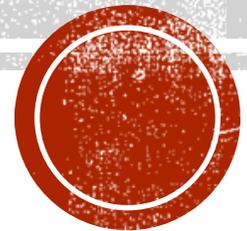


# Lipid Digestion & Absorption



# Students Learning Outcomes

❖ **By the end of this lecture, the students should be able to:**

1. Describe how Lipids are digested
2. Explain how the products of lipid digestion are absorbed into the blood
3. Illustrate the role of bile in lipid digestion



# Content

**I. Lipid digestion**

**II. Lipid absorption**



# Lipid digestion

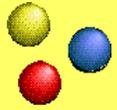
## Definition of lipids:

Lipids are heterogenous compounds of water insoluble (hydrophobic ) organic molecule

## Composition of ingested lipid

**90%** : Triglycerides (TGs)

**10%** : Cholesterol, cholesterol esters, phospholipids, free fatty acids



- Source of energy: 1 gm supplies 9.1 calories
- Minimal amount of fat is essential in our food to:
  - Essential fatty acids
  - Help Fat-soluble vitamins absorption

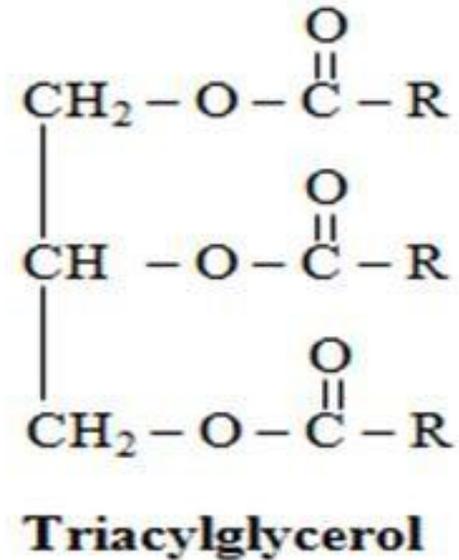
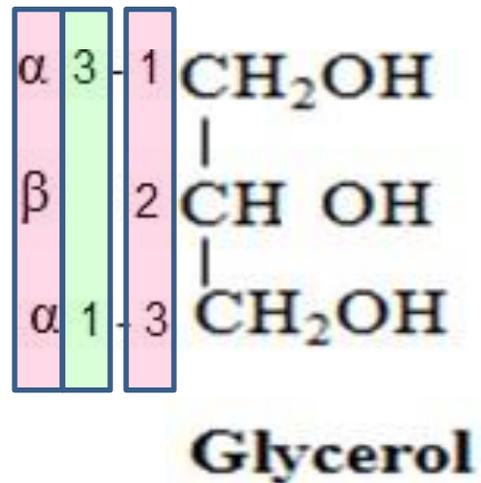
# Lipids



# Lipid digestion

- 1- Triglycerides (TGs)
- 2- Cholesterol esters
- 3- Phospholipids

# I. Digestion of triglycerides (TG)



**A- Emulsification**

**B- Enzymatic hydrolysis by lipase enzymes**



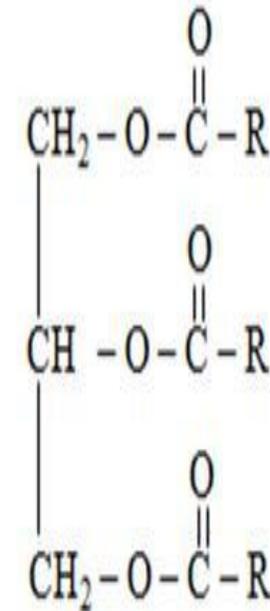
# I. Digestion of triglycerides (TG)

## A) Emulsification

**Definition :** It is the Breakdown of large fat globule into small molecules → increasing the surface area upon which the pancreatic lipase enzyme will act .

