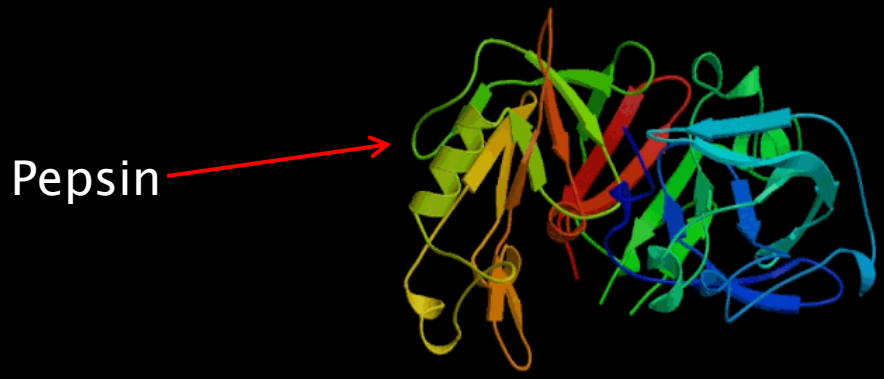
Protein and Lipid Digestion

MMHS

Anatomy and Physiology

Step 1 (Protien Digestion)

- A. Begins in the **stomach**, by the action of **pepsin**.
  1. **Pepsin** breaks down **proteins** into short chains of **amino acids** called **peptides**.
  2. Pepsin is released as **inactive pepsinogen** and is activated by **(HCl) hydrochloric acid** in the stomach.



Step 2 (Protein Digestion)

B. In the **small intestine (SI)**, several enzymes act:

1. **Trypsin** (made in the **pancreas**) breaks down the **peptide chains** into **dipeptides** (**2 amino acids**)

a. **Trypsin** will destroy the **proteins** that make up the **pancreas**, SO…

b. It is first released as **inactive Trypsinogen**.

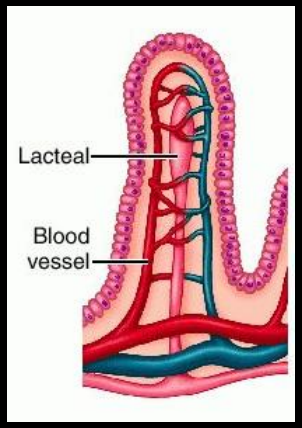
c. In the **small intestine (SI)**, the regulatory enzyme **enterokinase**, an **intestinal** enzyme, activates **trypsin** from inactive trypsinogen.

Step 3 (Protein Digestion)

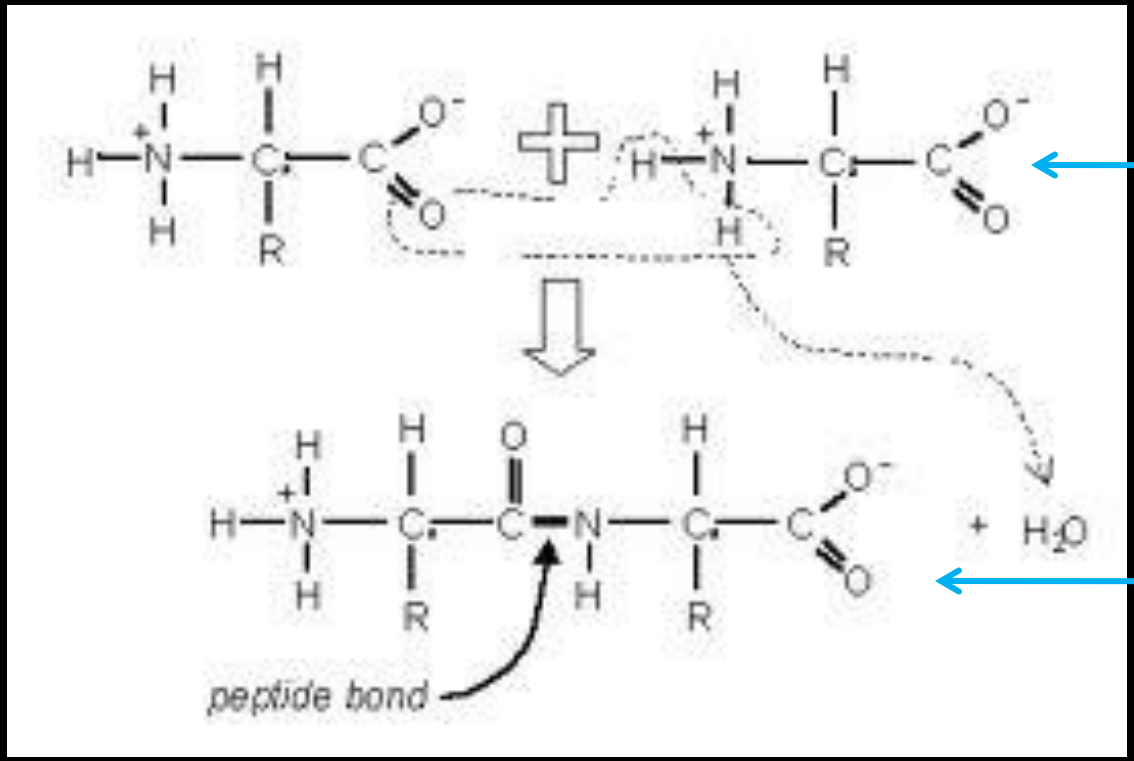
C. A group of intestinal enzymes called **Peptidases (Erepsin** is one such enzyme) that completes protein digestion by converting **dipeptides** into individual **amino acids.**

