

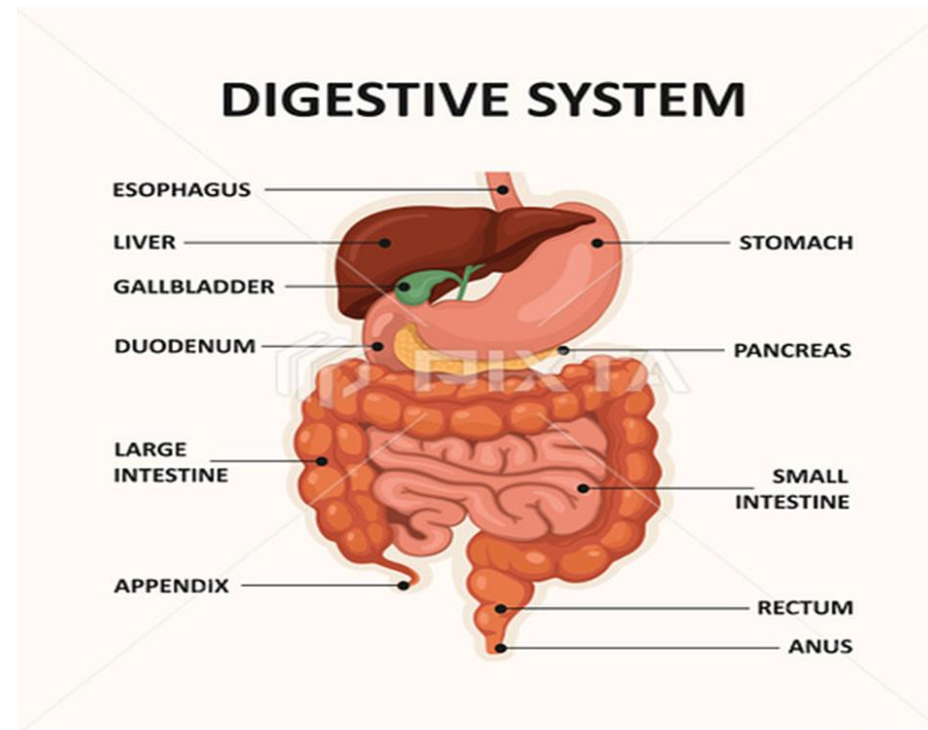
NOS

المدرسة
الوطنية الأرثوذكسية
الشميساني



The National
Orthodox School
Shmaisani

3.1 THE DIGESTIVE SYSTEM



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معتمدة من

Digestion and food absorption

- **Nutrition**

is taking in of materials for energy, growth and development

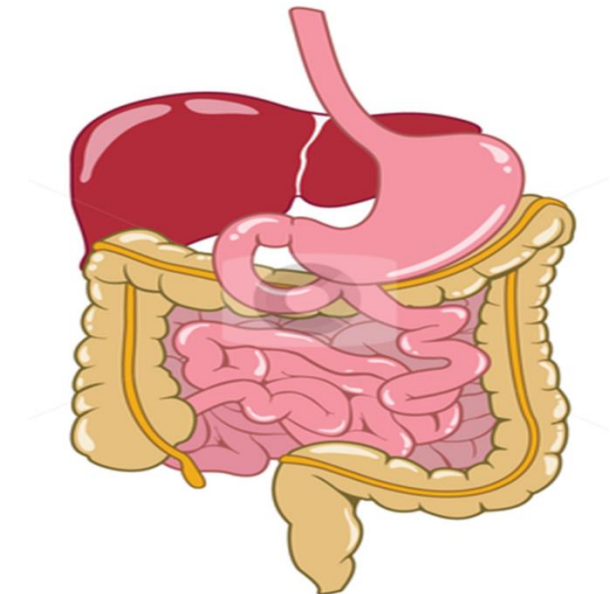
- **Balanced diet**

is the intake of food of all food groups (Carbohydrates , proteins , fats, vitamins , water , mineral ions , fibers) **in the correct proportions** to

provide molecules for metabolism and sufficient energy for the body

- **The diet of a person is affected by:**

1. **Age**
2. **Sex**
3. **Occupation**
4. **Climate**
5. **Special conditions: pregnancy, lactation, health problems**



❖ Age:

▪ Old people:

- Less fats
- More vitamins
- More minerals

▪ Children:

- More proteins
- More calcium
- More carbohydrates

❖ Sex:

- Males require more food than females of the same age and size for **larger muscle masses**

❖ Occupation:

- Hard workers need more amounts of food

❖ **Pregnancy:**

- **More proteins**
- **More calcium and vitamin D**
- **More iron**

❖ **Lactation:** production of breast milk for feeding the baby

- **More proteins**
- **More vitamins**
- **More calcium**
- **More fluids**

❖ **Health problems:**

- **Diabetic: avoid eating** large amounts of carbohydrates
- **Heart patients: less fats, less cholesterol, less salts**

❖ **Climate:**

- **Hot weather: more fluids, less carbohydrates**

The digestive system is responsible for breaking down the large and insoluble food molecules into small and soluble molecules so that they are absorbed into the bloodstream. This involves the following processes:

- **Ingestion**: taking of substances , e.g , food and drink , into the body through the mouth .
- **Digestion**: The breakdown of the large and insoluble food molecules (macromolecules) into small and soluble molecules (monomers). **Digestion takes place in different parts of the digestive system including the mouth, stomach and small intestine.**
- **Absorption**: The transport of the small soluble products of digestion (monomers) into the bloodstream through the villi of the small intestine.
- **Assimilation**: The movement of the small soluble products of digestion by blood into the body tissues to be used by cells .
- **Egestion** : passing out of food that has not been digested or absorbed as faeces , through the anus .

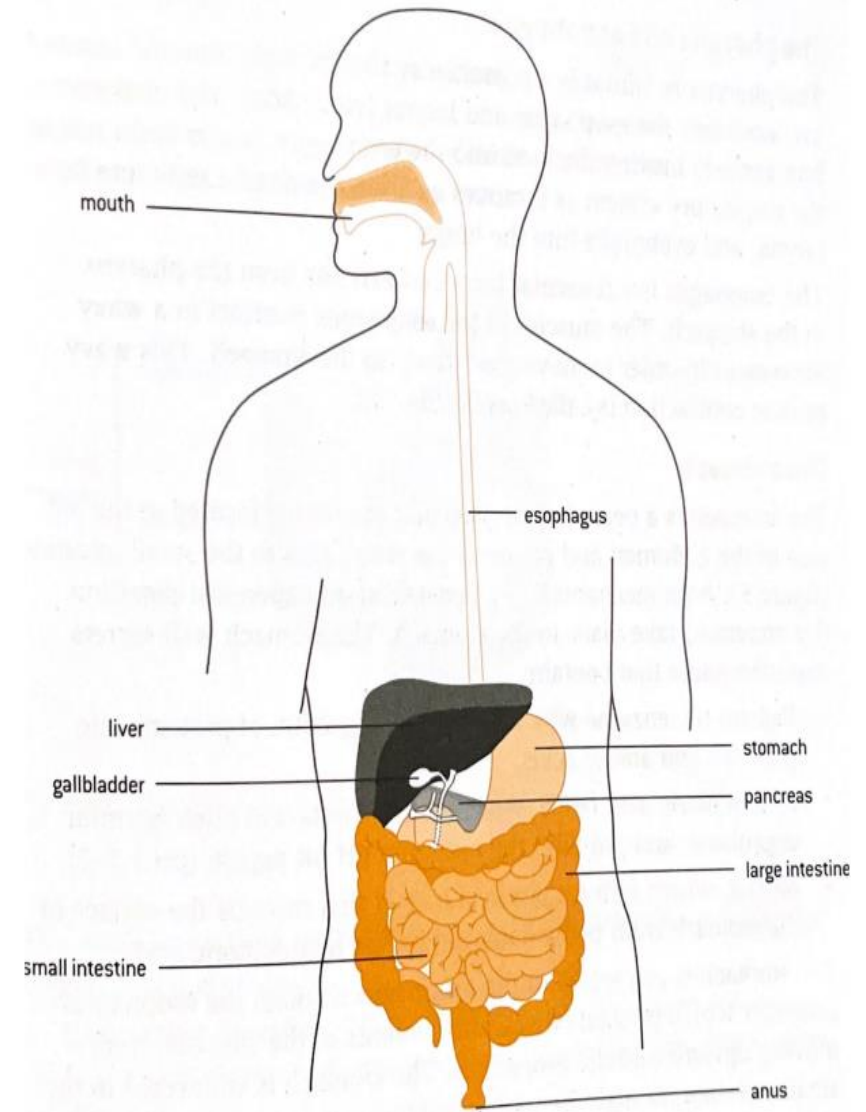
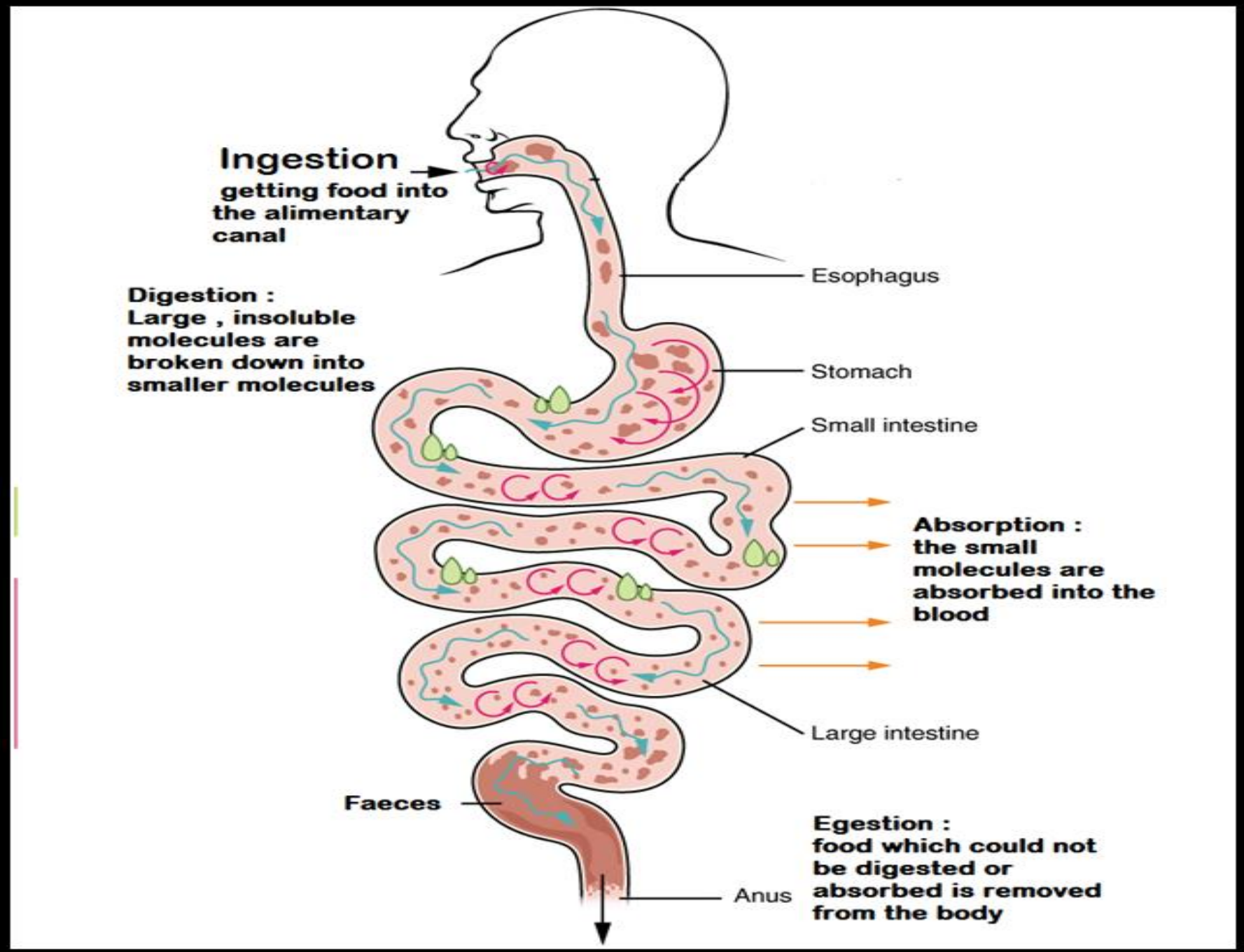


