Excretion & the Liver

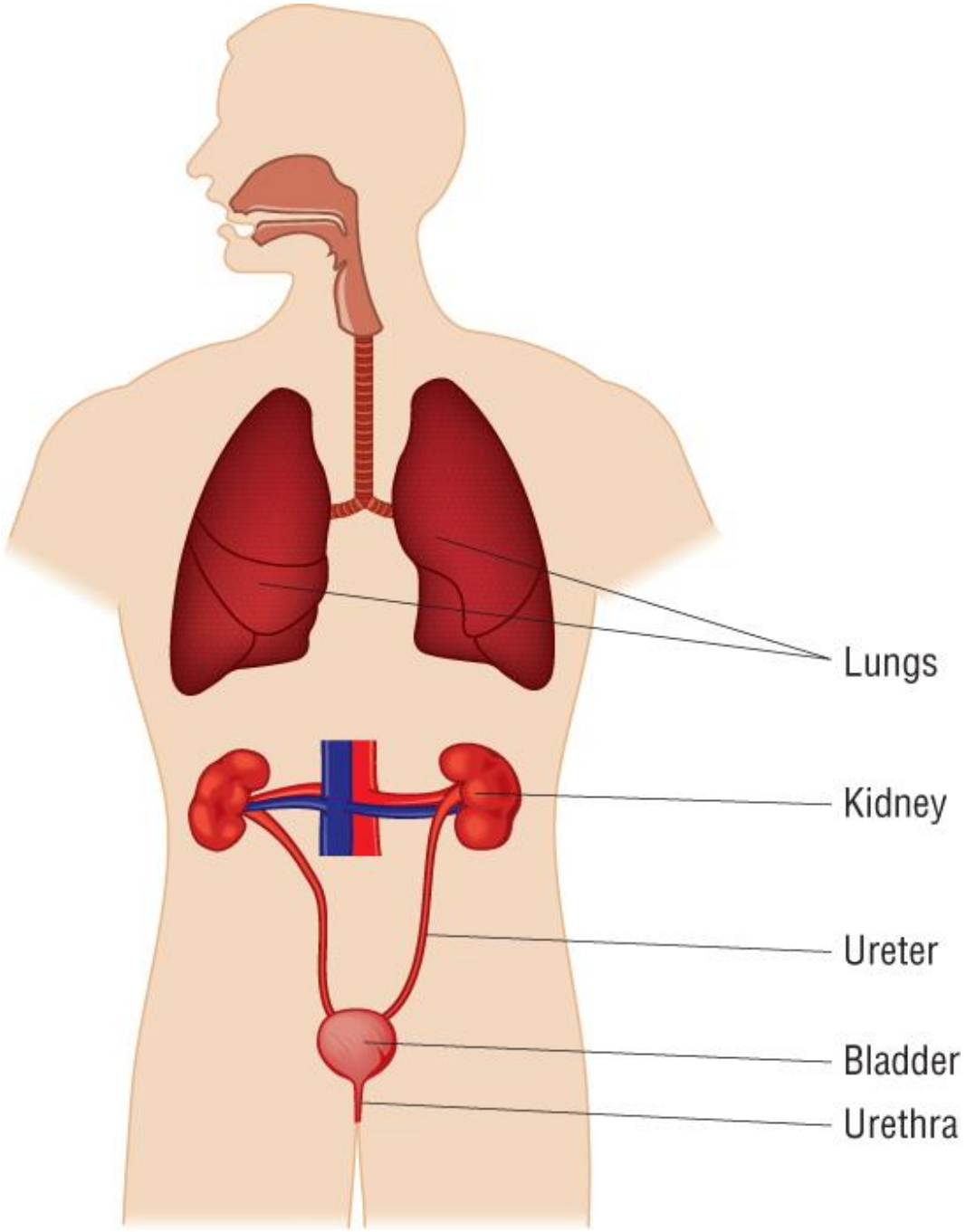
- Define the term: *excretion*.
- Explain the importance of removing metabolic wastes, including carbon dioxide and nitrogenous waste from the body.
- Describe, with the aid of diagrams and photographs, the histology and gross structure of the liver.
- Describe the formation of urea in the liver – including an outline of the ornithine cycle.
- Describe the roles of the liver in detoxification.