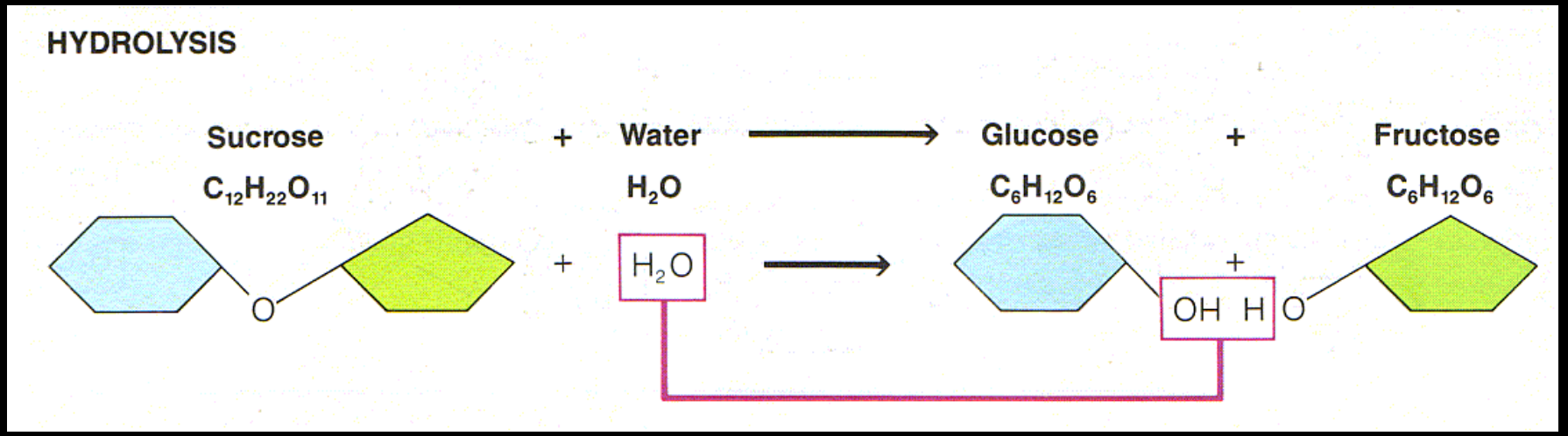
D. **Amino Acids** are absorbed by **active transport** (*ATP) into **simple columnar** cells of the **villus**, then into the **capillaries** by **diffusion**. (this is the same pathway as **monosacchs**.

* = requires ATP



The Process of Condensation (=the removal of H2O) to form a dipeptide from 2 amino acids.





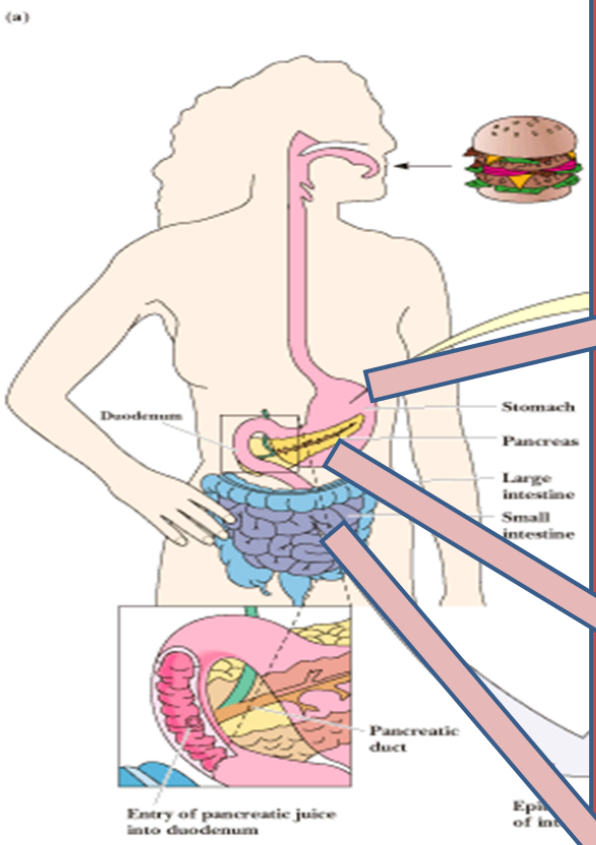
The Process of Hydrolysis
(=the addition of water to form two simple sugars from the disaccharide sucrose.

Protein Digesting Enzymes

The protein enzyme “Bromelain” comes from Pineapples.