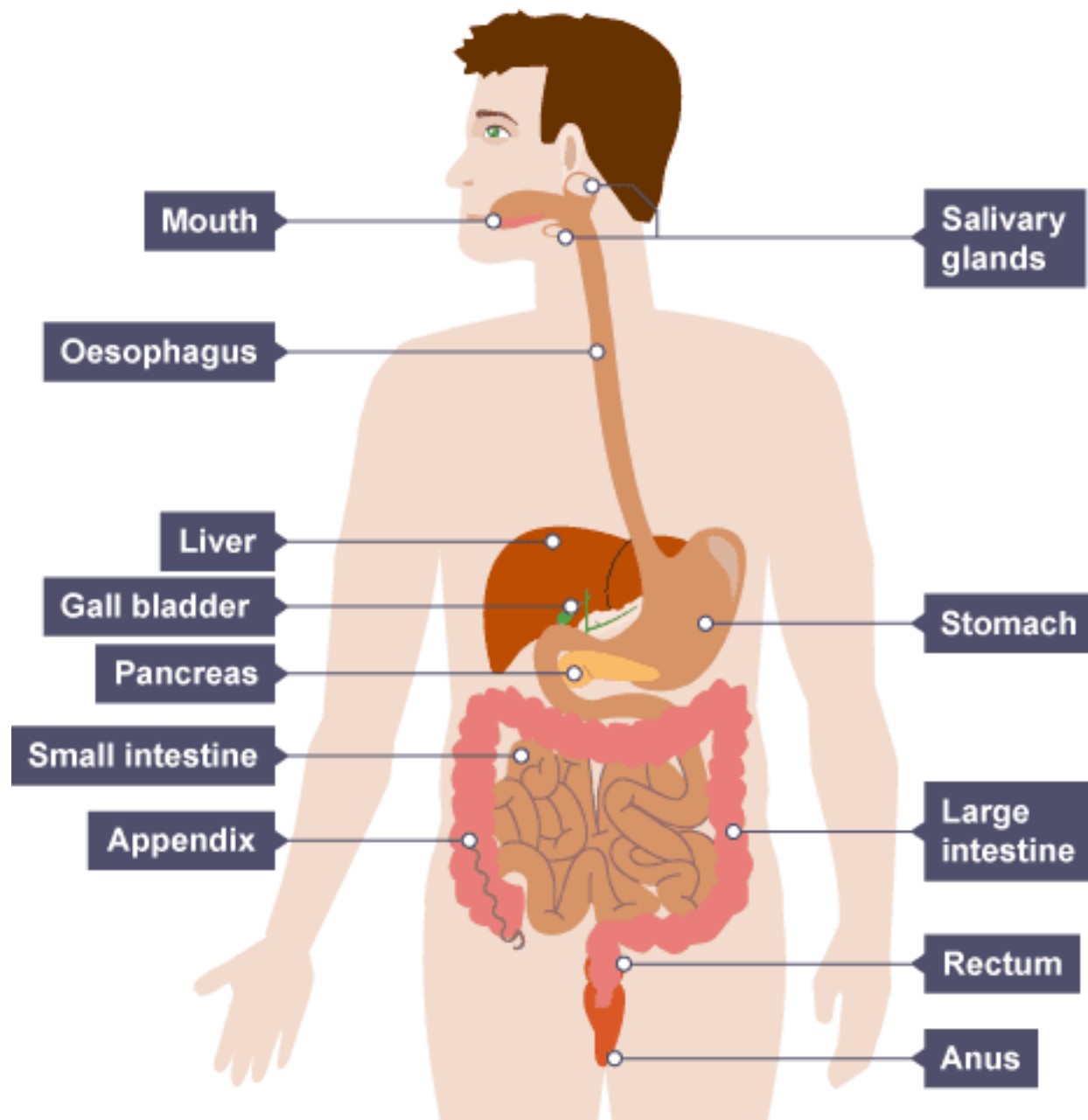
Figure 3. The digestive system



Question

Which of the following descriptions are correctly matched to the different stages of food breakdown?

	absorption	assimilation	egestion
A	small soluble food molecules move into the bloodstream	small soluble food molecules cross the cell membrane of cells	excretion of undigested or unabsorbed food through the anus
B	small soluble food molecules move into the bloodstream	small soluble food molecules cross the cell membrane of cells	passing out of undigested or unabsorbed food through the anus
C	small soluble food molecules cross the cell membrane of cells	small soluble food molecules move into the bloodstream	passing out of undigested or unabsorbed food through the anus
D	small soluble food molecules cross the cell membrane of cells	small soluble food molecules move into the bloodstream	excretion of undigested or unabsorbed food through the anus



What happens in the alimentary canal?

- The alimentary canal is a very long tube **starting at the mouth** and **ending at the anus**. Before we can make use of food, it has to get out of the alimentary canal and into the blood. This is called **absorption**, to be absorbed; molecules of food need to be broken down into smaller, soluble molecules to be able to pass through the walls of the alimentary canal into the blood. **This is called digestion.**

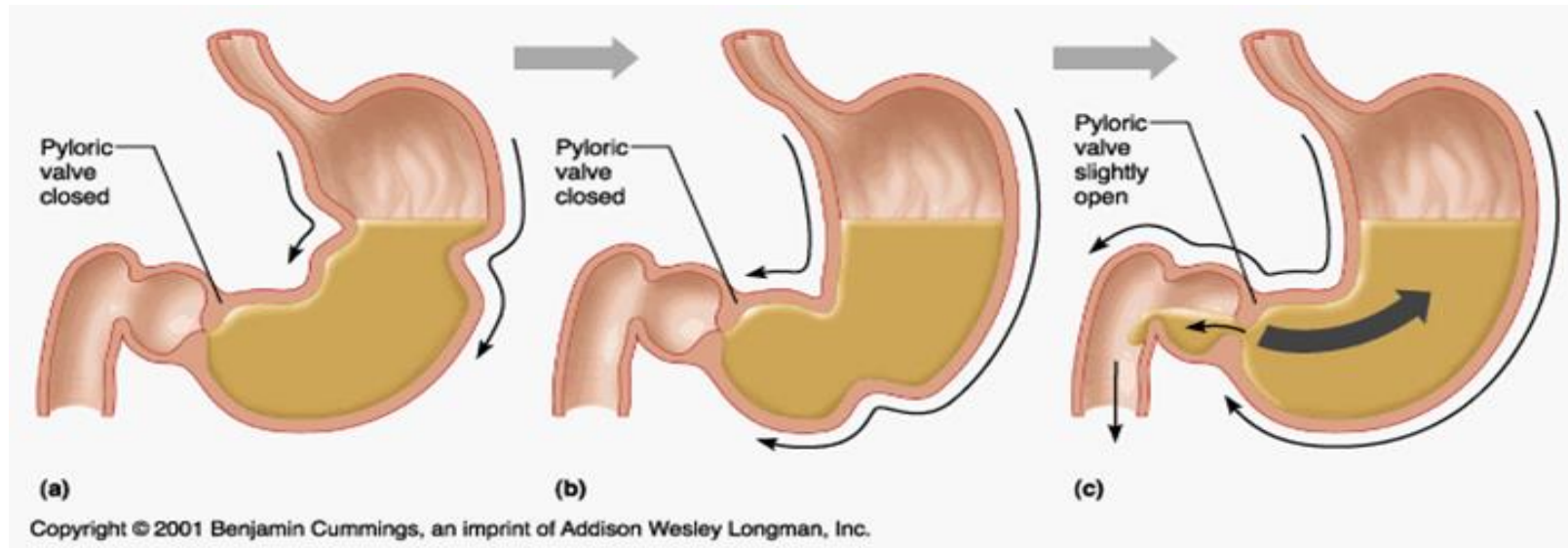
*The digestive system is a group of hollow organs that are connected together to form a long tube inside the body known as the alimentary canal. The alimentary canal includes the mouth, pharynx, esophagus, stomach and small and large intestines. In addition, there are **three associated organs that help in the digestion process and these are the liver, pancreas and gallbladder***

- **Digestion:** It's a biological process where food is broken down into **smaller, simpler, water-soluble substances** that can be easily absorbed by the body cells.

