Liver
CAP-ACP Resident Review Course
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Pre-session Review Materials

- I have nothing to disclose

- All cartoons/photos are my own, unless otherwise specified

The Liver – an overview

- Largest internal organ (2% of body weight, average 1300 g adult weight)
- Location: right upper quadrant abdomen
- >500 functions
- Massive regenerative potential: surgical removal of 60% of the liver→ regeneration of functional mass in 4-6 weeks
- Major interface between digestive system and the rest of the body
  - Nutrients absorbed in small intestine are processed by the liver before entering circulation – maintains metabolic homeostasis
  - Bile produced in liver travels via bile ducts to gallbladder for storage and secretion to duodenum

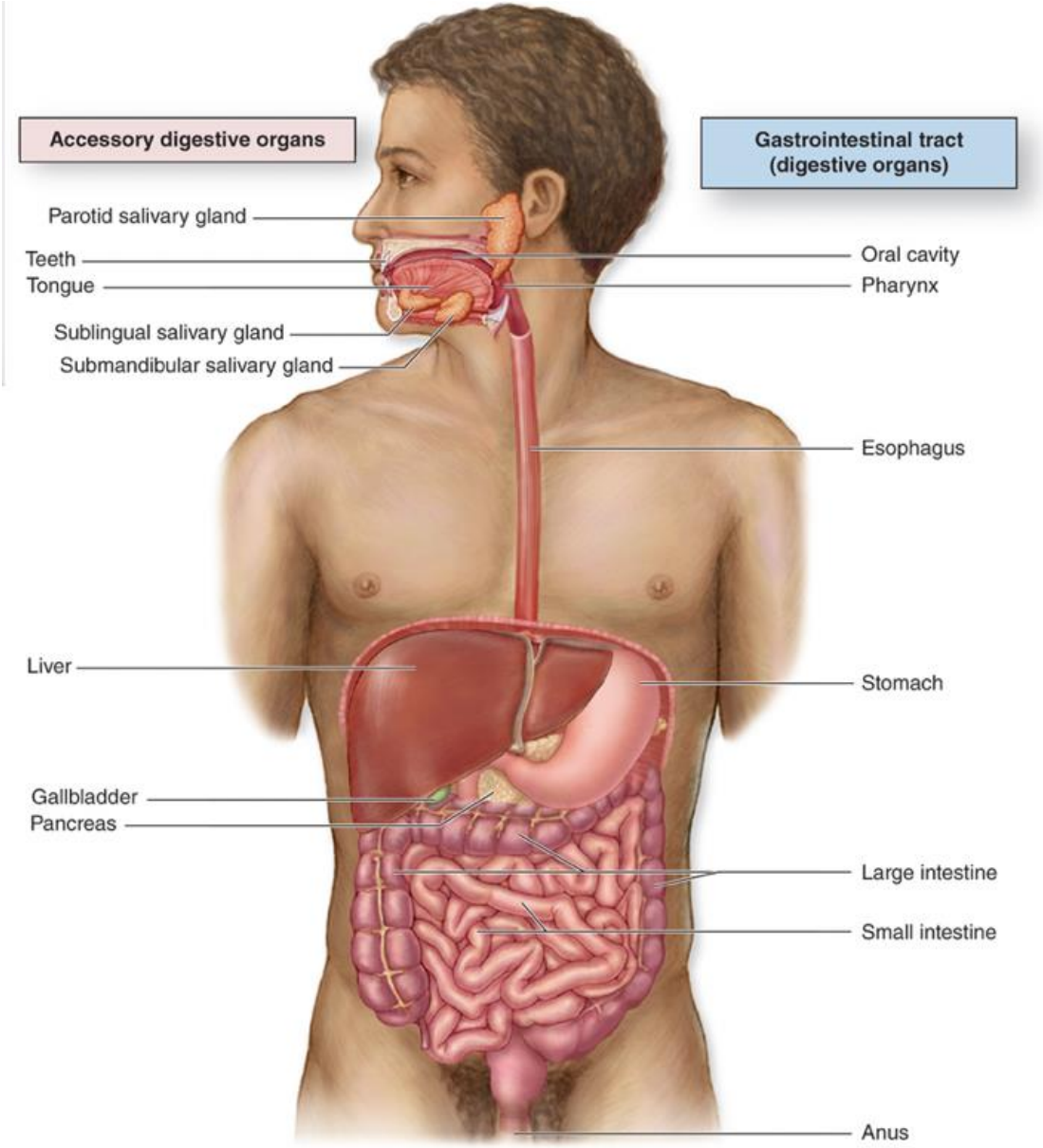


Fig 15-1 from Mescher A.L. ed. *Junqueira's Basic Histology Text and Atlas. 13th ed*. New York, NY: McGraw-Hill; 2013.

Functions (include, but not limited to):

- Exocrine function – secretion of **bile components**
- Endocrine function –secretion of **plasma proteins to blood** (i.e. albumins, fibrinogen, other clotting factors)
- **Processing of dietary nutrients** (amino acids, carbohydrates, lipids)
  - i.e. conversion of amino acids to glucose (gluconeogenesis)
- **Detoxification** (breakdown) of endogenous (made in the body) and exogenous (i.e. ingested toxins, medication, alcohol) compounds
- **Conversion of ammonia** (waste product of amino acid metabolism) **to urea** (later removed from blood by kidneys)
- **Storage** of glucose, triglycerides, iron, and fat soluble vitamins
- **Removal** of old/ineffectual **erythrocytes**

Macroscopic Biliary System

- Bile formed by the liver drains in to the right and left hepatic ducts, which join at the liver hilum (aka “porta hepatis”) to form the common hepatic duct
- The common hepatic duct is joined by the cystic duct, which drains the gallbladder, and the common bile duct is formed
- The common bile duct enters the pancreas and joins the pancreatic duct to drain contents in the duodenum via ampulla of Vater

