

Article

## Structure and Functions of the Liver (HEPAR)

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**Abstract:** This paper examines the growing liver anlage, which is divided into two parts – cranial and caudal. The liver is the second-largest organ in the human body (the largest being the skin) and the largest gland, weighing approximately 1-1.5 kg. It also serves as a link between the digestive system and the bloodstream. Most of its blood (70-80%) comes from the portal vein, which collects blood from the stomach, intestine, and spleen; only a smaller volume (20-30%) comes from the hepatic artery.

**Keywords:** Function, Blood, Liver, Cranial, Caudal, Heart, Vein, Stomach, Cell, Retinoid, Sinusoid, Regulator, Dimple, Disse.

### Introduction

The liver rudiment is first visible in the embryo at a length of 3-5 mm, when the epithelial cells lining the anterior entrance of the intestine become taller and then begin to multiply rapidly, forming a thickening.

This area is located caudal to the heart. After the intestinal tube is closed, the liver primordium becomes visible as an epithelial outgrowth from the ventral wall of the future duodenum, located immediately behind the stomach primordium.

The growing liver anlage forms a protrusion in the ventral mesentery, the so-called hepatic bay (hepatic diverticulum). This rapidly expanding protrusion soon becomes distinct in two parts—the cranial and the caudal.

The cranial portion grows into the mesenchyme of the ventral mesentery, dividing into right and left portions. Epithelial tracts and the rudiments of the bile ducts can soon be discerned here.

The endodermal liver rudiment develops as compact cellular cords, interconnected in a network-like fashion. Mesenchyme penetrates the loops of this network, where thin-walled blood vessels are formed.

As a result, one network permeates the other, and from the very beginning, a very close relationship is established between the epithelial structures and vascular elements. The caudal portion does not form epithelial strands and grows as a hollow organ, forming the gallbladder and gallbladder duct.

The liver is a complex, multifunctional organ. As an individual develops, one function (as the leading one) replaces another.

The liver, as we know, is a polymeric organ composed of structural and functional units called lobules. The process of lobule formation is highly complex and time-consuming.

Both the growing liver tracts and blood vessels participate in this process. As the interlobular connective tissue develops, the lobular structure becomes more noticeable by the end of the first year of extrauterine life.

However, a distinct lobular structure of the liver appears in children only by the age of 4-5 years. Formation of the definitive liver structure is generally complete by the age of 10.

## Results and Discussion

The liver is the second-largest organ in the human body (the largest being the skin) and the largest gland, weighing approximately 1-1.5 kg. It is located in the abdominal cavity beneath the diaphragm. The liver processes nutrients absorbed in the digestive tract and stores them for use by other parts of the body.

Therefore, the liver is the link between the digestive system and the blood. Most of its blood (70-80%) comes from the portal vein, which collects blood from the stomach, intestines, and spleen; only a smaller volume (20-30%) comes from the hepatic artery.

All substances absorbed in the intestine enter the liver through the portal vein, with the exception of complex lipids ( **chylomicrons** - droplets surrounded by a membrane), which are transported mainly by the lymphatic vessels.

The liver's position in the vascular system is optimal for collecting, transforming, and accumulating metabolites, as well as neutralizing and eliminating toxic substances. These are removed from the body through bile, an exocrine secretion of the liver that is essential for lipid digestion.

The liver also has the very important function of producing plasma proteins such as albumin, other carrier proteins, clotting factors and growth factors.

**The stroma** is a thin connective tissue capsule (**Glisson's capsule**) that covers the liver externally. The portal vein and hepatic artery enter the organ through **the hilum**, and the right and left hepatic ducts and lymphatic vessels exit. These vessels and ducts are surrounded by connective tissue until they terminate (or begin) in the portal spaces between the liver lobules. In this region, a fine network of reticular fibers forms, supporting the hepatocytes and endothelial cells of the sinusoids of the liver lobule.

**Hepatic lobule** - The main structural component of the liver is the liver cell, or **hepatocyte** (Greek: hepar – liver + kytos – cell). These epithelial cells are organized into interconnected plates and form 2/3 of the liver's mass.

Histological sections, viewed under a light microscope, reveal the structural units of the liver – **the hepatic lobules**. A hepatic lobule is formed by a polygonal mass of tissue measuring approximately 0.7 × 2 mm, with **portal spaces located along its periphery** and a central, or centrolobular, **vein in the center**.

