

LIVER HISTOLOGY

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- Histologically speaking, it has a complex microscopic structure, that can be viewed from several different angles.
- Physiologically speaking, the liver also performs many essential functions.
- We will examine every histological component of the liver, its macroscopic and microscopic vascular supply, and the biliary system.

Functions and Physiology

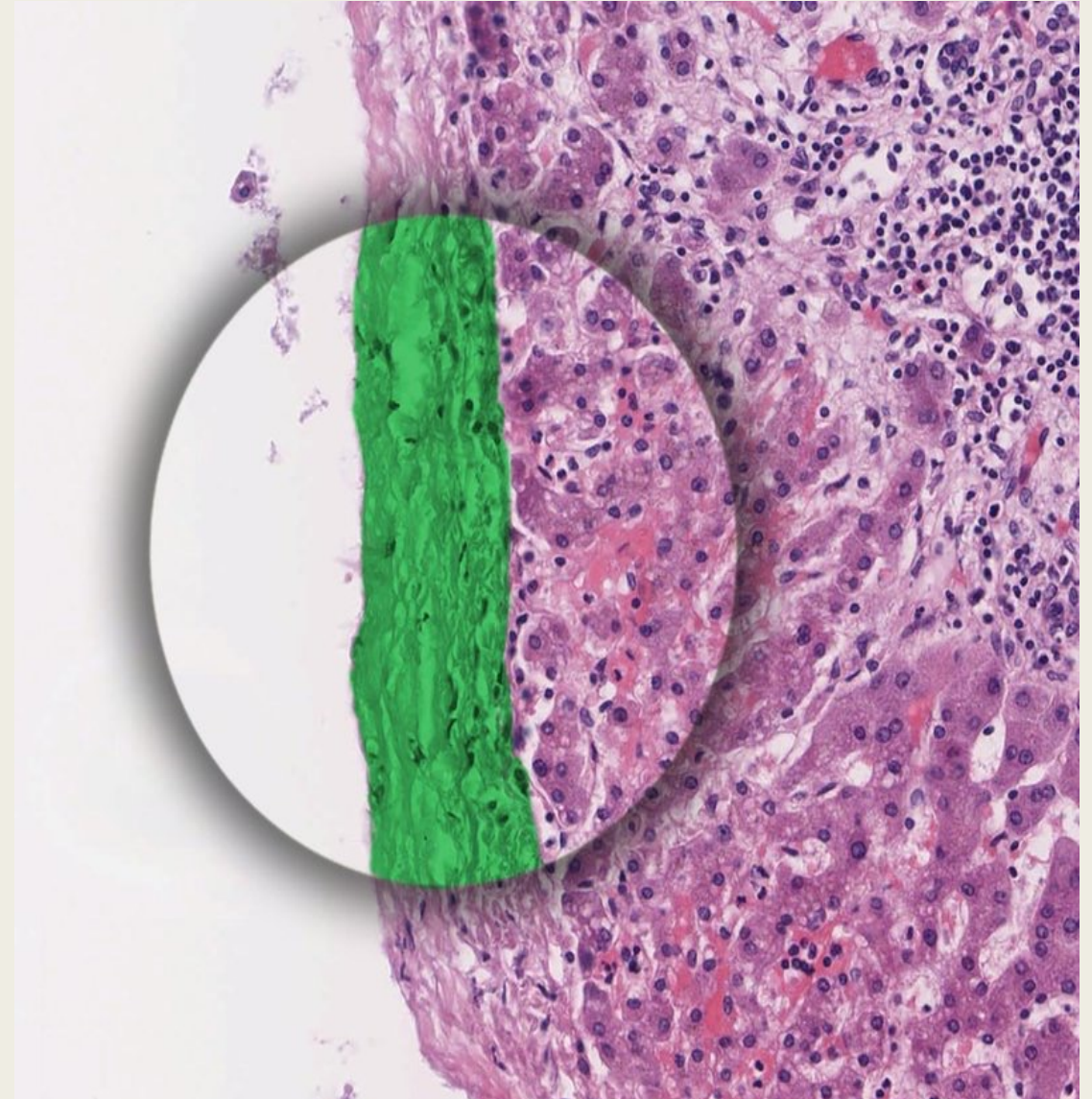
- The liver performs several important functions in the human body, such as given below:
 - Plasma protein synthesis - albumins, lipoproteins, glycoproteins, prothrombin, fibrinogen
 - Vitamin storage and modification - vitamins A, D, and K
 - Iron storage and metabolism - transferrin, haptoglobin, hemopexin, ferritin
 - Drugs and toxins degradation
 - Bile production
 - Carbohydrate metabolism

Histological Components

The liver consists of the following major histological components:

- **Parenchyma**, which is represented by hepatocytes
- **Stroma**, which is a continuation of the surrounding capsule of Glisson.
 - It consists of connective tissue and contains the vessels.
 - The capsule is also covered by a layer of mesothelium, arising from the peritoneum covering the liver.
 - The connective tissue of the stroma is type III collagen (reticulin), which forms a meshwork that provides integrity for the hepatocytes and sinusoids.

- **Sinusoids**, which are capillaries travelling between hepatocytes
- **Spaces of Disse**, are located between the hepatocytes and the sinusoids.



