15 LIVER AND GASTROENTEROLOGY TESTS

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OBJECTIVES

After completing this chapter, the reader should be able to

- Discuss how the anatomy and physiology of the liver and pancreas affect interpretation of pertinent laboratory test results
- Classify liver test abnormalities into cholestatic and hepatocellular patterns and understand the approach to evaluating patients with these abnormalities
- Explain how hepatic and other diseases, as well as drugs and analytical interferences, cause abnormal laboratory test results for bilirubin
- Understand hepatic encephalopathy and the role of serum ammonia in its diagnosis
- Discuss the laboratory test abnormalities typically associated with hemochromatosis
- Design and interpret a panel of laboratory studies to determine if a patient has active, latent, or previous viral hepatitis infection
- Understand the significance and utility of amylase and lipase in evaluating abdominal pain and pancreatic disorders
- Discuss the role of *Helicobacter pylori* in peptic ulcer disease and the tests used to diagnose it
- Discuss the tests and procedures used to diagnose *Clostridium difficile* colitis

Hepatic and other gastrointestinal (GI) abnormalities can cause a variety of clinically significant diseases, in part because of their central role in the body's biochemistry. This chapter provides an introduction to common laboratory studies used to investigate these diseases. Studies of the liver are roughly divided into those associated with (1) synthetic liver function, (2) excretory liver function and cholestasis, (3) hepatocellular injury, and (4) detoxifying liver function and serum ammonia. Specific tests may also be used to investigate specific disease processes including viral hepatitis, primary biliary cirrhosis (PBC), and hemochromatosis. This chapter also covers several tests for specific nonhepatic disease processes (including pancreatitis, *Helicobacter pylori* [*H. pylori*] infection, and *Clostridium difficile* [*C. difficile*] colitis).

ANATOMY AND PHYSIOLOGY OF THE LIVER AND PANCREAS

Liver

The *liver,* located in the right upper quadrant of the abdomen, is the largest solid organ in the human body.[1] It has two sources of blood:

1. The hepatic artery, originating from the aorta, supplies arterial blood rich in oxygen.
2. Portal veins shunt the venous blood from the intestines to the liver. This transports absorbed toxins, drugs, and nutrients directly to the liver for metabolism.

The liver is divided into thousands of lobules (**Figure 15-1**). Each lobule is comprised of plates of hepatocytes (liver cells) that radiate from the central vein much like spokes in a wheel. Between adjacent liver cells formed by matching grooves in the cell membranes are small bile canaliculi. The hepatocytes continually form and secrete bile into these canaliculi, which empty into terminal bile ducts. Subsequently, like tiny streams forming a river, these bile ducts empty into larger and larger ducts until they ultimately merge into the common duct. Bile then drains into either the gallbladder for temporary storage or directly into the duodenum.

The liver is a complex organ with a prominent role in all aspects of the body's biochemistry. It takes up amino acids absorbed by the intestines, processes them, and synthesizes them into circulating proteins including albumin and clotting factors. The liver is also involved in the breakdown of excess amino acids and processing of byproducts including ammonia and urea. The liver plays a similar role in absorbing carbohydrates from the gut, storing them in the form of glycogen, and releasing them as needed to prevent hypoglycemia. Most lipid and lipoprotein metabolism, including cholesterol synthesis, occurs in the liver. The liver is the primary location for detoxification and excretion of a wide variety of endogenous substances produced by the body (including sex hormones) as well as exogenous substances absorbed by the intestines (including a panoply of drugs and toxins). Thus, in patients with liver failure, standard dosing of some medications can lead to dangerously high serum concentrations and toxicity. The role of the liver in bilirubin metabolism is explored further below.

