



DIGESTION AND ABSORPTION OF PROTEINS

Asst. Prof. Dr. Jaafaru Sani Mohammed
Advanced Clinical Biochemistry I (MA 407)

Summer Semester

Lecture Six

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Outlines

- Objectives
- Introduction
- Dietary Protein Digestion
- Digestion in Stomach
- Digestion in SI
- Absorption into blood
- Summary
- Class activities

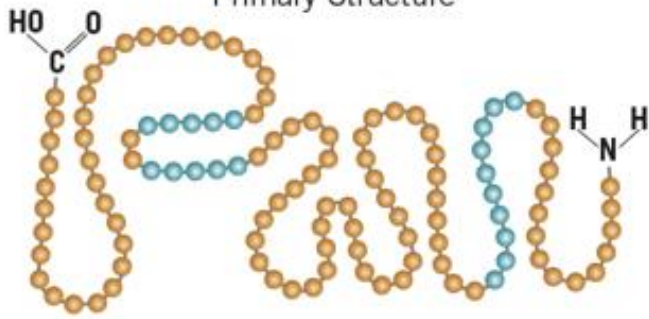
Objectives

- At the end of the lesson, the students should be able to understand:
- The importance of dietary protein
- The role of dietary proteins in the maintenance of quality life.
- Digestion of dietary proteins in the stomach, duodenum & SI
- The uptake of peptides and amino acids from the GIT
- The absorption and transport of amino acid to liver

