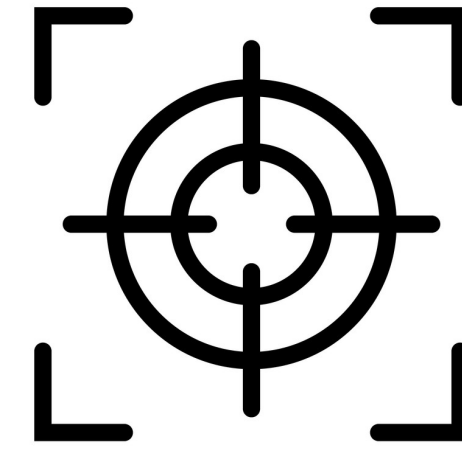




**Topic 4:  
Nutrition in Human**

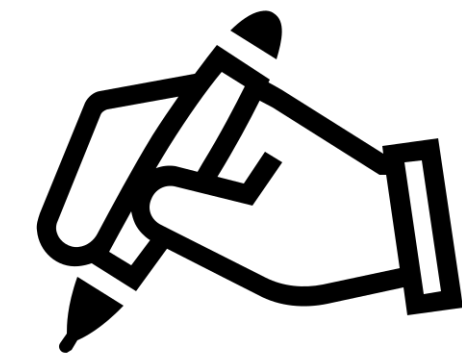


# Chapter Analysis



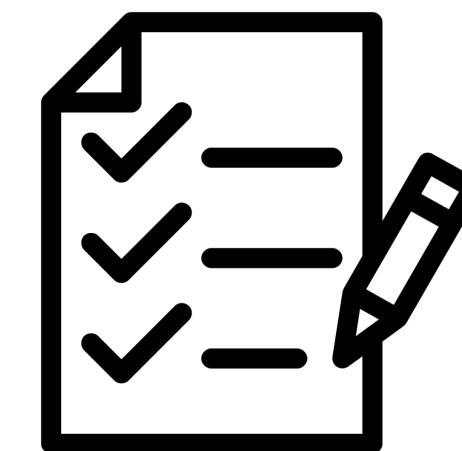
## **FOCUS**

- heavy content but straightforward



## **EXAM**

- Usually tested in both MCQ and structured question section A

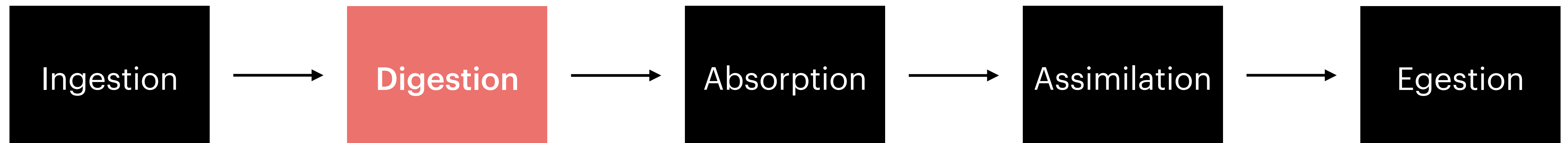


## **WEIGHTAGE**

- Constitute to around 4% in Paper 2 in the past 5 years

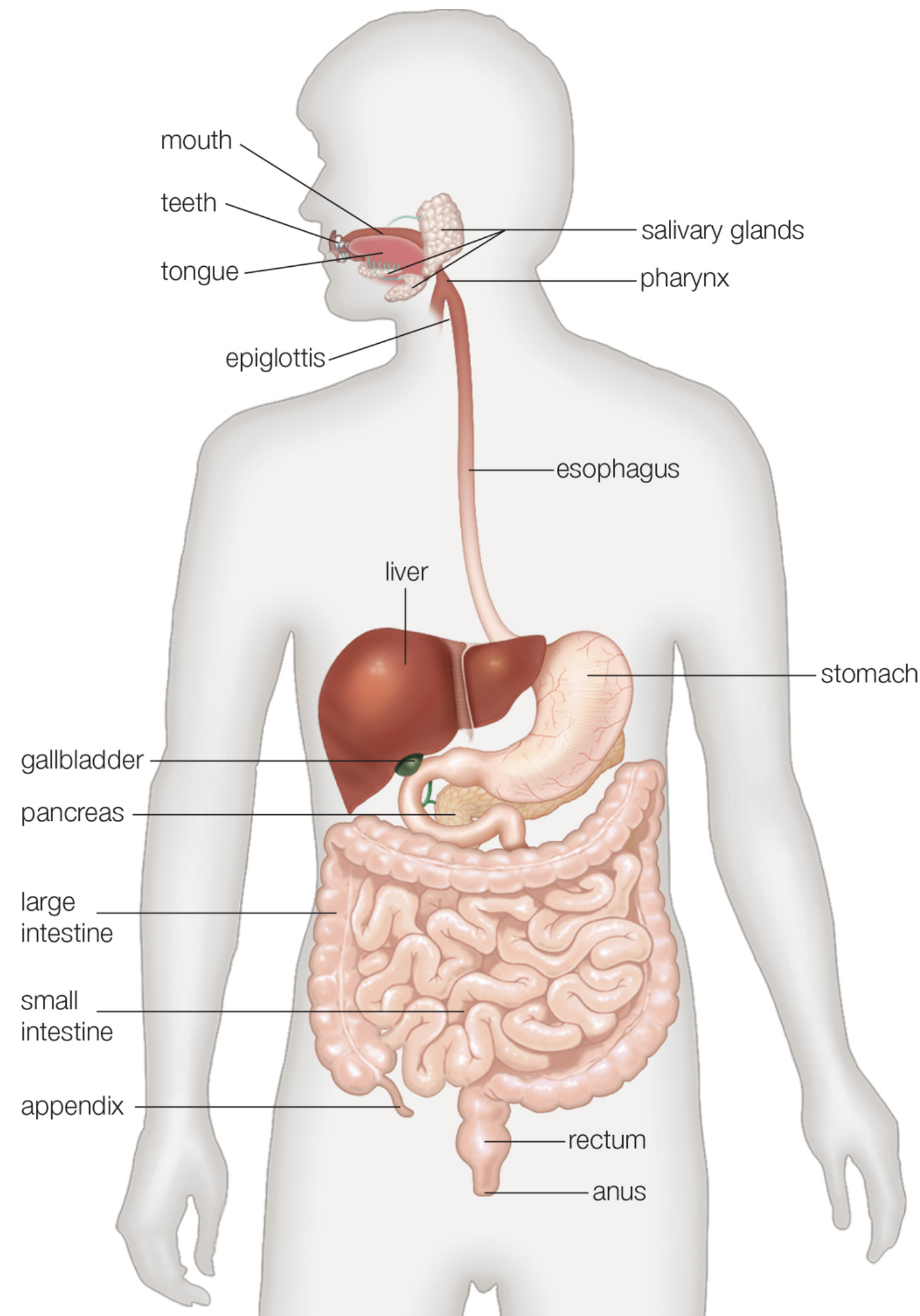
**Key Concept**

# Digestive System Digestion



Carbohydrate, proteins and fats are broken down into soluble glucose, amino acids, fatty acids and glycerol

# Overview of digestive system



## 1. Mouth and buccal cavity

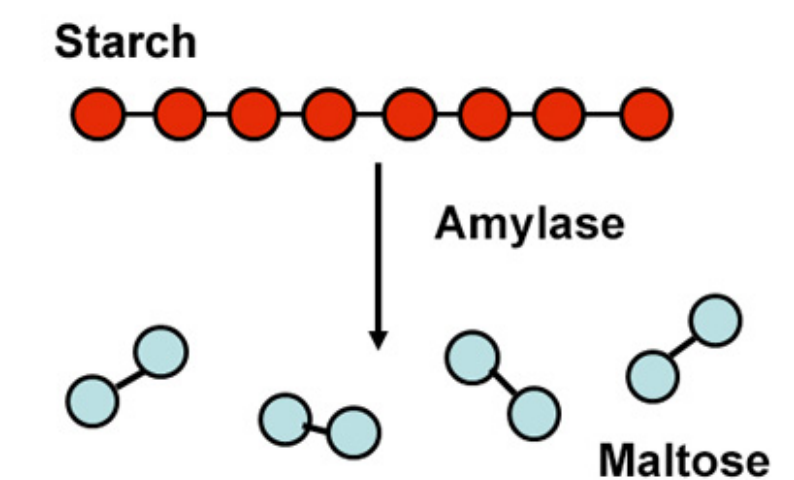
(a) Teeth: chewing, breakdown large pieces of food to smaller size.