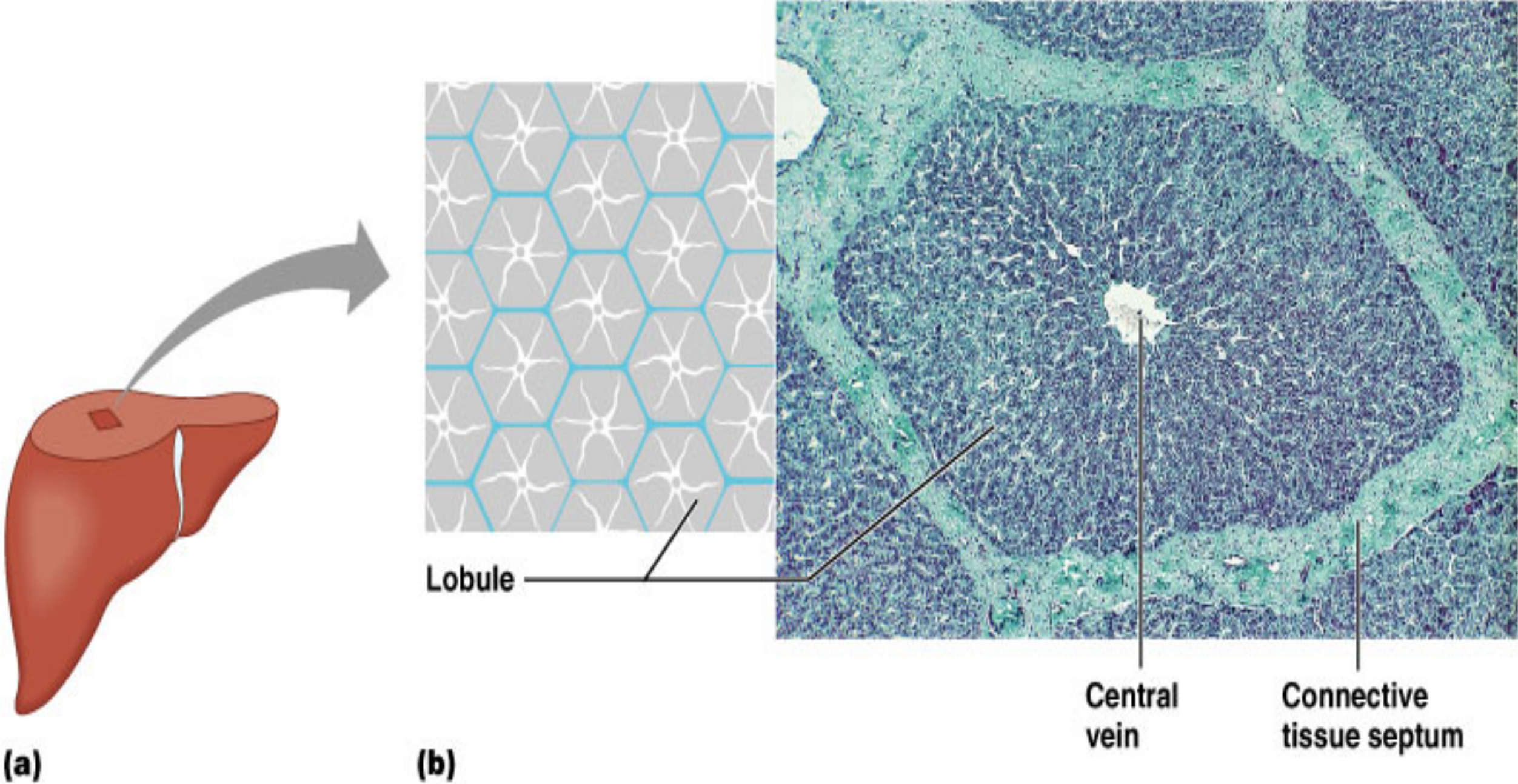
Glisson's capsule

Structure

- The liver consists of a large number of microscopic functional units - **hepatocytes** - that work in unison to ensure the overall, proper activity of the entire organ.
- There are three possible ways of describing one such unit, as given below:
 - Hepatic (classic) lobule
 - Portal lobule
 - Liver acinus

Hepatic (classic) lobule

- The classic lobule consists of **hexagonal plates** of hepatocytes stacked on top of each other.
- Within each plate, the **hepatocytes** radiate outwards from a central vein.
- As they extend towards the periphery, the hepatocytes are arranged into strips, similar to the spokes of a cartwheel.
- **Hepatic sinusoids** travel between the strips of hepatocytes, draining into the **central vein**.



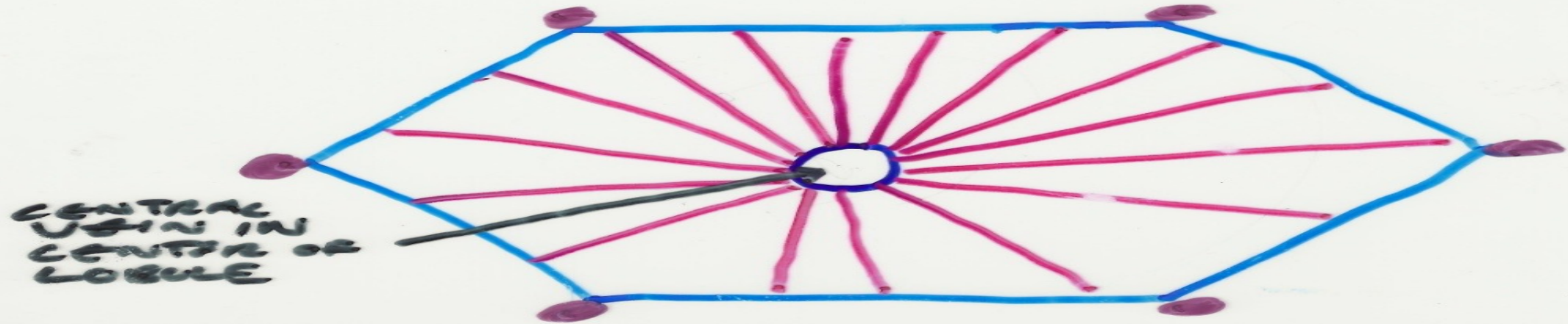
LOBULES - STRUCTURAL & FUNCTIONAL UNITS OF LIVER

HEPATOCTYTES - LIVER CELLS

HEPATOCTYTE FUNCTIONS:

- PRODUCTION OF BILE
- PROCESSING BLOODBORNE NUTRIENTS
- STORAGE OF FAT SOLUBLE VITAMINS
- DETOXIFICATION
- PHAGOCYTOSIS OF WORN OUT RBC