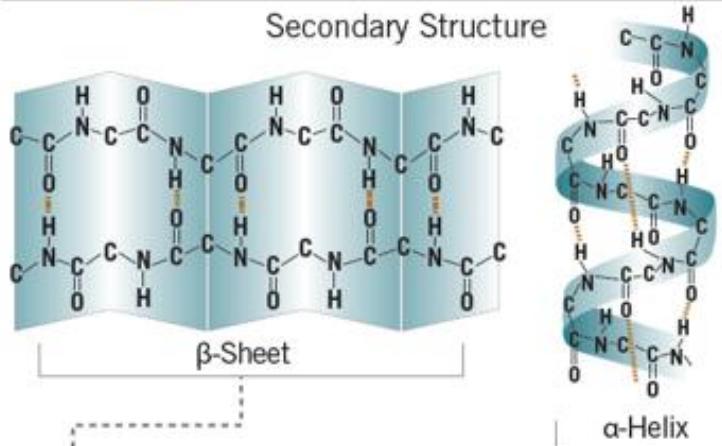


LEVELS OF PROTEIN STRUCTURE

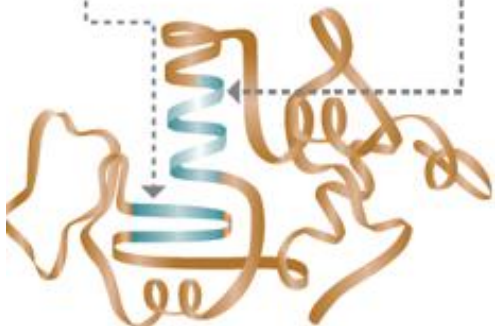
Primary Structure



Secondary Structure



Tertiary Structure



Quaternary Structure

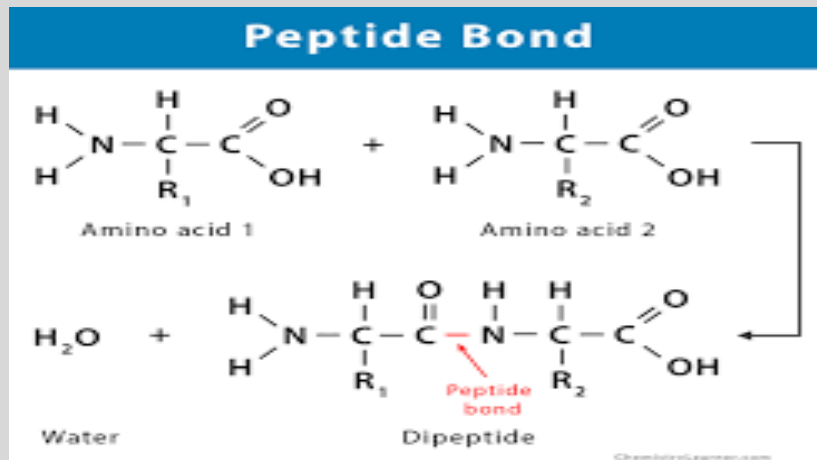


Introduction

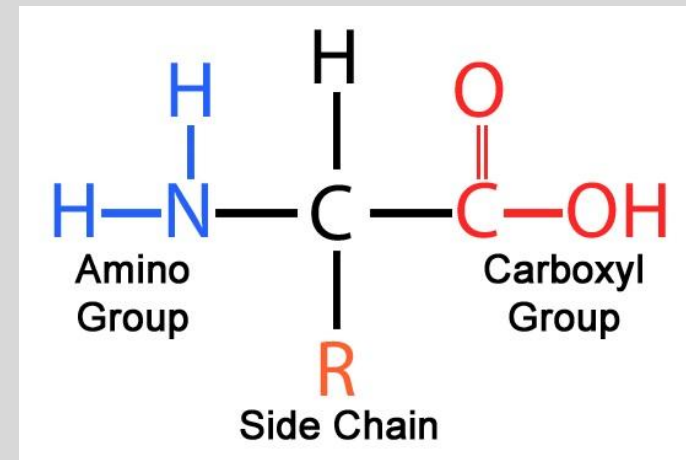
- **A protein** is a large, complex molecule composed of one or more chains of amino acids linked by peptide bonds.
- **Functions:** Proteins perform a vast array of functions in living organisms, including building and repairing tissues, catalyzing biochemical reactions, transporting molecules, supporting immune responses, and regulating cellular processes.
- **Structural Classification:** Primary, Secondary, Tertiary and Quaternary
- **Component:** 20 standard amino acids
- **Special Bond:** Peptide bond

Cont.

- Peptide?
- Molecules that are composed of two or more amino acids joined through:
 - **Amide formation (peptide bond)** between
 - **Carboxyl group** of the first amino acid and
 - **Amino group of the next amino acid.**



- Amino acids?
- An amino acid is an organic molecule with:
 - **Basic amino group (-NH₂),**
 - **Acidic carboxyl group (-COOH),**
 - **Organic R group (or side chain).**



Nutritionally Essential	Nutritionally Nonessential
Arginine ^a	Alanine
Histidine	Asparagine
Isoleucine	Aspartate
Leucine	Cysteine
Lysine	Glutamate
Methionine	Glutamine
Phenylalanine	Glycine
Threonine	Hydroxyproline ^b
Tryptophan	Hydroxylysine ^b
Valine	Proline
	Serine
	Tyrosine



Digestion of Dietary Protein

- The body's digestive system breaks down dietary protein into individual amino acids.
- The amino acids are absorbed and used by cells to build other proteins and a few other macromolecules, such as DNA.
- Being a good source of dietary protein, one egg (raw, hard-boiled, scrambled, or fried), supplies about six grams of protein.



Digestion in the Mouth

- Unless it is eating raw, the first step in digesting an egg as dietary protein (or any other protein in solid food) is chewing.
- The teeth begin the **mechanical breakdown** of large protein pieces into smaller ones that can be swallowed.
- The salivary glands secrete saliva to aid swallowing and the passage of the partially mashed proteins (egg) through the esophagus.

Digestion in the Stomach

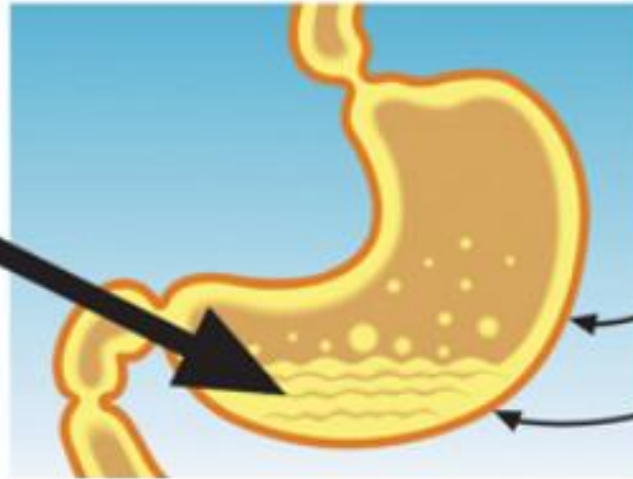
- The mashed protein (egg) pieces enter the stomach from the esophagus.
- Both mechanical and chemical digestion takes place in the stomach.
- The stomach releases gastric juices containing HCl and enzymes (pepsin), which initiate the chemical digestion of protein.
- Muscular contractions, called peristalsis, also aid in digestion.
- The powerful stomach contractions churn the partially digested protein into a more uniform mixture called chyme.

