



# HISTOLOGY

## Lecture 4: Liver and Spleen

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### Color Guide:

- Black: Slides.
- Red: Important.
- Green: Doctor's notes (Female).
- Blue: Doctor's notes (Male).
- Orange: Explanation.

GIT Block – 432 Histology Team





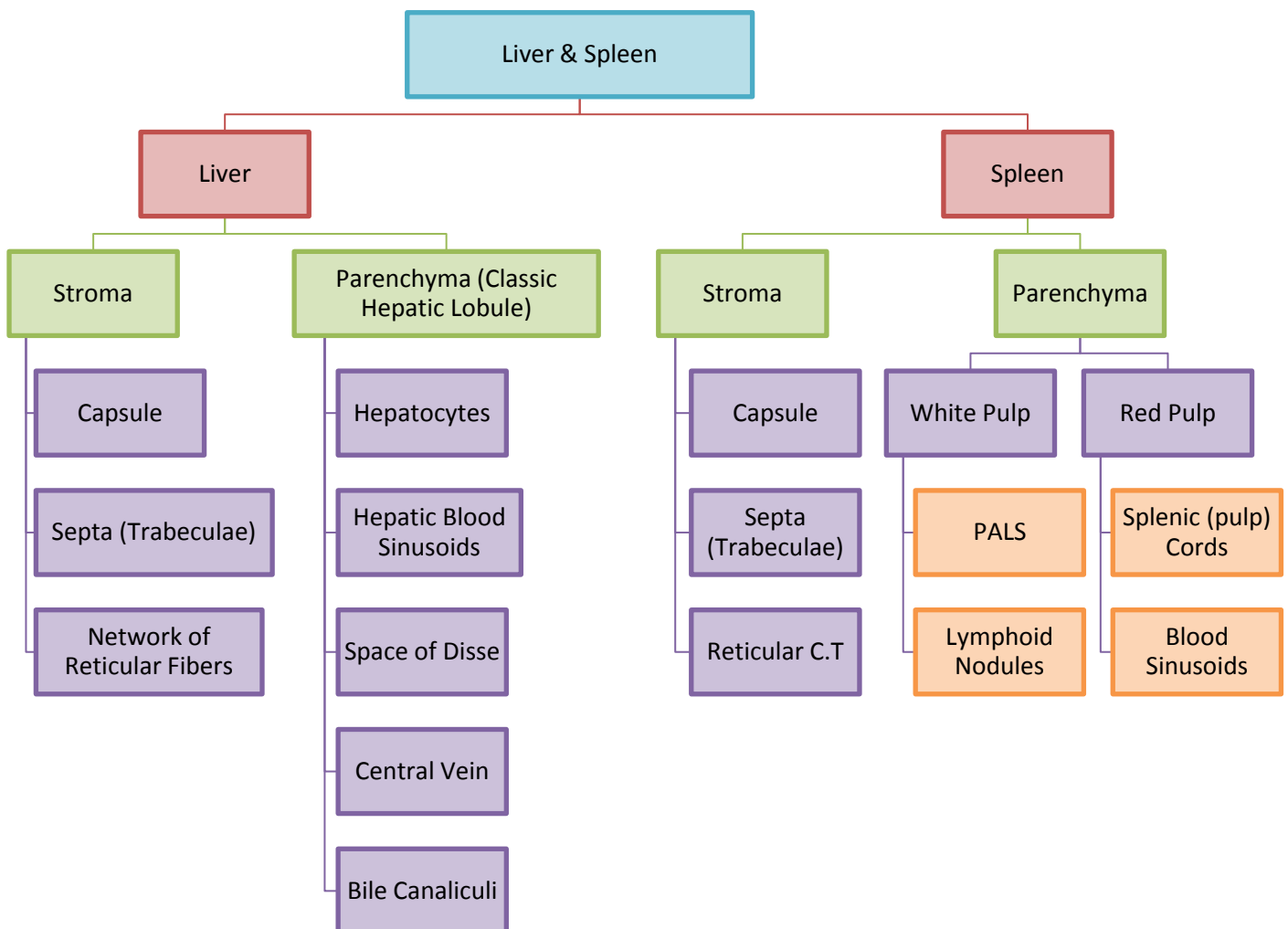
# Objectives

At the end of this lecture, you should describe the microscopic structure and the function of:

1. The histological structure of liver with special emphasis on the classic hepatic lobule.
2. The histological features of spleen.



