

Continuing Education Independent Study Series



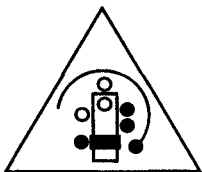
THE DIGESTIVE SYSTEM

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PREFACE

“The Digestive System” is part of the AST Continuing Education Independent Study (CEIS) Series. The series has been specifically designed for surgical technologists to provide independent study opportunities that are relevant to the field and support the educational goals of the profession and the Association.

Acknowledgments

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INTRODUCTION

Purpose

The purpose of this module is to acquaint the learner with the basic structure and function of the digestive system. Upon completing this module, the learner will receive 2 continuing education (CE) credits in category 1G.

Objectives

Upon completing this module, the learner will be able to do the following:

1. Identify the organs of the gastrointestinal tract and the accessory organs of digestion.
2. Explain the histology of the organs of the digestive tract.
3. Describe the anatomy of the organs of the digestive tract.
4. Describe the function of each of the organs of the digestive tract.

Using the Module

1. Read the information provided, referring to the appropriate figures.
2. Complete the enclosed exam without referring back to the text. The questions are in a multiple-choice format. Select the best answer from the alternatives given.
3. Mail the completed exam answer sheet to AST, CEIS Series, 7108-C S. Alton Way, Englewood, CO 80112-2106. Please keep a copy of your answers before mailing the answer sheet.
4. Your exam will be graded, and you will be awarded CE credit upon achieving a minimum passing score of 70%. If you are an AST member, your credits will be recorded automatically and you do not need to submit the credits with your yearly CE reporting form.
5. You will be sent the correct answers to the exam. Compare your answers with the correct answers to evaluate your level of knowledge and determine what areas you need to review.

Studying Technical Material

To study technical material, find a quiet place where you can work uninterrupted. Sitting at a desk or work table will be most conducive to studying.

Having a medical dictionary available as you study is very helpful so you can look up any words with which you are unfamiliar. Make notes in the margins of any new definitions so that you can review them.

The ultimate test of how well you learn this material is your ability to relate your knowledge to what is happening in the surgical field. As you concentrate on the surgical field, identify the structures you are seeing and their position within the body.

Additional Resource

Tortora G, Anagnostakos N. *Principles of Anatomy and Physiology*. 6th ed. New York: Harper & Row; 1990.

THE DIGESTIVE SYSTEM

The digestive system is responsible for the preparation of food for consumption by the cells of the body. The digestive system consists of the alimentary canal or tract through which the food passes and the accessory organs that produce secretions necessary for the breakdown of the food molecules.

Histology

The organs of the alimentary canal consists of four distinct layers:

1. **Mucosa:** The inner lining of the organs, consisting of epithelium, connective tissue (lamina propria), and muscularis mucosae (smooth muscle).
2. **Submucosa:** The middle layer of connective tissue. This is a very vascular layer and contains the submucosal plexus or plexus of Meissner, which is part of the autonomic nervous system.
3. **Muscularis:** The muscle layer, consisting of two layers of smooth muscle with the plexus of Auerbach, the major nerve supply of the alimentary canal. Wavelike contractions, peristalsis, propel food through the canal.
4. **Serosa:** The outer layer composed of connective tissue and epithelium that secretes serous fluid to moisturize outer surface of organs.

Peritoneum

The peritoneum is the largest serous membrane in the body. The parietal peritoneum lines the wall of the abdominal cavity forming a saclike structure enclosing most of the abdominal organs.

Visceral peritoneum (serosa) covers the surface of the abdominal organs. Since the peritoneum is a serous membrane, it secretes serous fluid. In some disease processes, the serous fluid production greatly increases. The excessive accumulation is called ascites.

The peritoneum contains several large folds that bind the abdominal organs to the abdominal wall. These folds contain the blood supply, nerves, and lymph vessels that supply the attached organs. These folds are as follows:

1. **Mesocolon:** Attaches the large intestine to the abdominal wall.
2. **Falciform ligament:** Attaches the liver to the anterior abdominal wall and to the diaphragm.
3. **Mesentery:** Attaches the small intestine to the posterior abdominal wall.
4. **Greater omentum:** Fatty apron, arising from the serosa of the stomach and duodenum, hangs over the intestines.

