LIPIDS

DIGESTION & ABSORPTION

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- The major dietary lipids are…
  - Triacylglycerol (more than 90%)
  - Cholesterol
  - Phospholipids
  - Free fatty acid
- The average normal Indian diet contains about 20-30gm lipids/day.
- Western diet is 2-3 times than Indian diet.

Digestion of Lipids

- Lipids are insoluble in aqueous solution.
- The digestive enzymes are present in aq. medium
- This leads certain problem in digestion & absorption of lipids,
- This is overcomes by……
  - Increasing the surface area of lipids for digestion.
  - Emulsification of lipids by bile salts.
  - Solubilizing the digested product for absorption.

Digestion in Stomach

- The heat of the stomach liquidizes the lipids.
- Emulsification of lipids starts in the stomach by peristaltic contraction.
- Both **lingual lipase** and **gastric lipase** acts on short chain triglycerides (SCT).
- SCTs are present in milk, butter, ghee.
- So, the action of these lipase is significant in newborns.

Digestion in Intestine cont…..

- Bile salts-
  - Bile salts are called biological detergents.
  - They helps in emulsification of lipids by forming micelle
  - Synthesized from cholesterol in the liver.
  - Secreted with bile in the small intestine.
  - Chemically these are……
    - Sodium glycocholate
    - Sodium taurochlate
- Along with bile salt phospholipids also helps in emulsification.

Digestion in Intestine

cont…..

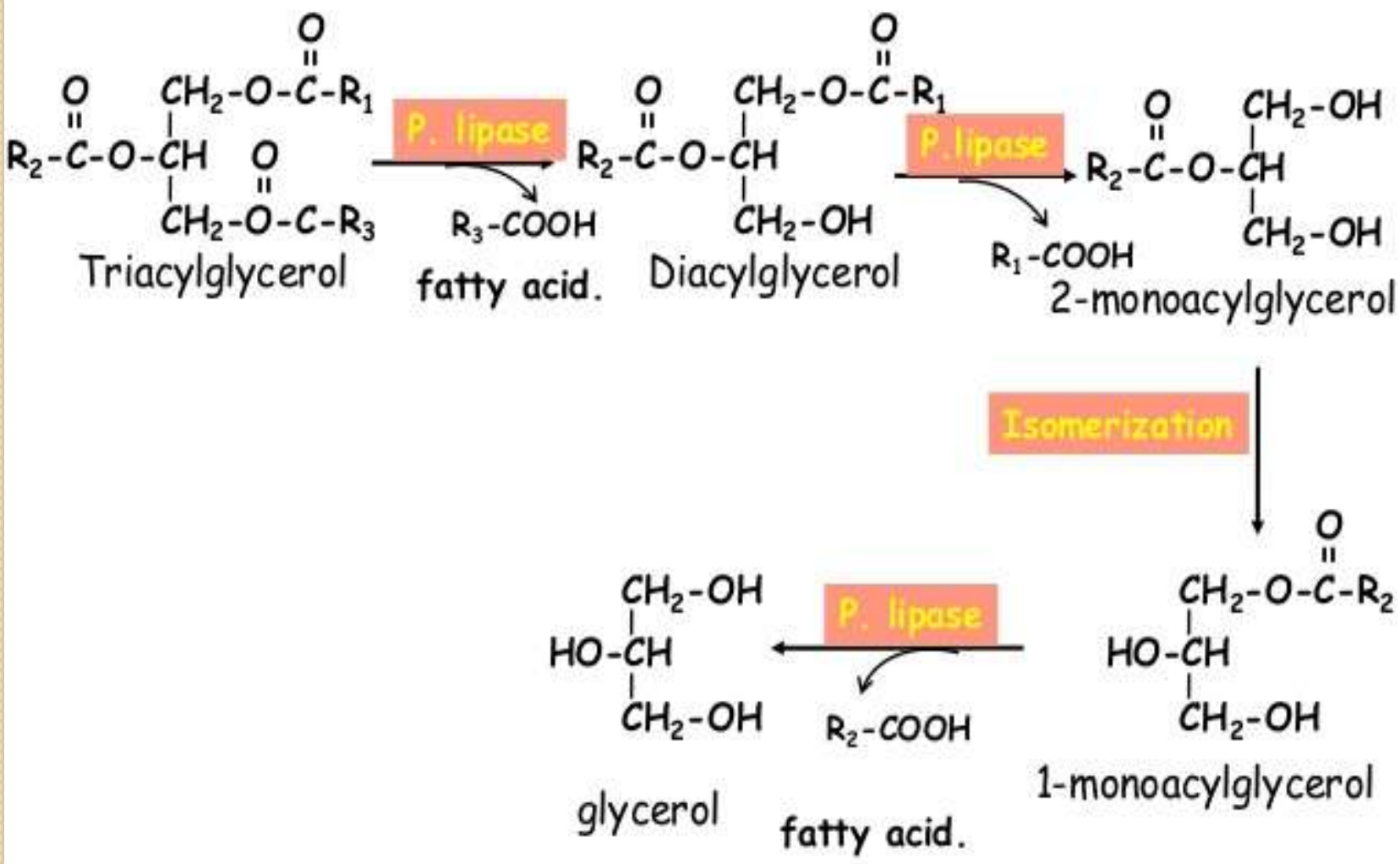
- Digestion of lipids by pancreatic enzymes
- Three enzymes which digest the lipids are…
  - Pancreatic lipase (for TGL)
  - Cholesteryl esterase (Cholesteryl esters)
  - Phospholipase-A_2 (Phospholipids).