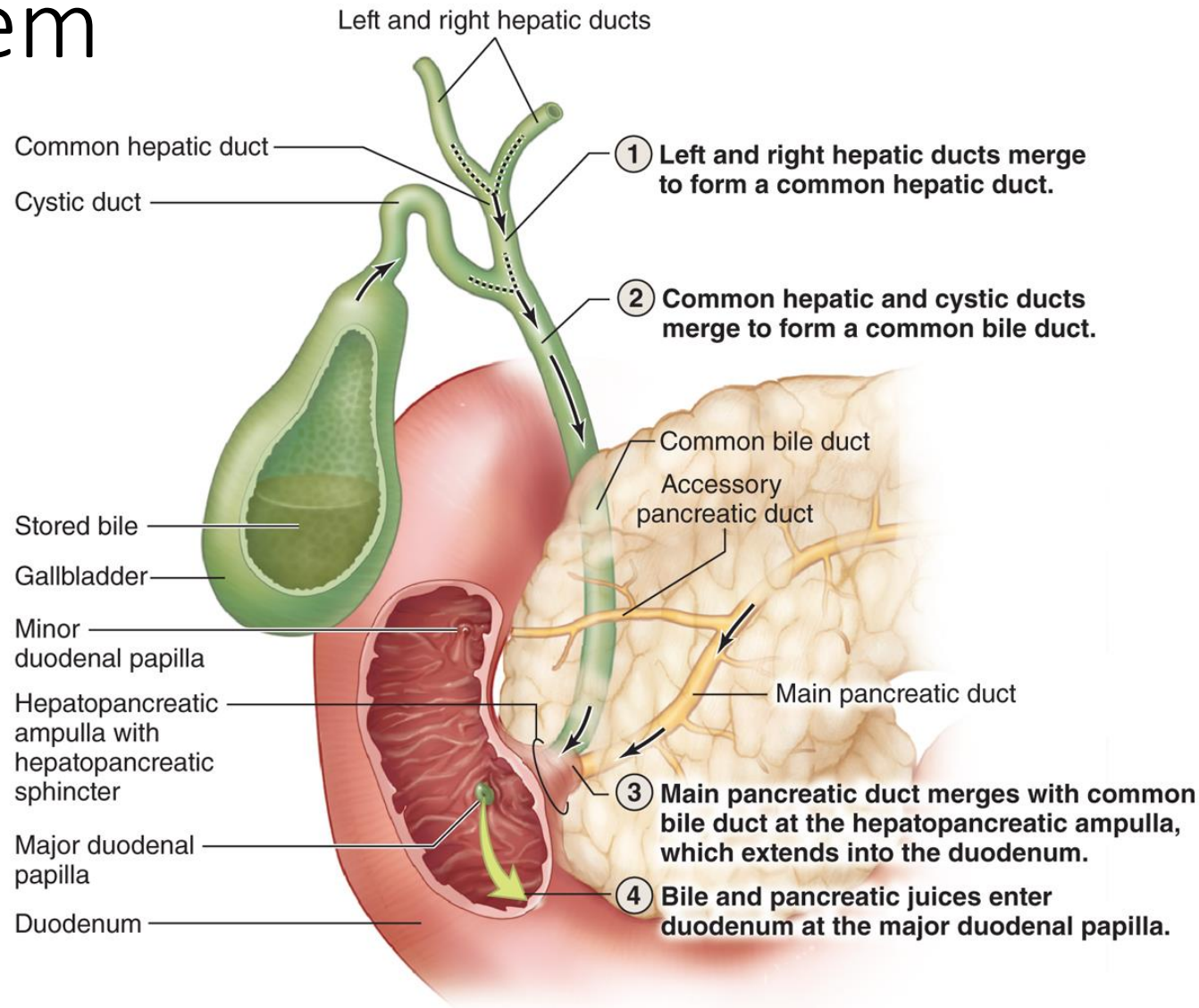


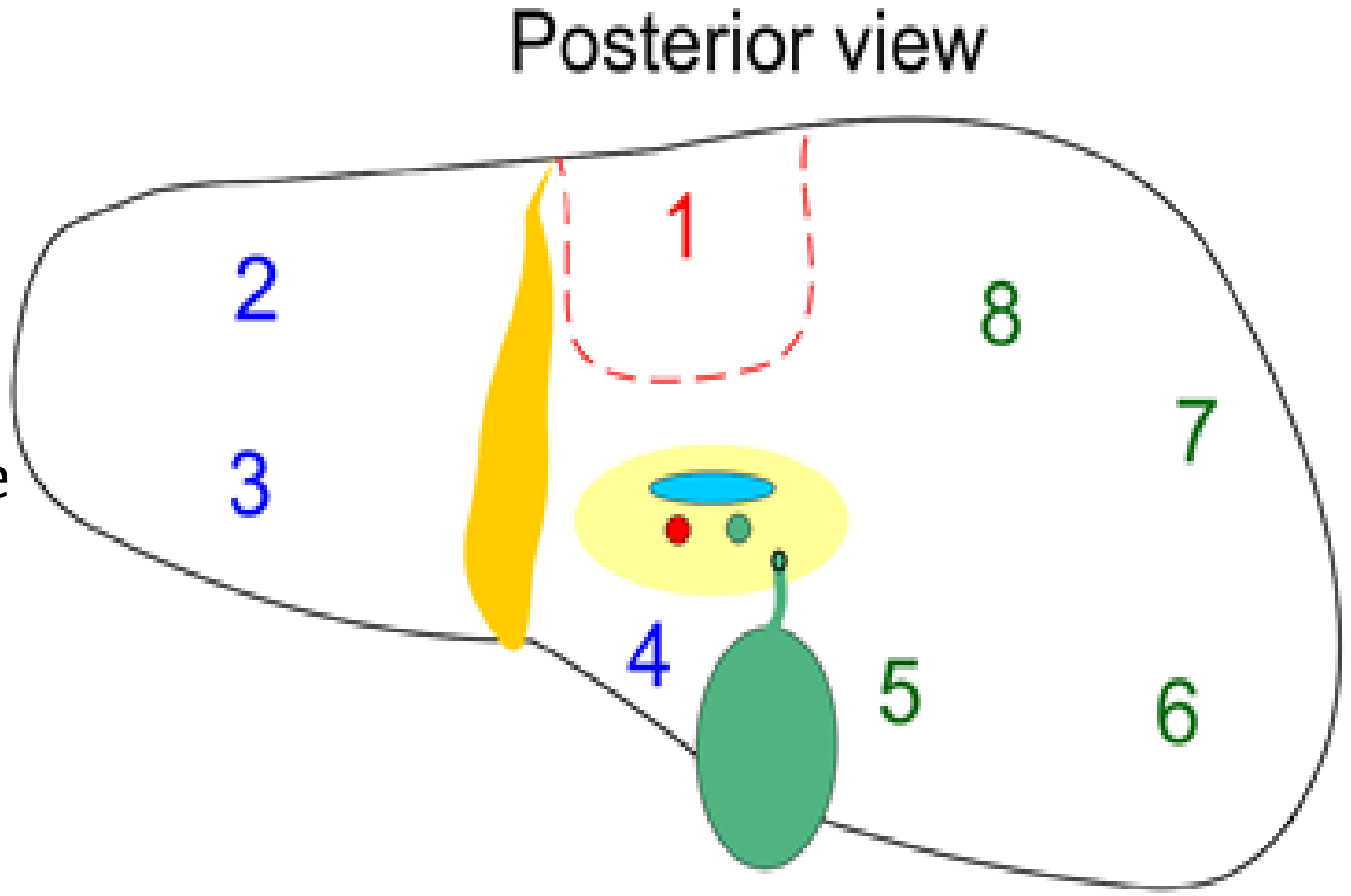
Fig 16-19 from Mescher A.L. ed. *Junqueira’s Basic Histology Text and Atlas. 13th ed*. New York, NY: McGraw-Hill; 2013.

Macroscopic Vasculature

- INFLOW - Dual blood supply
  - Hepatic artery
    - 1/3rd of blood supply
    - High pressure
    - Oxygen-rich, nutrient poor
  - Portal vein
    - 2/3rds of blood supply
    - Low pressure
    - Oxygen-poor, nutrient rich (drains from GI tract)
- OUTFLOW –
  - Hepatic vein
    - Collects oxygen-poor blood, drains to inferior vena cava

Porta hepatis

- We are looking at the posterior surface of the liver.
- Segments are noted (more on that soon)
- The yellow circle represents the porta hepatis
  - This contains 3 major structures:
    - Hepatic artery
    - Portal vein
    - Common hepatic duct
    - This trio will be repeated in the microanatomy



Original cartoon, Ashley Stueck

Macroscopic Segmentation

- Couinaud system of anatomy of the liver
  - Divides liver into functionally independent segments based portal branching - each segment has its own vascular supply, output, and biliary drainage

- Segments are numbered in a clockwise manner
  - Segment I is posterior around IVC
  - Segment IV is sometimes divided into IVa and IVb