1. Mechanical digestion

Mechanical digestion: is defined as :

- The breakdown of food into smaller pieces WITHOUT chemical change to food molecules
- **Large pieces → Smaller Pieces**
- This process is done by the **teeth** in the mouth where food is broken down into smaller pieces so as to have a **larger surface area** and to be mixed with saliva and exposed to enzymes. Mechanical digestion also takes place in the **stomach**.



2. Chemical Digestion

Chemical digestion: defined as :

The breakdown of large insoluble molecules into small, soluble molecules .

- **Complex molecules insoluble → Simple soluble molecules**
- This process includes **enzymes** which break down complex food into **simpler soluble substances**

e.g.

- **Carbohydrases : e.g amylase**

Polysaccharide (e.g. Starch) → Simple sugars (monosaccharides)

- **Proteases :**

Polypeptide ,Proteins → Amino acids

- **Lipases**

Fats → Fatty acids and glycerol

Explain how chemical digestion differs from mechanical digestion:

- **Chemical digestion**

breakdown of molecules ;and involves breaking bonds ;using enzymes ;And converting them from insoluble to soluble ;

- **Mechanical digestion**

Break down of food into smaller particles (pieces)to increase surface area for chemical digestion

Enzymes and digestion

Digestion is a hydrolysis reaction, which means it involves the splits of large molecules into smaller ones. Enzymes are essential for digestion to take place as they are integral to this process of breaking down large macromolecules. The resulting smaller molecules that can be absorbed into our blood are known as nutrients. These include amino acids, fatty acids, cholesterol and monosaccharides as well as vitamins and minerals. There are three main types of digestive enzymes (figure 2):

- **Protease**-an enzyme that breaks down **protein molecules** into their building blocks, amino acids. There are many proteases produced by the digestive system. The main two are **pepsin and trypsin**.
- **Carbohydrase**-an enzyme that breaks down **carbohydrate** molecules into their building blocks, monosaccharides (glucose, galactose and fructose). For example, amylase breaks down starch into maltose, which is then broken down by maltase into glucose.
- * **Lipase**- an enzyme that breaks down **fat** molecules into their building blocks, fatty acids and glycerol.

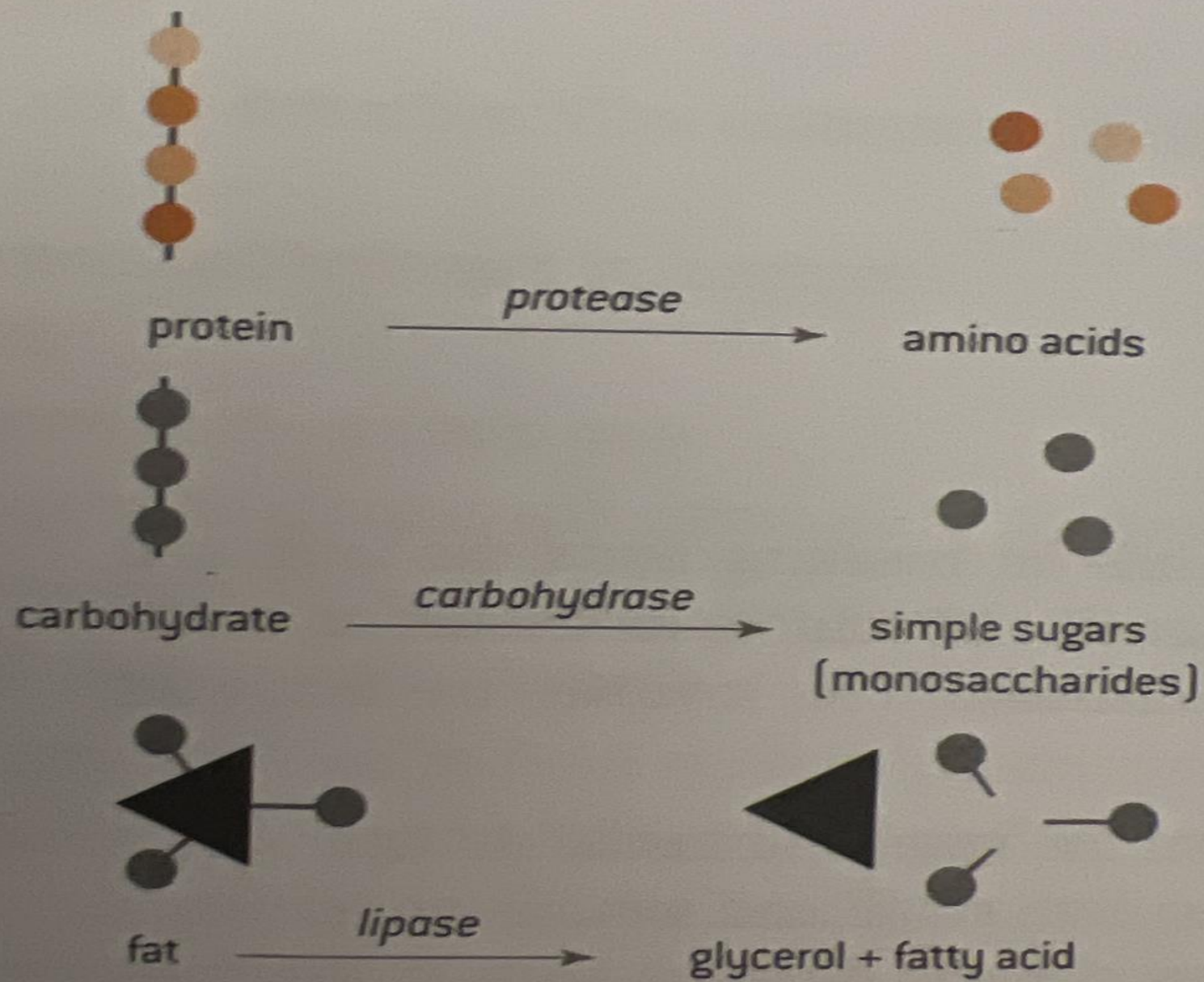


Figure 2. Digestive enzymes

The Process of digestion

The mouth

The journey of food travelling through the alimentary canal starts in the mouth. There are two types of digestion that take place in the mouth: mechanical and chemical digestion.

Mechanical digestion involves the chewing of food by the teeth to make it small enough to be swallowed.

Chemical digestion involves the mixing of food in the mouth with the saliva, which contains enzymes, to break down food into smaller molecules.

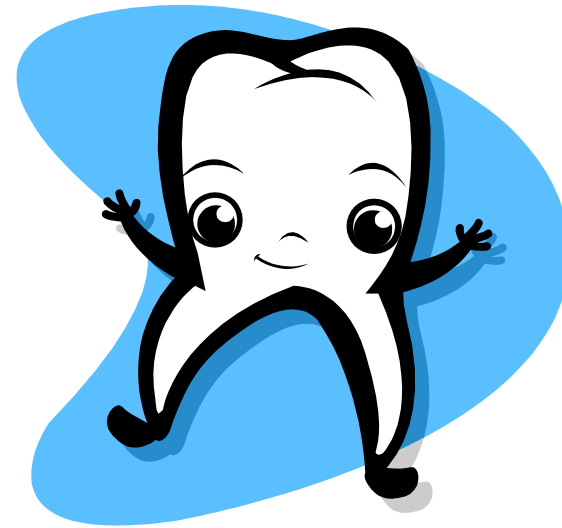
Saliva is a watery substance that is secreted by the salivary glands, which are located near the teeth .

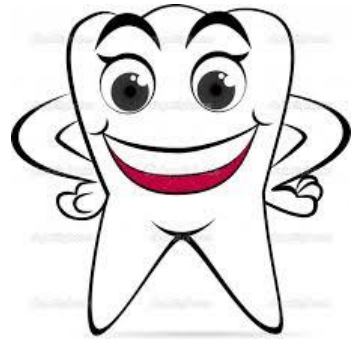
Saliva has several functions in the mouth:

It is composed of water, mucus, proteins, mineral salts, and amylase.

- It moistens food so it can pass more easily from the mouth into the pharynx and esophagus.
- It contains the enzyme amylase, which breaks down starch into maltose. Maltose can be further broken down in the small intestine.

How does mechanical digestion take place in the mouth ?

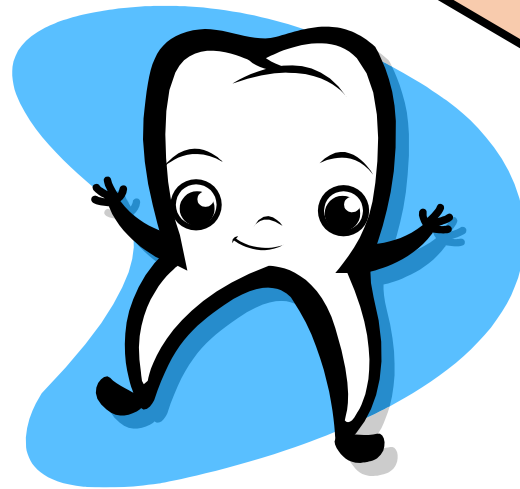




Teeth
AKA dentes

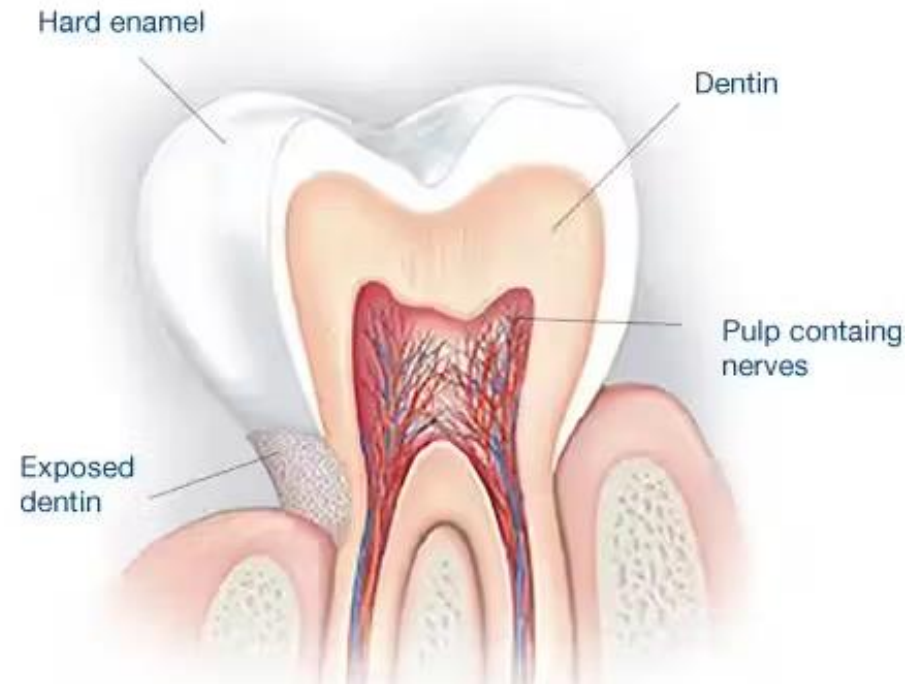


Teeth participate in mechanical digestion by breaking food particles into smaller ones mixing it with saliva. This makes it easier to swallow and give us the chance to taste it and also increases the surface area so that the enzymes can easily access every bit of the food.



