Protein and Lipid Digestion

MMHS

Anatomy and Physiology
Step 1 (Protein 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 **monosacch**s.

* = 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.)
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

A lipid (a triglyceride)
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** _emulsifies_ 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
Villi from the last part of the small intestine, the Jejunum.
Summary of Lipid Digestion

Absorption of Small lipids Versus Large Lipids
High Fat Diet = Cholesterol

Cholesterol
Cholesterol is a waxy fat carried through the bloodstream by lipoproteins.

HDL
High-density lipoproteins
"Good cholesterol"

LDL
Low-density lipoproteins
"Bad cholesterol"

"Good" cholesterol (HDL) is stable and carries "bad" cholesterol (LDL) away from the arteries. "Bad" cholesterol (LDL) sticks to artery walls and contributes to plaque build-up.
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.