Chemical Digestion of proteins

Acid
(Hydrochloric)

Pepsin
(Enzyme)

Gastric juices

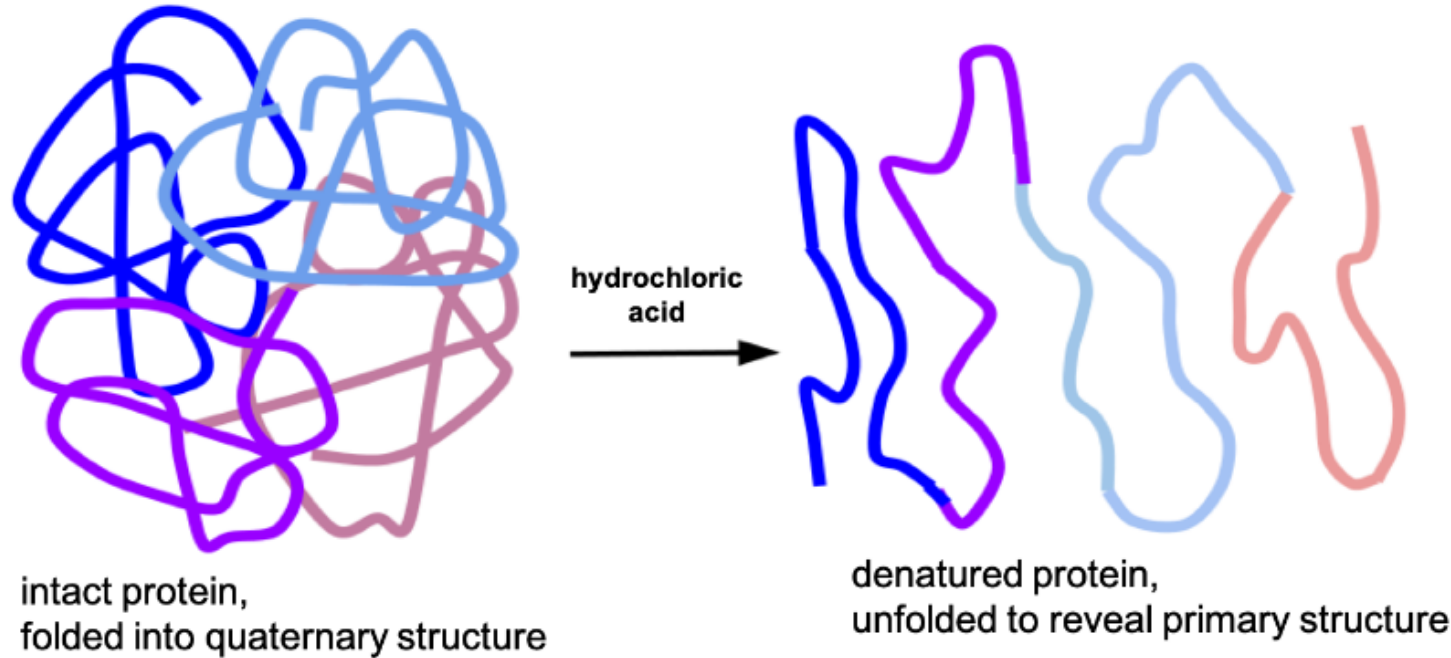


Mechanical Digestion

Muscular contractions
(Peristalsis)

Digestion in the Stomach

- **The acidic nature of the stomach (pH of 1.5-4.5) causes food proteins to denature.**
- **Unfolding their three-dimensional structure** to reveal just the polypeptide chain (the first step of chemical digestion of proteins) destroys protein function.
- This is what makes insulin not to be taken orally, its function will be destroyed in the digestive tract, first by denaturation and then further by enzymatic digestion.