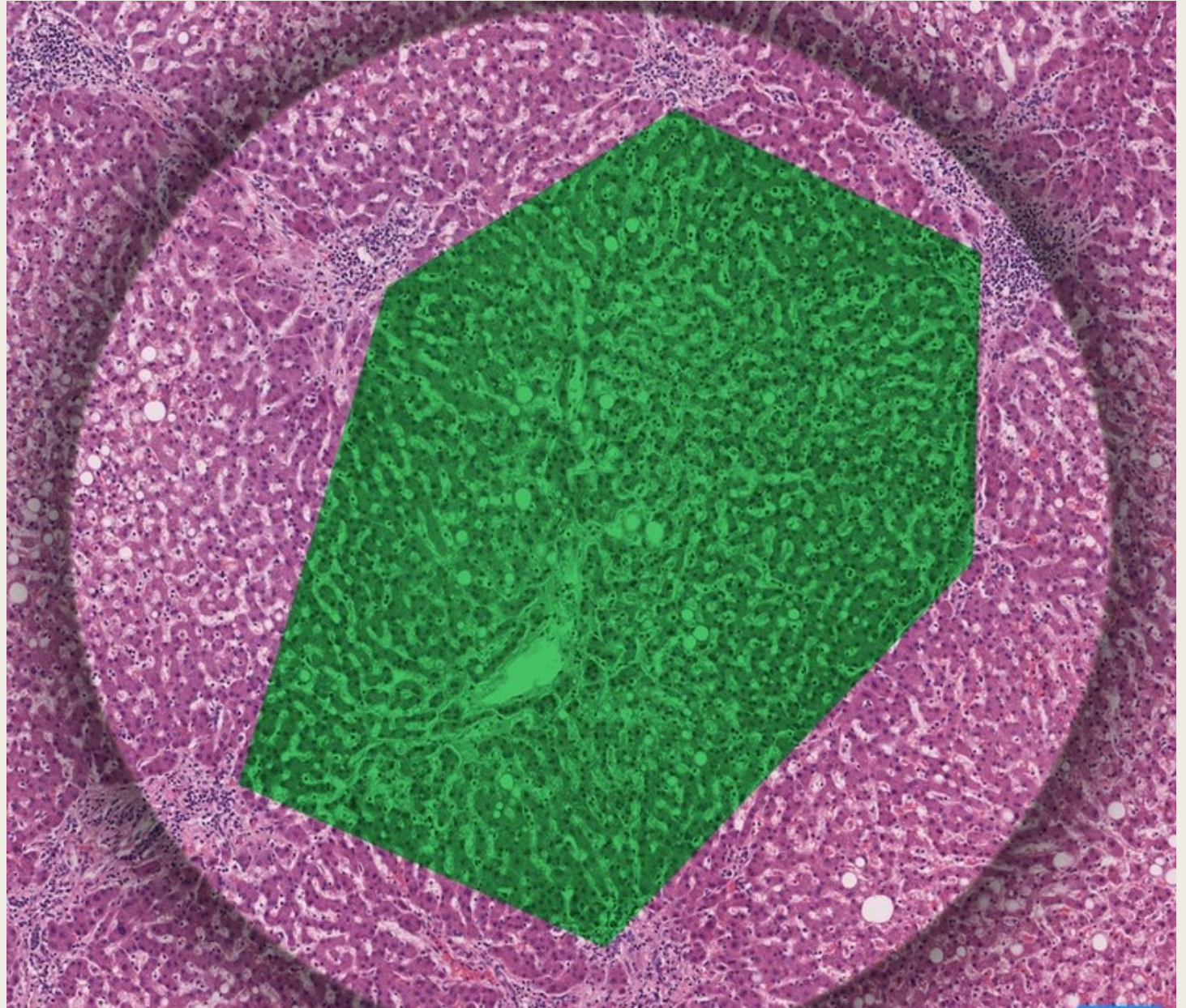
LOBULE IS 6 SIDED



LIVER CELLS ARE ARRANGED IN PLATES OF HEPATOCTYTES

● **TRIADS** OF HEPATIC ARTERY, HEPATIC PORTAL VEIN & BRANCH OF BILE DUCT

Hepatic lobule

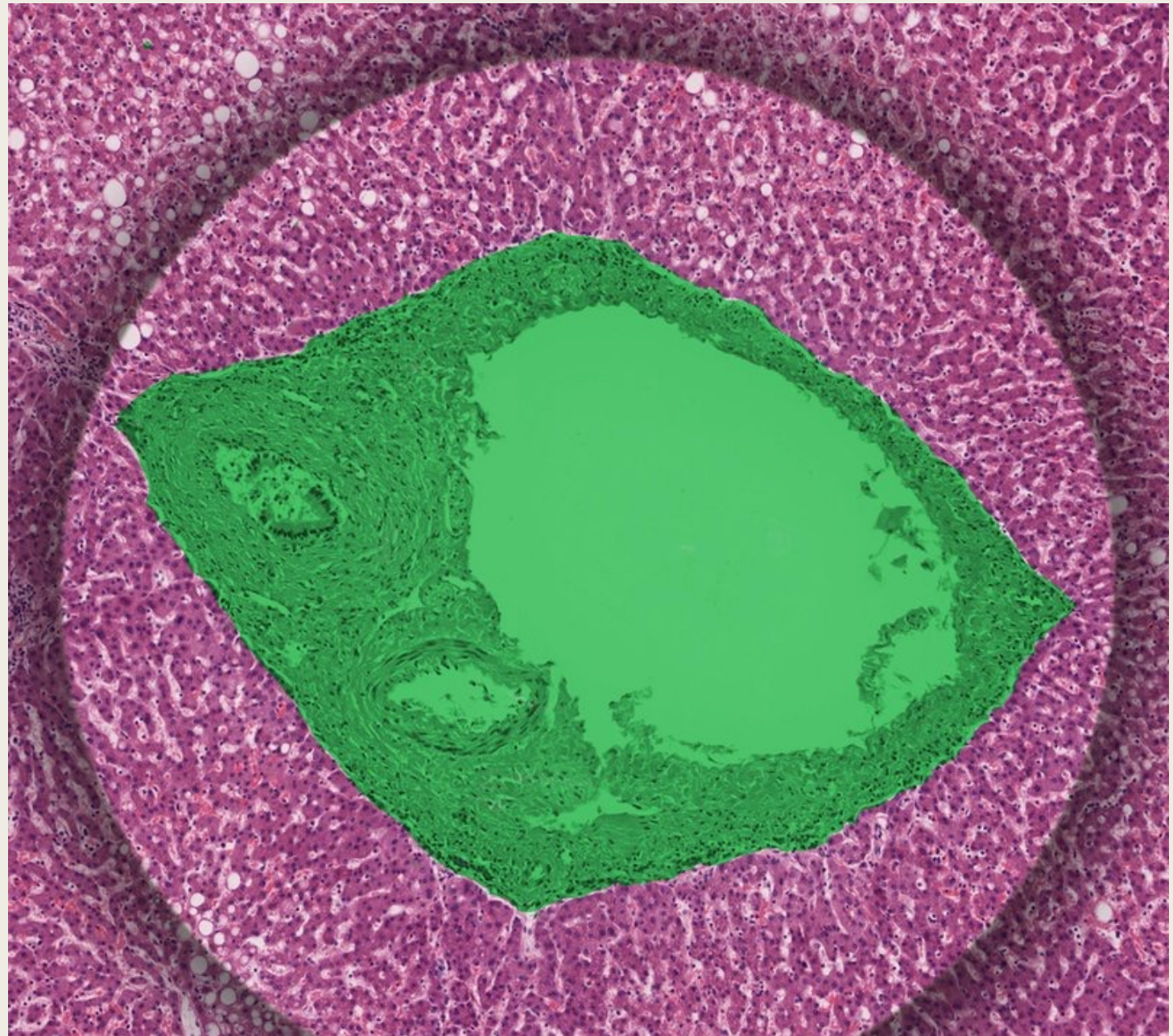


- One portal canal is located at each corner of the hexagonal classic lobule, making a total of six for each lobule.
- These portal canals are composed of the portal triads, which are surrounded by loose connective tissue.
- A periportal space (space of Mall), where lymph is produced, is sandwiched between the connective tissue of the portal canals and the hepatocytes.

Portal Lobule

- While the classic lobule focuses on the blood supply and hepatic mass arrangement, the portal lobule view underlines the **exocrine function** of the liver, which is bile secretion.
- Each functional unit is a triangle, having a central axis through a **portal field** and the imaginary vertices through the three different but closest portal canals surrounding it.
- The area covered by the triangle represents the hepatic regions that secrete bile into the **bile ducts**.