Digestion in Intestine

cont…..

- **Digestion of dietary triacylglycerols.**
- **Pancreatic lipase** hydrolyse fatty acids in the 1 & 3 positions of TGL, producing 2 monoacylglycerol (2-MAG) & 2 free fatty acids. These are the major end products of TGL digestion.
- An **isomerase** shift the ester bond from position 2 to 1
- This is then hydrolysed to glycerol & free fatty acid.
- major end products of TGL digestion are…
  - 2-MAG (78%)
  - 1-MAG (6%)
  - Glycerol & fatty acids (14%)

Hydrolysis of TGL by lipase

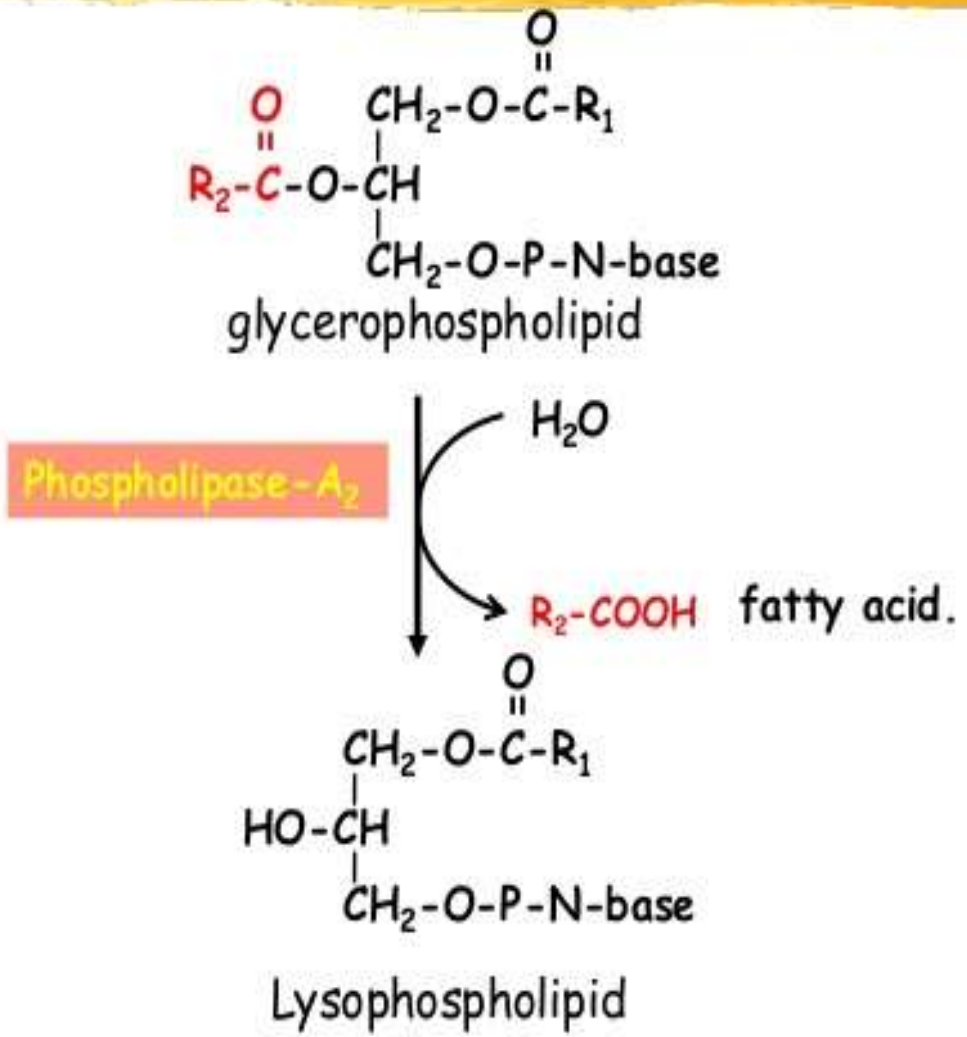


Digestion in Intestine

cont…..

