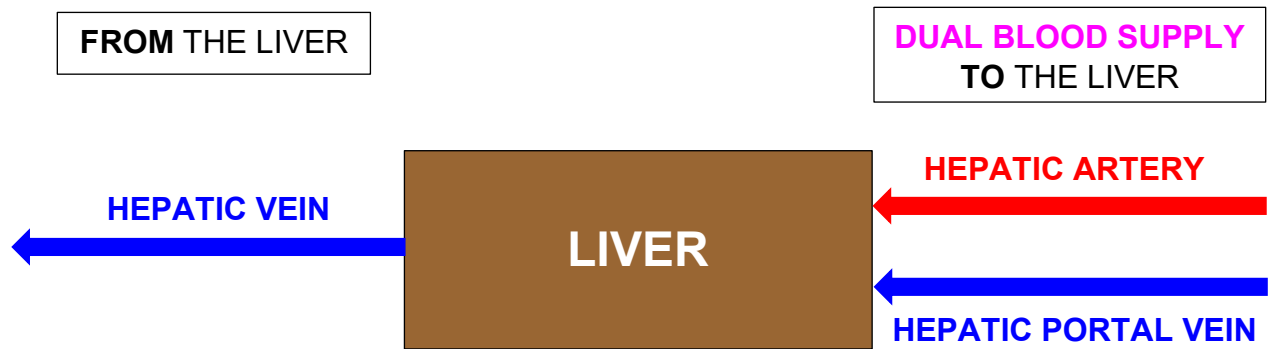


1. BLOOD VESSELS TO AND FROM THE LIVER



- The **hepatic artery**:

- carries **oxygenated** blood **to** the liver from the **heart** for **aerobic respiration** (via the **aorta**).
- may also carry **lactic acid (lactate)** from **anaerobic respiration**, which can be broken down into **glucose**, **pyruvate** or **carbon dioxide** and **water**.

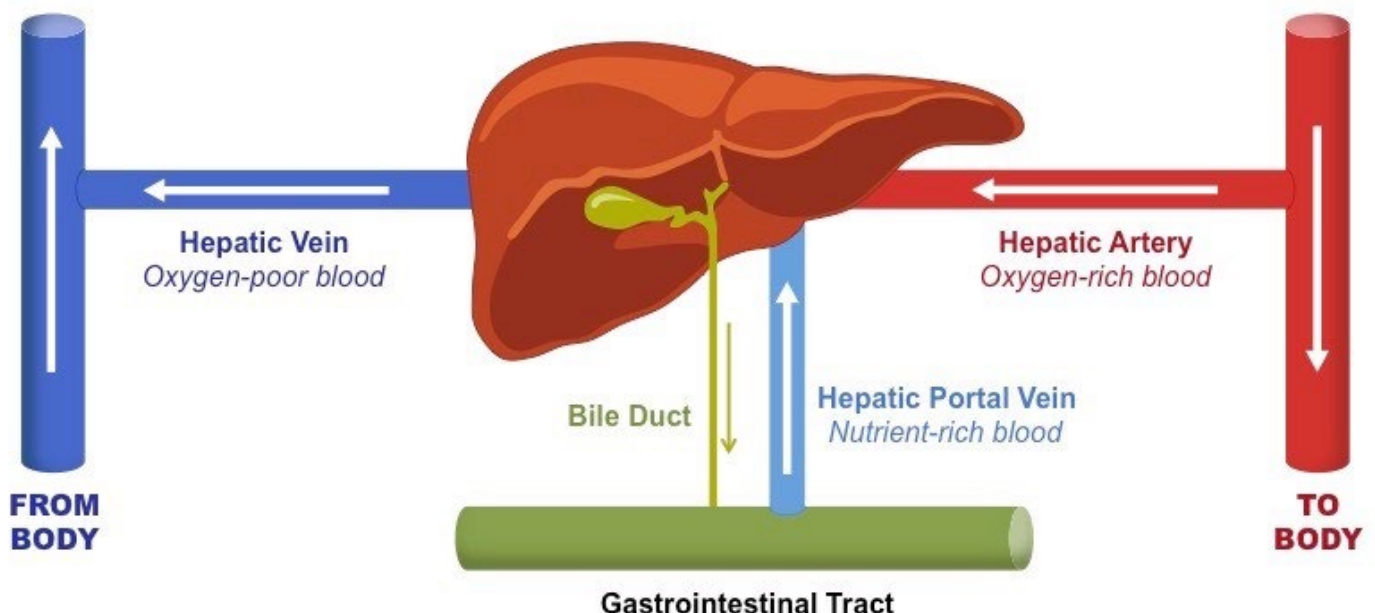
- The **hepatic portal vein**:

