

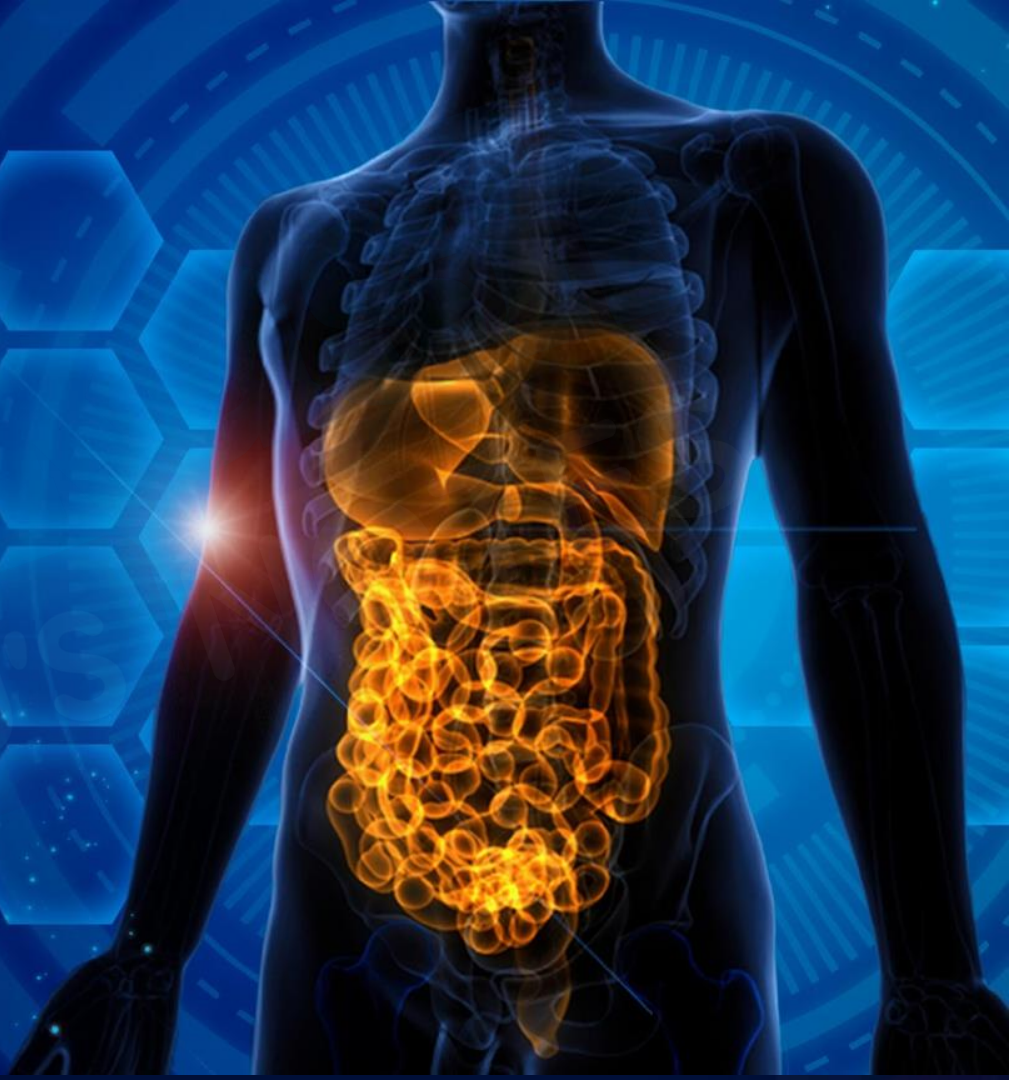


# Aakash



BYJU'S NOTES

## Human Physiology: Digestive system





# Key Takeaway





**Oesophagus**

**6**

**7**

**Stomach**

Muscles

**Small intestine**

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**Large intestine**

Functions

**Layers of the alimentary canal**

**10**



## Digestive glands

Salivary glands

Liver

Pancreas

Gastric glands

Intestinal glands

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## Digestion

In oral cavity

In stomach

In small intestine

## Digestive hormones

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## Absorption of nutrients



**Assimilation of nutrients**

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**Egestion**

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**Balanced diet**

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**Disorders of the digestive  
system**

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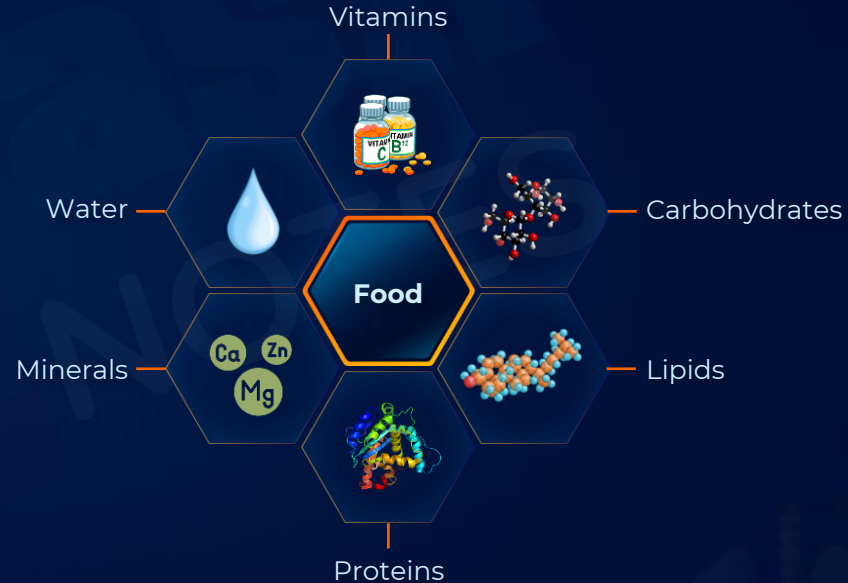
**Summary**



# Nutrients



- The word 'nutrient' is derived from the Latin word '**nutritio**', which means 'to nourish'.
- Nutrients are the **chemical substances** present in food.
- They are required by living organisms for the **growth** and **maintenance of bodily functions**.
- **Nutrition** is the process by which a living organism obtains nutrients that are necessary for their growth and maintenance.





# Nutrients



## Types of nutrients

### Based on constituents

#### Organic

- These are the compounds that **contain carbon**.
- These include carbohydrates, lipids, proteins, and vitamins.

#### Inorganic

- These are the compounds that **contain metal and other elements**.
- These include minerals and water.



# Nutrients

## Based on amount required

### Macronutrients

- These are required by the body in **large quantities**.
- These are involved in the synthesis of various compounds required by the body.
- Examples: Carbohydrates, fats, and proteins.

### Micronutrients

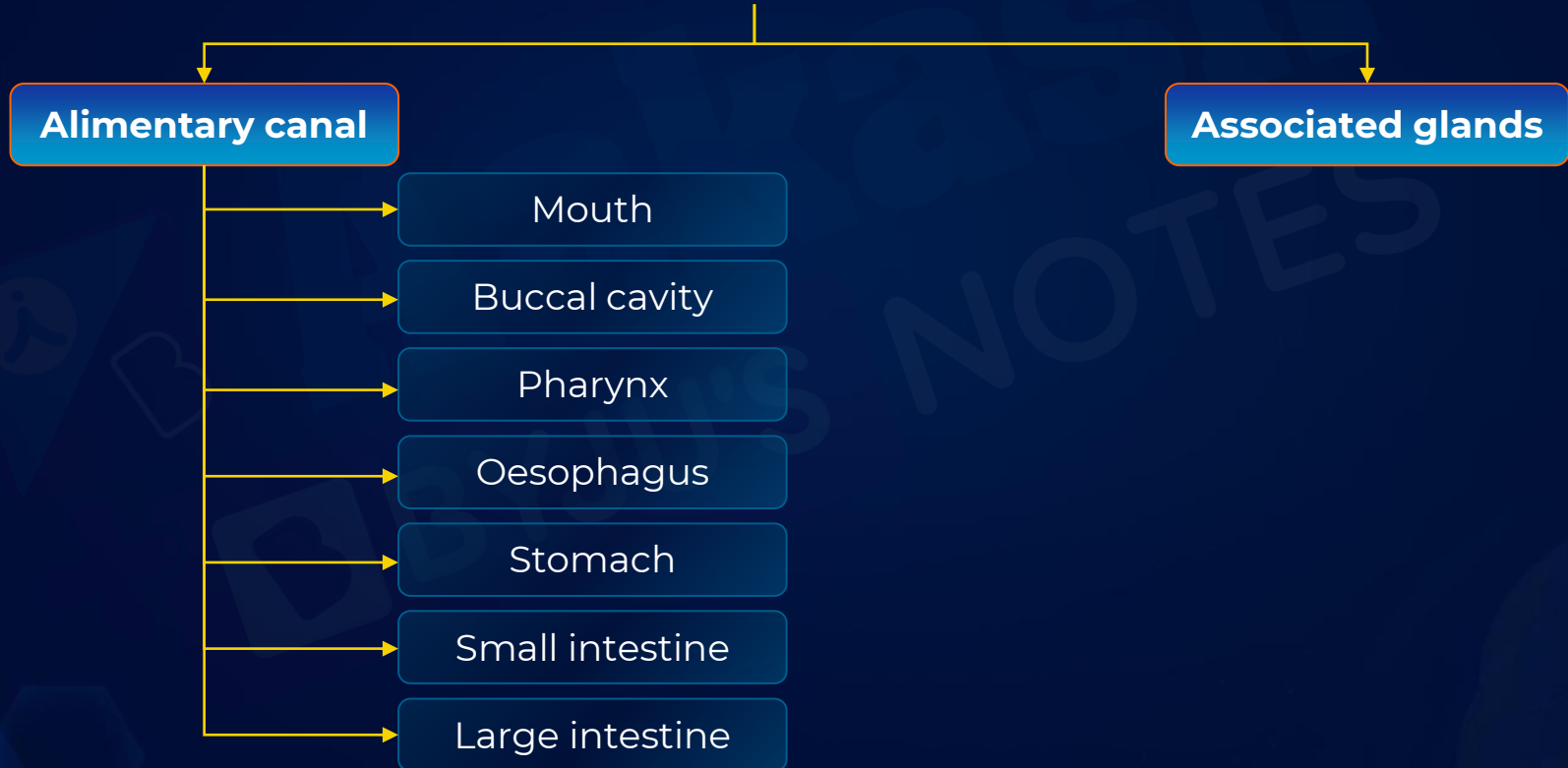
- These are required by the **body in less or minute quantities**.
- These are involved in the regulation of metabolism.
- Examples: Vitamins and minerals.



# Digestive System



**Digestion** is the breakdown of large food molecules into small food molecules.

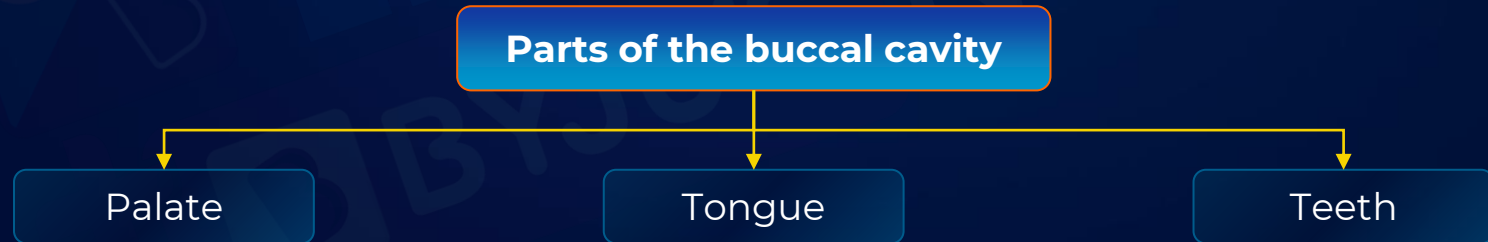




# Mouth & Buccal Cavity



- It is a transverse **opening** to the alimentary canal present below the nose and above the chin.
- It is bound by **two movable lips**, the **upper** and the lower lips.
- Mouth leads to the **buccal cavity** or the oral cavity.



**Roof of  
the buccal cavity**

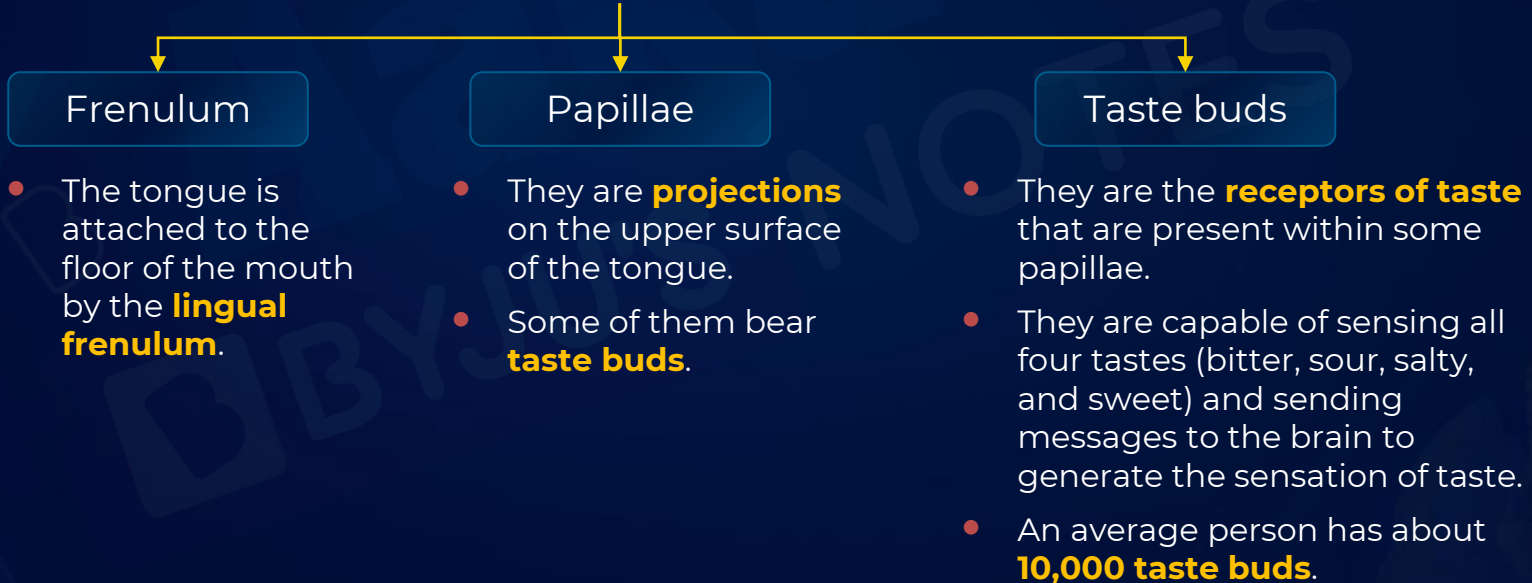


# Buccal Cavity



## Tongue

- It is a **freely movable muscular** organ that occupies the floor of the mouth.
- It is flat, voluntary, and sensory in function.





