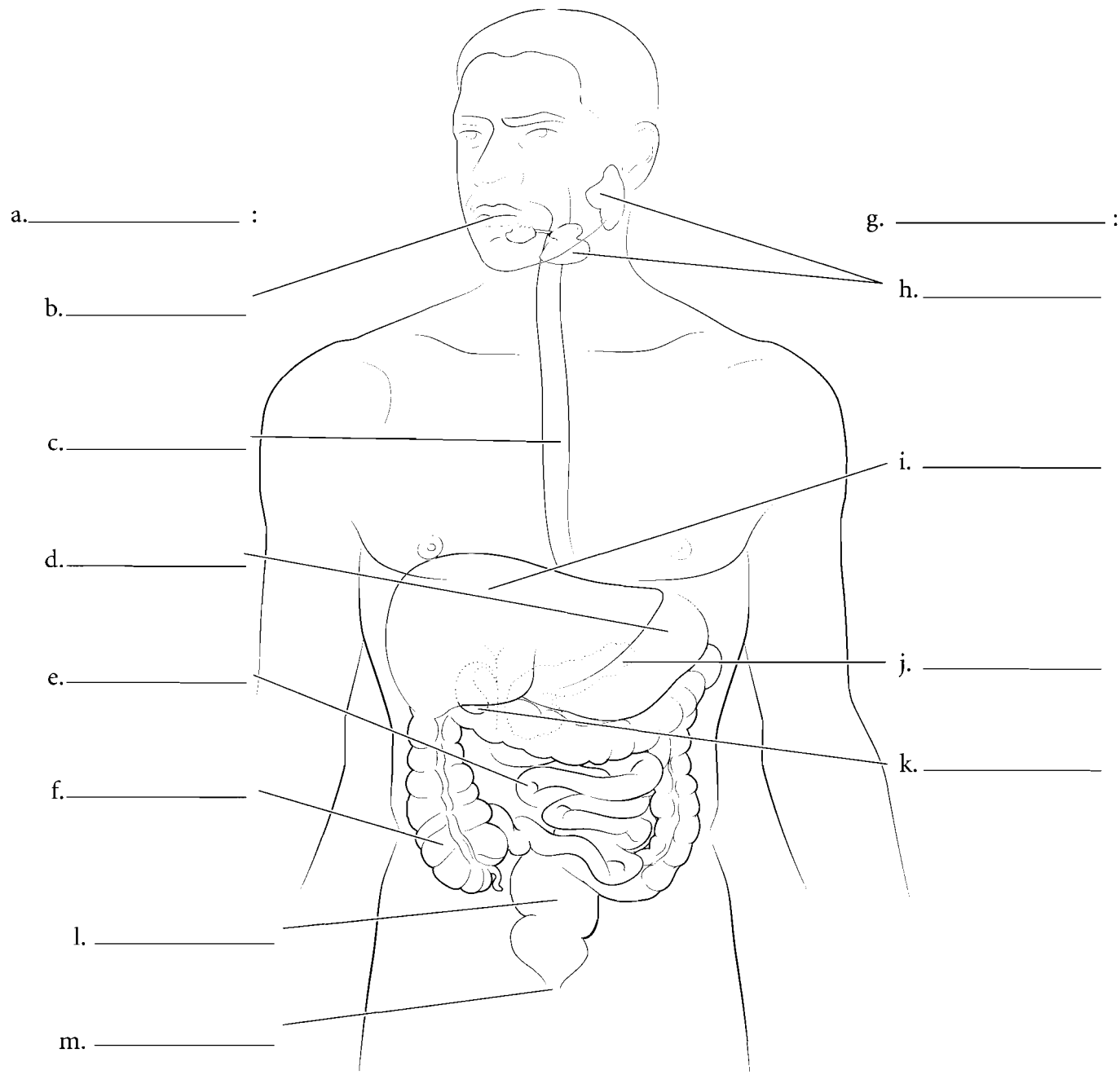
OVERVIEW OF THE DIGESTIVE SYSTEM

The digestive system is composed of a long tube called the **alimentary canal** and the **accessory organs** including the liver, pancreas, and gall bladder. The alimentary canal starts at the mouth, includes the esophagus, stomach, intestines, and rectum and terminates at the **anus**. It can be defined as the tube through which ingested products move. The accessory organs have digestive functions but they do not come into contact with material passing through the digestive tract. The alimentary canal consists of numerous organs including the **mouth** which is the opening to the system and is directly anterior to the oral cavity. The terminal aspect of the oral cavity is defined by the small mass of fleshy tissue called the uvula. Posterior to the oral cavity is the oropharynx. This chamber receives food and liquid from the mouth and air from both the mouth and nasal cavity. The oropharynx leads to the **esophagus** which is a muscular tube that takes ingested material to the **stomach**. The stomach is a storage organ leading to the **small intestine** where material is digested and absorbed. The **large intestine** receives material from the small intestine, removes a significant amount of water, and stores the fecal material prior to defecation.

The **salivary glands** are the most superior accessory glands. They lubricate food and add digestive enzymes to material that is swallowed. The **liver**, **pancreas** and **gall bladder** all add secretions to the ingested material and aid in the digestive process. Label the parts of the digestive system, including the alimentary canal and the accessory organs, and color the individual digestive organs a different color.

