

DIGESTIVE AND RESPIRATORY SYSTEMS

The digestive system is responsible for obtaining and processing food for the all of the cells in an organism. Structurally it is closely associated with the respiratory system so the two will be studied together. Each system is composed of a series of tubular structures through which materials pass. In the case of the digestive system the raw materials are food particles that are broken into simple molecules as they pass through the system. Material that is not broken down is removed from the system. In the case of the respiratory system the major materials moving through it are oxygen and the waste product carbon dioxide.

The digestive and respiratory system share some common spaces. The digestive system is composed of the mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum and anus. There are also a number of glands that lie outside the system that contribute to its function. These include the salivary glands, liver and pancreas. The respiratory system is composed of the mouth or external nares, the pharynx, glottis, trachea, bronchi, bronchioles and alveoli. The latter three structures are in the lung. As you study these two systems consider how the material moving through them is being altered.

Salivary glands

Three paired salivary glands lie in the head and neck region (Fig. 4.1). *Locate the following:*

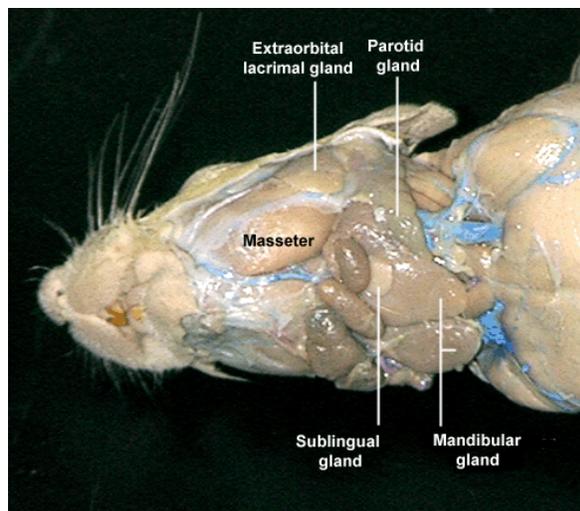


Figure 4.1 Glands of the neck region.

Parotid gland. These triangular glands lie ventral to the ear and extend along the lateral surface of the neck.

Mandibular gland. These large oval glands cover the ventral portion of the neck.

Sublingual gland. These light colored glands are closely associated with the mandibular gland.

The ducts of the salivary glands enter the mouth. The glands produce mucus to lubricate food. In humans, they produce amylase for the breakdown of starch.

Lymph nodes . These are darker and less globular than the salivary glands. They help initiate the immune response and are the site of lymphocyte replication.

Extraorbital lacrimal gland. This gland lies cranial to the parotid. It is one of several glands that produce tears in the rat. The others lacrimal glands lie deeper in the orbit.

Mouth and Pharynx

The digestive and respiratory systems are closely associated in the mouth. *Cut through the angle of the jaw on each side of the mouth. Push down on the jaw to expose the oral cavity.* The tongue attaches at the rear of the oral cavity. Lift the tongue and note that it is attached anteriorly by a sheet of tissue known as the **frenulum**. Also note the location of the two types of teeth, incisors for cutting and molars for grinding. The relationship between the spaces associated with the oral cavity can be confusing. *Try*

tracing the path food and air would take through this region (Fig. 4.2 - 4.4).

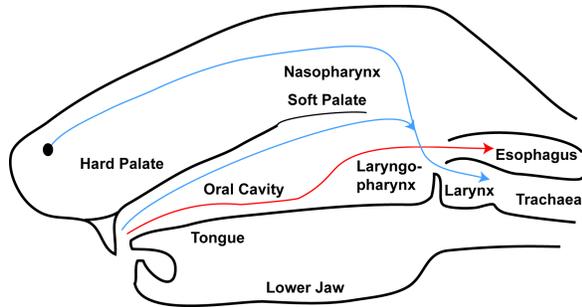


Figure 4.3. Sagittal section through the head of a rat showing the path taken by air and food.