= If you add pineapple to jello it will digest the jello and turn it to mush (YUK)

Summary of Protein Digestion



Dietary proteins

pepsin

Polypeptides
Amino acids

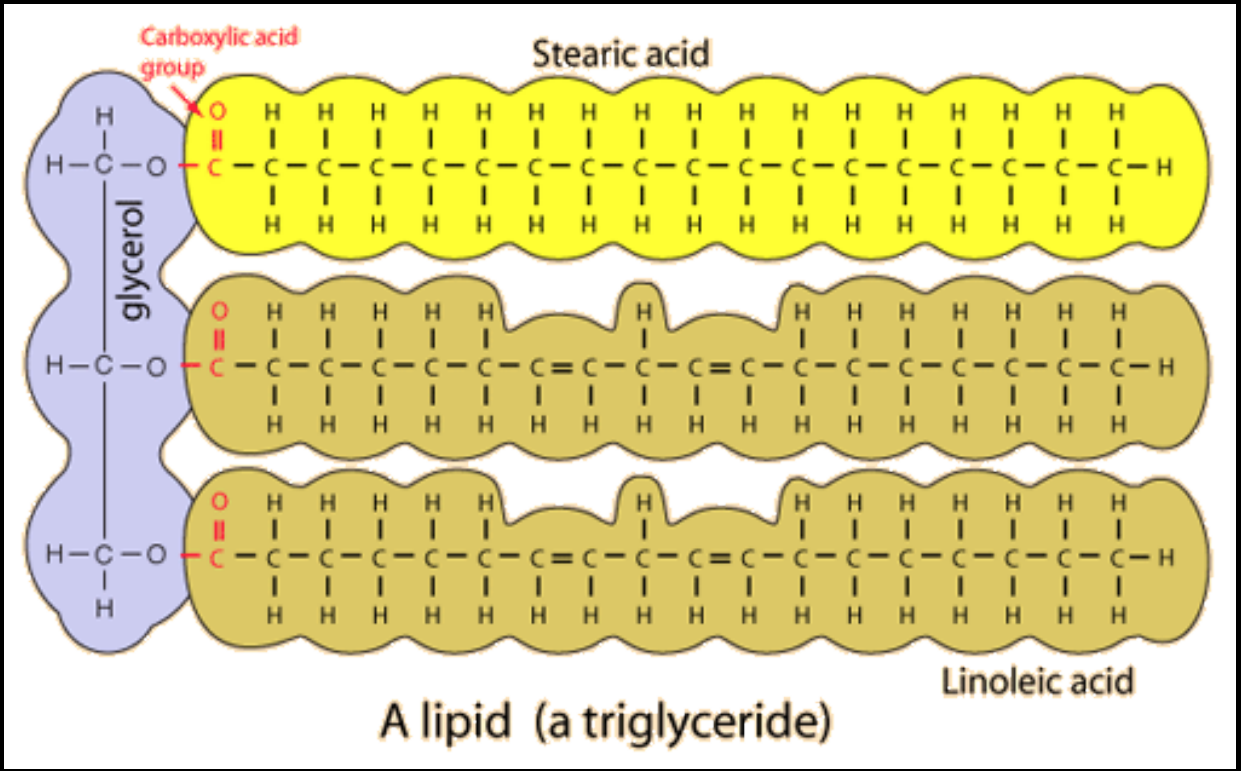
Trypsin
Chymotrypsin
Elastase
Carboxypeptidase

Oligopeptides
Amino acids

Aminopeptidases
Di & tri-peptidases

Amino acids

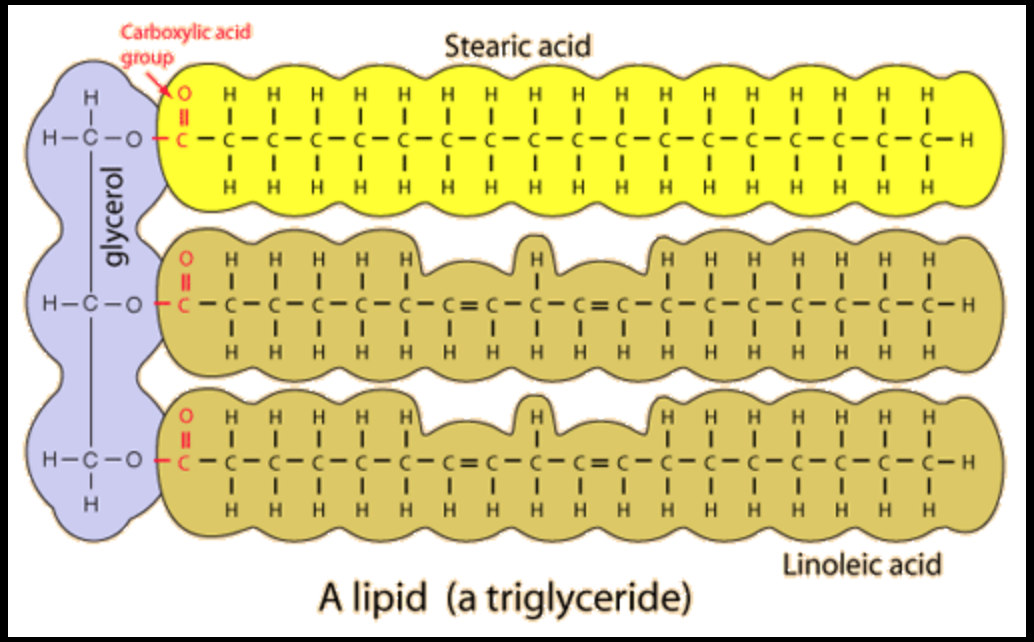
PART 2: LIPID DIGESTION



Lipid Digestion

A. The main lipids stored in the body are **triglycerides**.

1. **3 Fatty Acids** are attached to a single **glycerol molecule**.