- carries **deoxygenated** and **nutrient-rich** blood from the **stomach/intestine** to the liver
- prevents **glucose** entering the general circulation **immediately**
- helps **maintain** the **osmotic potential** of blood
- allows **toxins** to be **removed**

The hepatic portal vein **intercepts blood** from the **gut**, before it reaches the **general circulation**.

This way, it can **control** the **level** of **specific nutrients** in the **outgoing** blood.

- The **hepatic vein** carries **deoxygenated** blood **from the liver** to the **heart** (via the **vena cava**).

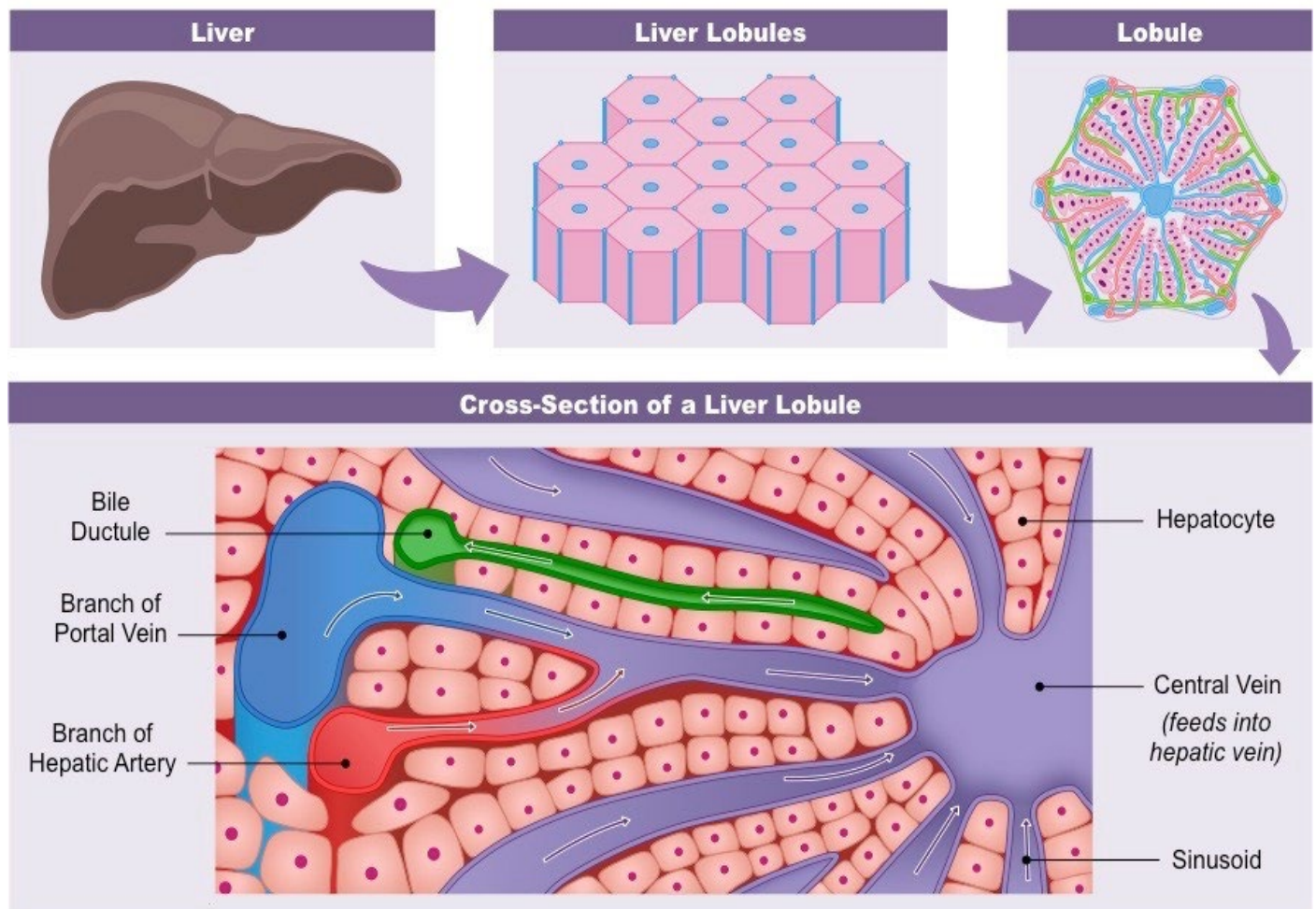


2. LIVER SINUSOIDS

Where they are in the liver

The liver is composed of smaller structures called **lobules**, which are roughly **hexagonal** in shape.

- Each lobule is surrounded by branches of the **hepatic artery** (provide oxygen) and the **hepatic portal vein** (provide nutrients)
- These blood vessels **drain** into **capillary-like** structures called **sinusoids**, which **exchange** materials directly with the **hepatocytes** (liver cells)
- The **sinusoids** drain into a **central vein**, which feeds **deoxygenated blood** into the **hepatic vein**
- Hepatocytes also produce **bile**, which is transported by vessels called **canaliculi** to **bile ducts**, which surround the lobule