Using tooth paste helps because:

- It is alkaline and so neutralizes acid near the teeth
- It contains antibacterial substances such as mint
- It may contain fluoride, which helps strengthen the enamel and reduce the acid damage



Chemical Digestion in the Mouth

- Food in the mouth is mixed with **saliva**, produced by **salivary glands**.
- Saliva consists mainly of water with amylase enzyme dissolved in it. Saliva also contains, salts ,**Lysozymes** and mucus

lysozyme is an important component of antibacterial in saliva.

- **Saliva production is affected by :**
 1. Taste
 2. Smell
 3. Thinking about food

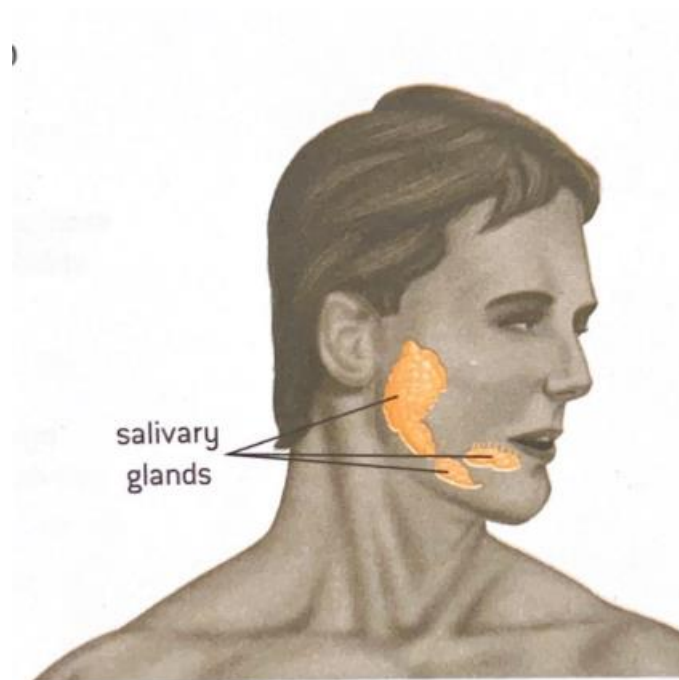


Figure 4. Salivary glands

Note that :

- ❖ Amylase begins the breaking down of **starch in food** into **maltose** (Disaccharide)
- ❖ Salts keep the PH neutral for amylase to work.
- ❖ Mucus helps bind the chewed food together to form a **bolus** and **lubricates** it so that **it slides easily down the oesophagus** when it is swallowed.
- ❖ Saliva makes food more soluble so as to be tasted.
- ❖ Usually, not all the starch in the food ingested will be digested because food is not kept in the mouth for a long time.
- ❖ If you chew a piece of bread for a long time in your mouth you will be able to taste the sweet maltose that is produced

Question

The table shows some major food groups, the enzymes involved in their digestion and the end products of digestion. Complete the table.

(3)

Major food group	Enzyme involved	End product of digestion
starch	Amylase	maltose
protein	protease	Short polypeptides and amino acids
Fat	lipase	glycerol and fatty acids

Which products are formed by the action of the enzymes protease and amylase?

	Protease	Amylase
A.	fatty acids	glucose
B.	glycerol	fatty acids
C.	proteins	starch
D.	amino acids	maltose

What is an example of assimilation?

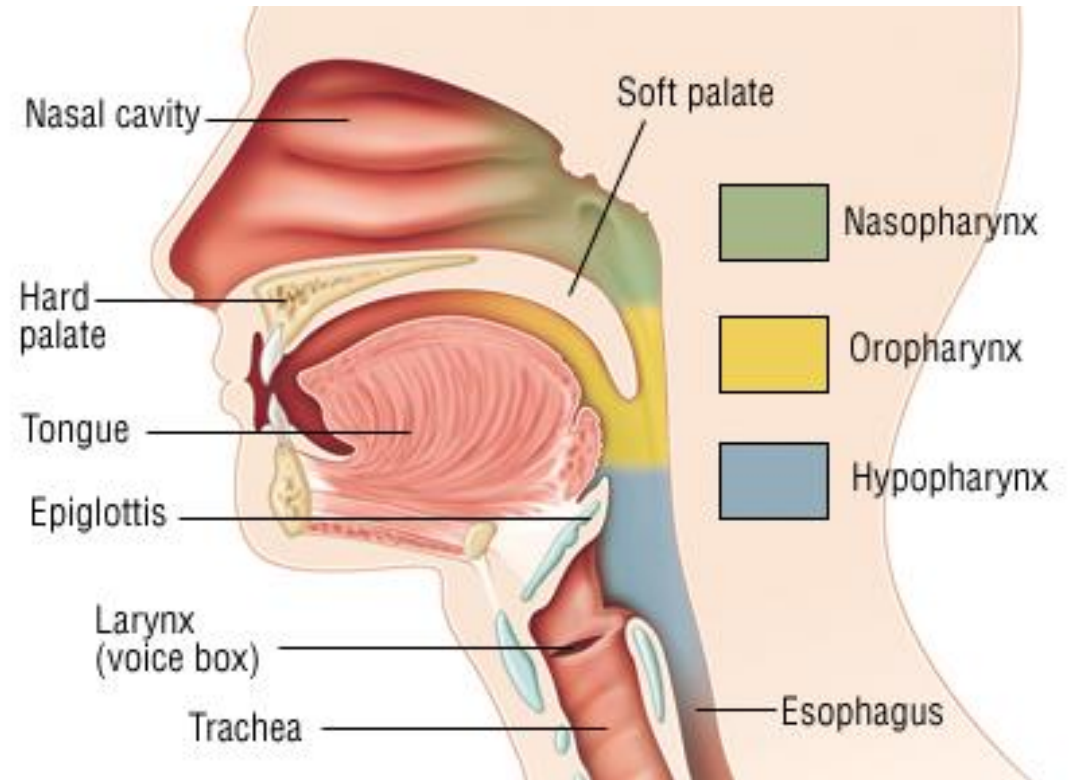
- A** absorption of glycerol into lacteals
- B** breakdown of alcohol in the liver
- C** building of proteins from amino acids
- D** release of a hormone from a gland

Which digestive processes take place in the mouth (buccal) cavity?

	chemical digestion	mechanical digestion	dissolving of nutrients
A	✓	✓	✓
B	✓	✓	x
C	✓	x	✓
D	x	✓	✓

Swallowing :

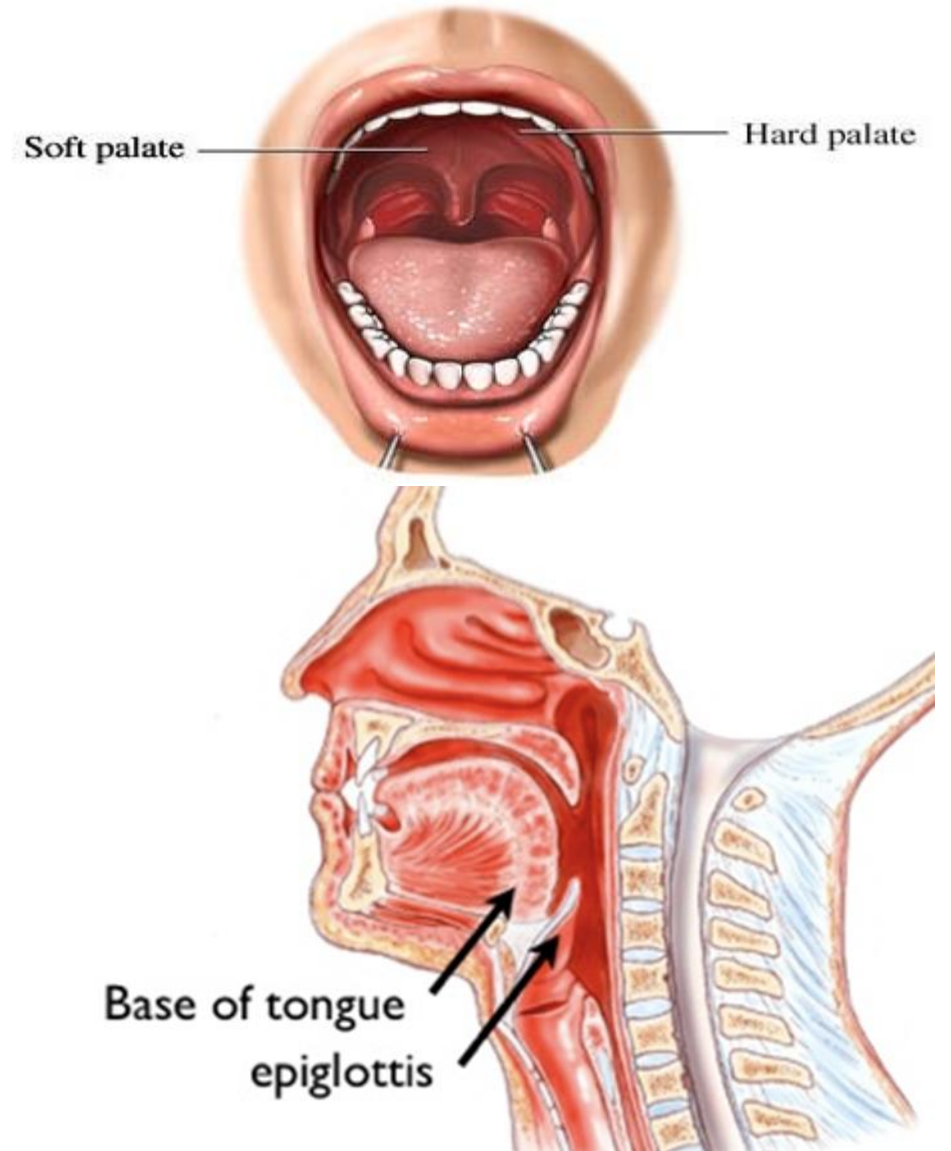
- The **bolus** is pushed by the tongue to the back of the mouth.
- There are two tubes at the back of the mouth.
- **One which takes air into the lungs → Trachea**
- **And another one just behind the trachea which takes food down into the stomach → oesophagus**