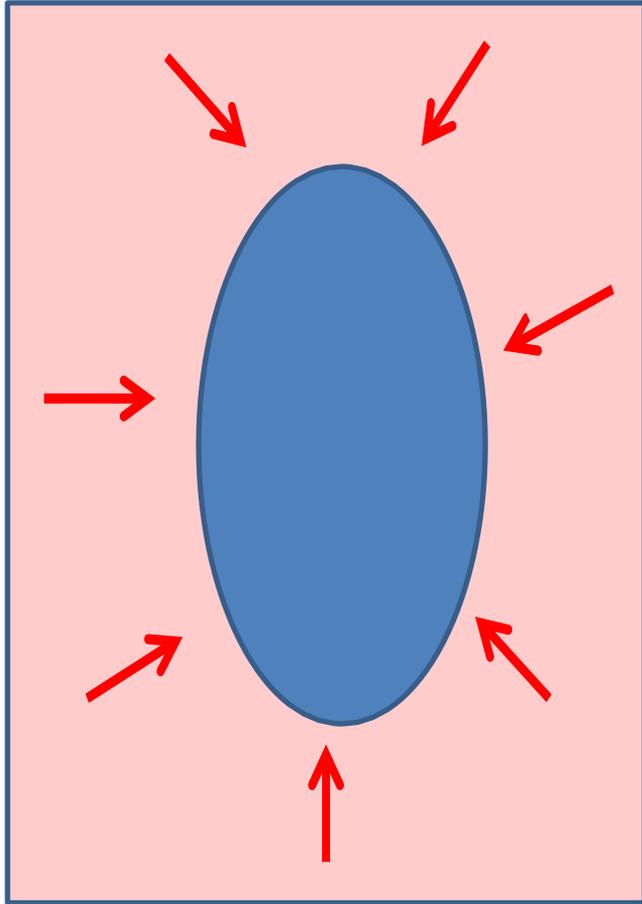
**Emulsification is done in**

1. **Mouth** by chewing
2. **Stomach** by peristaltic contractions
3. **Intestine** by peristaltic movement and bile salts



