having a spiral intestine over a convoluted, small intestine? Conversely, what disadvantage(s) might there be to having a spiral intestine vs. convoluted small intestine? Why might the rabbit have adopted the spiral solution for it's cecum?

III. HINDGUT FERMENTATION

Metazoans (multi-celled animals) including craniates lack the enzyme (cellulase) necessary for the digestion of cellulose, the primary structural carbohydrate found in plants. Thus, animals that subsist on plant products that are rich in cellulose (***e.g.***, leaves and stems vs. seeds and fruits) must rely on symbiotic bacteria within the gut to break down their food. Because (1) the breaking-down of cellulose by micro-organisms is a slow process and (2) because cellulose has a relatively low caloric content, special "fermentation" chambers are required to harbor the micro-organisms and store sufficient volumes of food. Among mammals, two regions of the gut tract have become evolved fermentation chambers. **Foregut fermentation** occurs in an elaboration of the esophagus and stomach and is characteristic of the ruminants (the Artiodactyl suborder Pecora: the giraffes, cervids (deer, musk deer and pronghorns) and bovids (antelopes, cattle, goats and sheep). **Hindgut fermentation** occurs in an elaboration of the large intestine and examples include rabbits, pigs, horses and koalas.

For our example of hindgut fermentation we'll examine the domestic or Old World rabbit (*Oryctolagus cuniculus*). Work through pp. 332-334 of your manual. You will be responsible for knowing the following structures identified in **bold**. You may want to make a brief description of the following structures to assist in your learning and identification.

stomach
small intestine
duodenum
jejunum
ileum
sacculus rotundus
large intestine
caecum
spiral valve
vermiform appendix
colon

taenia coli
haustra coli
pancreas
liver
gall bladder

? What is the function of the ileal papilla and sacculus rotundus?

? What is the function of the caecum?

? What is coprophagy? What is its purpose?

? What is the function of the vermiform appendix?

IV. FOREGUT FERMENTATION

For our foregut fermented, we will examine the foregut of the domestic sheep (*Ovis aries*). Work through pp. 334-335 of your manual. You will be responsible for knowing the following structures identified in **bold**. You may want to make a brief description of the following structures to assist in your learning and identification.

esophagus
"stomach"
rumen
reticulum
omasum
abomasum
duodenum

? Which chamber of the ruminant "stomach" secretes gastric juices and is thus homologous to the stomach of the cat?

? What <u>are</u> the function<u>s</u> of the rumen?

? What is the function of the reticulum?

? What is the function of the omasum?

? What is the function of the abomasum?

? What does ruminate literally mean? What does it figuratively mean?

? Why aren't foregut fermenters coprophagic?

? Which would you rather kiss, a fore-gut or hind-gut fermenter? Doesn't it depend upon the location of the kiss?

V. DIGESTIVE SYSTEM COMPARISONS

Using information from W & H and **your** own knowledge, fill in the organs involved and special adaptations thereof for each animal below.

	Stomach	Intestines	Initial Processing and Storage	Accessory Organs
Lamprey				
Shark				
Cat				
Ruminant Herbivore				
Cecal Herbivore				
Bird				