### Veterinary Bioscience: Metabolism

#### **DVM Year 1**

#### VETS30017 / VETS90116





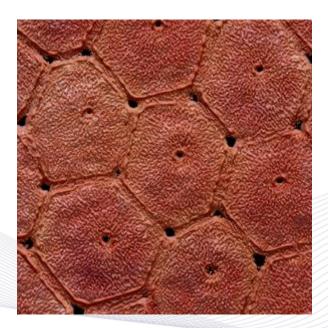








#### Structure and function of the Liver (part 1)



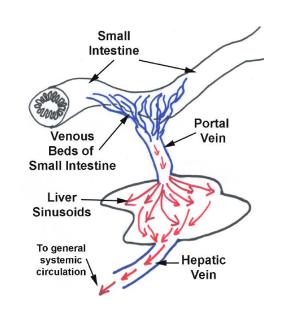
Prof. Simon Bailey bais@unimelb.edu.au

## Liver - function

Largest gland in the body

 Detoxification, biotransformation, synthesis, storage, phagocytosis

Capable of considerable regeneration



- LIVER:
- Large input via many sources
- Breaks up flow into small channels past hepatocytes
  - Modifies contents of flow
  - Single outputvia the hepaticvein

- SEWAGE TREATMENT PLANT:
- Large input via storm drains and sewer lines
  - -Breaks up flow into small channels over pebbles
    - Modifies contents of flow
  - Single large output via the outflow pipe

# Liver

- Uniform histology across species
- Outer connective tissue capsule
- Little connective tissue for an organ this size
- Framework of connective tissue around lobules
  - to support the liver parenchyma

## Cells of the liver

h – hepatocyte

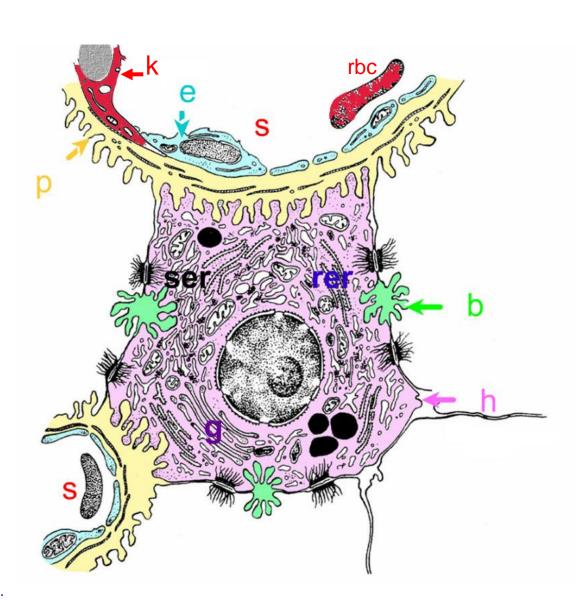
e – endothelial cell

k – Kupffer cell

s – sinusoids

b – bile canuliculi

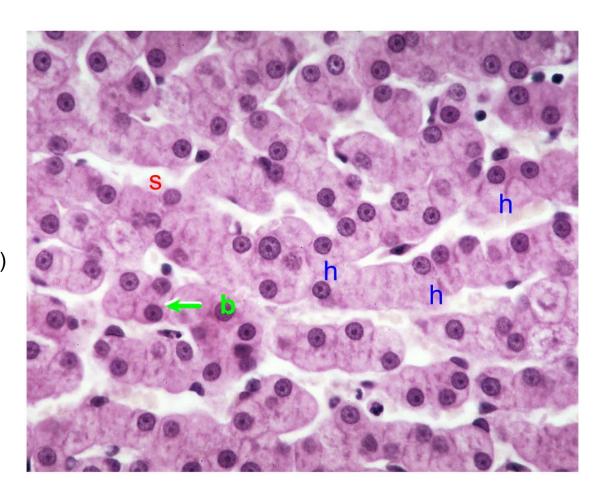
p – perisinusoidal space



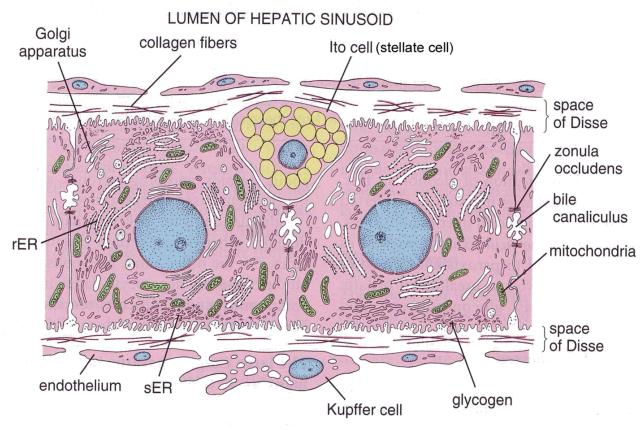
# Hepatocytes

h – hepatocytes:

- large round nucleus with prominent nucleolus
- s sinusoids
- b binucleate hepatocyte (dividing)