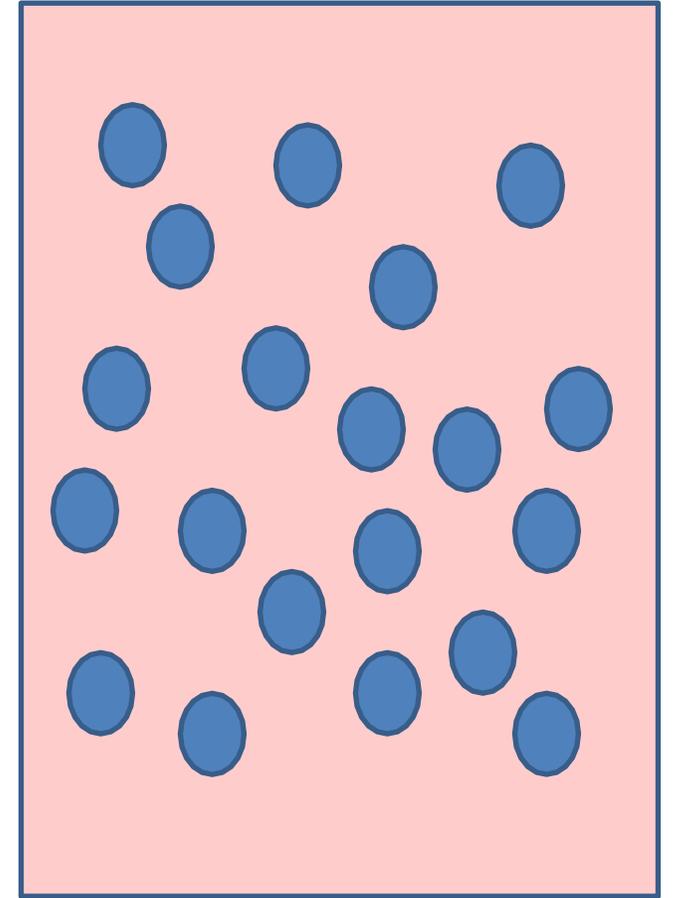
Triacylglycerol





**Large fat globule**

**Emulsification**



**Small molecules**



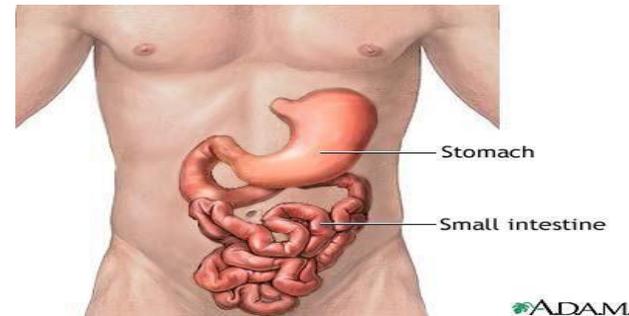
## B) Digestion by lipase enzymes

### Types of lipase enzymes:

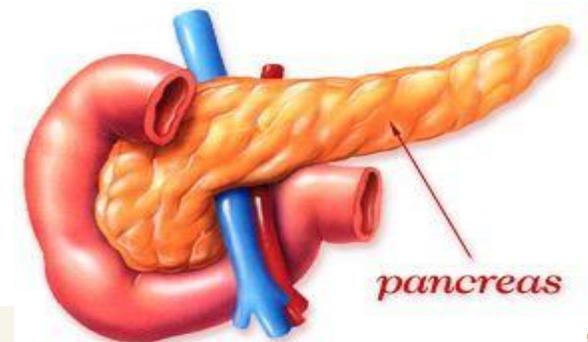


**1 Lingual lipase**

**2 Gastric lipase**



**3 Pancreatic lipase**



**the most active one is pancreatic lipase**



## 1- Lingual lipase

- Secreted from the **dorsal** surface of the **tongue**
- It has a minimal significance

