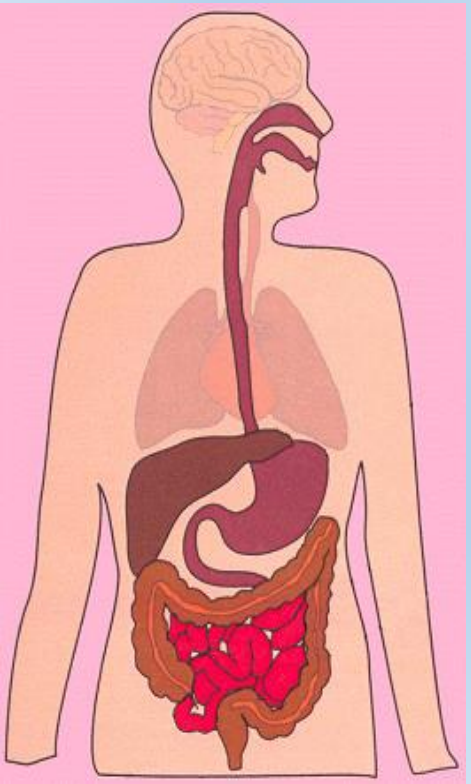
Biology Grade 9

CHAPTER 1: FROM FOOD TO NUTRIENTS: DIGESTION



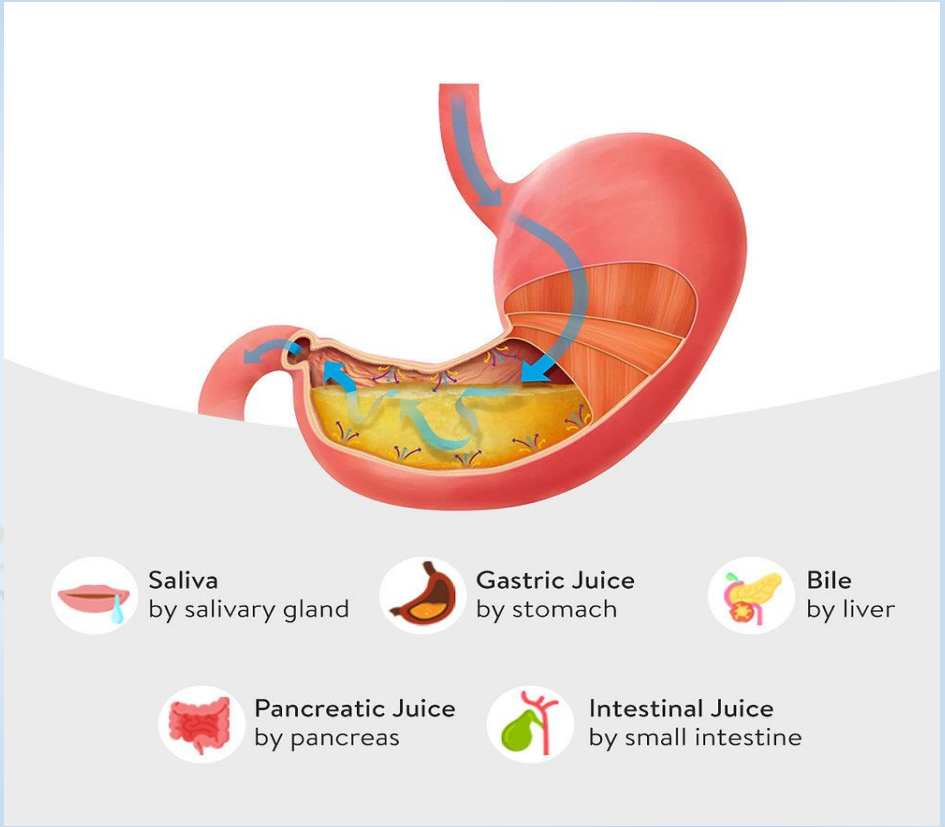
Activity 4: From Food to Nutrients

INSTRUCTOR: SUHAIB AUDI

Activity 4: From Food to Nutrients

❖ Digestive juices:

- Digestive juices are secretions from digestive glands into the digestive tube.
- These juices do not necessarily act at the site where they are produced.
- A **digestive juice** is **not the same** as an **enzyme**.
- A digestive juice contains **one or more enzymes**.
- An **enzyme** is **specific** to a certain type of food, while a **digestive juice** may act on **different types of food** because it contains a variety of enzymes.

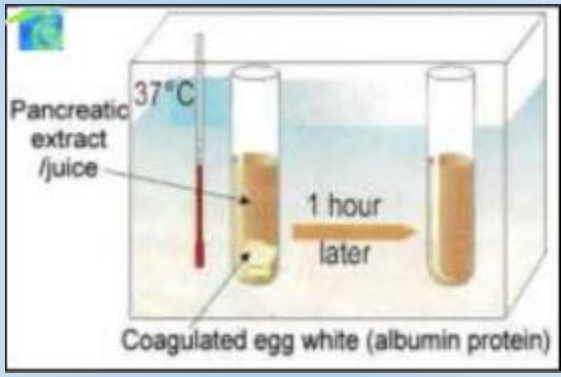


The following table summarizes the digestive juices produced in different digestive organs.

Organ	Juice	Enzyme	Substrate	Result	Medium
Mouth	Saliva	Amylase	Cooked starch	Maltose	Neutral pH=7
Stomach	Gastric juice	Pepsin	Protein	Peptide	Acidic pH=2
Small intestine	Pancreatic juice	Trypsin	Protein	Amino acids	Basic pH=8
		Amylase	Cooked and uncooked starch	Maltose	
		Lipase	Lipids	Glycerol and Fatty acids	
	Intestinal juice	Erepsin	polypeptide	Amino acids	
		Lipase	Lipids	Glycerol and Fatty acids	
		Maltase	Maltose	Glucose	
		Lactase	Lactose	Glucose and Galactose	
		Sucrase	Sucrose	Glucose and Fructose	

❖ Protein digestion

Protein is necessary for building our muscles; it is found in high concentration in egg white under the name of albumin. In our research of studying the digestion process of protein, we conduct the following in-vitro experiment.



a- Pick out the organic constituent of the albumin.

Proteins

b- Draw out the source of the added extract.

Pancreas.

c- Formulate a hypothesis to explain the result observed.

Hypothesis: **Pancreatic extract contains enzymes that digest albumin.**

d- Interpret the results of experiment doc a.