Portal spaces, areas located at the corners of the lobule, contain connective tissue, bile ducts, lymphatic vessels, nerves, and blood vessels. In the human liver, there are three to six portal spaces per lobule, each containing a venule (a branch of the portal vein), an arteriole (a branch of the hepatic artery), a duct (a component of the bile duct system), and lymphatic vessels.

The venule contains blood coming from the superior and inferior mesenteric and splenic veins. The arteriole contains oxygen-rich blood coming from the celiac trunk of the abdominal aorta. A duct lined with cuboidal epithelium carries bile synthesized by hepatocytes and eventually opens into the hepatic duct. One or more lymphatic vessels drain the lymph, which eventually enters the bloodstream.

In some animals (for example, pigs), the lobules are separated from each other by layers of connective tissue. In humans, these layers are absent, and the lobules are in such close contact with each other along most of their length that it is difficult to establish precise boundaries between the different lobules.

Hepatocytes in the liver lobule are oriented radially and arranged like bricks in a wall. These cell plates extend from the periphery of the lobule toward its center and anastomose freely with each other, forming a spongy structure resembling a labyrinth.

The space between these plates contains capillaries – **hepatic sinusoids** (up to 30  $\mu\text{m}$  in diameter).

Sinusoidal capillaries are irregularly dilated vessels that consist only of a discontinuous layer of fenestrated endothelial cells.

The fenestrae are approximately 100 nm in diameter, lack diaphragms, and are arranged in groups. There are also spaces between the endothelial cells, which, combined with the cellular fenestrae and the discontinuous basal lamina (depending on the species), give these vessels very high permeability.

The subendothelial space, known as **the space**.

**Dissertation** (0.2-1  $\mu\text{m}$ ), separates endothelial cells from hepatocytes. Fenestrae and discontinuities of the endothelium allow free flow of plasma, but not cellular elements, into the Disse space, ensuring unimpeded exchange of molecules (including macromolecules) between the sinusoidal lumen and hepatocytes and vice versa.

This exchange is important physiologically, not only because hepatocytes secrete a large number of macromolecules (e.g., lipoproteins, albumin, fibrinogen) into the blood, but also because the liver takes up and destroys many of these large molecules.

The basolateral surface of the hepatocyte, which faces the Disse space, contains numerous microvilli and has high endocytic and pinocytic activity.

The sinusoid is surrounded and supported by a thin sheath of reticular fibers. In addition to endothelial cells, the sinusoids contain macrophages known as **Kupffer cells**. These constitute 20-25% of the sinusoid's cells (especially numerous at the periphery of the lobule). They are located in the crevices between the endothelial cells or spread across their surface, moving along it. They possess high phagocytic activity and a powerful lysosomal apparatus; they effectively cleanse blood from the portal venous system of particles, microorganisms, antigens, and toxins.

The space of Disse (perisinusoidal space) contains **lipid-accumulating cells**, also known as stellate cells or Ito cells. They make up, on average, approximately 20-25% of the cells in the sinusoids. They are located in the space of Disse, enveloping the sinusoids externally with their long processes and contacting hepatocytes. These cells contain lipid inclusions rich in vitamin A.

In a healthy liver, these cells have several functions: absorption, accumulation and release of retinoids, synthesis and secretion of certain proteins of the intercellular substance and proteoglycans, secretion of growth factors and cytokines and regulation of the diameter of the sinusoidal lumen in response to the action of various regulatory factors (e.g., prostaglandins, thromboxane A<sub>2</sub>).

**Pit cells** (pit cells) make up about 5% of sinusoid cells and are located in the lumen of the sinusoids (attaching their processes to the endothelium), and less often in the Disse space.

Kupffer cells and hepatocytes, exerting regulatory effects on them. The nucleus is dark, and the cytoplasm contains characteristic granules with a dense center resembling a fruit pit. They share a number of characteristics with natural killer cells and possess high antitumor activity.

## Conclusion

The development of the liver begins during the embryonic stage as a hepatic diverticulum arising from the ventral wall of the foregut and undergoes complex differentiation into a multifunctional organ. The mature liver is organized into hepatic lobules composed of hepatocytes, sinusoids, and specialized supporting cells such as Kupffer cells, stellate (Ito) cells, and pit cells. The close structural and functional relationship between epithelial and vascular components from the earliest stages of development enables the liver to perform essential metabolic, detoxifying, synthetic,

and immunological functions. The definitive structural organization of the liver is achieved gradually and is generally completed by approximately 10 years of age.

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