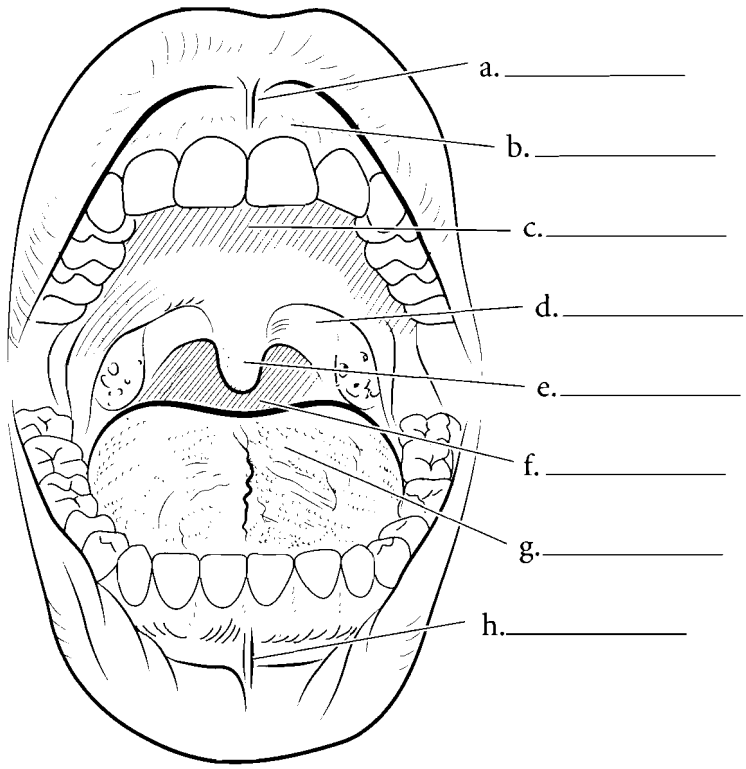


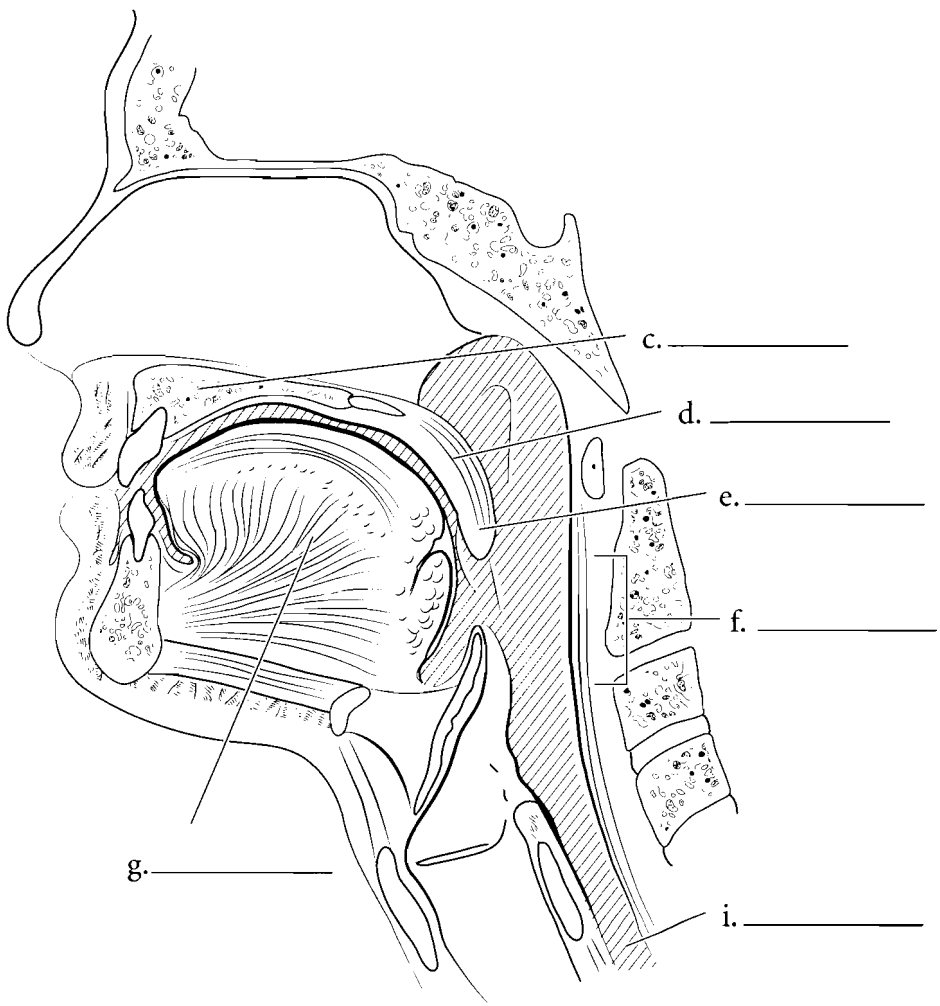
Answer Key: a. Alimentary canal, b. Mouth, c. Esophagus, d. Stomach, e. Small intestine, f. Large intestine, g. Accessory organs, h. Salivary glands, i. Liver, j. Pancreas, k. Gall bladder, l. Rectum, m. Anus

MOUTH AND ORAL CAVITY

The mouth is the entrance to the digestive system. It is bordered by the two **labia** or lips. Each labium has a **labial frenulum** (**superior** and **inferior**) that holds the lip to the **gingiva**. The gingiva (gums) have a surface tissue of stratified squamous epithelium which is the cell type that lines the entire oral cavity. The oral cavity encloses the teeth, and the **tongue.** It is bordered by the **hard palate**, the **soft palate**, the **uvula**, the cheek walls, the muscles and associated tissue that spans across the bodies of the mandible. The oral cavity leads to the **oropharynx**, which in turn leads to the **esophagus**.

The **tongue** is a large muscle in the oral cavity that pushes food to the posterior part of the oral cavity for swallowing and helps form speech. It is held to the floor of the oral cavity by the lingual frenulum.

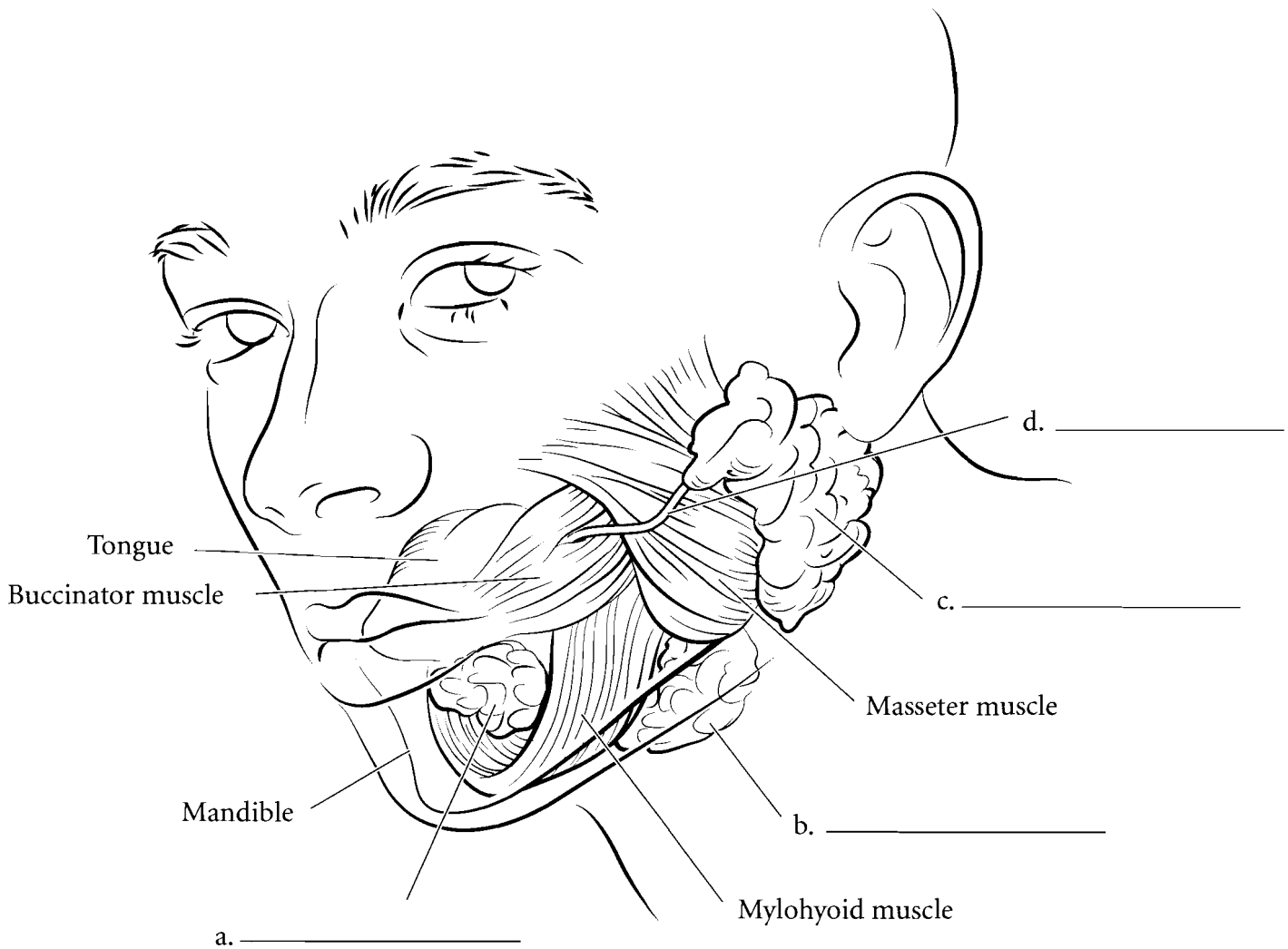




Answer Key: a. Superior labial frenulum, b. Gingiva, c. Hard palate, d. Soft palate, e. Uvula, f. Oropharynx, g. Tongue , h. Inferior labial frenulum, i. Esophagus

SALIVARY GLANDS

The three pair of salivary glands secrete saliva inside the oral cavity. The largest pair consists of the **parotid glands** and they are located just anterior to the ears. The **parotid duct** leads from the gland to posterior to the upper second molar. The **submandibular glands** are located inferior to the mandible and they take secretions to either side of the lingual frenulum. The **sublingual glands** are inferior to the tongue and have many tubes that lead to the lower oral cavity. Label the salivary glands and the parotid duct. Color each gland a different color.