Oral Cavity (Buccal)

The mouth consists of the following parts:

1. **Cheeks:** Muscular lateral walls.
2. **Hard palate:** Anterior bony portion of the roof of the mouth that is formed by the maxillae and palatine bones.

3. Soft palate: Posterior muscular portion of the roof of the mouth.
4. Tongue: Floor of the mouth composed of skeletal muscle covered with mucous membrane. Embedded within the mucous membrane are papillae.
5. Salivary glands: Three pairs of glands that secrete saliva into the mouth. Parotid glands are located slightly below the level of the ears and anterior to them, connected to the oral cavity by Stensen's duct (Figure 1). Submandibular glands are on the posterior aspect of the floor of the mouth beneath the tongue. The sublingual glands are found on the anterior mouth floor beneath the tongue.
6. Teeth: Accessory structures consisting of two sets, or dentitions, the deciduous or baby teeth and the permanent dentition. The teeth are held in place within the sockets of the alveolar processes of the mandible and maxillae by the periodontal ligament. A tooth consists of the root, neck, and crown.

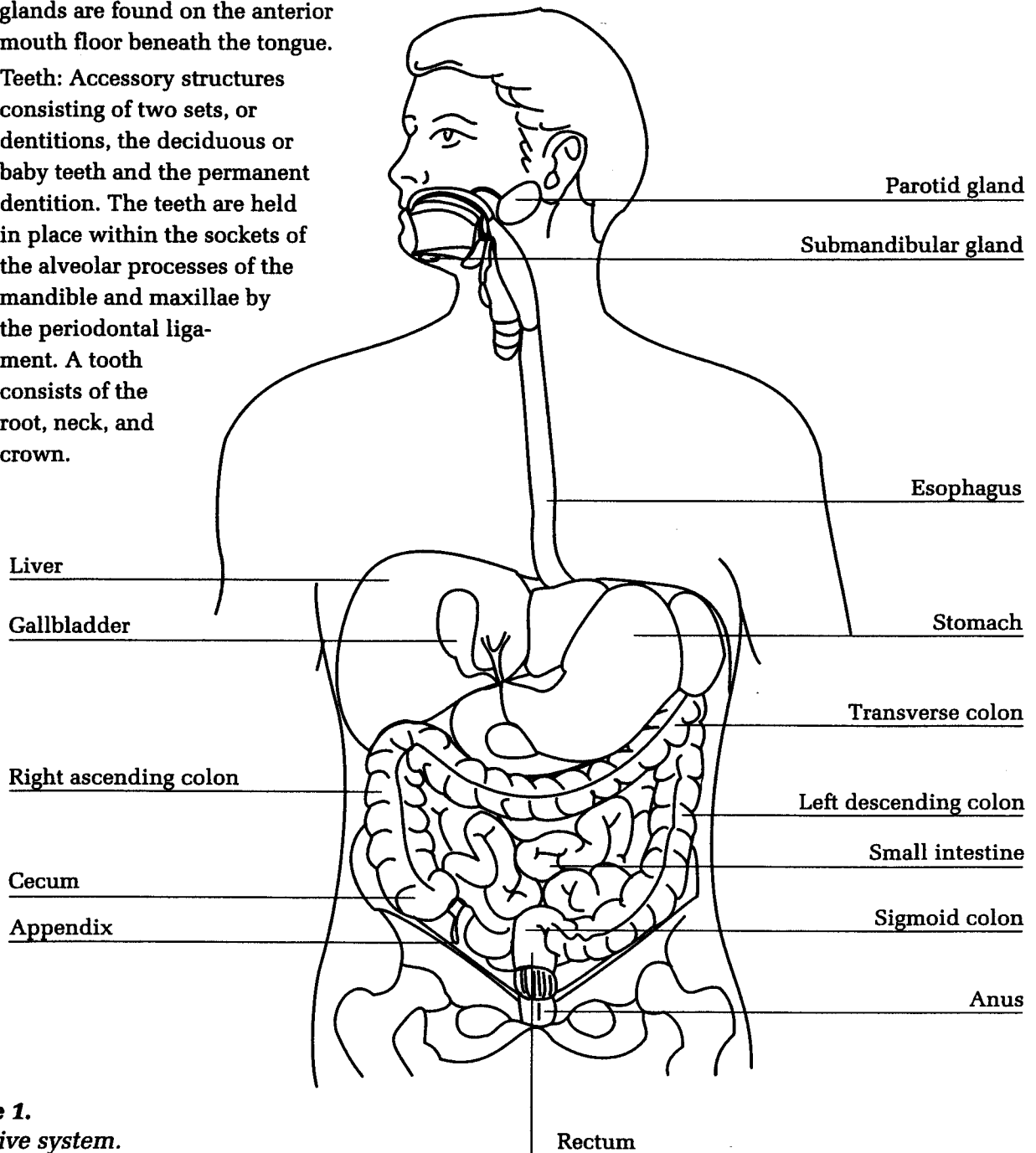


Figure 1.
Digestive system.

Esophagus

The esophagus (see Figure 1) is a muscular collapsible tube posterior to the tracheae connecting the oral cavity and the stomach. It moves food by peristalsis.

Stomach

The stomach (Figure 2) lies under the diaphragm in the upper left portion of the abdominal cavity. The stomach can be divided into four sections:

1. Cardia: The area around the esophagus.
2. Fundus: The area above and to the left of the cardia.
3. Body: The large central part.
4. Pylorus: The narrow lower portion.

The outer curve of the stomach is referred to as the greater curvature and the inner concave curve is referred to as the lesser curvature.