Lipid Digestion

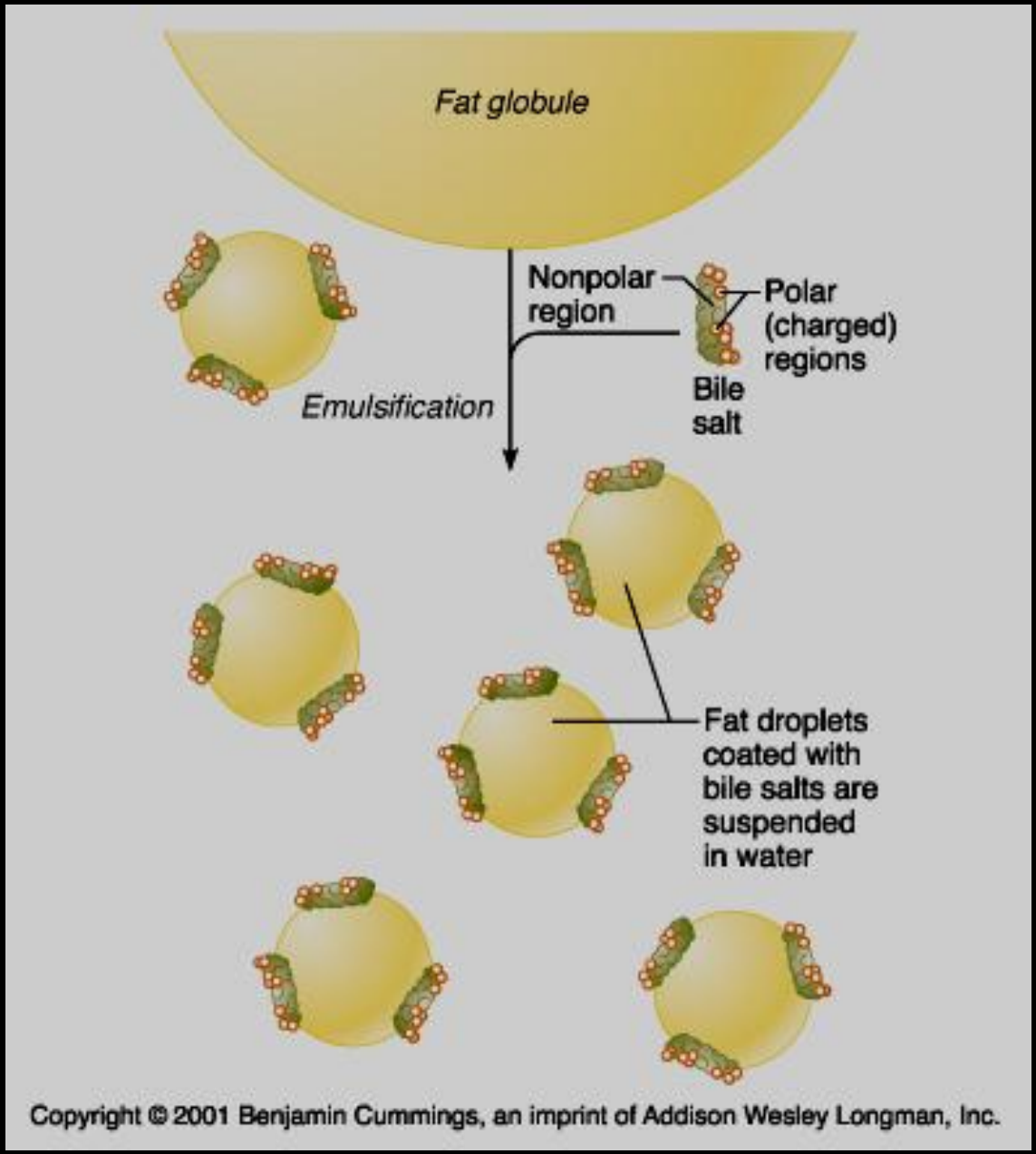
B. Lipid digestion begins in the **small intestine.**