What is excretion?

- The removal of waste products of metabolism.

- Examples of these waste products are:
  - Carbon Dioxide → **From Respiration**
  - Bile pigments → **From dead red blood cells**
  - Urea → **Nitrogenous excretory product from breakdown of excess amino acids**
  - Mineral salts → **From other metabolism**
  - Water

The main excretory organs



The Biggies

- The main two excretory products are:

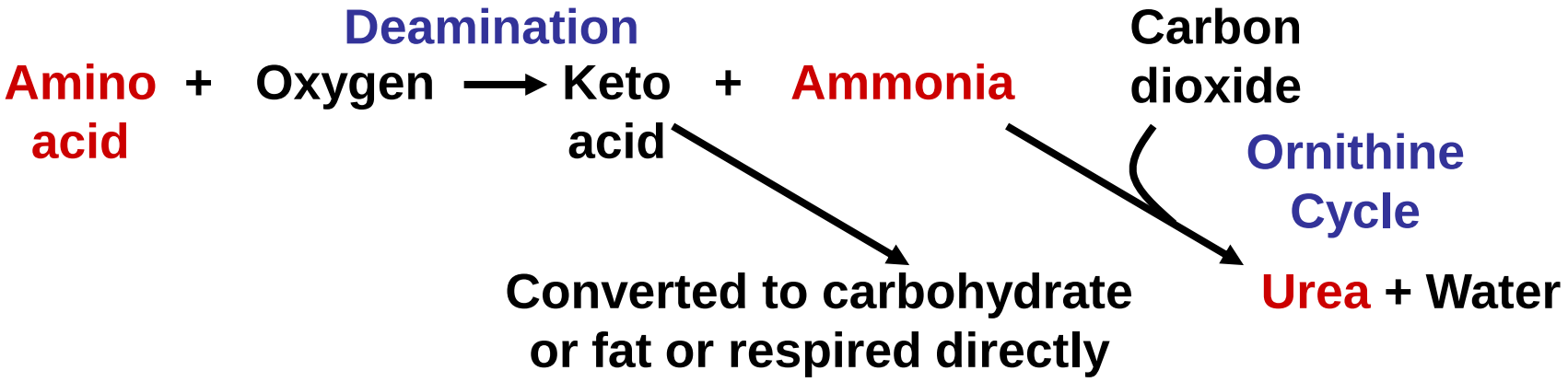
- Carbon Dioxide
- Urea

Carbon Dioxide

- Produced by every living cell in respiration.
- Excreted via lungs.
- Toxic in the body:
  - Competes with O_2 for space on haemoglobin.
  - Carbaminohaemoglobin has low affinity for O_2.
    - Remember the Bohr shift.
  - Reduces pH of blood.
    - Detected by respiratory centre in medulla oblongata.
    - Increases breathing rate and causes respiritory acidosis at pH<7.35.

