

Embryology, Anatomy and physiology of the liver

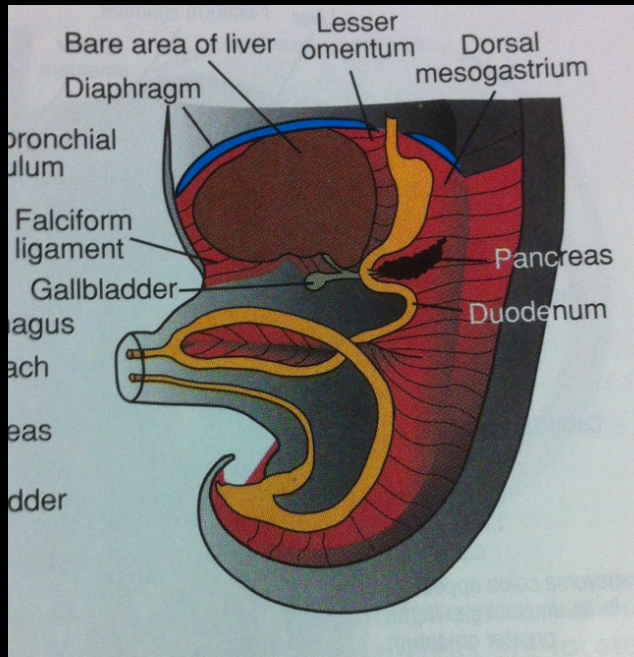
Christopher Lim

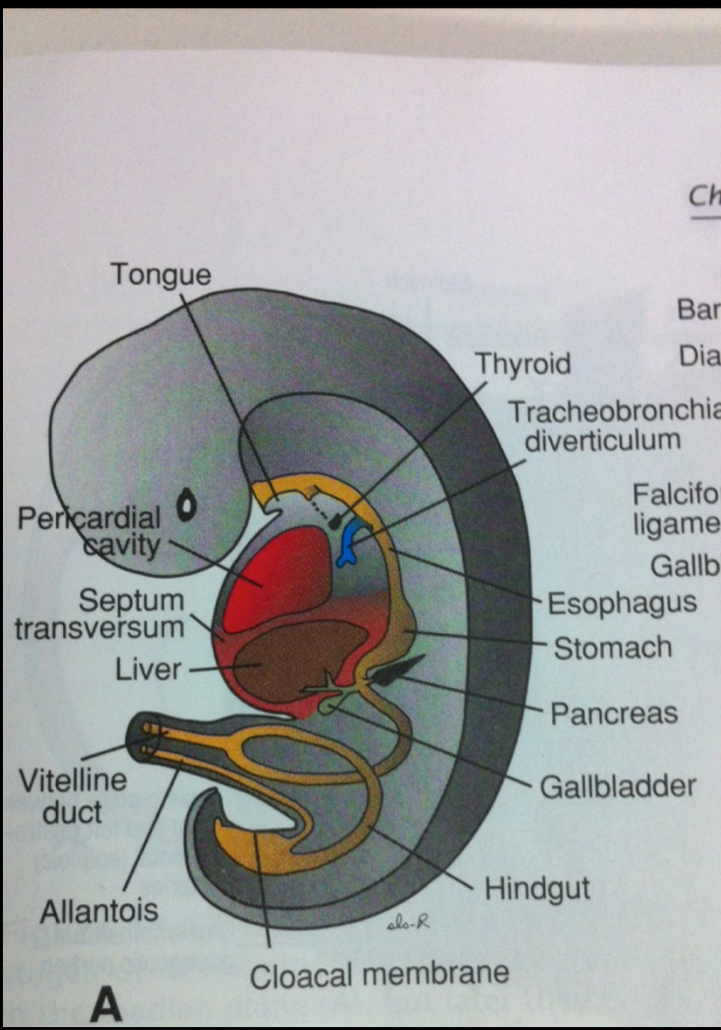
Colorectal Registrar

Presented 8th December 2014

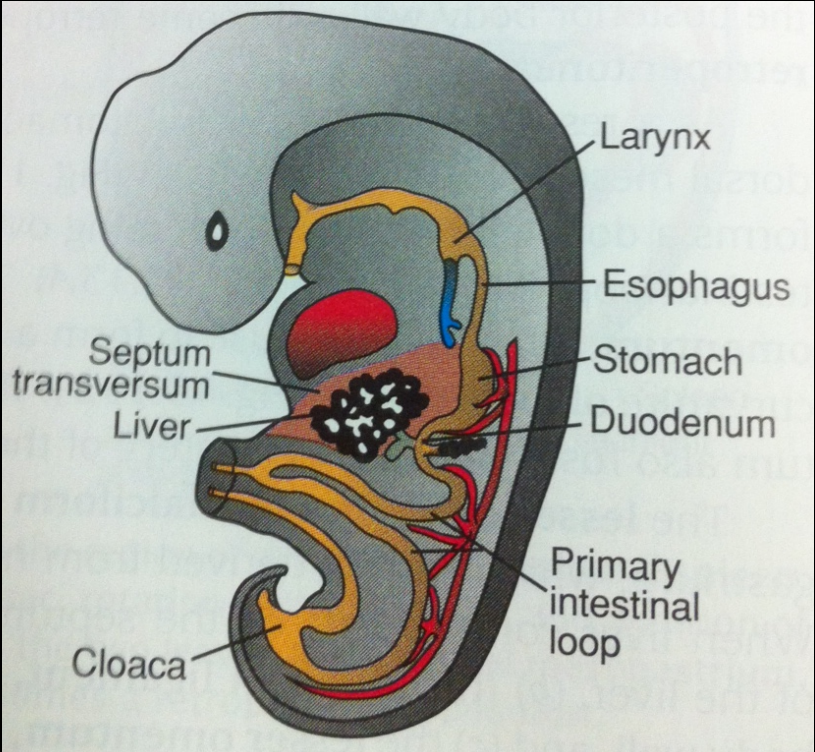
Embryology

- Liver primodium appears in the middle of the 3rd week as an outgrowth of endodermal epithelium at the distal end of the foregut
- Liver bud consists of rapidly proliferating cells that penetrate the septum transversum (Which is the mesodermal plate between the pericardial cavity and the stalk of the yolk sac)
- As the hepatic cells continue to penetrate the septum transversum, the connection between the hepatic diverticulum and the foregut (duodenum) narrows to form the bile duct
- A small ventral outpouching forms in the bile duct and this ultimately forms the gall bladder and cystic duct





- Epithelial liver cord cells intermingle with the Vitelline and Umbilical veins forming the hepatic sinusoids
- Liver cords form liver parenchymal cells
- Haemopoietic cells, kupffer cells and connective tissue cells are formed from the mesoderm of the septum transversum
- When the liver has invaded the entire septum transversum, the mesoderm of the septum transversum lying between the liver and foregut and anterior abdominal wall becomes membranous and becomes the lesser omentum and falciform ligament



- Mesoderm on the liver surface, differentiates into visceral peritoneum except at the cranial portion
- Liver at this portion (Bare Area of the liver) is in contact with the original septum transversum
- 10th week of gestation, liver is 10% of the total body weight (large number of sinusoids and haemopoetic function) – regresses in the last 2 months of intrauterine life, only a small amount at birth) – weight of the liver is 5% of TBW at the time of birth

- 12th week of gestation, bile production begins
- Because of the rotation of the duodenum, the bile duct ultimately lies posteriorly
- Any part of the foregut has the potential to differentiate into hepatic tissue but they are suppressed by factors produced by surrounding tissues (ectoderm, non cardiac mesoderm, particularly the notochord)
- These factors are blocked by FGF which is produced by cardiac mesoderm
- Formation of the liver is partially regulated by the hepatocyte nuclear transcription factors (HNF3 and 4)