# Plate of hepatocytes interposed between hepatic sinusoids

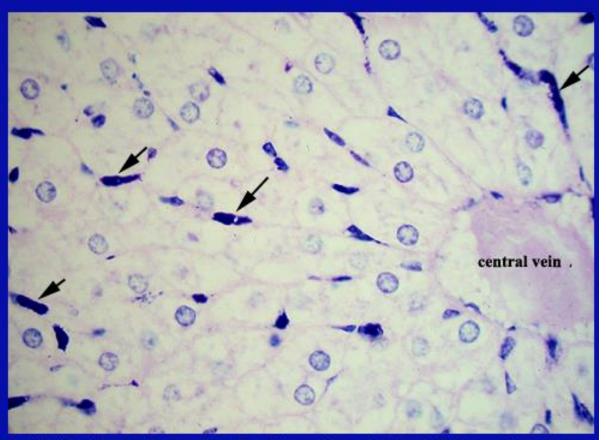


LUMEN OF HEPATIC SINUSOID

#### \*Stellate (Ito) cells:

Pericytes found in the perisinusoidal space; produce collagen fibres

#### Slide 41 Liver - rat (H&E)



detail of rat liver - phagocytic cells of sinusoids containing ink (arrows)

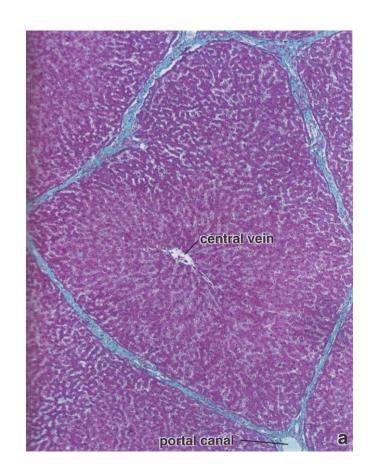
# Kupffer cells

- Macrophages
- Lining sinusoids
- Phagocytosis of debris, old RBCs
   (not a function of the hepatocyte)

# Parenchyma units described in 3 ways:

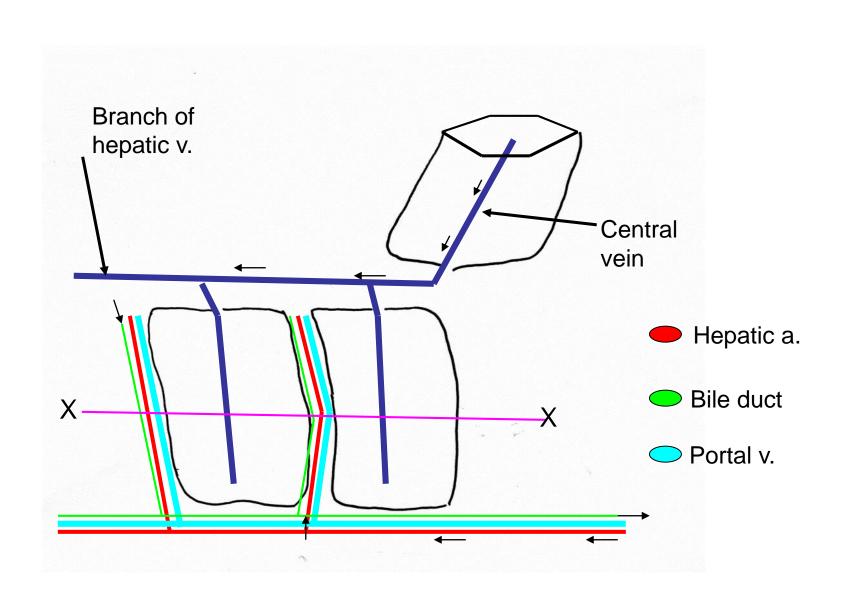
- Classical lobule
- Portal lobule
- Liver acinus

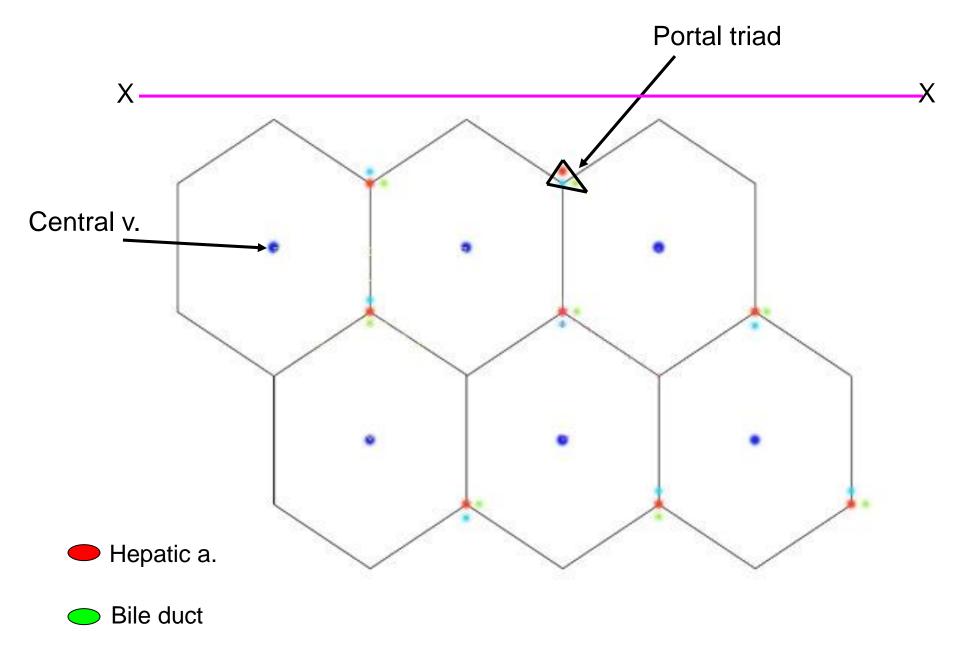
 Based on structural or functional concepts



# Hepatic or Classical Lobule

- Basic structural unit of the liver
- Hexagonal in shape
- Central vein at centre of hexagon
- Portal triads at periphery of hexagon
  - Portal vein
  - Hepatic artery
  - Bile duct





Portal v.

