

The Digestive System

Objectives:

1. Learn external anatomy of the pig.
2. Learn the anatomy of the digestive system.

I. Introduction: Humans (*Homo sapiens*) and domestic pigs (*Sus scrofa*) are both in the Class Mammalia in the subphylum Vertebrata. Fetal pigs are often used as model organisms when studying vertebrate anatomy. The location and arrangement of organs in the major organ systems are similar enough in both humans and pigs that the pig can be used as a model to study human anatomy. We will look at some of the similarities and differences in the two species.

Some terms used to describe the relative positions of body parts are used repeatedly throughout the lab, and appear in a glossary at the end of this exercise.

II. a. EXTERNAL ANATOMY

At the anterior end of the head is the snout, which is penetrated by two holes, the external nares, and the mouth with fleshy lips and muscular cheeks. Posterior to the snout are the eyes and upper and lower eyelids. Still farther posterior is the fleshy flap, the pinna, of each ear surrounding the external auditory meatus, which leads to the eardrum.

The slash on the right side of the neck was made to inject blue latex into a **jugular vein**. The blue latex thus fills the veins throughout the body. This will make the veins easier to identify later when the circulatory system is studied.

The trunk of mammals is divided into a **thorax**, which is bounded by ribs, and an **abdomen**. Part of the **umbilical cord**, which connected the fetus to the placenta, is attached to the abdomen. If you make a fresh cut across the umbilical cord, you will see: (1) a single, large, thin-walled **umbilical vein**, which takes oxygen-rich, food-laden blood from the placenta to the fetus; (2) two thick-walled **umbilical arteries**, which carry low-oxygen, waste-laden blood from the fetus to the placenta; and (3) a thin cord of tissue, the **allantoic stalk**, which is the remnant of a fetal membrane that helped to form the placenta. Red latex was injected into the umbilical arteries. This will make all the arteries easier to identify when the circulatory system is studied later.

On the abdomen, at either side of the umbilical cord, you will find a row of 5 or 6 mammary papillae. These are found in both sexes, but become functional only in mature females.

Determine whether you have a male or a female by seeing if there are one or two openings beneath the tail. If there are two openings and a conical projection, the pig is a female. The opening nearer the tail is the **anus**, the ventral opening is the **urogenital opening**. The conical projection is the **genital papilla**. In males, only the anus is present under the tail, just posterior to the proximal end of the umbilical cord is the urogenital opening. In males there is no genital papilla. Examine a pig of the opposite sex to identify the structures not present in your pig.

II. b. DIGESTIVE SYSTEM

The digestive system includes the alimentary canal, a passageway that extends from the mouth to the anus. You will view the regions along this tube that are specialized for various activities of the digestive system.

Oral Cavity, Nasal Cavity, and Pharynx

Insert one blade of your scissors into the mouth and, starting at one corner of the mouth, cut through the tissue and through the bone that forms the hinge of the jaw, following the path of food. Repeat on the other side. Continue carefully until a whitish tubular piece of tissue, at the posterior end of the tongue, "pops out" from the inside of the throat. This flap is the **epiglottis** which is found in the **pharynx** (pronounced fair-inks), a chamber in which the food and air passages cross. Continue cutting until you can see the entire hole in which the epiglottis had been inserted.

Path of Food

Food enters the **oral cavity** through the **mouth**, which is bounded by the lips. The roof of the oral cavity is formed by a bony palate, the **hard palate**. Press down on the hard palate with your finger from front to back. You will discover that at the back of the oral cavity the hard palate becomes the **soft palate**. The oral cavity is that part of the digestive tract from the lips to the end of the hard palate. Is the oral cavity dorsal to or ventral to the hard palate? _____
_____The tongue pushes food from the oral cavity into the region ventral to the soft palate, which is called the **oropharynx**. Projecting into the oropharynx is a thin flap, the epiglottis, which partially surrounds an opening at its base, called the **glottis**. The glottis eventually leads to the lungs. Poke around with your dull probe dorsal to the glottis and epiglottis for the opening of the **esophagus**. You will know you found it if you can stick the probe far down the throat. When food enters the oropharynx, a reflex makes the epiglottis fold back, closing the glottis and allowing food to slide into the esophagus. Once in the esophagus, peristaltic contractions of the esophagus push the food to the stomach.

Path of Air

Since the paths of air and food are closely associated, let's also trace the path of air through the head and neck. When the mouth is closed, air enters the body through the external nares. The external nares lead to a chamber dorsal to the hard palate, called the **nasal cavity**. Is the nasal cavity dorsal to or ventral to the oral cavity? _____
Air then passes from the nasal cavity to the **nasopharynx**, which is a chamber dorsal to the soft palate.