Portal field

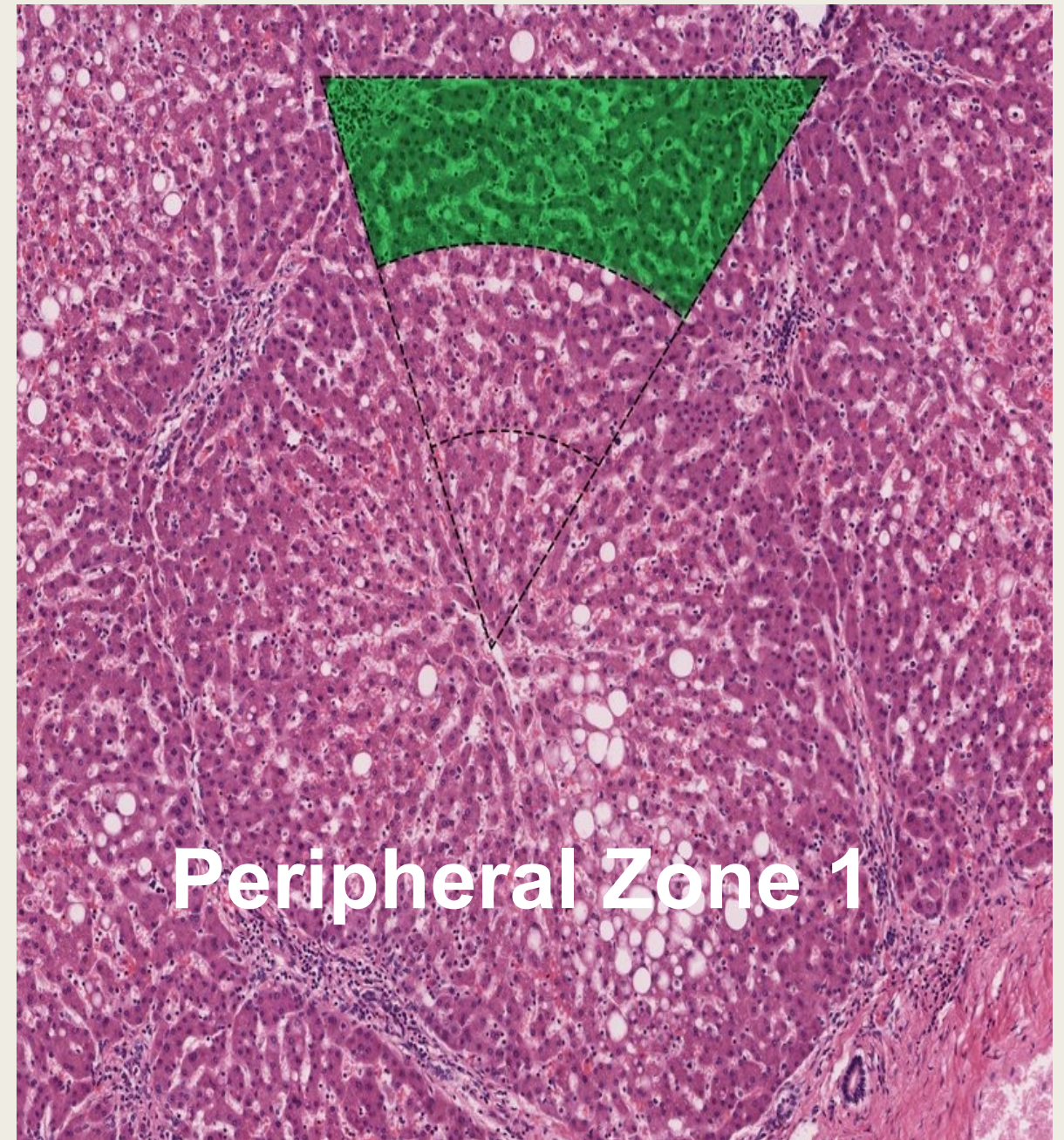


Liver Acinus

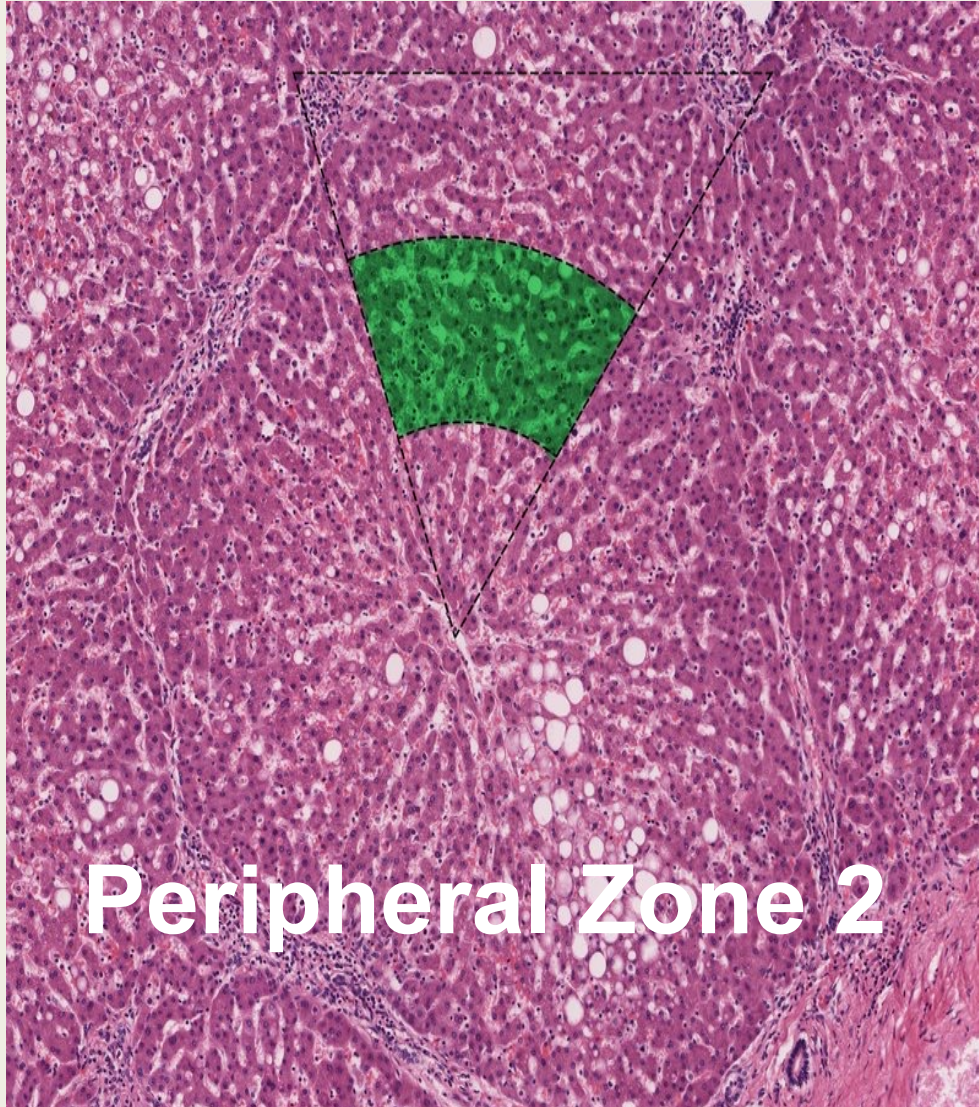
- A liver acinus functional unit is in the shape of an oval.
 - The short axis is represented by a shared border between two adjacent lobules together with the portal canals.
 - The long axis is an imaginary line between two adjacent central veins.
- Each half of the liver acinus can be divided into three zones:
- Zone 1 - It is the one closest to the short axis, hence to the portal canals and supply of arterial blood.
 - The hepatocytes in zone 1 receive the highest amount of oxygen.