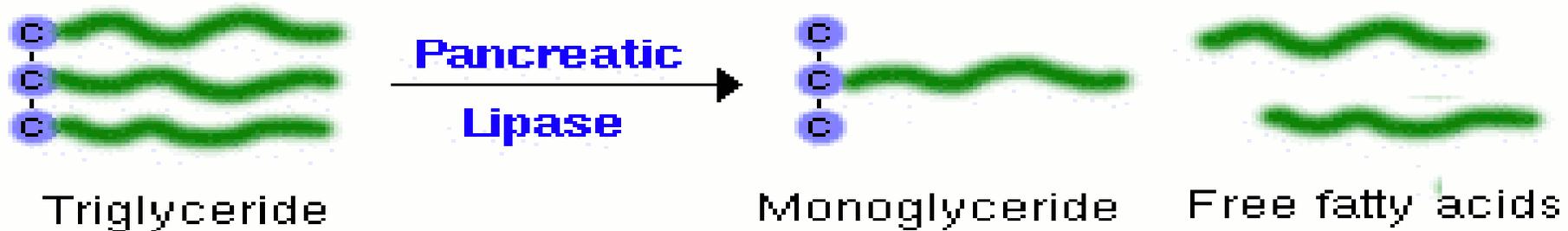
## 2- Gastric lipase

- Secreted from the **gastric juice**
- It has a minimal significance

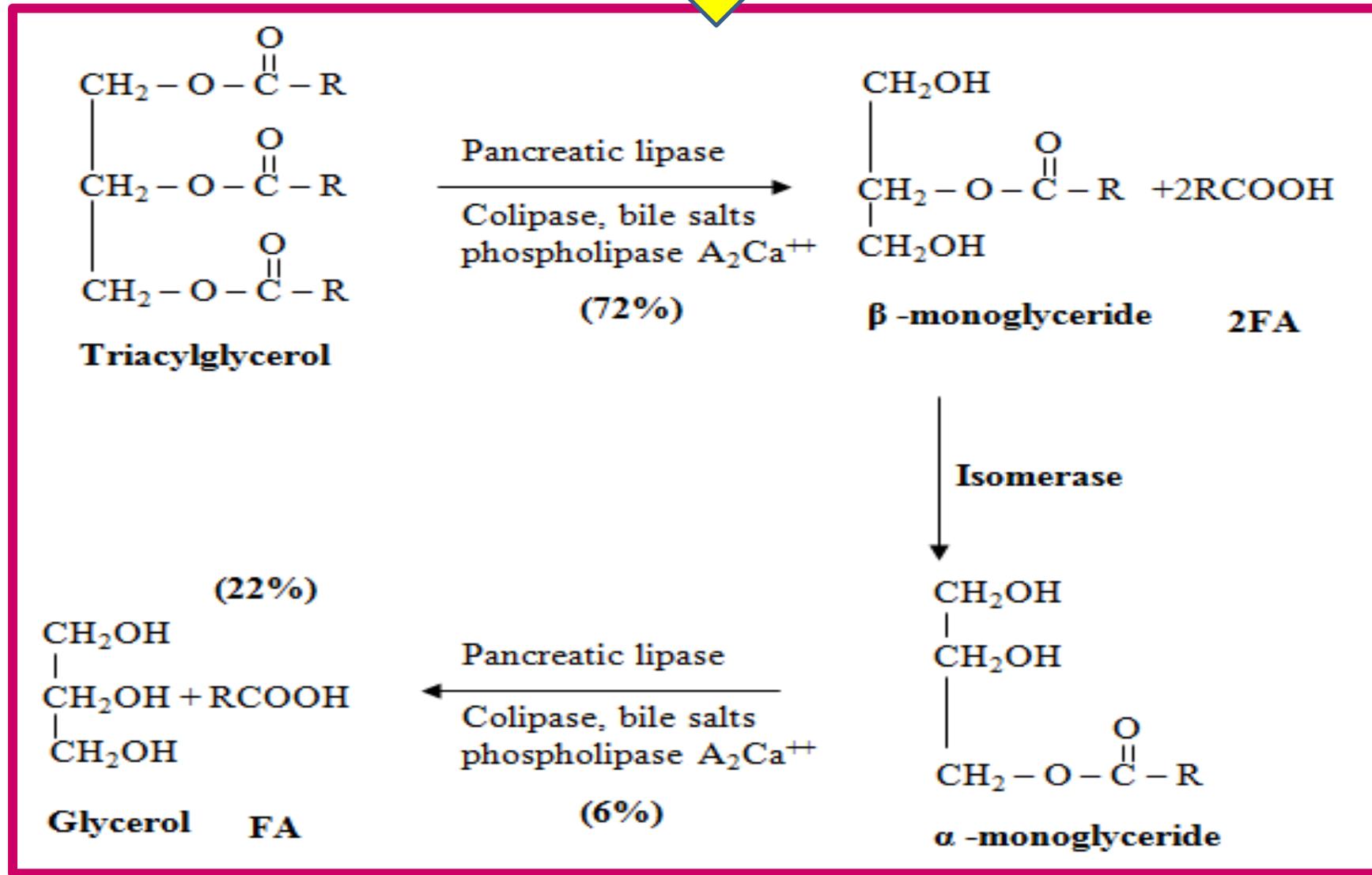


# 3- Pancreatic lipase

- **Major enzyme** acting on TGs
- **Secreted from:** the pancreatic juice
- **Optimum PH:** 8 ( alkaline)
- **Activated by:** Ca, bile salts, co lipase
- **Acts on:** outer primary alpha ester bond of TG producing:
  - 2 free fatty acids (FFA) and
  - **$\beta$  monoglycerides ( $\beta$  MAG)** in intestinal lumen