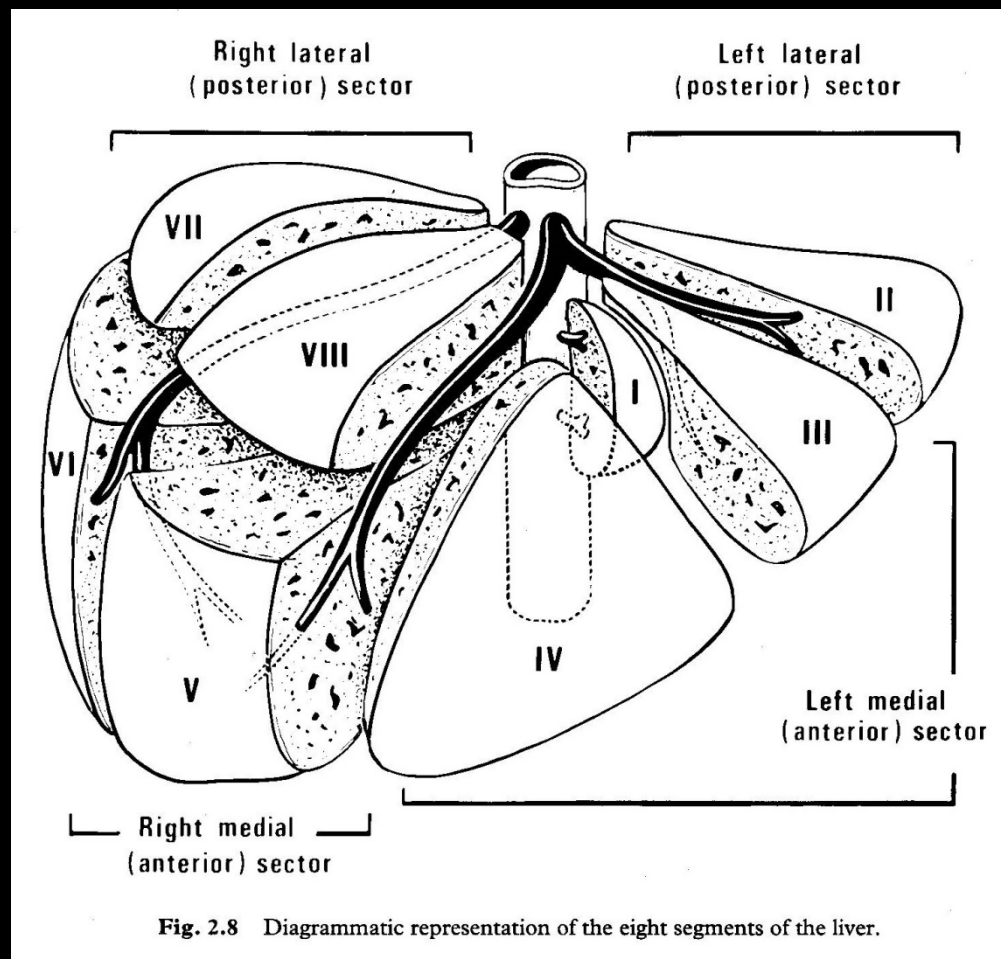
- Extrahepatic biliary atresia occurs when there is failure of recanalisation of the bile duct (pass through a solid phase in development)
- Lobulation doesn't really lead to any clinical consequences