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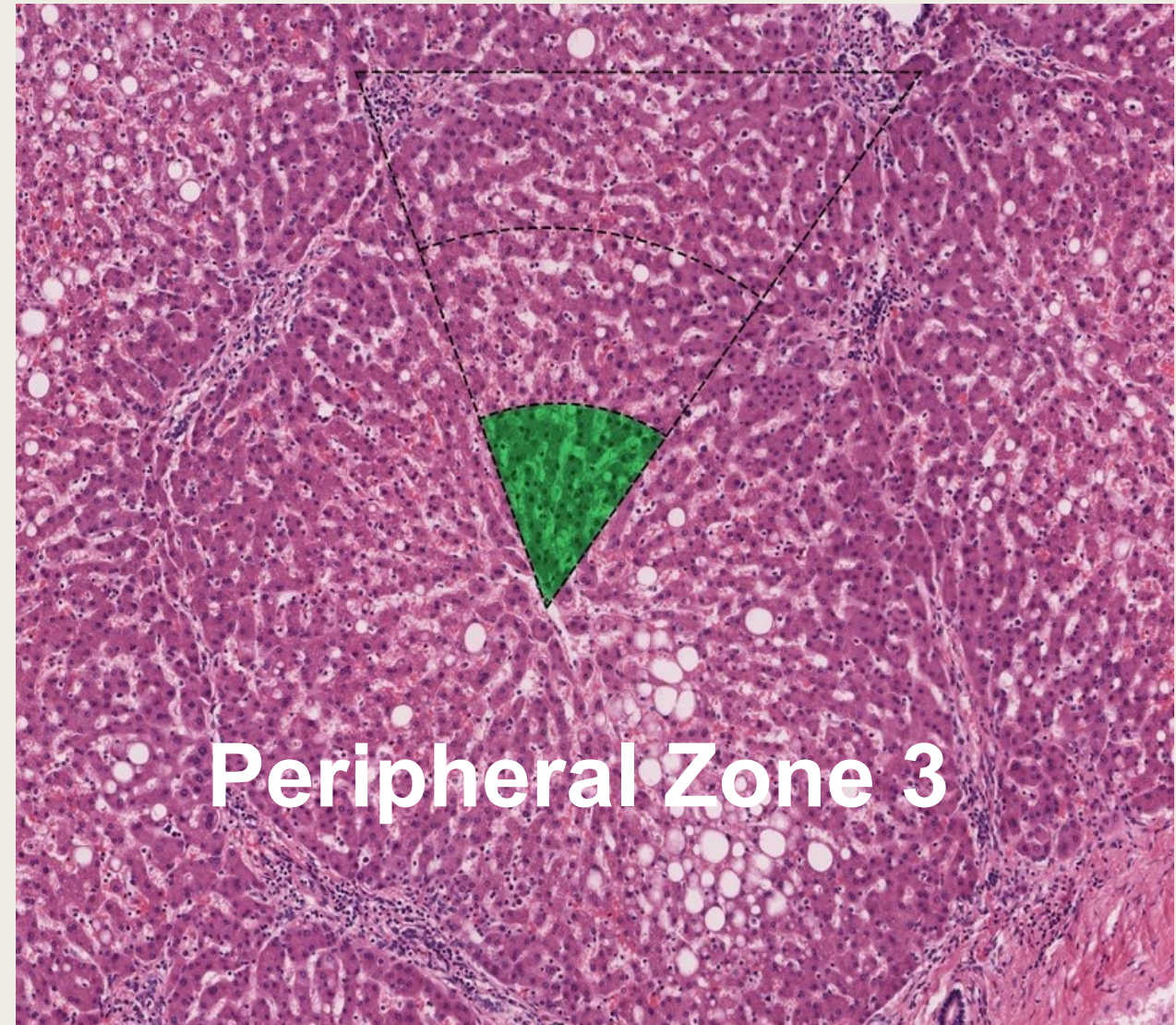
The hepatocytes in **Zone 1** receive the highest amount of oxygen.



Zone 2 - Located between zones 1 and 3.



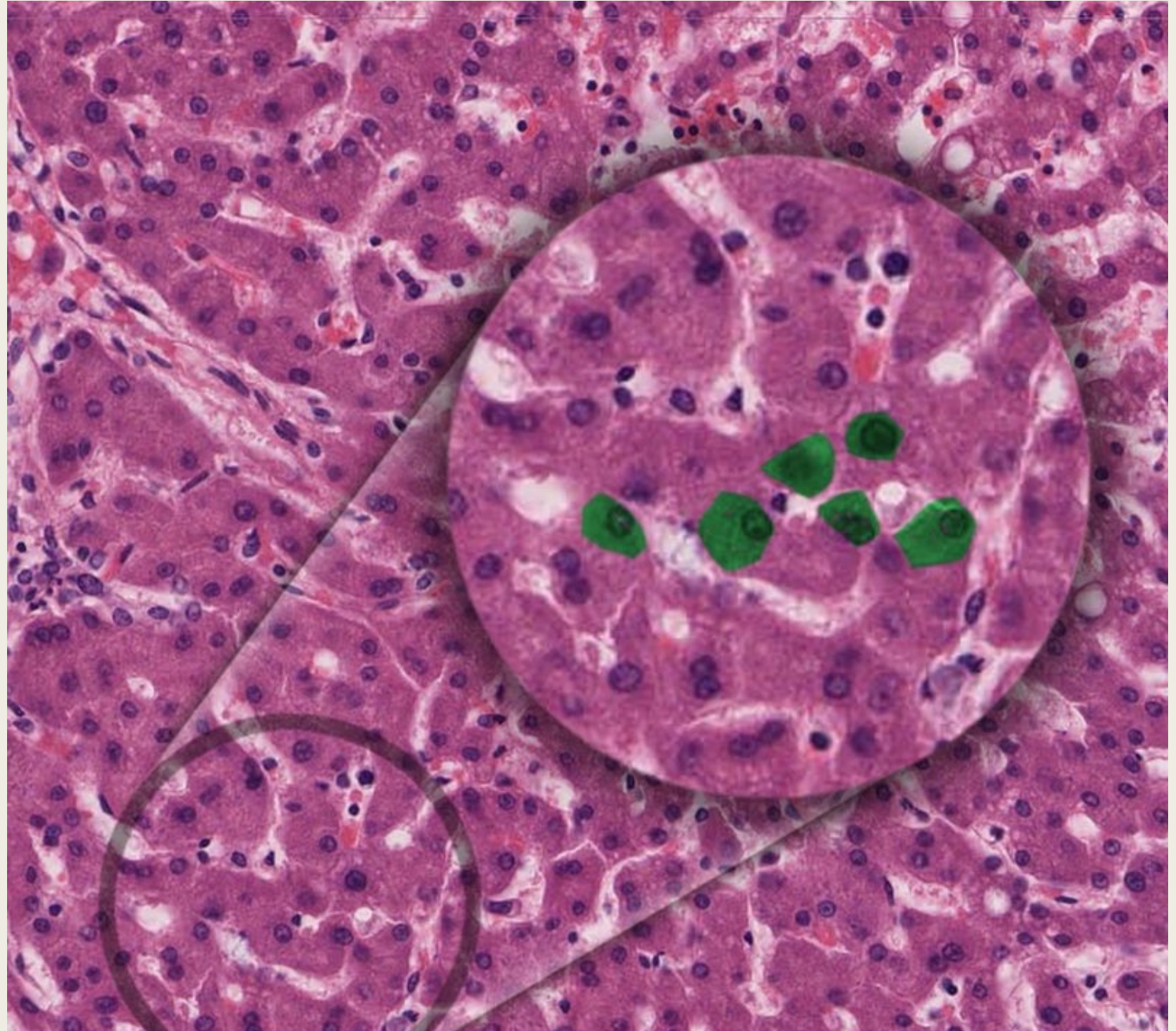
Zone 3 - It is the one furthest from the short axis but closest to the central vein, hence the hepatocytes receive the least amount of oxygen.



Hepatocytes

- These large and polyhedral (six surfaces) cells **make up 80% of the total cells of the liver.**
 - They can contain between two and four nuclei, which are large and spherical, occupying the center of the cells.
 - Each nucleus has at least two nucleoli.
- The **typical lifespan** of a hepatocyte **is five months.**
- Adjacent hepatocytes leave a very small space between them known as **bile canaliculi** which are almost 1.0-2.0 μm in diameter.

Hepatocyte



Hepatocytes contain the following organelles:

- Smooth endoplasmic reticulum, which is essential in **toxin degradation** and conjugation, as well as **cholesterol synthesis**.
- Mitochondria (up to 1000/cell)
- Golgi network contain granules with very low density lipoprotein and **bile precursors**.
- Peroxisomes are enzymes responsible for **detoxification reactions** taking place in the liver, for example, that of alcohol.

