LABORATORY EXERCISES FOR GUT ACCESSORY ORGANS

The organs accessory to the gut aid in the digestion or processing of food by the gut. These include the liver, the gall bladder and the pancreas. The exercises below contain slides from each of these organs taken from both the human slide box and the comparative collection. First familiarize yourself with the human material, then look at material from other vertebrate groups for comparison.

Liver. This organ is present in all vertebrates, is the largest internal organ, and is also the largest gland. The basic functional unit of the liver, the hepatocyte, is a multipurpose cell common to all vertebrates. These cells are responsible for processing carbohydrate and amino acid monomers absorbed from the small intestine into glycogen for energy storage and eventual release; for breaking down and eliminating blood-borne metabolites and toxins; for eliminating bilirubin (the main waste product of senescent erythrocytes); and for producing bile to aid in digesting lipids. Differences among livers of the different vertebrate groups mostly concern variations in the anatomical arrangement of sheets of hepatocytes and the way in which these sheets are exposed to the blood. All livers receive two circulations, from the hepatic portal vein, containing nutrient-rich blood from the gut; and oxygen-rich arterial blood from the systemic circulation. Blood from these sources mixes in the liver sinusoids and is exposed to hepatocytes for processing. In the livers of fishes, amphibians and birds there are no discrete lobules, but the livers of birds and mammals are subdivided into many anatomically distinct lobules, each with its own blood supply.

Liver slides 69 and 210 (injected vasculature), human histology. Use the posted information and a histology textbook to guide your exploration of slide 69. Identify lobules by their connective tissue borders; lobules usually have 5 or 6 sides, but not all lobules will have distinct borders. At some of the corners where several lobules meet, you should be able to identify elements of a portal triad: a branch of the hepatic portal vein, an arteriole, and a bile ductule. What type of epithelium lines the bile ductule? You may be able to see larger branches of the bile duct on your section; how does the epithelium in these branches differ from that of the ductules? The blood sinusoids can be seen on this slide, but they are more obvious on slide 210, taken from the liver after a marker dye was injected into the portal vein. Examine how the hepatocytes are organized into sheets between the sinusoids. On both slides the central veins are clearly visible. Bile canaliculi cannot be seen on these slides.

CVH slides 73 dogfish liver, 146 teleost liver, 166 toad liver, 171 alligator liver. Examine these slides to identify the same elements as for the human liver. The major difference between the livers of fish, amphibians and reptiles and those of birds and mammals is the lack of distinct lobulation. The operation of the hepatocytes is the same in all livers. Can you determine how the sheets of hepatocytes are organized? As with the human specimens, bile canaliculi are not visible on these slides. A major component of the dogfish liver is the presence of large amounts of the lipid, squalene, in droplets in most hepatocytes; these droplets are unstained in your slide. This lipid is less dense than water, so contributes to the buoyancy of these organisms.

Gall bladder. Most vertebrates have a gall bladder, which receives and stores bile synthesized in the liver. The gross anatomy of the gall bladder varies among vertebrates, but the histological structure of the wall of this organ is similar.

Gall bladder slide 211 human and CVH slide 154, codfish. Look for the epithelium, lamina propria, muscularis and adventitia in the bladder wall of both specimens. How does the epithelial folding compare in these slides, and what is the purpose of this folding?

Pancreas. The vertebrate pancreas is a gland associated with the duodenum, or with the caudal part of the intestine in animals that do not have a duodenum. This gland produces both exocrine and endocrine secretory products. The exocrine secretions are synthesized in simple acinar glands in the stroma; this type of secretory unit makes up about 99% of the total volume of the gland. Their secretions consist of proto-enzymes, in the form of zymogen granules, which are released into the acinar lumens, collected in intercalated ducts and then carried by the pancreatic duct to the small intestine. These proto-enzymes are cleaved by enzymes in the lumen of the small intestine to form active digestive enzymes. Why is the active form of these digestive enzymes not released from the pancreatic acini? Endocrine secretions are produced by the islets of Langerhans, groups of cells embedded within the stroma of the acinar region and isolated by a thin connective tissue capsule. The hormones glucagon and insulin are released by different types of islet cells, but these cell types cannot be distinguished on these slides.

Pancreas slide 144 human, CVH slides 69 dogfish and 170 alligator. On the human slide, identify the acinar region and locate islets embedded within the acinar tissue. Try to find acini in which you can identify a lumen. Can you differentiate the acinar secretory cells from those forming the beginning of the intercalated ducts? Can you identify any ducts in your tissue? Ducts will have a cuboidal or low columnar epithelium and will be surrounded by connective tissue. Within the islets, the secretory cells are arranged in clumps or cords, surrounded by fenestrated capillary sinusoids, represented by narrow spaces between the cells. Can you see a connective tissue capsule around the islets? In the dogfish pancreas ducts are plentiful within the acinar region but details of the acini themselves are not clear, nor are the islets differentiated well from the acinar region by the stain used. In the slide taken from the alligator, pancreatic tissue is closely associated with the small intestine, a portion of which is seen in oblique or cross-section. Here the pancreatic acini are clearly visible and in the cytoplasm of some acinar secretory cells zymogen granules can be seen toward the apical surface. Branches of the pancreatic duct of various sizes are also visible; what type of epithelium is present in these ducts? Islets tend to be smaller than in the mammalian pancreas, but the islet cells are not well stained on this slide.