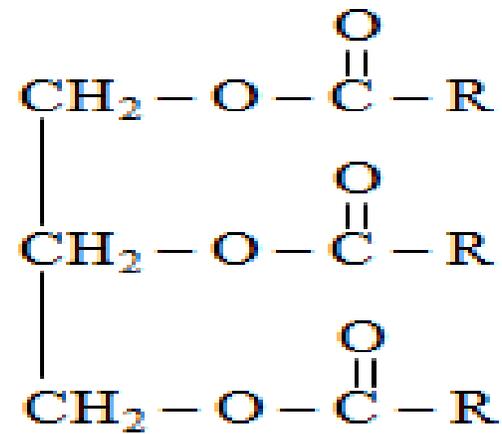


# 3- PANCREATIC LIPASE

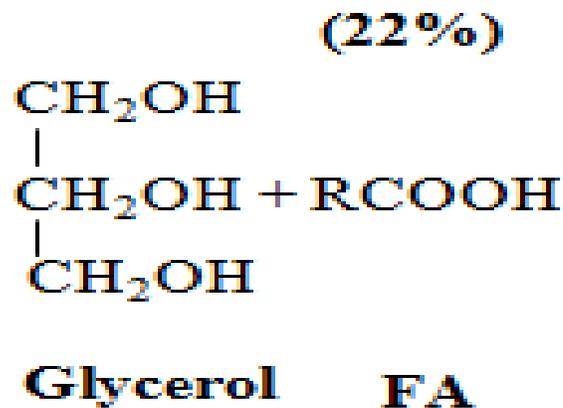
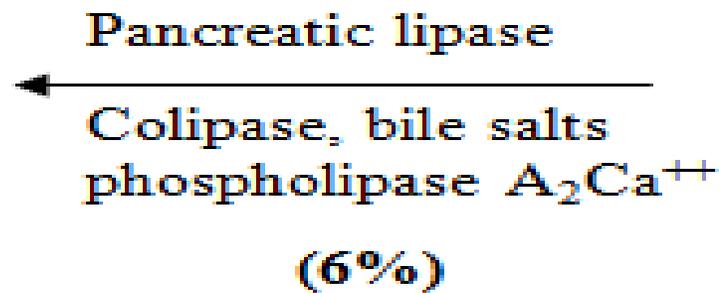
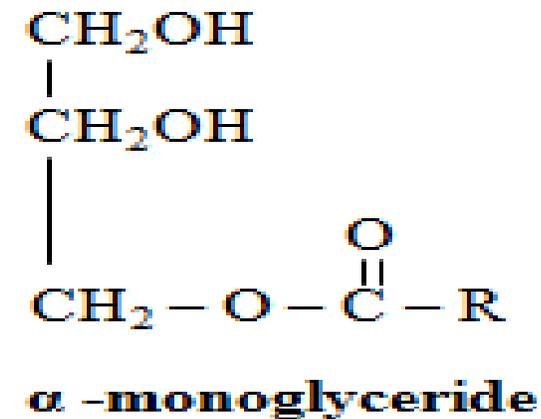
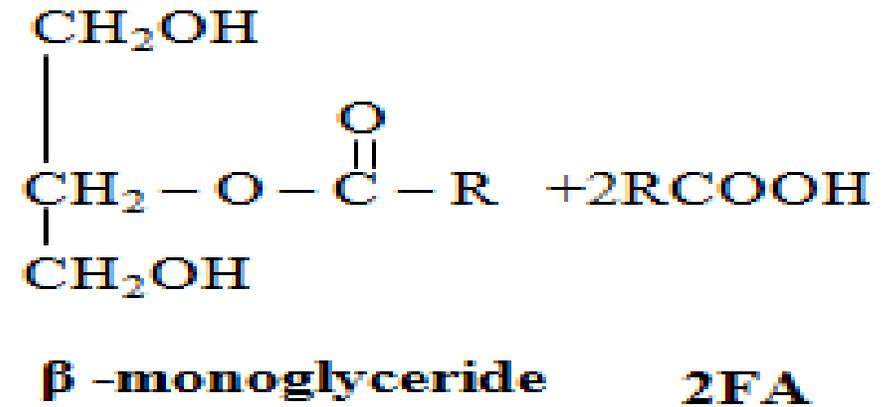
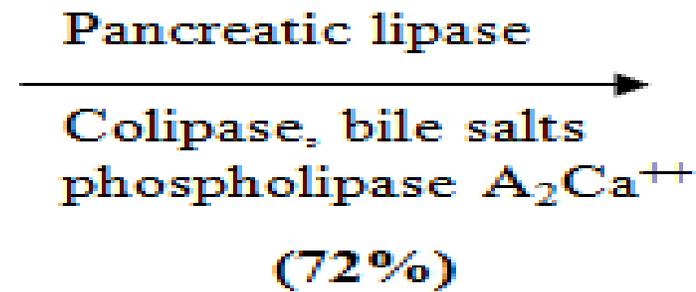