- Digestion of dietary phospholipids.
- Phospholipase-A_2 hydrolyse fatty acids at the 2-position of glycerophospholipid, producing lysophospholipids.
- lysophospholipids being detergents, helps in emulsification and digestion of lipids.

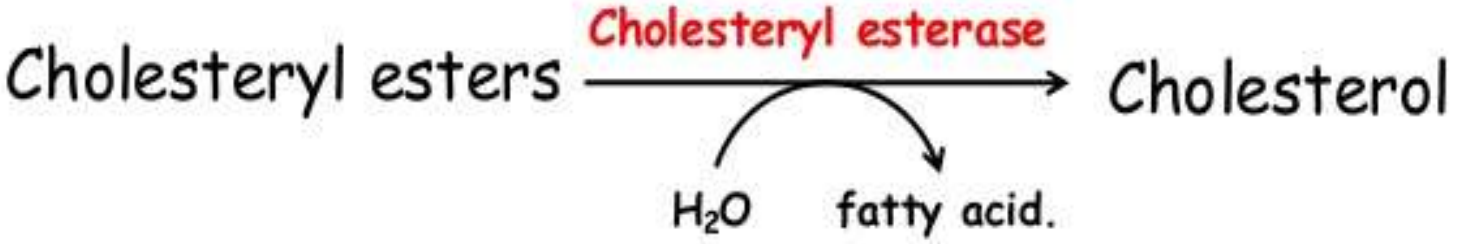
Hydrolysis of phospholipid



Digestion in Intestine

cont…..

- Digestion of dietary Cholesterol ester.
- Cholesteryl esters are hydrolysed by **pancreatic Cholesterol ester hydrolase** (C. esterase) to produce cholesterol and free fatty acids.



Products of Lipid Digestion.

- **Following are the end products of lipid digestion**
  - Free fatty acids.
  - 2-MAG
  - 1-MAG
  - Glycerol
  - Free Cholesterol
  - Lysophospholipids
- These together with bile salt form **mixed micelles**
- Fat soluble vitamins (A,D,E & K) are also packaged in these micelles and are absorbed.

Absorption of Lipids

- Mixed micelles are spherical particles with hydrophilic exterior and hydrophobic interior core.
- Micelles are attached at the microvilous surface of upper part of small intestine.
- All the digested products passively diffuse in to mucosal cell.
- **Short & medium chain fatty acids** do not require bile salt for there absorption.
- They absorbed directly in to intestinal cells and they enter portal blood rather than lymph & transport to the liver bound to serum albumin.