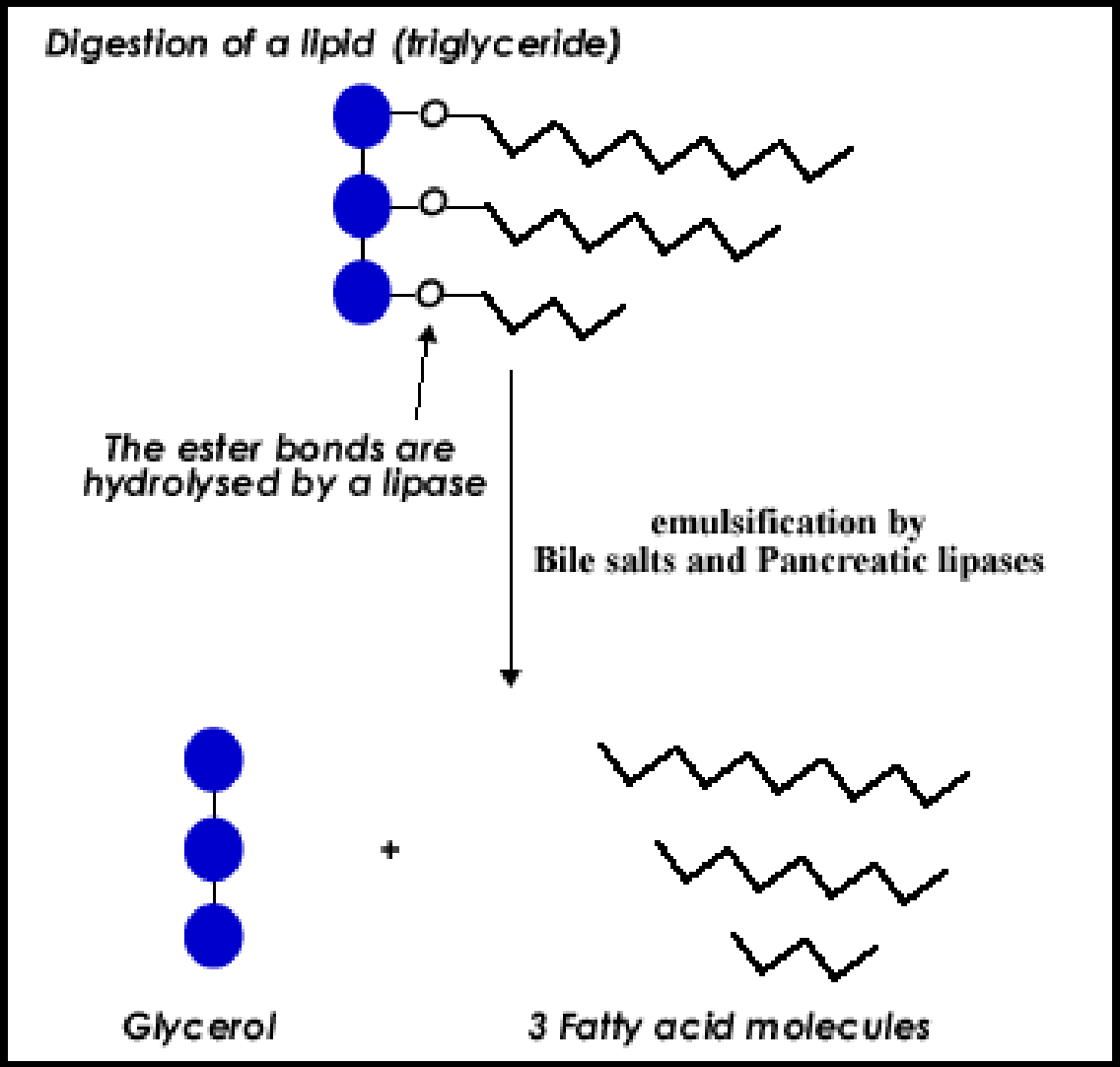
1. **Bile** (not an enzyme) –made in the **liver**, stored in the **gall bladder** **emulsifes** fat into tiny droplets which (↑ *S.A.)

2. Pancreatic **lipase** breaks down **lipids** into **fatty acid tails** and **glycerol** by (**hydrolysis**).

* = Surface Area

Bile Emulsification of a large fat globule into many fat droplets





All you need to do is add Water.

Hydrolysis of a Triglyceride into 3 Fatty Acids and a Glycerol.