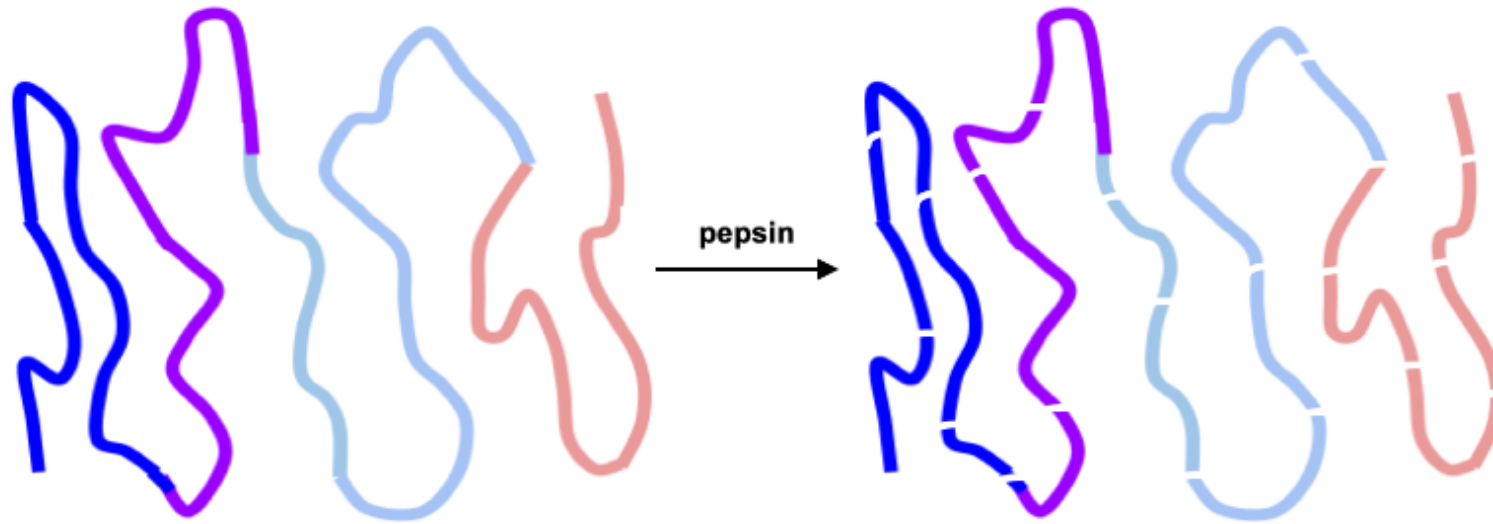


- In the stomach, proteins are denatured because of the acidity of hydrochloric acid.

Digestion in the Stomach

Digestion in the Stomach

- Once proteins are denatured in the stomach, the peptide bonds linking amino acids together are more accessible for enzymatic digestion.
- That process is started by an enzyme called pepsin which is an activated form of pepsinogen.
- Pepsin begins breaking peptide bonds, creating shorter polypeptides.



denatured protein,
unfolded to reveal primary structure

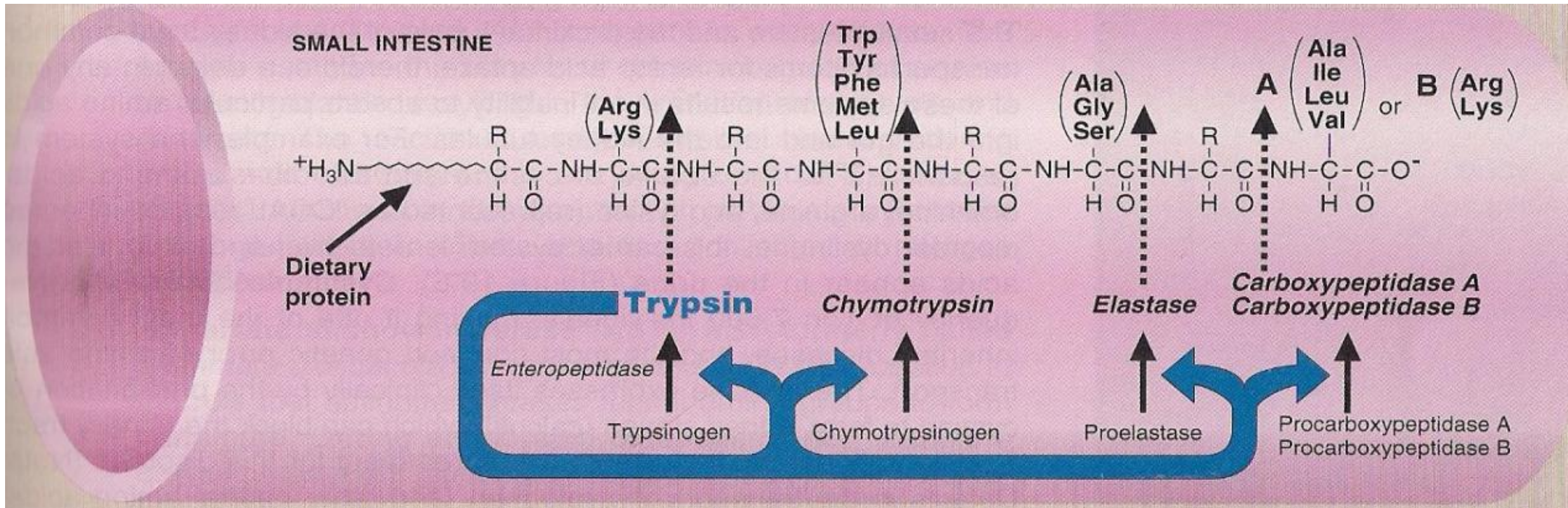
Enzymatic digestion by pepsin
begins to break the protein into
shorter polypeptides