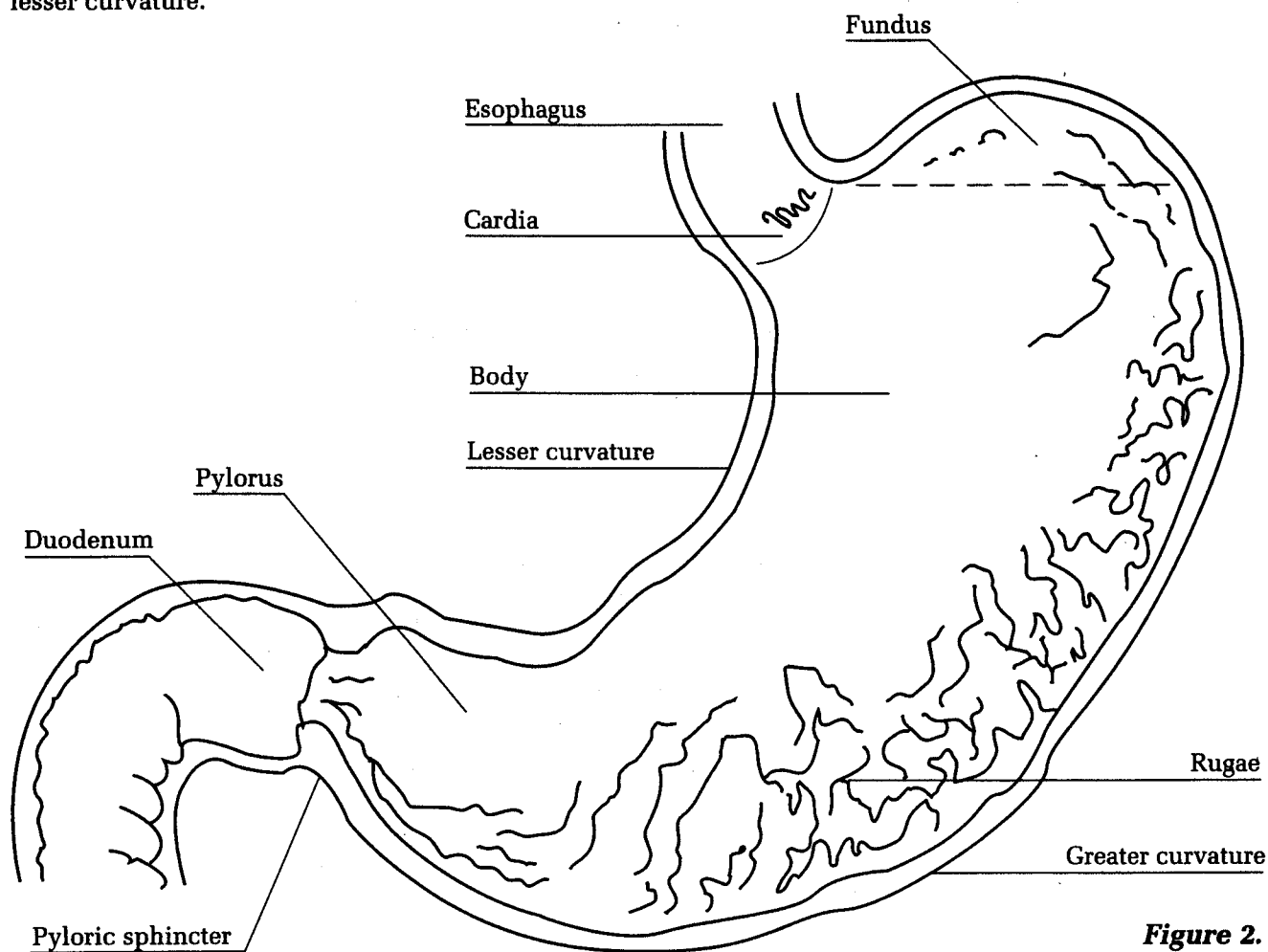


Figure 2.
Stomach.

Histologically, the stomach is composed of the four basic layers of the alimentary canal. The stomach lies in folds called rugae when empty. Within the mucosa of the stomach are gastric glands consisting of four types of cells that secrete various substances into the stomach:

1. **Zymogenic cells:** Secrete pepsinogen, which is the precursor of pepsin which is responsible for the digestion of proteins.
2. **Parietal cells:** Secrete hydrochloric acid, which converts pepsinogen to pepsin.
3. **Mucous cells:** Secrete mucous, which protects the stomach walls from erosion.
4. **Enteroendocrine cells:** Produce the hormone gastrin, which stimulates gastric secretions and increases motility.

The muscularis layer of the stomach consists of three layers of smooth muscle arranged longitudinally, circularly, and obliquely. These three layers allow the stomach to contract in a variety of ways to thoroughly mix the food and break it down into smaller portions.

Digestion within the stomach is accomplished in two ways: (1) mechanically, the movements mix, macerate, and reduce the food to a liquid or chyme; and (2) chemically, the enzymes secreted break down the food molecules.

Small Intestine

The small intestine (see Figure 1) is the site of most of the digestion and absorption of food in the body. The small intestine is divided into four parts:

1. **Duodenum:** First section of the small intestine and originates at the pylorus of the stomach. The duodenum is 10 inches long.
2. **Jejunum:** Second portion of the small intestine and is 8 feet long.
3. **Ileum:** Last portion, which joins the large intestine at the ileocecal valve. The ileum is 12 feet in length.

The small intestine, similar to the other organs of the alimentary canal, is composed of the four basic layers of tissue. These layers are somewhat modified in the small intestine to aid in digestion and absorption. The mucosa of the small intestine contains glands that secrete the following substances:

1. **Intestinal glands, or crypts of Lieberkühn:** Secrete intestinal juice that consists of enzymes that digest carbohydrates, proteins, and nucleic acid.
2. **Duodenal glands, or Brunner's glands:** Secrete an alkaline mucous to help protect the epithelium from the acid of the stomach chyme.

The following structures increase the surface area of the interior of the small intestine to increase digestion and absorption:

1. **Plicae circulares:** Permanent ridges or folds in the intestine that cause the chyme to spiral through the intestine.

2. Villi: Fingerlike projections of mucosa that give the intestines their velvety appearance. Within each villus are an arteriole, venule, capillary, and a lacteal vessel.
3. Microvilli: Fingerlike projections of plasma membrane on the absorptive cells of the epithelium of the mucosa.