- **Increase surface area to volume ratio of the food** that enzyme can act on more efficiently.

(b) Salivary glands: Secrete saliva into mouth via salivary ducts.

- saliva contains **salivary amylase** that **digest starch to maltose**

(c) Tongue: mix food with saliva into bolus



## 2. Oesophagus

- A narrow muscular tube that connects the buccal cavity and stomach
- It is made up of two layers of muscle. The external layer is the **longitudinal muscle** and the inner layer is the **circular muscle**.

# Overview of digestive system

## Stomach

Stomach wall has pits that lead to **gastric gland**, which secretes

(1) mucus which protects the stomach walls

(2) gastric acid/dilute hydrochloric acid

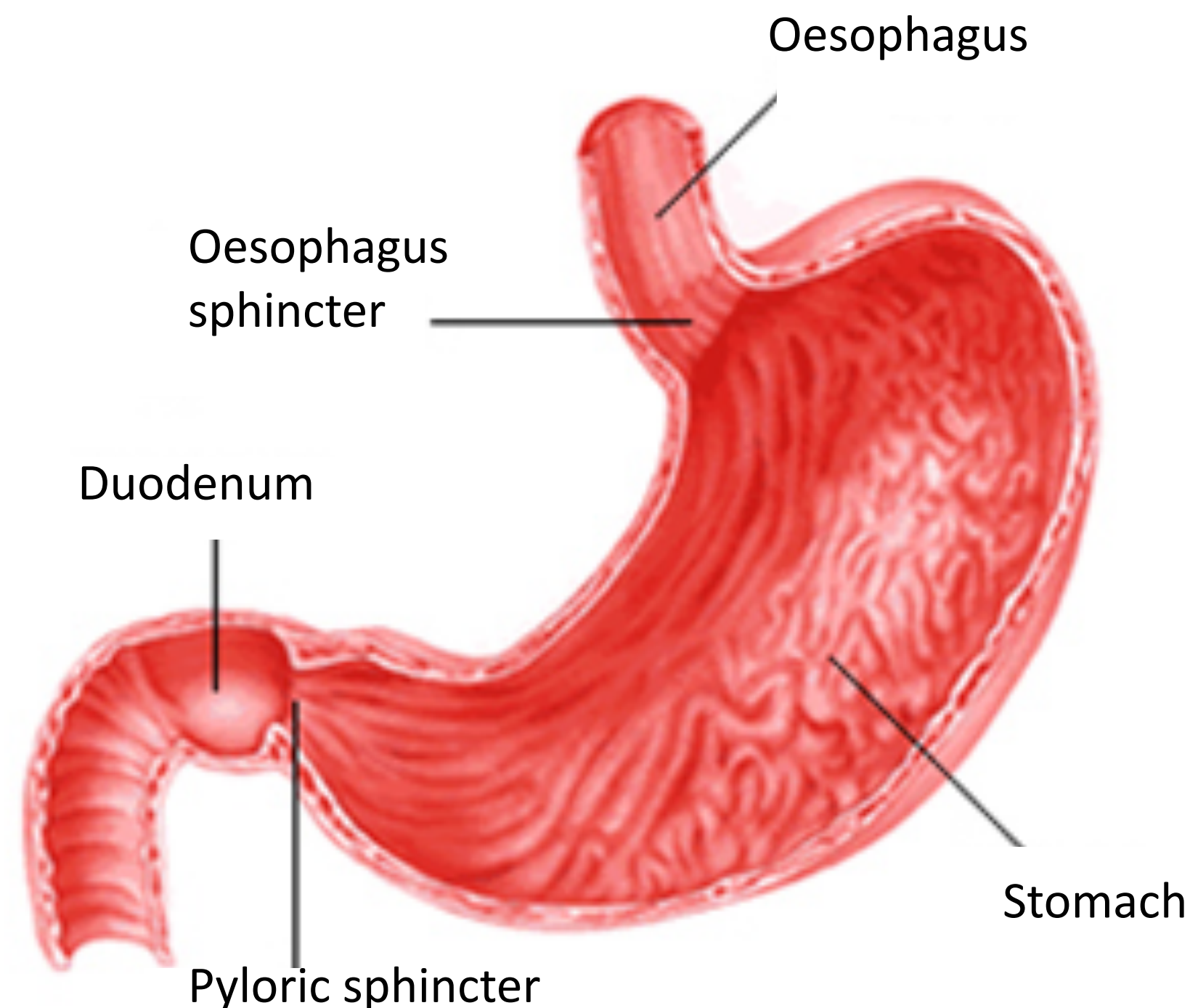
- Gastric acid is pH 2, **denatures salivary amylase** thus stop its activity
- changes the **inactive pepsinogen into the active form, pepsin**
- provides an acidic environment as pepsin **optimum pH** is 2
- **kills germs and bacteria.**

(3) pepsinogen (inactive form)

- dilute HCl activates pepsinogen to pepsin
- pepsin **digest proteins to polypeptides**

- Food normally remains in the stomach for about three to four hours. The partly digested food becomes liquefied, forming chyme.