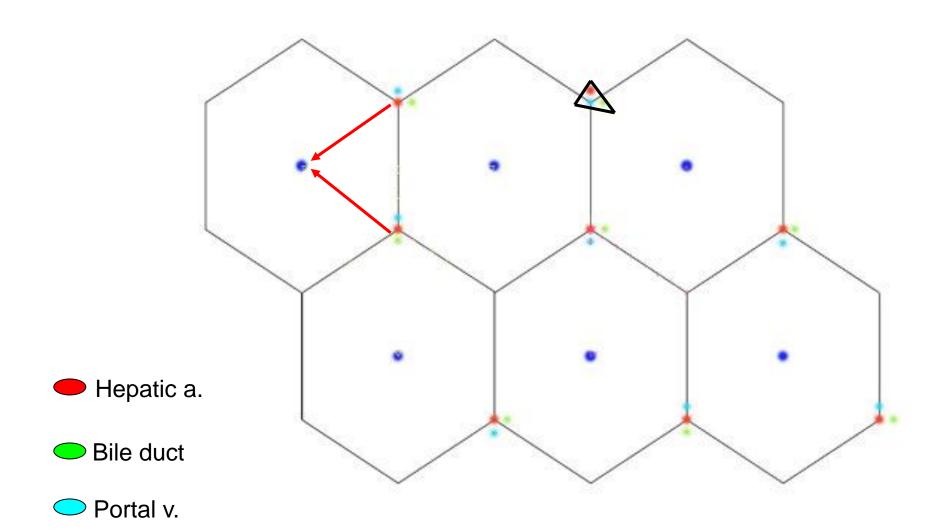
Hepatic or classical liver lobules

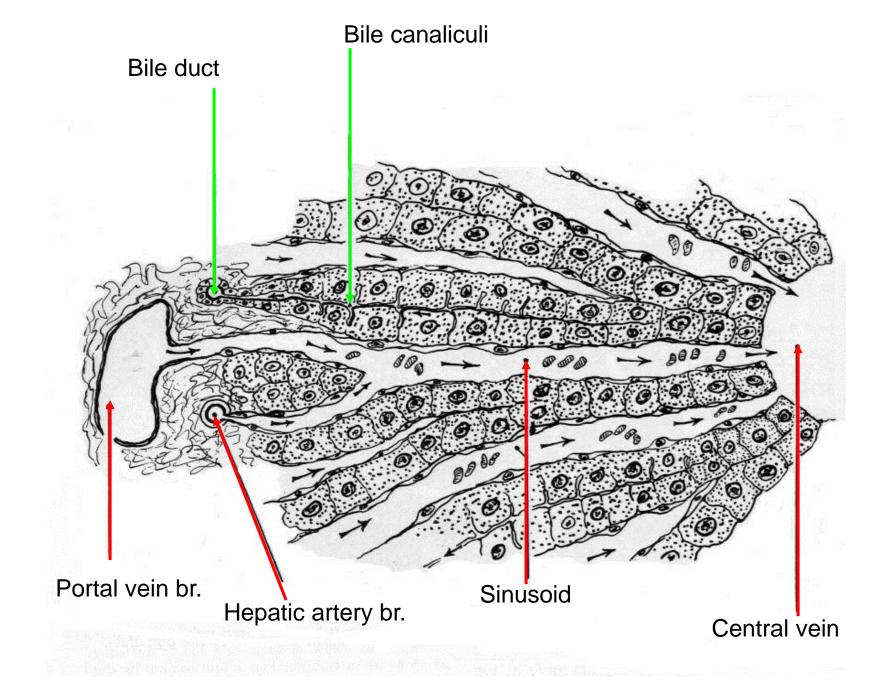
# Classical lobule

- Cords of hepatocytes radiate from the central vein
- Sinusoids\* extend between the cords of hepatocytes
  - Lined by endothelial cells
  - Kupffer cells phagocytic cells
  - Blood flows in a centripetal direction to central vein

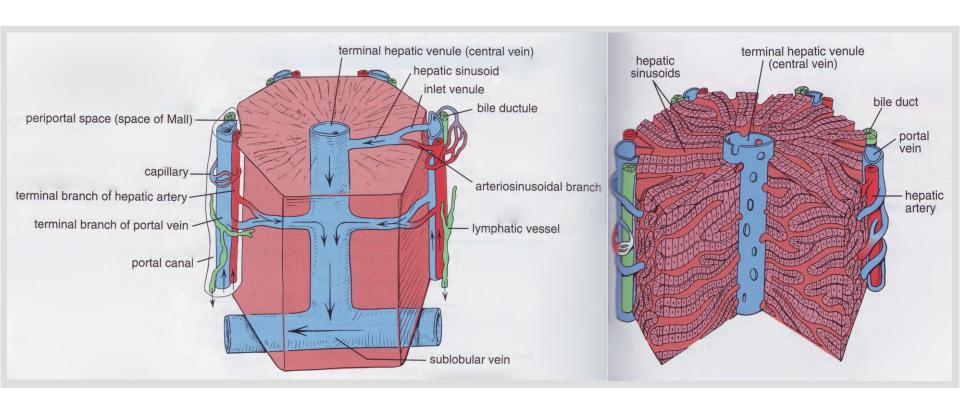
<sup>\*</sup>Sinusoids: tiny endothelium-lined passages for blood flow through tissues