- Enzymatic digestion of proteins begins in the stomach with the action of the enzyme pepsin.

**Digestion in
the Stomach**

Digestion at the Small Intestine

- The chyme leaves the stomach and enters the small intestine, where the majority of protein digestion occurs.
- The pancreas secretes digestive juices into the small intestine, and these contain more enzymes to further break down polypeptides.
- The two major pancreatic enzymes that digest proteins in the small intestine are **chymotrypsin** and **Trypsin**.
- Trypsin activates other protein-digesting enzymes called proteases and together, these enzymes **break down proteins into tripeptides, dipeptides, and individual amino acids**.

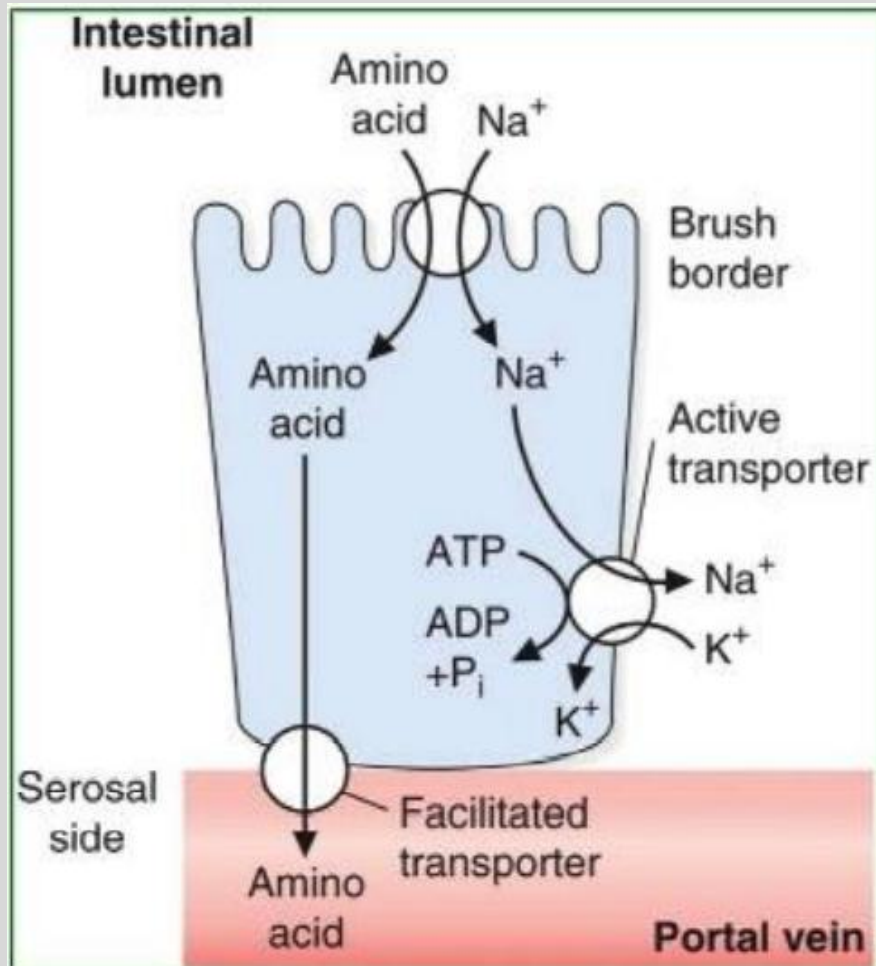


Digestion in the Lumen

Cont.