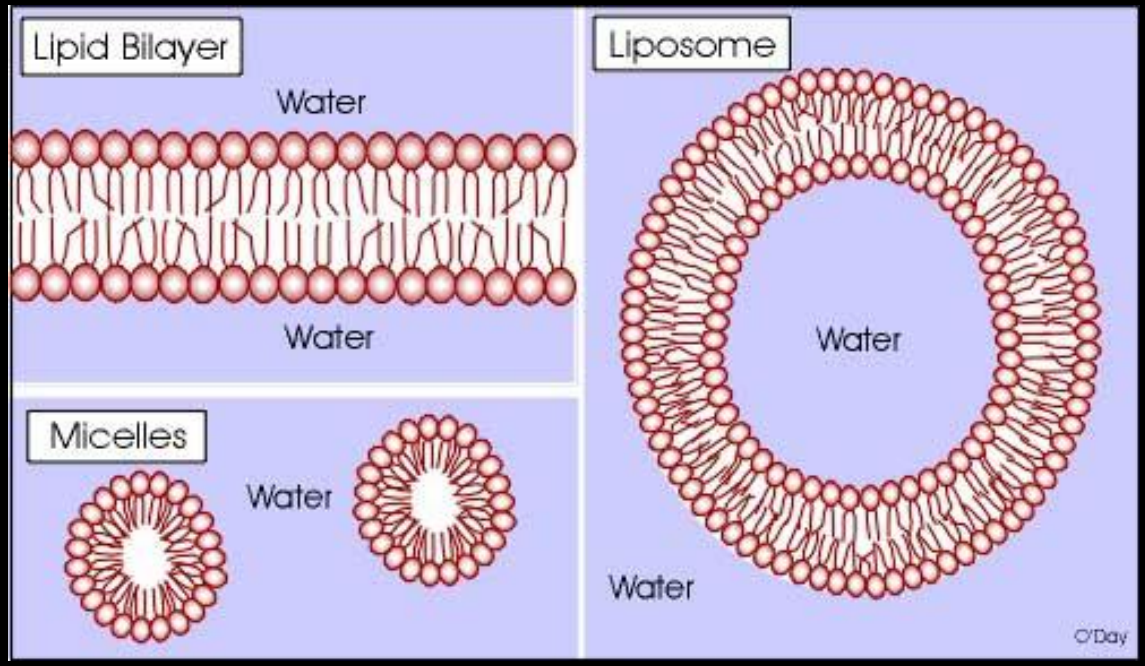
Lipid Digestion

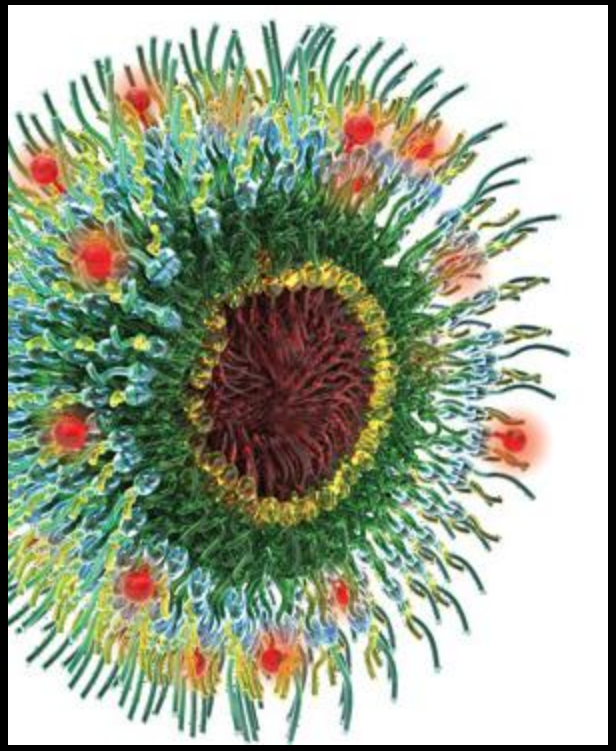
C. Absorption of lipids is more **complicated.**

1. If the **fatty acid chain** is short (10-12 carbons), then absorption follows the same path as **carbohydrates** or **proteins.**

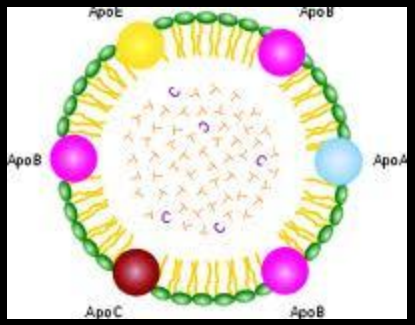
2. Large fats take a more complicated route.
   a. **Bile salts** form around the lipid creating **micelles**.
   b. In the **micelles**, fats are broken down into **fatty acids** and **monoglycerides** and enter the **s. columnar cells** by **active transport.**

Lipids grouping into a Micelle





Lipid Digestion



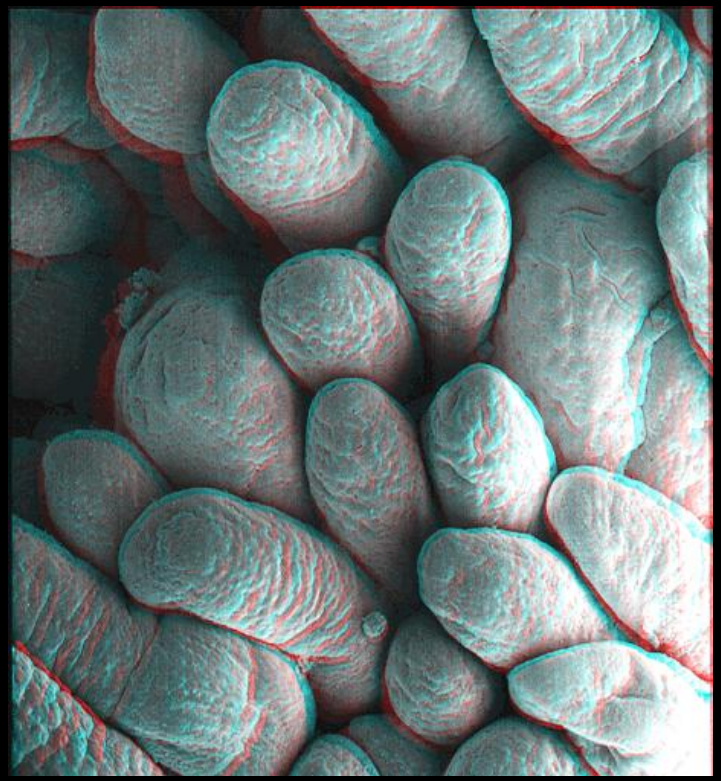
3. Once in the **Epithelial Cells**, the lipid products are reassembled into **triglycerides** and coated with **protein** to form **chylomicrons.**