After 1 hour, in the presence of pancreatic extract, the coagulated egg white disappears.

This means that the pancreatic extract digest the egg white (protein).

In order to examine our hypothesis, we applied biuret test for the tube at different intervals of time, and we measured the % of intact enzymes inside the pancreatic juice.

Knowing that, proteins give coagulation aspect with their specific food test while short proteins (peptide) don't.

(Min)	Biuret test	% of the enzyme
0	Violet color + coagulation	100
30	Violet color	100
60	Violet color disappeared	100

d- Verify if your hypothesis is validated / verified /proved / confirmed.

At 0 min, protein was present then it is transformed into peptides at 30min and then into amino acids at 60 min. **So, pancreatic extract contains enzymes that digest albumin protein.**

e- Show that "During chemical transformation, enzymes remain intact". (Intact: not broken).

Since during digestion from 0 to 60min, the % of enzyme remains constant at 100%, then **during chemical transformation enzymes remain intact**.

There is a big suspection that there may be more than one enzyme that can digest protein but in different modes. In order to solve this suspection, we add to a piece of protein two different suspected enzymes: **Pepsin (produced by stomach) and Trypsin (produced by pancreas)**. The results are illustrated beside:

Tubes	A	B
Enzyme	Pepsin	Trypsin
Substrate at 0 min	Protein	Protein
Time	⇩	⇩
At 30 min	Peptide	Peptide
At 60 min	Peptide	Amino acids

f- Distinguish between the modes of action of pepsin and trypsin.

Pepsin digests protein into peptides while trypsin digests protein into amino acids.

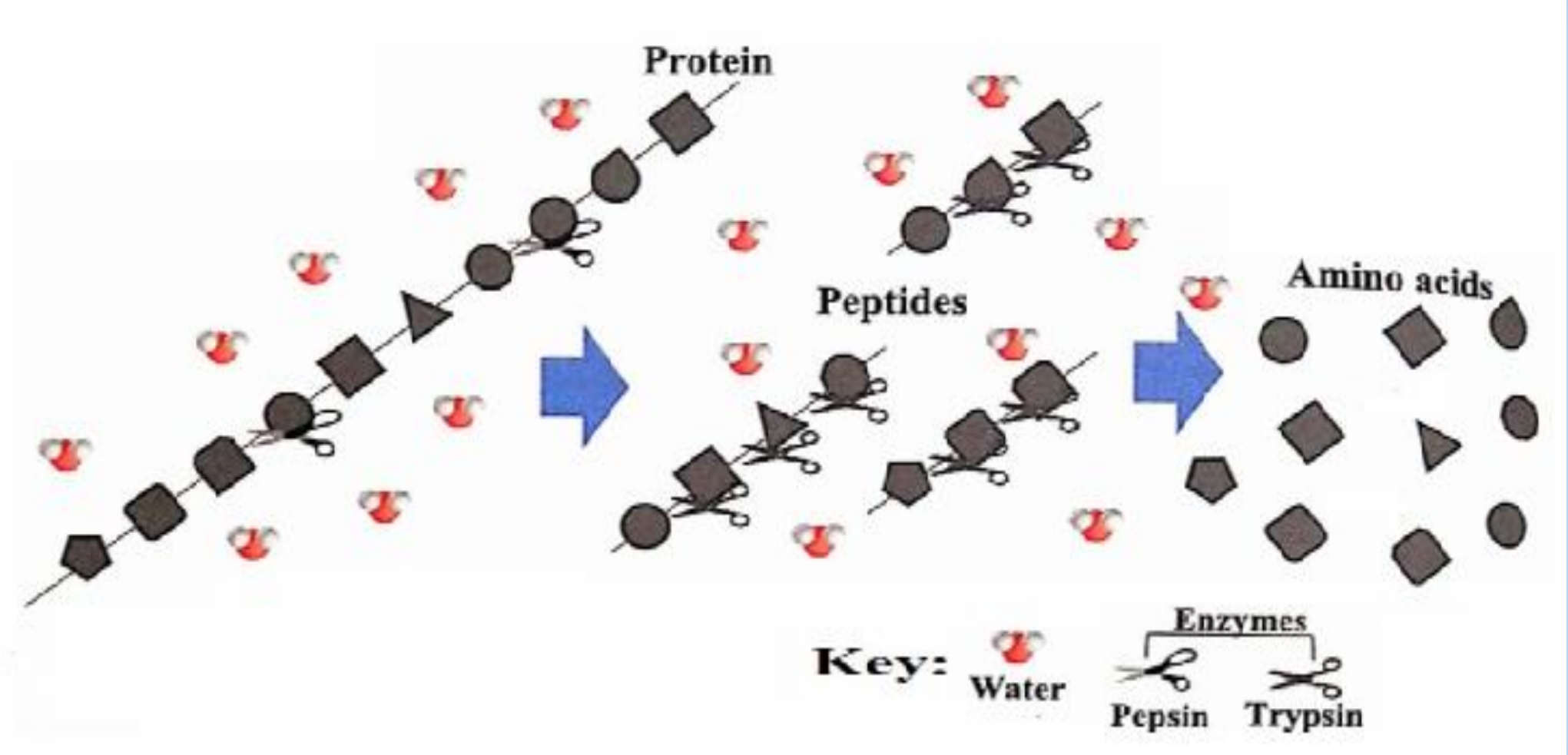
g- Name the final product of protein digestion.

Amino acids.

h- Indicate the pH of the chemical medium in the stomach and in the small intestine. Justify your answer.