Digestion in the small intestines employs both mechanical and chemical processes. The mechanical digestion consists of segmentation and peristalsis. Chemical digestion is accomplished by enzyme action. The enzymes involved include the following:

1. Pancreatic amylase, maltase, sucrase, and lactase: Break down carbohydrates.
2. Trypsin, chymotrypsin, carboxypeptidase, and peptidases: Break down proteins.
3. Pancreatic lipase: Break down fats.
4. Nucleases: Break down nucleotides.

In addition to digestion, the prime function of the small intestine is absorption. The small intestine is responsible for about 90% of all absorption of nutrients in the body. The mechanical and chemical breakdown of food is aimed at reducing the ingested food to a form that can be absorbed by the small intestine into the blood or lymph. The following nutrients are absorbed in the small intestine:

1. Carbohydrates as monosaccharides.
2. Proteins as amino acids.
3. Lipids as monoglycerides and fatty acids.
4. Water.
5. Electrolytes.
6. Vitamins (A,D,E,K,B,and C).

Large Intestine

The functions of the large intestine are completion of absorption, production of some vitamins, formation of feces, and expulsion of feces.

The large intestine is about 5 feet in length and divided into segments. The segments are the cecum, right ascending colon, transverse colon, left descending colon, sigmoid colon, rectum, and anus (see Figure 1). The vermiform appendix projects from the cecum and is attached to the ileum and abdominal wall by the mesoappendix.

The large intestine has the four basic layers of tissue of the alimentary tract. The mucosa contains columnar cells adapted for water absorption and goblet cells that secrete mucus. The submucosa is similar to that found in the other organs. The muscularis is somewhat modified in the large intestine. Portions of the longitudinal muscles are thickened and form bands called taeniae coli. Contractions of these bands throughout the large intestine gather the large intestine into pouches called haustra. This phenomenon gives the large intestine its puckered appearance.

Digestion in the large intestine is both mechanical and chemical. The haustra churn the chyme and peristalsis moves the chyme along. Bacteria ferment the remaining chyme and synthesize some of the B vitamins and vitamin K. Some remaining water is also absorbed.

Accessory Organs

Pancreas

The pancreas (Figures 3 and 4) lies posterior to the greater curvature of the stomach, is connected to the duodenum by one or two ducts, and is considered retroperitoneal.

The pancreas is divided into three parts: head, body, and tail.

There are two major ducts from the pancreas to the small intestines. The larger duct, the duct of Wirsung, unites with the common bile duct and enters the duodenum at the ampulla of Vater. The small accessory duct, the duct of Santorini, also empties into the duodenum above the ampulla of Vater.

The pancreas is composed of two types of cells. The major portion of these cells is the acini cells that secrete the pancreatic juices that include enzymes, salt, and sodium bicarbonate. The other cells, which are arranged in clusters, are called the islets of Langerhans. These cells produce the hormones of glucagon, insulin, and somatostatin.

Liver

The liver (see Figure 3) is located under the diaphragm in the upper right and center of the abdominal cavity. The liver is divided into two major lobes: the larger right lobe and the smaller left lobe. The two lobes are separated by the falciform ligament. The right lobe can be further divided into the inferior