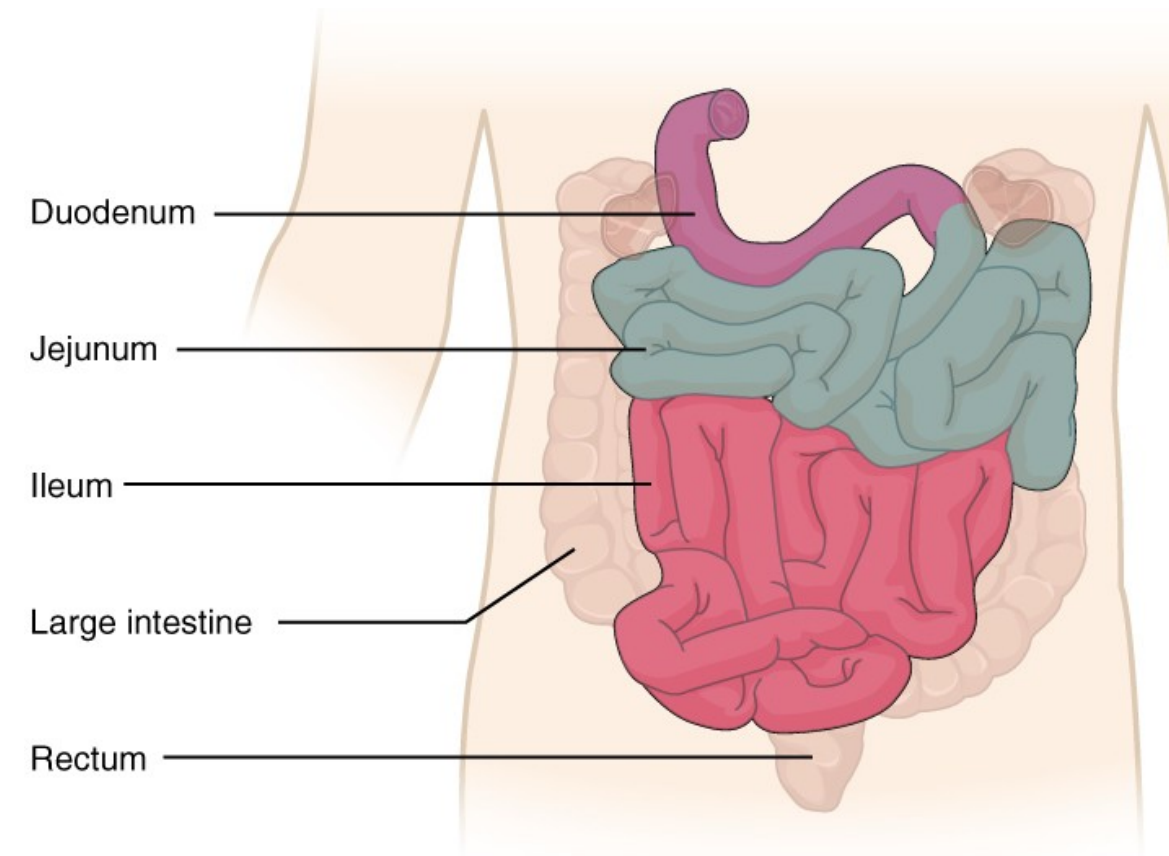
- The pyloric sphincter is located at the place where the stomach joins the small intestine. When the muscle contracts, the entrance to the small intestine closes. When the ring relaxes, chyme passes in small amounts into the duodenum



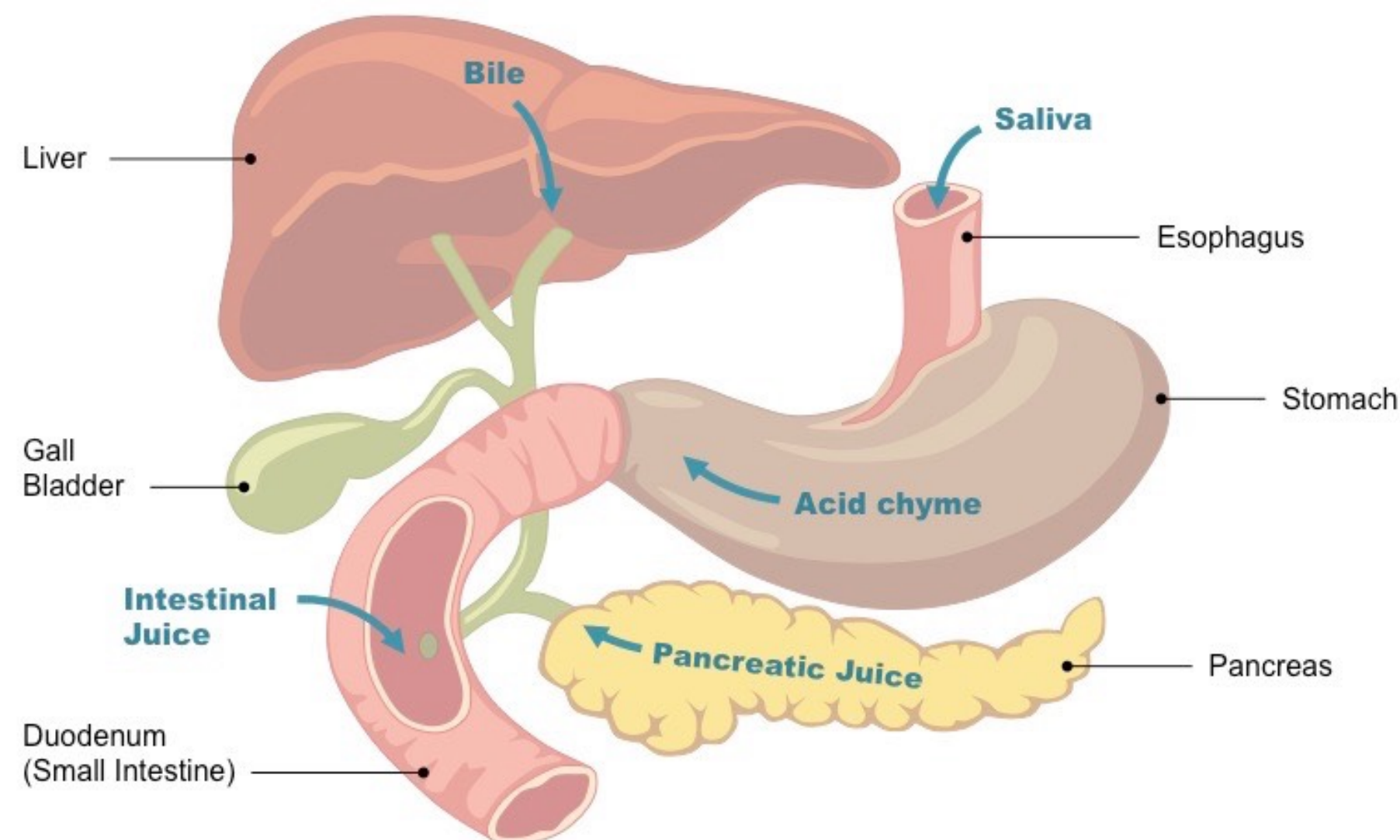


# Overview of digestive system

## Small Intestine



- The small intestine is divided into three parts: the duodenum, jejunum and ileum.
- In the duodenum, chyme from the stomach mixes with
  1. **Pancreatic juice** secreted from pancreas
  2. **Intestinal juice** secreted by epithelial cells of small intestine
  3. **Bile** from gall bladder
- all three juices are alkaline, thus they neutralise the acidic chyme from stomach and provide an optimum alkaline environment for pancreatic and intestinal enzymes