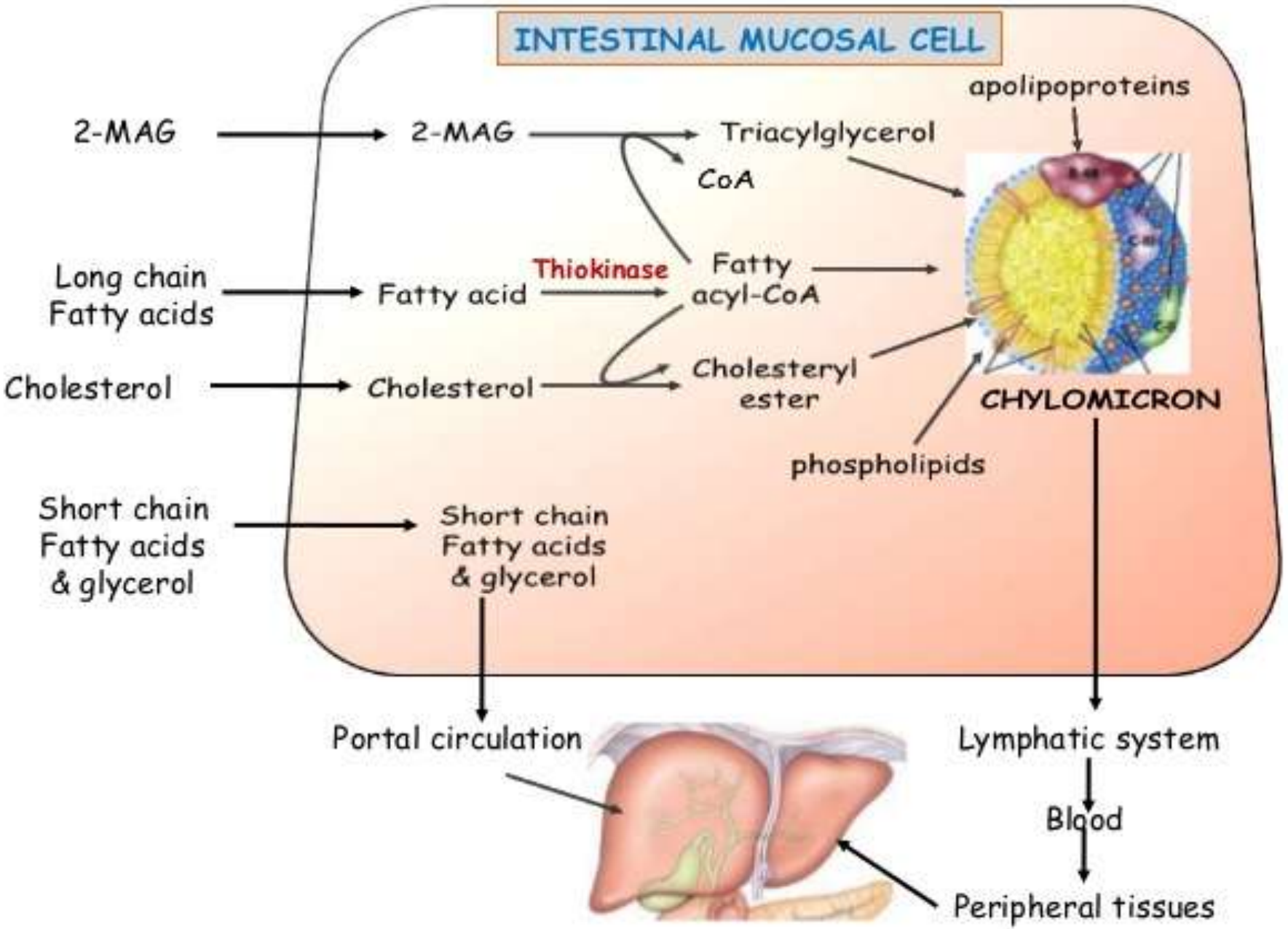
Enterohepatic circulation of bile salt

- Bile salt of the micelles are not absorbed along with digested product of lipids.
- They reabsorbed in the lower part of the small intestine and retune to the liver by portal circulation for resecretion in to the bile.
- This is called as **Enterohepatic circulation of bile salt.**

Synthesis of Lipids

in the intestinal cells

- 1-MAG are further hydrolyzed to glycerol & FFA.
- Long chain fatty acids are activated by **Thiokinase** to fatty acyl coA.
- This acyl coA combine with 2-MAG to give TAG.
- The absorbed cholesterol & lysophospholipids are reacyled to regenerate cholesterylester and phospholipids.
- Free glycerol released in the lumen of the intestine is not reutilized but passes directly to portal vein.
- However, **the glycerol 3-phosphate**, formed within intestinal cells by glucose, can reutilized for TAG synthesis.


INTESTINAL MUCOSAL CELL
apolipoproteins
2-MAG
2-MAG
Triacylglycerol
CoA
Thiokinase
Fatty acyl-CoA
Long chain Fatty acids
Fatty acid
Cholesterol
Cholesterol
Cholesteryl ester
CHYLOMICRON
phospholipids
Short chain Fatty acids & glycerol
Short chain Fatty acids & glycerol
Portal circulation
Lymphatic system
Blood
Peripheral tissues

Transport of lipids

- The resynthesized lipids in intestinal mucosal cells along with fat soluble vitamins are **hydrophobic in nature**.
- So, they all packed in lipoprotein called **chylomicrons**.
- Chylomicrons are composed of……
  - Triacylglycerols (85-90%)
  - Cholesterol & cholesteryl ester (5%)
  - Phospholipids (7%)
  - Protein (apolipoprotein) (1-2%)
- Chylomicrons pass from lymph into the blood through the **thoracic duct**.
- After a fatty meal, the plasma appears milky due to the presence of these particles.