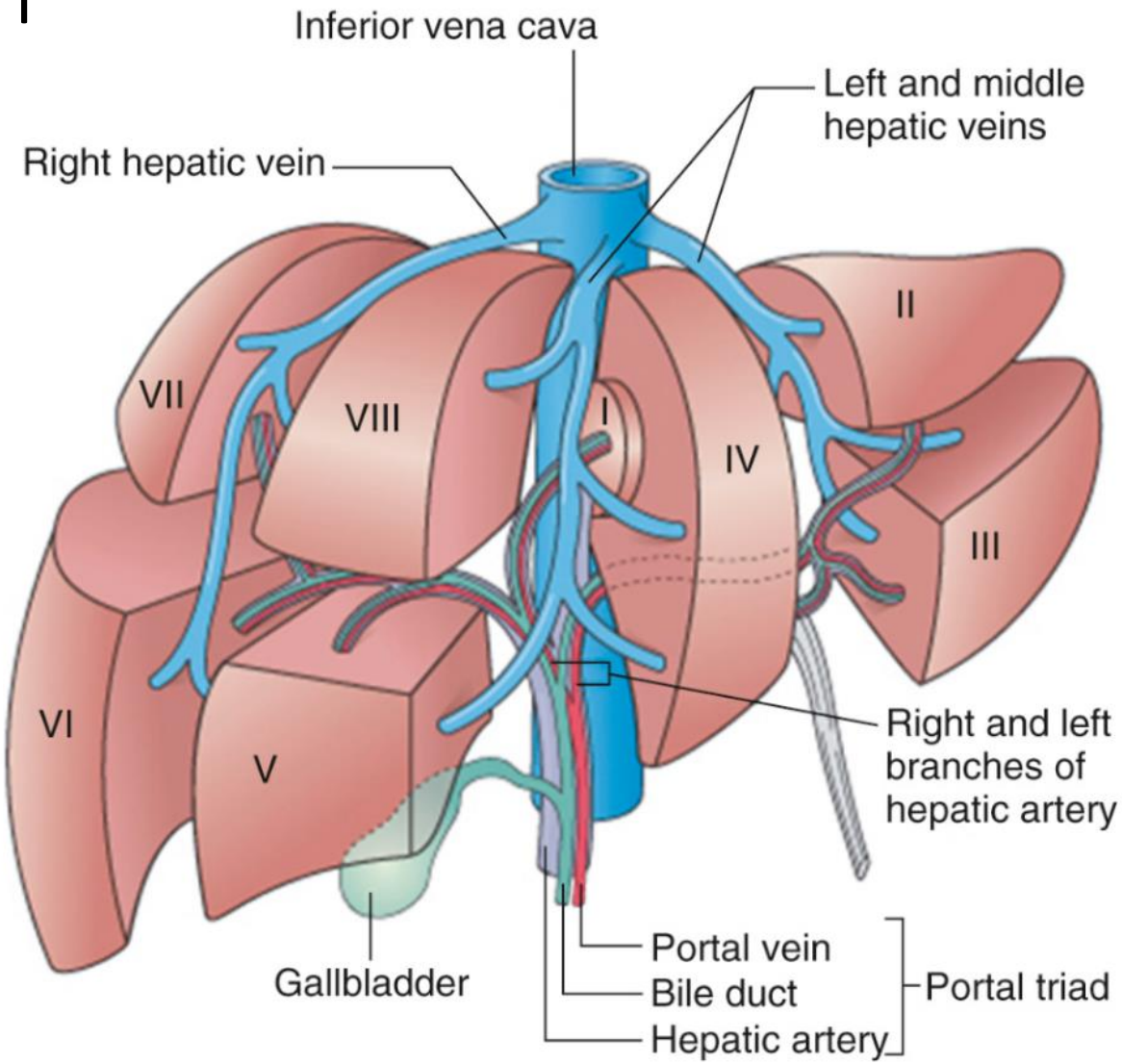
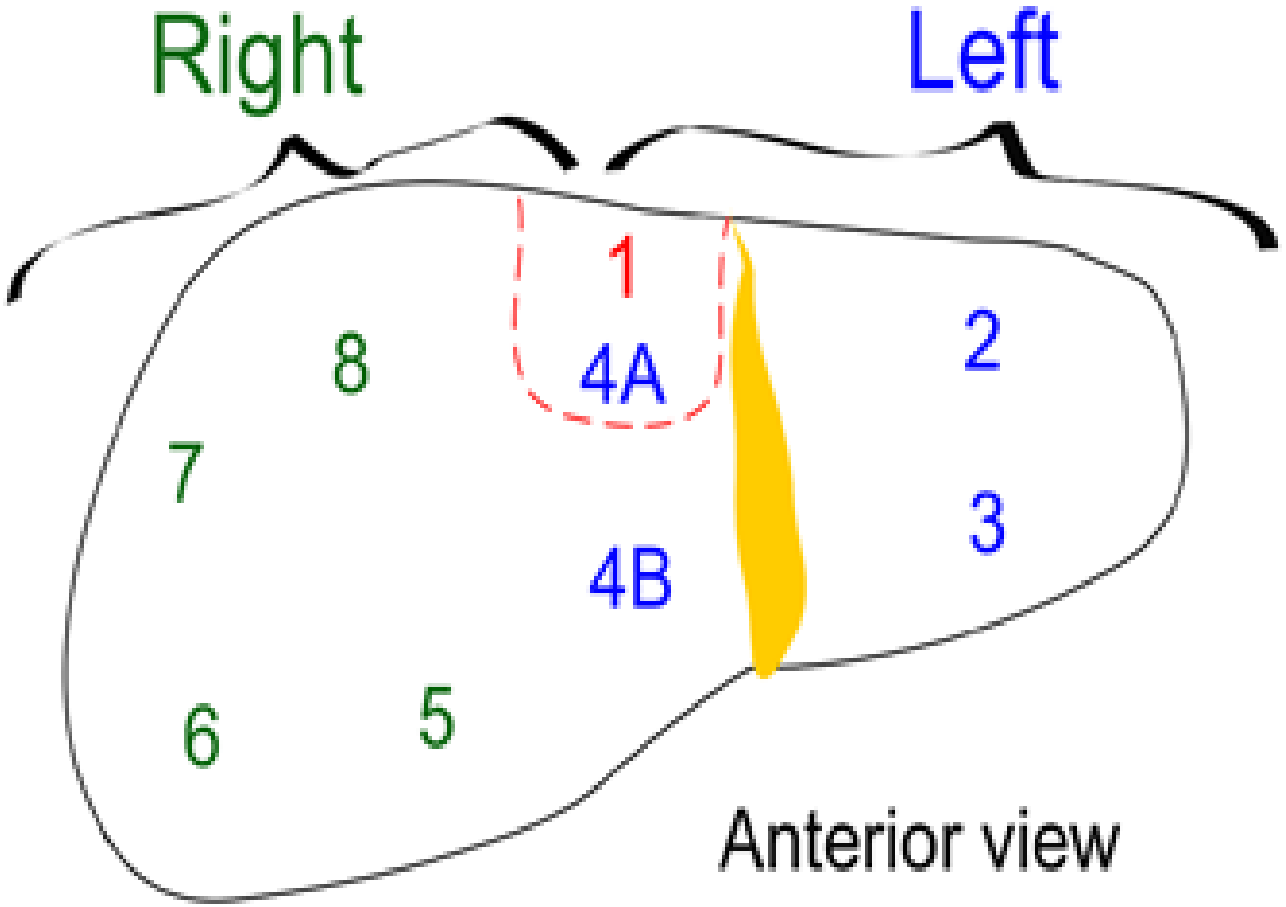


Fig 1.5 from Burt AD, Ferrell LD, Hubscher SG, eds. *MacSween's Pathology of the Liver* . 7th ed. Philadelphia, PA: Elsevier; 2018.

Macroscopic Segmentation

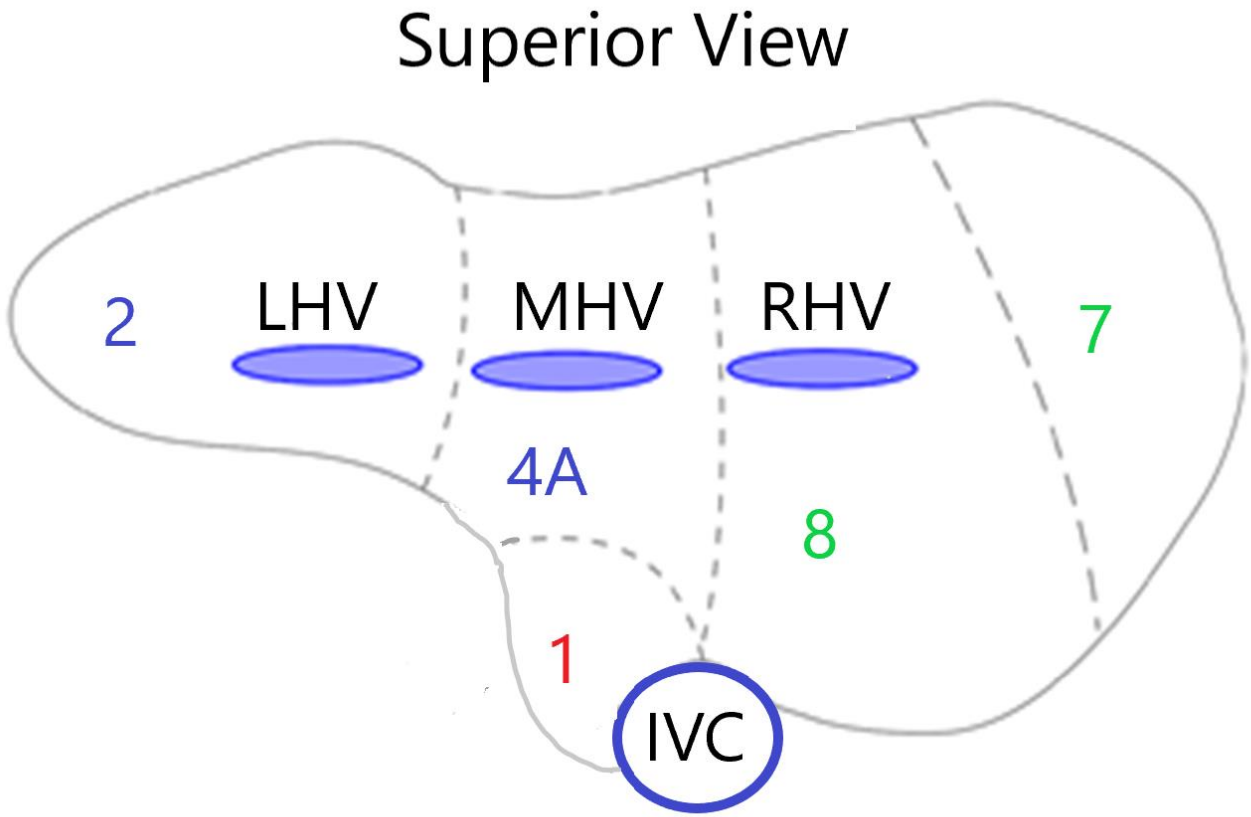
- Here's another cartoon illustrating segmentation
- The liver is also separated into right and left lobes
  - Left contains segments 2, 3, and 4
    - The left lateral (segments 2 and 3) is separated from the rest of the left by the falciform ligament
  - Right contains segments 5-8
  - Caudate (segment 1) is separate