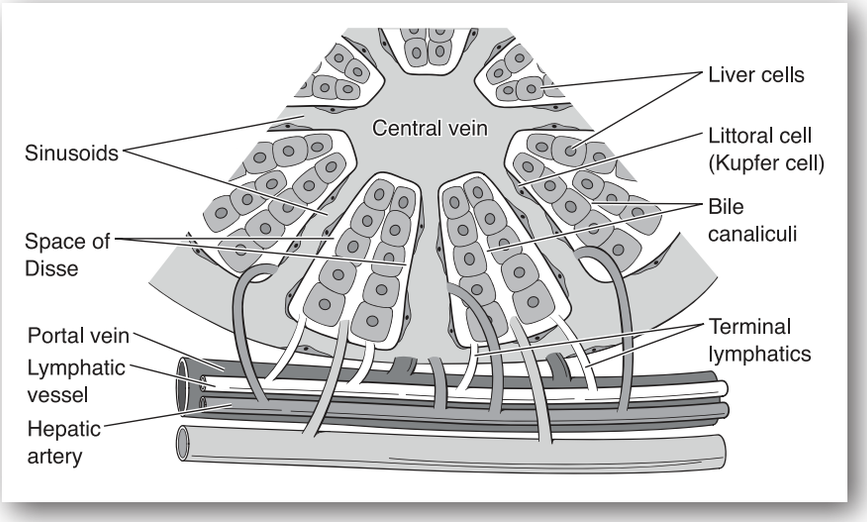

FIGURE 15-1. Basic structure of a liver lobule including the lymph flow system comprised of the spaces of Disse and interlobular lymphatics. *Source:* Reproduced with permission from Guyton AC. Medical Physiology. 5th ed. Philadelphia: WB Saunders; 1976.

With its double blood supply, large size, and critical role in regulating body metabolic pathways, the liver is affected by many systemic diseases. Although numerous illnesses affect the liver, it has tremendous reserve capacity and can often maintain its function in spite of significant disease. Furthermore, the liver is one of the few human organs capable of regeneration.

Pancreas

The *pancreas* is an elongated gland located in the retroperitoneum. Its head lies in close proximity to the duodenum, and the pancreatic ducts empty into the duodenum. The pancreas has both exocrine glands (which secrete digestive enzymes into the duodenum) and endocrine glands (which secrete hormones directly into the circulation).

The pancreatic exocrine glands produce enzymes that aid in digestion of proteins, fats, and carbohydrates (including trypsin, chymotrypsin, lipase, and amylase). Insufficient enzyme production (i.e., pancreatic exocrine insufficiency) is associated with malabsorption of nutrients, leading to progressive weight loss and severe diarrhea. The glands also produce many hormones including insulin and glucagon. Insufficient insulin production leads to diabetes mellitus. Thus, the pancreas plays an important role in digestion and absorption of food as well as metabolism of sugar. Like the liver, the pancreas has a tremendous reserve capacity; over 90% glandular destruction is required before diabetes or pancreatic insufficiency develops.

AN INTRODUCTION TO LIVER TESTS AND THE LFT PANEL

Investigation of liver disease often begins with obtaining a panel of liver tests generally referred to as the *LFT panel* or *LFTs* (liver function tests). This panel may vary slightly between hospitals and laboratories but generally includes the aminotransferases (previously referred to as *transaminases*), including aspartate aminotransferase (AST), alanine aminotransferase (ALT), bilirubin, alkaline phosphatase (ALP), and albumin. LFT is a misnomer because not all of these tests actually measure liver function (specifically, aminotransferases reflect liver injury). Additionally, the liver has several functions, and different tests reflect these different functions. **Table 15-1** divides liver tests into rough categories. Although there is considerable overlap between these categories, these divisions may provide an initial framework for understanding the LFT panel.

This grouping of tests mirrors a division of liver diseases into two broad categories: cholestatic and hepatocellular. In cholestatic disease, there is an abnormality in the excretory function of the liver (i.e., namely secretion of bile by hepatocytes and passage of bile through the liver and bile ducts into the

TABLE 15-1. Categories of Liver Tests

PROCESS	MOST CLOSELY RELATED TESTS
Protein synthesis	Albumin
	Prealbumin
	PT/INR (clotting factors)
Excretion into the bile ducts and drainage into the duodenum (impairment of this process is defined as cholestasis)	Bilirubin
	ALP
	5'-nucleotidase
	GGT
Hepatocellular injury	Aminotransferases:
	AST
	ALT
Detoxification	Ammonia (NH_3+)

ALP = alkaline phosphatase; ALT = alanine aminotransferase; AST = aspartate aminotransferase; GGT = gamma-glutamyl transpeptidase; INR = international normalized ratio; PT = prothrombin time.