# Hepatic or classical liver lobules

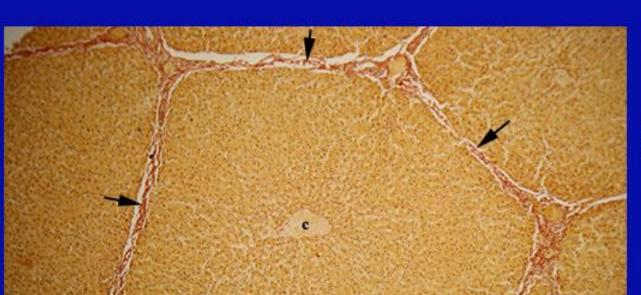




# Blood supply to the liver lobule



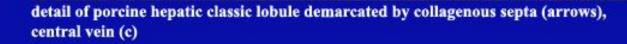
#### Slide 40 Liver - pig (Van Gieson)







section of porcine liver - low magnification



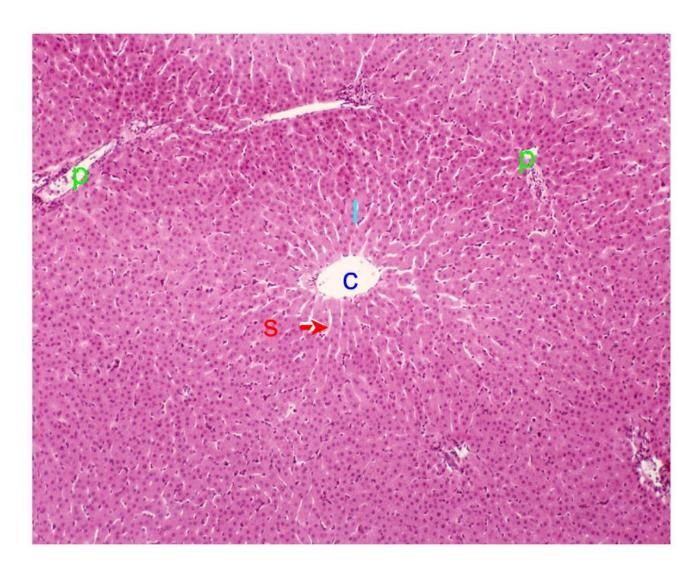


# Liver

s – sinusoids

p – portal canal

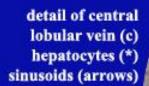
c – central vein



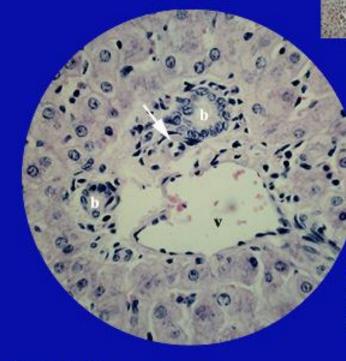
#### Slide 39 Liver - sheep (H&E)



section of ovine liver - low magnification central lobular vein (c) portal canal (p)

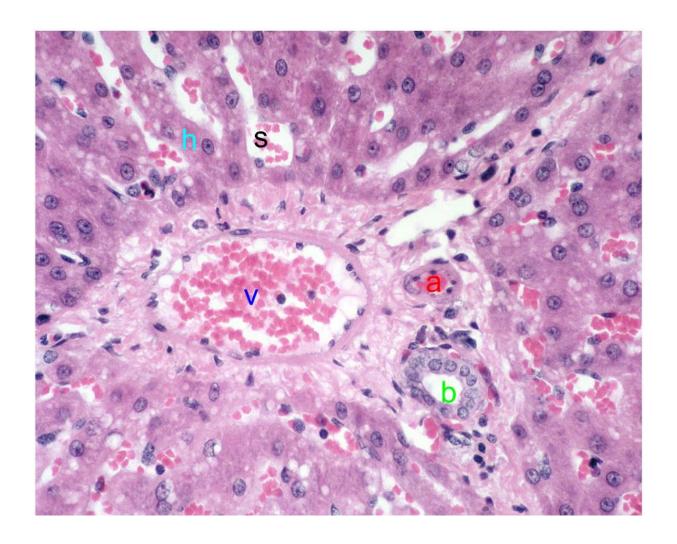


detail of portal canal
with portal triad:
bile ductule (b)
branch of portal vein (v)
branch of hepatic artery (arrow)