Original cartoon, Ashley Stueck

Macroscopic Outflow

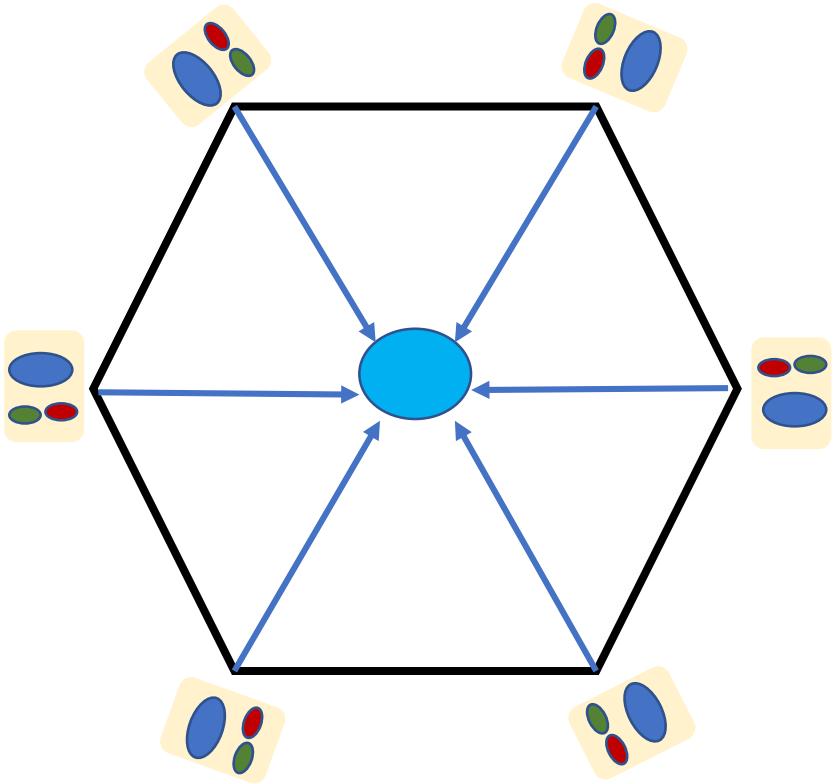
- If we look at the superior surface of the liver, we can see the vascular outflow
- The right lobe is drained by the right hepatic vein
- The left lateral lobe is drained by the left hepatic vein
- Segment 4 is drained by the middle hepatic vein
- All hepatic veins drain into the IVC
- The caudate lobe drains directly into IVC



Original cartoon, Ashley Stueck

Liver microanatomy

- Liver parenchyma composed of thousands of polygonal structures called **hepatic lobules**
  - Around the periphery of each hepatic lobule, there are portal tracts (aka portal triads) which contain:
    - the hepatic artery/arteriole
    - the portal vein/venule
    - the bile duct
  - In the centre of the lobule, there is a draining hepatic vein/venule (aka “central vein”)