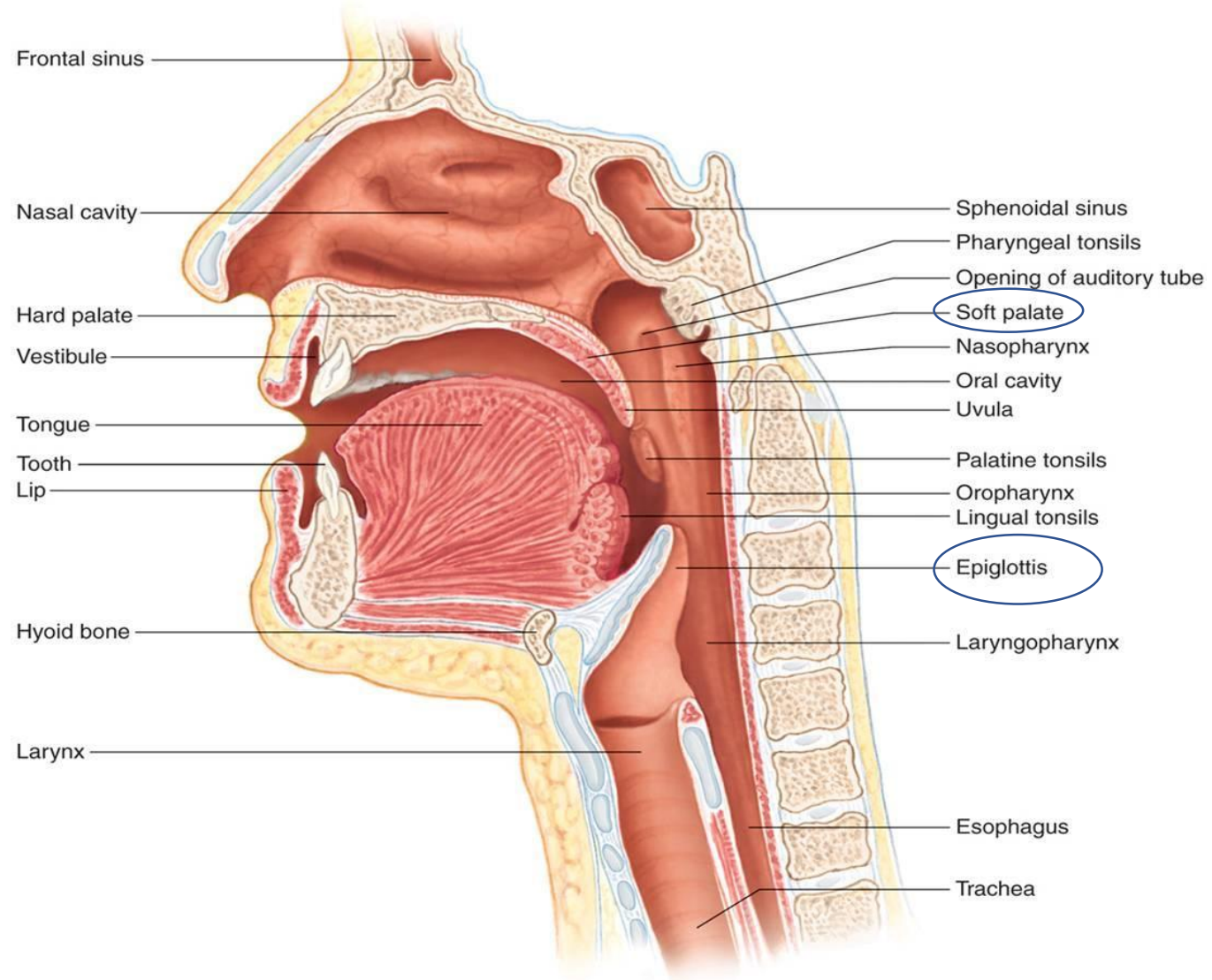
While swallowing certain actions take place to prevent the entrance of food into the trachea:

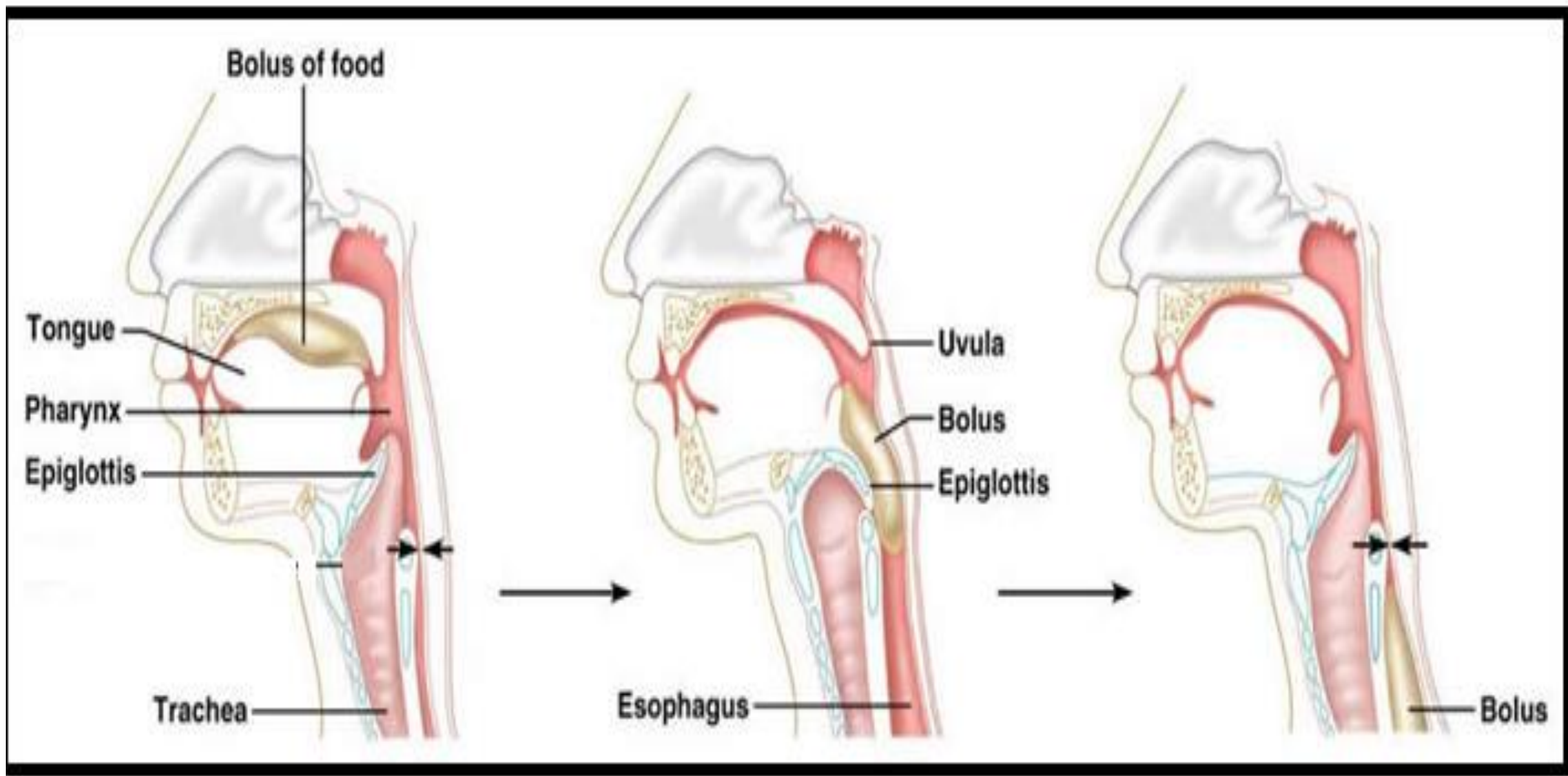
<https://www.youtube.com/watch?v=tRIpwPD3gc8>

1. Soft palate closes the entrance to the nasal cavity.
2. Epiglottis which is a piece of cartilage covering the entrance of the trachea makes a bridge over the entrance of the trachea preventing food from passing through.
3. Muscles in between the rings of cartilage of the trachea contract to reduce the diameter of the trachea.



4. Movement and contraction of the larynx (Adam's apple) moves the trachea upwards so no food enters.





- **When** the bolus enters the oesophagus it moves by **peristalsis** of **circular** and **longitudinal** muscles.