# Buccal Cavity



## Tongue

### Functions

- It helps in **chewing** the food.
- It aids in **swallowing** the food.
- It is an organ of **taste**.
- It acts as a brush to **clean the teeth**.
- It plays an important role in **speech**.

### Myth buster box

- The common assumption that the human tongue is divided into different taste areas is a myth.
- The ability to sense different tastes - sweet, salty, sour and bitter - is not allocated to different parts of the tongue.
- The taste receptors that pick up these tastes are actually distributed all over the tongue.



# Buccal Cavity

- They are **hard structures** that are present in the form of **two semicircles** embedded in the socket of the jaw bone.
- They are **ecto-mesodermal** in origin.
- They have several uses such as gripping, cutting, gnawing, tearing, and crushing.

## Teeth





# Buccal Cavity



## Teeth

### Types of dentitions

#### Heterodont

Presence of different types of teeth in the oral cavity

Example: Human beings, cheetah.

#### Homodont

Presence of a single type of teeth in the oral cavity

Example: Dolphins

**Note: In elephants, the upper incisors are modified into curved tusks.**

### Types of human teeth

#### Incisors

- Eight in number
- Chisel shaped
- Shaped for cutting

#### Premolars

- Eight in number
- Bicuspid (two cusps at the crown)
- Shaped for chewing and crushing

#### Canines

- Four in number
- Dagger shaped
- Shaped for ripping and shredding

#### Molars

- Twelve in number
- Upper jaw has 3 roots and lower jaw has 2 roots
- Shaped for chewing, crushing, and grinding



# Buccal Cavity



## Teeth

### Types of teeth based on placement in jaw

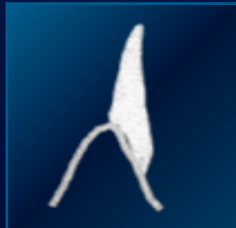
#### Thecodont

Teeth in bony socket of jawbone.  
E.g.: Man, crocodile.



#### Pleurodont

Teeth on the lateral side of jawbone.  
E.g.: Reptiles.



#### Acrodont

Teeth on the terminal part of jawbone.  
E.g.: Amphibians, fish.





# Buccal Cavity

## Teeth

### Monophyodont

- Teeth **appear only once** in life
- E.g. Last molar in man (wisdom teeth).

### Diphyodont

- Bear **two sets of teeth during the life**, one set of temporary teeth which are replaced by permanent teeth.

### Polyphyodont

- Teeth which **appear more than twice** in life.
- E.g. – Sharks.

### Temporary/Milk/Deciduous teeth

- Fully developed by the age of two to three years.
- **20 in number**, eight incisors, four canines and eight molars.
- Premolars are absent.

### Permanent teeth

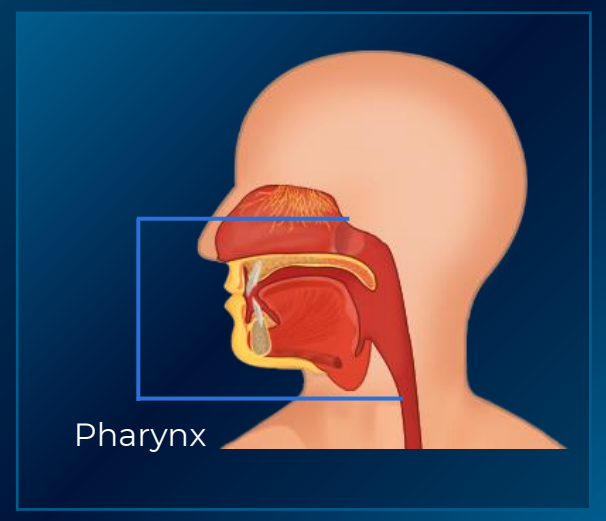
- Replace the temporary teeth
- **32 in number** with eight incisors, four canines, eight premolars and 12 molars
- Once broken, cannot be replaced naturally.
- Start forming at the age of six and completely replace the temporary teeth by the age of 12.



# Pharynx



- The oesophagus and trachea open into the pharynx.
- **Functions**
  - It is the **common passage** for food and air.
  - It helps in swallowing.
    - Muscles of the pharynx contract, raising and expanding the pharynx, thus helping in swallowing.
  - It has the **tonsils**.
    - **Tonsils** are the first line of defense against illness.
- **Epiglottis**
  - It is a **cartilaginous flap** located in the throat.
  - It **prevents the food from entering the glottis** (opening of the windpipe) while swallowing.

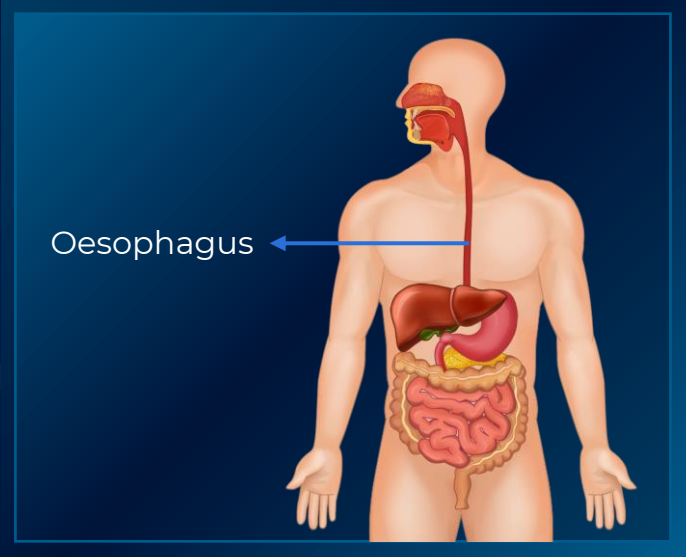


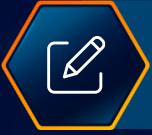


# Oesophagus



- It is a **narrow muscular tube**.
- It extends posteriorly through the neck, thorax, and the diaphragm.
- It is also known as the **food pipe**, or the **food tube**.
- It transfers food from the pharynx to the stomach by **peristalsis**.
  - **Peristalsis** is a series of wave-like muscle contractions that move food.
- Muscles in the oesophagus prevent entry of air into the digestive tract.
- Muscular **gastro-oesophageal sphincter** regulates its opening into stomach.

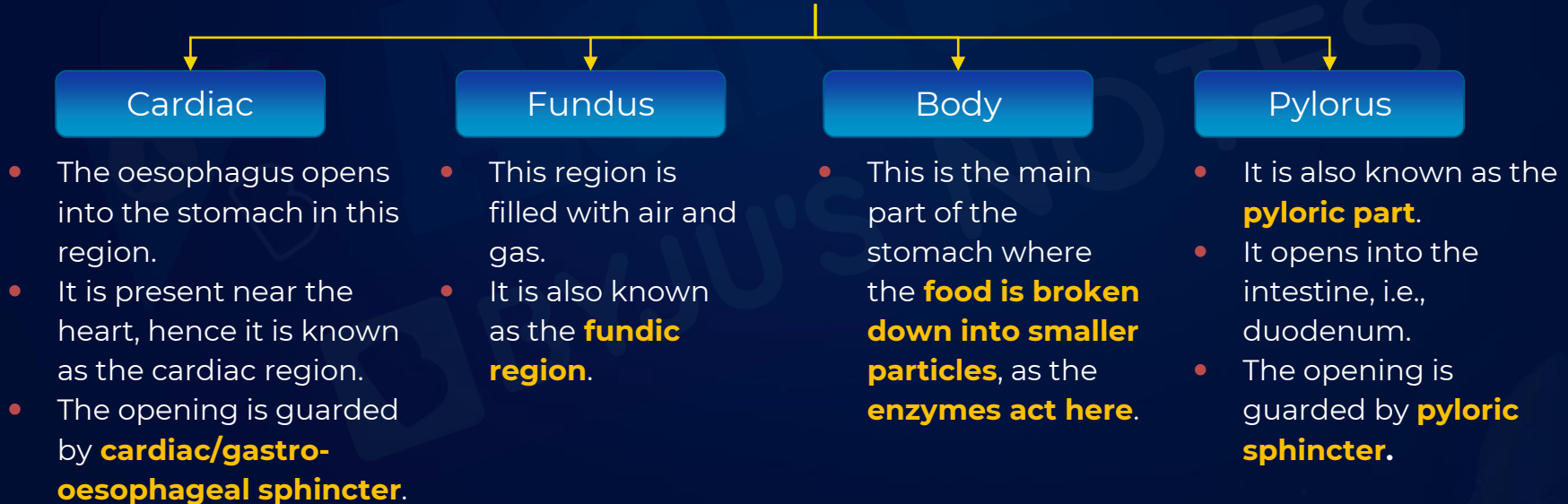




# Stomach



- It is a **J-shaped** bag located in the **upper-left part** of the abdomen.
- It is a **hollow organ** that holds the food.
- It is also known as 'gaster' and plays an important role in digestion.





# Stomach



## Muscles of stomach

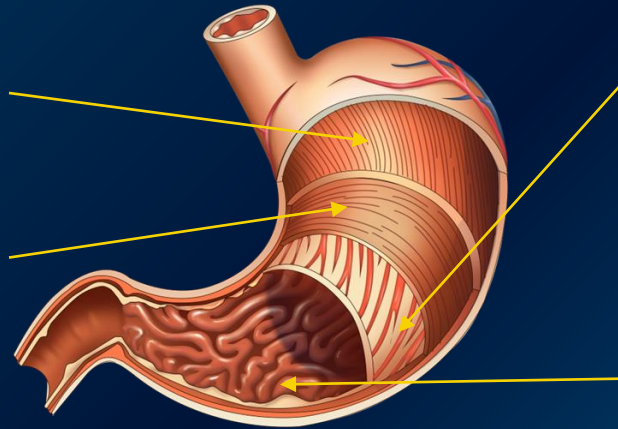
- The churning action in the stomach is brought in by the muscles of the stomach.
  - Physical breakdown of food in the stomach.
  - Formation of chyme.

### Longitudinal muscle

- Runs lengthwise.

### Circular muscle

- Present in a ring-like arrangement.



### Oblique muscle layer

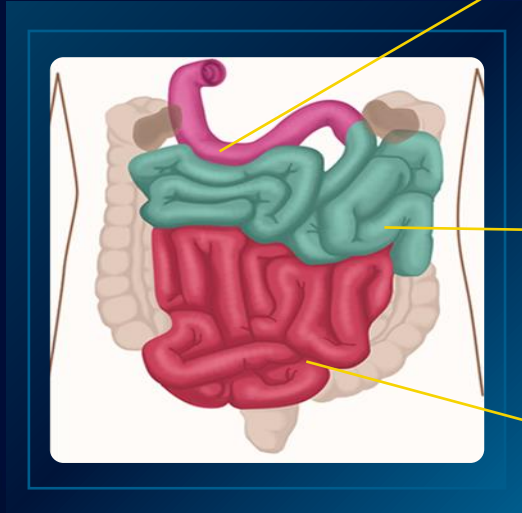
- **Unique** muscle present only in the stomach
- **Aids in digestion**

### Rugae

- **Irregular folds** present in the innermost layer which disappear when distended.



# Small Intestine



**Parts of small intestine**

## Duodenum

- It is the **shortest and widest part** of the small intestine.
- The opening of stomach into duodenum is **regulated by pyloric sphincter**.
- It is **C shaped**.

## Jejunum

- It is the middle part of the small intestine
- It is highly coiled.

## Ileum

- It is the longest part of the small intestine.
- The wall of ileum is thinner than that of jejunum.



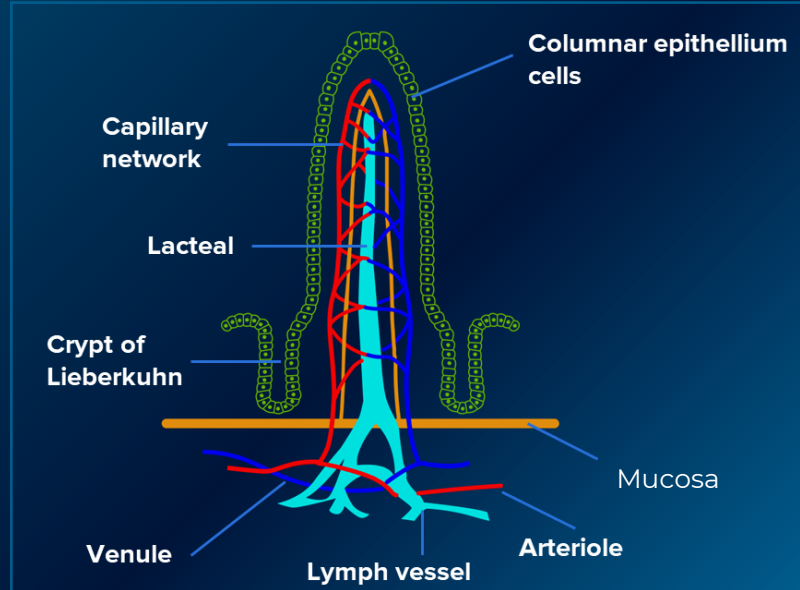
# Small Intestine



## Other parts of small intestine

### Villi

- **Finger-like projection.** present in the small intestine
- Composed of **mucosa** layer
- Increase the **surface area** for absorption
- Covered by **epithelium**, and have **lacteal** (lymph capillary) and **blood capillaries**.





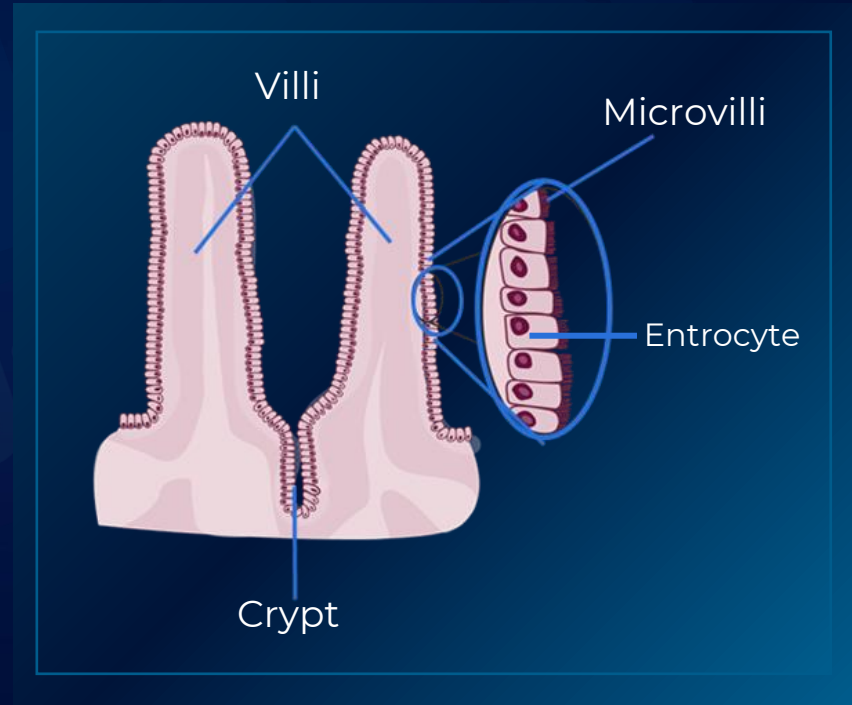
# Small Intestine



## Other parts of small intestine

### Microvilli

- **Microscopic projections** present in a single villus
- Give a brush border appearance
- **Increases** the surface area for absorption of food



### Structuring of microvilli



# Large Intestine

It is known as the large intestine because of its **large diameter**. It is about **1.5 m long**.