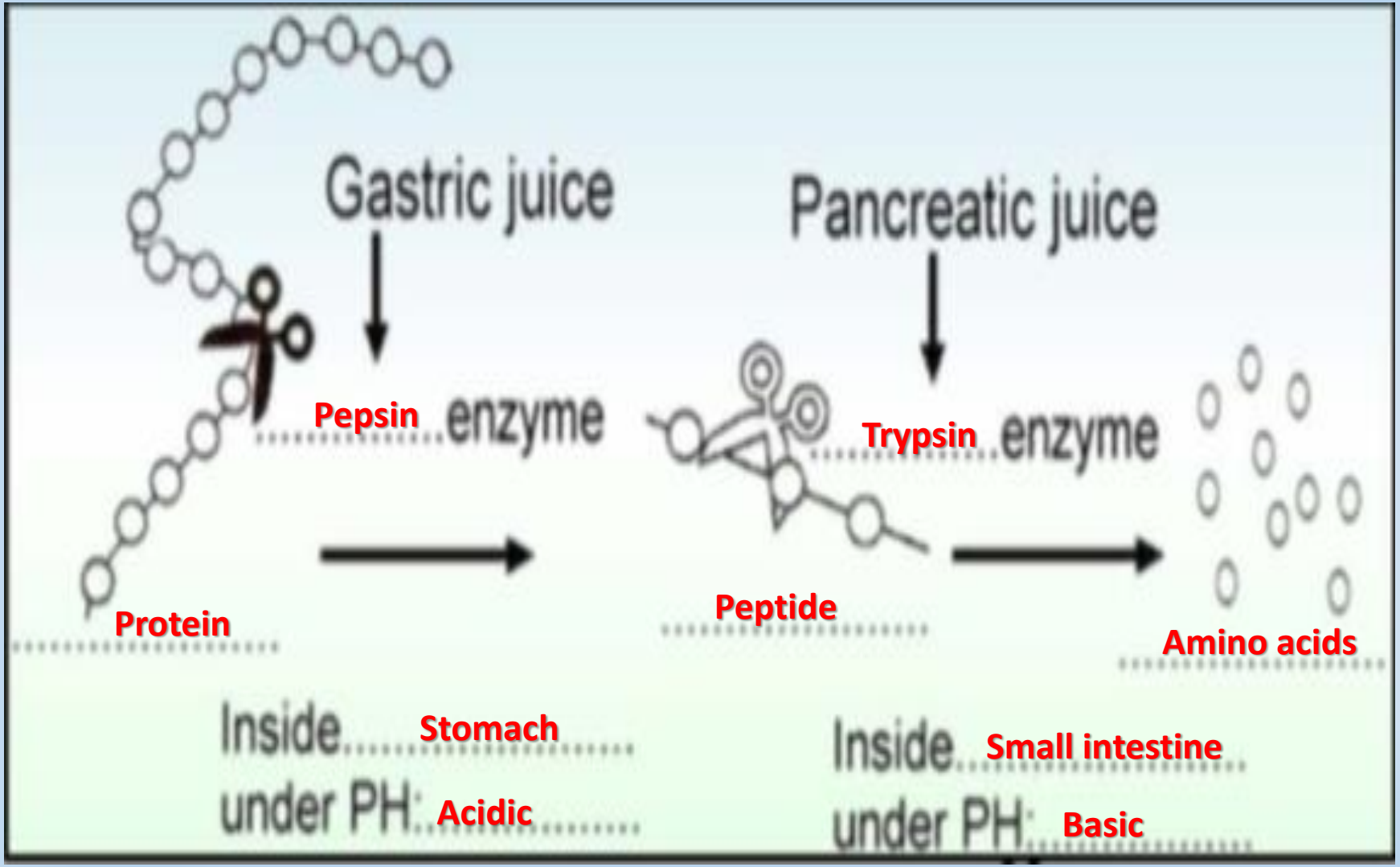
- The pH medium of the stomach is acidic, since pepsin that is secreted in the stomach is active at an acidic pH.
- The pH medium of the small intestine is basic, since trypsin that is secreted in the small intestine is active at a basic pH.

i- Draw the schematic diagram of the molecular simplification of proteins into amino acids.



Title: Schematic diagram of the molecular simplification of proteins into amino acids.

❑ Summarize all the steps of the molecular simplification of protein.



Title: Molecular simplification of protein.

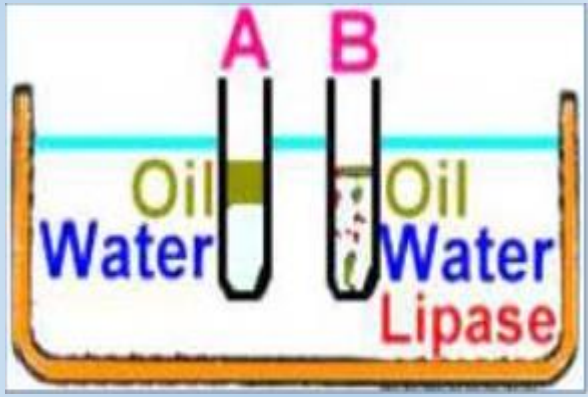
Note:

- **Proteases:** are the enzymes that digest proteins ex: pepsin, trypsin..
- **Peptidases:** are the enzymes that digest peptide ex: trypsin

	Pepsin	Trypsin
Similarities	Protein digestive enzyme (protease)	Protein digestive enzyme (protease)
Differences	• Secreted by stomach • Digest proteins into peptides • Optimal pH = 2 (acidic)	• Secreted by pancreas • Digest peptides into amino acids • Optimal pH = 8 (basic)

❖ Digestion of Lipids

Lipids are fats in solid states and oil in liquid states. They are an important source of energy but they can cause heart diseases in case of sedentary life. So how are lipids being digested? In our study of the digestion process of lipids, we suspect that an enzyme called lipase, found in pancreatic juice, digests this lipid. To validate this hypothesis, we conduct the following experiment under the convenient conditions.



1) 1.1. Pick out the posed problem.

How are lipids being digested?

1.2. Pick out the studied hypothesis.

Hypothesis: An enzyme called lipase, found in pancreatic juice, digest lipids.

1.3. Pick out the sentence that shows the benefit and the side effect of lipids.

They are an important source of energy but they can cause heart diseases in case of sedentary life.

1.4. Pick out the variable factor.

Lipase in tube B only.