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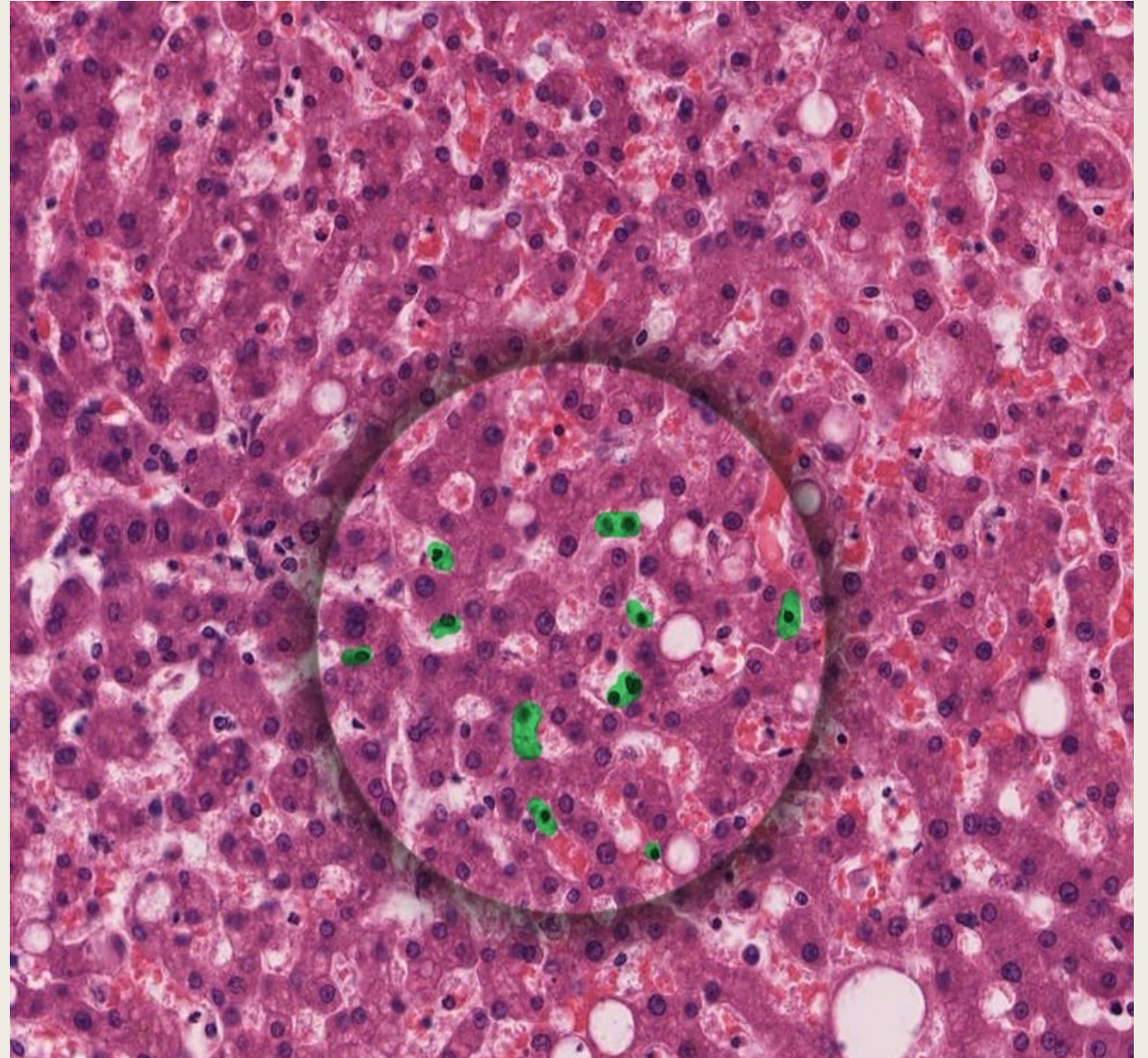
- Glycogen deposits
- Lipid droplets
- Lysosomes, which are responsible for iron storage under the form of ferritin.

Perisinusoidal space (Space of Disse)

- This space is situated between the layers of hepatocytes and the sinusoidal endothelial cells.
- The hepatocytes extend villi into the perisinusoidal space, increasing the extent and rate of exchange, together with the microvilli.
- The perisinusoidal space contains a specific type of cell called **hepatic stellate cells**.

Stellate cells

Storage of hepatic vitamin A
Responsible for hepatic fibrosis

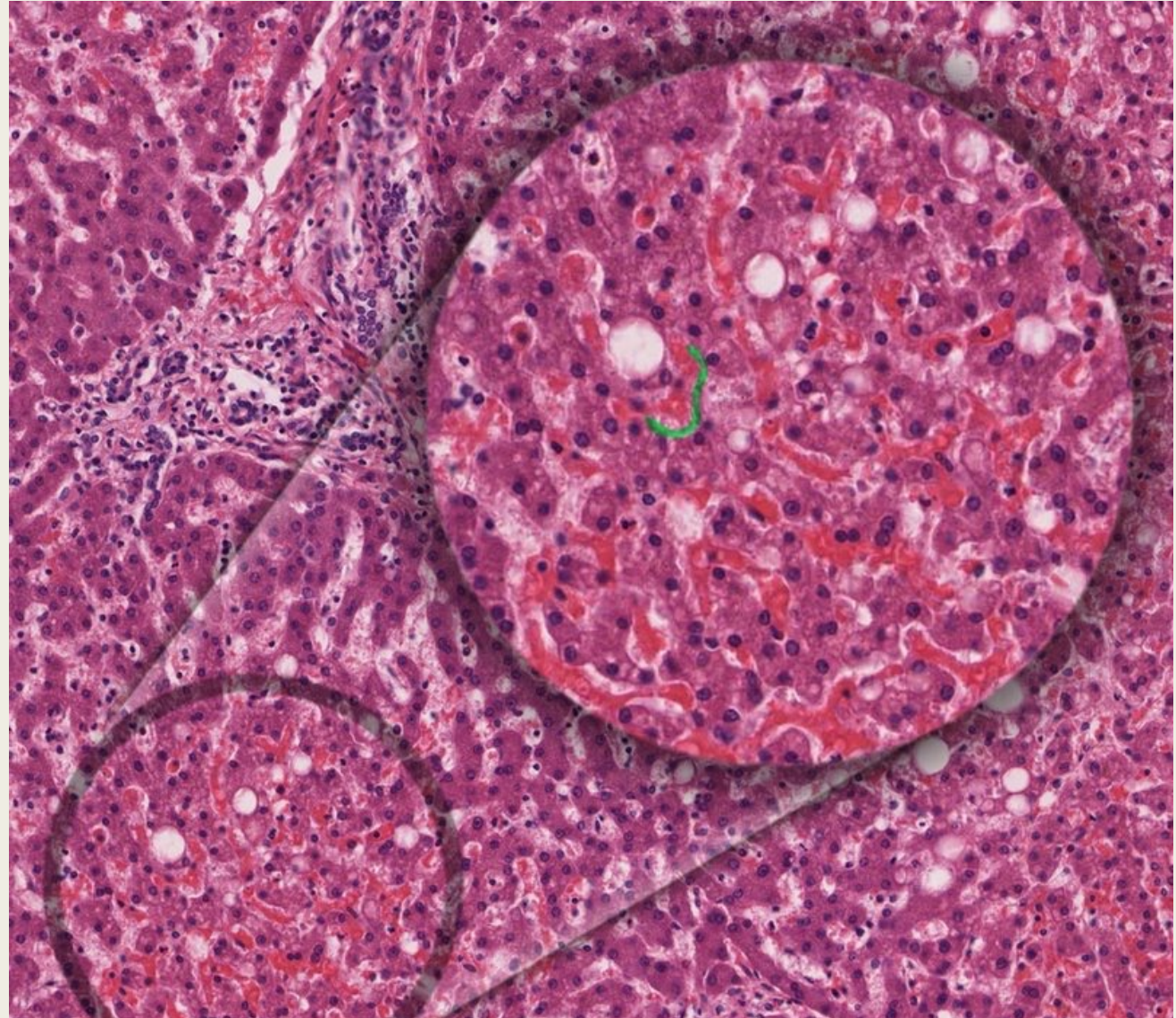


Perisinusoidal space (Space of Disse)

- The hepatic stellate cells role is the storage of hepatic vitamin A inside lipid droplets, which is subsequently released as retinol.
- The hepatic stellate cells are also responsible for hepatic fibrosis because they secrete large amounts of collagen during liver injury.