# Mind Map

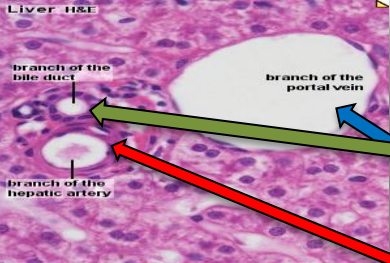





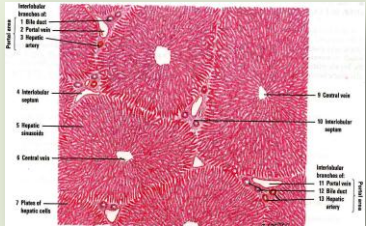
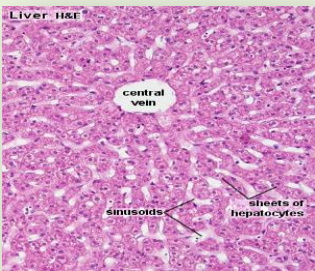
# Liver

Stroma (Non-functioning part)	
<b>Capsule “Glisson’s Capsule”</b>	Dense fiber C.T can be seen with naked eye.
<b>Septa &amp; Portal Areas (tracts)</b>	Absent in human (actually it exists, but it is very delicate to be seen).
	It's C.T coming from capsule.
	It divides the liver into hepatic lobules.
<b>Reticular Fibers</b>	The thickness and the density differ according to the animal. In humans it's very delicate to the limit that it can't be seen. While it's very clear/obvious in camels and pigs. So, if septa are obvious in human liver; then this is abnormal.
<b>Reticular Fibers</b>	Act as a network, or a floor for the parenchyma to be settled on.
Parenchyma “Classic Hepatic Lobules”( The functioning cells)	
<b>Hepatocytes</b>	Anastomosing (interconnected) plates of hepatocytes.
	<b>Polyhedral</b> in shape, it has at least 2 sides facing the sinusoids.
	<b>Nucleus:</b> 1 (75%) or 2 (25%), vesicular with prominent nucleoli (pale euchromatin means it's active).
	<b>Cytoplasm:</b> acidophilic (ER exists abundantly in the hepatocyte BUT this doesn't not make the cell cytoplasm basophilic; because there are other organelles such as mitochondria that are more abundant in the cell so they take the upper hand and making the cell acidophilic).
	<b>Organelles:</b> <ul style="list-style-type: none"> <li>○ Mitochondria ++++ (up to 20% of the size of nuclei; most abundant).</li> <li>○ ER (sER “detoxication”, eER) abundant, sER are more.</li> <li>○ Golgi complex.</li> <li>○ Lysosomes, help digest lipid.</li> <li>○ Peroxisomes, for enzymes, digest lipid.</li> </ul>
	<b>Inclusions “Deposits”:</b> <ul style="list-style-type: none"> <li>○ Glycogen, increase with alcohol</li> <li>○ Lipid (few droplets), due to storage of extra fat in the hepatocytes, increase with alcohol</li> <li>○ Lipofuscin (old age) (hepatocytes are long-living cells; stable cells).</li> </ul>
<b>Hepatic Blood Sinusoids</b>	In between plates of hepatocytes.
	<b>Contains:</b> <ul style="list-style-type: none"> <li>○ <b>Fenestrated &amp; Discontinuous Endothelial Cells:</b> <ul style="list-style-type: none"> <li>➤ It allows free passage of plasma (not blood cells).</li> <li>➤ Basal Lamina is absent.</li> </ul> </li> <li>○ <b>Kupffer Cells:</b> <ul style="list-style-type: none"> <li>➤ Are Macrophages.</li> <li>➤ Found on the luminal (inner) surface of endothelial cells.</li> <li>➤ Function: Phagocytosis.</li> </ul> </li> </ul>
	Sinusoids are different from capillaries in that they're: (large, irregular, fenestrated, & has no basement membrane).
<b>Space of Disse (Perisinusoidal spaces of Disse)</b>	Is a space between sinusoids and hepatocytes named after a scientist
	Space of disse contains the plasma coming from the sinusoids.
	<b>Contains:</b> <ul style="list-style-type: none"> <li>○ <b>Fat Storing Cells (Ito Cells):</b> <ul style="list-style-type: none"> <li>➤ Contain Vitamin A-rich lipid.</li> <li>➤ Form reticulin.</li> <li>➤ Produce reticular fibers of the liver.</li> </ul> </li> <li>○ <b>Reticular Fibers (Type 3 Collagen).</b></li> <li>○ <b>Plasma of blood.</b></li> <li>○ <b>Microvilli of hepatocytes.</b></li> </ul>
<b>Central Vein</b>	Located in the center of classic hepatic lobule.
<b>Bile Canaliculi</b>	As we know, hepatocytes form Bile. The dripping of bile makes a groove in the membrane of each hepatocyte. This groove is the Canaliculus.