The results are illustrated in the given table:

Time (hrs)		0	1	2	3
Tube A	% Oil	100	100	100	100
Tube B	% Oil	100	80	65	60
	% Fatty acids	0	20	35	40

2. Determine if digestion really took place in tube A.

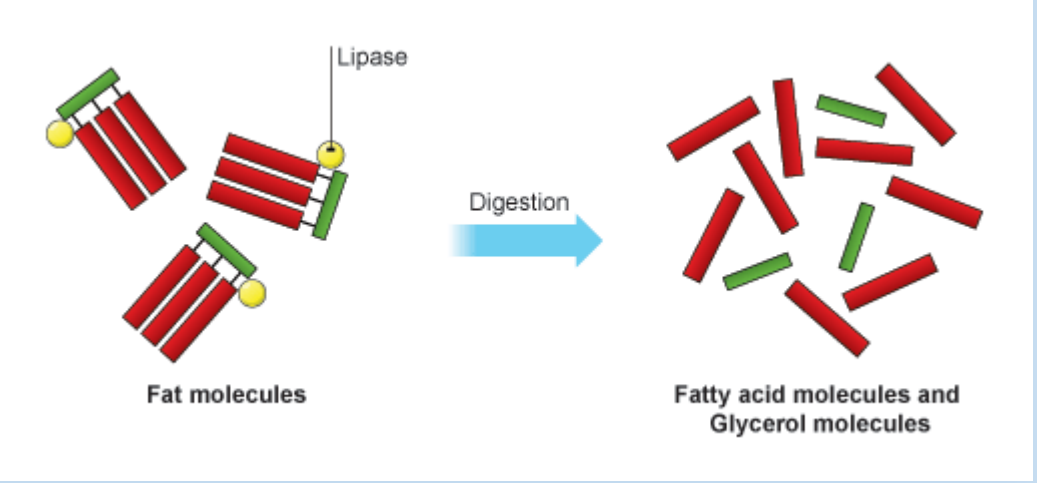
Since in tube A the % of oil remains constant at 100% as the time increases from 0 to 3 hrs. **Then digestion didn't take place.**

3. Interpret the results of tube B.

The % of oil decreases from 100% to 60% **while** the % of fatty acid increases from 0 to 40% as the time increases from o to 3hrs in tube B that contains lipase enzyme. **This indicates that lipase partially digests oil into fatty acids.**

4. Conclude concerning the role of lipase.

We conclude that lipase is a specific enzyme that digests lipids into fatty acids.



5- Construct a graph that shows the result of tube B.

Time (hrs)		0	1	2	3
Tube A	% Oil	100	100	100	100
Tube B	% Oil	100	80	65	60
	% Fatty acids	0	20	35	40

Scale: 10%

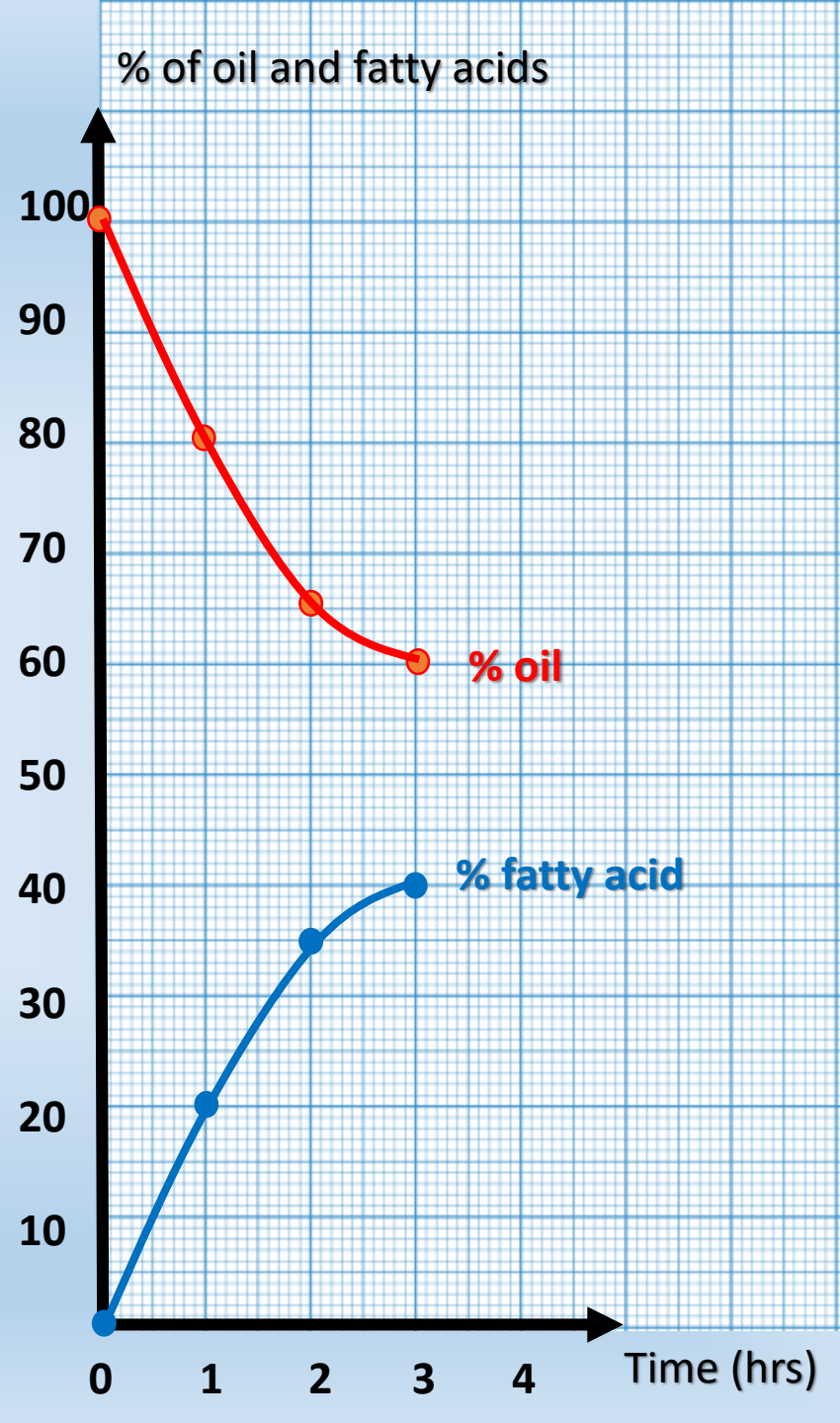
1 hr

Title: A graph shows the variation of the % of oil and fatty Acids in tube B as a function of time (hrs).

Interpret the results of tube B.

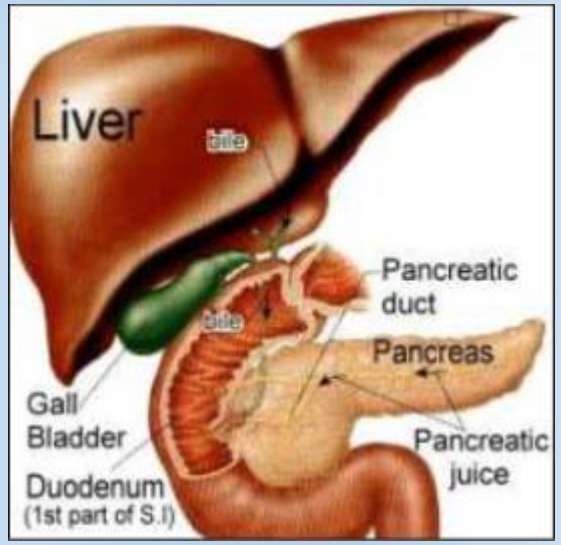
The % of oil decreases from 100% to 60% **while** the % of fatty acid increases from 0 to 40% as the time increases from o to 3hrs in tube B that contains lipase enzyme.