View the nasopharynx by cutting a slit down the length of the soft palate. Is the nasopharynx dorsal or ventral to the oropharynx? _____
Notice the oval hole in the soft palate. When the pig is not swallowing food, the epiglottis projects into that hole so that air passes directly from the nasopharynx into the glottis (the opening surrounded by the epiglottis). In that process, air crosses the food pathway. Is the glottis dorsal or ventral to the opening of the esophagus? _____ After air enters the glottis, it proceeds through the larynx and trachea to the lungs.

Pressed against the diaphragm is the dark brown **liver**, the largest organ in the abdomen. The liver has a variety of functions, including the production of bile, which aids the digestion of fats. Bile is stored temporarily in the gall bladder, a grayish or greenish sac embedded in the posterior face of the liver, just to the right of the umbilical vein.

At the posterior edge of the liver, find a long, flat, smooth, brown organ on the left side of the abdominal cavity that superficially resembles the liver, but is not attached to the liver. This structure is the **spleen**, which functions in the storage, destruction, and production of red blood cells. The spleen is not part of the digestive system.

Now lift the left side of the liver and observe the large, sac-like **stomach** between the liver and spleen. Make a longitudinal incision with your scissors down the length of the stomach. Locate the **cardiac** (toward the heart) **end** of the stomach near the diaphragm where the esophagus enters the stomach. At the posterior end of the stomach is a constriction where the stomach joins the anterior end of the small intestine. This constriction between the stomach and small intestine is the **pyloric sphincter**, which is a muscular ring (sphincter) that you can observe by continuing your longitudinal incision to the small intestine.

The anterior end of the small intestine is the **duodenum**. The duodenum begins at the pylorus, extends to the right side of the abdomen, then loops back to the left half of the body, passing close to the stomach and spleen. Lying in this loop between the duodenum and stomach is the **pancreas**. The pancreas is a long, irregularly-shaped gland consisting of many small spheres. One end is attached to the beginning of the duodenum, the other end is attached to the spleen. The pancreas produces digestive enzymes, which are passed to the duodenum by a duct. Bile produced in the liver also empties into the duodenum. Ducts from the liver and gall bladder join to form the **common bile duct**, a tube about 1-2 mm in diameter and 1-2 cm long that enters the anterior side of the duodenum right next to the pylorus. The small intestine continues posteriorly, looping back and forth, and filling most of the abdominal cavity. Spread the loops of the small intestine and see that it is loosely held in place by fan-like folds of connective tissue (**mesentery**) that contain many blood vessels. Why would so many blood vessels attach to the small intestine? _____

Follow the small intestine until you find the T-shaped junction with the **colon (large intestine)**. A sac, the **caecum**, will be on one side of the junction, the colon on the other side. In humans there is a relatively small caecum off of which a worm-like extension, the appendix, is found. Follow the colon as it spirals inward, then spirals outward, and, finally, runs posteriorly along the dorsal body wall. The spiraled part of the colon looks quite distinct from the small intestine, because it is bound into a tight ball by connective tissue. In the pelvic region the posterior end of the colon is called the **rectum**. The external opening of the rectum is the anus.

IDENTIFY the following structures in the human torso model: esophagus, coelom, peritoneal cavity, diaphragm, liver, gall bladder, stomach, cardiac end of stomach, pyloric end of stomach, duodenum, pancreas, common bile duct, colon, caecum, vermiform appendix, and rectum.

What are some similarities in the digestive system of the pig and human? _____

What are some differences in the digestive system of the pig and human? _____

GLOSSARY OF FREQUENTLY USED ANATOMICAL TERMS

A number of terms will be used quite frequently in the dissection exercises. These terms are used to describe the location of parts on the organism.

Some of these terms (anterior, distal, dorsal, lateral, medial, posterior, proximal, and ventral) are often used relatively. For example, if we say that the diaphragm is anterior to the stomach, it does not mean that you will find the diaphragm at the anterior end of the organism. It means that, once you find the stomach, you will find the diaphragm on the anterior side of the stomach, i.e. the side closest to the anterior end of the animal.

anterior -- the head end of an animal, or in that direction. (e.g. on the pig, the front legs are anterior to the umbilical cord.)

cross section (c.s., t.s., x.s.) -- cut at right angles to the long axis of a structure or organism.

distal -- the part of an organ or limb that is furthest from the origin or point of attachment. (E.g. the fingers are distal to the wrist.)

dorsal -- the back or upper side of an animal, or in that direction. (e.g. the vertebral column is dorsal to the heart.)

lateral -- the side, or toward the side.

left -- the organism's left.

longitudinal section -- a cut along the long axis of a structure or organism.
May be either a frontal or sagittal section.

medial or median -- on or toward the midline of the organism.

posterior -- the tail end of an animal, or in that direction.

proximal -- the part of an organ or limb that is nearest the origin or point of attachment. (the wrist is proximal to the fingers)

right -- the organism's right.

ventral -- the underside of an animal, or in that direction. (e.g. the heart is ventral to the vertebral column.)