## Caecum

- **Pouch-like** structure into which ileum opens
- Host to **symbiotic microbes**
- **Small blind sac** that opens into the colon.
- Has narrow finger-like projection known as **vermiform appendix**
  - **Vestigial organ**
  - Residual part from ancestors with no known function
  - Well- developed in herbivores
  - Inflammation of appendix is known as **appendicitis**

## Colon

- **Reabsorbs fluids**
- **Processes waste products** and prepares for elimination from the body.
- Has the following **four parts**:
  - Ascending colon
  - Transverse colon
  - Descending colon
  - Sigmoid colon

## Rectum

- Last part of the digestive tract
- Descending colon open into rectum
- Ends in **anal canal** that opens through **anus**
- Anus has two sphincters that control **bowel movement**:
  - Internal anal sphincter
  - External anal sphincter
- Voluntary

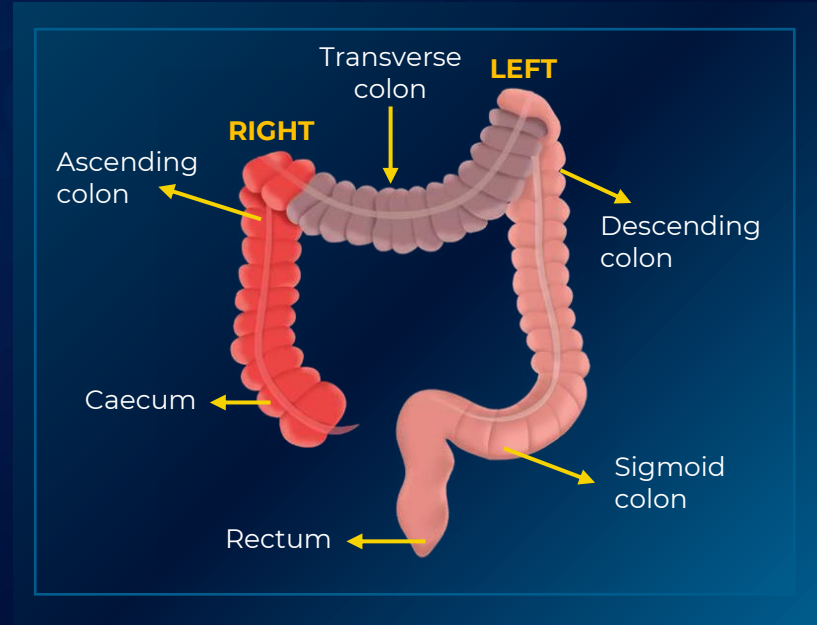


# Large Intestine

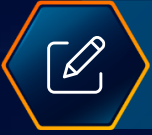


## Functions

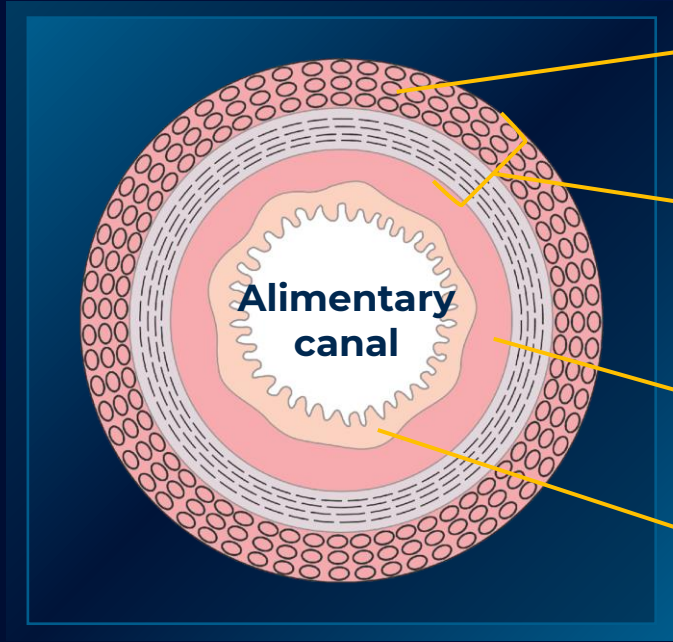
- **Absorption of water and electrolytes**
  - In large intestine, digestion does not occur rather absorption occurs.
  - Colon absorbs water, minerals and some drugs.
- **Elimination of solid waste**
  - Rectum eliminates the food that is not digested as solid waste.
  - Most of the water is reabsorbed by osmosis.
- **Secretion of mucus**
  - Mucus helps in **adhering the waste** particles together and **lubricating** for an easy passage.



**Large intestine structure**



# Layers of the Alimentary Canal



Serosa

Muscularis

Submucosa

Mucosa





# Layers of the Alimentary Canal



## Serosa

- Outermost layer of the stomach.
- Often known as **visceral peritoneum**.
- It is made up of thin squamous epithelium also called **mesothelium**.

## Submucosa

- Made of **loose connective tissues**
- Contains the following:
  - Nerves
  - Blood vessels
  - Lymph vessels
- In duodenum, glands are present in submucosa as well.

## Muscularis

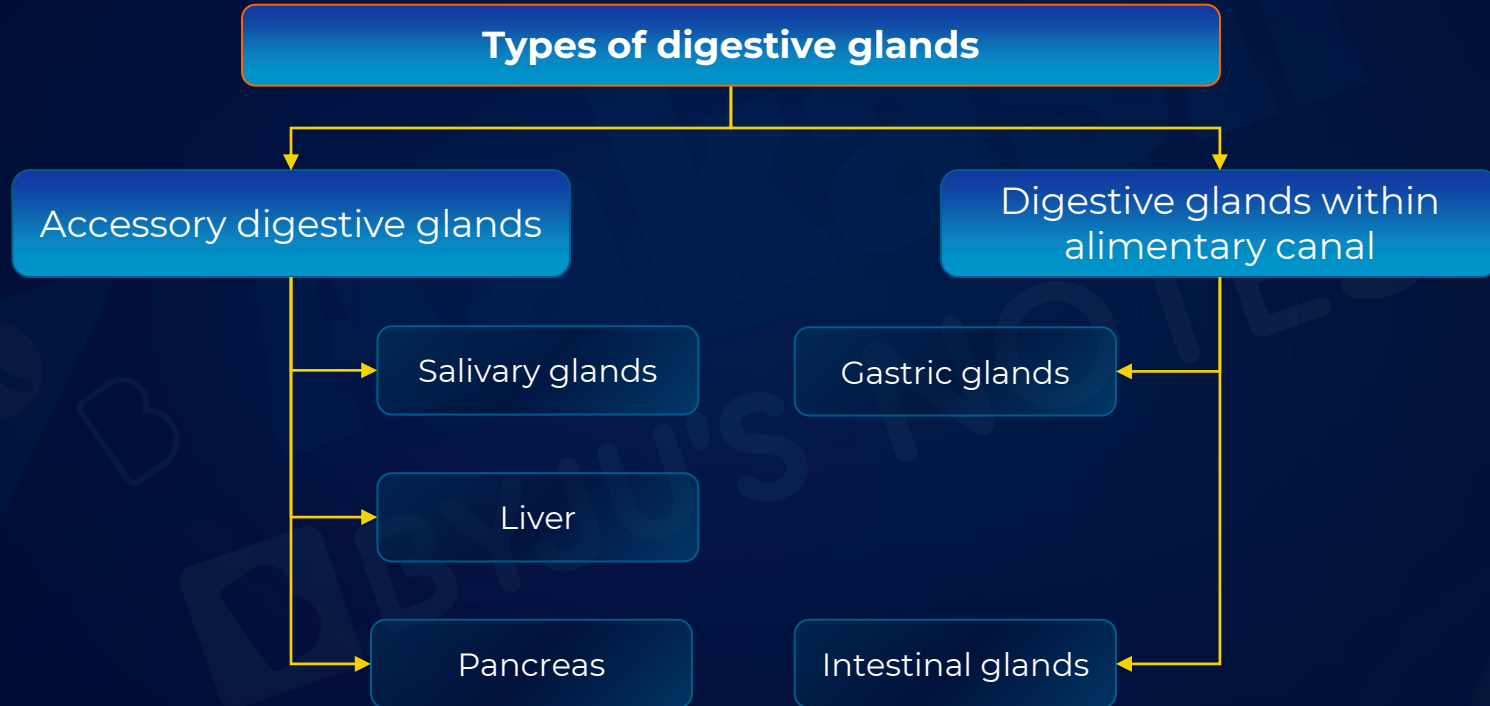
- Formed by **smooth muscles**
- Arranged into inner circular and outer longitudinal layers

## Mucosa

- **Innermost** lining of the lumen of alimentary canal
- Contains **secretory** and **absorptive** cells
- Forms irregular folds known as **rugae** in stomach
- Also forms **villi** and **crypts of Lieberkühn** in small intestine.
- Has **mucus-secreting goblet cells**.
- Mucus helps in **lubrication**.
- Villi have microscopic projection called '**microvilli**'.
- Mucosal epithelium has goblet cells which secrete mucus for lubrication.



# Digestive Glands





# Salivary Glands



- These glands secrete **saliva** into the **oral cavity**.
  - **Saliva** is a watery substance produced in the mouth of certain animals, including humans.
  - It is slightly acidic (**6.8 pH**) and **1-1.5 L** is secreted per day.

## Components of saliva

### Water

- Prevents **drying** of mouth
- **Taste buds** can sense the taste only when the **food is moist**

### Electrolytes

- Act as **buffering agents**

### Lysozyme

- Has **antimicrobial** properties

### Salivary amylase

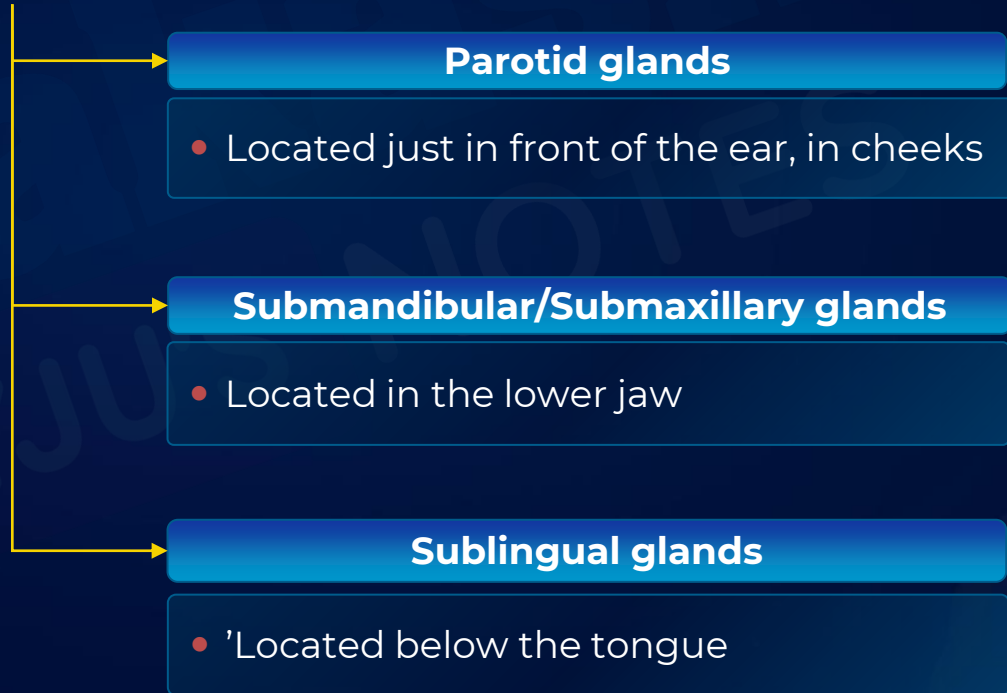
- Helps in the **digestion of starch**



# Salivary Glands



There are **three pairs of salivary glands** at different locations.