This indicates that lipase <u>partially</u> digests oil into fatty acids.



❑ Role of Bile ? 🤔

Bile is a liquid secreted by the liver and stored in the gall bladder. Some scientists supposed that **bile is an enzyme that digests lipids**, others thought, **bile may facilitate lipid digestion**. So, in order to know the real role of bile, we conduct 2 experiments in tubes C and D.



1- Pick out the objective of this experiment.

To know the real role of bile.

2- Draw out the two studied hypotheses.

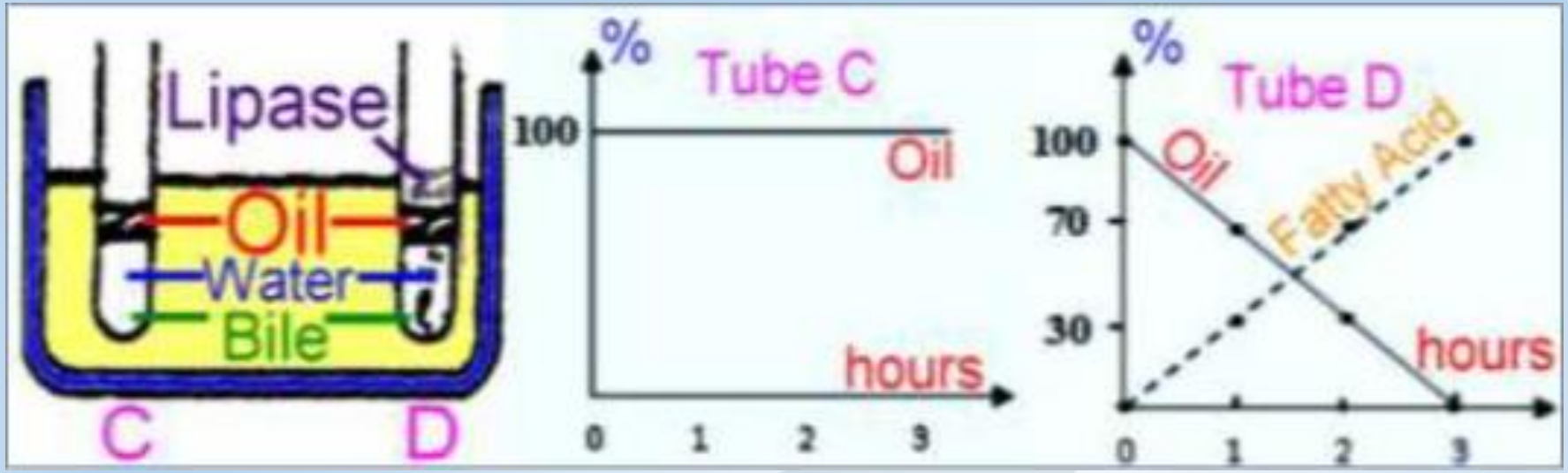
Hypothesis-1: Bile is an enzyme that digests lipids.

Hypothesis-2: Bile facilitates lipid digestion.

3- Pick out the sentence that shows the source of bile.

Bile is a liquid secreted by liver and stored in gall bladder.

The results of both tubes are summarized below:



4- Determine if the 1st hypothesis is validated.

Since the % of oil remains constant at 100% in C that **contains only bile**, then bile couldn't digest oil, so it is not an enzyme. It is not validated.

5- Give the significance indicated by the results obtained in tube D.

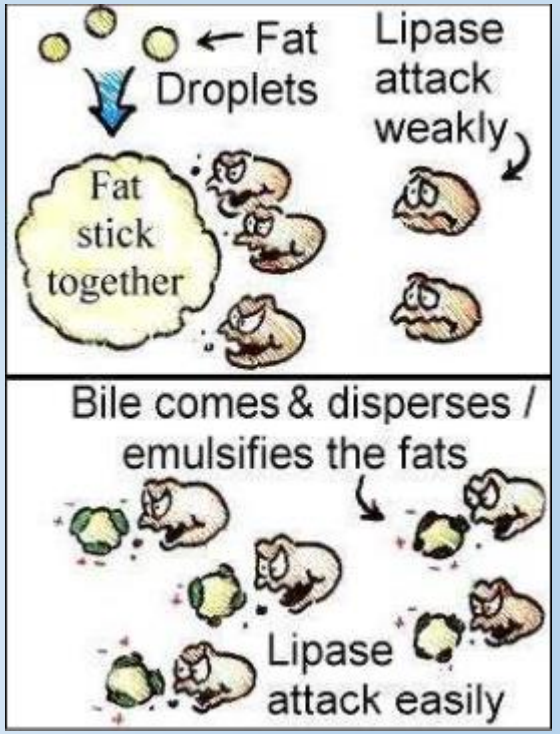
In the presence of Bile, lipase digests oil **completely** into fatty acid.

6- conclude the role of bile.