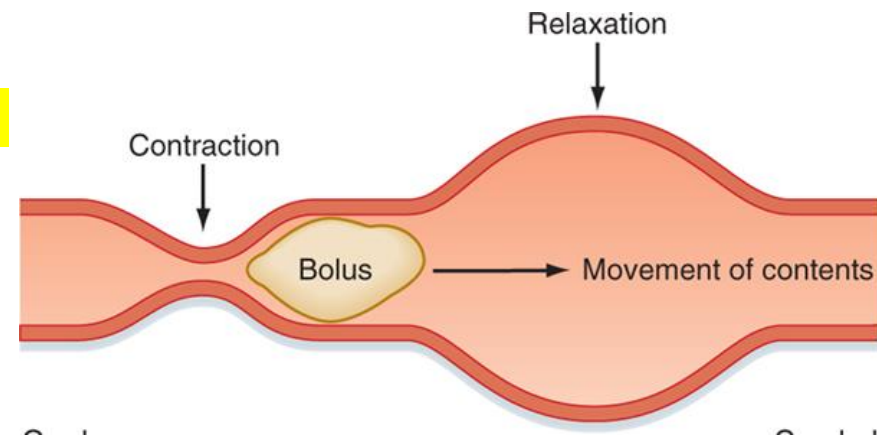
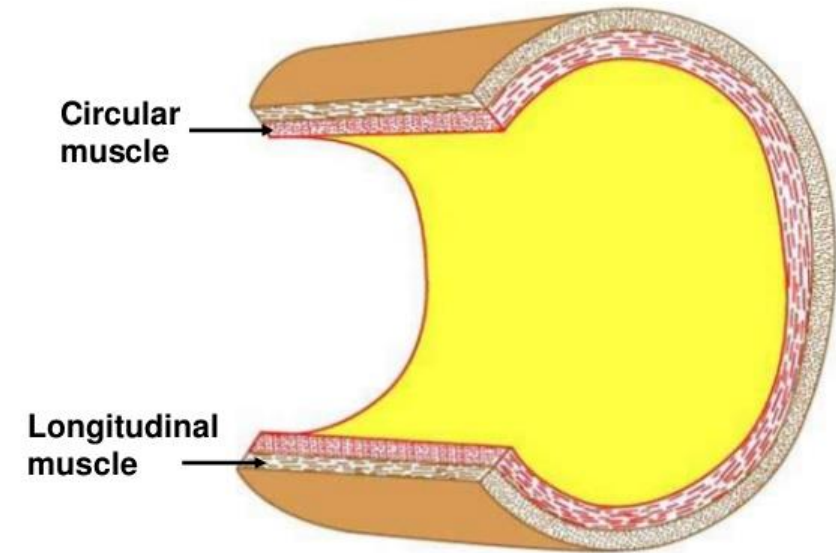
Circular muscles behind the food contract longitudinal relax, whereas circular muscles in front relax & **longitudinal muscles contract** → which pushes food forward causing the bolus to move down the oesophagus into the stomach

When the circular muscles contract and the longitudinal relaxes → the oesophagus becomes narrower

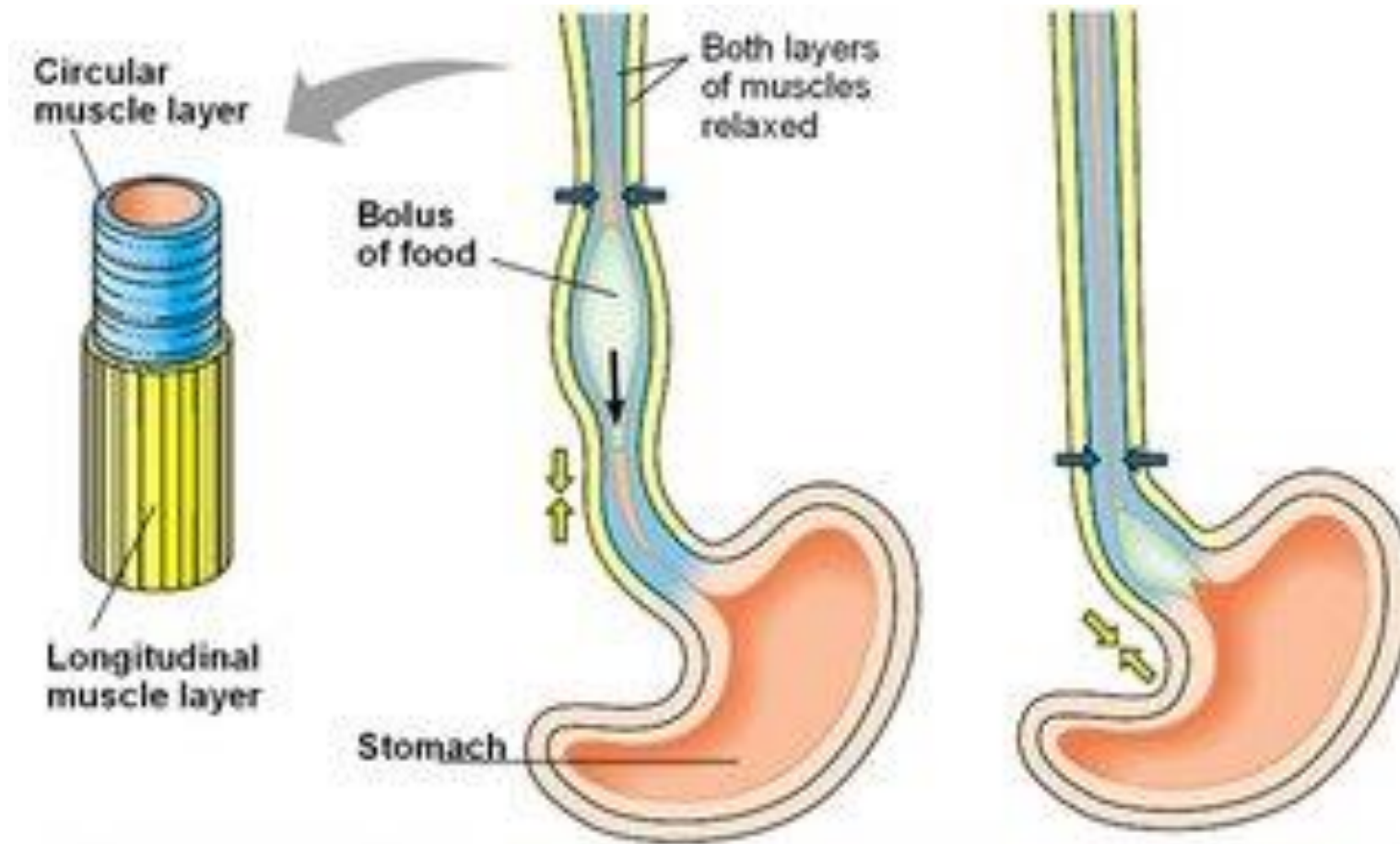
When the circular relax and the longitudinal contract → the oesophagus becomes wider

<https://www.youtube.com/watch?v=VwiGXtNnh1E>

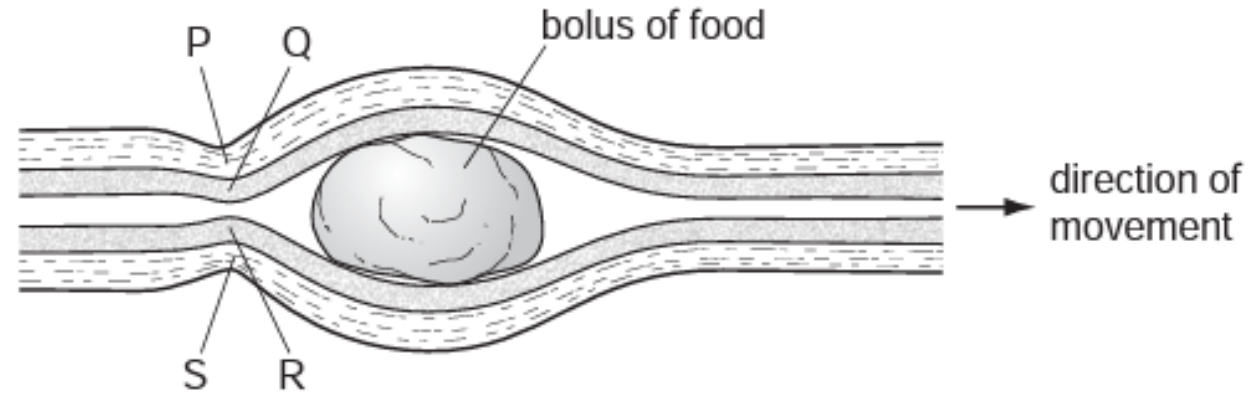
Part of the gut wall



- Mucus is found to make it easier for food to pass along
- The passage of solid or semisolid food from the mouth to the stomach takes 4 to 8 seconds; very soft foods and liquids pass through in about 1 second.



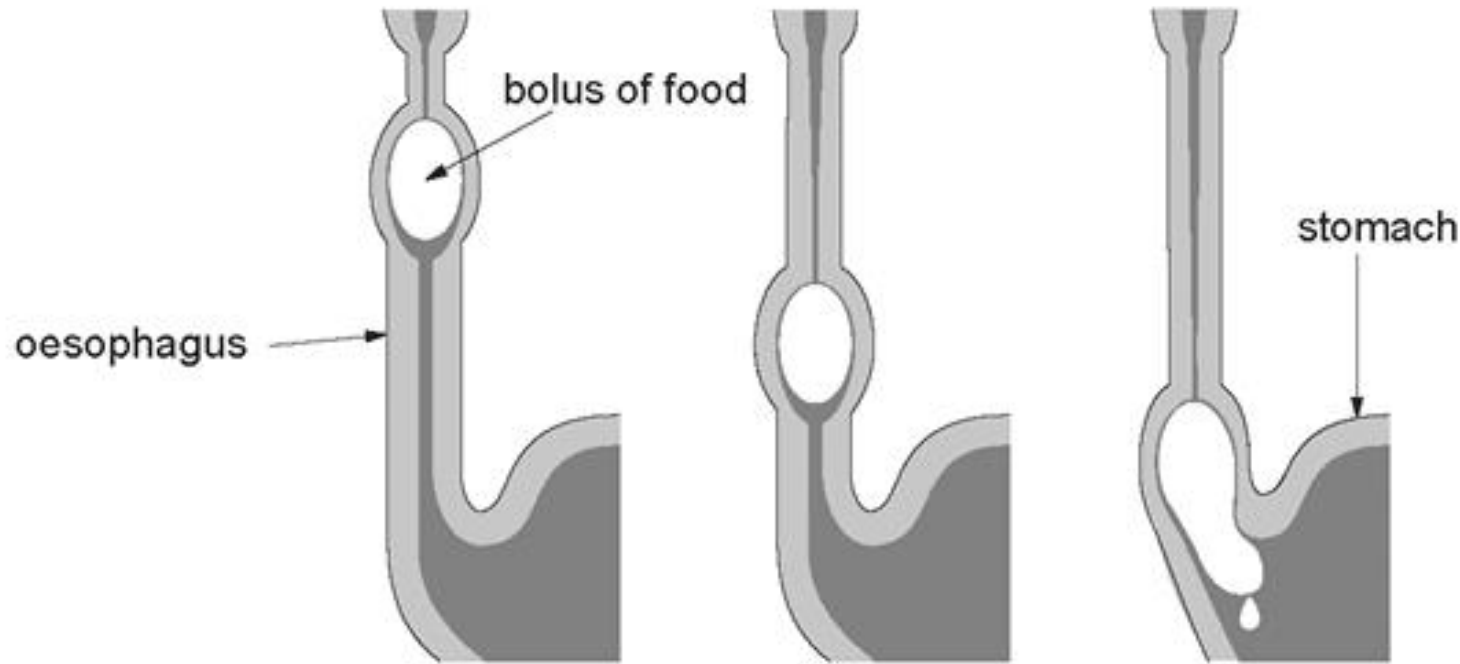
The diagram shows a bolus of food moving along the oesophagus.