- **Fate of  $\beta$  monoglycerides ( $\beta$  MAG)**
  - **72%** is absorbed as such with the help of bile salts
  - **28%** is converted to  $\alpha$  monoglyceride by **isomerase** enzyme
- **Fate  $\alpha$  monoglyceride ( $\alpha$  MAG)**
  - **6%** is absorbed as such with the help of bile salts
  - **22%** undergo hydrolysis by **pancreatic lipase** into:
    - Glycerol
    - FFA





**Triacylglycerol**



## 4- INTESTINAL LIPASE



✓ Act within intestinal mucosal cells →  
hydrolyse the absorbed primary ( $\alpha$ )  
monoglycerides forming glycerol and FFA



## II. Digestion of Cholesterol Esters

- **By the action of cholesterol esterase enzyme**  
**(in intestinal lumen)**
- **Products of digestion:**
  - ✓ **Free cholesterol**
  - ✓ **Fatty acids**



## III. Digestion of Phospholipids

- **By the action of phospholipase A2. enzyme** (in intestinal lumen), activated by **trypsin** & requires **bile salts** for activity
- **Products of digestion:**
  - ✓ **Lysophospholipids**
  - ✓ **Fatty acids**



# Lipid Absorption

- 1- Triglycerides (TGs)
- 2- Cholesterol esters
- 3- Phospholipids

# Lipid Absorption

It is the transport of lipids from the intestinal lumen into the mucosal cells of intestine:

The end products of lipid digestion are

1.  $\alpha$  monoglycerides
2.  $\beta$  monoglycerides
3. Fatty acids
4. Glycerol
5. Cholesterol
6. Lyso-phospholipids

# 1- Glycerol , short chain FA

- Both are water soluble
- So, absorbed to the portal circulation → liver

# 2- Long chain FA, monoglycerides Cholesterol & Lyso-phospholipids

- All are **water insoluble**
- So, need the help of **bile salts** to be absorbed