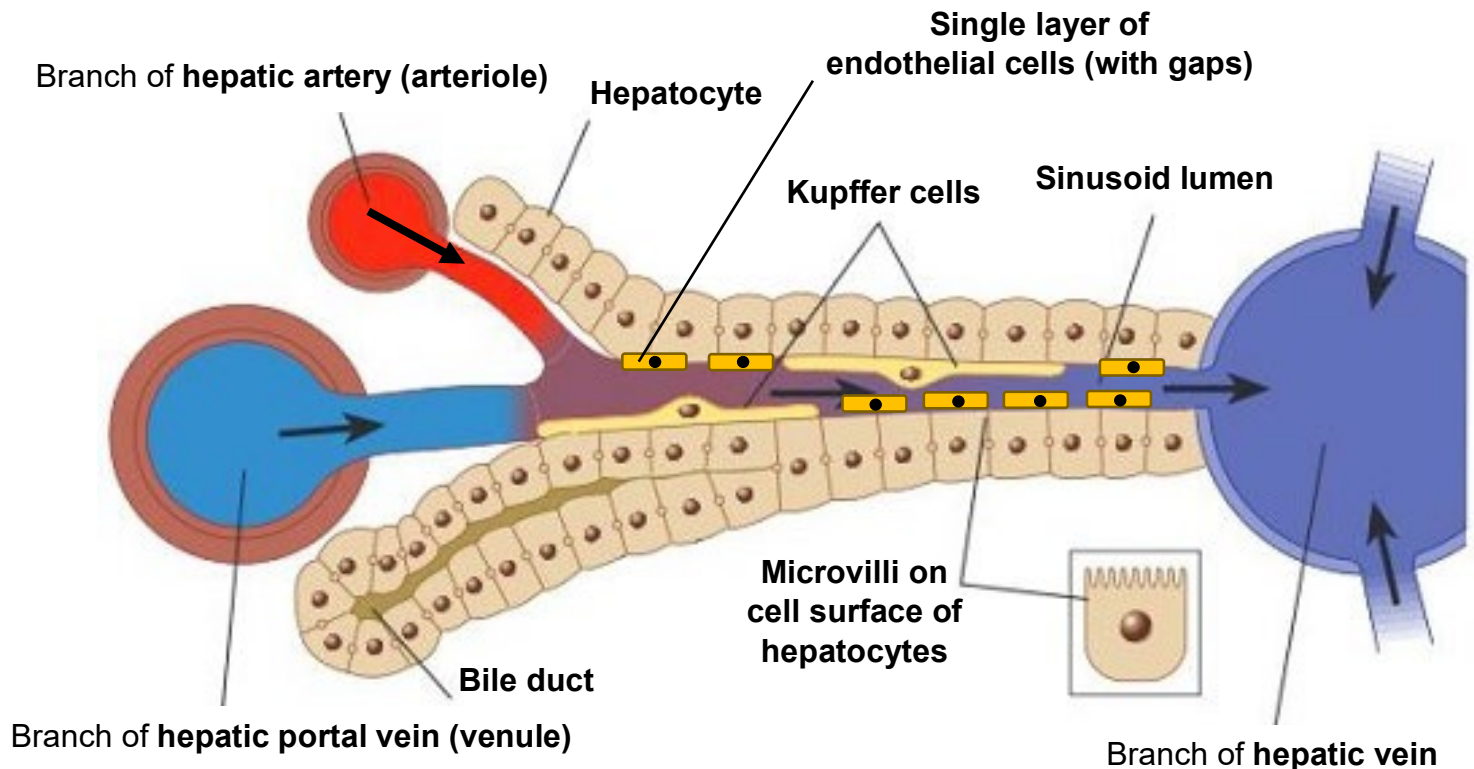


This page is **just so you can visualise** where sinusoids are in the liver

What you **are expected to know about them** for **IB** is shown next

Structure and function of a sinusoid

- The **hepatic artery** and **hepatic portal vein** drain into vessels called **sinusoids**.