## Borders of Classic Hepatic Lobules

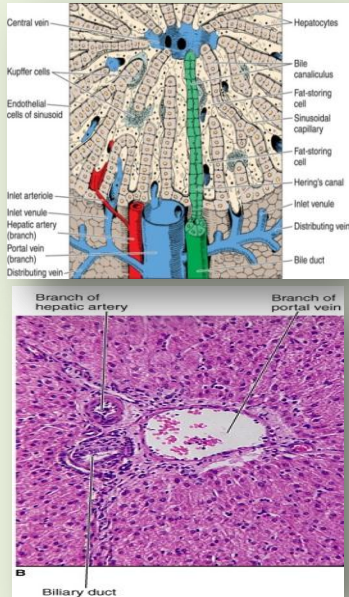
Borders of Classic Hepatic Lobules	
<b>Septa</b>	C.T septa, e.g. in pigs.
<b>Portal Areas (Portal Tracts)</b>	Present in the corners between usually 3 hepatic lobules (Peripheral). Usually 3 in number (Actually, the doctor said that they're 4, but she said that it's ok if you forget about the forth one. What matters are the 3 mentioned in slides. All 4 are: venule, bile ducts, arteriole, & lymphatic).
	<p><b>Contents:</b></p> <ul style="list-style-type: none"> <li>○ C.T.</li> <li>○ Bile Ducts (Interlobular Bile Ducts) (recognized by their round nuclei).</li> <li>○ Venule (Branch of portal vein). Because it's the <b>largest structure</b> in this area, it was named after it (recognized by their flat nuclei + large diameter).</li> <li>○ Arteriole (Branch of hepatic artery) (recognized by their flat nuclei).</li> </ul>