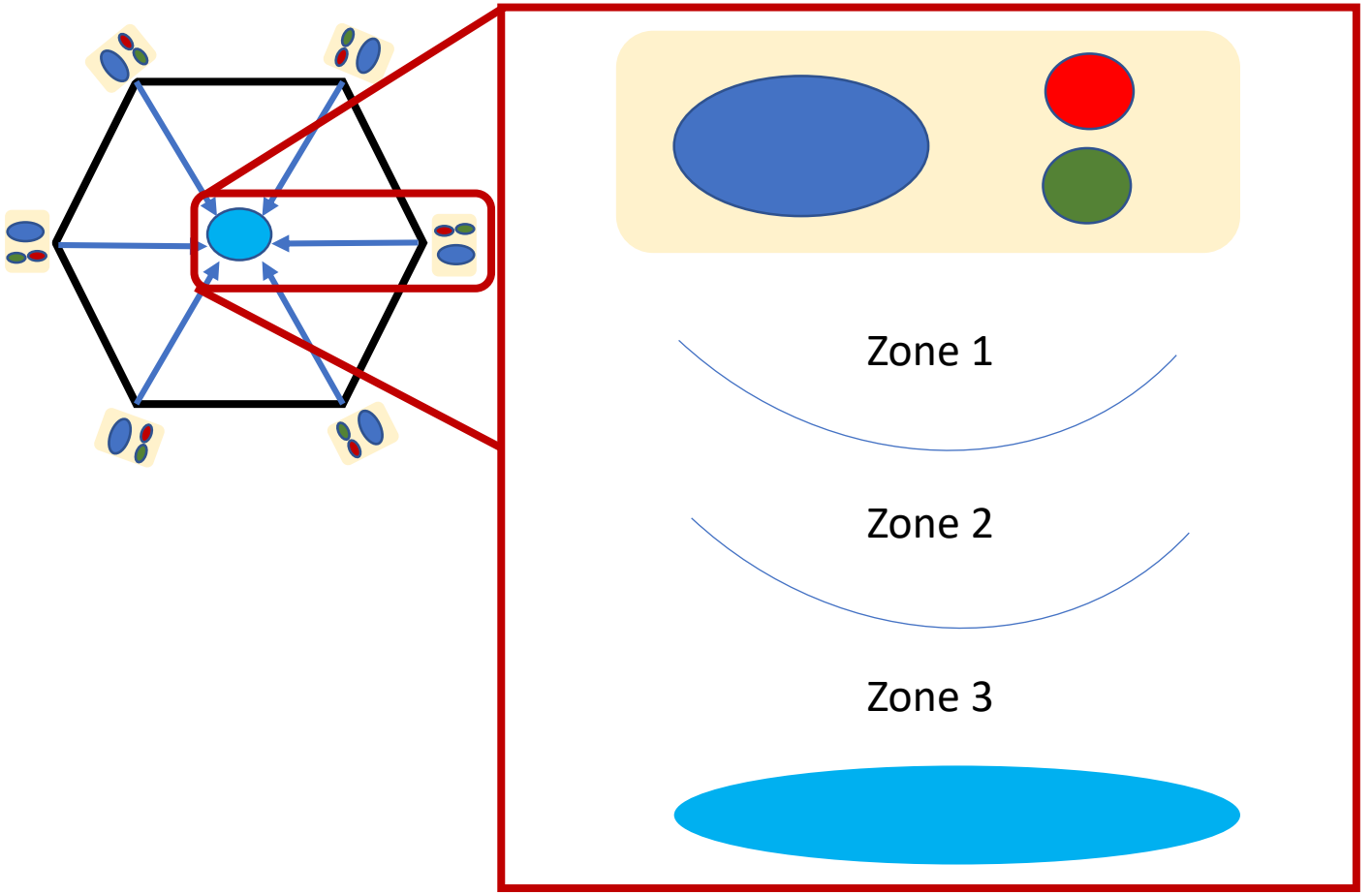


Hepatic lobule
Arrows indicate blood flow

Original cartoon, Ashley Stueck

Liver microanatomy

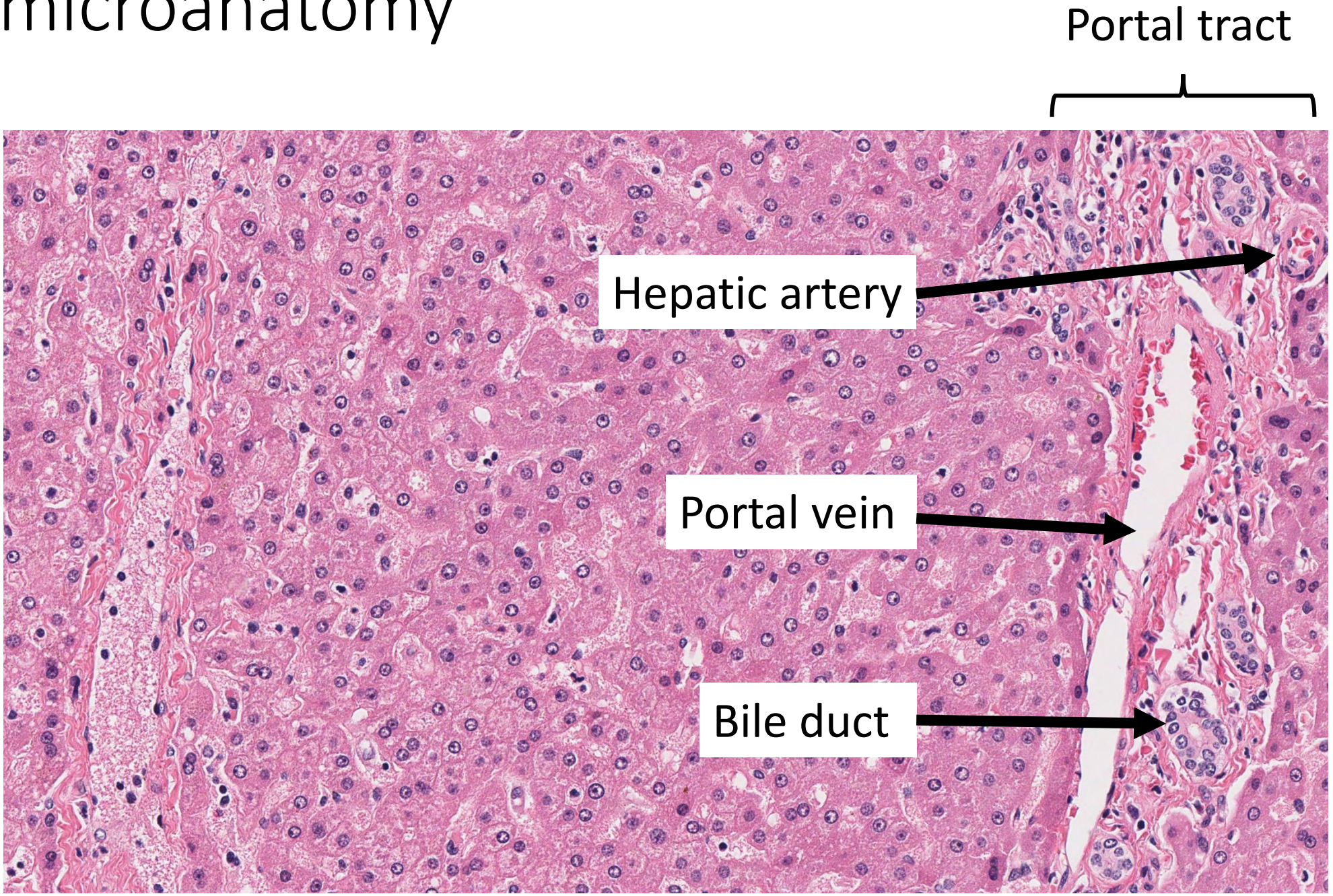
- Liver parenchyma can also be described via **acini**
- Each acinus is smaller than a lobule
- Is composed of a portal tract, hepatic vein, and their intervening tissue
- Is divided into 3 zones
  - Zone 1 – periportal
  - Zone 2 – middle
  - Zone 3 – pericentral
  - Zones have particular functions and diseases