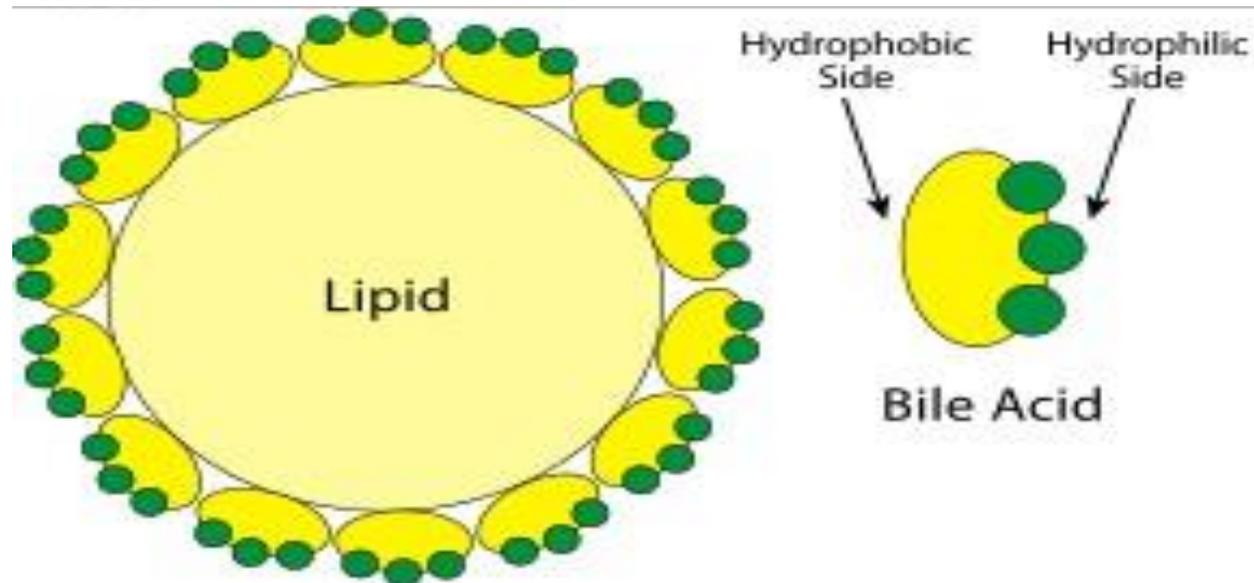


# Mechanism by which bile salts help in absorption of lipid

How



- Bile salts surround these component (by their unpolar end while their polar endings directing outward) → water soluble micelles (0.1 –0.5  $\mu$  in diameter)

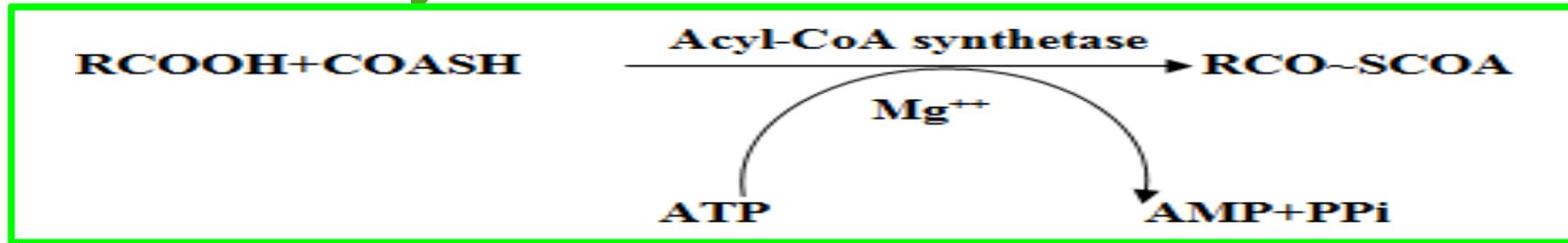


## Mechanism by which bile salts help in absorption of lipid

- ❑ Water soluble **micelles** → enter the **intestinal villi by endocytosis** → where fat digestion is completed (through action of **intestinal lipase (on  $\alpha$  monoglycerides)**).
- ❑ Then the bile salts are separated from these lipid components in the **intestinal mucosa** → and **reabsorbed to the liver** through the enterohepatic circulation

Then In the mucosal cells , the TGs and other lipids are resynthesized once again as follow:

### I. FA activated to acyl-CoA



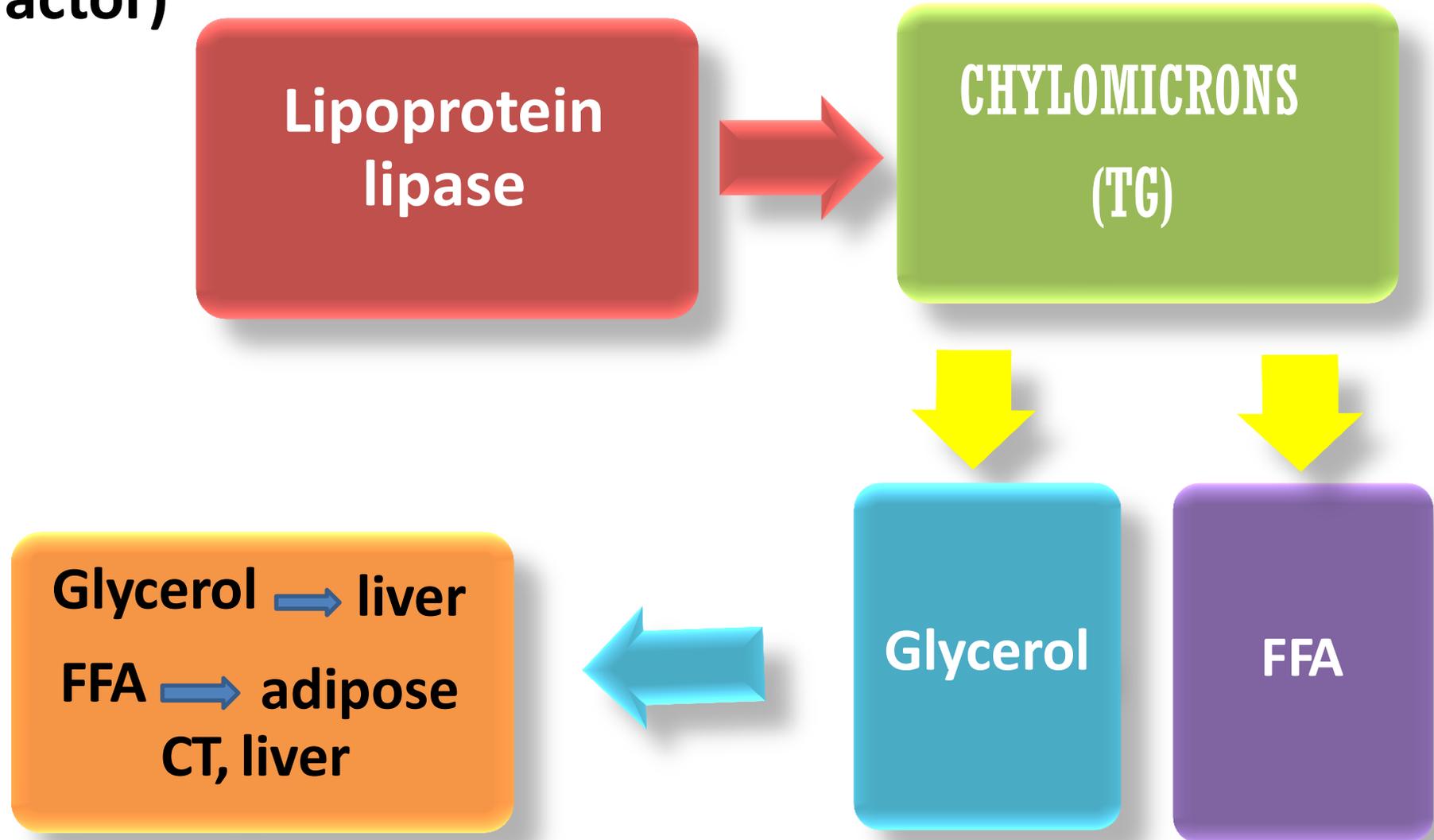
### II. Fatty acyl CoA then binds to:

- 1- **β MAG** → to reform TGs
- 2- **cholesterol** → to form Cholesterol esters
- 3- **lysophospholipids** → to form phospholipids

### III. TGs, Cholesterol esters & phospholipids

All are water insoluble → bind to **apolipoprotein B48** → form **chylomicrons** → pass through lymphatic vessels → thoracic duct → to systemic circulation, causing **plasma turbidity** (lipemic plasma) **2 hours after meal**.

This turbidity is soon cleared by lipoprotein lipase enzyme (Plasma clearing factor)



**Life**  
isn't about  
finding yourself.

...

**Life**  
is about  
creating yourself.