- **Sinusoids** are a type of small blood vessel found in the liver that perform a **similar function** to capillaries (**exchange**).
- Sinusoids are where the **exchange** of materials occur between **hepatocytes** (liver cells) and **blood**.

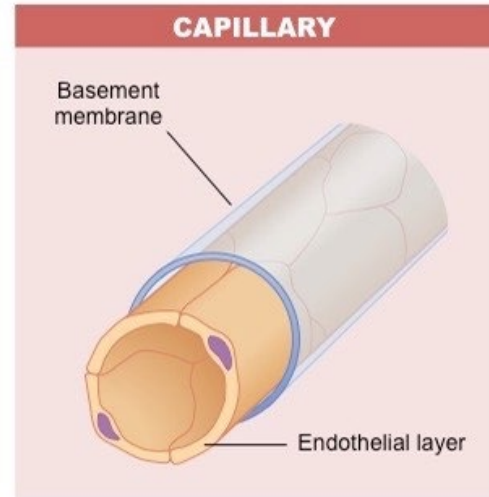
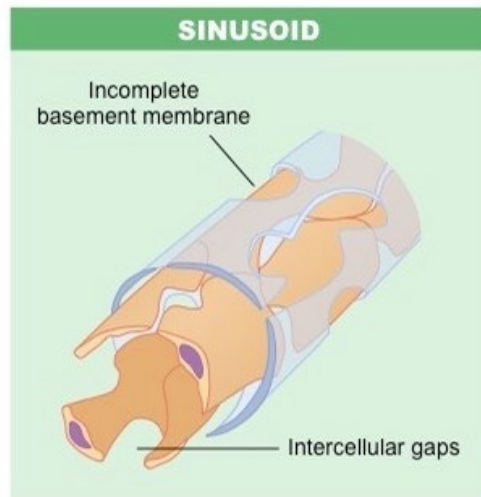