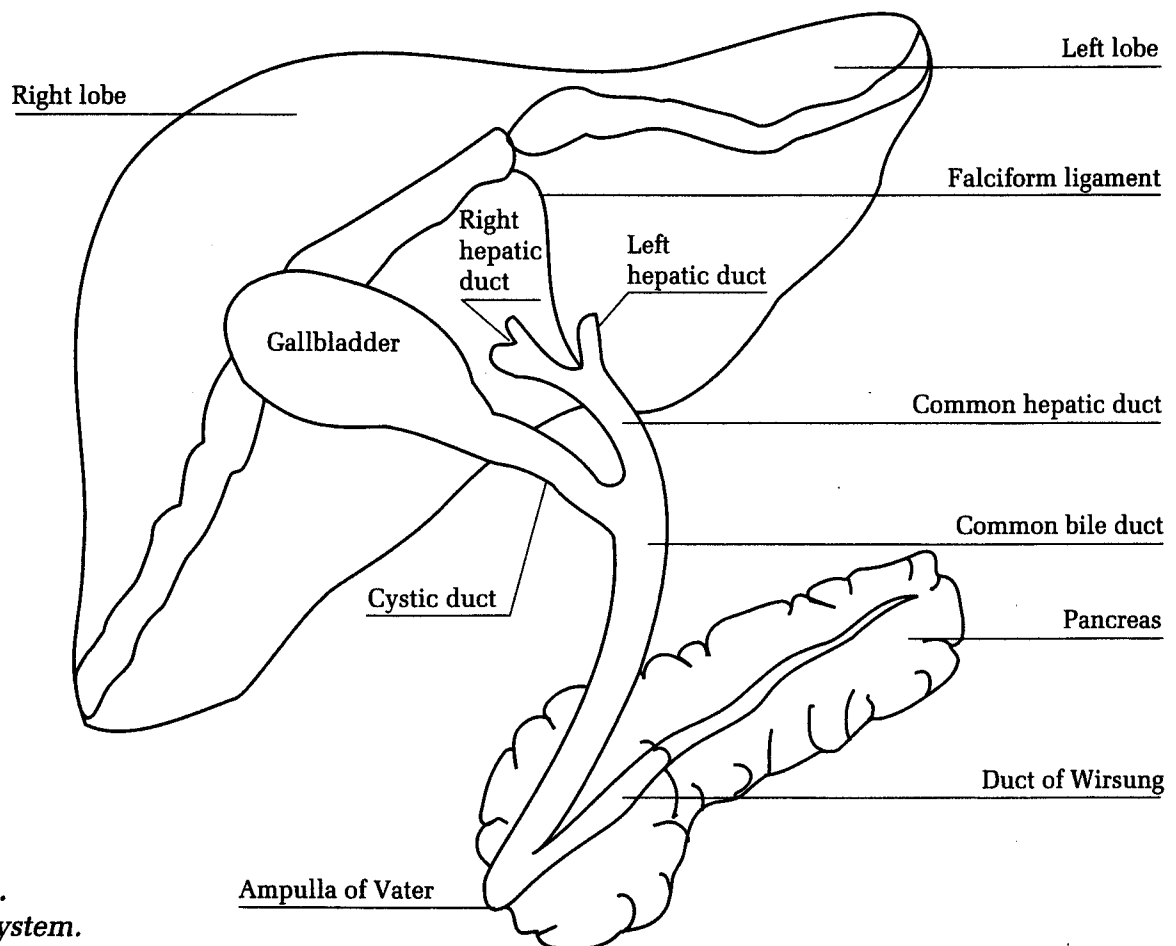


Figure 3.
Biliary system.

quadrate lobe and the posterior caudate lobe. Within the free border of the falciform ligament is the ligamentum teres, which is the remnant of the umbilical vein of the fetus.

The functional units of the liver are lobules. The lobules consist of hepatocytes, or liver cells, that secrete bile and are arranged around a central vein. Also found in the lobules are phagocytic cells, or Kupffer's cells, that destroy old blood cells, bacteria, and toxins. The bile is secreted into a series of ducts eventually becoming the right and left hepatic ducts. These unite to form the common hepatic duct. The common hepatic duct then empties into the common bile duct.

The liver performs many vital functions, which include the following:

1. Carbohydrate metabolism: Maintains blood sugar levels.
2. Fat metabolism: Breaks down fatty acids and synthesizes lipoproteins and cholesterol.
3. Protein metabolism: Deamination, conversion of ammonia, and synthesis of plasma proteins.
4. Elimination of drugs and hormones.
5. Production and elimination of bile.
6. Storage of glycogen, iron, copper, and vitamins A,D,B,E, and K.
7. Phagocytosis.
8. Activation of vitamin D.