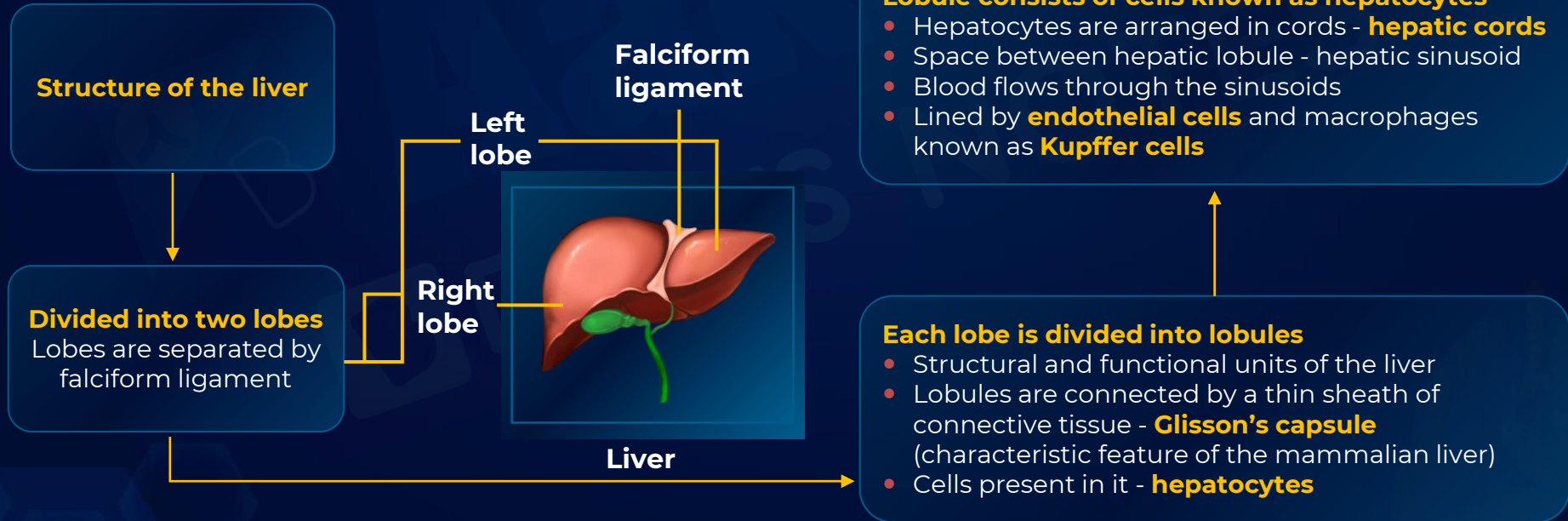




# Liver

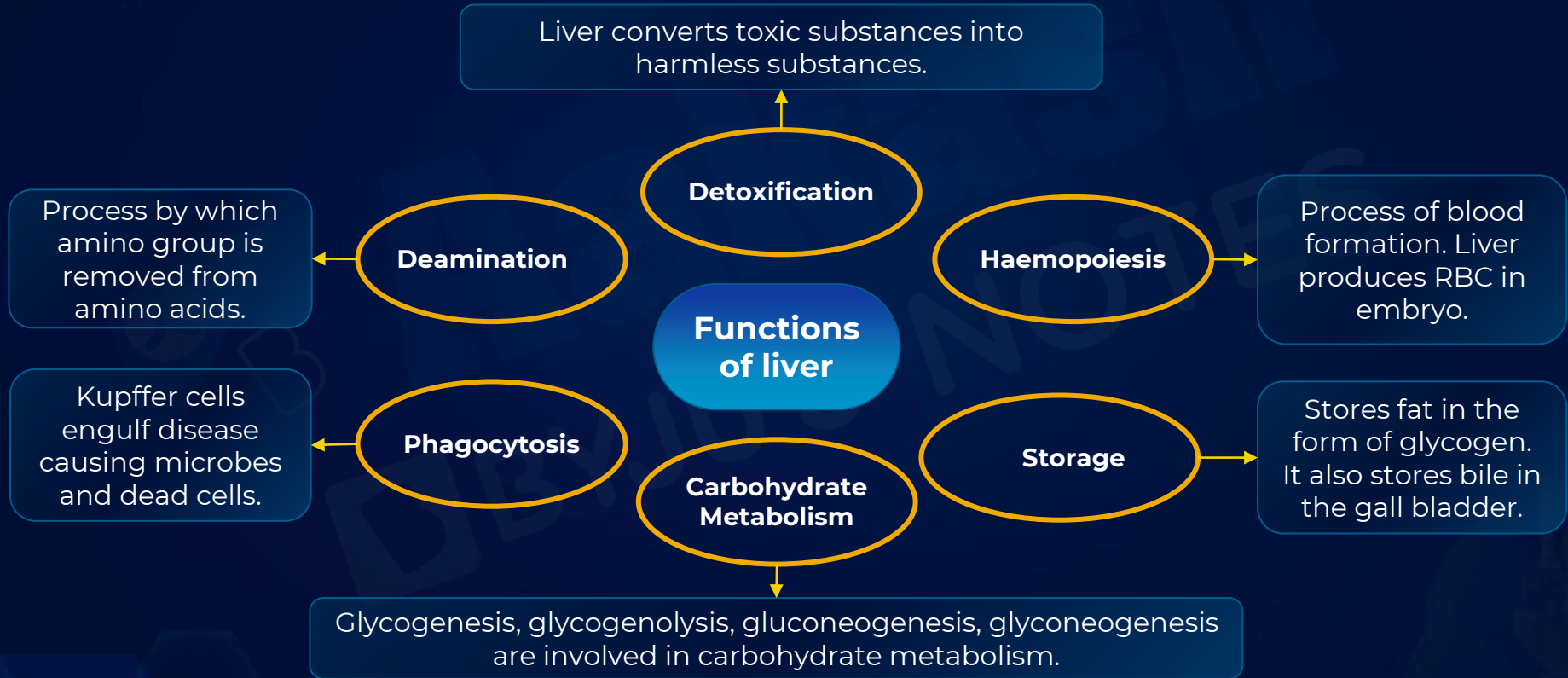


- It is the **largest gland** of the human body (weight: 1.2-1.5 kg in adults).
- It plays a crucial role in digestion.
- It is located in the **upper right side** of the abdominal cavity.





# Liver

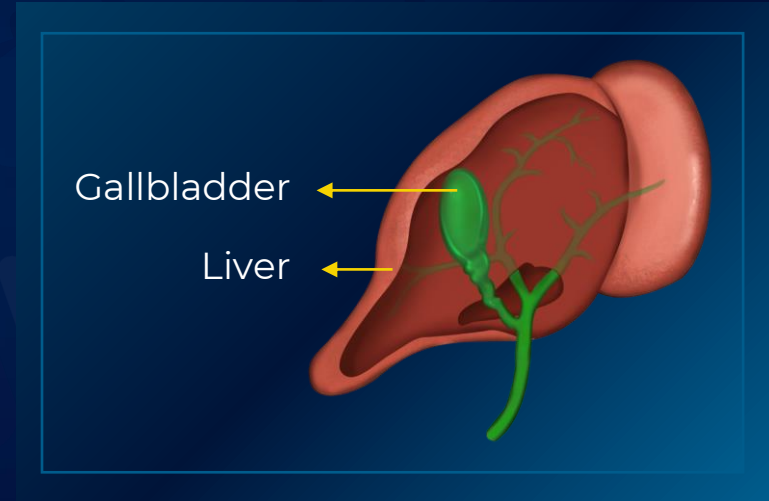




# Bile



- It is secreted by the liver cells or **hepatocytes**.
- It is stored in the **gallbladder**.
  - It is a **pear-shaped** organ attached to the posterior surface of the liver by the connective tissues.
  - It acts as a **concentrating reservoir** for bile.





# Pancreas



- The pancreas secretes **enzymes** and **hormones** that help in digestion.
- The pancreas is a **compound organ**, i.e., it functions as both an **exocrine** and **endocrine gland**.
- **The exocrine pancreas**
  - The exocrine part of the pancreas secretes an alkaline pancreatic juice.
  - Composition of the pancreatic juice
    - Sodium bicarbonate
    - Trypsinogen
    - Chymotrypsinogen
    - Procarboxypeptidase
    - Pancreatic lipase
    - DNase
    - RNase



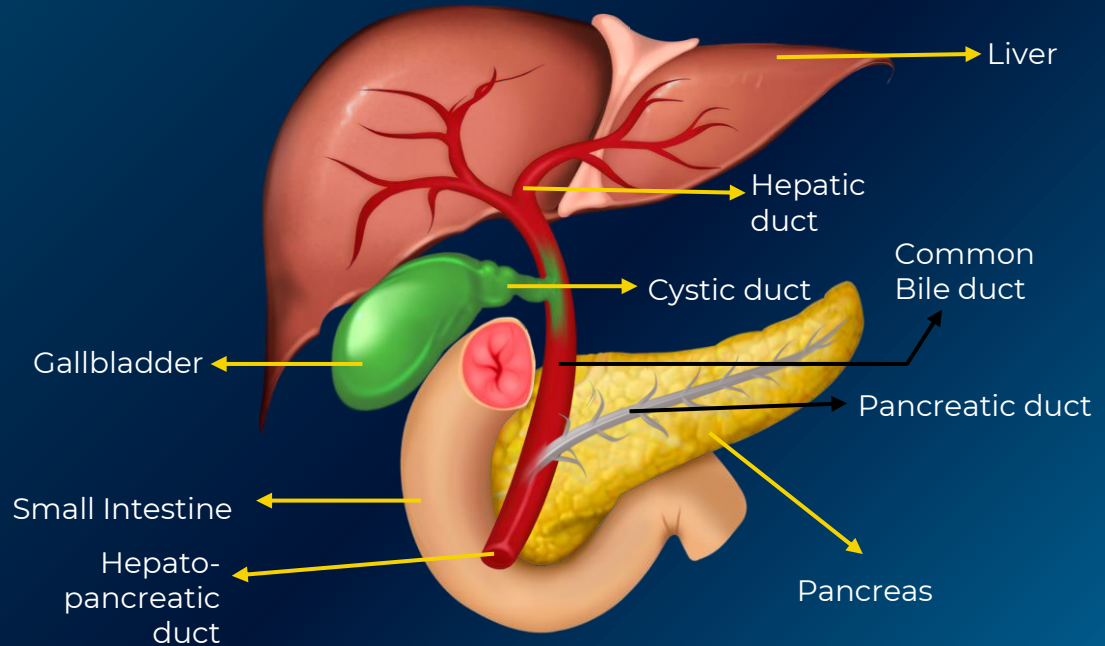
# Ducts of the Liver and the Pancreas



1. The bile stored in the gallbladder is transported into a **common bile duct** that is formed by the joining of **hepatic duct** (duct of the liver) and **cystic duct** (duct of the gallbladder).

2. The common bile duct and the pancreatic duct join together to form the **hepato-pancreatic duct**. It is guarded by **sphincter of Oddi**.

3. The bile flows through the hepato-pancreatic duct into the **duodenum**.

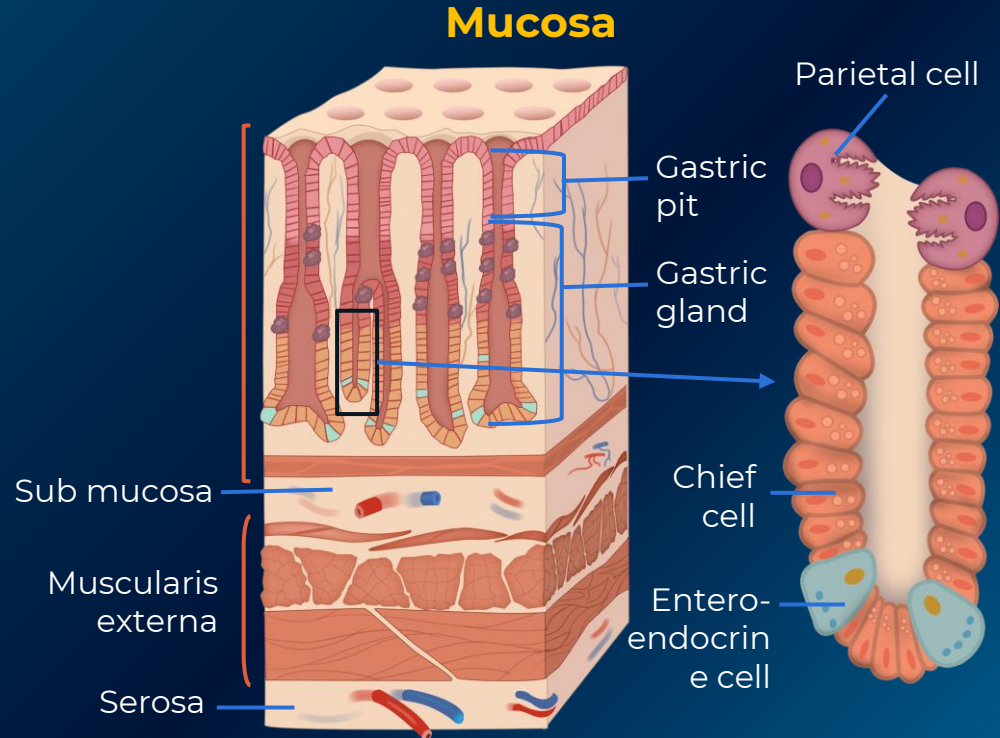


Ducts of the bile and pancreatic juice



# Gastric Glands

- They are part of the alimentary canal.
- They are present in the **mucosal regions**.
- They are **tubular glands** formed by the epithelium of the stomach.
- These are the glands that secrete **enzymes** necessary for digestion.





# Gastric Glands



## Cells of the mucosa

### Goblet/ Mucus neck cells

- Present throughout the epithelium
- Secrete mucus
- Mucus protects the stomach lining from the strong acids in the stomach

### Chief/ Peptic cells

- Secrete the enzyme **pepsinogen**
- Secretions of the chief cells aid in the digestion of proteins

### Oxyntic/ Parietal cells

- Secrete **hydrochloric acid** (HCl)
- HCl provides the acidic environment required for the activation of pepsinogen
- Oxyntic cells also secrete the **Castle's intrinsic factor**
- The intrinsic factor helps in the absorption of vitamin B<sub>12</sub>

### Enteroendocrine cells

## Pepsinogen

- Pepsinogen is an **inactive enzyme**.
- The common term given to the inactive precursor of an enzyme is **zymogen** and pepsinogen is a zymogen released by the chief cells.
- Pepsinogen is activated by the acidic medium provided by **HCl**.

**Gastric juice = Mucus +  
Pepsinogen + Hydrochloric  
acid**



# Intestinal Glands

**Epithelial cells of the small intestine are modified into intestinal glands**

## **Crypts of Lieberkuhn**

- Simple tubular structures
- Occur throughout the small intestine between the villi
- Cells found in the lining
  - i. Enteroendocrine cells (Produce hormones)
  - ii. Goblet cells (Secrete mucus)
  - iii. Paneth cells (Unicellular cells found in the mucosal layer of the crypts of Lieberkuhn of the jejunum and they secrete antimicrobial proteins)

## **Brunner's glands**

- Found only in the submucosal layer of the duodenum
- Synthesise and secrete the non-enzymatic alkaline secretion of the intestinal juice
- Also secrete enzymes and mucus
- Mucus protects the duodenal wall from the effects of digestion
- Open into the crypts of Lieberkuhn



# Digestion



- The process of **mechanical** and **chemical** breakdown of the complex nutrients into simpler nutrients is known as digestion.