Which row describes the condition of the muscles at P, Q, R and S?

	P	Q	R	S
A	contracted	relaxed	contracted	relaxed
B	contracted	relaxed	relaxed	contracted
C	relaxed	contracted	contracted	relaxed
D	relaxed	contracted	relaxed	contracted

The diagram shows a process occurring in the human digestive system.



(a) (i) Name the process shown in the diagram. [1]

..... **peristalsis**

(ii) Explain how the bolus of food is moved along the oesophagus. [2]

By the action of contraction and relaxation of the circular and longitudinal muscles in the wall of the esophagus (antagonistic muscle pair)

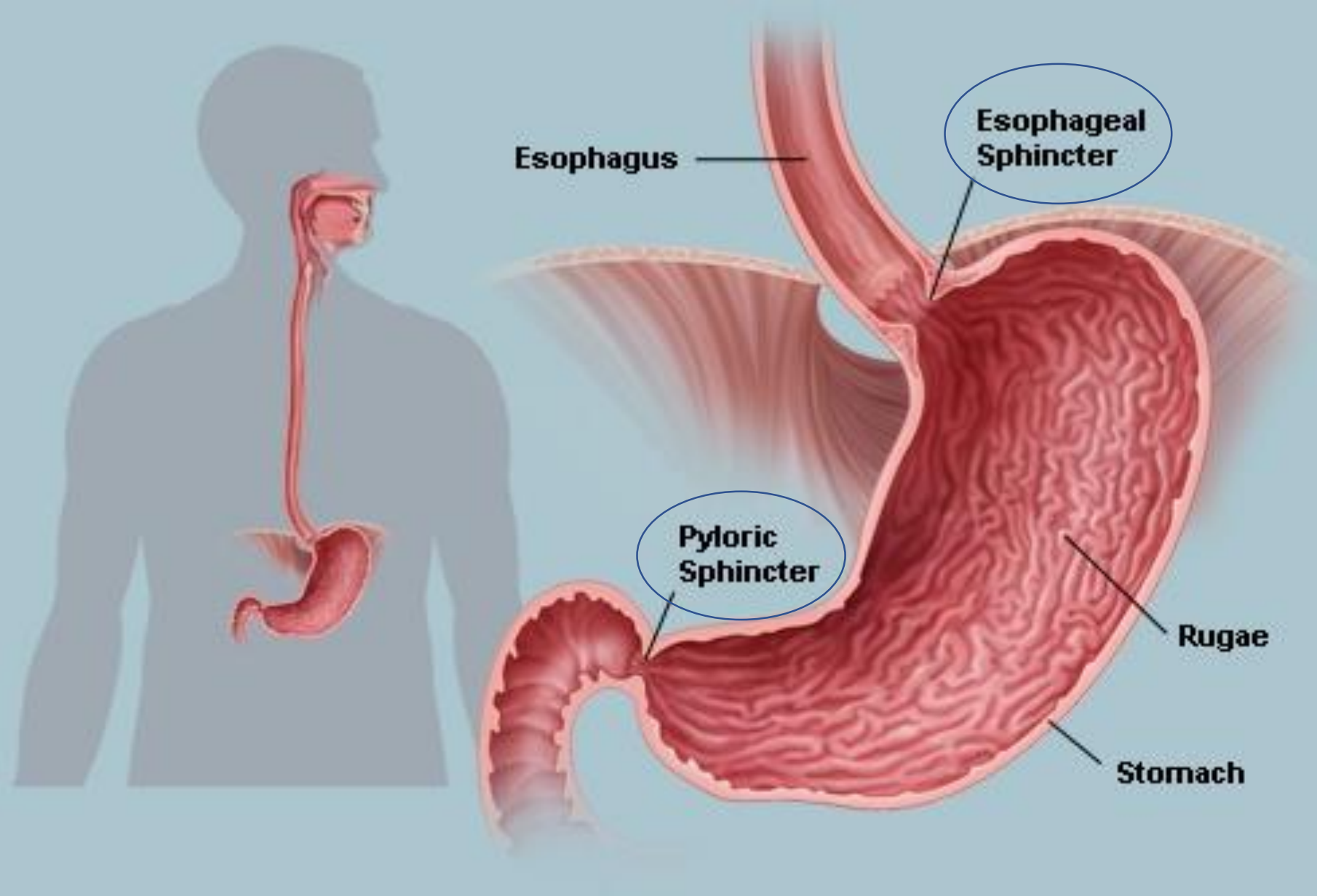


In The stomach :

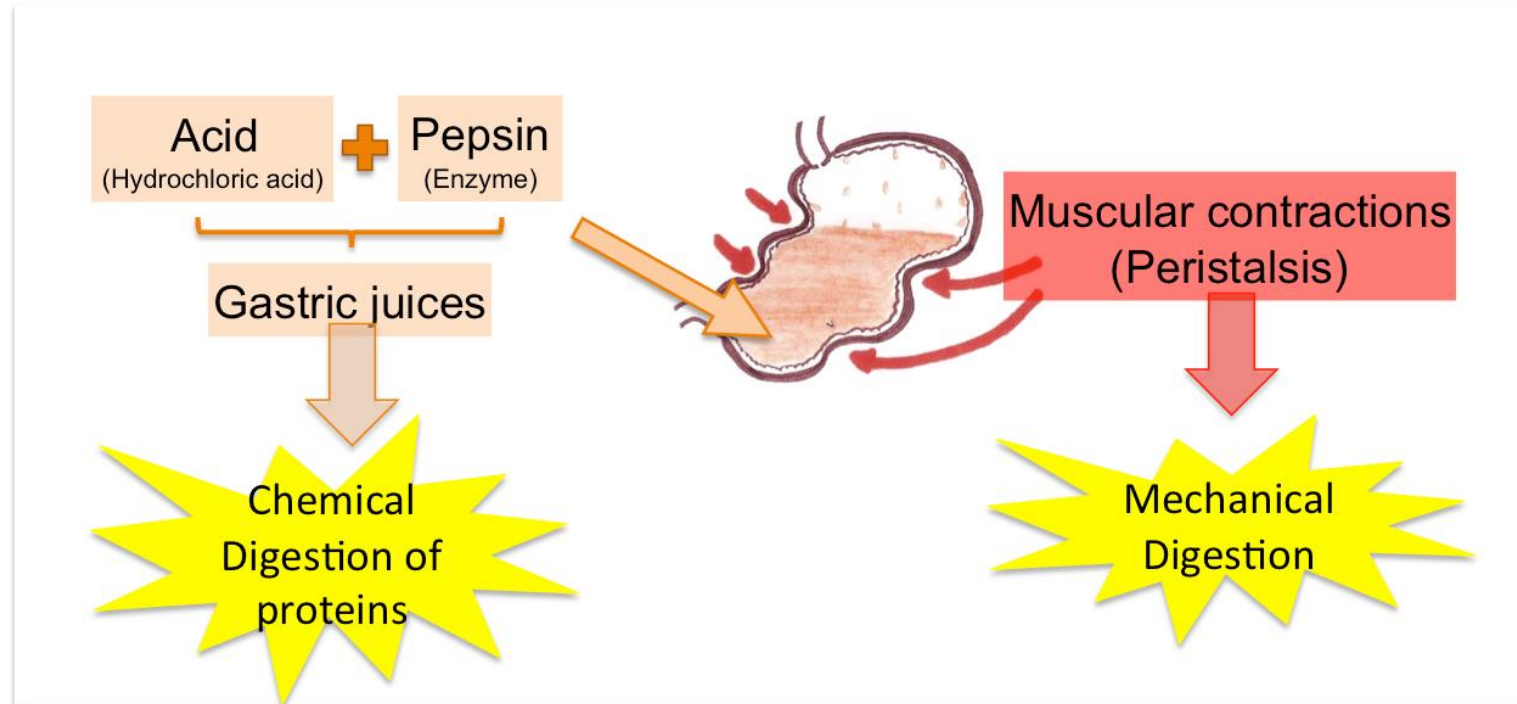
The stomach is a pear-shaped muscular sac that is located at the left side of the abdomen and connects the esophagus to the small intestine (figure 5). Both mechanical (by peristalsis) and chemical digestion (by enzymes) take place in the stomach. The stomach wall secretes digestive juices that contain:

- **Pepsin, the enzyme which begins the digestion of proteins into peptides and amino acids.**
- **Hydrochloric acid (HCl), which kills bacteria and other harmful organisms, and provides the optimum pH for pepsin (pH 1.5-2).**
- **Mucus, which forms a physical barrier that protects the surface of the stomach from being damaged by the hydrochloric acid.**

The stomach is connected to the esophagus through the **oesophageal sphincter** which prevents the acidic contents of the stomach from moving upward into the esophagus. The stomach is connected to the small intestine through the **pyloric sphincter** that opens to allow food to pass from the stomach to the small intestine.

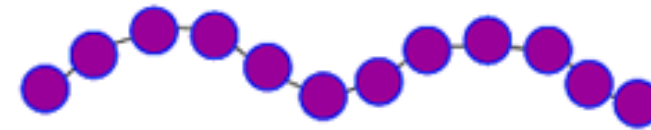


- In the walls of the stomach there are **Gastric Glands** that produce **Gastric juice**.
- **Gastric Juice contains:**
 - 1-Hydrochloric acid (HCL).
 - 2-Protease enzymes (Pepsin and rennin).