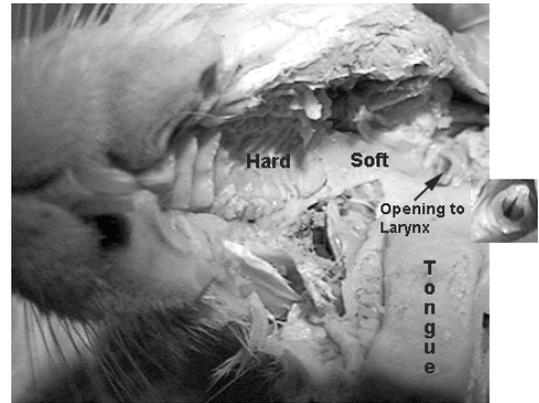


Figure 4.3. Oral cavity. Inset: view into the slit-like glottis and triangular epiglottis.

Hard palate. The bony roof of the oral cavity.

Soft palate. A continuation of the tissue lining the roof of the oral cavity.

Pharynx. A space at the back of the oral cavity divided into:

- **Nasopharynx.** Dorsal to the soft palate the nasopharynx receives air from the external nares and is not directly in the oral cavity,
- **Oropharynx.** The space ventral to the soft palate.
- **Laryngopharynx.** The space posterior to the soft palate and anterior to the esophagus. Both food and air pass through the oral cavity, however their pathways diverge in the laryngopharynx. Dorsally food moves into the **esophagus** and the digestive system. Ventrally air moves into the **larynx** and the respiratory system.

Glottis. (Fig. 4.2) A slit-like opening into the **larynx** (1, Fig. 4.4), leading via the **trachea** (2, Fig. 4.4) into the lungs. Unlike the esophagus, the trachea has rings of cartilage to keep it open.

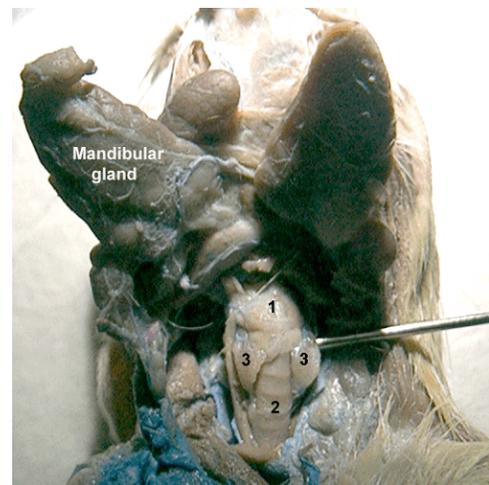


Figure 4.4. Upper respiratory tract.

Epiglottis. (Fig 4.2) A flap of tissue that blocks the larynx when food or fluid is in the laryngopharynx.

Thyroid & Parathyroid glands (3, Fig 4.4). Posterior to the larynx, paired thyroid glands control metabolism. A parathyroid gland is embedded at the anterior end of each. It regulates blood calcium.

Body Cavities, Pleura and Peritoneum

The body cavity of mammals is divided into an anterior and posterior region by a muscular **diaphragm**. The anterior region is further divided into two lateral **pleural** cavities that house the lungs and a central **pericardial** cavity that houses the heart.

Posterior is the **abdominal (peritoneal)** cavity which contains the digestive, reproductive and excretory organs. The walls of the body cavities and the surfaces of the organs are covered with an epithelium, derived from mesoderm. **Parietal** epithelium lines the body wall and covers the surface of the diaphragm. **Visceral**

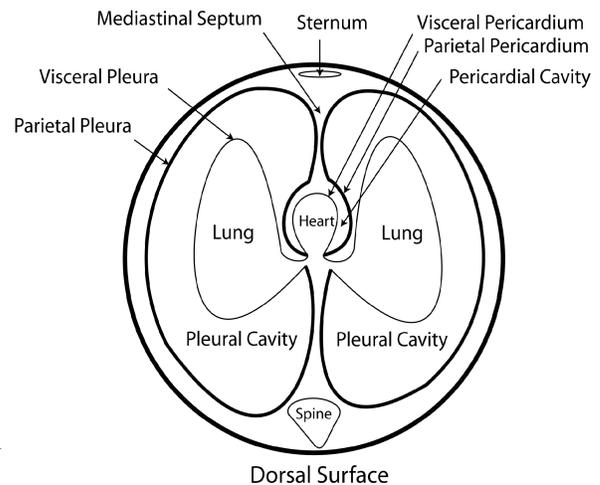


Figure 4.5. Sagittal section at the level of the lungs.

epithelium covers the surface of the internal organs. These two types of epithelium are further divided into **pleura, pericardium** or **peritoneum** depending on the body cavity in which they are found. Ventral to the heart the walls of the two plural cavities meet to form the **mediastinal septum**. The heart lies in a space within the septum. The **pericardial** sac surrounding the heart is formed by the **parietal pericardium** and the surface of the heart is covered with **visceral pericardium** (Fig. 4.5).