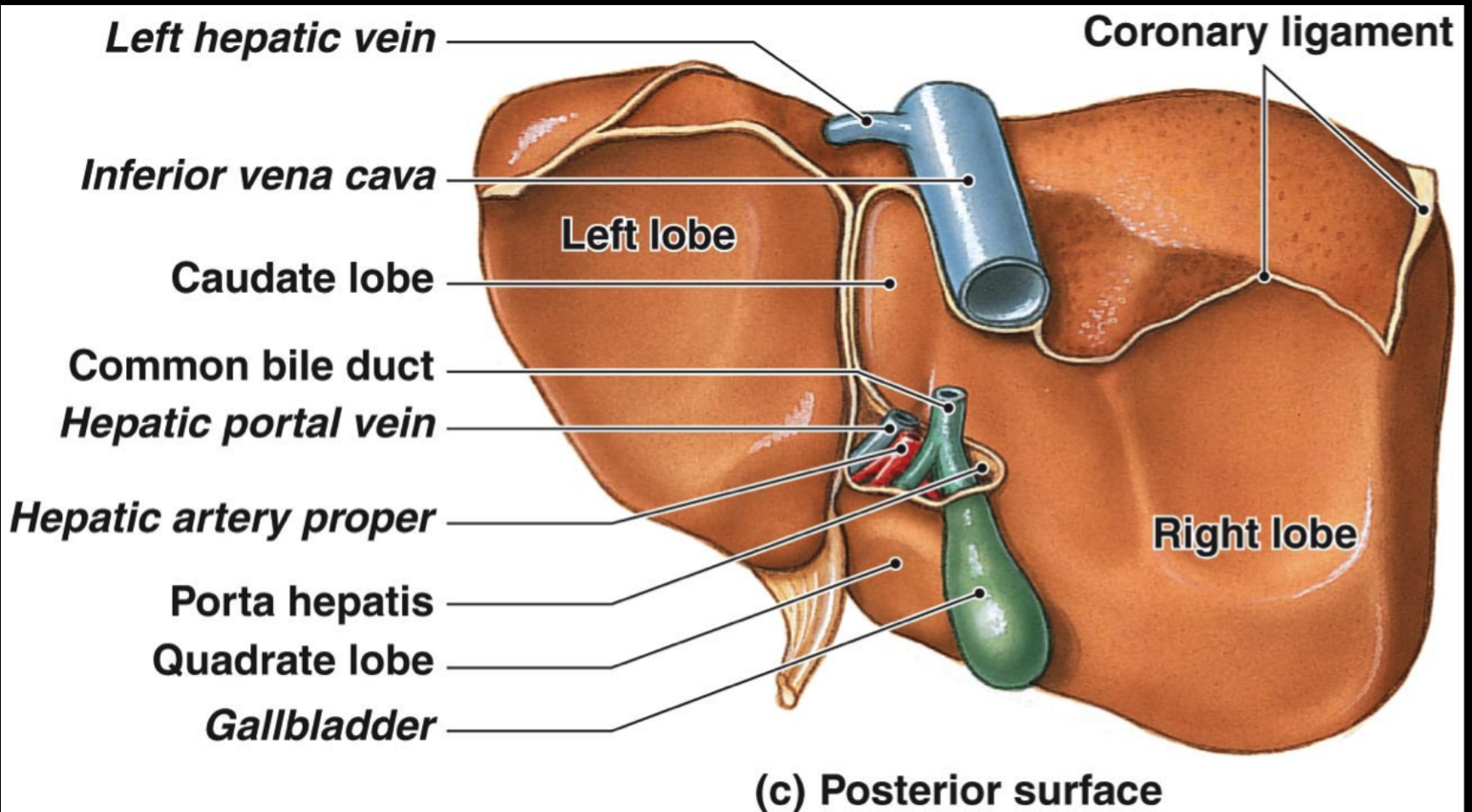
Anatomy

- Weighs 1.5kg and 1.5L/min of blood flow
- Wedge shaped organ
 - 2 surfaces
 - Diaphragmatic (Anterior, Superior, Posterior and Right)
 - Visceral (Slopes downwards and forwards and to the right)
 - Most main vessels and ducts leave via the porta hepatis
 - Hepatic veins leave via the posterior surface

- Diaphragmatic surface is mostly covered in peritoneum that peels off in places to join the adjacent diaphragm
- Relations:
 - Anteriorly: Diaphragm, Lung, pleura (particularly on the right side), ribs and costal cartilages 6-10 on the right and costal cartilage of 6 and 7 on the left, anterior abdominal wall in the epigastrium
 - Superiorly: pericardium and heart centrally and the lung and pleural on each side

- Coronary and triangular ligaments
- Lobes and segments of the liver
 - Anatomical left and right demarcated by the falciform ligament
 - Quadrate lobe
 - Caudate lobe
 - Functional left and right
 - Line running from the middle of the GB notch back to the middle hepatic vein or left side of the IVC
 - Right portal vein divides into 2 branches supplying the right medial (Anterior) and right lateral (posterior) sectors (Segment 5, 8 and Segment 6,7 respectively)
 - Left portal vein divides the left lobe into another 2 sectors – left anterior and left posterior (Segment 3,4 and Segment 2)
 - Each sector is divided into 2 segments except in the left posterior sector (segment 2)
 - Segment 1 – receives branches of portal triads from both right and left and drains independently directly into the IVC
 - Looks like a clock
- Ligamentum venosum





- Glisson's capsule condenses around the portal trinity and surrounds them as they enter the liver (Valoean sheath)
- Within the sheath, the portal vein is surrounded by loose areolar tissues in comparison to the bile ducts and hepatic arteries
- There is a common pattern with regards to the distribution of the structures but it must be noted that there are many variations (up to 20%)
- Within the sheath:
 - The bile duct is usually elliptical, and its inferior surface usually faces the artery
 - Portal system tends to lie posterior to the bile duct and hepatic artery
 - Bile duct tends to lie superior to the artery and close to it

- Intrahepatic portal vein
 - Left portal vein (3-5cm) is relatively constant – curves forward after giving off a branch to segment 2, it then supplies segment 3 to the left of the sheath and segment 4 to the right of it
 - Right portal vein (1-3cm) divides into 2 divisions (gentle curve to the right posterior aspect of the liver – supplying segment 6 and 7) and (Gentle curve towards the centre of the liver – supplying segment 5 and 8)
- Intrahepatic bile ducts
 - Segmental ducts in the left are fairly constant
 - Right hepatic duct is formed by the junction of the right lateral and right medial ducts
 - On a cholangiogram, it is easy to identify the right lateral duct because it curves around the right medial duct