- HCl provides **acidic conditions** (medium) PH=2 For pepsin to work, and also helps to kill bacteria(by denaturing their enzymes) in food protecting us from food poisoning.
- Pepsin **begins** the digestion of proteins t **short polypeptide chains.**
- Rennin is only found in the stomach of **young mammals.** It coagulates (clots) the milk proteins to make it easier for pepsin to work on them. **Don't memorize reading only**
- After food is mixed with the gastric juice and enzymes it is called **chyme.**

Digestion of protein / polypeptide

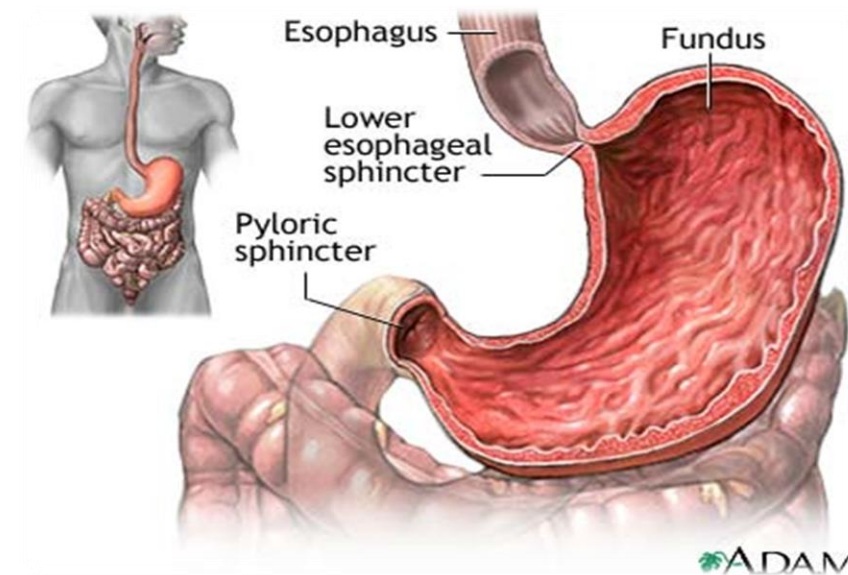
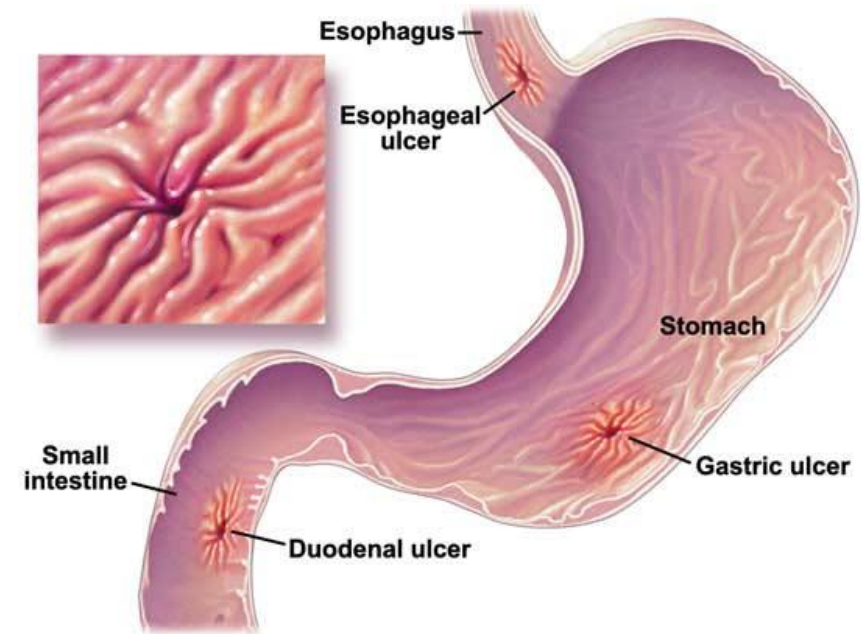


The peptide bonds between the amino acids are hydrolysed

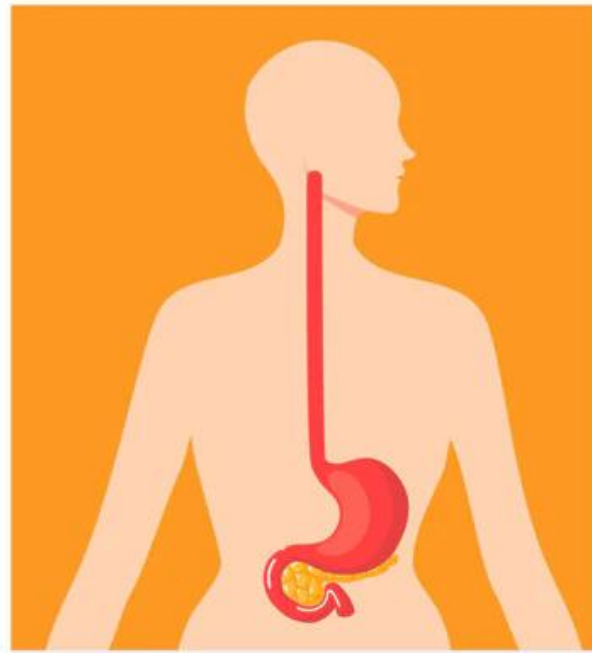
Pepsin is a protease that hydrolyses the protein into smaller polypeptides



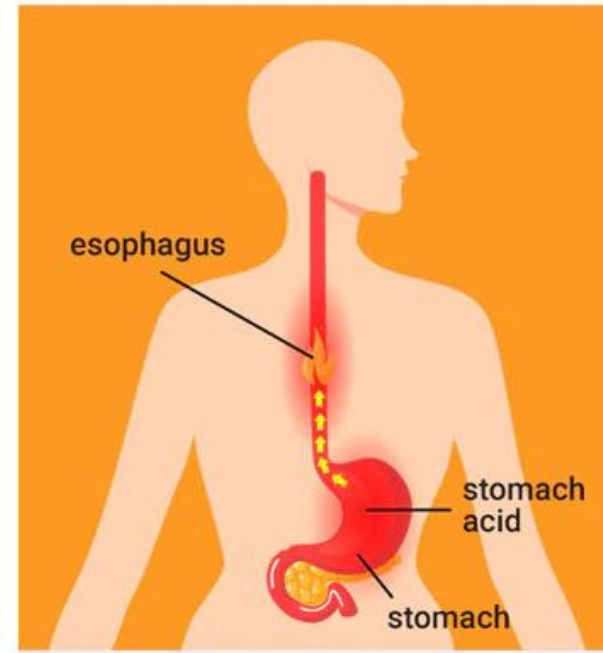
- Like all the parts of the **alimentary canal** , the stomach contains **goblet cells** that secrete a mucus layer to protect it from HCl and prevent the stomach from digesting **itself**, if this layer is removed or damaged it causes **Ulcer**.
- Remember that **alcohols** are absorbed in the stomach
- The stomach can store food for quite time, after one or two hours the **pyloric sphincter** relaxes and lets the chyme into the duodenum.



A burning sensation that is called heartburn because it is experienced in a region very near the heart; it is unrelated to any cardiac problem. Drinking alcohol and smoking can cause the sphincter to relax, worsening the problem. The symptoms often can be controlled by avoiding foods that strongly stimulate stomach acid secretion (coffee, chocolate, tomatoes, fatty foods, orange juice, mint , and onions)



NORMAL



ACID REFLUX

Two functions of the alimentary canal are mechanical digestion and chemical digestion.

(a) Outline where **and** how mechanical digestion occurs in the alimentary canal.

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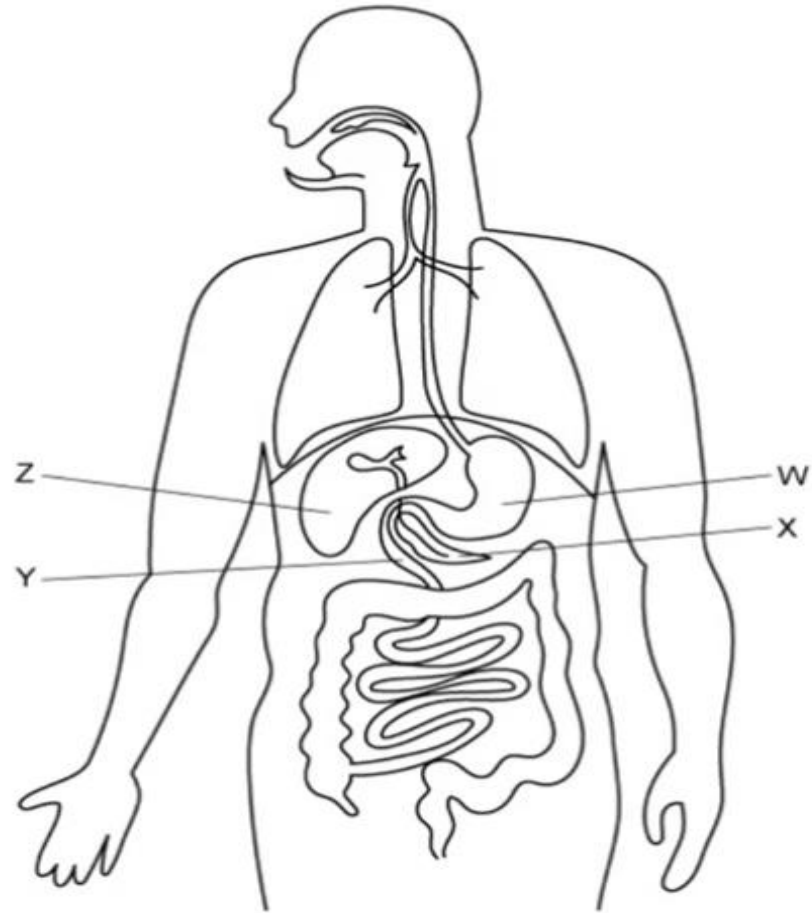
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Question	Answer	Marks
1(a)	<p>(food) is broken down into smaller pieces (without chemical change) ;</p> <p><i>sites of mechanical digestion:</i> mouth / buccal cavity (in context mechanical) ; stomach (in context of mechanical) ;</p> <p>chewing / mastication ; role of a named teeth ; <i>ref to</i> involvement of tongue ; <i>ref to</i> movement of the jaw ; churning / muscular, action of the stomach ;</p>	4

The diagram below shows the organs of the digestive system.



In which organs does the digestion of proteins take place?

- A** W & Y **B** W & Z **C** Z only **D** W & X

The walls of the alimentary canal (*digestive system*) contain smooth muscles ! Food moves throughout the length of the alimentary canal by peristalsis



Remember: sugars in the stomach are disaccharides and a small amount of polysaccharides, that couldn't be digested in the mouth. **digested yet.** Fats in the stomach, are **not**



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Thank you