Space of Disse

Between the layers of hepatocytes and the sinusoidal endothelial cells

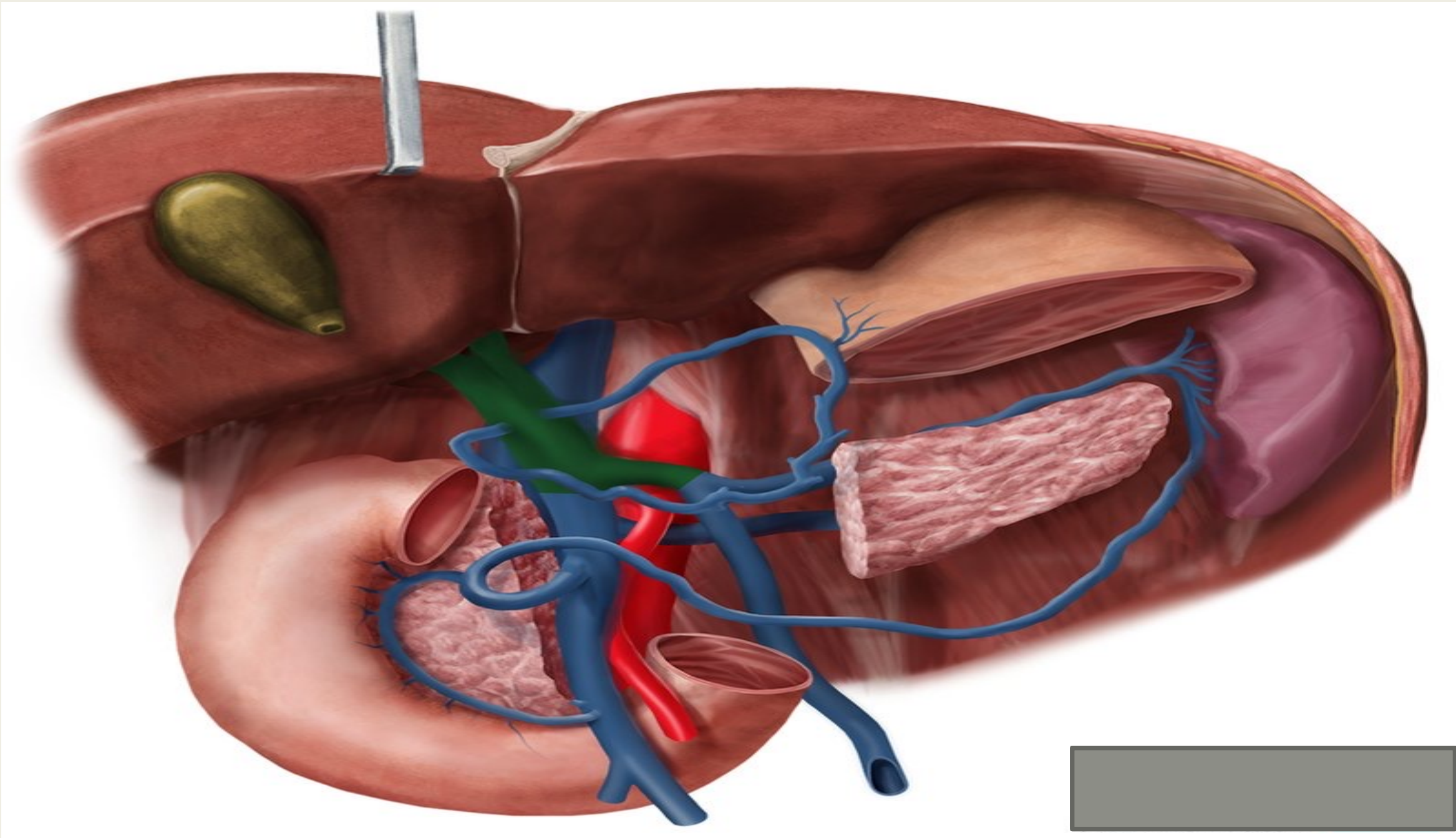


Vasculature - Liver

- The liver, as an organ, receives **blood from two different sources.**
- The major one is via the **hepatic portal vein (75%),** which carries venous blood from the intestine, pancreas and spleen.
- Despite the lack of oxygen, this blood contains high amount of nutrients, endocrine secretions, broken down erythrocytes, but also ingested toxins.
- The second major source is via the **hepatic artery (25%),** which brings oxygenated blood to the liver.