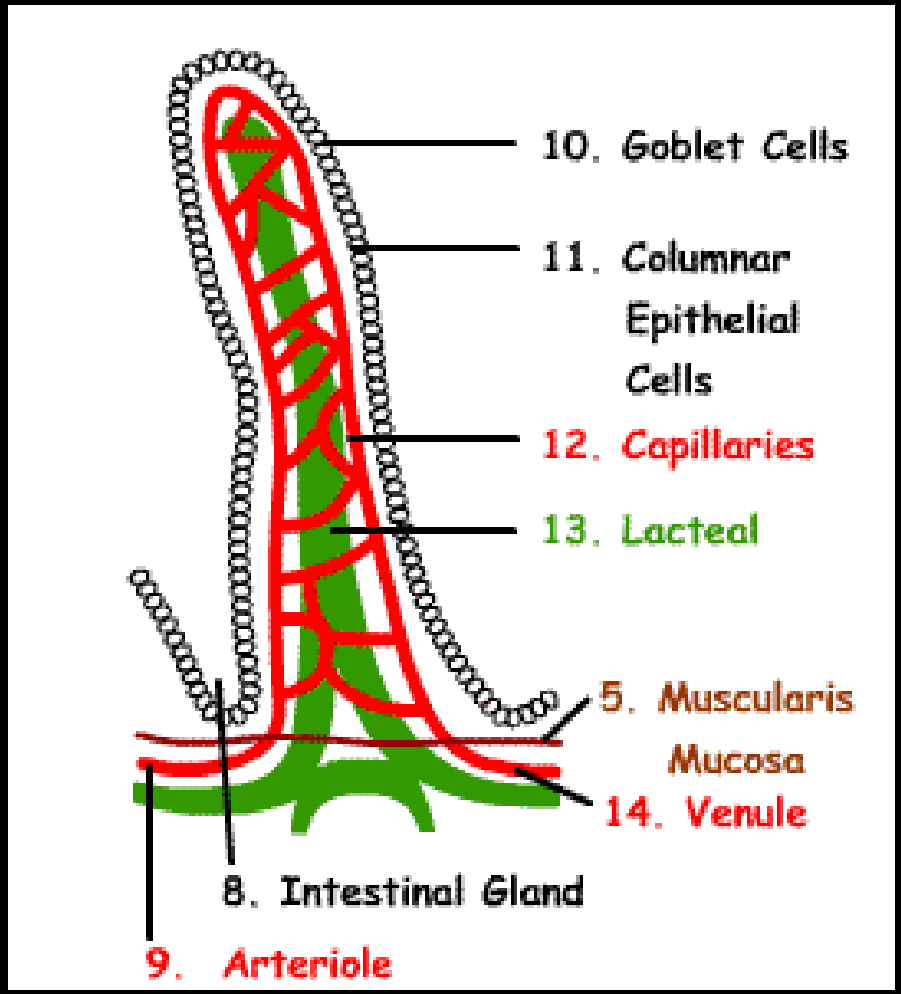
Then, they are passed into the **lacteal** in the center of each **villus** (1) or (**villi** (=many)).

a. The **lacteal** is part of the **lymphatic system**.

b. Lipids can then be **stored** as fat tissue until needed to fulfill energy requirements then they are **returned** to the **blood stream** for metabolism.