# Hepatic triad

- a hepatic artery
- v portal vein
- b bile duct
- s sinusoid
- h hepatocytes



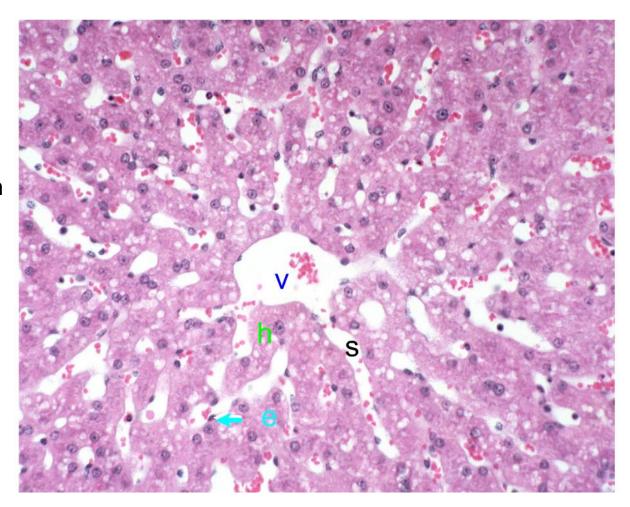
## Liver – central vein

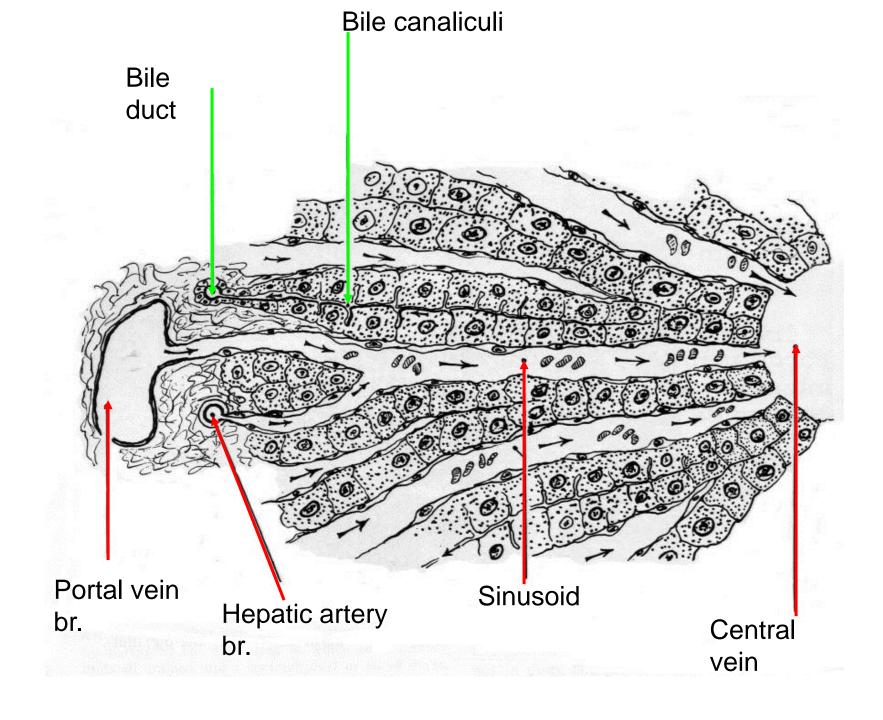
v – central vein

s – sinusoid

e – fenestrated endothelium

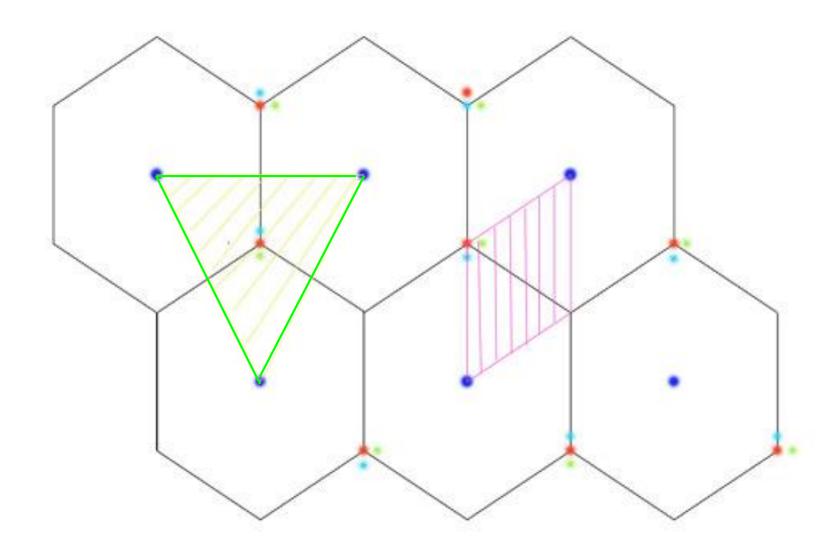
h - hepatocyte





## Portal lobule

- Functional secretory unit
  - Drains bile
- Triangular in shape
  - Boundary defined by lines between the central veins of 3 adjacent classical lobules
  - Bile ductule is its central axis