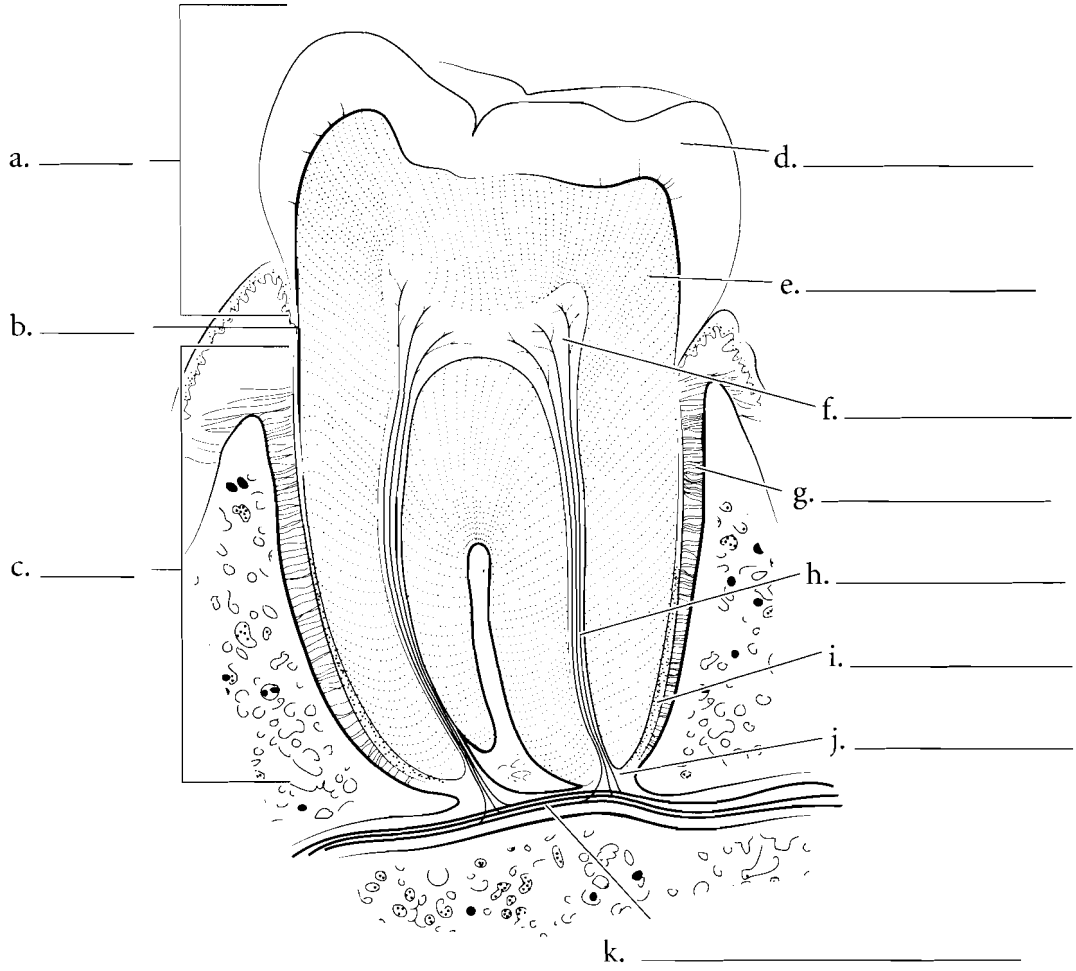
Answer Key: a. Sublingual gland, b. Submandibular gland, c. Parotid gland, d. Parotid duct

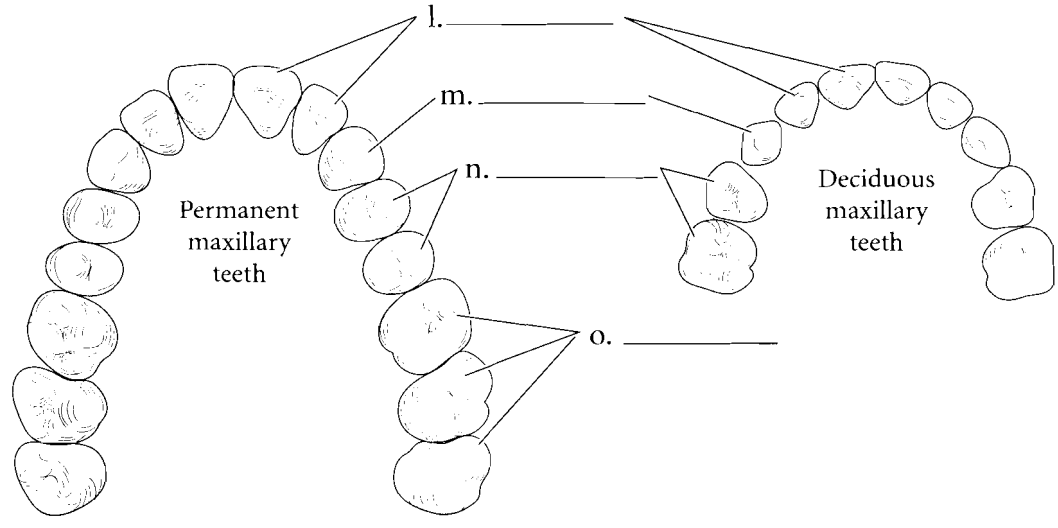
TEETH

The tooth has three general regions: the crown, the neck, and the root. The **crown** is the part of the tooth that erupts from the gums into the oral cavity. The **neck** is normally at the level of the gingiva and the **root** is imbedded into the bone. The tooth fits into the alveolar socket of the maxilla or the mandible and is held there by the **periodontal ligaments**.

The internal anatomy of the tooth reveals the hard **enamel** which is an extremely dense material that resists wear and abrasion. Deep to this is the **dentin**, a material similar to bone that provides the major structure of the tooth. In the root, the dentin is coated with **cementum** that helps fix the tooth in the alveolar socket. Inside of the dentin is the **pulp cavity** that houses **nerves** and **blood vessels**. These structures enter the tooth by the **apical foramen** and make their way to the pulp cavity by the **root canal**.

Humans have two series of teeth. Early in development come the **deciduous (milk) teeth**. The **permanent teeth** emerge as the skull is increasing in size. In deciduous teeth there are **incisors, cuspids (canines)**, and **molar teeth** but there are no premolars. In adults there are the **incisor teeth**, the **cuspids**, **premolars (bicuspids)**, and **molar teeth**. Label the parts of the tooth and then color in the regions of the tooth on one side of the illustration and the enamel, dentin, and other features on the other part of the illustration. For the deciduous and permanent teeth, use the same color for the incisors on both illustrations. Use another color for the cuspids and another for the premolars, and so on for the rest of the teeth.