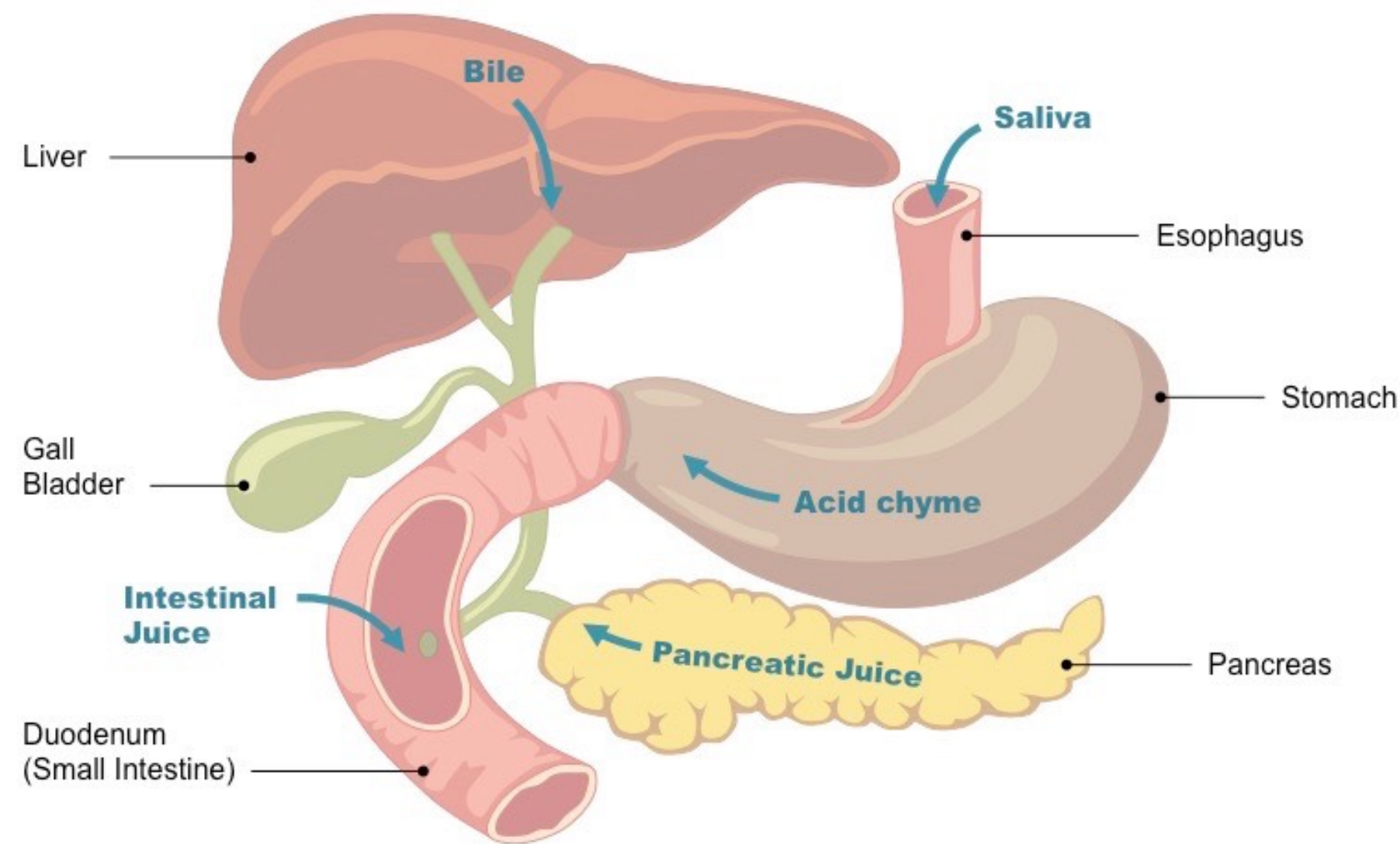


### **BILE**

- Bile is produced by the liver and stored in the gall bladder.
- It passes into the small intestine through the bile duct.
- Bile **emulsifies large fat droplets** into **smaller** fat droplets, **increasing the surface area to volume ratio** of the fats for **lipase** to work on and **speeds up fat digestion**

# Overview of digestive system

## Small Intestine



- Enzymes found in pancreatic juice: trypsinogen, pancreatic amylase and pancreatic lipase
- Enzymes found in intestinal Juice: enterokinase, erepsin, maltase, lactase, sucrase, intestinal lipase

### Proteins

|                        |                      |   |                  |
|------------------------|----------------------|---|------------------|
| Trypsinogen (inactive) | enterokinase         | → | Trypsin (active) |
| Proteins               | trypsin              | → | Polypeptides     |
| Polypeptides           | erepsin / peptidases | → | Amino acids      |

### Carbohydrate

|         |                    |   |                    |
|---------|--------------------|---|--------------------|
| Starch  | pancreatic amylase | → | Maltose            |
| Maltose | maltase            | → | Glucose + Glucose  |
| Lactose | lactase            | → | Glucose + Lactose  |
| Sucrose | sucrase            | → | Glucose + Fructose |

### Fats

|      |   |   |                        |
|------|---|---|------------------------|
| Fats | pancreatic lipase/<br>intestinal lipase | → | Fatty acids + glycerol |
|------|---|---|------------------------|

**Key Concept**

# Absorption

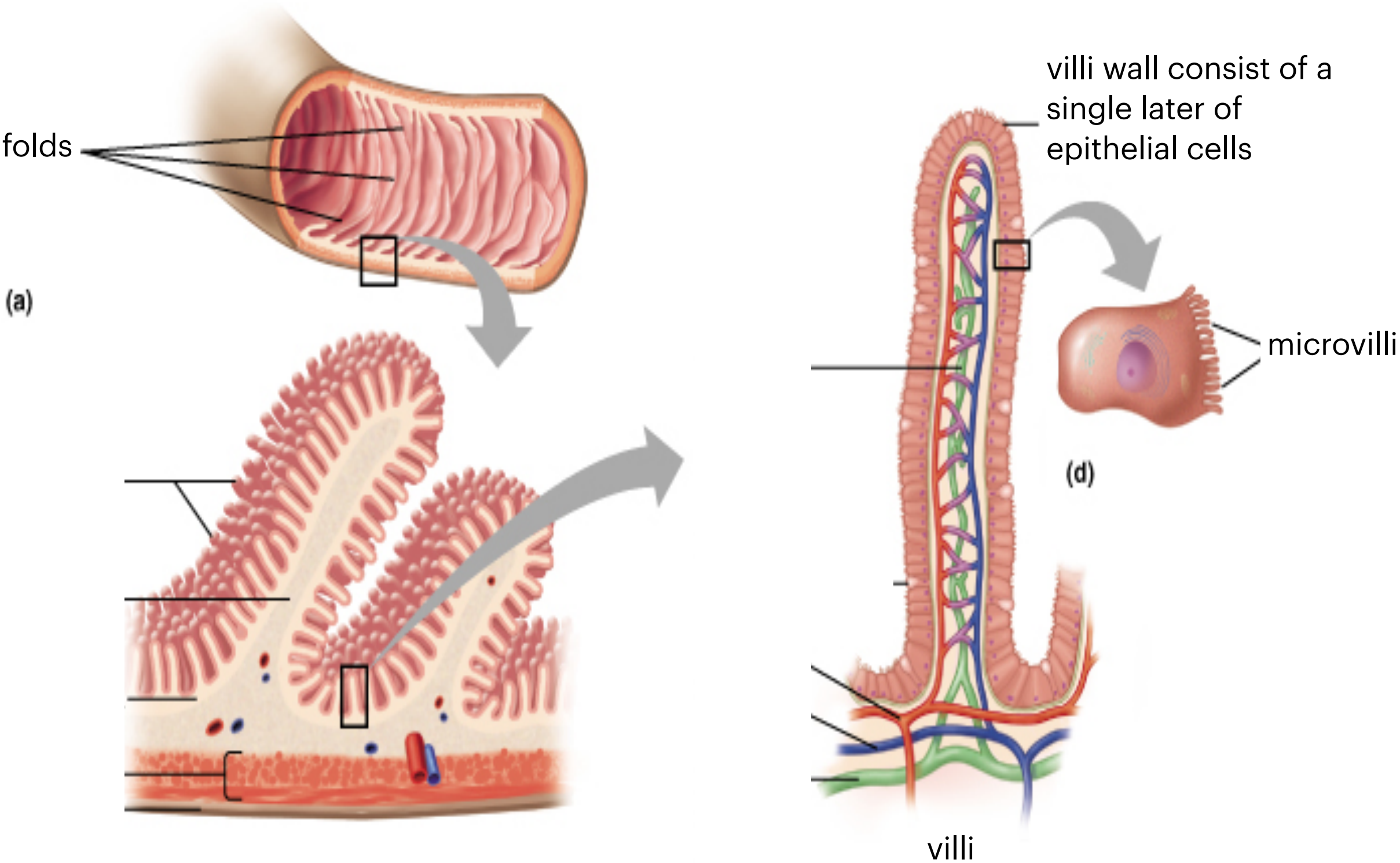


Glucose, amino acids, fatty acids and glycerol  
are absorbed into body cells



# adaptation of small intestine

function: digestion and **absorption (focus)**



| Structure  | Adaptation   |
|--|--|
| <ul style="list-style-type: none"> <li>• There are many large <b>fold</b> at the inner wall of small intestine</li> <li>• <b>Villi</b> are finger like projections that are present on the folds</li> <li>• <b>Microvilli</b> are present on each epithelial cells of villi</li> </ul> | <p><b>Increase surface area to volume ratio</b> for absorption of food nutrients by small intestine</p>                              |
| <p>Villi wall is only <b>one cell thick</b></p>  | <p><b>Reduce distance</b> for digested nutrients to diffuse into blood vessels or lacteal</p>  |
| <p>Within each villus is a <b>network of capillaries and lacteal</b></p>   | <p>Continuous transport of digested food substances <b>maintains the steep concentration gradient</b> of nutrients for diffusion</p> |