## Types of digestion

### Chemical digestion

Involves 4 classes of digestive enzymes

Carbohydrases

Proteinases

Lipases

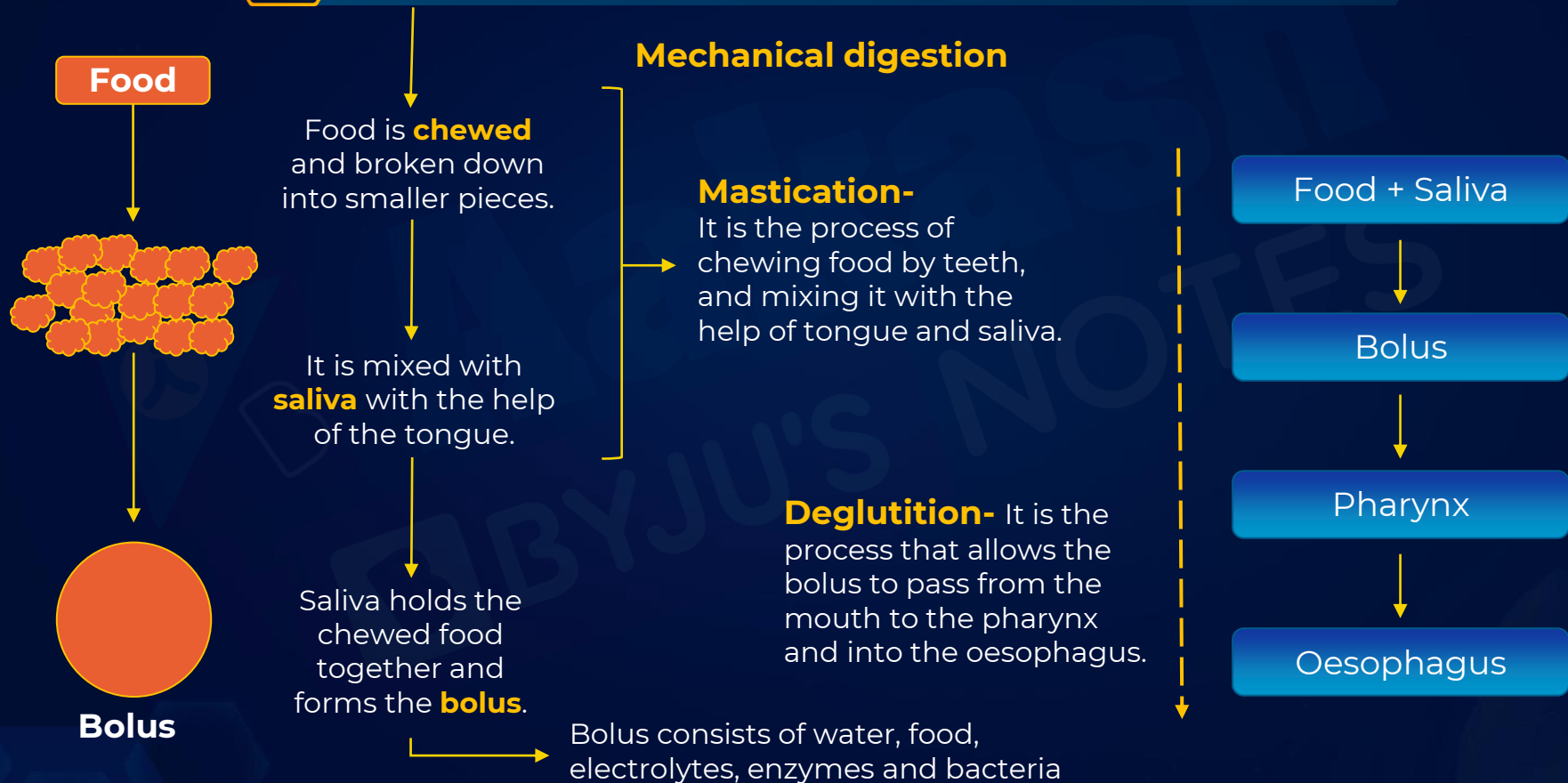
Nucleases

### Mechanical digestion

- The digestion that involves the **mechanical breakdown of food** is known as mechanical digestion.
- It **does not involve enzymes**.
- It helps to **reduce the size** of the food particles. This aids in the smooth movement of the particles through the alimentary canal.
- Mouth** and the **stomach** aids in the mechanical digestion.



# Digestion in Oral Cavity



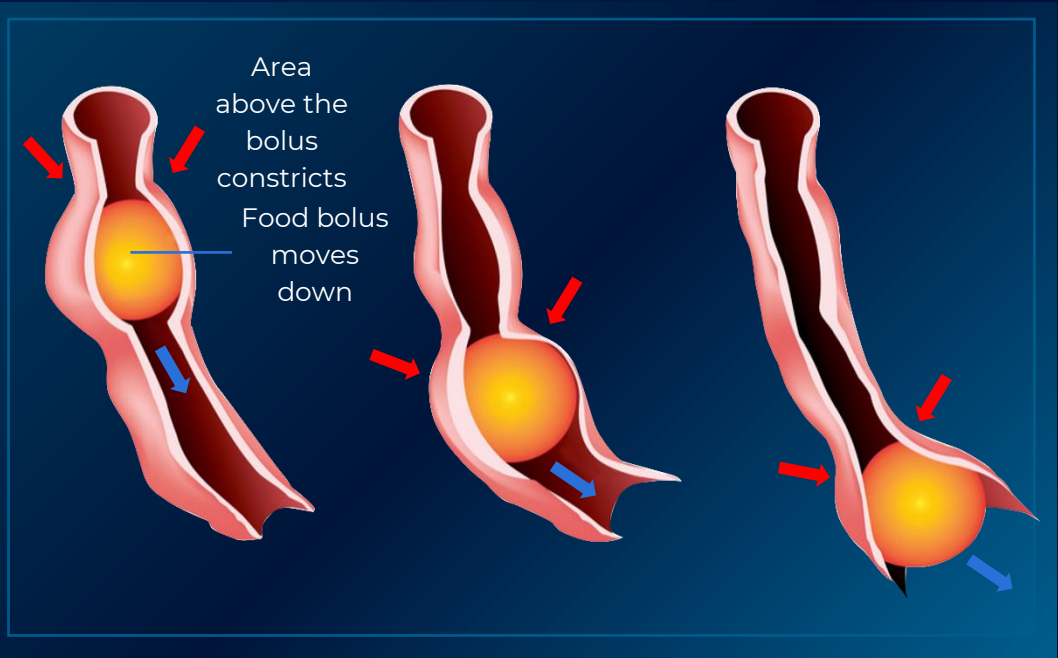


# Digestion in Oral Cavity



## Digestion in oesophagus

- The process of contraction and relaxation of the oesophagus to move the bolus down the oesophagus is known as **peristalsis**.
- Breakdown of food **does not occur** in the oesophagus.



## Process of peristalsis



# Digestion in Oral Cavity

## Chemical digestion

Chemical digestion in the oral cavity	
<b>Carbohydrates</b>	<ul style="list-style-type: none"><li>• Carbohydrates are long chains of sugar molecules (polysaccharides).</li><li>• Saliva contains enzymes like <b>salivary amylase</b>.</li><li>• It breaks down polysaccharides into simpler forms like monosaccharides.</li><li>• <b>30% of ingested starch</b> is hydrolysed to <b>disaccharide maltose</b> in this step.</li></ul>
<b>Proteins</b>	<ul style="list-style-type: none"><li>• Proteins are chains of amino acids.</li><li>• They are <b>not digested in the oral cavity</b>.</li></ul>
<b>Lipids</b>	<ul style="list-style-type: none"><li>• Lipids are made up of <b>glycerol and fatty acids</b>.</li><li>• They are <b>not digested in the oral cavity</b>.</li></ul>
<b>Nucleic acids</b>	<ul style="list-style-type: none"><li>• Nucleic acids are made up of nitrogenous bases and phosphate groups held by hydrogen bonds.</li><li>• They are <b>not digested in the oral cavity</b>.</li></ul>

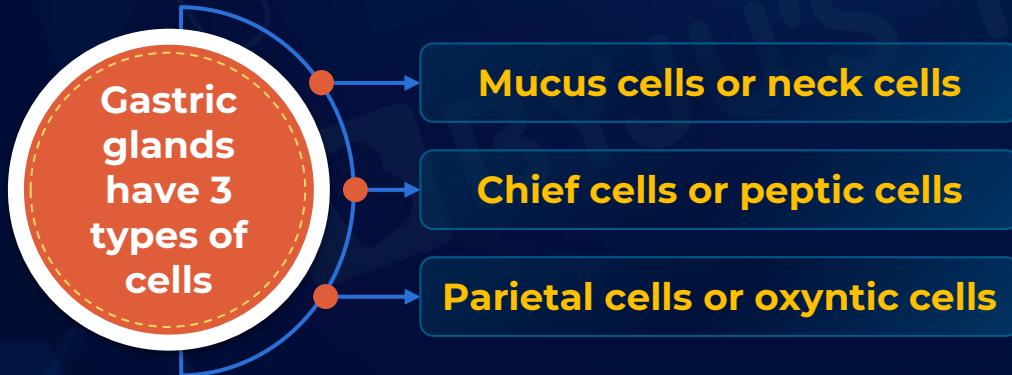


# Digestion in Stomach



## Mechanical digestion

- The stomach stores food for about 4–5 hours.
- The inner wall of the stomach is convoluted
  - Stomach folds up when empty.
  - It swells up like a balloon as it fills with food.
  - The infolded rugae of the stomach allow it to expand to many times its empty size.



**Mechanical digestion**

**Bolus enters the stomach**

**It mixes with gastric juices with the help of the churning of the stomach wall.**

**This results in the formation of chyme.**



# Digestion in Stomach

## Chemical digestion

<b>Carbohydrates</b>	<ul style="list-style-type: none"><li>Carbohydrates are <b>not digested</b> in the stomach.</li></ul>
<b>Proteins</b>	<ul style="list-style-type: none"><li>Proteins are digested by the action of the enzyme known as <b>pepsin</b>.</li><li>Pepsin converts some proteins into <b>proteases and peptides</b>.</li></ul>
<b>Lipids</b>	<ul style="list-style-type: none"><li><b>Lipases</b> are secreted by the gastric glands that bring about little digestion of lipids.</li><li>Lipases act on lipids and break it down into fatty acids and glycerol.</li><li>Not all lipids are broken down in stomach.</li></ul>
<b>Nucleic acids</b>	<ul style="list-style-type: none"><li>They are <b>not digested</b> in the stomach.</li></ul>
<b>Milk proteins</b>	<ul style="list-style-type: none"><li><b>Soluble milk proteins</b> present in the stomach are <b>digested by</b> an enzyme known as <b>rennin/chymosin</b>.</li><li>It acts on soluble milk protein and converts it into insoluble milk protein.</li><li>Further, the insoluble milk proteins are digested by pepsin.</li><li>Rennin is present in the gastric juice of infants.</li><li>As the individual grows up, the quantity of rennin is reduced and pepsin functions as the major enzyme that digests milk proteins.</li></ul>



# Digestion in Small intestine



## Mechanical digestion

- Chyme enters the small intestine through the **pyloric sphincter**.
- The movement of the walls of the small intestine allows the chyme to mix thoroughly with the secretions of the intestine

## Chemical digestion

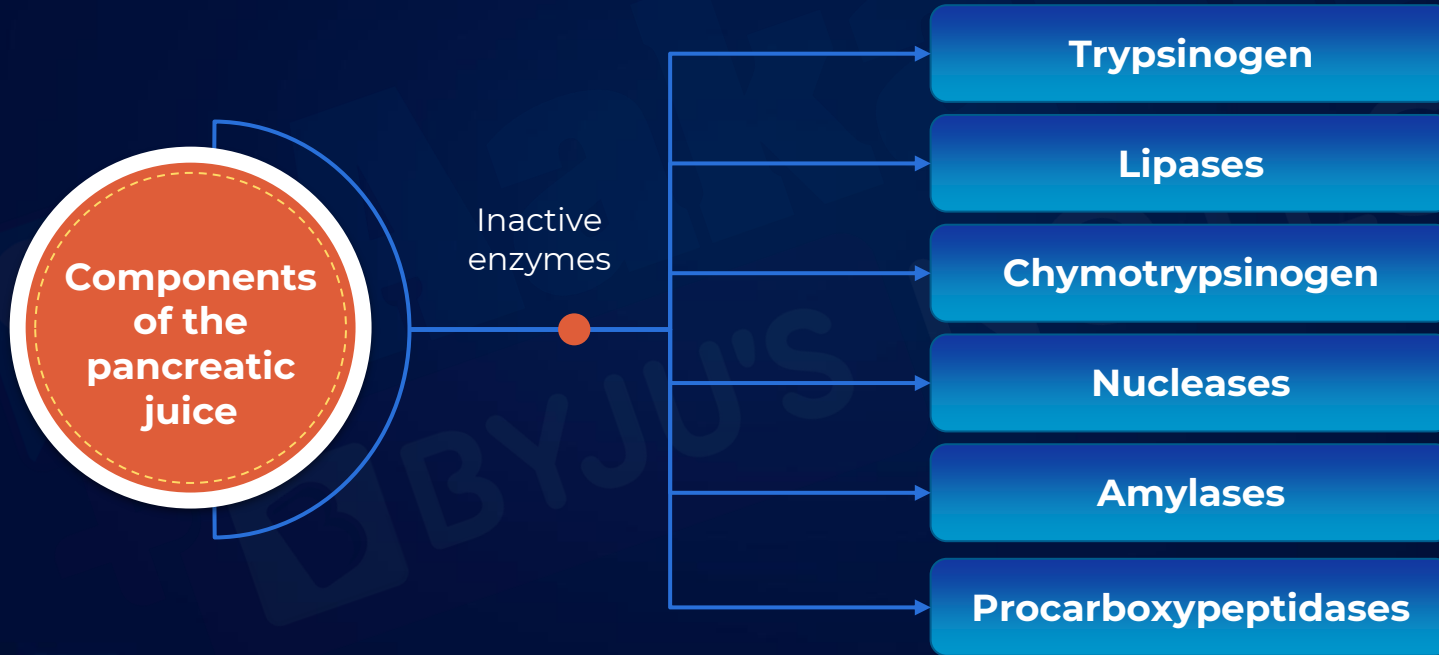
- Pancreatic juice and bile are released into intestine via hepato-pancreatic duct.



# Digestion in Small intestine



## Components of pancreatic juice



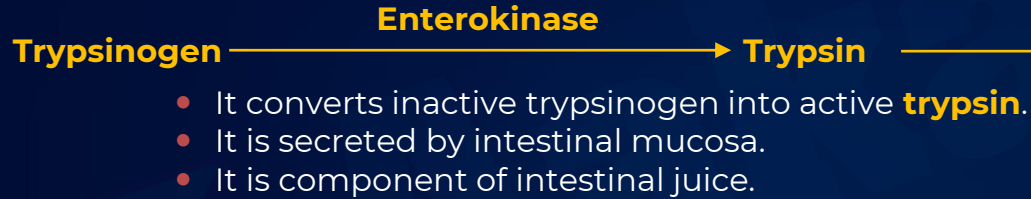


# Digestion in Small intestine

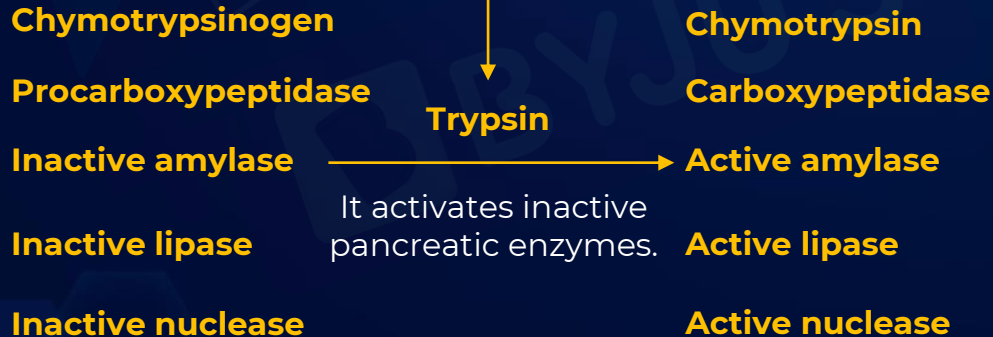


## Activation of pancreatic juice

### Step 1:



### Step 2:





# Digestion in Small intestine



## Bile juice

### Components of bile juice

- The **bile juice** is the other component of the hepatopancreatic juice.
- It does not contain any enzymes but it plays an important role in the digestion of fats.
- Bile juice does not contain any enzymes.
- Bile **helps in emulsification** of fats.
- It also **activates lipases**.