- **Hepatic artery** brings **oxygenated** blood to the **liver** from the heart via the aorta
- **Hepatic portal vein** brings **digested food** to the **liver**
- This allows **hepatocytes** to carry out **aerobic respiration**
- Blood from **both** blood vessels **mixes** in the **sinusoid**
- Blood is in **contact** with **hepatocytes** here
- **Hepatocytes (liver cells)** change the chemical composition of the blood in several ways:
 - releasing **glucose** or storing it as **glycogen**
 - **removing toxins** from the blood
 - producing **plasma proteins**
 - producing **cholesterol/phospholipids/bile salts**
- **Kupffer cells** are **phagocytes** that **break down erythrocytes (red blood cells)**
- The **sinusoid wall** is also lined with a **single layer** of **very thin endothelial** cells
- There are many **gaps** between these **endothelial** cells – we say it has a **fenestrated endothelium**
- **Hepatic vein** carries **deoxygenated** blood **from** the liver to the heart via the vena cava

How sinusoids are different to capillaries

- This is a popular exam question.

SINUSOIDS	CAPILLARIES
Larger in diameter	Smaller in diameter
Kupffer cells are located inside	Kupffer cells are not located inside
Have open pores/fenestrations	Do not have open pores/fenestrations
Basement membrane is incomplete	Basement membrane is complete



3. FIVE FUNCTIONS OF THE LIVER

- **Hepatocytes** carry out functions 1, 2, 3 and 5.
- **Kupffer cells** carry out function 4.

1. DETOXIFICATION

- **Hepatocytes** absorb **toxins** from the blood and **convert** them by **chemical reactions** into **less/non-toxic** substances e.g. **alcohol**; **excess amino acids**; **lactate**

2. PRODUCTION OF PLASMA PROTEINS

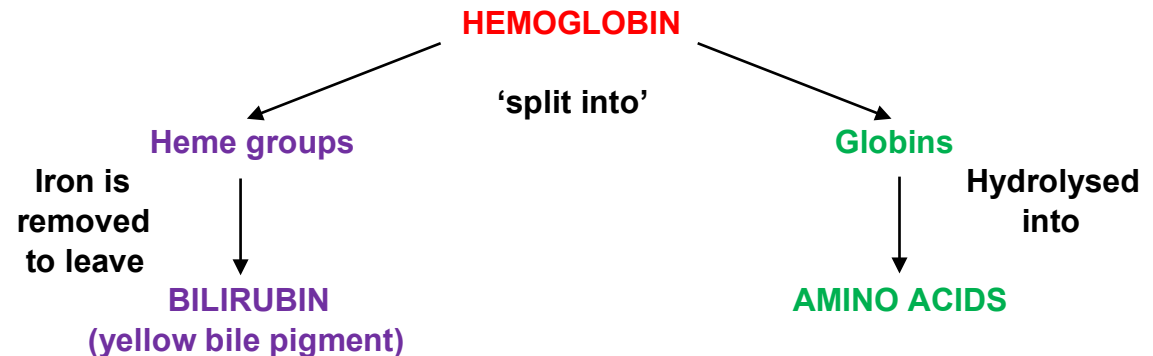
- **Rough ER** of **hepatocytes** produces **90%** of the plasma proteins in blood, including **fibrinogen** and **albumin**
- **Golgi body** of **hepatocytes** processes and **modifies** plasma proteins **before** they are released into the blood

3. CONVERTING CHOLESTEROL TO BILE SALTS

- **Bile salts** **emulsify** large fat droplets into **many smaller** fat droplets, **increasing** their **surface area**.
- This **increases** the **rate** of **lipid digestion** by **lipase**.
- **Hepatocytes** can also **make cholesterol** if there is **not enough** in the diet.

4. BREAKDOWN OF ERYTHROCYTES (THEIR SHORT LIFE SPAN IS 120 DAYS)

- Specialised **phagocytes** called **Kupffer cells** are in the **walls** of liver **sinusoids**.
- These **break down red blood cells** by **phagocytosis** and **absorb** the useful **products**.