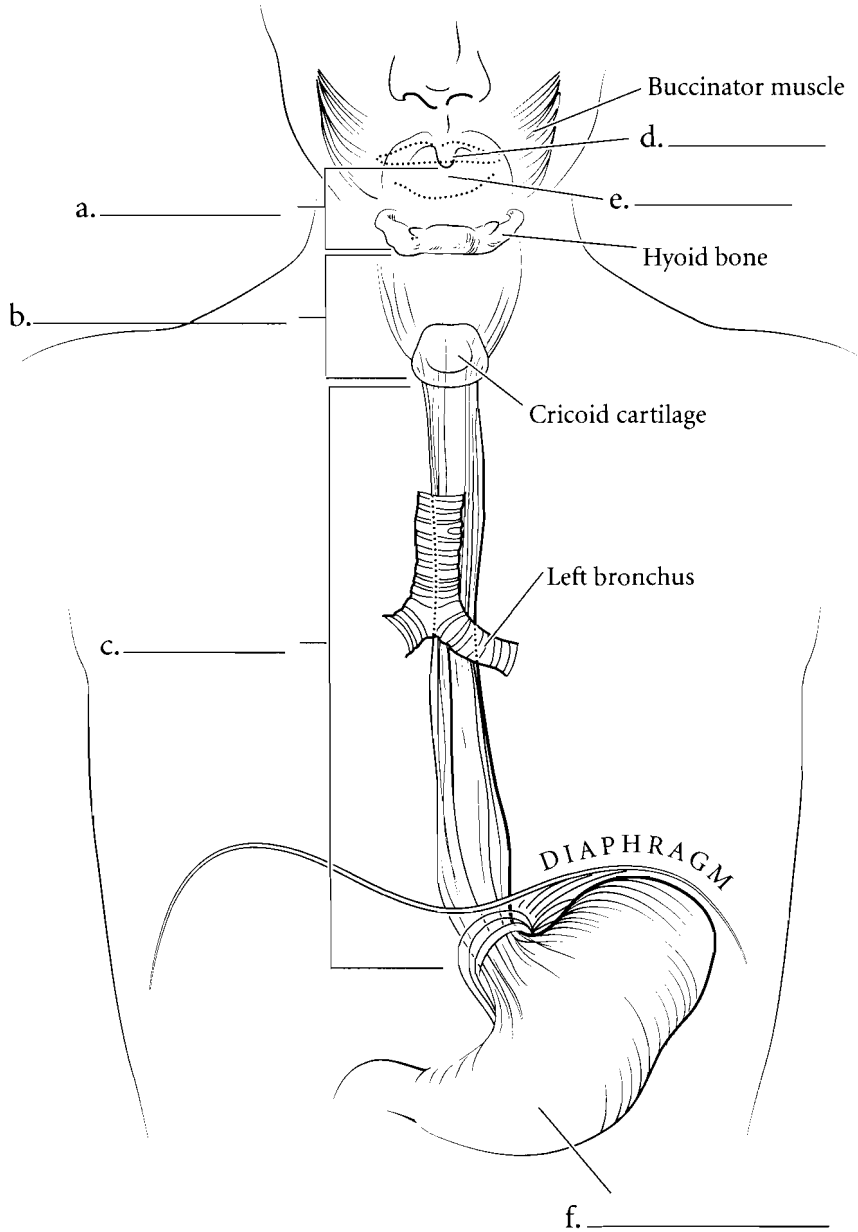


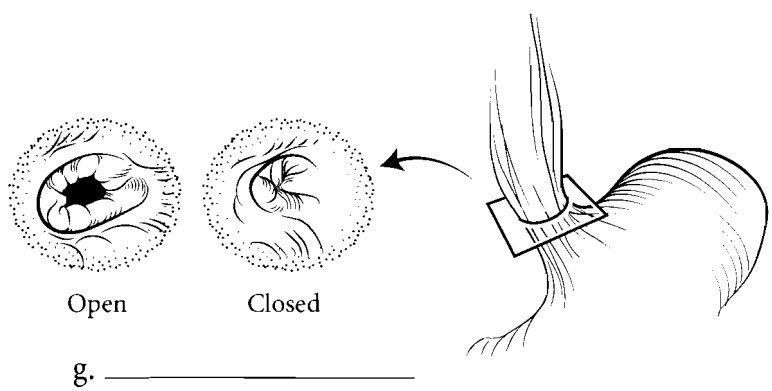


Answer Key: a. Crown, b. Neck, c. Root, d. Enamel, e. Dentin, f. Pulp cavity, g. Periodontal ligament, h. Root canal, i. Cementum, j. Apical foramen, k. Blood vessels and nerves, l. Incisors, m. Cuspids (canines), n. Premolars (bicuspids), o. Molars

ESOPHAGUS

Food moves from the **oral cavity** to the **oropharynx** by action of the tongue. The **uvula** flips upward keeping the food from entering the nasal cavity. Food passes from the oropharynx into the laryngopharynx before moving to the esophagus. The food enters the **esophagus** as a lump or **bolus** and passes through the **esophageal sphincter** to the stomach. Once it enters the stomach the bolus mixes with stomach fluid and becomes a liquid called chyme. Label and color the structures leading to the esophagus and the esophagus itself including the esophageal sphincter.





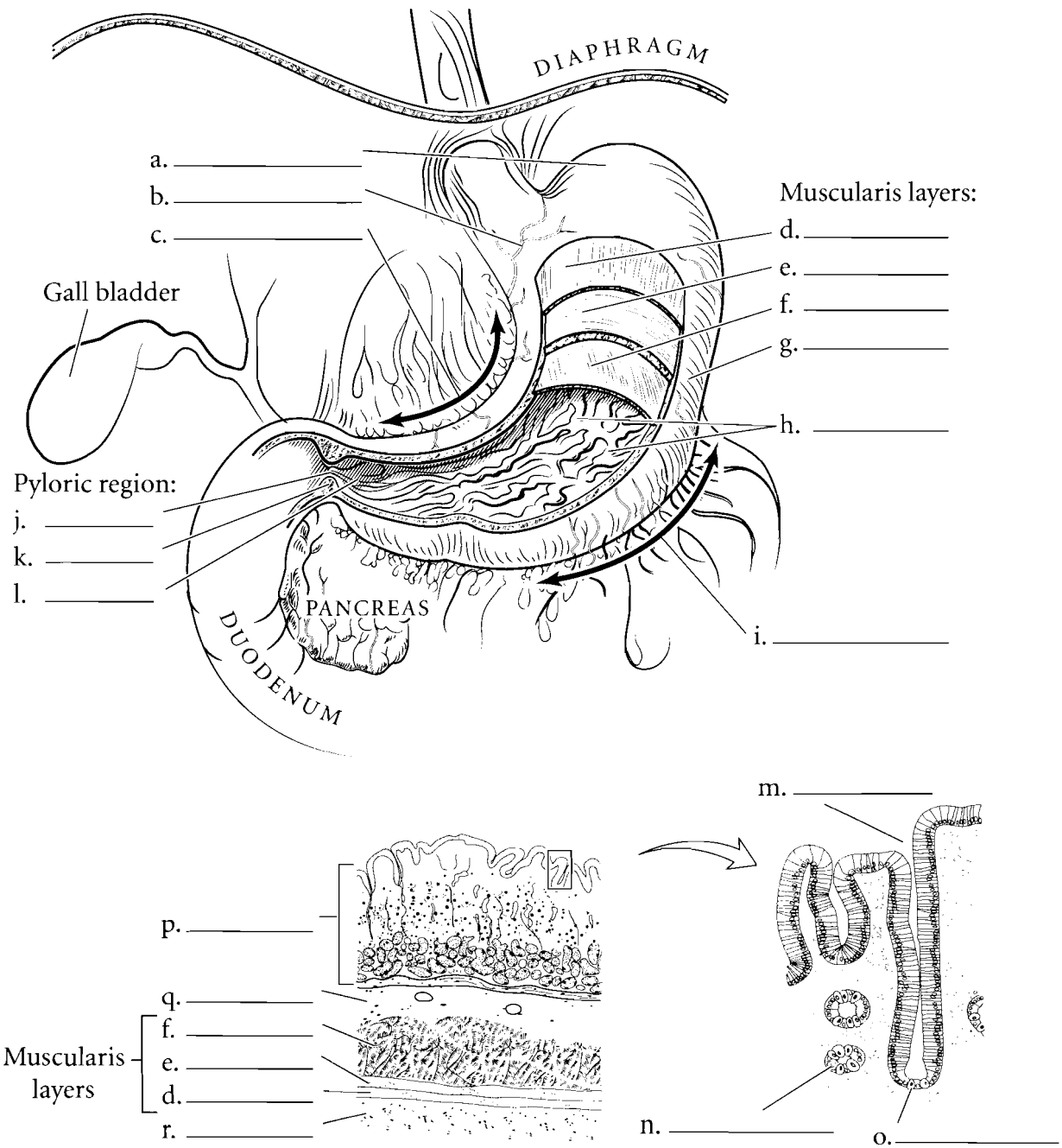
Answer Key: a. Oropharynx, b. Laryngopharynx, c. Esophagus, d. Uvula, e. Oral cavity, f. Stomach, g. Esophageal sphincter