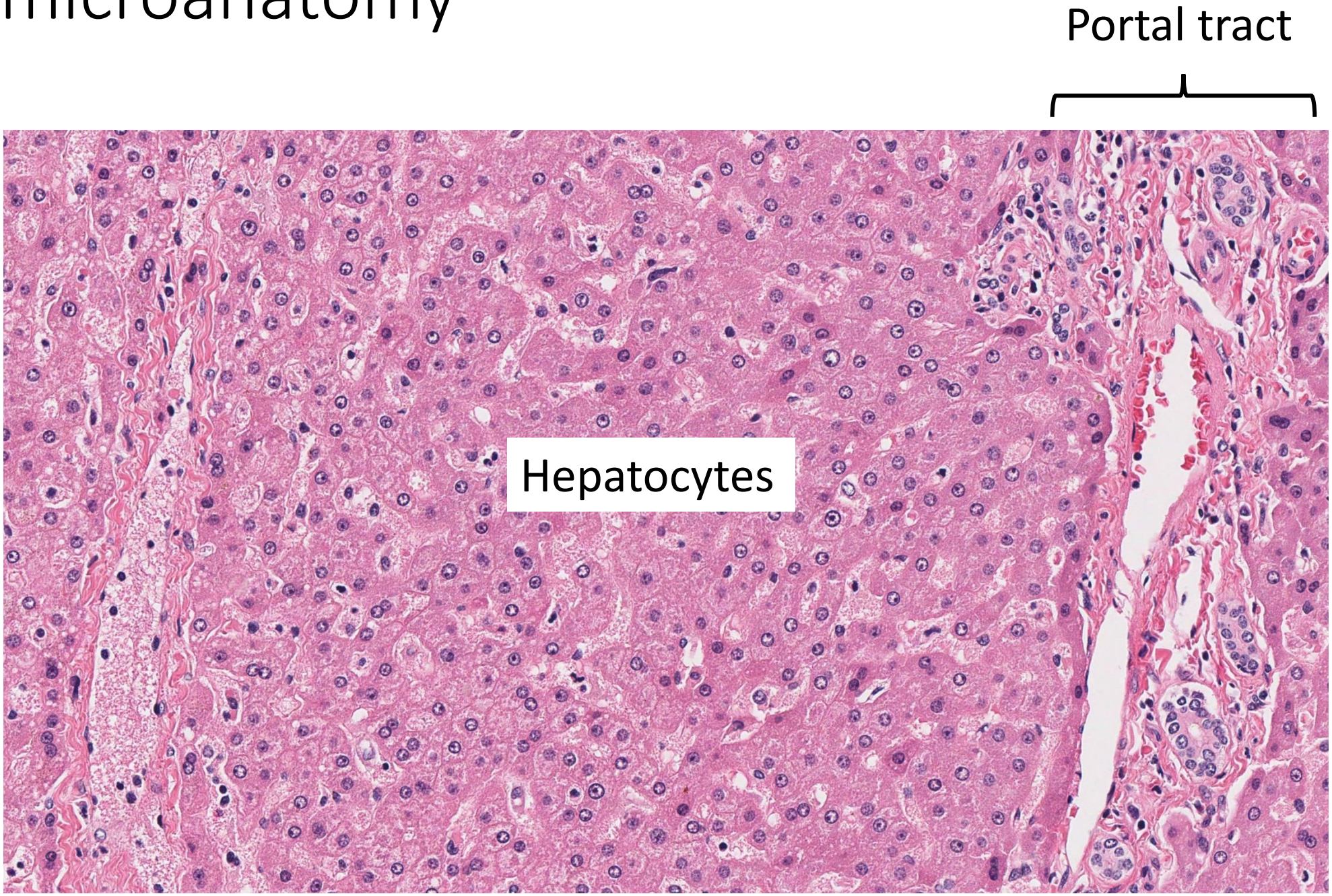
Hepatic acinus

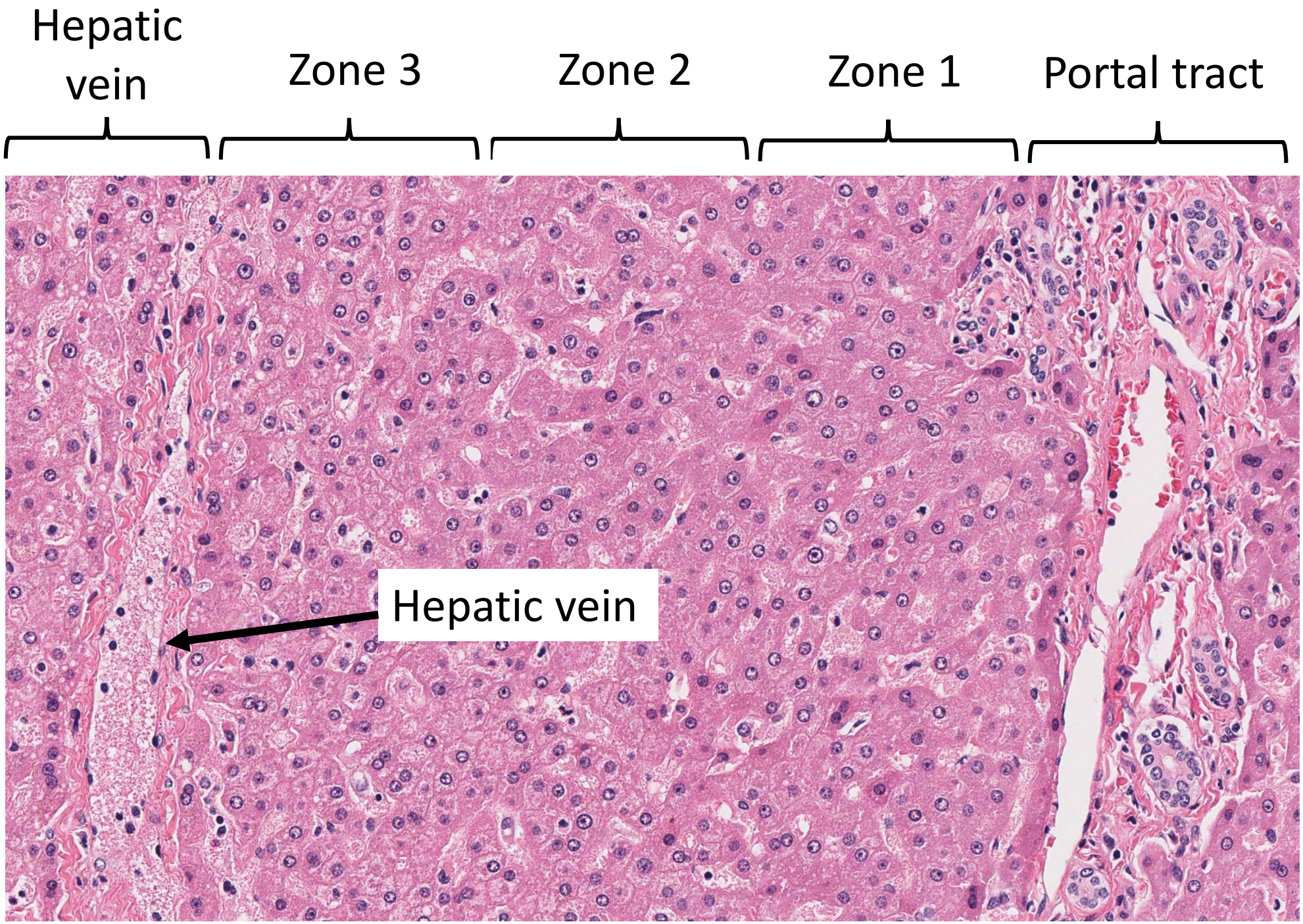
Original cartoon, Ashley Stueck

Liver microanatomy



Liver microanatomy

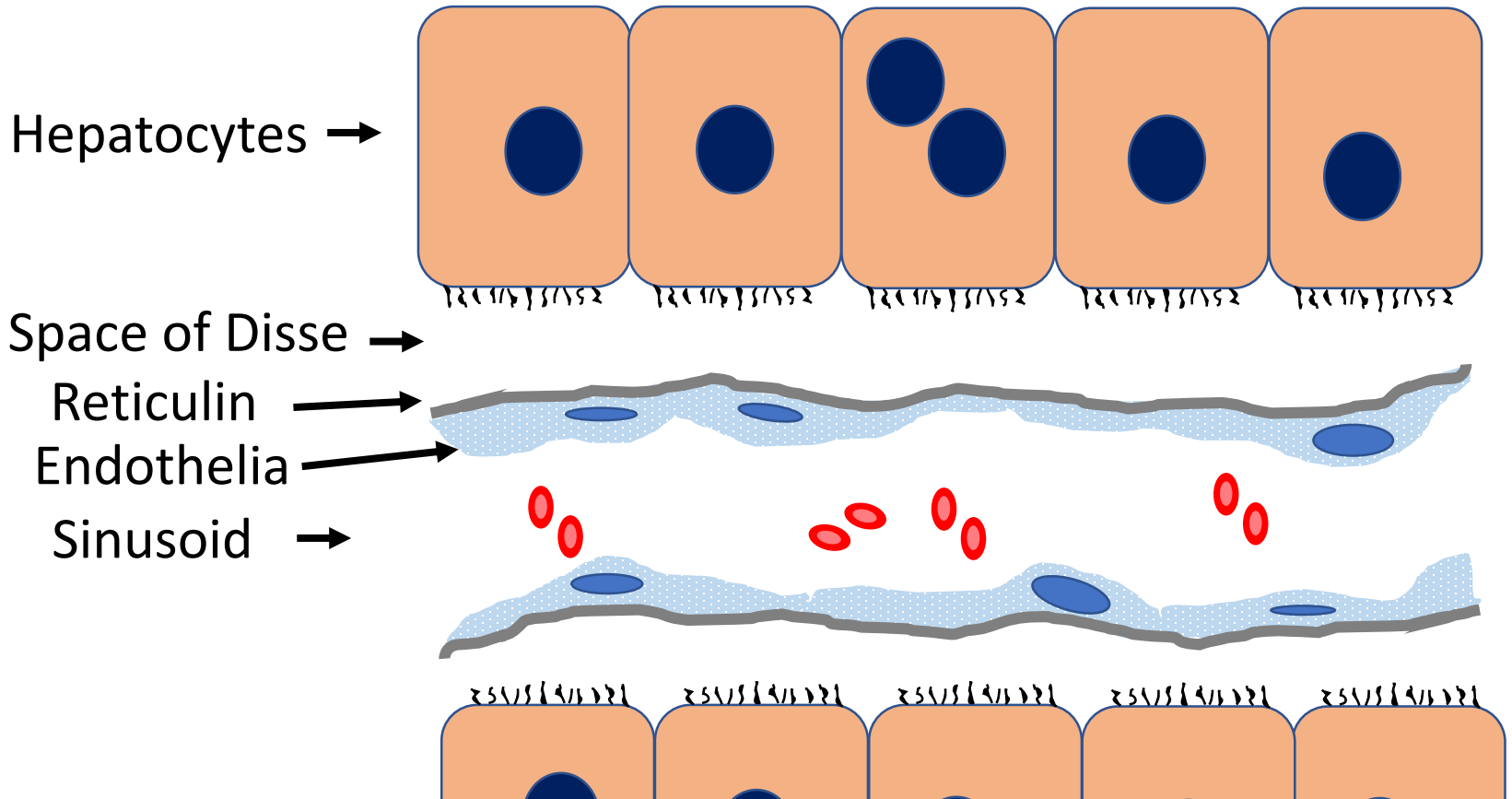



Hepatic vein
Zone 3
Zone 2
Zone 1
Portal tract
Hepatic vein

Hepatocytes and the hepatic sinusoid

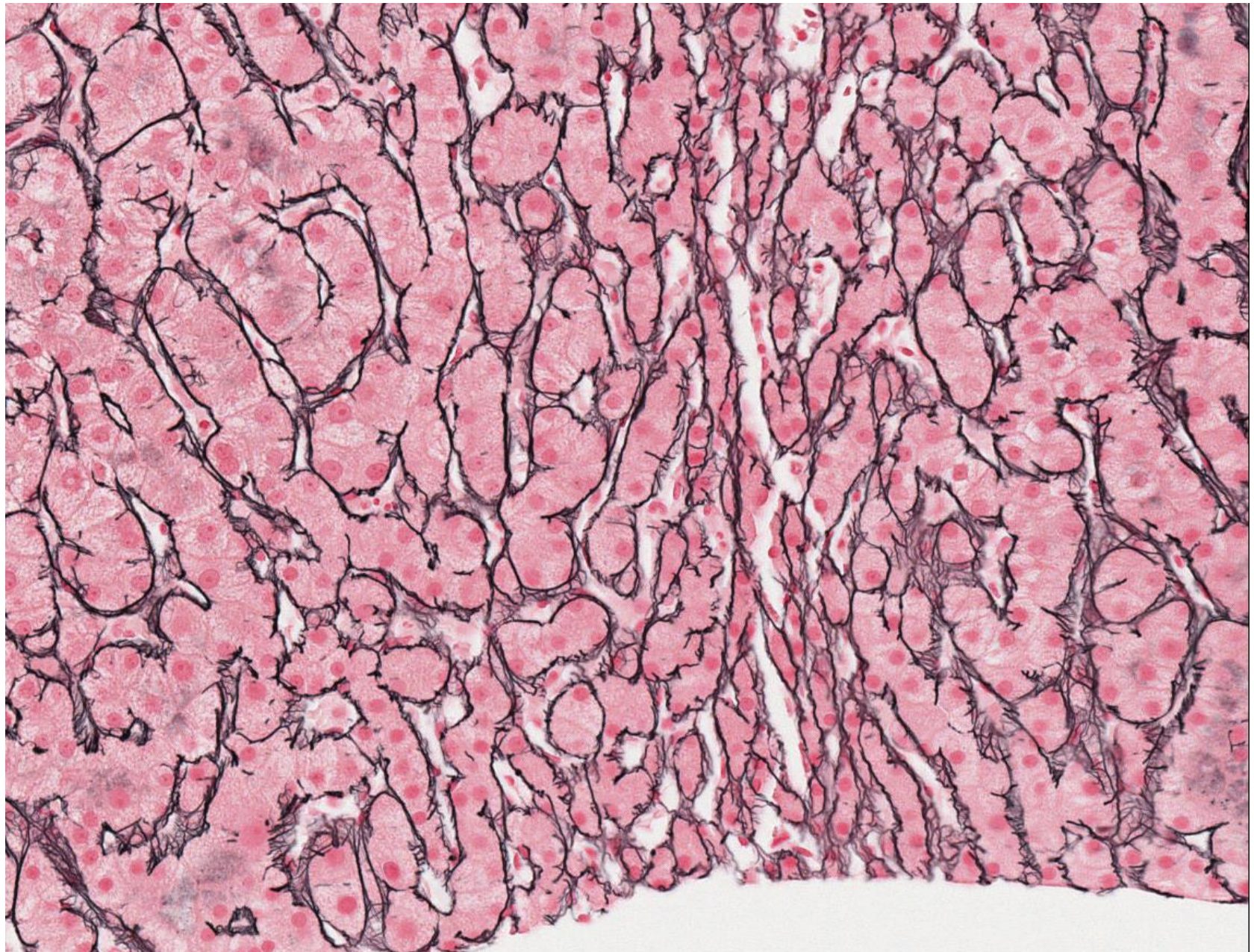
- Hepatic artery and portal vein branch into **vascular sinusoids** between hepatocytes, which drain into the central vein.
- Sinusoids are lined by fenestrated endothelial cells – discontinuous nature allows for blood to fill perisinusoidal space (**space of Disse)**
- This allows for **blood** to come into **direct contact** with **microvilli** on the surface of **hepatocytes** – facilitates their function