## L\M of Liver & Their Explanation

L\M of Liver & Their Explanation	
<b>Classic Hepatic Lobule</b>	
	<ul style="list-style-type: none"> <li>○ The picture was taken from a pig's liver, and that's why the septa here are obvious.</li> <li>○ Stained by special stains to stain C.T by this deep blue coloration.</li> <li>○ The yellow arrow points to the septa.</li> <li>○ The blue circle shows the central vein, and there is what looks like rays radiating from it. These are cords of "hepatocytes"; extend to the border of hepatic lobule.</li> <li>○ From septa, we have condensation of C.T at corners, because it contains very important structures called "portal areas".</li> </ul>
	<ul style="list-style-type: none"> <li>○ Human Liver.</li> <li>○ This is the functional and structural unit of the liver and it's called "classic hepatic lobule".</li> <li>○ It's formed of a polygonal mass of liver tissue with portal areas at the periphery &amp; central (centrolobular) vein in the center.</li> <li>○ We can notice here that the septa are not clear as they were in the pig's liver.</li> <li>○ Since the septa are not clear in the normal human liver, we identify hepatic lobules by imagination. We see the central vein and the hepatocytes radiating from it; so the architecture will be obvious.</li> </ul>
	<ul style="list-style-type: none"> <li>○ Pink cells, contain nuclei; these are the "hepatocytes" mainly.</li> <li>○ Between them, there are spaces called "hepatic sinusoids".</li> <li>○ Hepatocytes start from the central vein. They don't go straightforward, but rather branch and then re-anastomose with one another cord forming what looks like a network in the end. But still leaving space for "hepatic sinusoids".</li> <li>○ While looking at the picture we may think that sinusoids come in direct contact with the hepatocytes but actually they DON'T. There is a space between them called "Space of Disse".</li> <li>○ "Space of Disse" is hardly if not impossible to be seen by L.M, it has to be seen by E.M.</li> </ul>

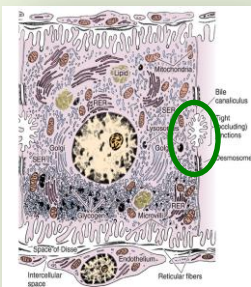
# L\|M of Liver & Their Explanation

## Portal Area



- Bile is green. Bile pathway is opposite to the pathway of blood. Bile pathway is going away from the hepatocytes to the portal area. While, blood pathway is coming from the portal area towards the hepatocytes.
- Blood pathway drains into the sinusoids, so sinusoids contain mixed blood.
- Hepatocytes take raw material to metabolize it, and then release some of it back into the sinusoids. Then from sinusoids it goes to the central vein, which carry blood away from the classic hepatic lobule to the inferior vena cava.
- Central veins coming out of hepatic lobules come together to form hepatic veins and then go to inferior vena cava.
- To differentiate between vascular structures and other structures, we should remember that, vascular organs are lined by simple squamous epithelium, so their nuclei will be flat and small.
- And to differentiate between veins and arteries, we look for smooth muscles in arteries, as they are NOT present in veins.

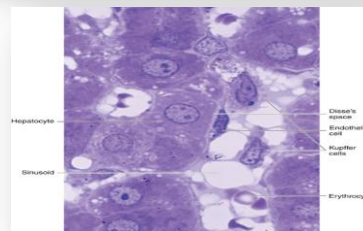
## Hepatocytes



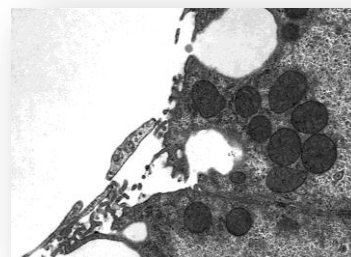
- The surface contains microvilli is the surface facing the sinusoids. It has microvilli to increase surface area; to help absorb and excrete the materials in the sinusoids. These microvilli do NOT extend to reach the sinusoids, but rather they extend to the space of Disse.
- There is desmosome to prevent leaking of bile between cells.
- The green circle shows the bile canaliculus.