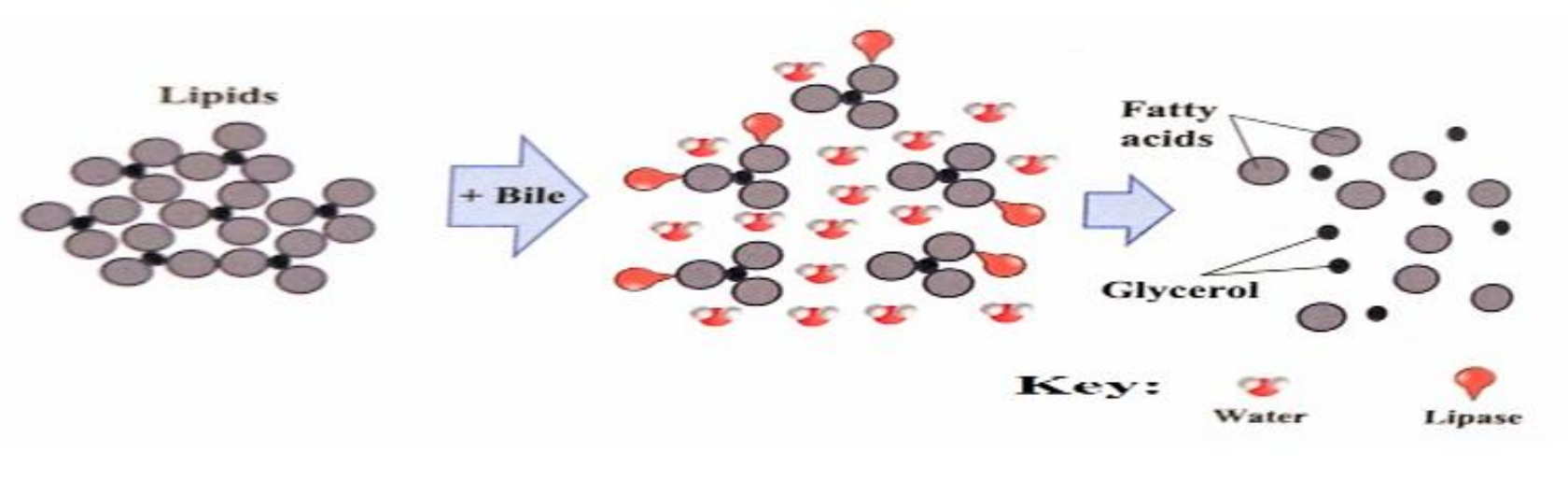
Bile **Facilitates** lipid digestion.

7- Referring to the adjacent figure, explain the mode of action of bile.

Bile disperses or emulsifies oil which facilitates the action of lipase.



8- Knowing that glycerol was obtained with 3 fatty acids at the end, schematize this process.



Title: Schematic diagram showing the molecular simplification of lipids into fatty acids and glycerol.

Note: Bile is not a digestive juice since it doesn't contain digestive enzymes

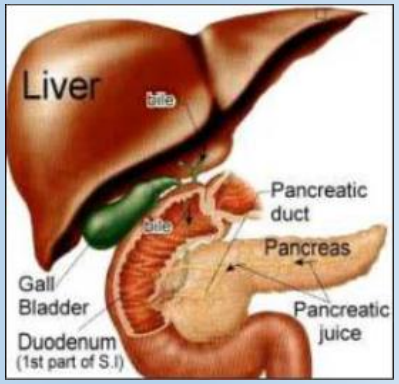
9- Name the products of digestion of one lipid molecule by its enzyme.

Three fatty acids and one glycerol molecule.

Summary:

❑ Bile:

- **Definition:** Greenish alkaline liquid made of minerals, water, pigments …
- **Manufactured** by the liver, **stored** in the gall bladder, and **poured** into the small intestine. (Duodenum).
- Note: Bile is not a digestive juice since it doesn't contain digestive enzymes.



- **Role:**

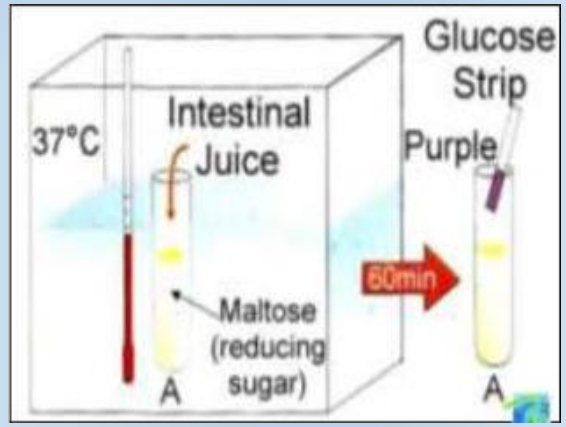
a) Renders the medium alkaline (basic) in the small intestine which is appropriate for the activity of the enzymes of the pancreatic and intestinal juices.

b) Facilitates the digestion of fats by splitting them into droplets (emulsification of fats) which in turn facilitates their digestion.

- **Note:** KOH has the same role as bile (both turns the medium basic).

❖ Digestion of Reducing Sugar (Maltose)

In our field of studying the digestion of maltose, we add intestinal juice to maltose solution, then we insert glucose strip to test its presence.
Glucose strip becomes purple in the presence of glucose & yellow in its absence.



1. Analyze the experiment.

Glucose strip turns **purple** after inserting it into the tube that contains intestinal juice with maltose.

2. Give the significance indicated by the color observed on the glucose strip.

This indicates the presence of glucose.

3. Derive a conclusion concerning the digestion of maltose.

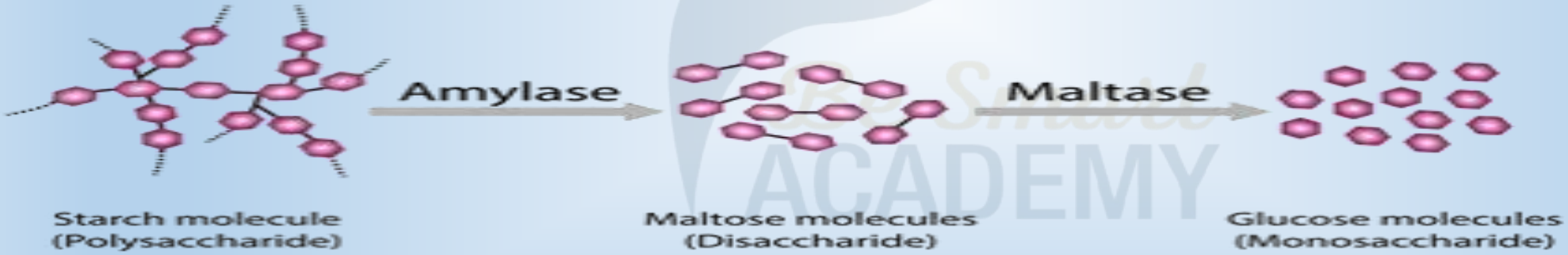
Intestinal juice contains enzymes that digest maltose into glucose.