**Key Concept**

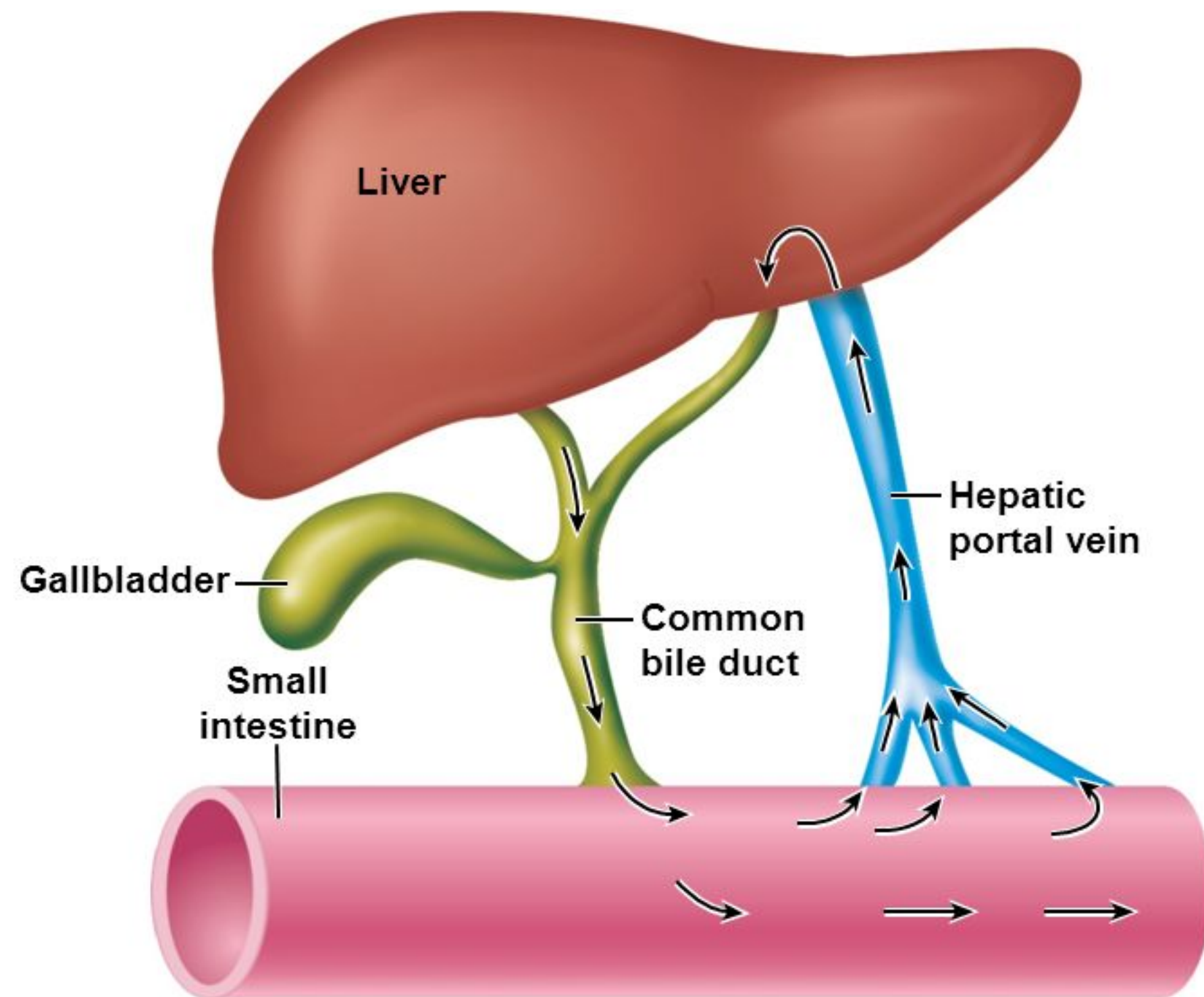
# Assimilation



Absorbed nutrients are utilised by body



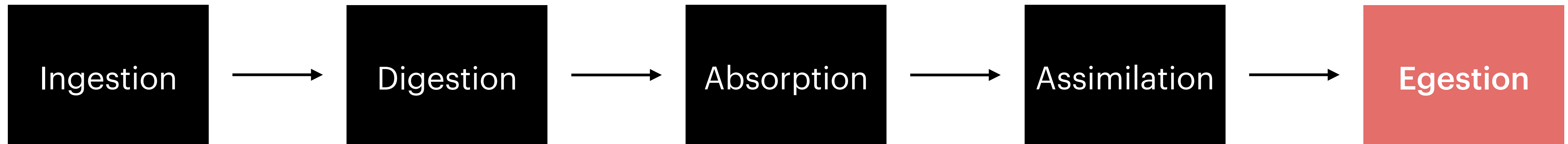
# Hepatic Portal Vein



- Digested food molecules such as amino acid and glucose are absorbed by villi on the small intestine
- They converge into a large blood vessel called the **hepatic portal vein**, which transport blood rich in absorbed nutrients **from the small intestine to the liver**