## Liver Sinusoids



## Space of Disse







# Spleen

Stroma	
Capsule	Is covered by visceral layer of peritoneum; <b>mesothelium</b> (Thick).
	Occasionally contains smooth muscle cells (SMCs), <b>to help storing blood.</b>
	Because spleen in animals acts as storage of blood, so it acts as a sac of blood, and so these smooth muscles are present to make it contract to help pump the blood into the circulation when needed.
Trabeculae (Septa)	Irregular.
Reticular C.T	C.T.
Parenchyma	
White Pulp	<b>Contains:</b> <ul style="list-style-type: none"> <li>○ <b>Periarterial Lymphatic Sheaths (PALS):</b> <ul style="list-style-type: none"> <li>➤ Housing T Lymphocytes, (named housing; because it surrounds the arteriole. That's why it's called "PALS").</li> </ul> </li> <li>○ <b>Lymphoid Nodules (with germinal centers).</b> <ul style="list-style-type: none"> <li>➤ Housing B Lymphocytes.</li> </ul> </li> </ul>
	Both "PALS" & "Lymphoid Nodules" have the <b>acentrically</b> located central artery (central arteriole).
	Central arteriole is always on one side. Although it's named central. Central here means that it's present within the cells but NOT central in position. And the word "acentrically" above means: Not Central. Like when we say "avascular" it means: Not Vascular
Red Pulp	<b>Contains:</b> <ul style="list-style-type: none"> <li>○ <b>Pulp (Splenic) Cords:</b> <ul style="list-style-type: none"> <li>➤ Extravasated blood cells, plasma cells, macrophages, &amp; reticular cells and fibers; <b>no specific cells.</b></li> </ul> </li> <li>○ <b>Blood Sinusoids:</b> <ul style="list-style-type: none"> <li>➤ Are lined with elongated fusiform <b>endothelial cells</b> with large intercellular spaces.</li> <li>➤ And supported by discontinuous circular basement membrane.</li> </ul> </li> </ul>
<b>N.B;- pulps:</b> <ul style="list-style-type: none"> <li>○ Has No cortex.</li> <li>○ No medulla.</li> <li>○ No afferent lymphatic vessel.</li> </ul> (This is to know how to differentiate between pulps and lymph nodes or thymus)	

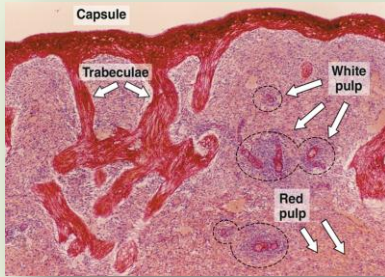
## Doctor's Notes

- Function of spleen is filtration of blood (not lymph). So that old non-functioning blood cells are degenerated, and the remnant raw materials are recycled.
- Blood vessels, lymphatic and nerves pass through the trabeculae.
- Blood vessel entered from outside, then it branched, each branch will go in a trabecula, when it's in the trabecula, it is surrounded by T lymphocytes.
- So, in spleen T Lymphocytes surround the arteriole, and so called "periarterial lymphatic sheaths".
- Then B-lymphocytes and macrophages come to surround it.
- The end/fate of the arteriole in humans:
  - Some of the branches open to allow free circulation of the blood "red pulp", it's like bleeding but within the organ so it's a sac of blood
  - And some are closed