# Digestion in Small intestine



## Chemical digestion by hepatopancreatic juices

<b>Carbohydrates</b>	<ul style="list-style-type: none"><li>• Remaining 70% of the polysaccharides are broken down into disaccharides</li><li>• Achieved with the help of Pancreatic amylase</li></ul>
<b>Proteins</b>	<ul style="list-style-type: none"><li>• Trypsin, chymotrypsin, carboxypeptidase digests proteins, proteoses and peptones</li></ul>
<b>Lipids</b>	<ul style="list-style-type: none"><li>• Digestion of lipids by the hepatopancreatic juices occurs in two stages.</li><li>• Step 1 : Emulsification</li><li>• Step 2 : Action of hepatopancreatic juices</li></ul>
<b>Nucleic acids</b>	<ul style="list-style-type: none"><li>• Nucleic acids are broken down by nucleases in the pancreatic juice.</li><li>• They act on nucleic acids to form nucleotides.</li><li>• Some nucleotides are broken down into nucleosides</li></ul>

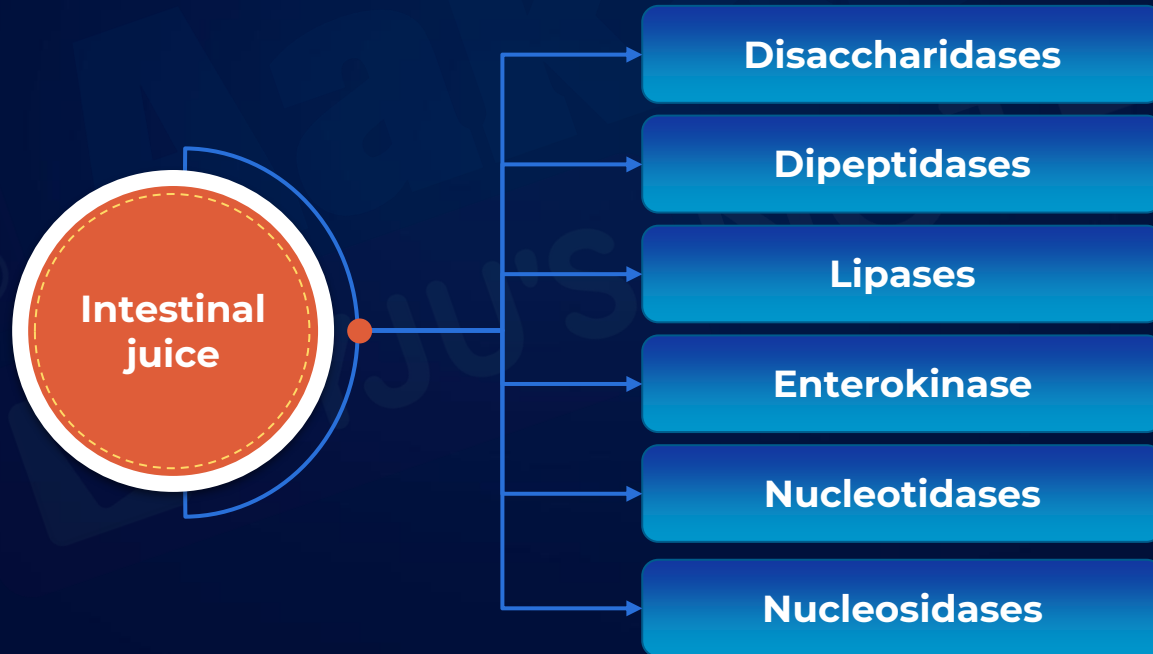


# Digestion in Small intestine



## Action of intestinal juice

- **Intestinal juice/succus entericus** is secreted by the goblet cells and the brush border cells of the intestinal mucosa.





# Digestion in Small intestine



## Chemical digestion by intestinal juices

Carbohydrates	Maltose	Maltase	→	Glucose + Glucose			
	Lactose	Lactase	→	Glucose + Galactose			
	Sucrose	Sucrase	→	Glucose + Fructose			
Proteins	Dipeptides	Dipeptidase	→	Amino acids			
Lipids	Di and monoglycerides	Lipases	→	Glucose + fatty acids			
Nucleic acids	Nucleotides	Nucleotidases	→	Nucleosides	Nucleosidases	→	Sugar+ bases

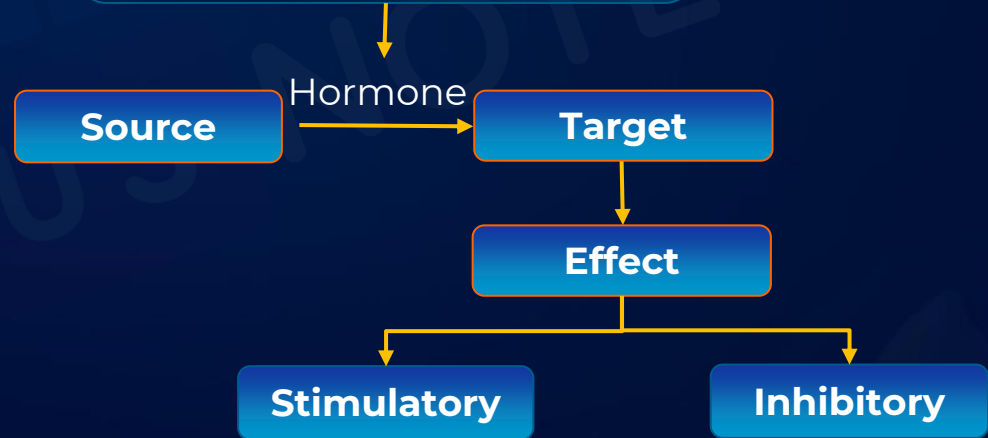


# Digestive Hormones



- Hormones are **chemical messengers** that are produced in **small amounts** in our body.
- They **control and coordinate** various activities in the body.
- The process of digestion is also coordinated by several digestive hormones.

- Hormones are chemical messengers which act on specific targets.
- They can have stimulatory or inhibitory effect on target.





# Digestive Hormones



Source	Hormone	Target	Action
Stomach	Gastrin	Stomach	<ul style="list-style-type: none"><li>• Stimulates secretion of gastric juice</li><li>• Stimulates gastric mobility</li></ul>
Duodenum	Enterogastrone/ Gastric inhibitory peptide	Stomach	<ul style="list-style-type: none"><li>• Inhibits secretion of gastric juice</li><li>• Inhibits gastric motility</li></ul>
Duodenum	Secretin	Pancreas	<ul style="list-style-type: none"><li>• Stimulates release of bicarbonates into pancreatic juice</li></ul>
Duodenum	Secretin	Liver	<ul style="list-style-type: none"><li>• Stimulates secretion of bile</li></ul>
Duodenum	Secretin	Stomach	<ul style="list-style-type: none"><li>• Inhibits gastric secretion and motility</li></ul>
Small intestine	Cholecystokinin/ Pancreozymin	Pancreas Gallbladder	<ul style="list-style-type: none"><li>• Stimulates release of pancreatic juice</li><li>• Stimulates release of bile</li></ul>



# Digestive Hormones



Source	Hormone	Target	Action
Stomach	Serotonin	Stomach	<ul style="list-style-type: none"><li>• Causes contraction of stomach muscle</li></ul>
Stomach, Duodenum	Somatostatin	Stomach Small intestine Gallbladder and liver	<ul style="list-style-type: none"><li>• Inhibits gastric secretion</li><li>• Inhibits intestinal absorption</li><li>• Inhibits contraction and bile release</li></ul>
Stomach	Histamine	Stomach	<ul style="list-style-type: none"><li>• Stimulates parietal cells to release HCl</li></ul>



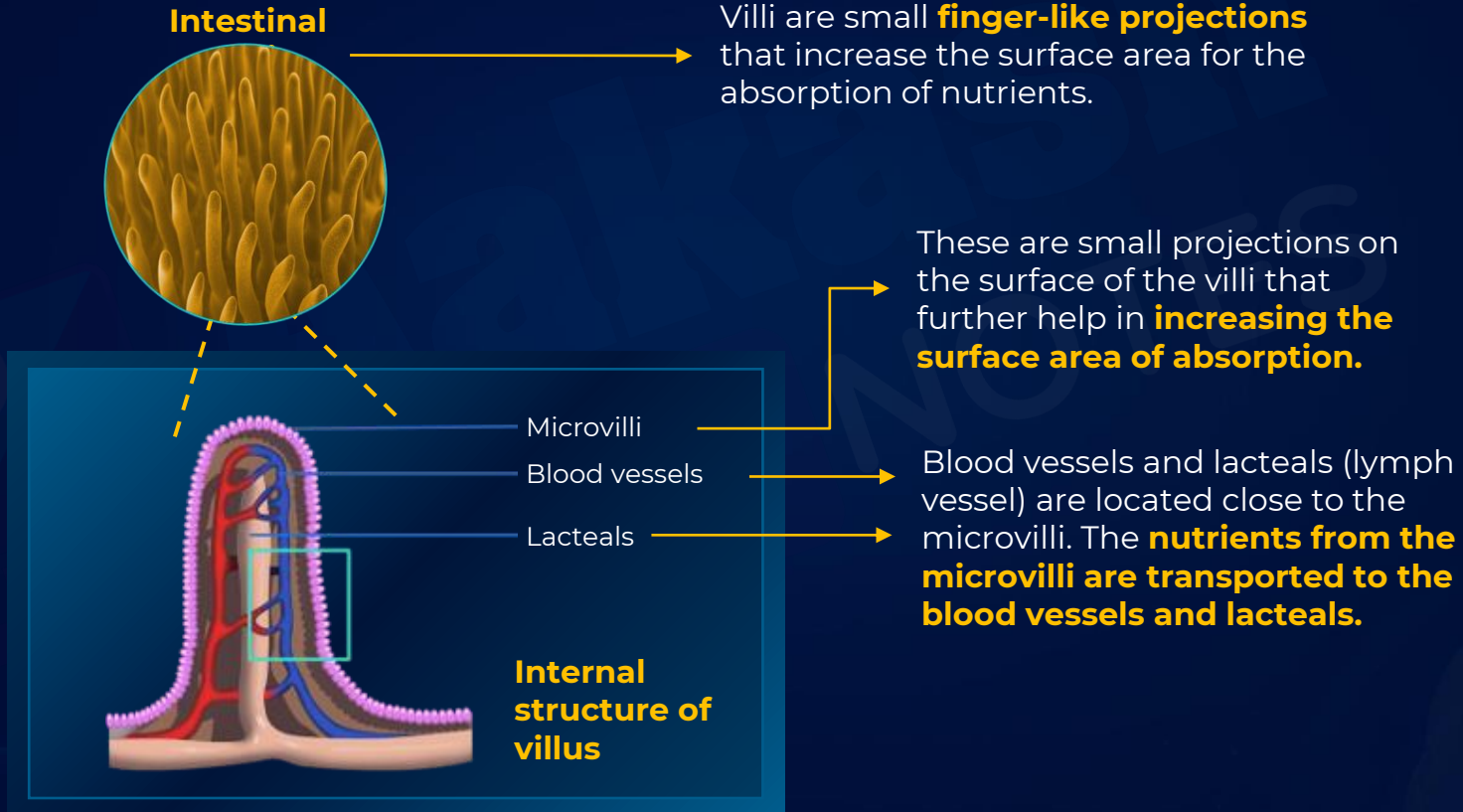
# Absorption of Nutrients



- It is the process by which the products of digestion are passed on from the mucosa of the digestive organs to the blood or lymph vessels.
- The **small intestine** is the **principal organ** for the **absorption** of nutrients.
- The nutrients absorbed in the small intestine are as follows:
  - Glycerol
  - Fatty acids
  - Fructose
  - Glucose
  - Amino acids



# Absorption of Nutrients





# Absorption of Nutrients



Mechanism of absorption in the small intestine			
Nutrients		Transportation from the intestinal lumen to the epithelial cells	Transportation from the intestinal cells to the blood vessels/lacteal
Carbohydrates	Fructose	Facilitated diffusion	Facilitated diffusion into the blood vessels
	Glucose Galactose	Active transport coupled with transport of sodium ions.	Facilitated diffusion into the blood vessels
Amino acids		Active transport	Simple diffusion
Fatty acids and glycerol		<ul style="list-style-type: none"><li>In the lumen, lipid droplets (containing fatty acids and glycerol) combine with <b>bile salts</b> to form <b>micelles</b>.</li><li>Micelles enter epithelial cells by <b>simple diffusion</b>.</li></ul>	<ul style="list-style-type: none"><li>Inside the cells, the micelles form small protein-coated fat globules known as <b>chylomicrons</b>, which are released into the lacteals.</li></ul>

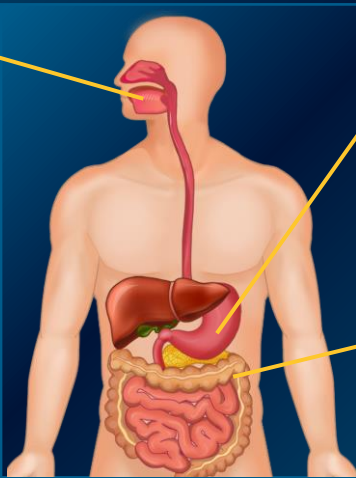


# Absorption of Nutrients



## Buccal cavity

- Not much absorption occurs here.
- Certain drugs are absorbed into the blood capillaries, lining the **mucosa of mouth** and the **lower side of the tongue**.