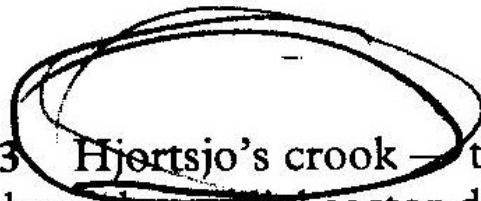
Right medial sector
hepatic duct



Left hepatic
duct



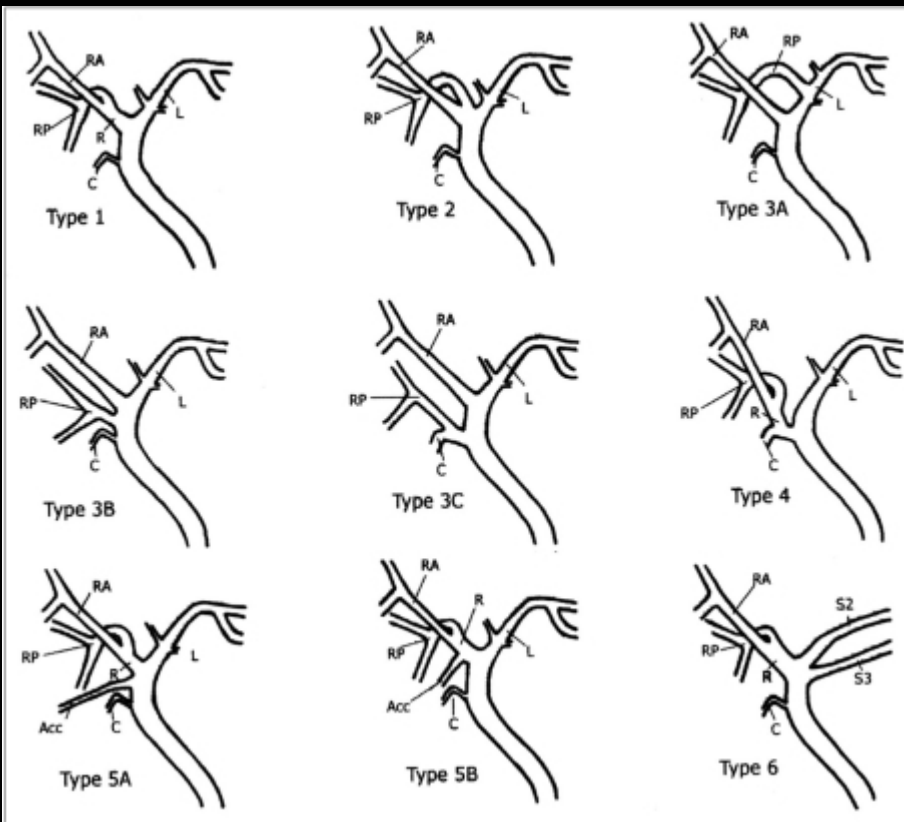
Right lateral sector
hepatic duct

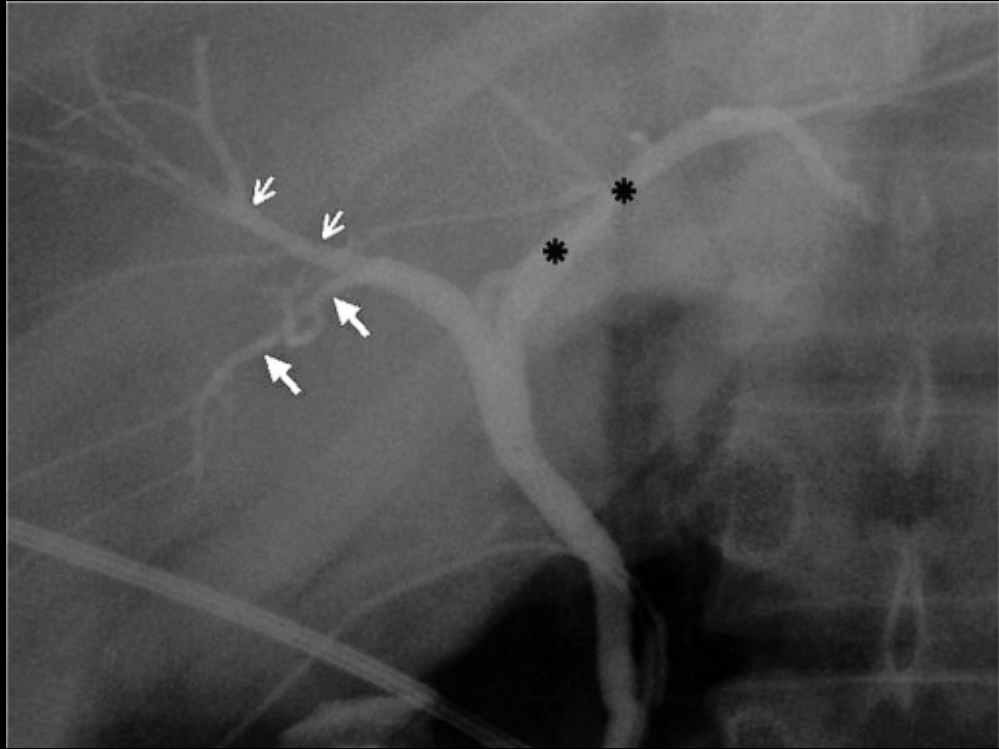