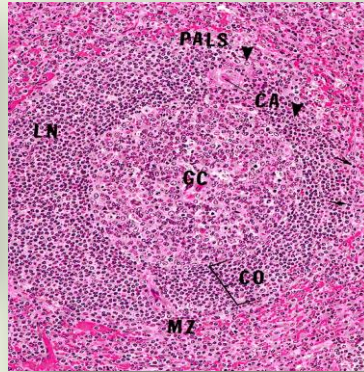
## L\M of Spleen & Their Explanation

### L\M of Spleen & Their Explanation

#### Spleen

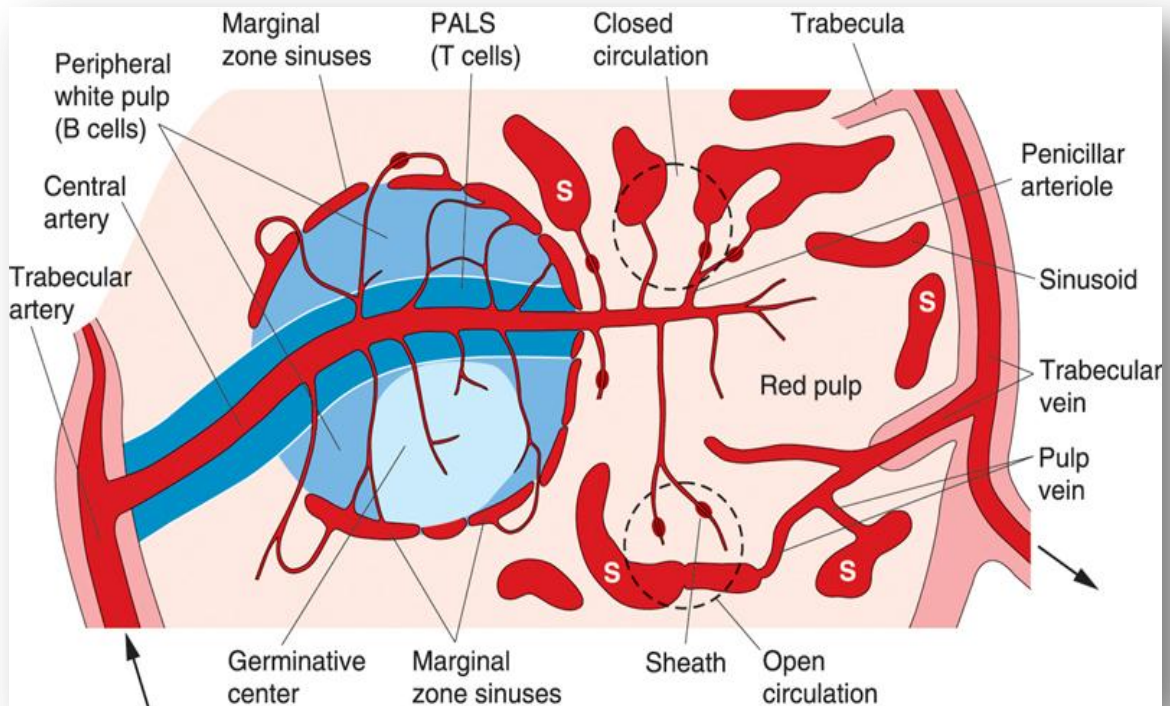
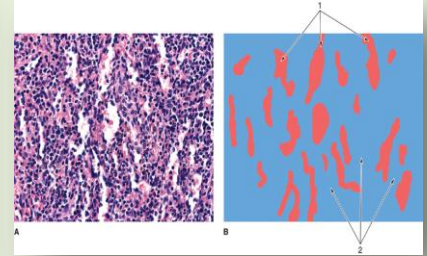


#### White Pulp



- Looks blue because of the stain (H&E). But originally, it's grey.
- Center is pale, and margins are dark.
- And then around it mature cells, which are active cells called "Germinal Cells"