STOMACH

The stomach is located on the left side of the body, just inferior to the diaphragm. It is the part of the alimentary canal located between the esophagus and the small intestine. The stomach has an upper **cardia** and a small domed portion called the **fundus**. The stomach contents are restricted from flowing back into the esophagus by the esophageal sphincter. If stomach fluid refluxes into the esophagus, it is felt as "heartburn."

The main portion of the stomach is the **body** and the narrow region, leading to the **duodenum** is the **antrum** or **pyloric region**. This leads to the **pyloric canal** which is controlled by the **pyloric sphincter**. The **greater curvature** is located on the left edge of the stomach and the **lesser curvature** is on the right side. The stomach has inner ridges called **rugae** which allow for expansion of the stomach.

The stomach has many layers. The inner layer is called the **mucosa** which is rich in glands that secrete acids and inactive enzymes such as pepsinogen into the stomach cavity. Pepsinogen is activated by hydrochloric acid. The mucosa has **gastric pits** with **parietal cells** and **chief cells** emptying into the pits. The parietal cells secrete hydrochloric acid and the chief cells secrete pepsinogen. External to the mucosa is the **submucosa** and this layer has many blood vessels imbedded in connective tissue. Beyond this is the **muscularis**. In the stomach there are three layers of the muscularis. These are the **oblique layer**, **circular layer**, and **longitudinal layer**. The most external layer is the **serosa** (also known as the **visceral peritoneum**) and this is next to the abdominal cavity. Label the parts of the stomach and color them in. Color the layers of the muscularis using different colors of red or pink for each layer. Color the general regions of the stomach different colors along with the separate sphincters.

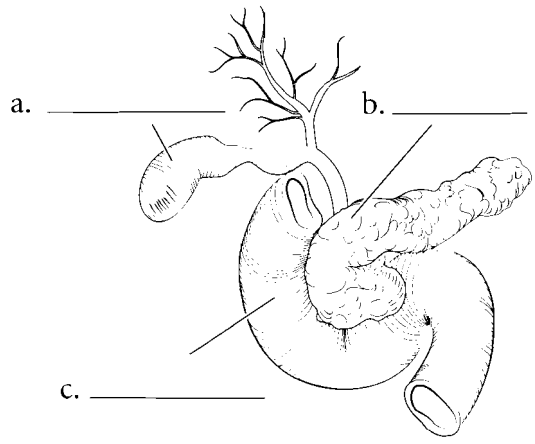


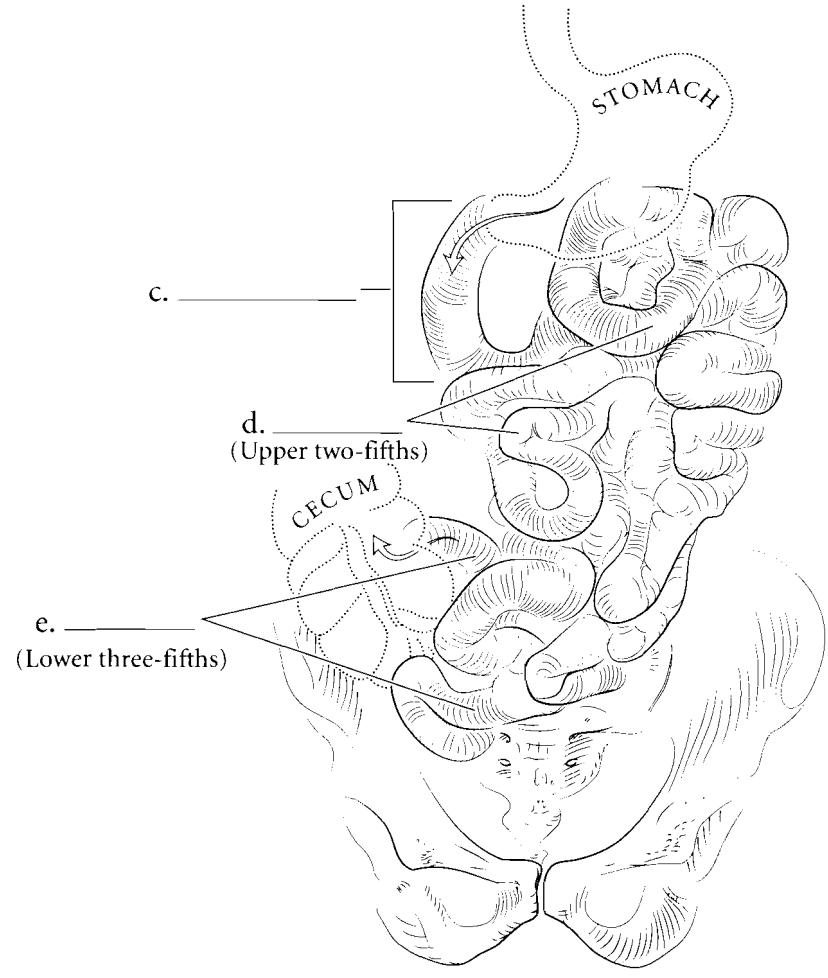
Answer Key: a. Fundus, b. Cardia, c. Lesser curvature, d. Longitudinal layer (of muscularis), e. Circular layer (of muscularis), f. Oblique layer (of muscularis), g. Body, h. Rugae, i. Greater curvature, j. Pyloric canal, k. Pyloric sphincter, l. Antrum, m. Gastric pit, n. Chief cell, o. Parietal cell, p. Mucosa, q. Submucosa, r. Serosa