The abdominal cavity is lined with **parietal peritoneum** and the surface of the abdominal structures are covered with **visceral peritoneum**. The organs in this region are attached to the body wall by extensions formed by the passage of the peritoneum to and from the body wall. These extensions are known as **mesenteries** or **ligaments**.

As you begin your dissection note the extent of the mesenteries and ligaments. They help keep the internal organs in place. Also note that the majority of the mesenteries arise from the dorsal body wall.

Opening the Body Cavities

To open the body cavities you will need to make the five incisions shown in figure 4.6. The skin should already have been loosened on both sides along the midventral length of the body and into the groin area. Use care not to damage major blood vessels.

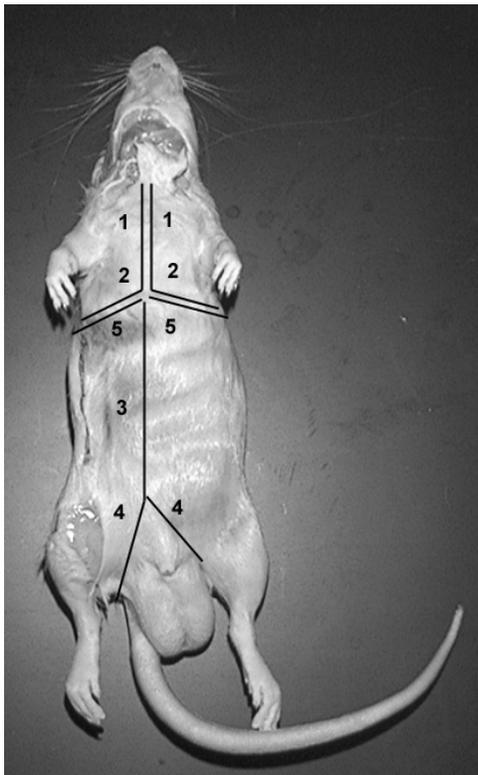


Figure 4.6. Sequence of cuts for opening the body cavities.

1. *Several centimeters to the right of the midline cut through the clavicle and posteriorly to the diaphragm. Repeat on the left side using care not to damage the mediastinal septum that divides the thoracic cavity into two sides.*
2. *Cut laterally through the ribs and along the edge of the diaphragm toward the vertebral column. Avoid cutting the diaphragm.*
3. *Make a cut slightly to the right of the midline and follow it posteriorly until just above the genital area.*
4. *If the skin has not been removed continue cut three laterally through only the skin to the caudal margin of the ischium. Use care so the underlying reproductive structures are not damaged.*
5. *In the abdominal cavity cut laterally along the edge of the diaphragm toward the vertebral column.*

Spread the flaps of body wall to reveal the internal organs.

Gently break the ribs near the spinal column to help hold the pleural cavity open.

*Carefully lift the midventral flap of skin and bone. Note the **mediastinal septum** attached to this flap. It divides the thoracic cavity into two pleural cavities..*

Relationships between structures in the thoracic cavity.

Note the position of the multi-lobed lungs on either side of the heart and the position of the diaphragm and ribs. The **heart** lies within the pericardial cavity formed from parietal pericardium (Fig. 4.5). The surface of the heart is covered with visceral pericardium. Make sure you can distinguish between these two types of pericardium. Also make sure that you can distinguish between the parietal and visceral pleura. See Figure 4.5 for clarification of the relationship between the various types of tissues.