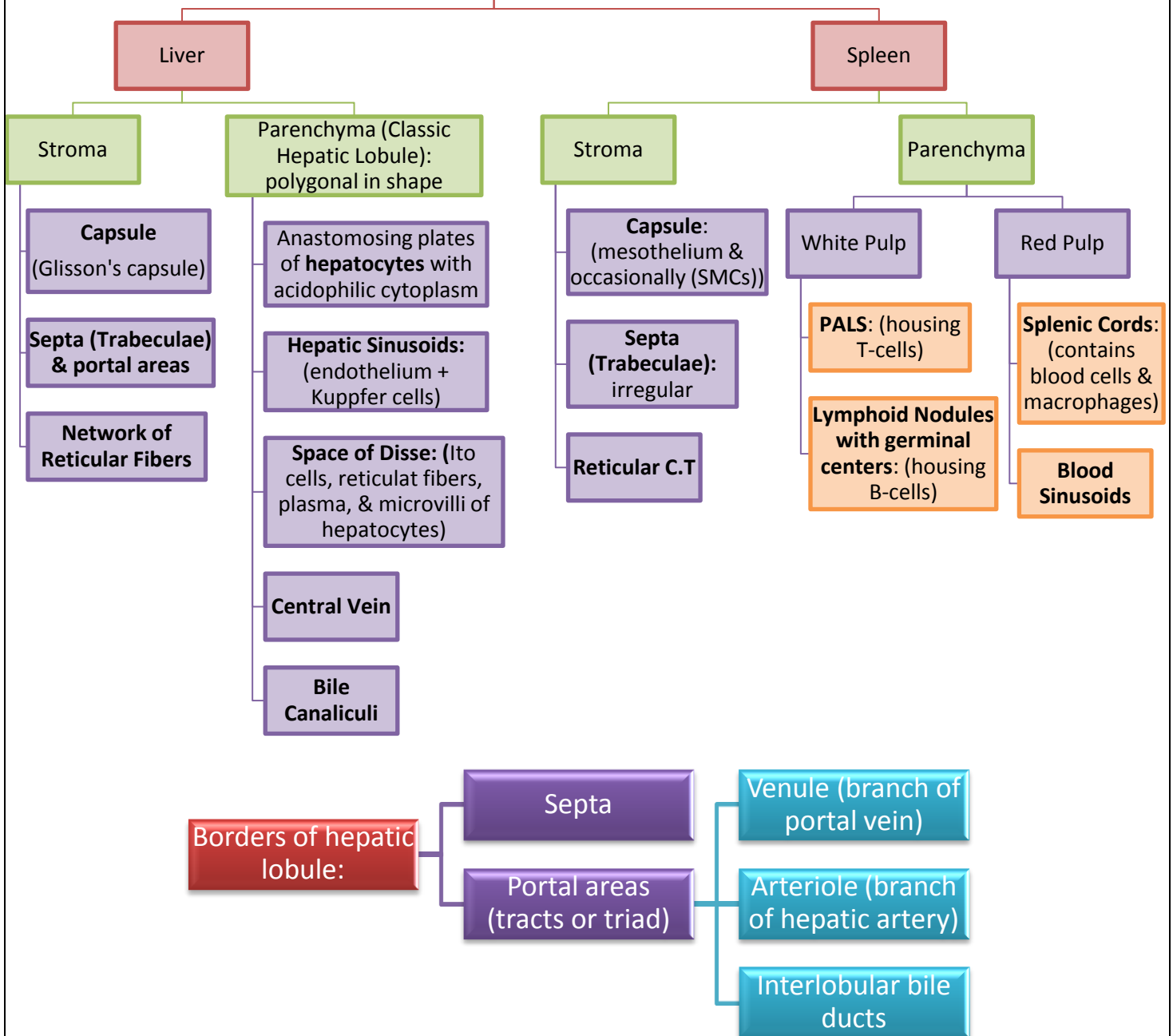
#### Red Pulp





# Summary

## Liver & Spleen



Hepatic Sinusoids (in the liver)	Blood Sinusoids (in the red pulp of spleen)
Are lined by <b>fenestrated</b> endothelial cells.	Are lined by elongated fusiform endothelial cells.
<b>Discontinuous.</b>	Large intercellular spaces.
Basal lamina is <b>absent.</b>	<b>Discontinuous</b> and <b>circular basement membrane.</b>





## Questions

Q1: The most abundant Organelle in the Hepatocytes:

- A- Golgi complex      B- Lysosomes  
C- rER                      D- Mitochondria

Q2: The capsule of the spleen contains:

- A- Septa                      B- smooth muscle cells  
C- Glisson's Capsule      D- Lipofuscin

Q3: The only organ in the body its lymphoid nodules penetrated with arteriole:

- A- Liver                      B- Spleen  
C- Kidney                    D- pancreas

### Answers:

1	2	3
D	B	B



**If you have any questions or suggestions please do not  
hesitate to contact us on:**

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***Best of luck!***