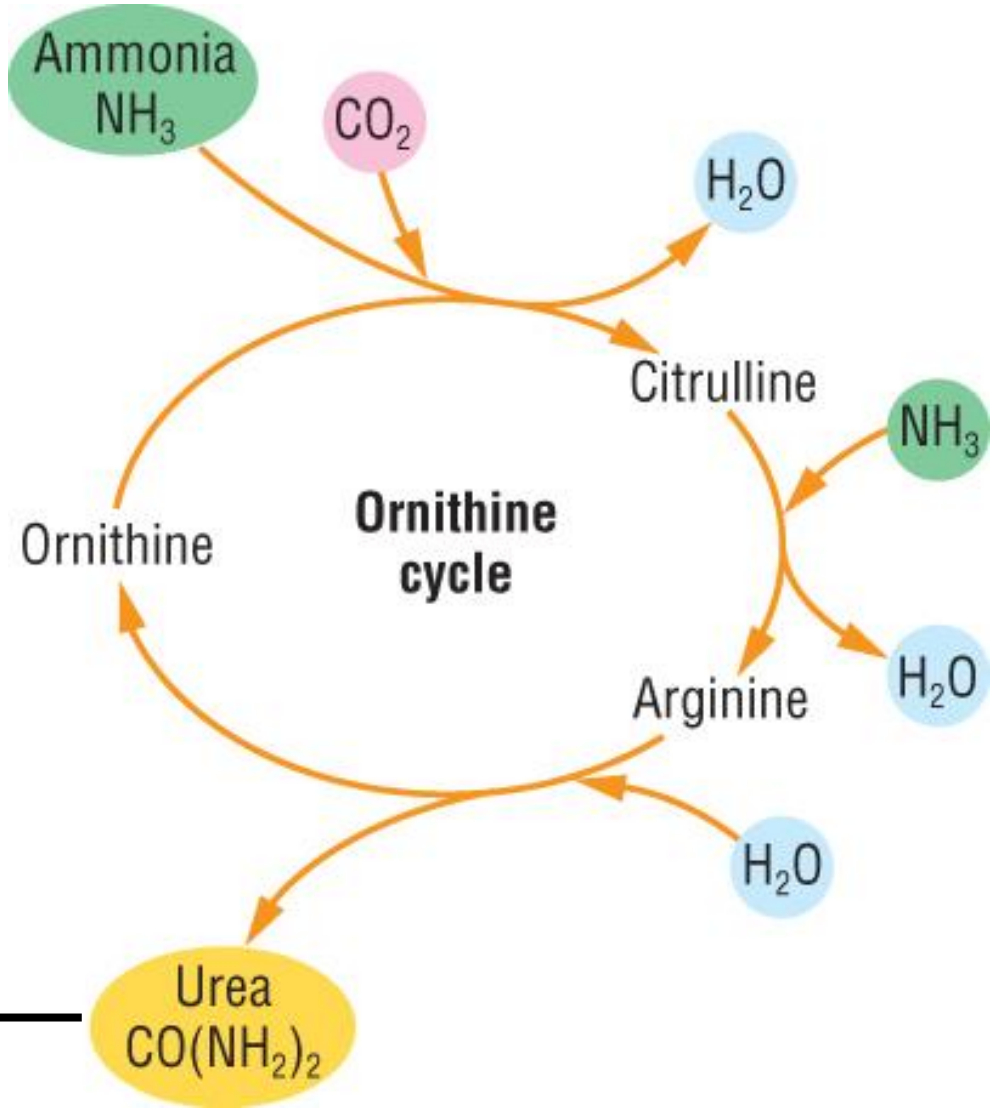
Urea

- Produced in the liver from excess amino acids.
  - Deamination.
- Transported in solution in blood, removed by kidneys.



Deamination

Amino acid + **Oxygen** ⟶ **Keto acid** +



Excreted by the kidneys in urine ⟵

Other functions of the Liver

- Regulation of blood composition.
  - Controls glucose concentration.
  - Controls amino acid levels (Deamination/Transamination).
  - Controls lipid levels.
  - Removes toxins.
  - Removes unwanted proteins (Eg. hormones).
  - Produces bile from RBC breakdown.
  - Synthesises plasma proteins.
  - Synthesises cholesterol.
  - Stores vitamins.
  - Synthesises foetal RBCs.

Carbohydrate Control

- Hexose sugars from digestion converted into glucose.
- Regulation of glucose under the control of insulin/glucagon.

Lipid Control

- Only a limited amount of glucose can be stored as glycogen.
  - Any excess is converted to lipids for storage elsewhere.
- Cholesterol is used in many cell membranes.
  - Excess cholesterol is removed by the liver & excreted via bile.

Hormone Control

- Hormones need to be broken down after they have “delivered their message”.