**Key Concept**

# Egestion

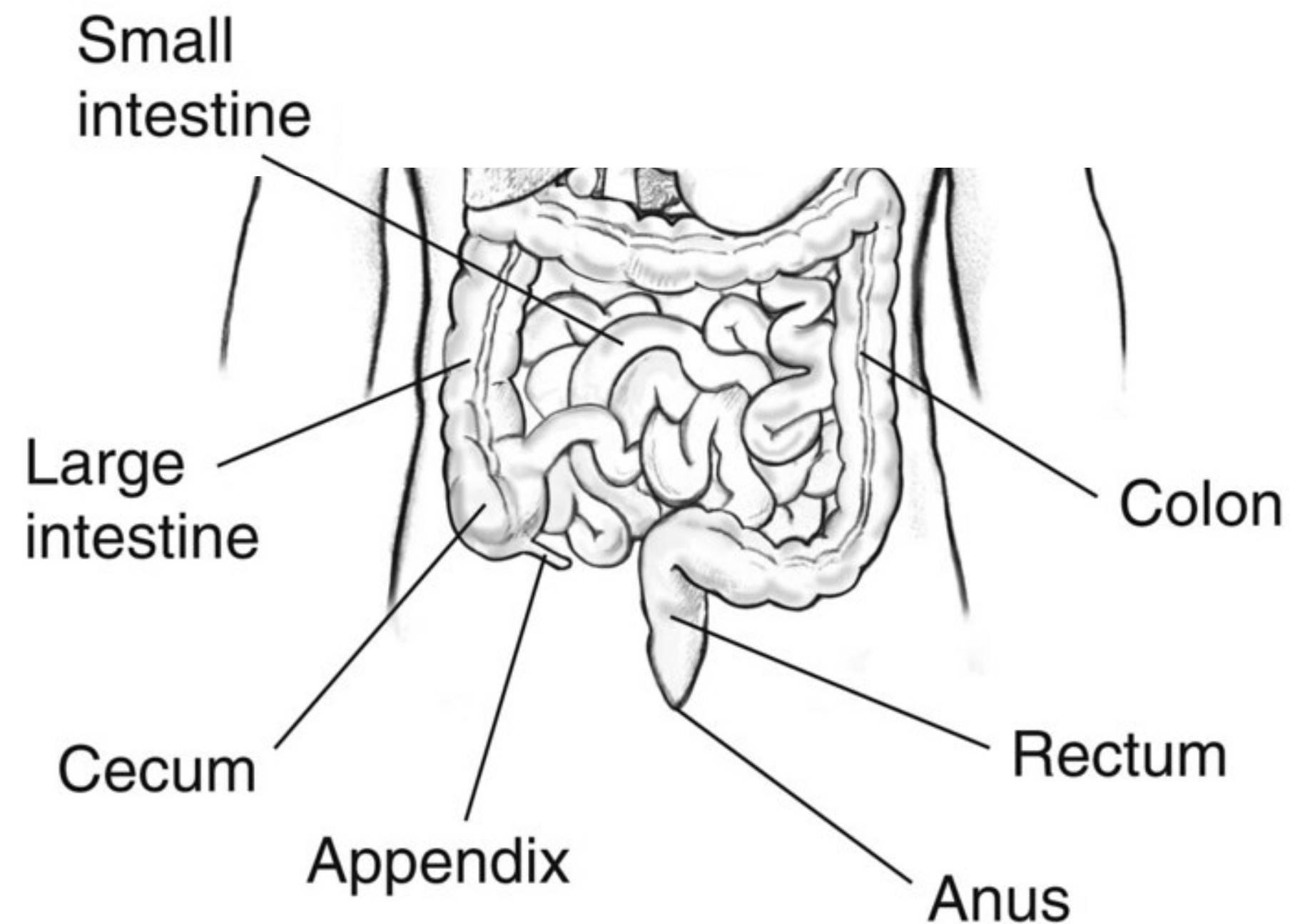


Removal of undigested food  
out of body



# Egestion

## Large Intestine



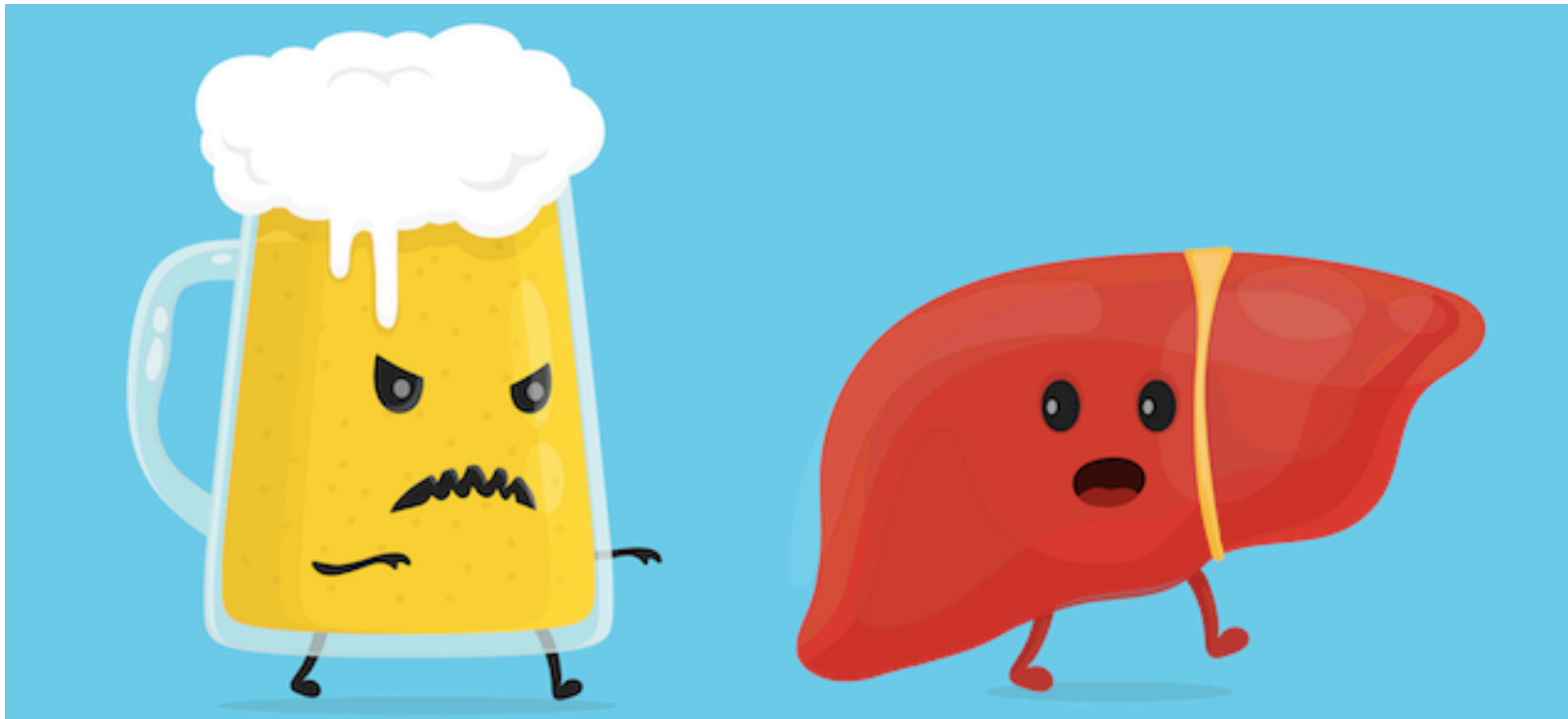
### 5. Large Intestine

- The large intestine serves to **absorb the remaining water and mineral salts** that have not been absorbed by the small intestine (most of the water had been absorbed by the small intestine)
- **No digestion** occurs in the large intestine
- The undigested waste matter comprises mainly cellulose, which is indigestible to humans.
- Faeces is temporarily **stored in rectum**. When the rectum contracts, the faeces is then expelled through the anus.

