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## ANATOMY OF THE LIVER: STRUCTURAL ORGANIZATION, PHYSIOLOGICAL FUNCTIONS, AND CLINICAL SIGNIFICANCE

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**Abstract:** *The liver is the largest internal organ in the human body and plays a crucial role in metabolic regulation, detoxification, and synthesis of essential biomolecules. Its structural organization includes complex vascular and biliary systems that support numerous physiological processes necessary for maintaining homeostasis. The liver receives a dual blood supply from the hepatic artery and the portal vein, allowing efficient processing of nutrients and toxins absorbed from the gastrointestinal tract. Histologically, the liver is composed of hepatic lobules containing hepatocytes, sinusoidal capillaries, Kupffer cells, and bile canaliculi. Recent scientific studies have expanded our understanding of hepatic microarchitecture and its role in metabolic regulation and immune responses. The aim of this article is to analyze the structural organization of the liver, its physiological functions, and its clinical significance based on modern anatomical and medical research.*

**Keywords:** *liver anatomy, hepatocytes, hepatic lobule, portal triad, liver physiology, hepatology*

### INTRODUCTION

The liver is one of the most essential organs of the human body, performing numerous metabolic, synthetic, and detoxification functions. It is the largest gland in the body, with an average weight of approximately 1.4–1.6 kg in adults. Anatomically, the liver is located in the right upper quadrant of the abdominal cavity beneath the diaphragm.

The liver plays a central role in regulating metabolic processes such as

carbohydrate metabolism, lipid metabolism, and protein synthesis. In addition, it functions as a major detoxification organ responsible for metabolizing drugs, toxins, and metabolic waste products.

Due to its complex anatomical structure and wide range of physiological functions, the liver has become a major focus of research in anatomy, physiology, and clinical medicine. Understanding the structural organization of the liver is



essential for diagnosing hepatic diseases and performing surgical procedures such as liver resection and transplantation.

The purpose of this study is to review the anatomical structure, physiological functions, and clinical significance of the liver based on modern scientific literature.

## MATERIALS AND METHODS

This article is based on a comprehensive literature review of scientific publications related to liver anatomy, physiology, and hepatology. Academic databases including medical journals, textbooks, and peer-reviewed articles published between 2015 and 2025 were analyzed.

The selected sources included studies describing liver morphology, hepatic vascularization, histological organization, and functional physiology. The collected data were systematically analyzed and synthesized to provide an updated overview of the structural and functional characteristics of the liver.

## RESULTS

### Macroscopic Structure of the Liver

The liver is located in the right hypochondrium and epigastric regions of the abdominal cavity. It lies inferior to the diaphragm and superior to the stomach, duodenum, and transverse colon.

Traditionally, the liver is divided into four anatomical lobes:

- Right lobe
- Left lobe
- Caudate lobe

- Quadrate lobe

These lobes are separated by anatomical structures such as the falciform ligament, ligamentum teres, and ligamentum venosum.

In clinical practice, the liver is functionally divided into eight segments according to the Couinaud classification system. This segmentation is based on the distribution of the portal vein, hepatic artery, and bile ducts and is particularly important for surgical procedures.

### Vascular Supply

The liver has a unique dual blood supply system.

Approximately 70–75% of hepatic blood flow originates from the portal vein, which transports nutrient-rich blood from the gastrointestinal tract. The remaining 25–30% is supplied by the hepatic artery, which provides oxygenated blood.

Both blood supplies mix within hepatic sinusoids, specialized capillary channels that allow metabolic exchange between blood and hepatocytes.

Venous blood exits the liver through the hepatic veins, which drain into the inferior vena cava.

### Microscopic Structure

The functional unit of the liver is the hepatic lobule. Each lobule is typically hexagonal and consists of hepatocytes arranged in plates surrounding a central vein.

Between hepatocyte plates are sinusoidal capillaries that allow blood to



flow from the portal triads toward the central vein.

The portal triad consists of three main structures:

- branch of the portal vein
- branch of the hepatic artery
- bile duct

Kupffer cells located within the sinusoids function as macrophages and play a crucial role in immune defense by removing bacteria and cellular debris from the bloodstream.

## DISCUSSION

### Physiological Functions

The liver performs more than 500 physiological functions that are essential for maintaining homeostasis.

### Metabolic Functions

The liver regulates carbohydrate metabolism by converting glucose into glycogen and releasing glucose when blood sugar levels decrease.

### Detoxification

The liver metabolizes drugs, toxins, and metabolic waste products through enzymatic processes involving the cytochrome P450 system.

### Bile Production

The liver produces bile, which is essential for digestion and absorption of dietary fats in the small intestine.

### Protein Synthesis

The liver synthesizes many important plasma proteins, including albumin and blood clotting factors.

### Storage Functions

The liver stores glycogen, vitamins A and B12, and minerals such as iron and copper.

### Clinical Significance

Liver diseases represent a major global health challenge. Structural or functional abnormalities of the liver can lead to severe medical conditions.

Common liver diseases include:

- Viral hepatitis
- Non-alcoholic fatty liver disease
- Liver cirrhosis
- Hepatocellular carcinoma

Understanding liver anatomy is critical for clinical diagnosis, radiological imaging, and hepatobiliary surgical procedures. Modern imaging techniques such as CT and MRI allow precise visualization of hepatic structures, improving treatment outcomes.

## CONCLUSION

The liver is a highly complex organ with a unique structural organization that enables it to perform numerous essential physiological functions. Its anatomical features, including the hepatic lobule structure and dual blood supply, support metabolic regulation, detoxification, and synthesis of vital biomolecules.

A comprehensive understanding of liver anatomy and physiology is essential for medical research, clinical practice, and surgical interventions. Continued research in hepatology will further improve the diagnosis and treatment of liver diseases.



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