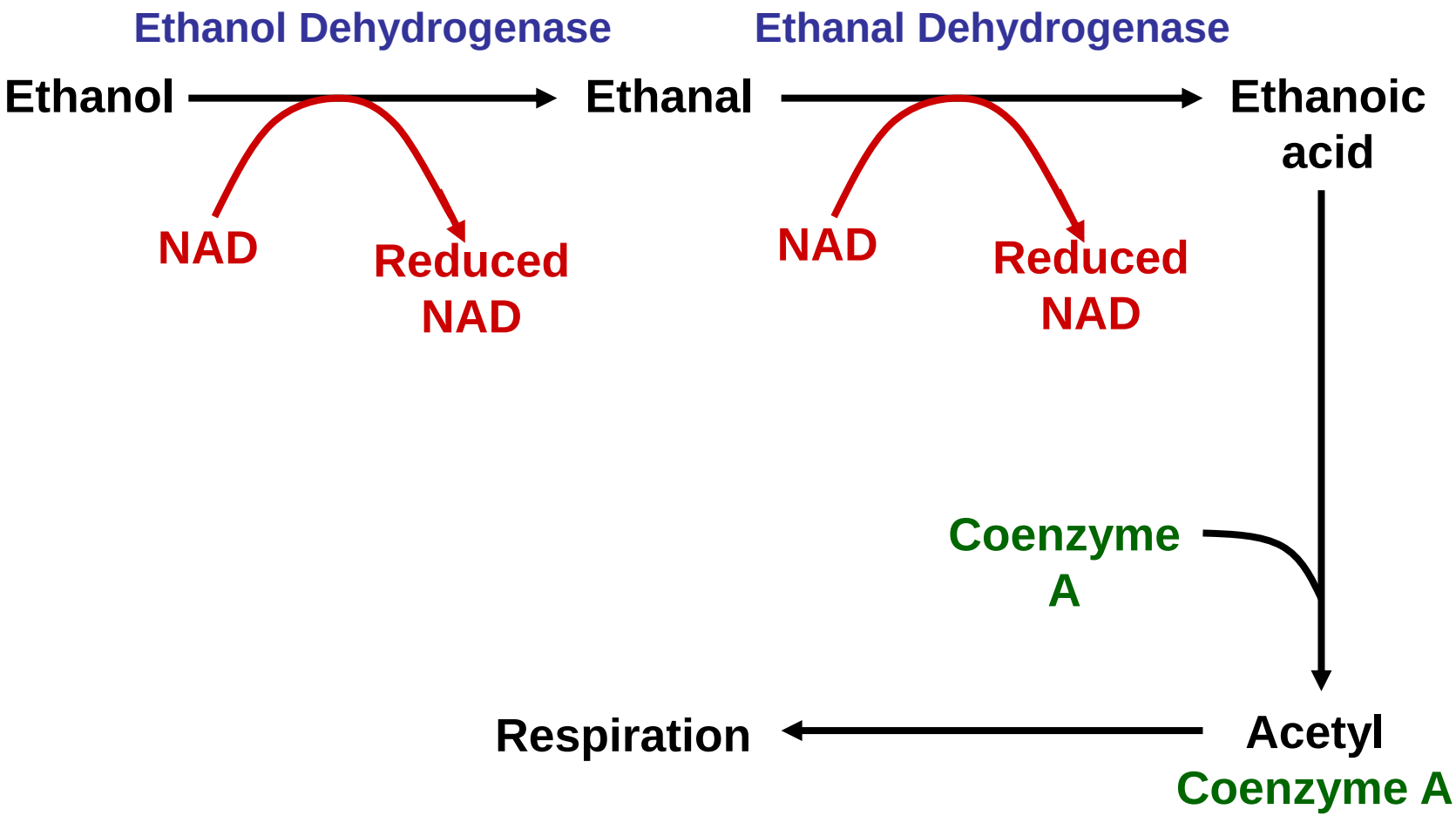
- Protein hormones are deaminated.
- Steroid hormones are excreted in bile.

Toxin Control

- Apart from Urea, many metabolic processes produce toxic products.
- We also take some voluntarily
  - Alcohol & other drugs.

- Liver cells contain enzymes to detoxify these substances.