**Key Concept**

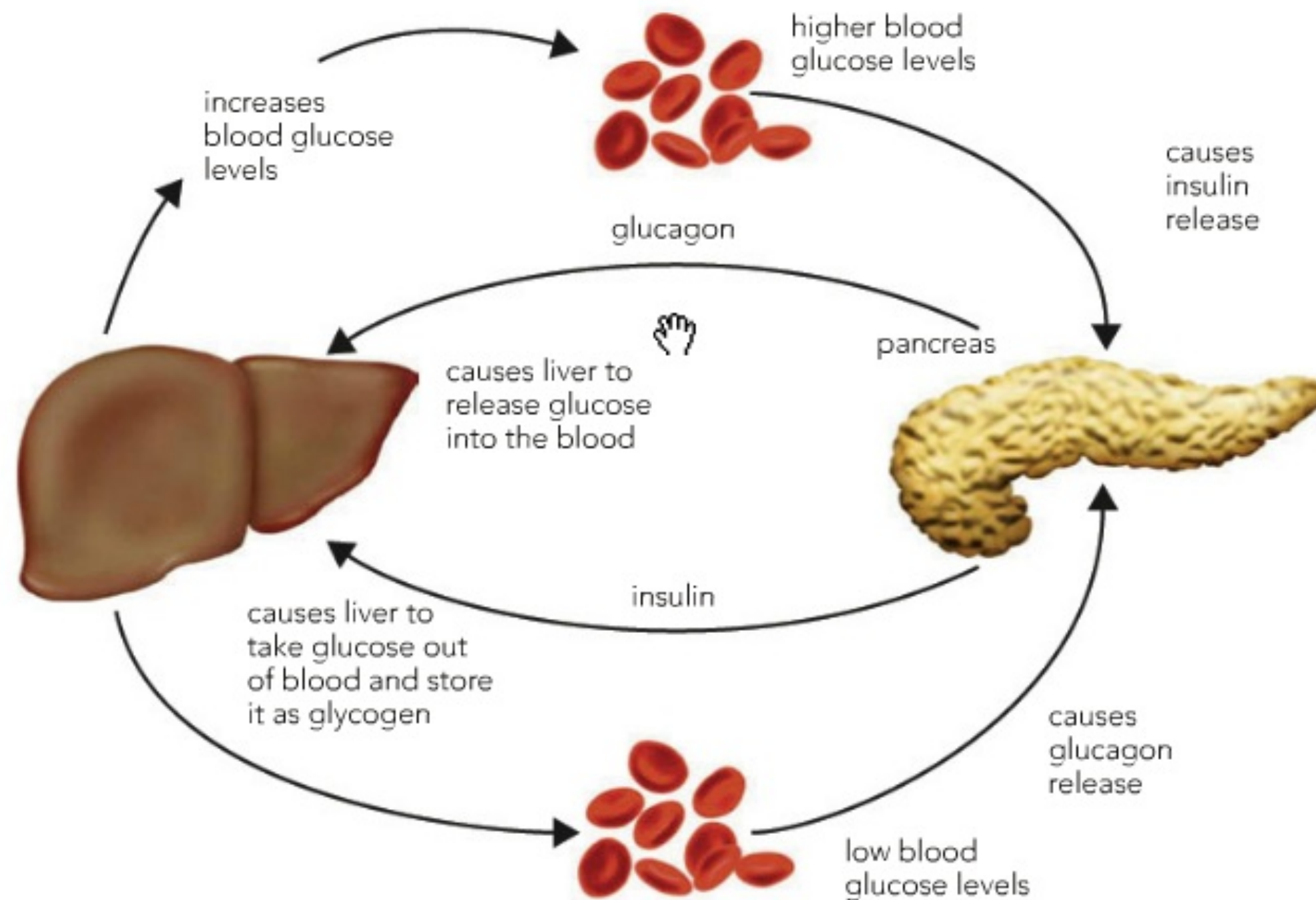
# **Liver**

## **Effect of alcohol**





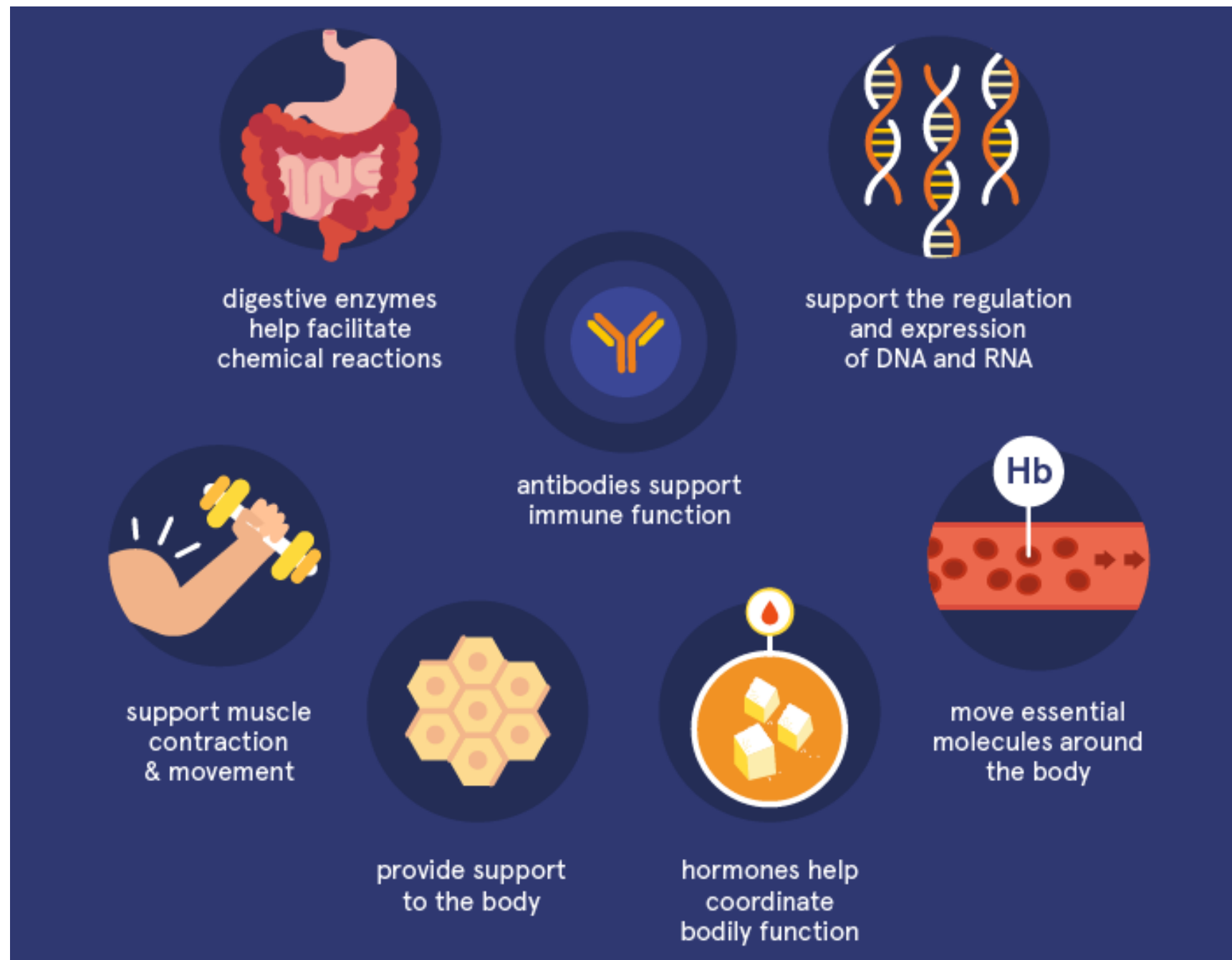
# Function of liver



## 1. Regulation of blood glucose concentration (carbohydrate metabolism)

- When blood glucose is higher than normal, the islets of Langerhans in the pancreas will secrete insulin. Insulin will stimulate liver cells to convert excess glucose to glycogen and stored in liver. This decrease blood glucose level back to normal.
- When blood glucose level is lower than normal, the islets of Langerhans in the pancreas will secrete glucagon. Glucagon stimulates the liver cells to convert stored glycogen in the liver back into glucose. The glucose is released into the blood, which increase blood glucose level back to normal.