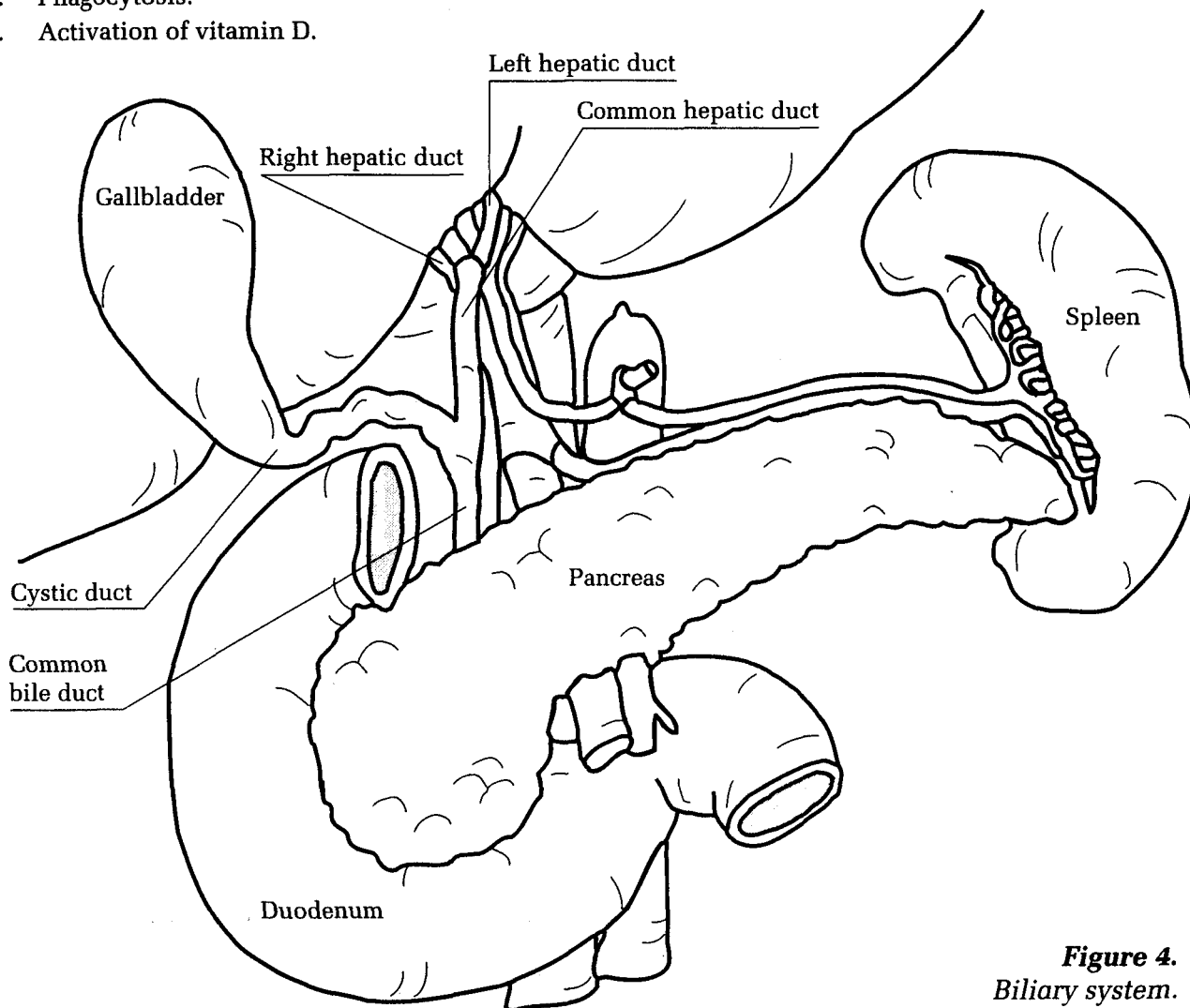


Figure 4.
Biliary system.

Gallbladder

The gallbladder (see Figures 3 and 4) is located under the liver and attached to the liver by visceral peritoneum referred to as the liver bed.

The gallbladder is a collapsible sac with an inner layer of mucosa arranged in folds, rugae, and a muscular layer. The gallbladder is connected to the common bile duct by the cystic duct.

The function of the gallbladder is to store and concentrate bile until it is needed in the small intestine to emulsify fats. The gallbladder ejects bile whenever high concentrations of fats enter the duodenum causing the intestinal mucosa to secrete cholecystokinin. This hormone causes the muscularis to contract.