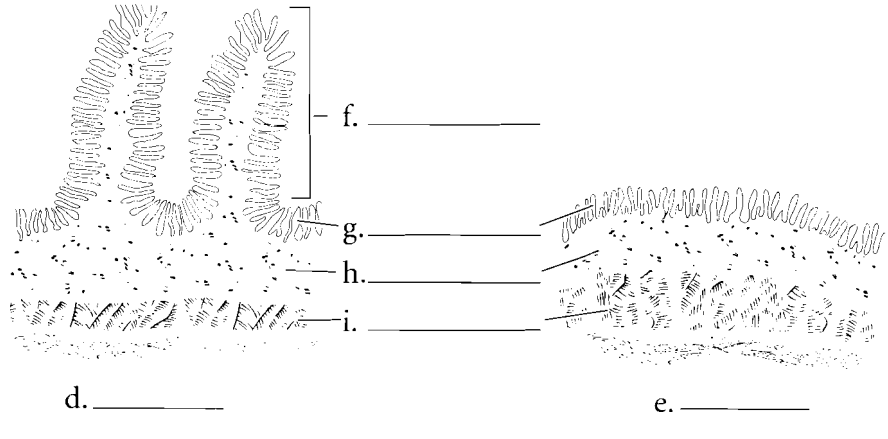
SMALL INTESTINE

The small intestine receives the contents of the stomach, continues the process of digestion and absorbs nutrients. The first part of the small intestine is the **duodenum**, a short tube of about twelve inches in length, that receives material from the stomach, enzymes and buffers from the **pancreas**, and bile from the **gall bladder**. The duodenum has **circular folds** in the wall that increase the surface area. The **jejunum** is the next section of the small intestine and it makes up about forty percent of the small intestine. There are **circular folds** in the jejunum as well. The **ileum** is the terminal portion of the small intestine and represents about sixty percent of the small intestine. The small intestine is small in diameter and that is how it gets its name.

The small intestine is distinguished from the rest of the alimentary canal by the presence of **villi**. These small structures in the mucosa increase the surface area of the small intestine and house blood capillaries and lacteals for the absorption of nutrients. The small intestine has the four layers typical of the other organs of the gastrointestinal tract: the mucosa, **submucosa**, **muscularis**, and serosa. Label the parts of the small intestine and color in the various regions and layers of the small intestine.





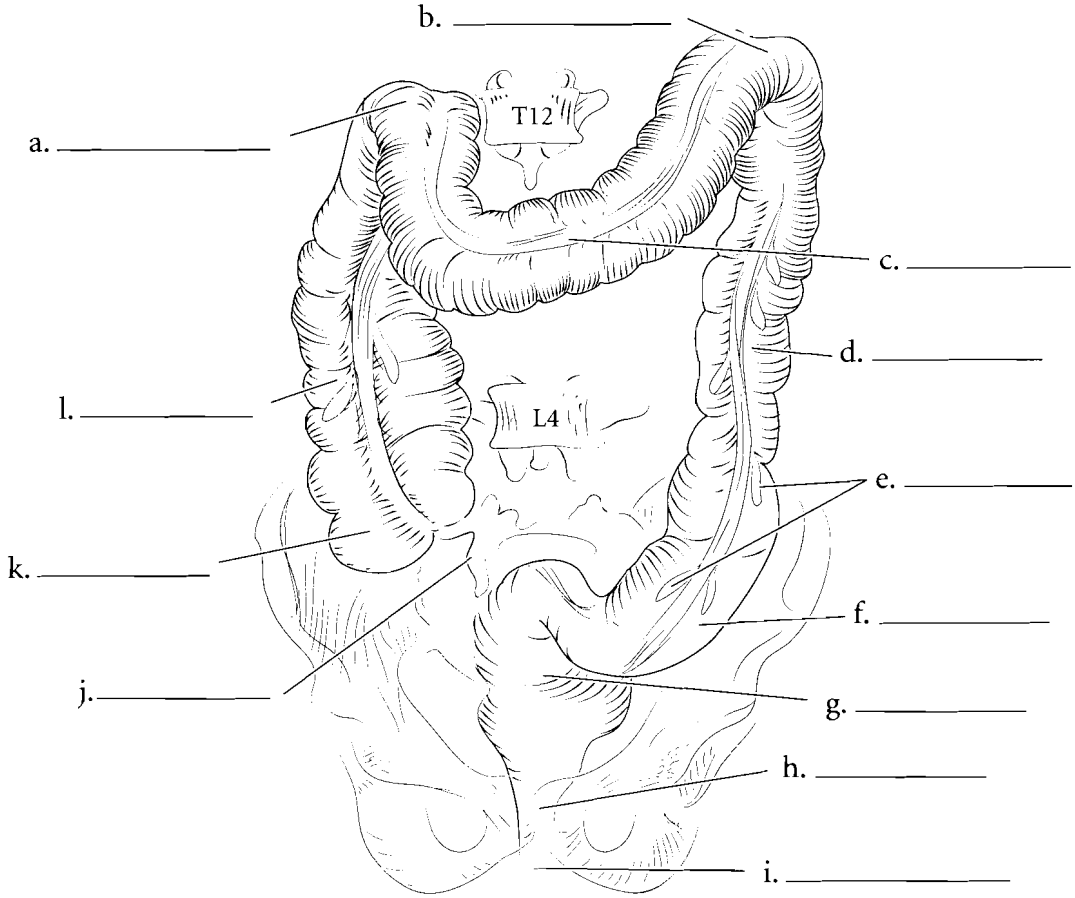


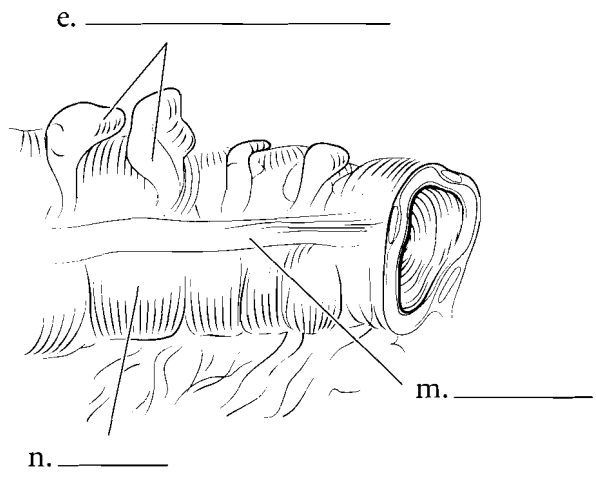
Answer Key: a. Gall bladder, b. Pancreas, c. Duodenum, d. Jejunum, e. Ileum, f. Circular fold, g. Villi, h. Submucosa, i. Muscularis

LARGE INTESTINE

The large intestine is shorter than the small intestine but has greater width. The large intestine begins in the lower right quadrant of the abdomen with a sac-like structure called the **cecum**. The ileocecal valve is a muscular sphincter that prevents the fecal material in the cecum from flowing back into the ileum. At this junction is the **vermiform appendix**. Material in the large intestine moves from the cecum to the **ascending colon** and then makes a sharp turn at the **hepatic flexure**. Once this turn is accomplished, the material is in the **transverse colon**. From here there is a sharp downward angle called the **splenic flexure** and the material enters the **descending colon**. From the descending colon, the material enters an S-shaped tube called the **sigmoid colon** and then enters the **rectum**. The rectum is the end of the large intestine. The rectum leads to the **anal canal** which is a short tube leading to the **anus**.

There are several anatomical features that separate the large intestine from the small intestine. The large intestine has long strips of smooth muscle that run the length of the large intestine. These are called the **teniae coli**. These muscles pull the intestine into small compartments called **haustra**. Another distinguishing feature of the large intestine is the presence of small fat globules called **epiploic appendages**. Label the parts of the large intestine and color in each region with a different color. Color the haustra light red and the tenia coli pink. Color the epiploic appendages yellow.