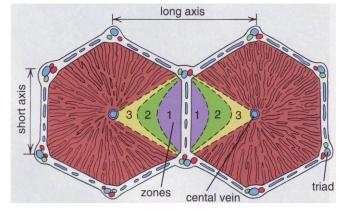


Portal lobule

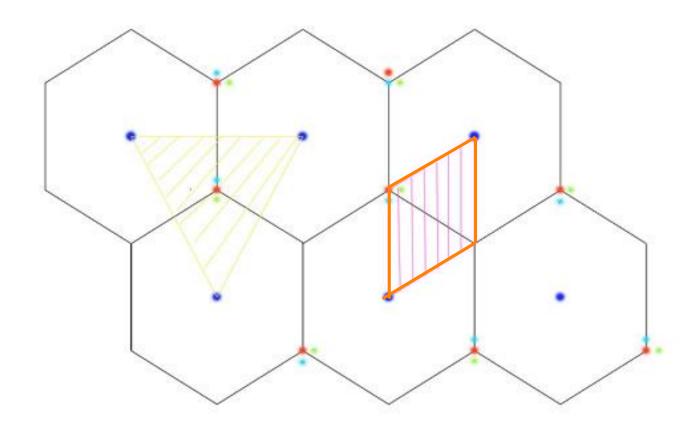
liver acinus

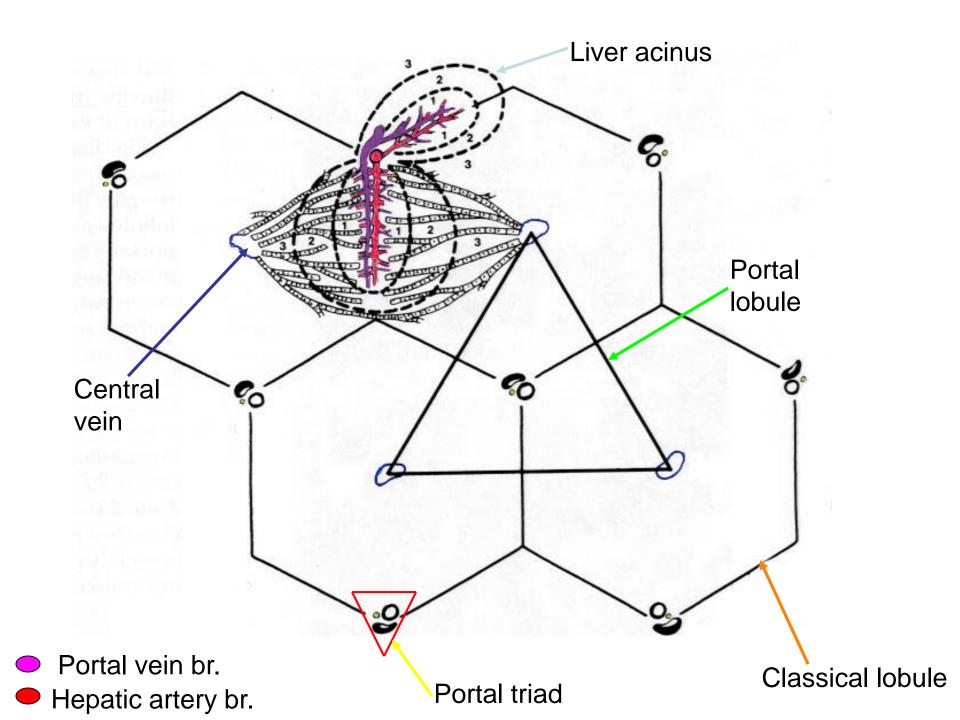
# Liver acinus

- Functional unit
  - The blood supply to the hepatocytes
- Diamond shaped
- Boundary defined by drawing lines between 2 adjacent central veins via the portal triads