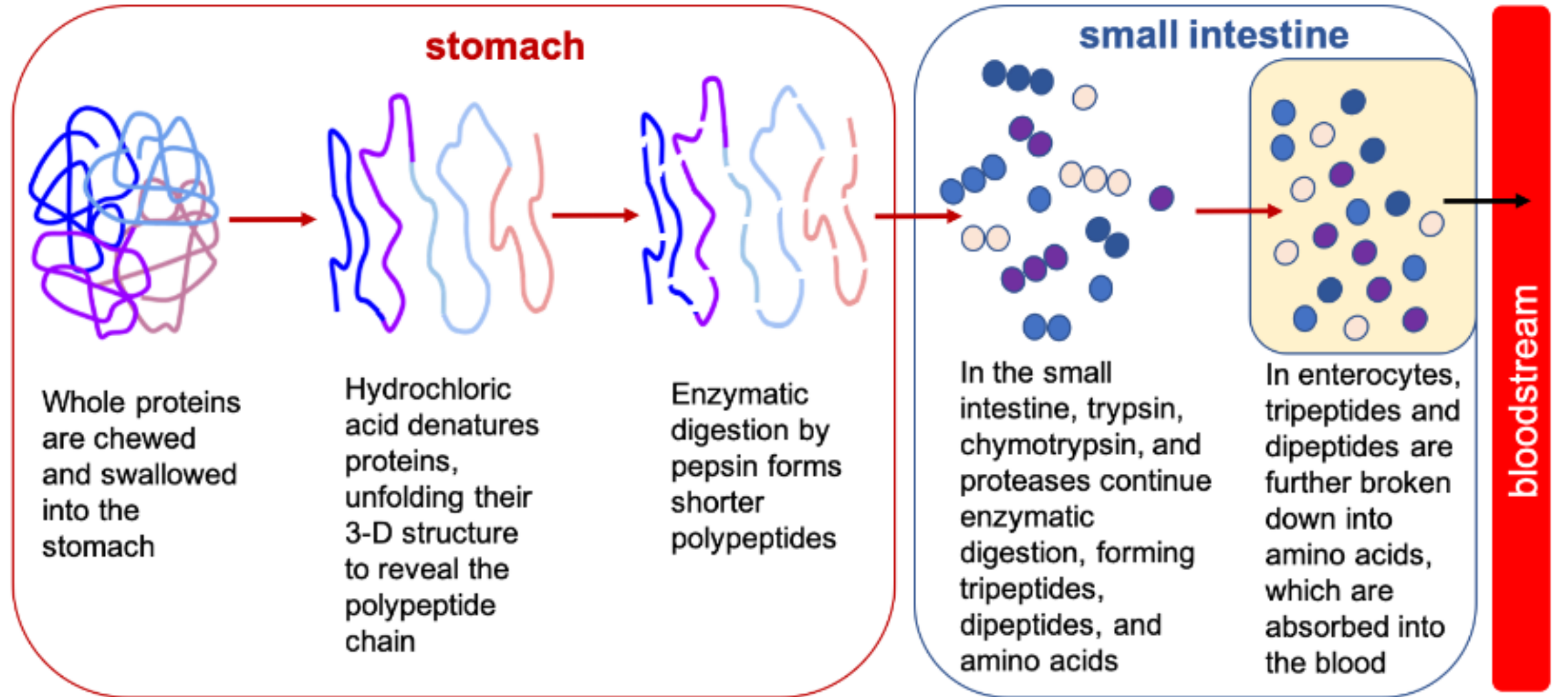
- The cells that line the small intestine release additional enzymes that also contribute to the enzymatic digestion of polypeptides.
- Tripeptides, dipeptides, and single amino acids enter the enterocytes of the small intestine using active transport systems, which require ATP.
- Once inside, the tripeptides and dipeptides are all broken down to single amino acids, which are absorbed into the bloodstream.
- There are several different types of transport systems to accommodate different types of amino acids.
- Amino acids with structural similarities end up competing to use these transporters.