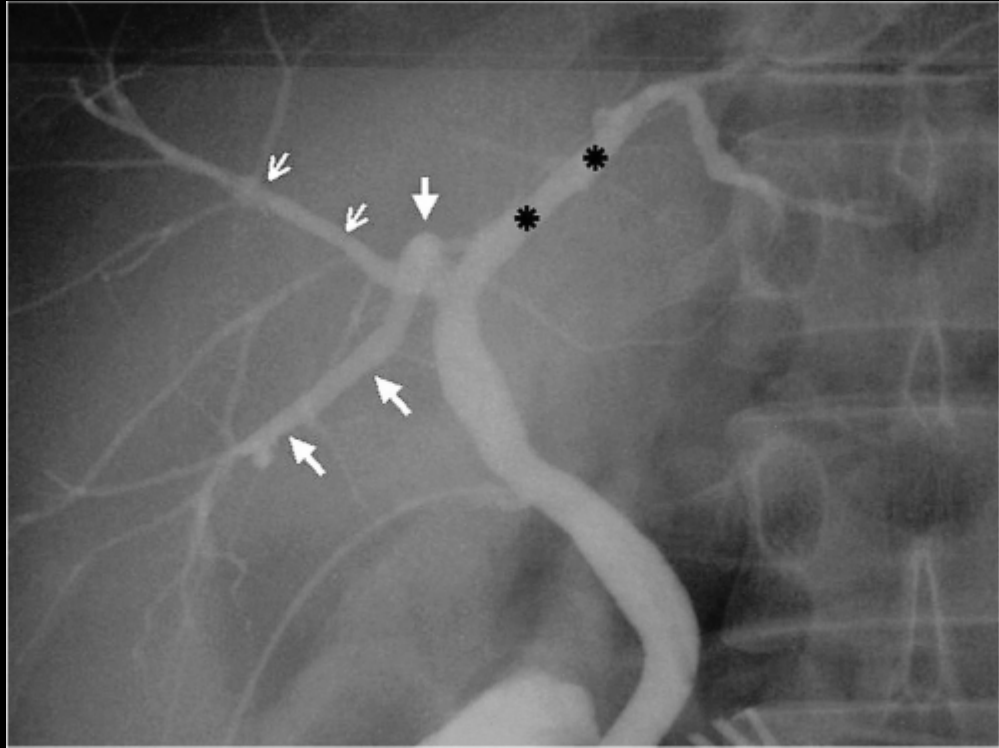
Common hepatic duct

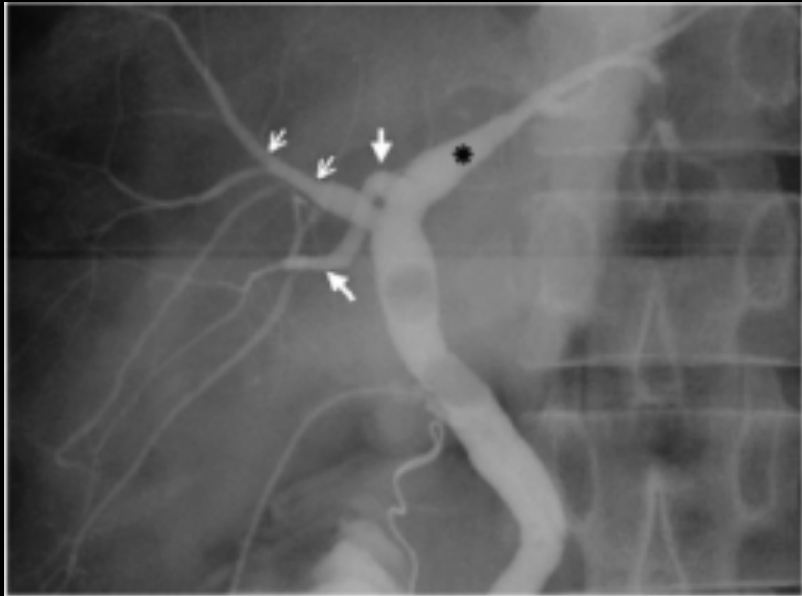


Fig. 2.13 Hjortsjo's crook — the right lateral sector duct hooks around the right medial sector duct.