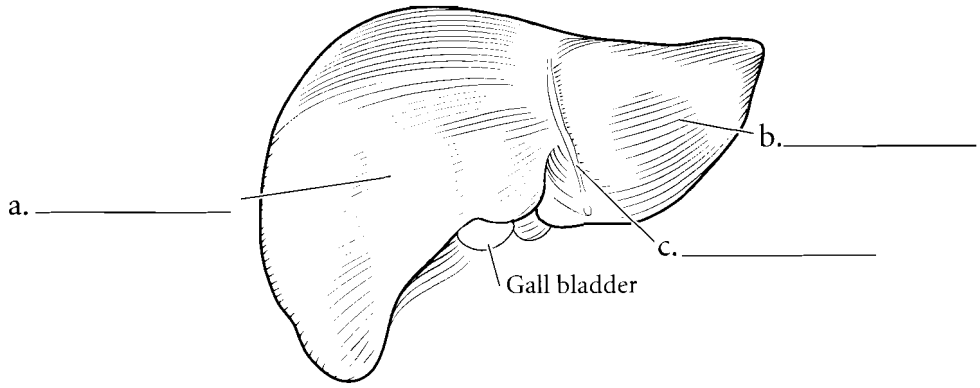


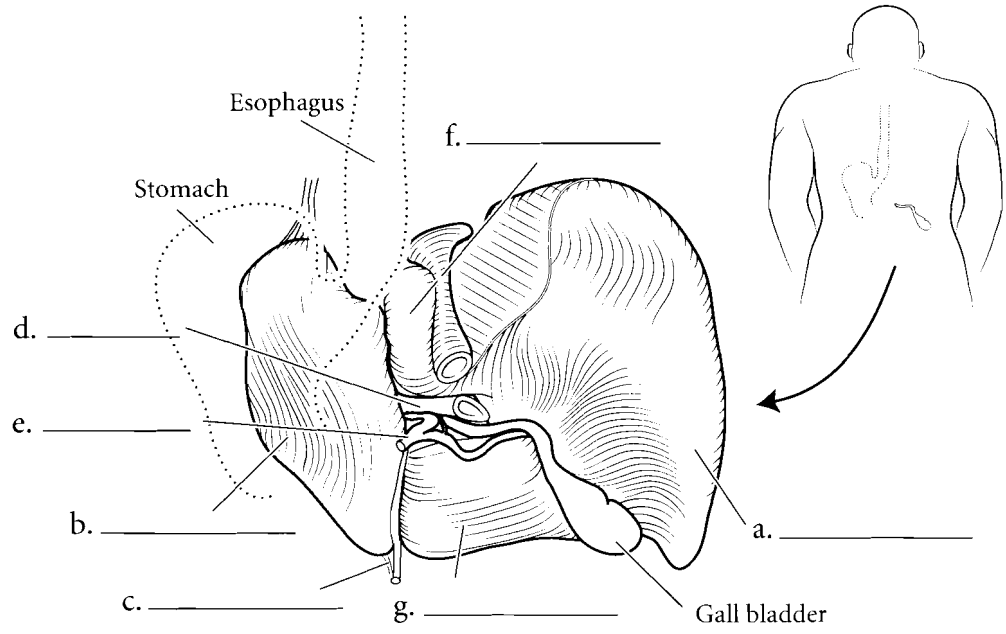
Answer Key: a. Hepatic flexure, b. Splenic flexure, c. Transverse colon, d. Descending colon, e. Epiploic appendages, f. Sigmoid colon, g. Rectum, h. Anal canal, i. Anus. j. Vermiform appendix, k. Cecum, l. Ascending colon, m. Tenia coli, n. Haustra

LIVER

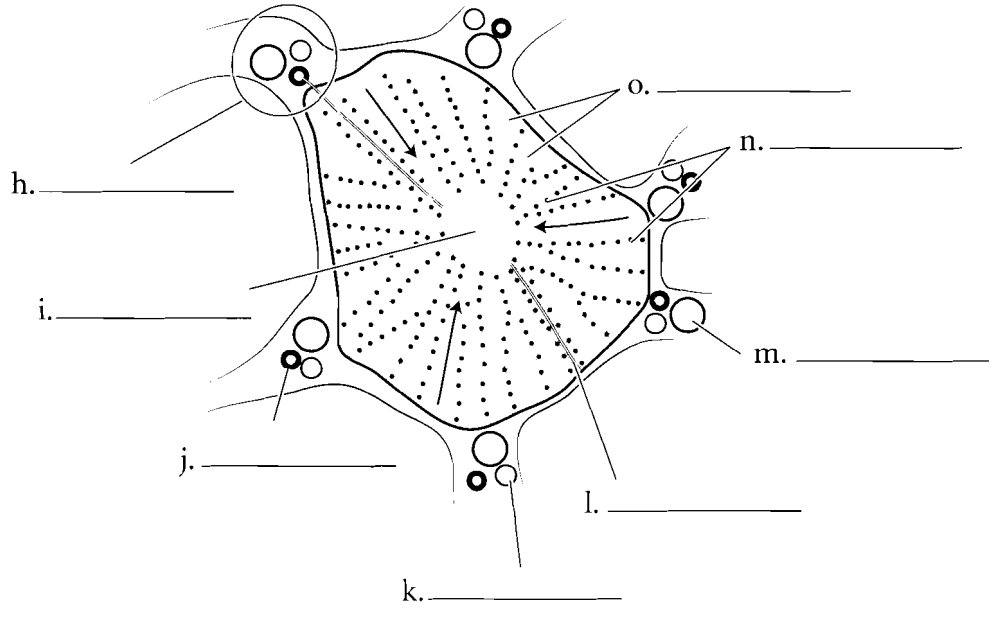
The liver is the largest internal organ of the body. It is on the right side of the body and plays a major metabolic function in digestion and also in processing material from the blood. The liver has four lobes in humans and is held to the diaphragm by the **falciform ligament**. The **right lobe** is the largest of the lobes. The **left lobe** is also reasonably large. The **quadrate lobe** is anterior and is rectangular in shape when seen from the inferior view. The **caudate lobe** is a posterior lobe of the liver.

The blood flows into the liver from two sources. The **hepatic portal vein** takes blood to the liver from the digestive tract and some abdominal organs. The **hepatic artery** brings oxygenated blood to the liver. The liver is composed of microscopic sections called **liver lobules**. These are typically hexagonal columns that have a **central vein** that takes blood back to the heart via the hepatic vein. Blood travels to the central vein by **sinusoids**, canals that are lined by **hepatocytes** (liver cells). Hepatocytes clean the blood or process material in the blood. Old blood pigments are recycled by the liver and are converted to bile. The bile moves through **bile canaliculi** and eventually is stored in the gall bladder. The branches of the hepatic artery, portal vein, and **bile duct** are clustered together and form the **portal triad**. Label the liver structures on the illustrations. Color in the lobes of the liver using different colors for each lobe. Color the hepatic portal vein blue, the hepatic artery red, and the bile ducts green.