# Liver acinus





# Liver - pig

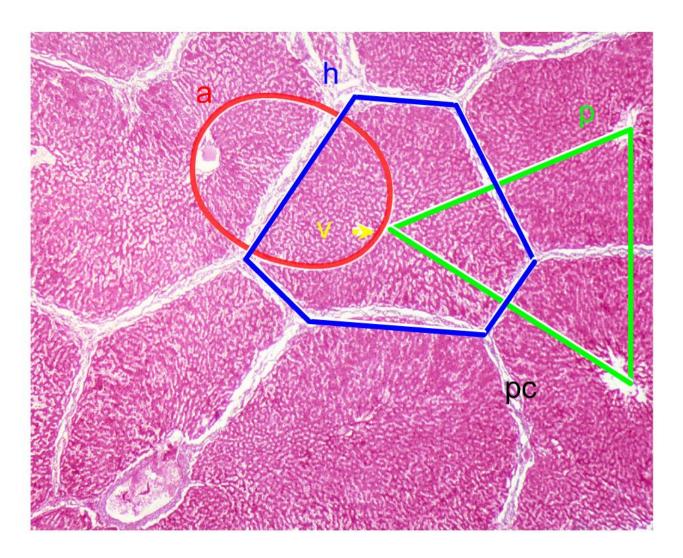
h – hepatic lobule

a – liver acinus

p – portal lubule

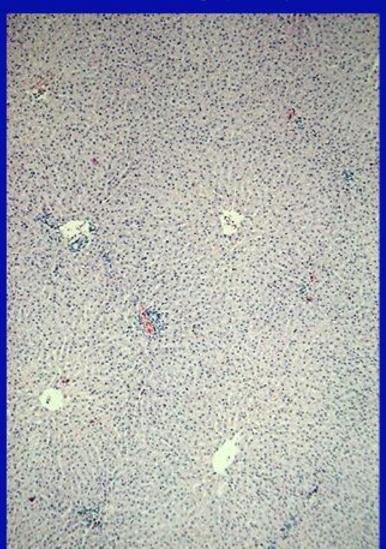
v – central vein

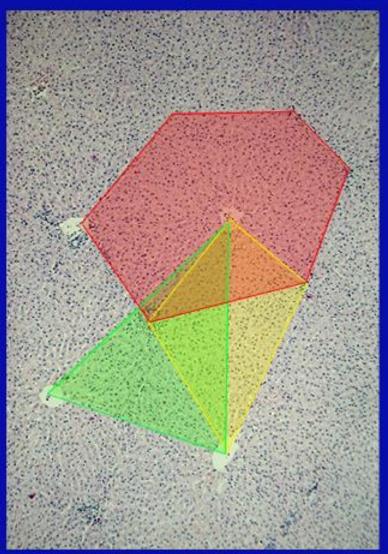
pc – portal canal



#### Slide 39 Liver - sheep (H&E)



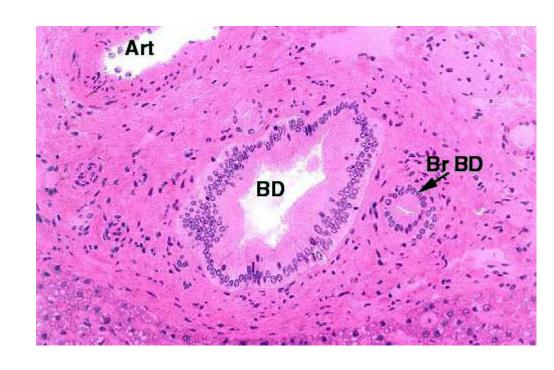




section of ovine liver - medium magnification: classic lobule (red), portal lobule (green), liver acinus (yellow)

# Bile ducts

- Convey bile to the common bile duct and gall bladder
- Add bicarbonate to bile
- Interlobular –
   Part of portal triad
   Join to form hepatic ducts
- Epithelial lining:
   Cuboidal → columnar
- Larger ducts: outer connective tissue with elastic fibres

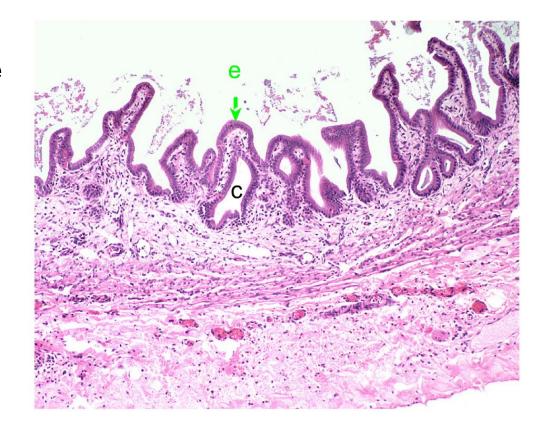


## Gall bladder

- Stores and concentrates bile
- Active resorption of Na across GB epithelium
- (draws water with it)
- Sphincter of Oddi regulates duodenal bile duct opening
- Emptying of GB in response to food
- Horse, rat, elephant and some deer lack a gall bladder
- These species are able to upregulate bile production when required

## Gall bladder

- Simple columnar epithelium
- Mucosal crypts
  - small epithelial diverticulae
- No muscularis mucosa
- Loose connective tissue lamina propria / submucosa
- Muscularis externa –
- bundles of muscle fibres,
   random orientation
- Tunica serosa



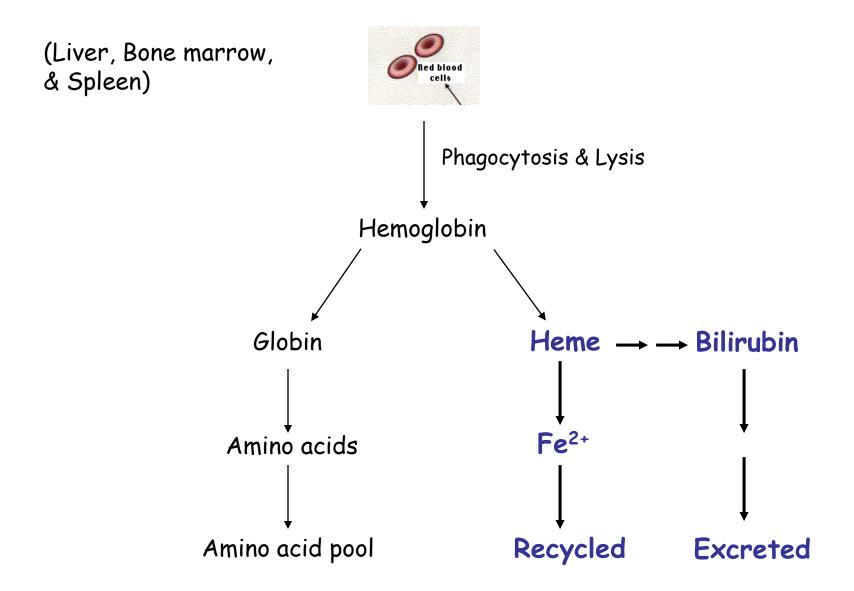
## Constituents and functions of bile

- From hepatocytes:
  - Bile salts
  - Cholesterol
  - Lecithin
  - Bile pigments (bilirubin)
- (from duct cells: bicarbonate)