# Function of liver

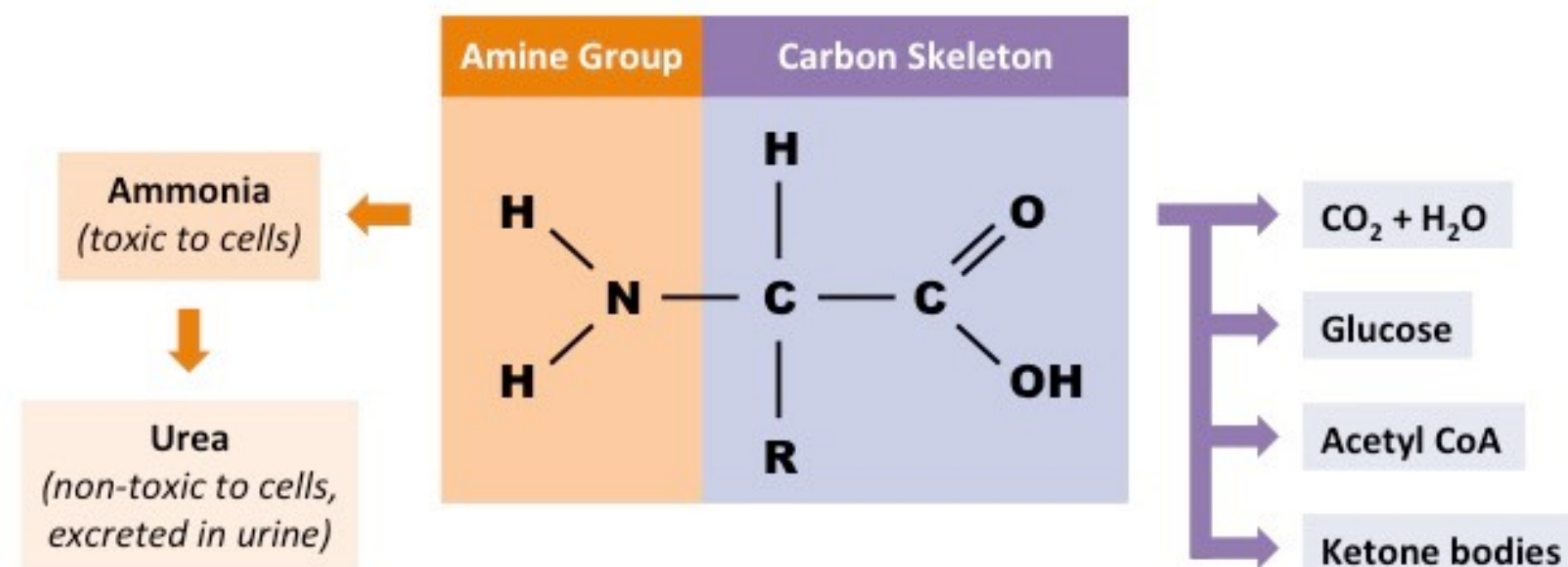


## 2. metabolism of amino acids

- The liver synthesizes essential proteins from amino acids in the diet, including blood clotting proteins like prothrombin and fibrinogen.

## 3. Deamination

- Excess amino acid is deaminated by the liver, which is the removal of the amino group ( $-NH_2$ ) from an amino acid.
- The amino group is first converted into ammonia, which is toxic to cells, then converted to urea by enzymes in the liver, and eventually removed in urine.





# Function of liver

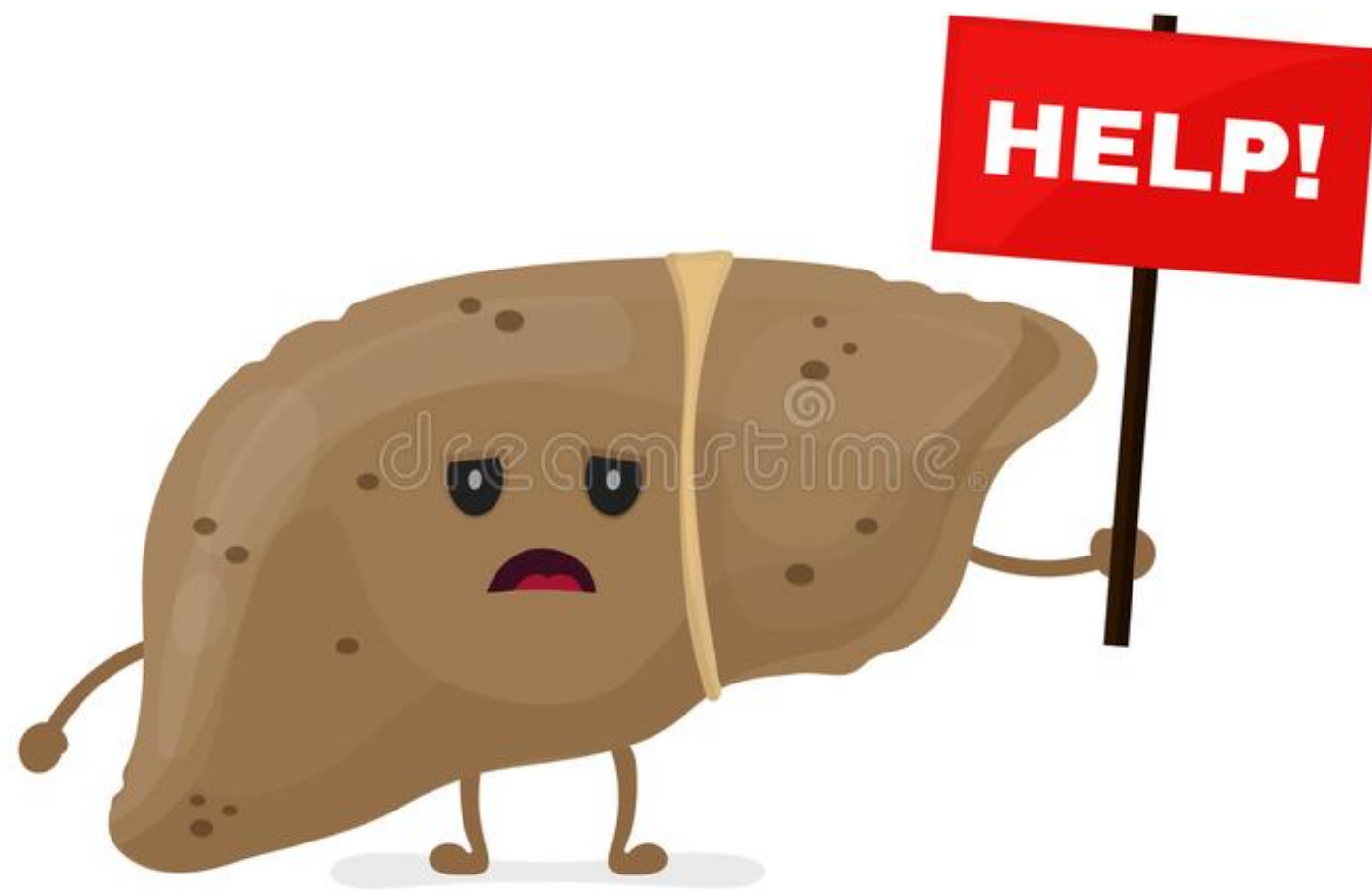


## 4. Detoxification

- The liver breaks down **toxic substances** for **excretion** in urine or bile.
- E.g. alcohol is broken down **acetaldehyde**, catalysed by **alcohol dehydrogenase**.
- **Acetaldehyde** is then converted to harmless **acetic acid** by **acetaldehyde dehydrogenase**.

### Effects of excessive consumption of alcohol:

- Alcohol irritates oesophageal, stomach and intestinal linings, leading to inflammation and ulcers
- When liver cells are inflamed and damaged, liver cells are replaced with fibrous scar tissues. This is called liver cirrhosis.
- Liver function is lost - reduced ability of previous 6 functions has very serious complications
- Alcohol is also a depressant, which inhibit the central nervous system (CNS), impairs and slows the activity of the brain and nervous system leading to a slower reaction time and reduced self control.
  - Greater risk taking and poor decision making
  - vulnerable to unintentional accidents and injuries.



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