The Villus

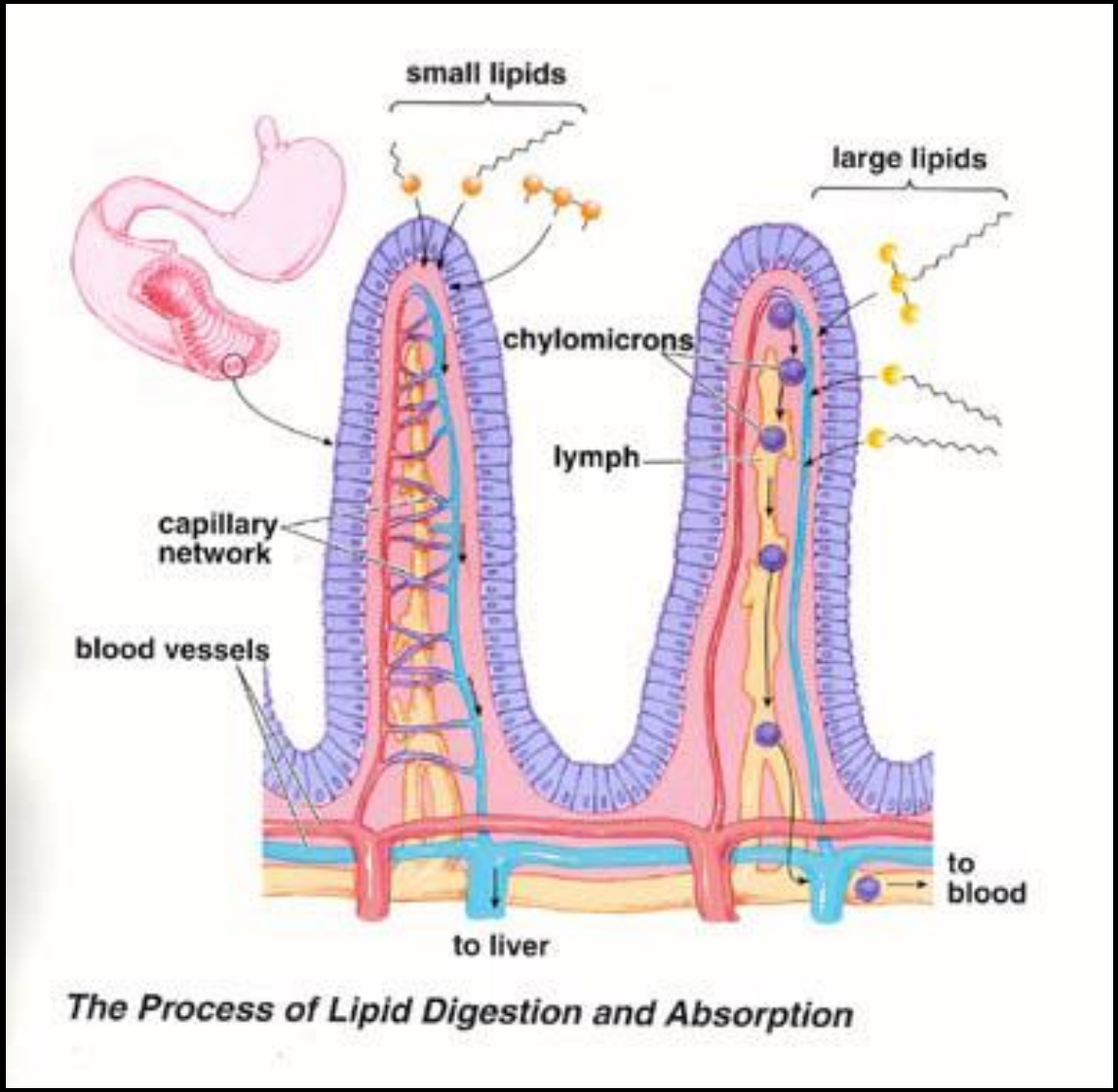



10. Goblet Cells
11. Columnar Epithelial Cells
12. Capillaries
13. Lacteal
5. Muscularis Mucosa
14. Venule
8. Intestinal Gland
9. Arteriole

Villi from the last part of the small intestine, the Jejunum.

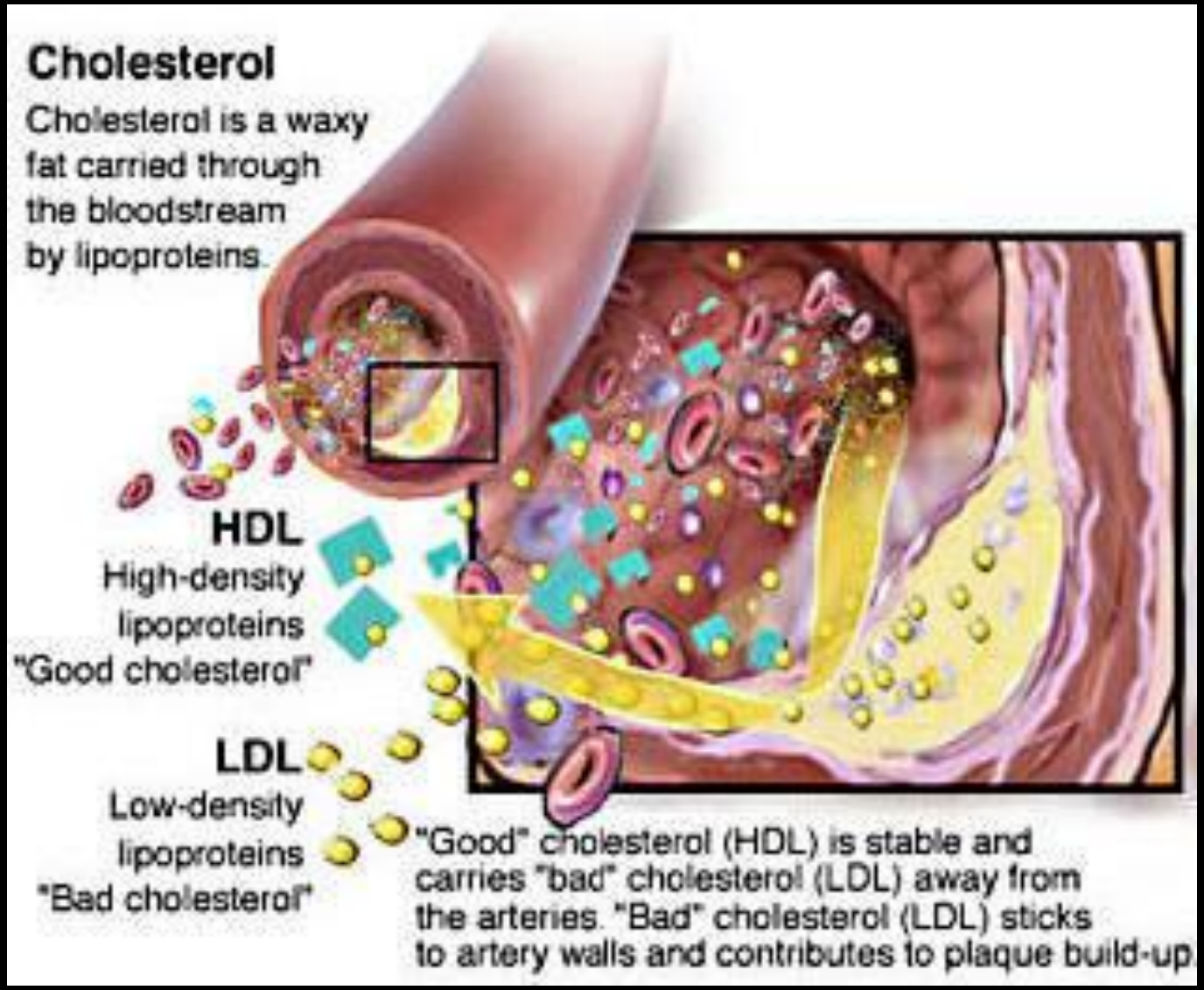
Summary of Lipid Digestion

Absorption of
Small lipids
Versus
Large Lipids



The Process of Lipid Digestion and Absorption

High Fat Diet = Cholesterol



THE VILLUS

CLASSWORK:
Label the parts of your villus diagram in pencil using the word bank provided at the bottom of your page.

*Ref. p. 462 in text.