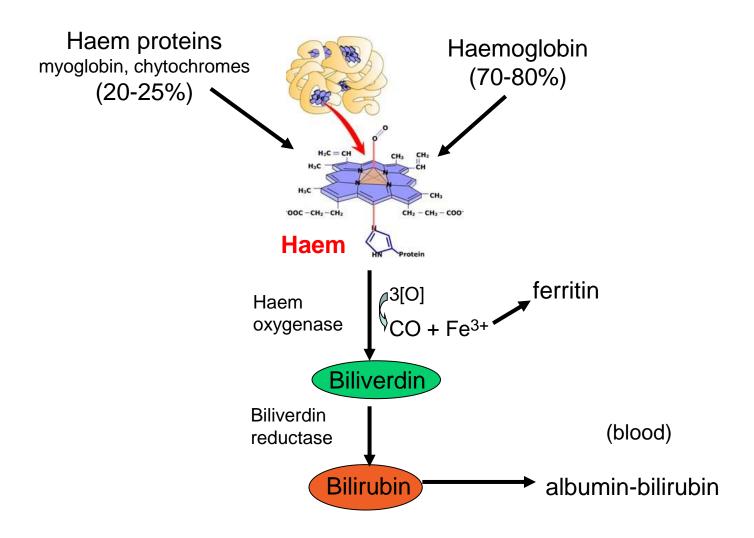
#### **Functions:**

- Aids absorption and digestion of fat
- Excretion from the liver

### Extravascular Pathway for RBC Destruction

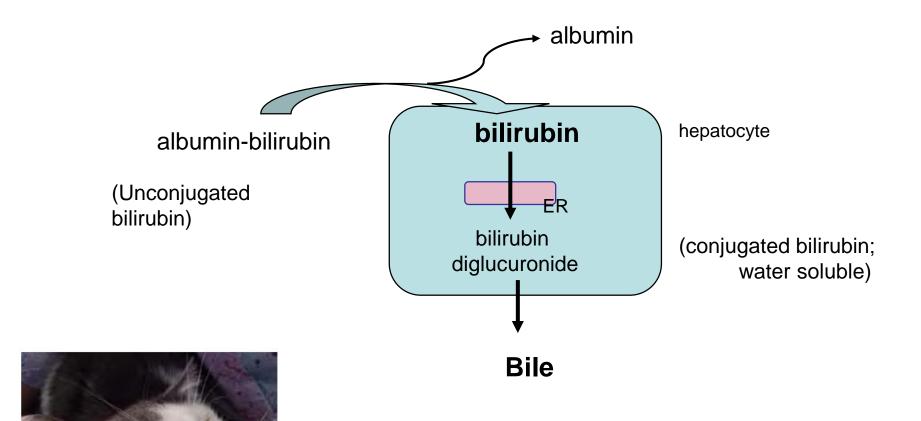


# Bilirubin production

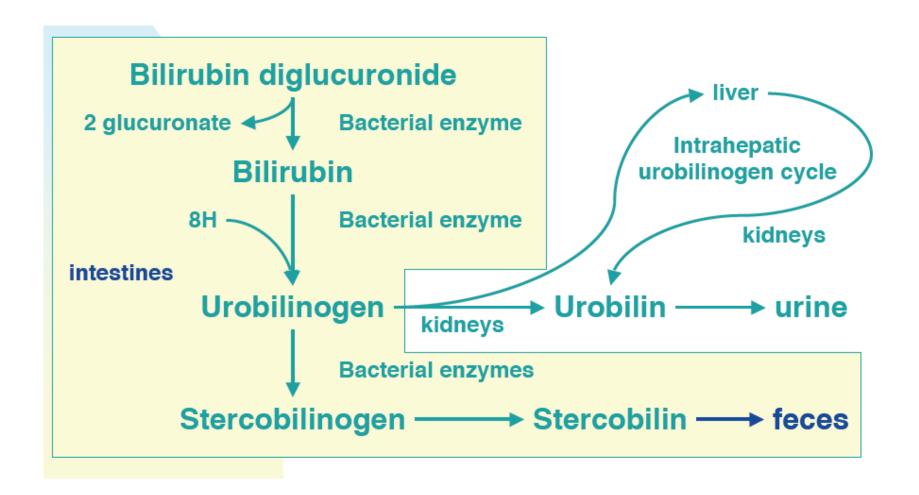


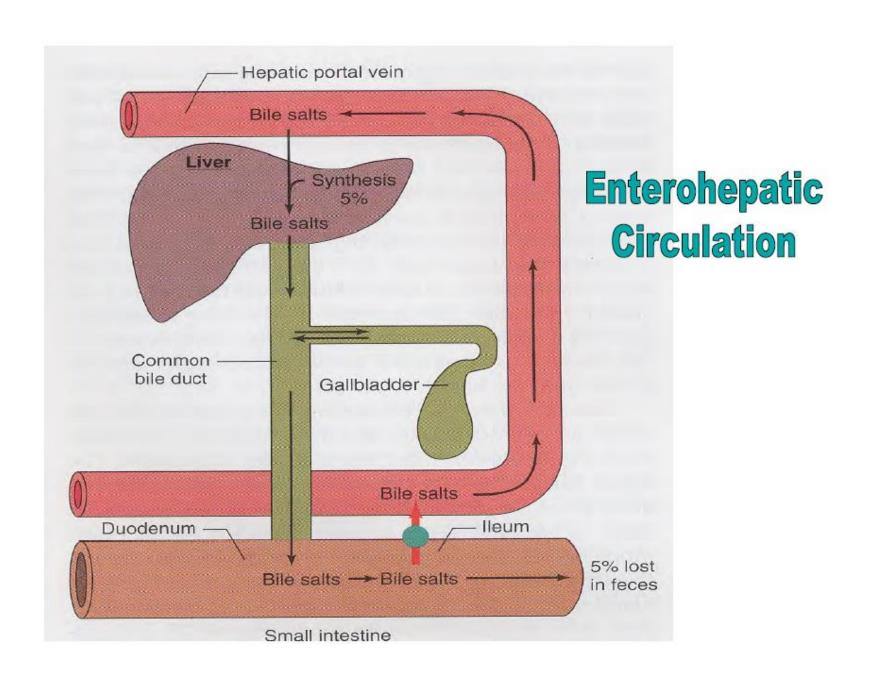
(Unconjugated bilirubin)

# Bilirubin processing



### Bilirubin Excretion





# Summary