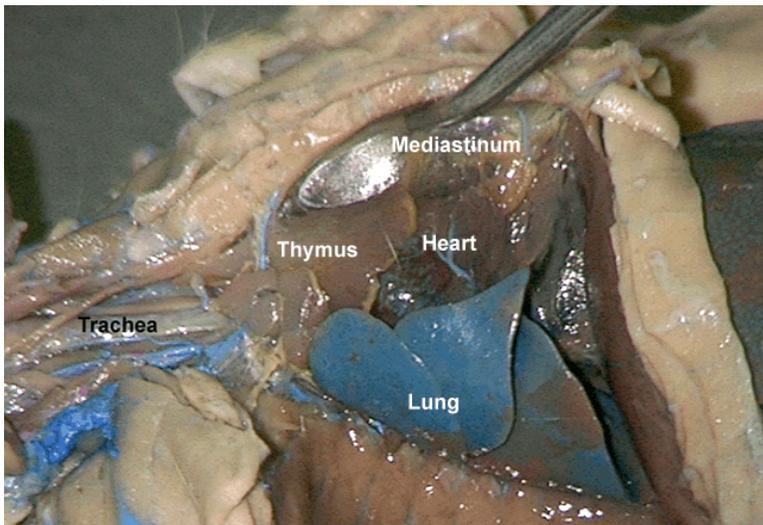


Figure 4.7. Lateral View of the thoracic cavity.

Thymus - (Fig. 4.7) this gland is part of the endocrine system. In young rats the thymus gland lies within the mediastinal septum and over the anterior part of the heart. This gland is part of the immune system and functions in the maturation of T-lymphocytes. It is quite large in young animals and gets smaller as the animals age. It produces thymosin which stimulates the immune response.

Respiratory System

Return to the pharynx and trace the pathway air would take from the nasopharynx into the laryngopharynx, through the glottis, larynx, trachea, and **bronchi** into the lungs. Gently reflect the heart and lung and try to find where the bronchi enter the lungs. Avoid damage to any of the blood vessels in this region. Cut off a piece of the lung and note all the small channels. Within the lung the bronchi divide repeatedly forming thin walled spaces, **alveoli**, where gas exchange occurs. The movement of air into and the lungs is controlled by increasing the size of the pleural cavity as the muscular **diaphragm** contracts enlarging this space. When the diaphragm relaxes, it curves into the pleural cavity reducing the size of the space and forcing air out of the lungs.

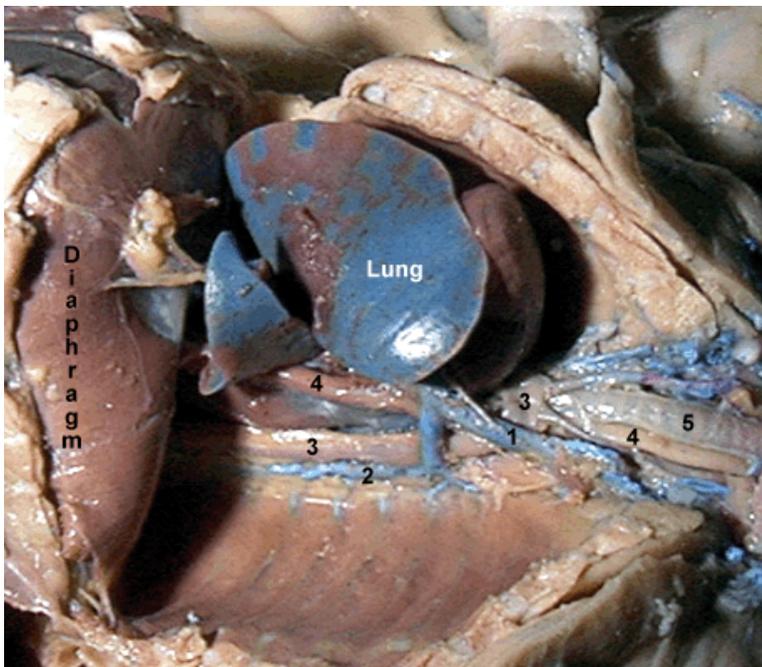


Figure 4.8. Thoracic cavity with the lung reflected to the right to expose the deep structures.

1. **Left cranial vena cava**
2. **Azygous vein** - drains the back.
3. **Descending aorta** - carries blood to organs in the abdominal cavity
4. **Esophagus** - this tube is only expanded when filled with food
5. **Trachea** - this tube contains rings of cartilage to keep it from collapsing.

Digestive System

Now trace the path food would take through the digestive organs (Fig 4.7-4.12, Table 4.1). Deflect the heart and lungs to the right and trace the esophagus through the diaphragm.