## Stomach

Alcohol, water and simple sugars

## Large intestine

Water, minerals and some drugs



Mucosa of the mouth



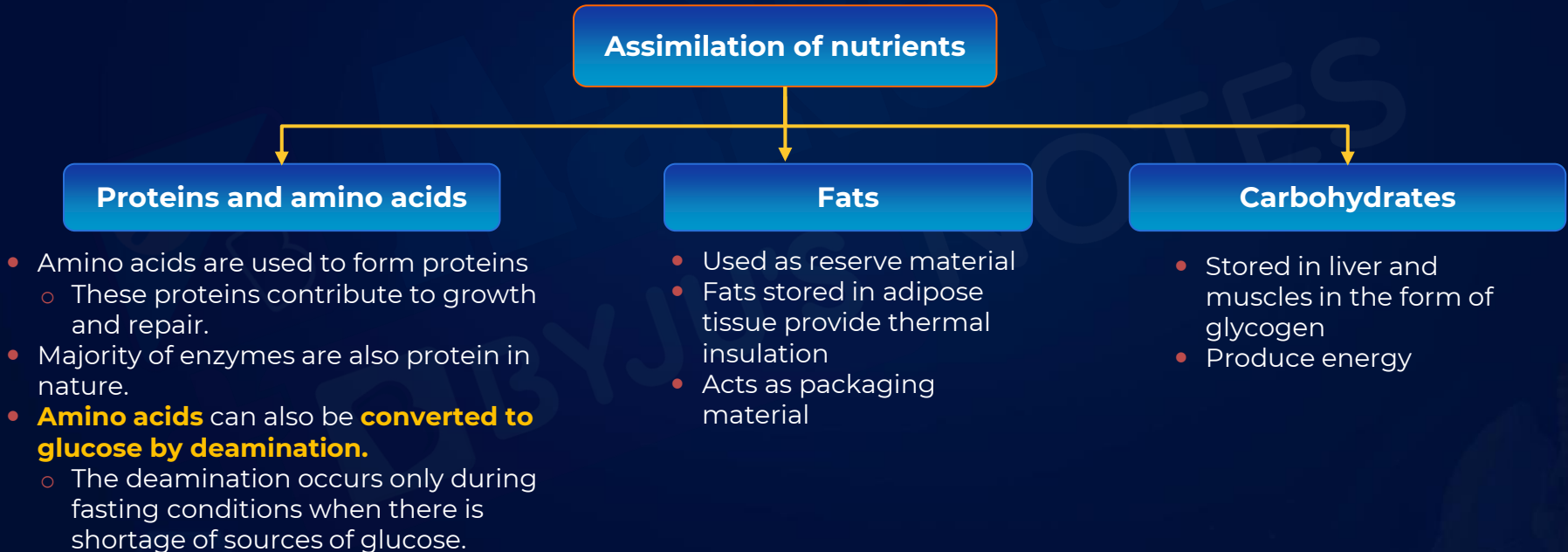
Lower side of the tongue



# Assimilation of Nutrients



- It is the process by which **absorbed substances** reach **tissues in the body that utilise** them in carrying out various functions.

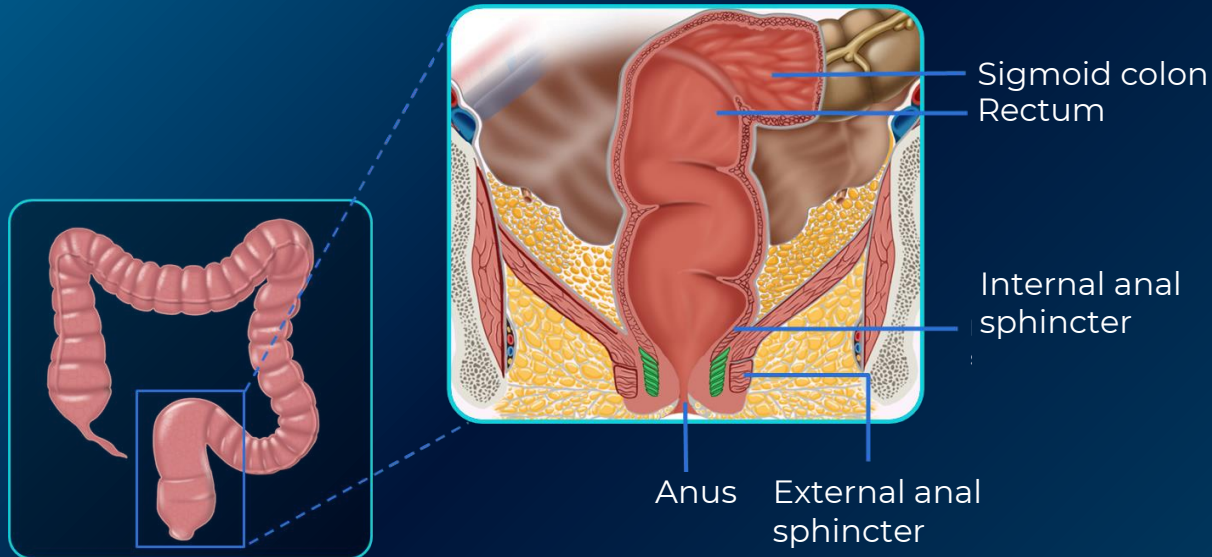




# Egestion



- It is the process by which undigested wastes are removed from the body.
- As chyme passes through the large intestine, it gets converted into the semi-solid **faeces** that enter the rectum through the sigmoid colon.





# Egestion



## Large intestine

- The rectum opens into the anus, which is guarded by the **internal and external anal sphincters**.
- As the faeces reach the rectum, they cause a movement of the rectal wall.
- This initiates a neural reflex known as **defecation reflex**, causing an urge or desire for its removal.
- The involuntary relaxation of the internal anal sphincter and a **voluntary relaxation of the external anal sphincter** causes defecation.
- It occurs with the help of a **mass peristaltic movement**.



# Calorific Value



- The **calorific value of food** is the total **amount of energy** that the body could generate during the metabolism of food.
- Calorific value is expressed in the units of **calorie (cal) or joule (J)**.
- **One calorie** or **one joule** is the amount of heat energy required to raise the temperature of **1 g of water by 1°C**.
- Calorific value may also be expressed in kilocalorie (**kcal/calorie**) or kilojoule (**kJ/joule**).
- One kilocalorie is the amount of energy required to raise the temperature of **1 kg of water by 1°C**.

1000 cal/J

=

1 kcal/1kJ

=

1 calorie/joule

- The actual amount of energy of combustion of **1 g of food** is the **physiologic value of food**.



# Calorific Value



	Proteins	Carbohydrates	Fats
<b>Gross calorific/energy value</b> (Amount of heat liberated from the complete combustion of <b>1 g of food</b> in a bomb calorimeter)	5.65 kcal/g	4.1 kcal/g	9.45 kcal/g
<b>Physiological calorific/energy value</b> (Actual amount of heat liberated from the complete combustion of <b>1 g of food</b> )	4.0 kcal/g	4.0 kcal/g	9.0 kcal/g



# Balanced Diet



- A balanced diet is a diet that fulfils all of an **individual's nutritional needs**.

Components of a balanced diet	
Nutrients	Source
Carbohydrates	Grains like wheat and rice, fruits, and vegetables.
Fats	Cooking oils, nuts, milk, egg yolk.
Proteins	Milk, eggs, meat, fish, pulses.
Vitamins and minerals	Fruits, vegetables, milk, pulses, eggs, meat.



# Disorders of the Digestive System



- Digestive system disorders include:
  - Inflammation of the intestinal tract that may be caused due to bacterial, viral, or parasitic infections (tapeworm, roundworm, threadworm, hookworm, pinworm, etc.)
  - Liver dysfunction
  - The deposition of bile pigments causes the yellowing of the skin and eyes

## Disorders of digestive system



### Vomiting

- It is the emptying of the contents of the stomach through the mouth.
- It may be preceded by the feeling of **nausea** (uneasiness in the stomach).
- The reflex action of vomiting is controlled by the **vomit centre** in the medulla of the brain.
- Causes: Food poisoning, infections, overeating etc.



# Disorders of the Digestive System



## Disorders of digestive system

### Jaundice

- Liver dysfunction
- Yellowing of skin and eyes observed due to deposition of bile pigments

### Diarrhoea

- It is the abnormal frequency of bowel movement.
- Faecal matter appears watery
- Reduces absorption of food
- Causes: Food poisoning, imbalance in microbiota etc.

### Constipation

- This is a condition when hard faeces are retained in the colon.
- Bowel movements occur irregularly
- Causes: Dehydration, lack of exercise etc

### Indigestion

- It is the improper digestion of food.
- It may also generate the feeling of fullness.
- Causes: Inadequate enzyme secretion, anxiety, food poisoning, overeating, spicy food etc.



# Protein-Energy Malnutrition



## Protein-energy malnutrition

- Dietary deficiency of proteins and calories
- Prevalent in underdeveloped countries

### Effects of PEM in children

#### Marasmus

#### Characteristics



- Impaired replacement of tissue proteins.
- Skin: Dry, thin and wrinkled.
- Decline of growth rate and body weight.
- Impaired development of brain and mental facilities.

- Simultaneous **deficiency of proteins and calories.**
- Cause: Substitution of mother's milk early in the child's life with foods that are poor in both proteins and calories.

#### Characteristics

#### Kwashiorkor

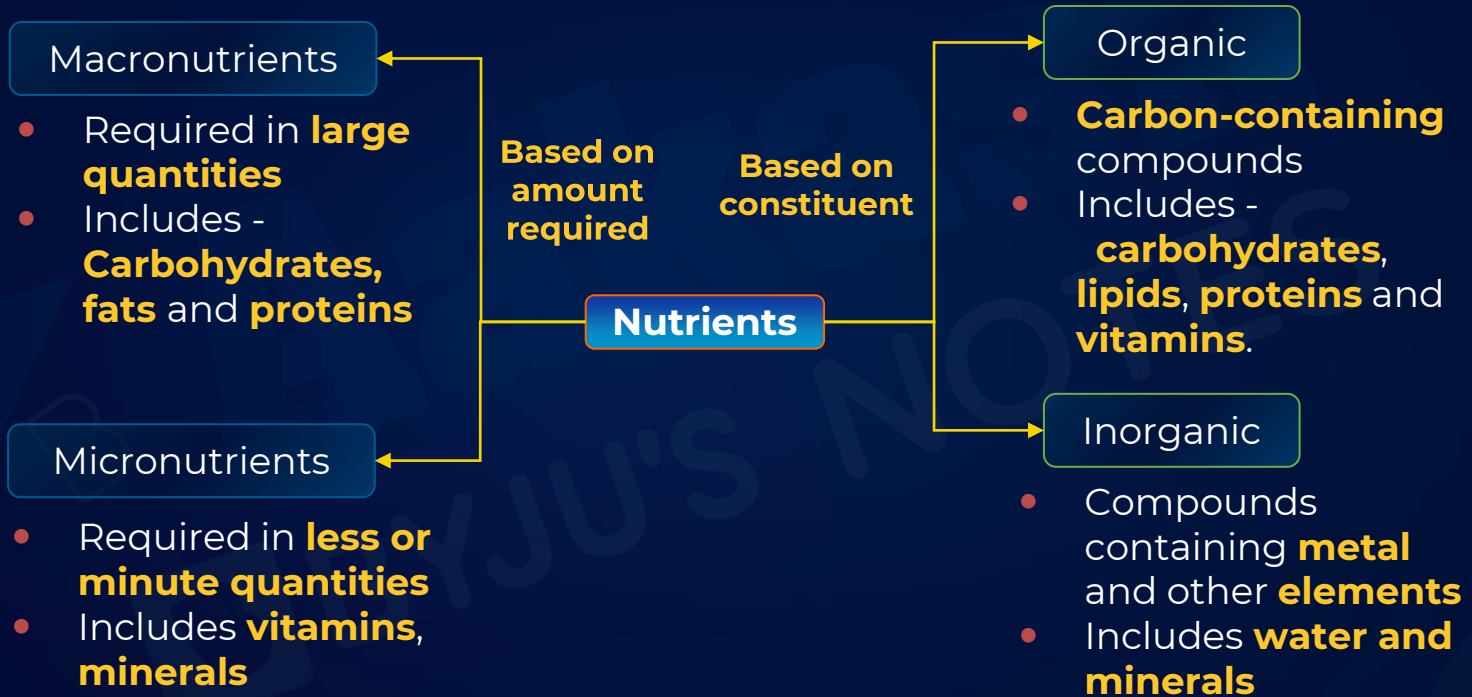


- Wasting of muscles, thinning of limbs.
- Failure of growth and brain development.
- However, some fats are still left under the skin.
- Extensive oedema and swelling.

- **Deficiency of proteins** unaccompanied by the deficiency of calories.
- Cause: Substitution of mother's milk with a high calorie and low protein diet in a child of more than one year in age.