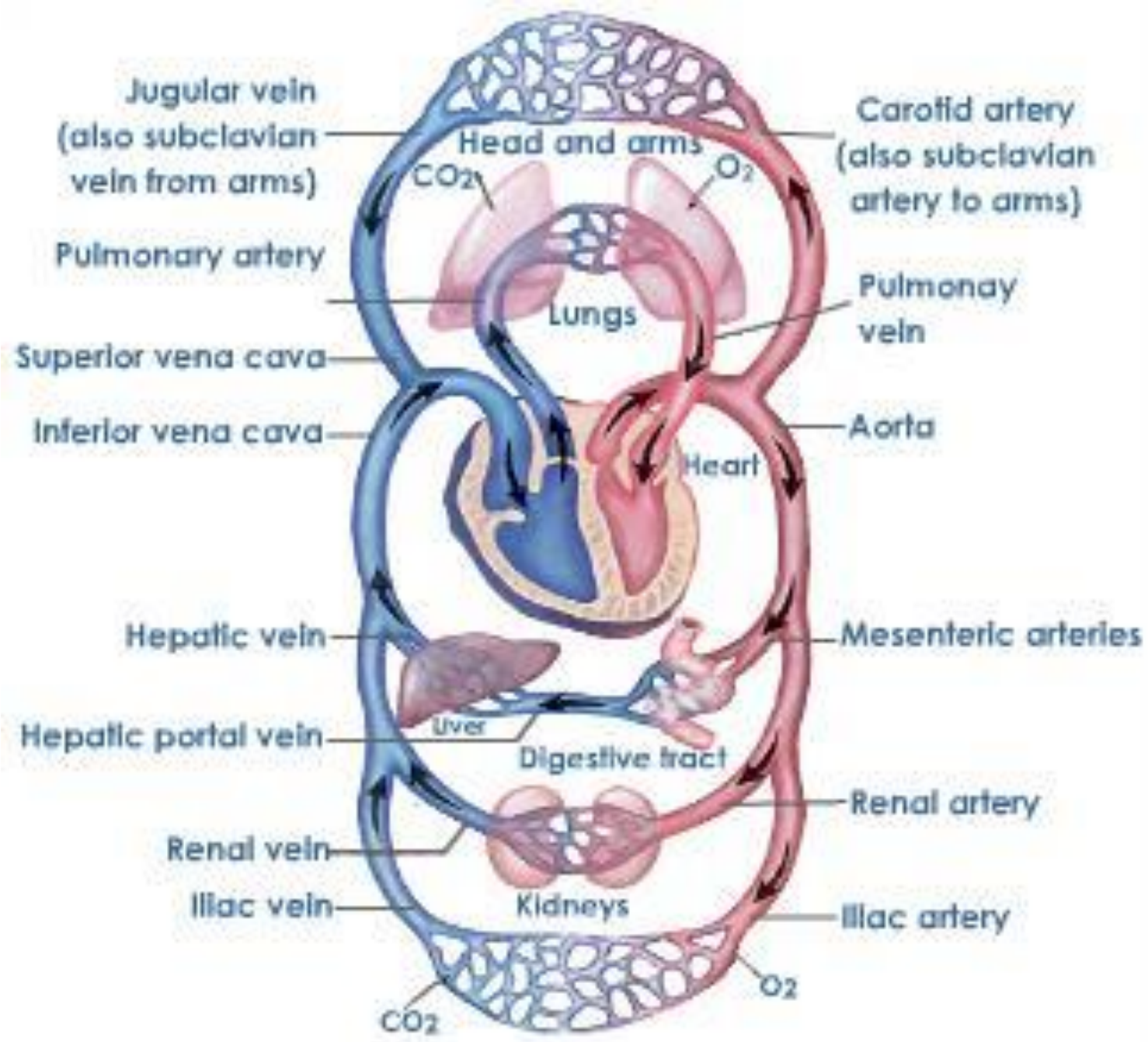
Detoxification of Alcohol



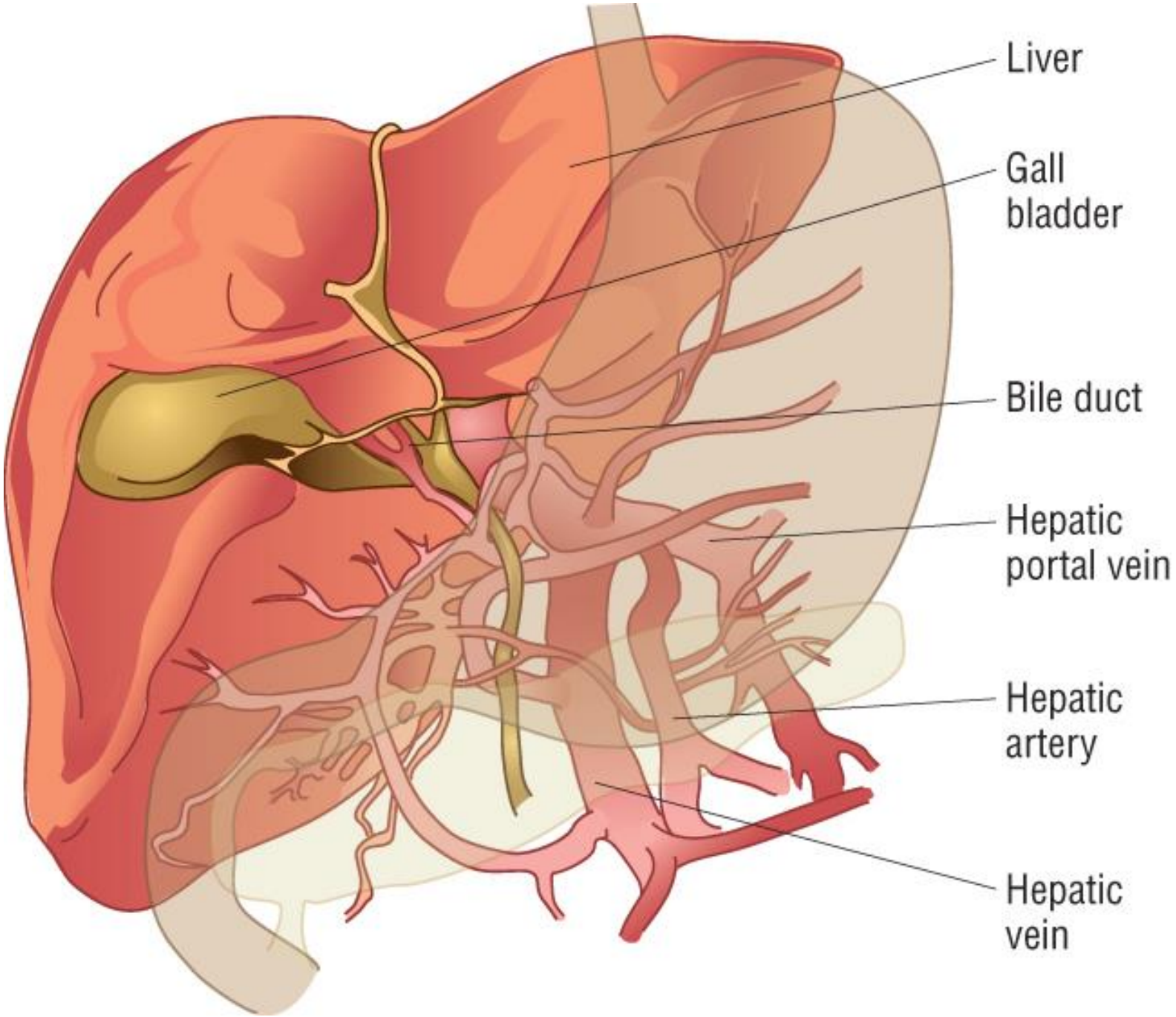
Structure of the Liver

- Liver cells (hepatocytes) carry out many functions that regulate the composition of the blood.
  - They need to be supplied by large quantities of blood.
  - The liver is structured to allow as much blood as possible to reach as many hepatocytes as possible.