❖ Digestion of starch

Substrate	Enzyme	pH	Temperature	Time	Product
Cooked starch	Salivary amylase	7	37°C	15min.	Maltose
Maltose	Maltase	8	37°C	15min.	Glucose

Table showing the conditions for digestion of starch and maltose

Cooked starch —Salivary amylase (pH=7)→ **Maltose** —Intestinal maltase (pH=8)→ **Glucose**

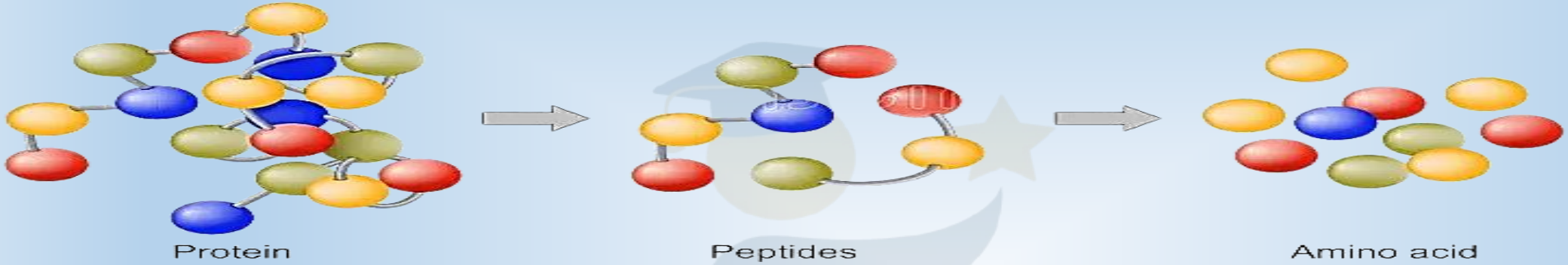


Notes:

- *Maltose with hot Fehling test gives brick red precipitate.*
- *Glucose with hot Fehling test gives brick red precipitate or with glucose test strip gives violet color.*

❖ Digestion of protein

Protein —Pepsin (pH = 2)→ **peptide** —Trypsin (pH = 8)→ **amino acids**



- Biuret test + **protein** → **Violet color (+ve test)**
- Biuret test + **peptide** → **Violet color (+ve test)**
- Biuret test + **amino acids** → **Blue color (-ve test)**

❖ Digestion of Lipid

Lipids —Bile→ emulsified lipids —Lipase (pH=8)→ Fatty acids and glycerol

✓ Bile: is a liquid secreted by liver and stored in gall bladder.

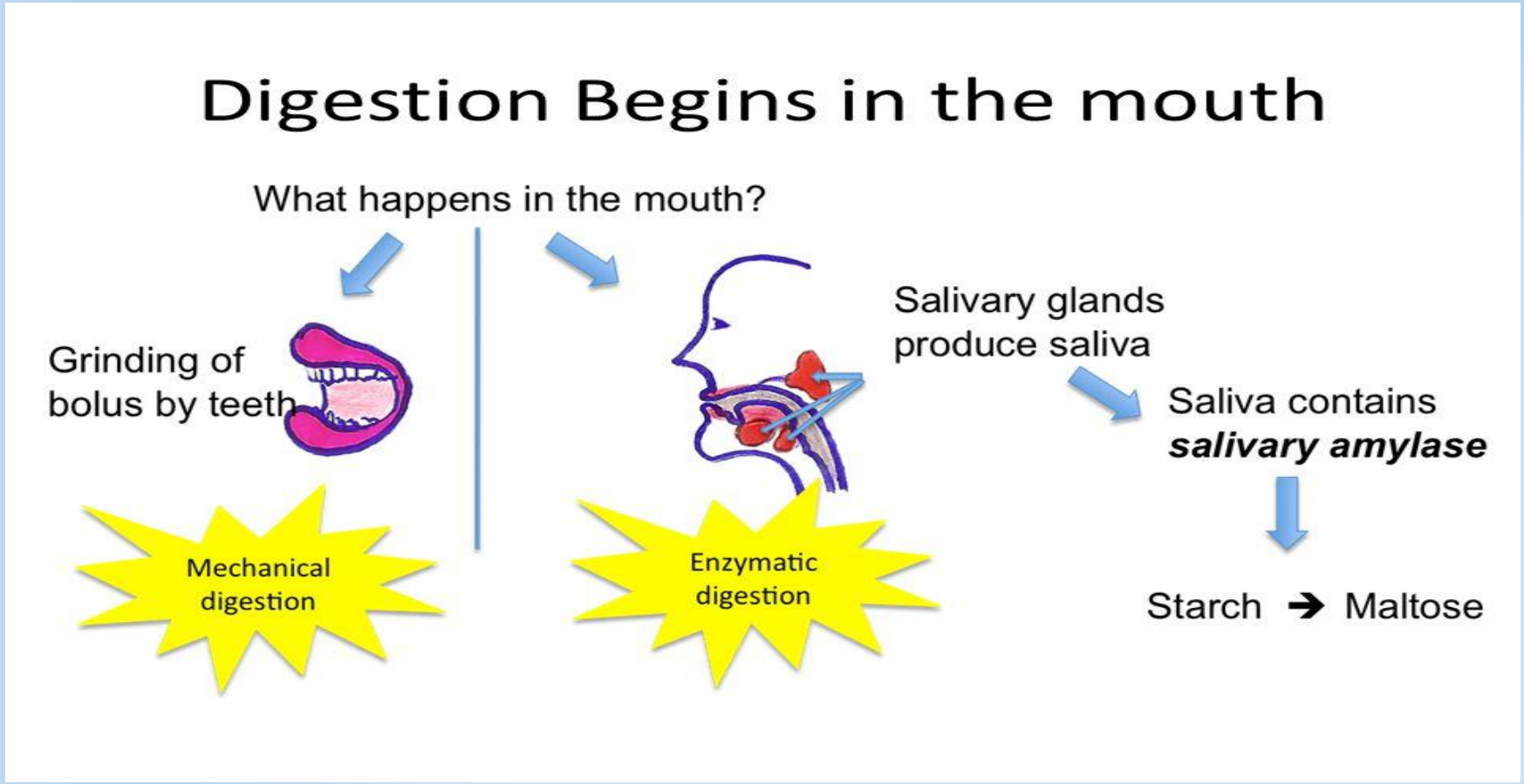
✓ It is not an enzyme.

✓ **Role of bile:**

1) emulsifies lipid.

2) renders the medium alkaline (basic).

❖ Mechanical vs. Chemical Digestion



Mechanical digestion: is the breakdown of large pieces of food into small ones without any change in their contents.

Chemical digestion: is the transformation of food into simple nutrients under the action of specific enzymes.