Vasculature - Liver

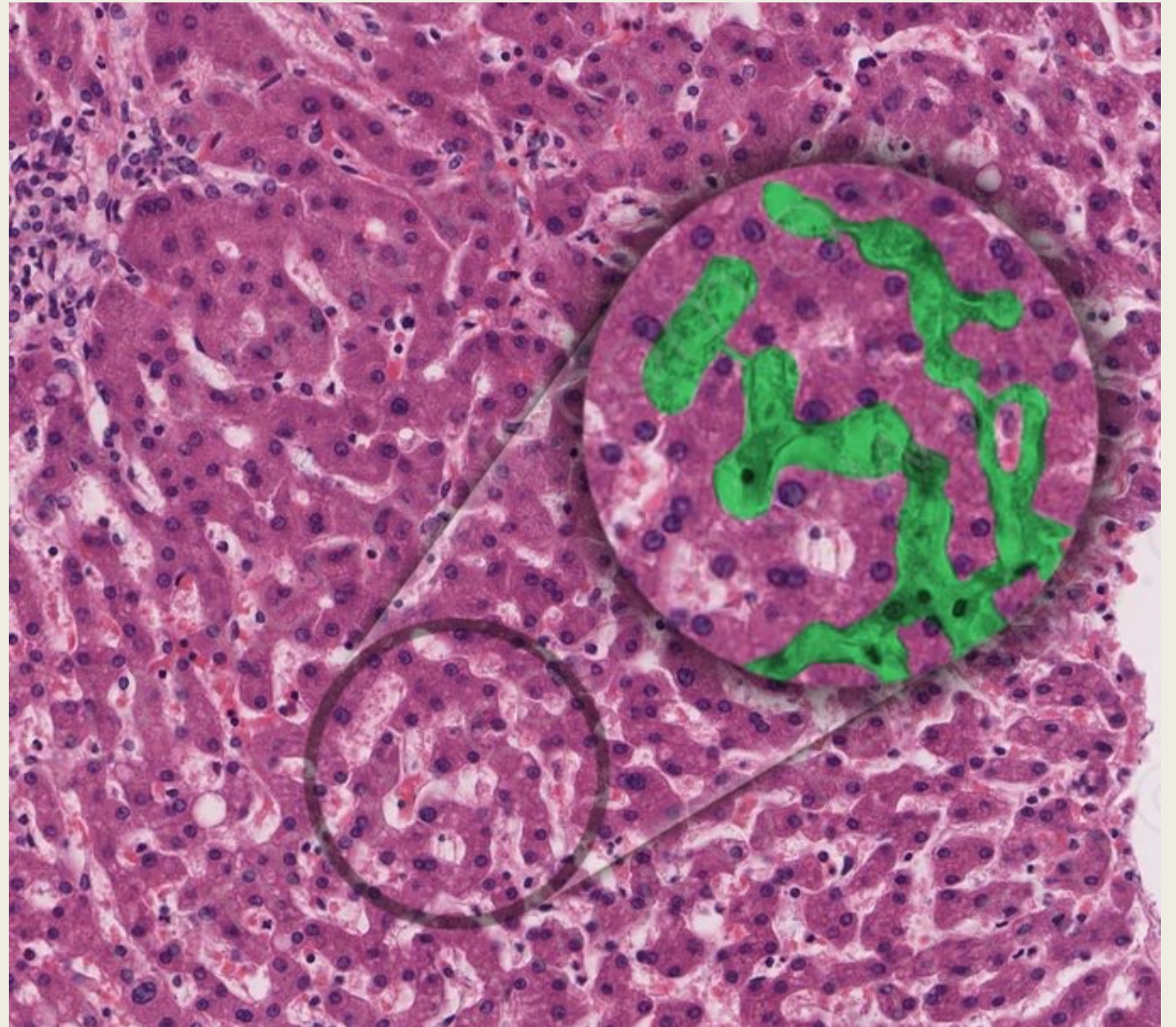
- Together with the bile duct, the hepatic portal vein and hepatic artery form the portal triad.
- Those structures supply blood to the sinusoids and the hepatocytes, subsequently draining into the central vein followed by the sublobular veins.
- The second drainage pattern is via the hepatic veins, which end up in the inferior vena cava.



Parenchyma

- Interlobular vessels connect the portal triads and sinusoids, transporting the blood into the latter.
- The **hepatic sinusoids** have fenestrae and gaps between endothelial cells.
- A basement membrane is also absent.
- The endothelial cells display flat and condensed nuclei, with poorly stained cytoplasm.

Hepatic sinusoid

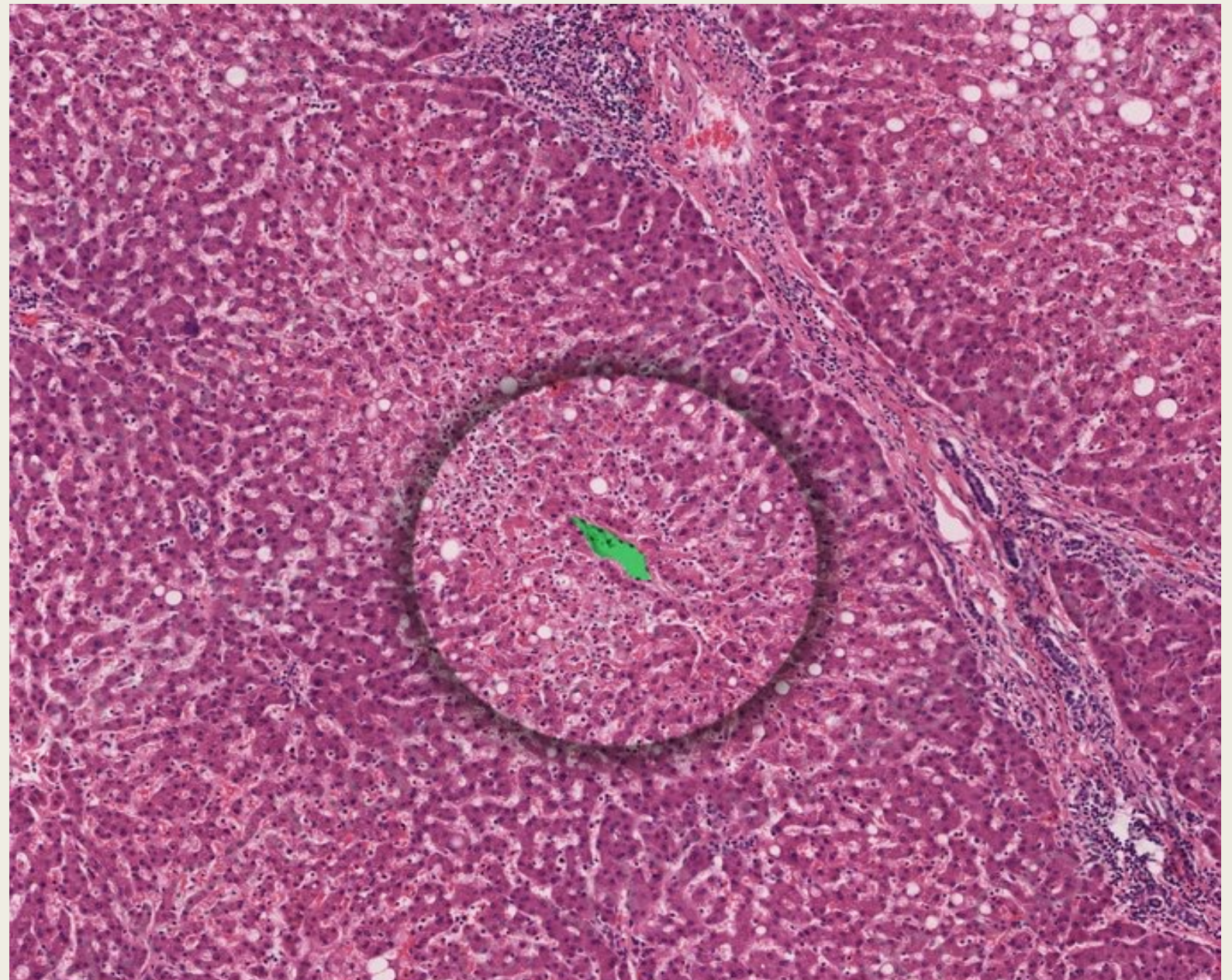


Stellate macrophage



- The name of the blood vessels travelling through the portal canals are called **interlobular vessels**.
- They send blood into the sinusoids, which in turn empty into the sinusoids via inlet vessels.
- From the sinusoids, the blood drains into the central vein, which occupies the central axis of the classic liver lobule.
- The endothelial cells forming the central veins are surrounded by a small quantity of connective tissue fibers.

Central vein



- As they travel through the parenchyma, the central veins become larger, subsequently emptying into the sublobular veins.
- The endothelial lining of the sublobular veins is surrounded by a high quantity of connective tissue fibers, consisting of a layer of both collagenous and elastic fibers.
- Several sublobular veins then converge into larger and valveless hepatic veins, which ultimately empty into the inferior vena cava.

- The sinusoids also receive arterial blood from the hepatic arteries.
- In addition, sinusoids contain a specific cell type called Kupffer cell, containing ovoid nuclei.
- These monocyte derivatives of the mononuclear phagocytic system are part of the sinusoid lining from which they extend processes into the lumen.
- **Kupffer cells** continuously **sample the blood** travelling through the sinusoids, phagocytosing antigens, microorganisms, and damaged red blood cells.