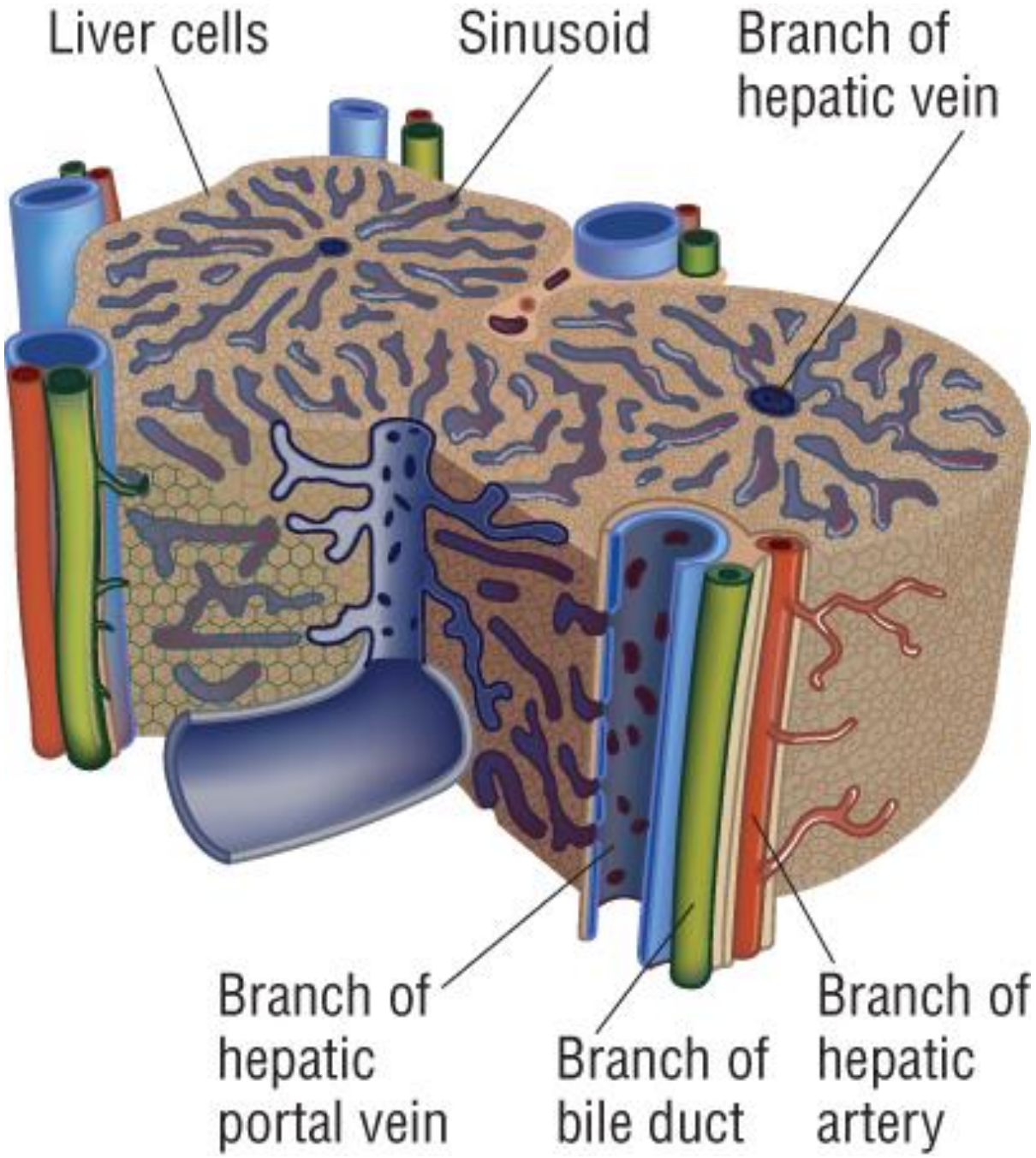
Position of the Liver



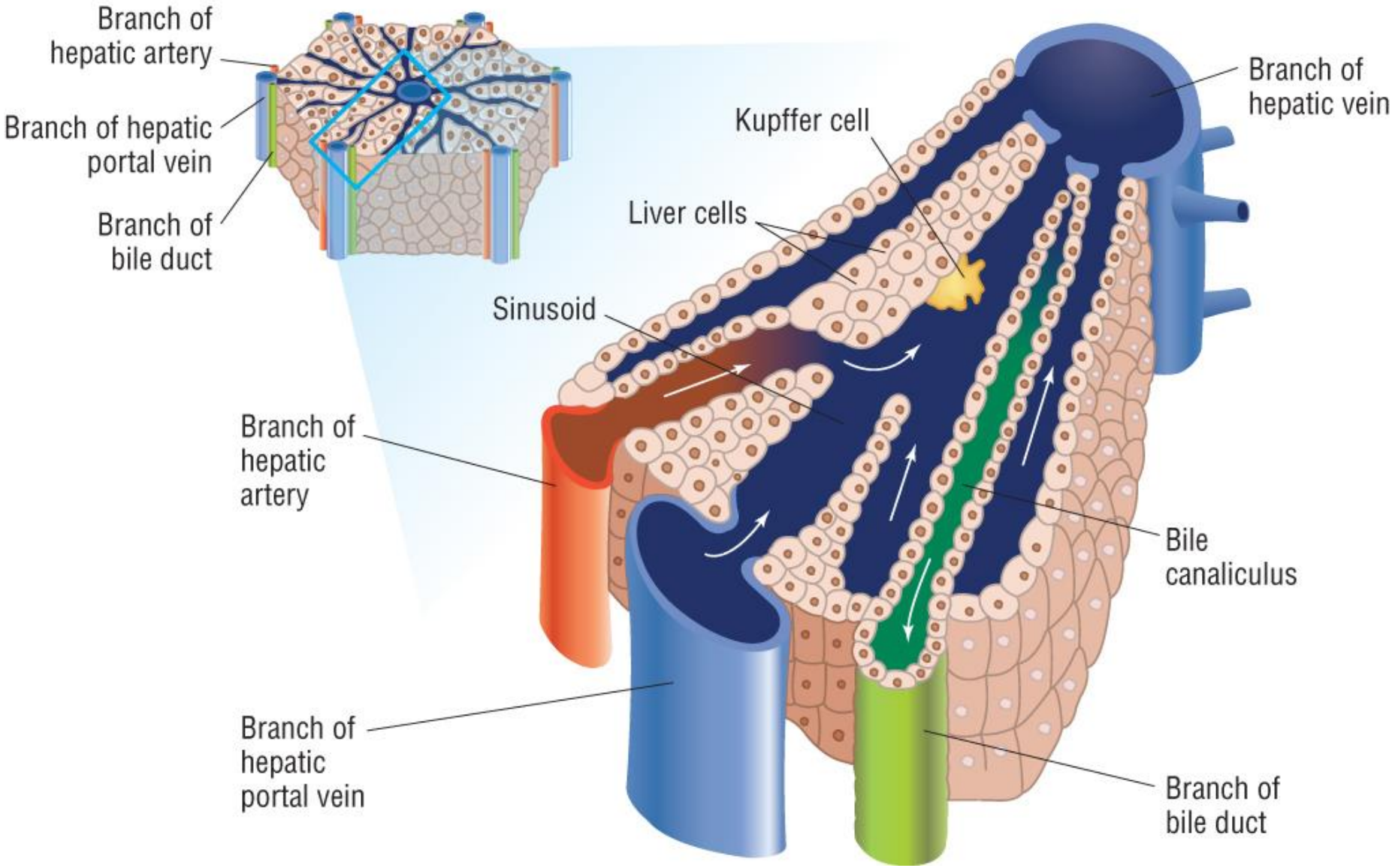
The Liver


Liver
Gall bladder
Bile duct
Hepatic portal vein
Hepatic artery
Hepatic vein

Arranging liver cells into cylindrical lobules



Liver cells in a lobule



Hepatocytes

- Simple cuboidal shape
- Many microvilli on their surface
- Due to their many different functions, have dense cytoplasm with plenty of the appropriate organelles.

Kupffer Cells

- Specialised macrophages (phagocitic WBC).
- Move around within sinusoids.
- Help to breakdown & recycle RBCs.