- **Iron**, **bilirubin** and **amino acids** are **released** into the **blood**.
- Most **iron** is carried to the **bone marrow** and used to produce **new** red blood cells.
- **Bilirubin** is carried to the **liver** and used to produce **bile**.

5. NUTRIENT STORAGE & REGULATION

Absorbed food is first taken to the liver, which allows the levels of some nutrients to be regulated by hepatocytes. Example:

- If blood glucose level is **too high**, **insulin** stimulates **hepatocytes** to **absorb** glucose and **convert** it to **glycogen** for **storage**.
- If blood glucose level is **too low**, **glucagon** stimulates **hepatocytes** to **break down glycogen** and **release glucose** into the **blood**.

4. JAUNDICE



**CAUSED BY AN ACCUMULATION OF BILIRUBIN
(YELLOW BILE PIGMENT) IN BLOOD PLASMA**

THE SKIN AND EYES BECOME YELLOW

With **normal red blood cell production**:

- **Kupffer cells** break down red blood cells (in the liver)
- By **phagocytosis** in the **sinusoids**
- **Heme** groups are converted to **bilirubin** (yellow bile pigment)
- **Bilirubin is transferred to bile**
- (So) **bilirubin** (in bile) **leaves the body** in **faeces** (so it does not accumulate)

With **jaundice**:

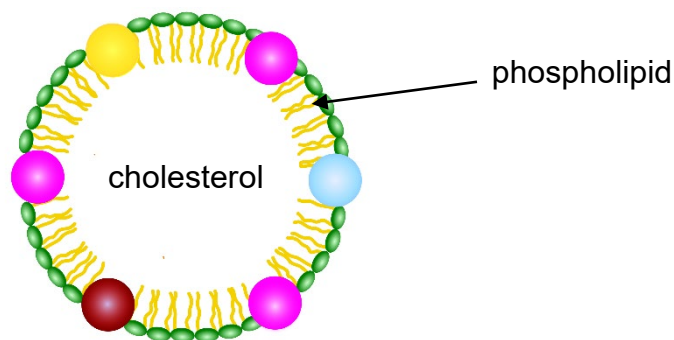
- **Bilirubin is not transferred to bile by the liver**
- (So excess) bilirubin **accumulates** in the **blood**
- **Causes** of this include:
 - **liver disease** (hepatitis, liver cancer, cirrhosis, chronic alcoholism)
 - **immaturity** of the liver
 - **blocked** bile ducts
 - **gallstones**
 - **increased numbers** of **red blood cells** are broken down
- In **infants**, if bilirubin levels **remain high** for **long periods**, a form of **brain damage** can occur that can lead to **deafness** and **cerebralpalsy**.
- In **adults**, jaundice usually just results in **itchiness**.

5. HIGH DENSITY LIPOPROTEIN (HDL) v LOW DENSITY LIPOPROTEIN (LDL)

- **Cholesterol** is **needed** by the body for many purposes, such as making **steroid hormones** and **plasma membranes**.
- The liver can **produce** cholesterol (if in short supply) or **convert** it to **bile salts** (if in excess).
- **High levels** of blood cholesterol are **not** automatically worrying:

IT DEPENDS ON WHETHER THE CHOLESTEROL IS BEING CARRIED
TO OR FROM BODY TISSUES

- Cholesterol is transported in **lipoproteins**, which are **small spheres** coated in **phospholipid**.



- These can be **high**-density lipoproteins (HDLs) or **low**-density lipoproteins (LDLs).

HIGH-DENSITY LIPOPROTEINS (HDLs)	LOW-DENSITY LIPOPROTEINS (LDLS)
'Good' cholesterol	'Bad' cholesterol
Collects cholesterol from body tissues and carries it back to the liver for removal from the blood	Carries cholesterol from the liver to body tissues

- HDL **lowers** blood cholesterol levels and is therefore 'good', while LDL is considered 'bad' as it **raises** blood cholesterol levels.