Lipid metabolism

By

Dr. Hussein Abdelaziz
Objectives

By the end of lecture the student should:

- Identify importance of lipids in food.
- Describe digestion of different types of lipids.
- Illustrate absorption of lipids from intestine.
- Summarize transport of dietary lipids from intestine.
• 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
Digestion of lipids

1- Triglycerides
2- Phospholipids
3- Cholesterol esters
1- Digestion of triglycerides

A- Emulsification

B- Enzymatic hydrolysis by lipase enzymes
• Breakdown of large fat globule → small ones
- Breakdown of large fat globule → small ones
- Occurs in:
  - Mouth by chewing
  - Stomach by peristaltic contractions
  - Intestine by peristaltic movement,
    - bile salts
    - lysophospholipids
Types:
1- lingual lipase
2- gastric lipase
3- pancreatic lipase
4- intestinal lipase
the most active is pancreatic lipase.
1- Lingual lipase

- secreted by the dorsal surface of the tongue (Von-Ebner’s glands)
- Is not of much significance in humans compared to rat or mouse
physiological significance in:

- **Infants:**
- **adults:**

2- Gastric lipase (pH 3-6)

- Triacylglycerols
  - Short & medium chain unsaturated fatty acids
- Gastric lipase (infants)
- Short & medium free fatty acids & 1,2 diacylglycerols
Act within intestinal mucosal cells to hydrolyse the absorbed primary (α) monoglycerides forming glycerol and FFA.
2- Digestion of phospholipids

- Phospholipids → lysophospholipids

- Intestinal phospholipase may complete the hydrolysis of lysophospholipids

- Phospholipase A$_2$ activated by trypsin & requires bile salts for activity
3- Digestion of cholesterol esters

Cholesterol esters by cholesterol esterase $\rightarrow$ FA & free cholesterol
The end products of lipid digestion are:

- monoglycerides,
- FA,
- glycerol,
- cholesterol,
- & lysophospholipids

1. Glycerol and short chain FA:
   - water soluble
   - carried through portal circulation

2. Long chain FA, monoglycerides, cholesterol & lysophospholipids:
   - need bile salts to be absorbed
• Bile salts surround these component (by their unpolar end while their polar endings directing outward) → water soluble micelles (0.1 – 0.5 μ in diameter)
How

- Micelles soluble in water, enter microvilli of mucosal cells by endocytosis where fat digestion may be completed through action of intestinal lipase:
Lipid absorption

Blood

Lumen

Passive diffusion

F.A

Gly

F.A

MG

LPh.L

Chol

Micelle

Chylomicrons

Unstirred water layer

Enterocyte

Baso-lateral border

Lymph

TG

Chol.E

Ph.L

TG

Chol.E

PL

Resynthesis

Blood
• In the mucosal cells triglycerides and other lipids are resynthesised once again as follow:

1- FA activated to acyl-CoA

\[ \text{RCOOH} + \text{COASH} \xrightarrow{\text{Acyl-CoA synthetase}} \text{RCO}~\text{SCOA} \]

\[ \text{Mg}^{++} \quad \text{ATP} \quad \text{AMP} + \text{PPi} \]
2- Reesterification of absorbed $\beta$-monoglyceride with 2 Acyl-CoA $\rightarrow$ triglycerides

3- Re-esterification of glycerol 3p with 3 Acyl-CoA $\rightarrow$ triglycerides

Glycerol 3p is derived from:
- Glycerol by Glycerokinase, present in liver, kidney & to small degree in small intestine but deficient in adipose tissue
- DHAP derived from glucose by glycolysis.
- Resynthesis of phospholipids & cholesterol esters by combination of cholesterol and lysophospholipids absorbed with acyl-CoA
The triglycerides, phospholipids & cholesterol bind with a protein \((\text{Apolipoprotein B}_{48})\) forming chylomicrons \(\rightarrow\) lacteals & pass with lymphatic drainage \(\rightarrow\) the thoracic duct \(\rightarrow\) systemic circulation.
Immediately after absorption of lipids there is turbidity of plasma due to circulating chylomicrons (appear in plasma 2 hours after meals)

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

Chylomicrons (TG)

Glycerol $\rightarrow$ liver

FFA $\rightarrow$ adipose

CT, liver

Glycerol

FFA
Summary
Questions
Thank You