As you continue your dissection note the membranes that support the organs. Try to preserve them as well as all of the major blood vessels. Locate all the structures listed in table 4.1.

Table 4.1. Major structures of the digestive system listed in sequence.

Structure	Function
Mouth (oral cavity)	Initial processing of food.
Pharynx Nasopharynx Oropharynx Laryngopharynx	Pathway for only air Pathway for air and food Point where food meets air that has entered through the nose
Esophagus	Connects the pharynx and stomach.
Stomach	Produces mucus, hydrochloric acid, and pepsin (a protease). Together they initiate the breakdown of proteins. The highly acid stomach deactivates the salivary enzymes that were initiating the breakdown of carbohydrates.
Pyloric valve	Regulates movement of material out of the stomach
Small intestine (duodenum, jejunum, ileum)	Receives ducts from gall bladder and pancreas. Breakdown of fats, carbohydrates and proteins is completed in this organ.
Caecum	A large blind pouch located between the small intestine and the colon. It contains bacteria that produce cellulase, which facilitates the breakdown of the cellulose found in plant material. Breakdown products are then absorbed into the bloodstream.
Colon (ascending, transverse, descending)	Reabsorption of ions and water and production of mucus to lubricate material as it passes towards the rectum.
Rectum	A muscular portion of the digestive tract that completes water reabsorption.
Anus	Controls the removal of feces.

Structures accessory to the digestive tract

Liver	Processes glucose and stores it as glycogen, detoxifies other products delivered by the circulatory system, and produces bile.
Bile Duct*	Transports bile from ducts in the liver to the duodenum. Bile helps neutralize the partially digested material entering the duodenum and the bile salts help to emulsify fats. In humans the bile is stored in the gall bladder before transport to the duodenum.
Pancreas	Lies in the mesentery near the duodenum and stomach. This gland produces enzymes responsible for protein digestion. It is also an endocrine organ that releases insulin and glucagon into the circulatory system to regulate blood glucose levels.
Spleen	This organ is responsible for the production of lymphocytes and the breakdown of old red and white blood cells.

* Deflect the liver anteriorly and try to find the clear bile duct as it leaves the liver in route to the duodenum (Fig. 4.10).

Abdominal structures

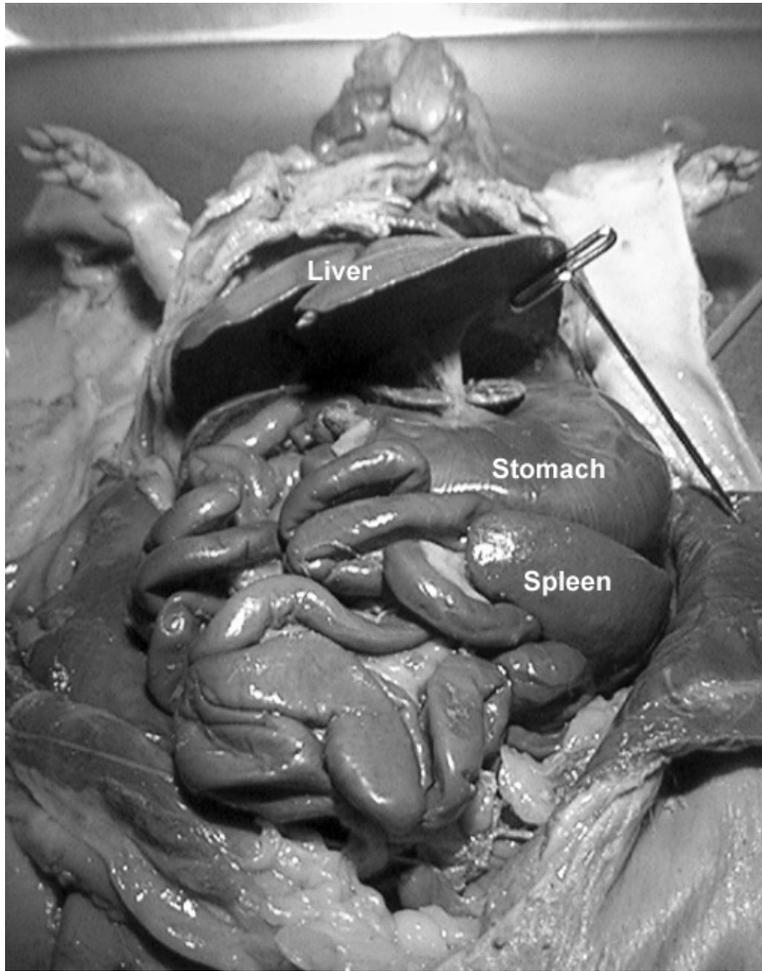


Figure 4.9. Abdominal cavity.