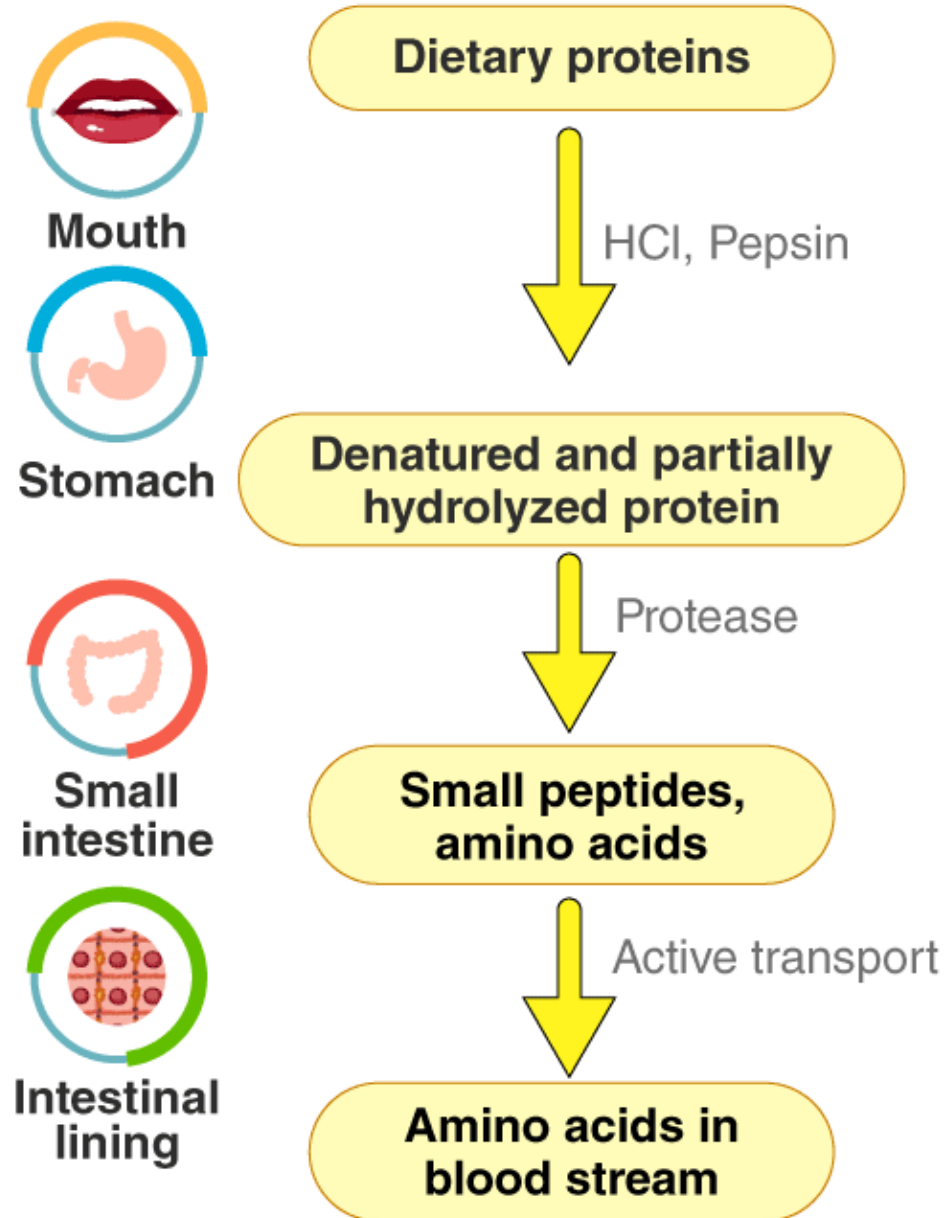
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- Proteins that aren't fully digested in the small intestine pass into the large intestine and are eventually excreted in the feces.
- Plant-based proteins are a bit less digestible than animal proteins due to their presence in the cell walls.

Summary





SUMMARY

Class Activity

1. Protein digestion begins in the mouth with the action of salivary enzymes. **True/False.**
2. Hydrochloric acid in the stomach causes dietary proteins to denature **True/False.**
3. Pepsin is an enzyme that is secreted by the pancreas and breaks down peptide bonds in the small intestine. **True/False.**
4. Trypsin and chymotrypsin are two major pancreatic enzymes that digest proteins in the small intestine. **True/False.**
5. Amino acids are absorbed into the bloodstream directly from the small intestine. **True/False.**
6. Protein digestion begins in the _____ with the action of gastric enzymes.
7. The end products of protein digestion are _____, which are the building blocks of proteins.
8. The enzyme that activates other intestinal enzymes involved in protein digestion is called _____.
9. The process of moving amino acids from the intestinal lumen into the intestinal cells is called _____.
10. The transport protein that carries most of the amino acids and drugs in the blood is called _____.

References

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