❖ Mechanical vs. Chemical Digestion

➢ **Digestion is a mechanical and chemical process that breaks down ingested food into nutrients.**

1. Distinguish between chemical and mechanical digestion.

- **Chemical digestion** is the digestion of food by **digestive enzymes**. In chemical digestion, the large carbohydrate, lipid and protein molecules in food are split into smaller molecules by **hydrolysis.**
- **Mechanical digestion** is a set of **physical movements** that enhance chemical digestion by breaking down large food pieces into smaller ones.

2. "Mechanical digestion facilitates chemical digestion". Justify this statement.

- Mechanical digestion facilitates chemical digestion in such a way that food become cut, dissolved and thoroughly mixed with digestive enzymes.

3. Give examples on mechanical digestion.

- **Mastication, the teeth cut and grind food before it is swallowed.**
- **Peristaltic movements, move the food through the digestive tract.**
- **Muscles in the wall of the esophagus push the food towards the stomach, causing a wave-like movement. This is peristalsis.**
- **The strong muscular walls of the stomach churn the food into chime (a semi fluid mixture).**

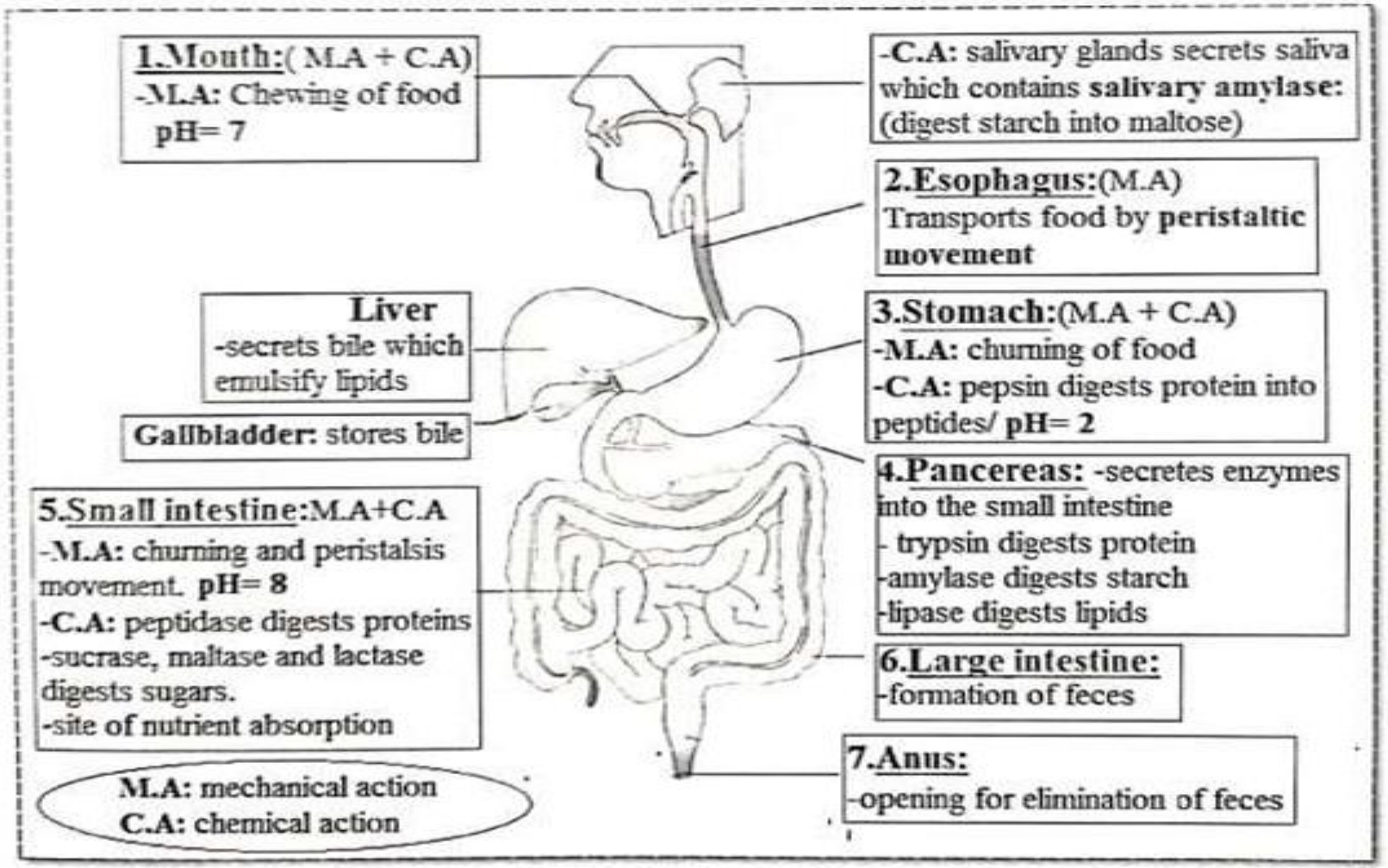
Classify the following actions into chemical and mechanical digestion by using (+).

Digestive tube	Mouth		Esophagus	Stomach		Small intestine		Large intestine
Action	Teeth	Salivary amylase	Peristaltic movement	Gastric pepsin	Churning movement	Peristaltic movement	Pancreatic juices	Peristaltic movement
Mechanical	+		+		+	+		+
Chemical		+		+			+	

Digestion

Chemical digestion (C.A)

Mechanical digestion (M.A)



1.Mouth:(M.A + C.A)
-**M.A:** Chewing of food
pH= 7

-**C.A:** salivary glands secrets saliva which contains **salivary amylase:** (digest starch into maltose)

2.Esophagus:(M.A)
Transports food by **peristaltic movement**

Liver
-secrets bile which emulsify lipids

Gallbladder: stores bile

3.Stomach:(M.A + C.A)
-**M.A:** churning of food
-**C.A:** pepsin digests protein into peptides/ **pH= 2**

4.Pancereas: -secretes enzymes into the small intestine
- trypsin digests protein
-amylase digests starch
-lipase digests lipids

5.Small intestine:M.A+C.A
-**M.A:** churning and peristalsis movement. **pH= 8**
-**C.A:** peptidase digests proteins
-sucrase, maltase and lactase digests sugars.
-site of nutrient absorption

6.Large intestine:
-formation of feces

7.Anus:
-opening for elimination of feces

M.A: mechanical action
C.A: chemical action