The various regions of the coiled small intestine are connected by a layer of tissue known as the **mesentery**. *Gently spread the intestine to see the extent of this mesentery.* Also note the band of tissue extending from the stomach to the liver. This is the **lesser omentum**. Not visible in this photo is the **greater omentum** which attaches the spleen to the greater curvature of the stomach. All of these mesenteries help keep the organs in place.

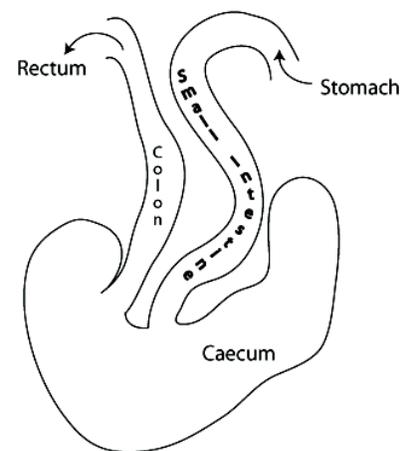


Figure 4.10. Relationship between the various regions of the digestive system.

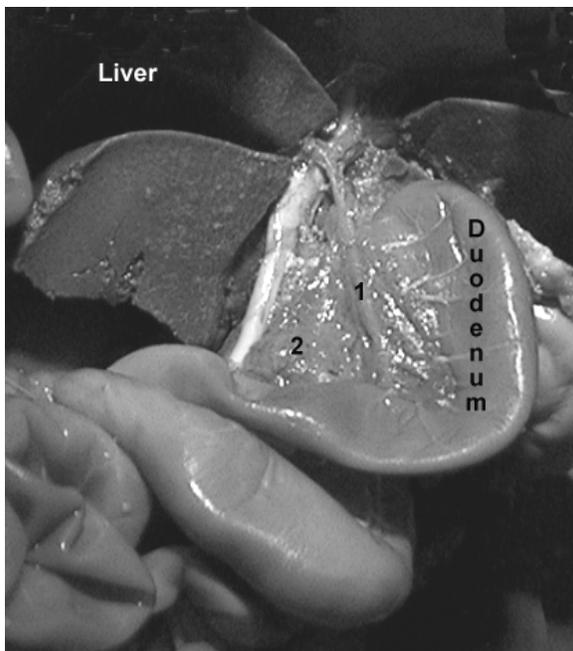


Figure 4.11. Relationship between the liver, bile duct (1), pancreas (2) and duodenum.

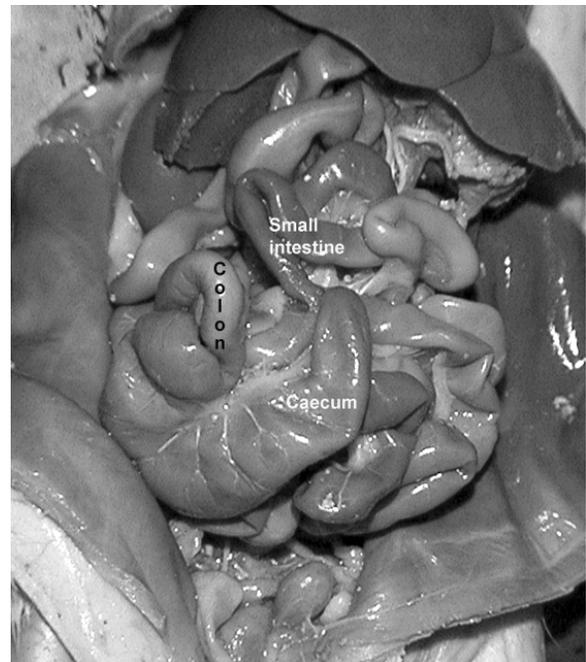


Figure 4.12. Relationship between the caecum and the rest of the digestive tract.