Original cartoon, Ashley Stueck



Selected Ancillary Studies

Reticulin

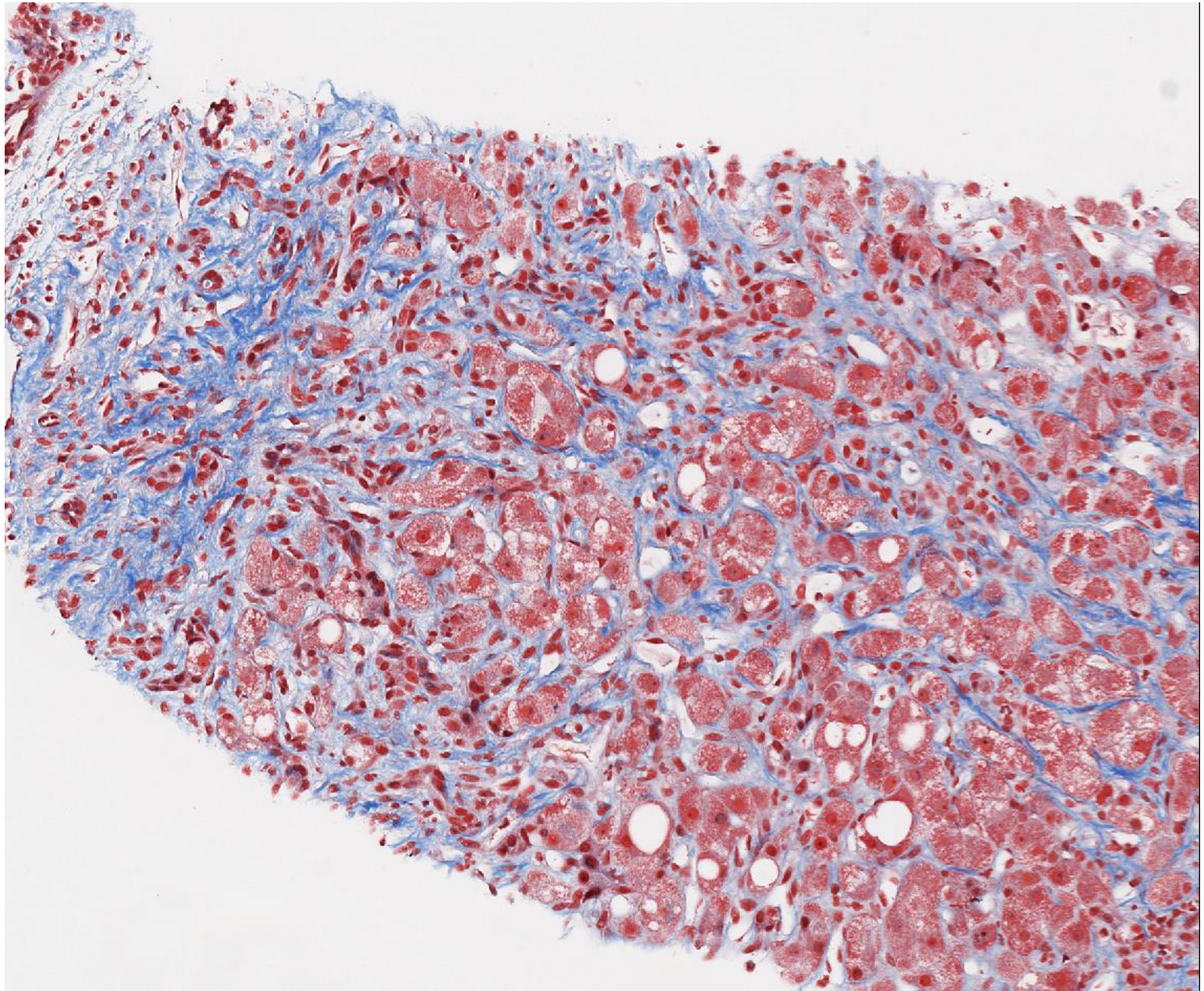


Type 3 collagen framework

Useful to:

- Highlight atrophy, regeneration, necrosis
- Highlight congestive injury (rbcs in space of Disse)
- In HCC, thick (>2 cells) plates and reticulin loss

Trichrome

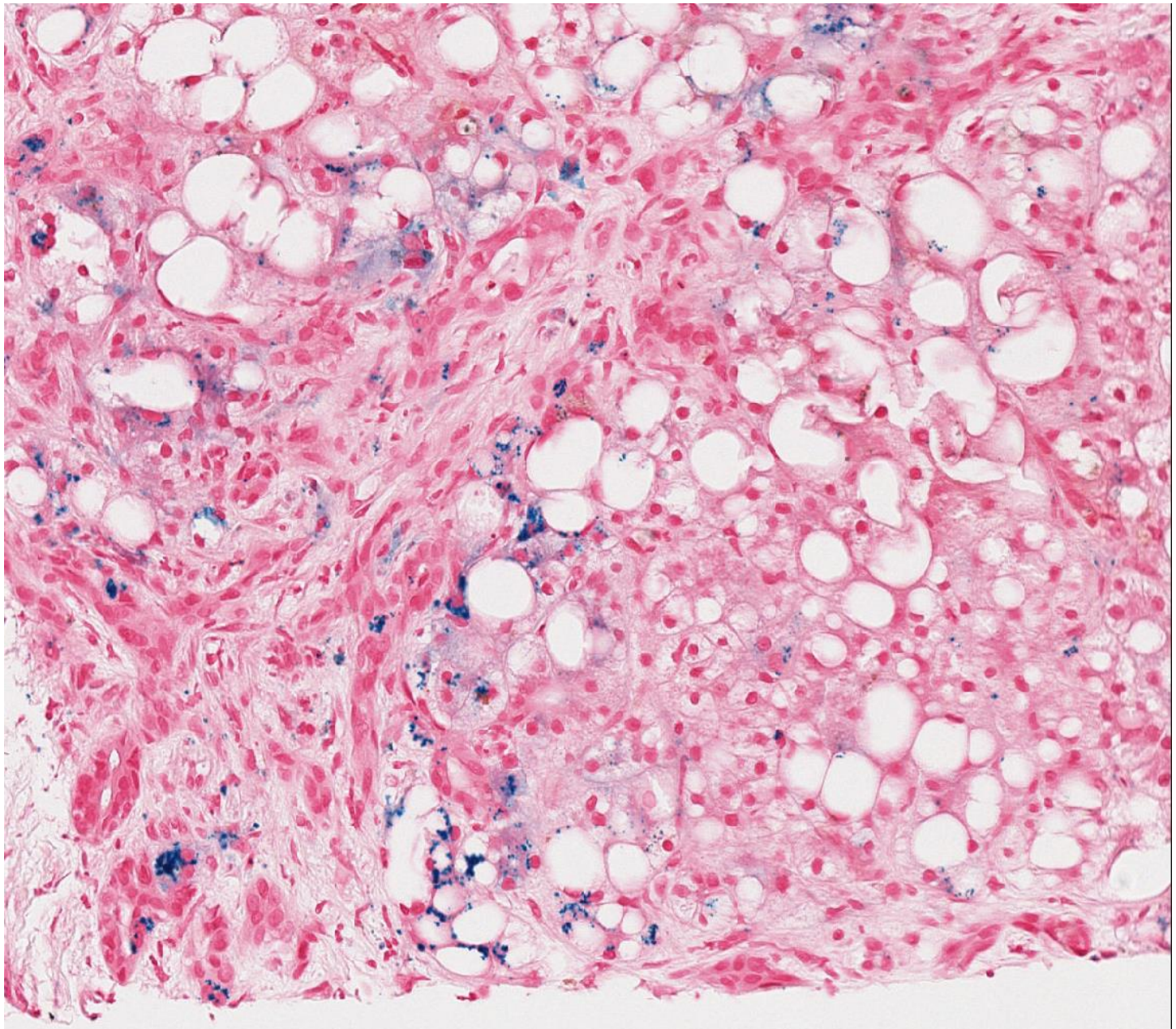


Collagen, fibrosis

Other things that may stain with trichrome:

- Amyloid
- Elastic
- Necrosis/reticulin fibres when collapsed together

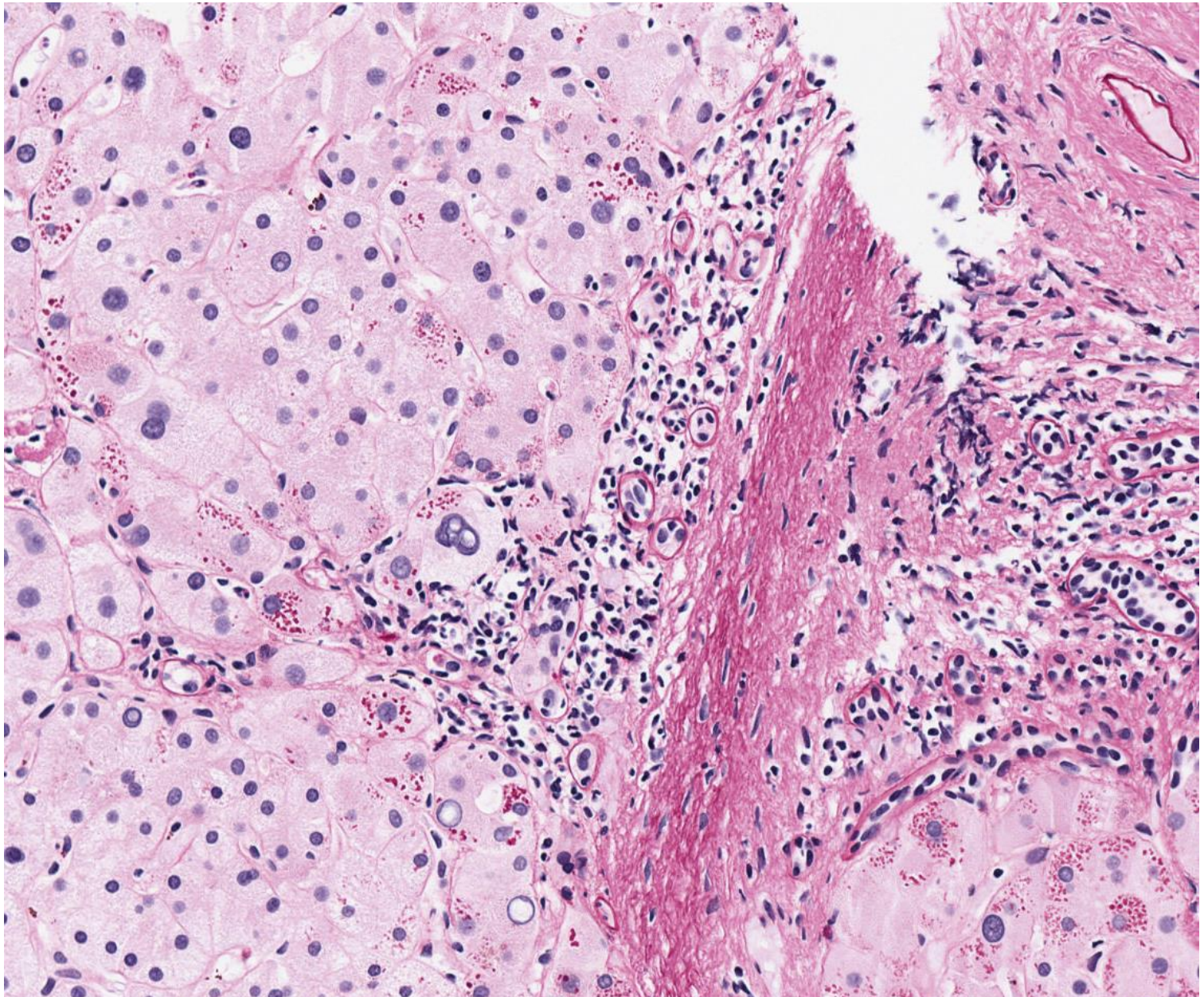
Perls' Prussian Blue



- Haemosiderin
- Normal liver = no granules

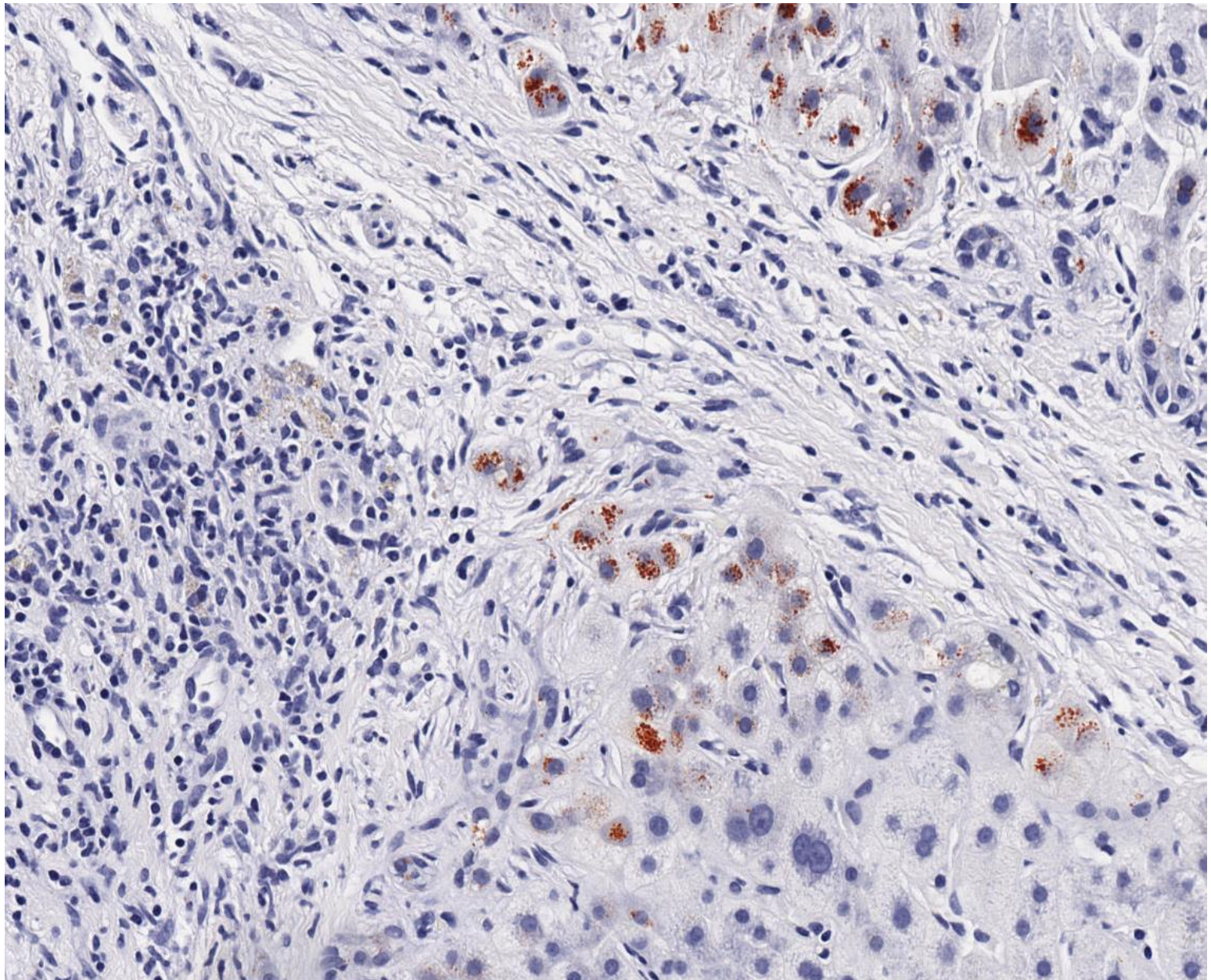
- Iron accumulates in Zone 1 first
- Where iron is – epithelial cells or reticuloendothelial – important in differential

PAS-D



- Primarily used for identification of alpha-one-antitrypsin globules
- A1AT accumulate in zone 1 first
- Also useful to assess basement membranes, reticulin, macrophages
- PAS: glycogen (hepatocyte cytoplasm +++)

Rhodanine



- Copper
- Accumulates in zone 1 first
- Seen in Wilson Disease, chronic cholestatic diseases

Biliary tree IHC

- Monokeratin
- LMWK
- CK7
  - Also helpful in biliary tree diseases to quantify/demonstrate duct loss, show cholestatic change in hepatocytes
- CK19
- EpCAM
- May show patchy, variable intensity expression of CDX2
  - None of the above are specific; also seen in tumours of elsewhere in pancreaticobiliary tree, upper GI tract
- Albumin ISH (not many labs have) – more specific for liver, also seen in hepatocytes/hepatocellular lesions!

Hepatocellular IHC

- Monokeratin
- LMWK
- Arginase – most specific and sensitive
- Heppar-1/HSA
- CD10 or pCEA – canalicular staining
- Albumin ISH