Liver Lobule

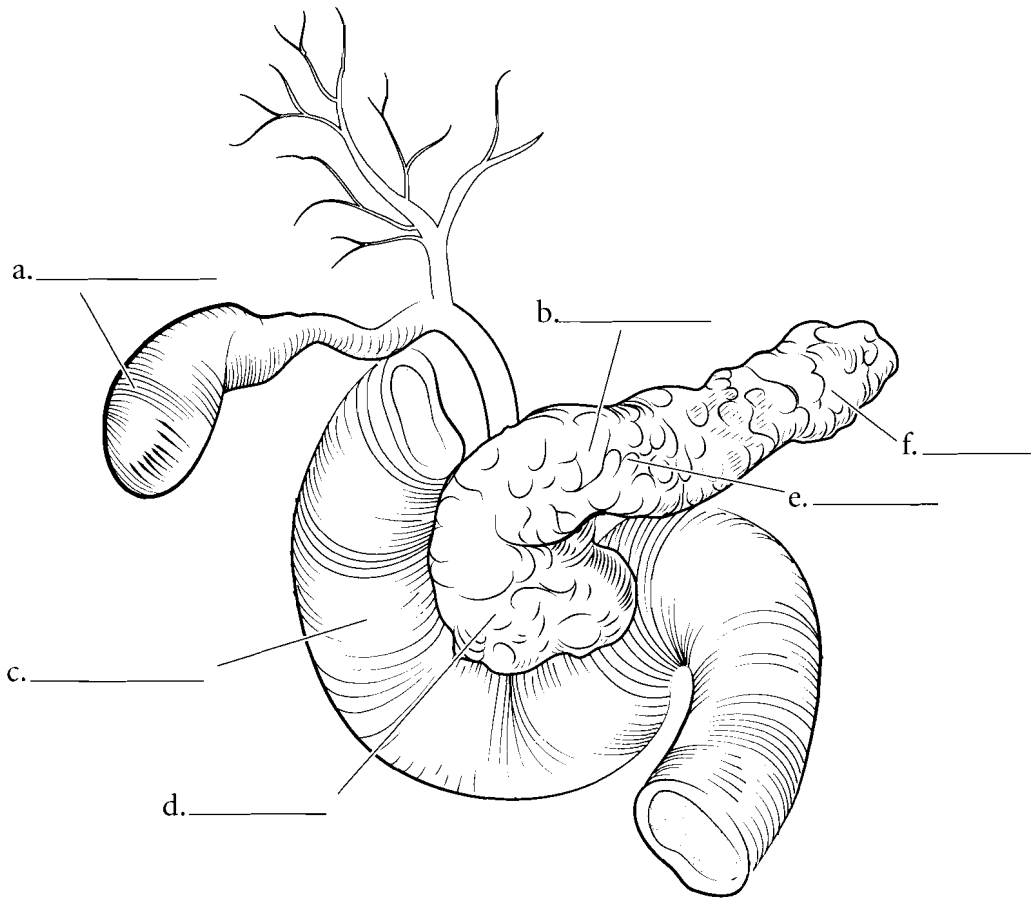


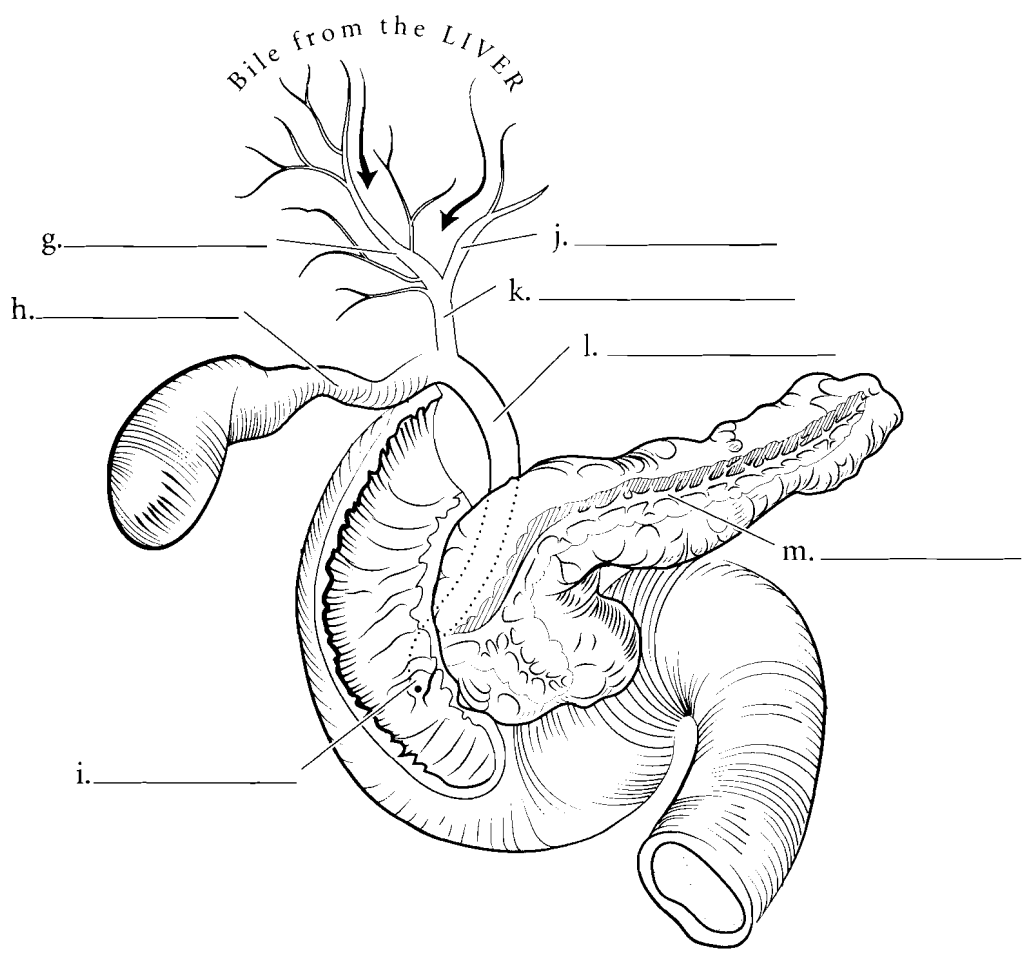
Answer Key: a. Right lobe, b. Left lobe, c. Falciform ligament, d. Portal vein, e. Hepatic artery, f. Caudate lobe, g. Quadrate lobe, h. Portal triad, i. Central vein, j. Bile duct, k. Hepatic artery branch, l. Bile canaliculus, m. Portal vein branch, n. Hepatocytes, o. Sinusoids

PANCREAS/ GALL BLADDER

The **pancreas** is a complex organ that has both a digestive function and an endocrine function. The digestive function of the pancreas consists of producing enzymes for the digestion of materials in the small intestine and the secretion of buffers to increase the pH of the fluid secreted from the stomach. The pancreas has a **head**, next to the duodenum, a main **body** and a **tail** near the spleen. The enzymes and buffers secreted into the small intestine flow into the **pancreatic duct** before entering the small intestine.

The **gall bladder** receives bile from the **liver**, storing and condensing it prior to secreting it into the small intestine. Bile is an emulsifier of fats, making them disperse in the liquid chyme of the digestive tract. Bile flows from the **left** and **right hepatic ducts**, into the **common hepatic duct**, into the **cystic duct** then entering the gall bladder. When the gall bladder contracts, bile moves back out the cystic duct and into the **common bile duct** before entering the small intestine. Usually the common bile duct and the pancreatic duct join before they enter the small intestine. In this case the tube is called the hepatopancreatic ampulla and it leads to the **duodenal papilla**. Label the parts of the pancreas, gall bladder and ducts and color them in.





Answer Key: a. Gall bladder, b. Pancreas, c. Duodenum, d. Head, e. Body, f. Tail, g. Right hepatic duct, h. Cystic duct, i. Duodenal papilla, j. Left hepatic duct, k. Common hepatic duct, l. Common bile duct, m. Pancreatic duct