Abnormalities in lipid digestion & absorption

- **Lipid malabsorption**
- Loss of lipid in the faeces results Lipid malabsorption. (loss may be as much as 30 gm/day)
- This includes fat soluble vitamin & essential fatty acids.
- **Steatorrhea**-
- It is a condition characterised by the loss of lipids in the feces. It may be due to……
  - Bile salt deficiency occurs in **liver disease** or due to **obstruction in the bile duct**.
  - Pancreatic enzyme deficiency occurs in **pancreatitis or cystic fibrosis**.
  - defective chylomicron synthesis occurs in congenital **abetalipoproteinaemia**

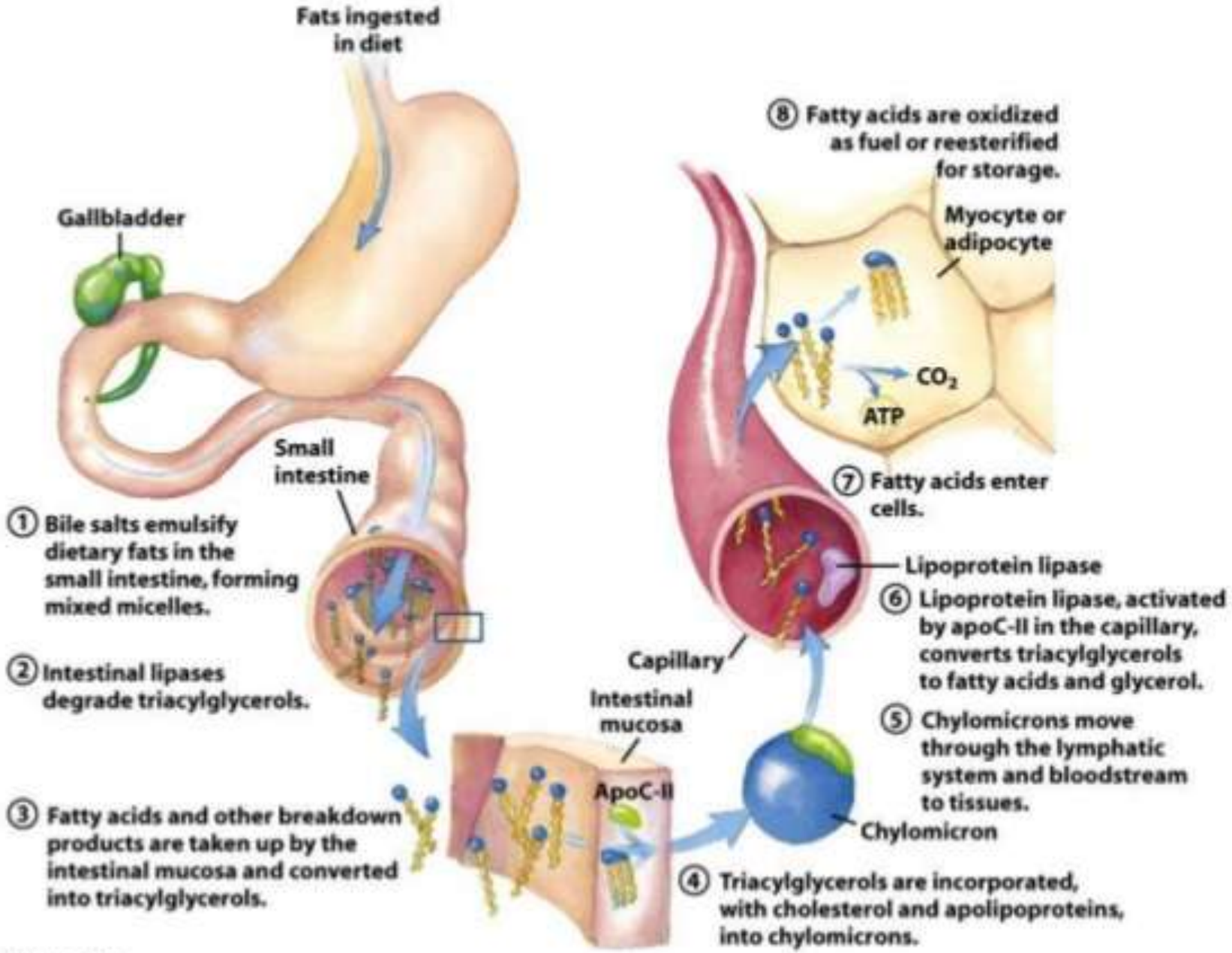


Figure 17-1
Lehninger Principles of Biochemistry, Fifth Edition