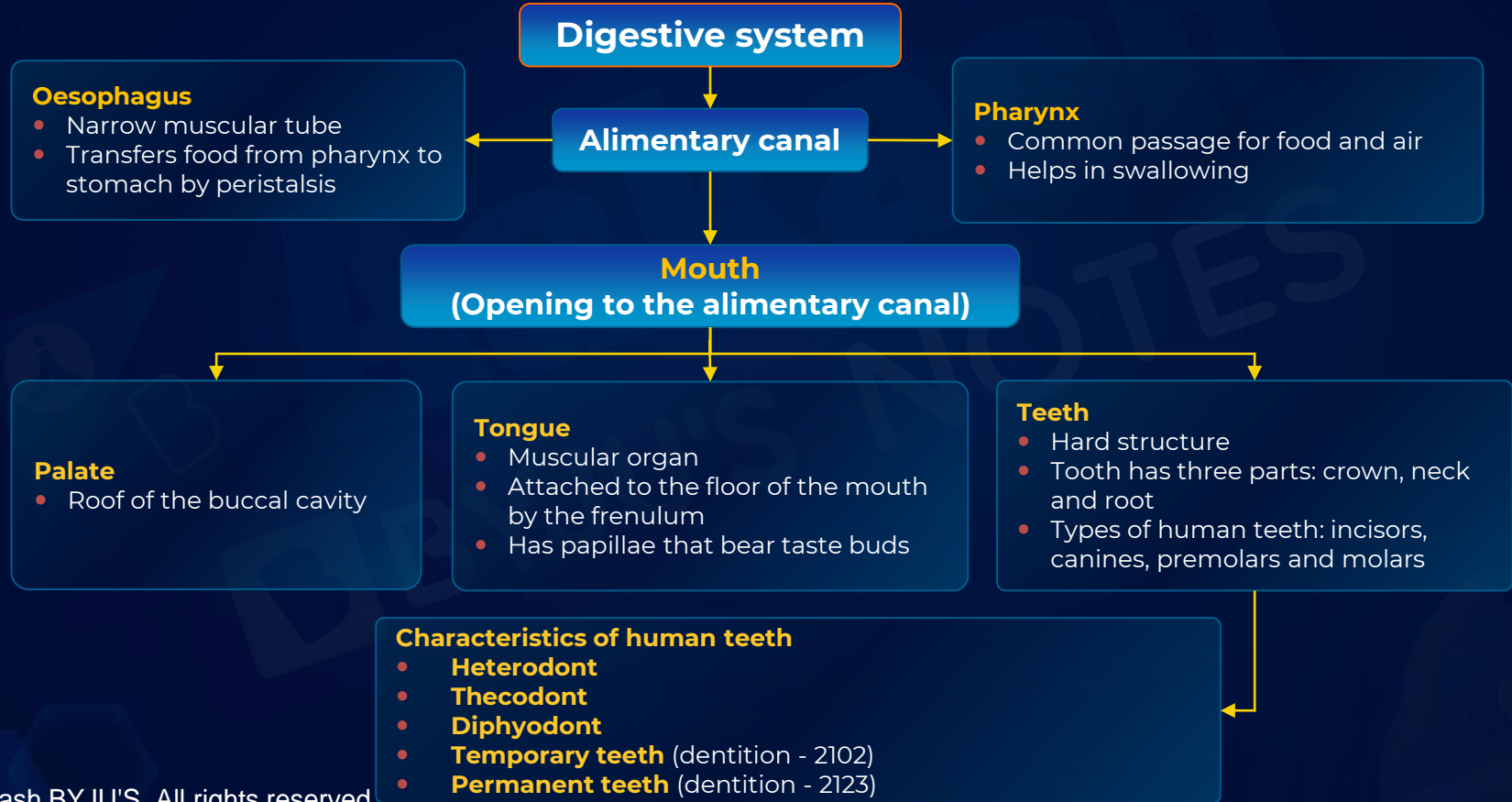


# Summary





# Summary





# Summary



## Duodenum

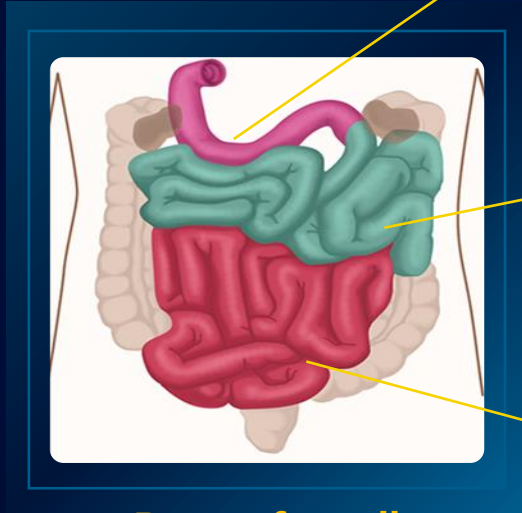
- Shortest and widest part of the small intestine
- C shaped

## Jejunum

- Middle part of the small intestine and is coiled

## Ileum

- Longest part of the small intestine

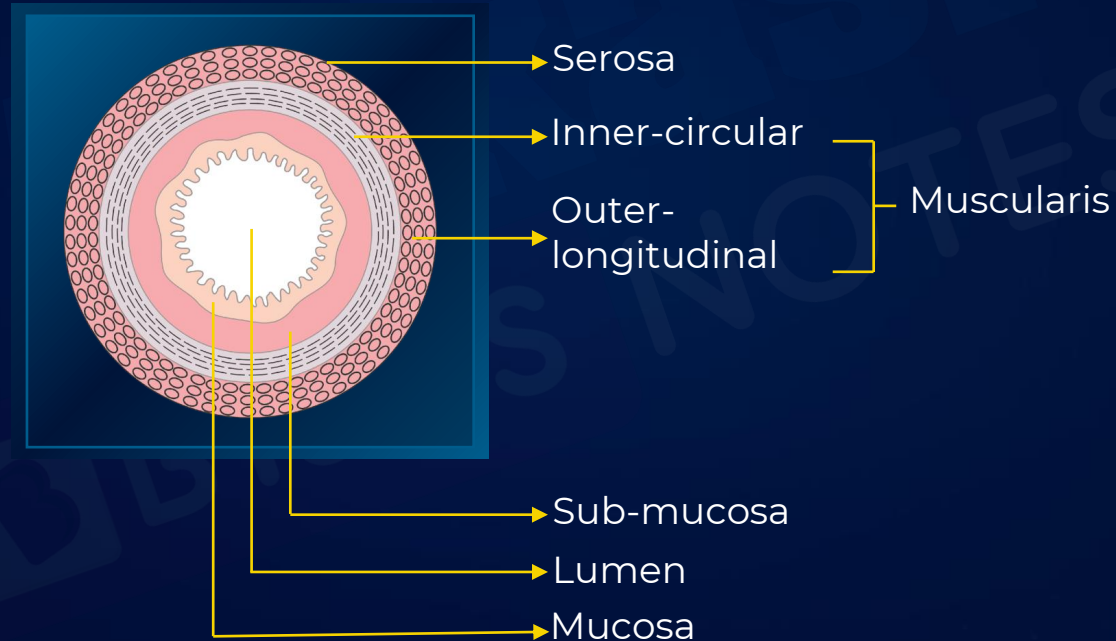


**Parts of small intestine**



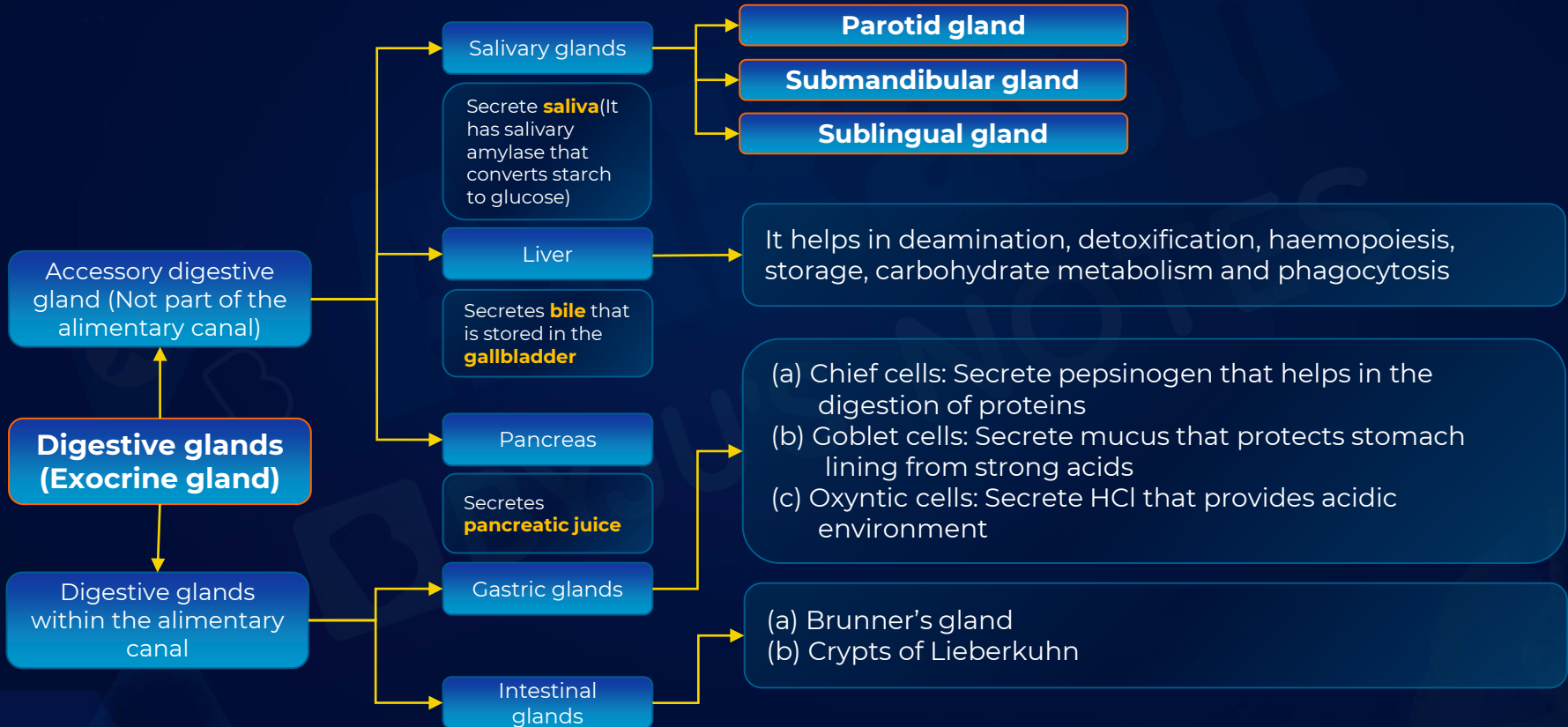
# Summary

## Layers of alimentary canal



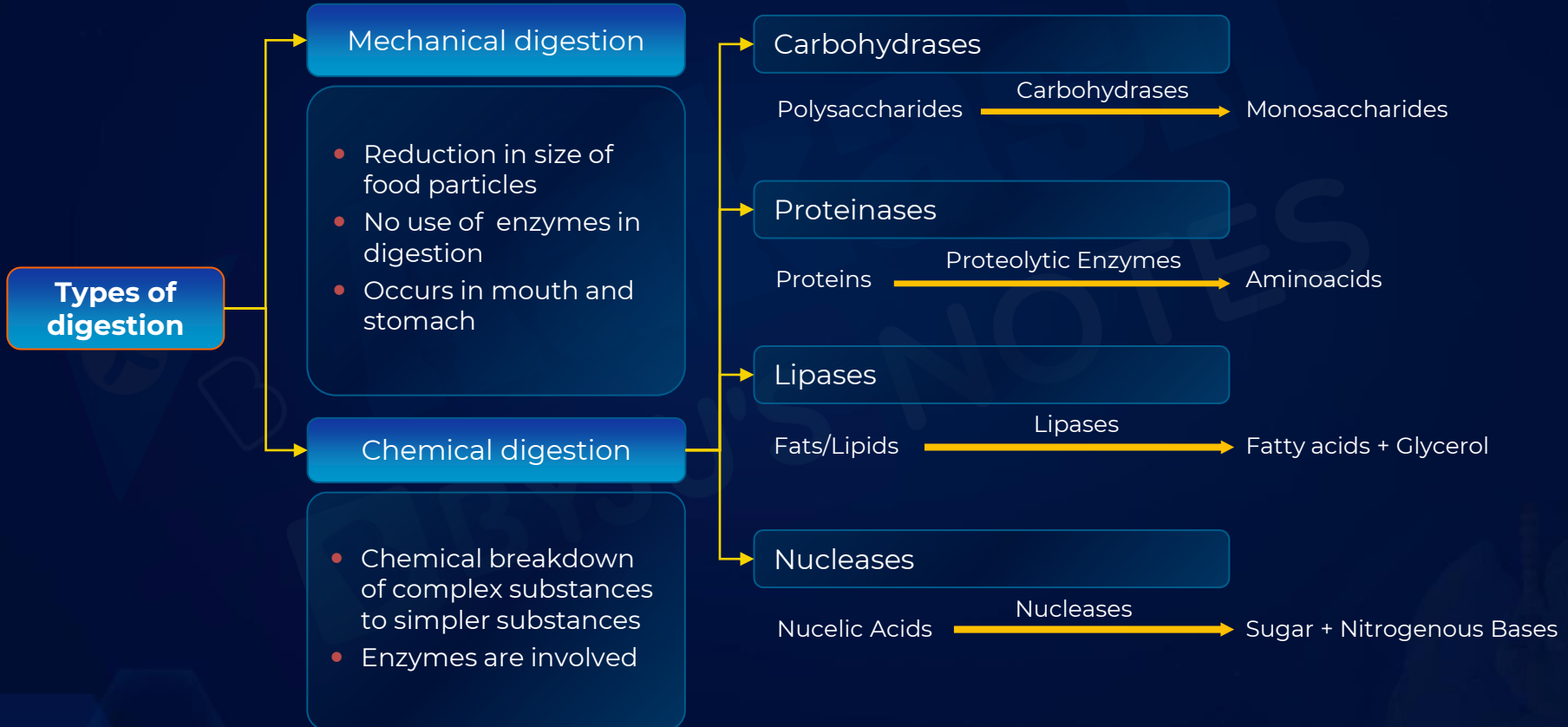


# Summary





# Summary





# Summary

	Carbohydrates	Proteins	Lipids	Nucleic acids
Mouth	30% of polysaccharides are digested into monosaccharides by <b>salivary amylase</b> .	×	×	×
Oesophagus	×	×	×	×
Stomach	×	Some proteins are broken down into polypeptides by <b>pepsin</b> .	Some lipids are broken down into glycerol and fatty acids by <b>lipase</b> .	×
Small intestine (Hepatopancreatic juice)	Remaining 70% of carbohydrates are digested into disaccharides by <b>pancreatic amylase</b> .	Remaining proteins, proteoses, and peptones are broken down into dipeptides by <b>trypsin</b> , <b>chymotrypsin</b> and <b>carboxypeptidase</b> .	Water-insoluble fats are emulsified with the help of <b>bile salts</b> . They are digested into di and monoglycerides by the action of <b>lipase</b> .	Nucleic acids are broken down into nucleotides and nucleosides by the action of <b>nuclease</b> .
Small intestine (Intestinal juice)	Disaccharides are broken down into monosaccharides by <b>disaccharidase</b> .	Dipeptides are broken down into monoamino acids by the action of <b>dipeptidase</b> .	Di and monoglycerides are broken down into glycerol and fatty acids by <b>lipase</b> .	Nucleotides broken down into nucleosides by <b>nucleotidases</b> which are broken down into sugars and bases by <b>nucleosidases</b> .

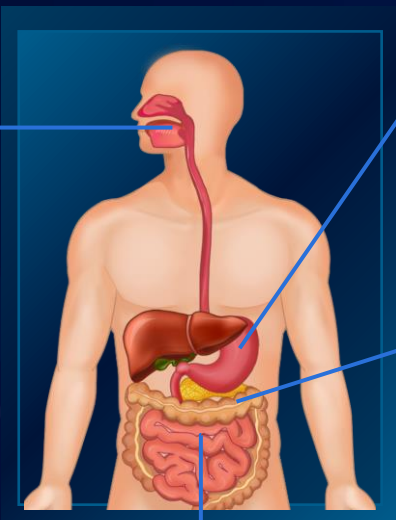


# Summary



**Buccal cavity**

Few drugs



**Stomach**

Alcohol, water, and simple sugars

**Large intestine**

Water, minerals, and some drugs

**Small intestine**

Glycerol, fatty acids, fructose, glucose, amino acids

- **Assimilation:** Process by which **absorbed substances** reach **tissues in the body**
- **Egestion:** Process by which undigested wastes are removed from the body
- **Calorific value:** Total **amount of energy** that the body can generate during the metabolism of food.
  - **One calorie or one joule** is the amount of heat energy required to raise the temperature of **1 g of water by 1°C**.



# Summary



## Disorders of digestive system

### Vomiting

- Emptying of the contents of the stomach through the mouth

### Jaundice

- Liver dysfunction

### Diarrhoea

- Abnormal frequency of bowel movement

### Constipation

- Hard faeces being retained in the colon

### Indigestion

- Improper digestion of food