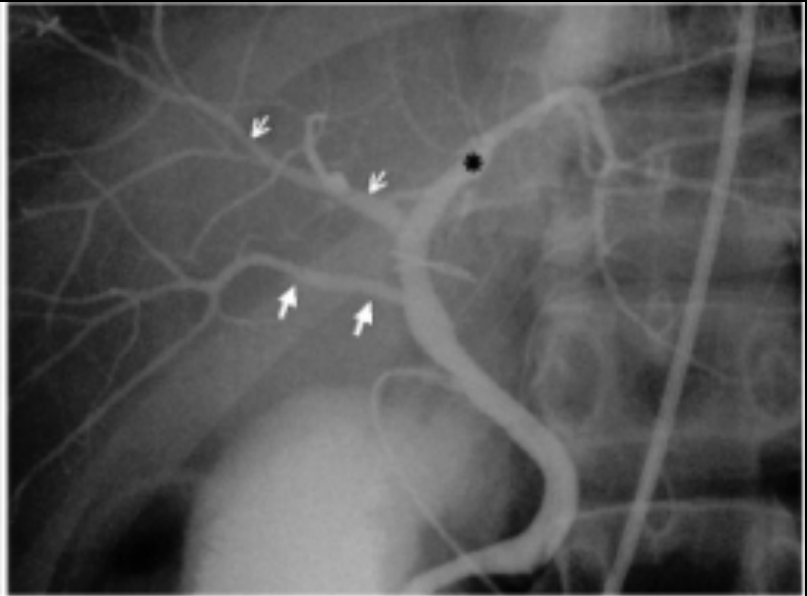








A

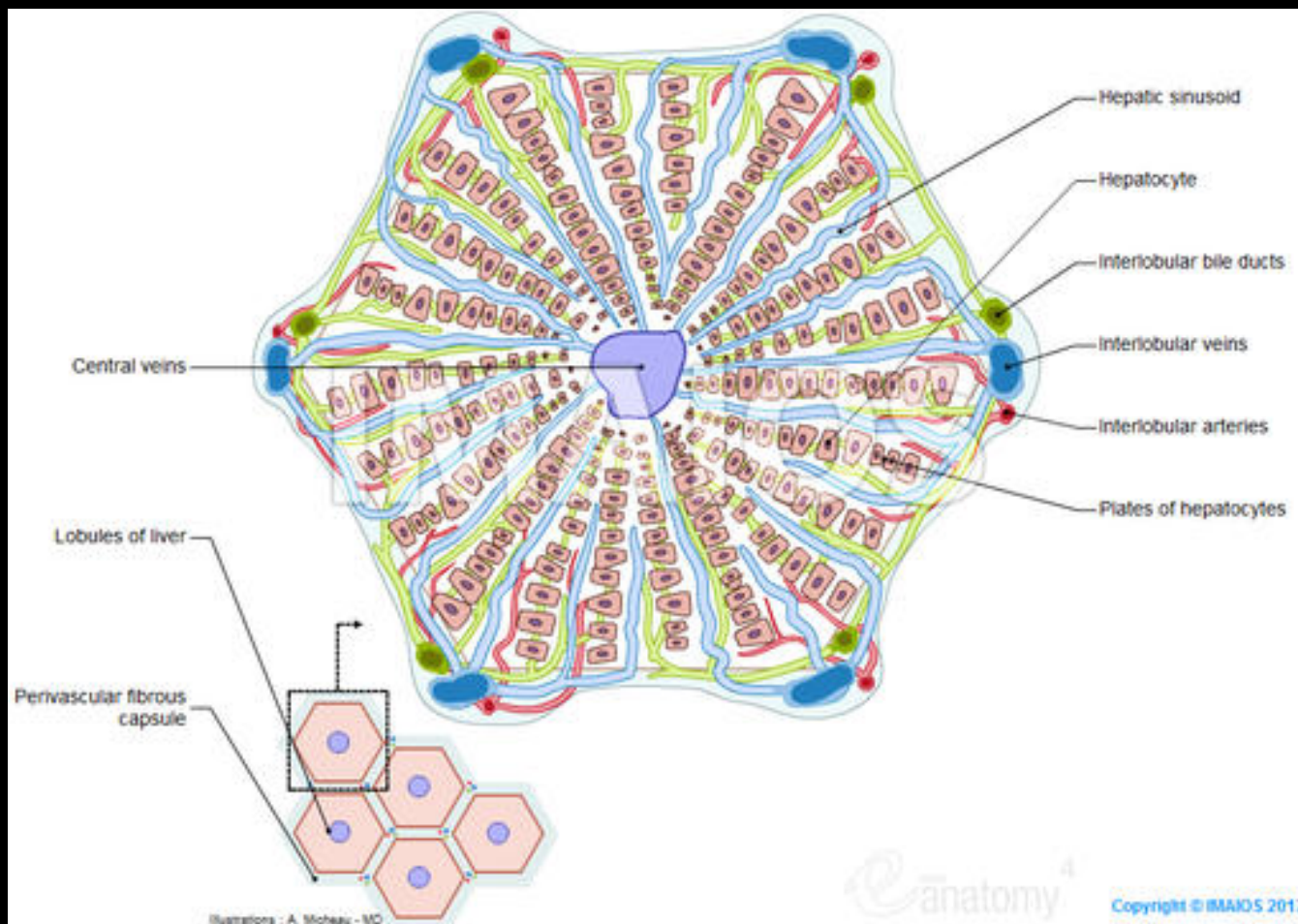


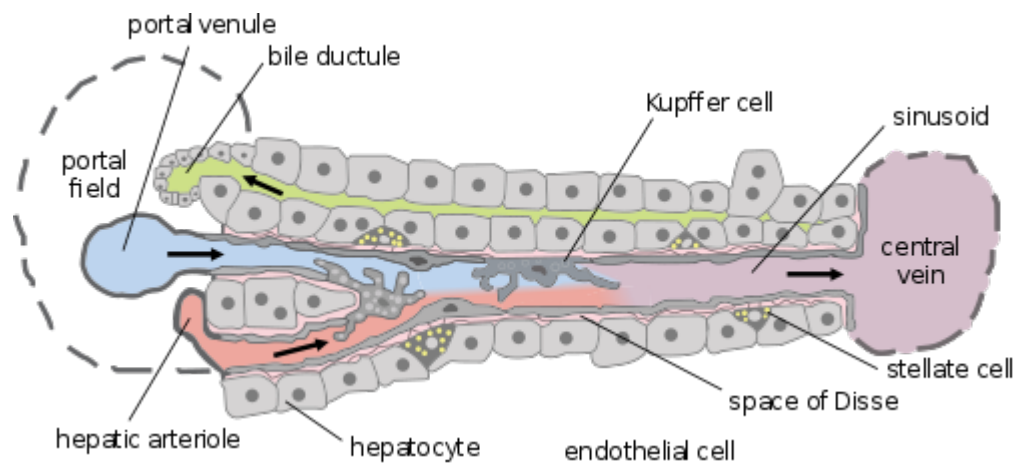
B

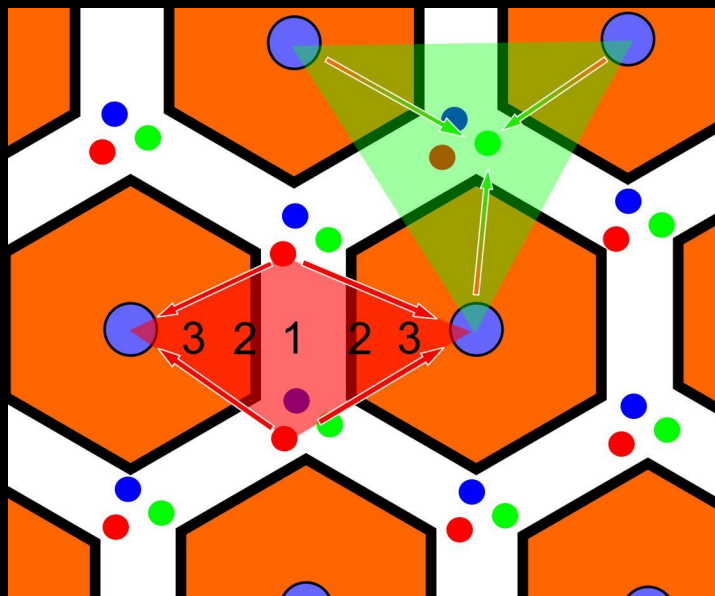
- Intrahepatic Arteries
 - Variations are common but of little surgical significance
- Fissures of the liver
 - Main fissure
 - Separates 5, 8 from 4 (spans from GB bed to mid IVC)
 - Main trunk of the middle hepatic vein lies here
 - Left fissure
 - Separates left posterior from left anterior sector
 - Main trunk of left hepatic vein lies here
 - Umbilical fissure
 - Fissure venosum
 - Dorsal fissure
 - Right Fissure
 - Right hepatic vein lies in this

Physiology of the liver

- Serves as a filter between the blood coming from the GIT (Portal System) and the blood of the rest of the body
- Blood flows through the sinusoids and eventually end up in the hepatic veins and subsequently the IVC
- During its passage, it is modified extensively
- Bile is formed and passed into the intestines







Function of the Liver

- Metabolism and detoxification
 - Carbohydrate metabolism
 - Glycogen storage
 - Gluconeogenesis
 - Maintenance of blood glucose level
 - Fat metabolism
 - Detoxification of substances
 - Kupffer cells
 - Cytochrome P450
 - Removal of ammonia
 - Bile secretion ~ 500ml per day
 - Production of plasma proteins (albumin, acute phase proteins, transport steroids, hormones and clotting factors)