

Digestion and absorption of Proteins

Digestion

- Ingested proteins are enzymatically hydrolyzed into amino acids in the gastrointestinal tract.
- When protein enter the stomach, it stimulates the secretion of hydrochloric acid by the parietal cells of the gastric glands and pepsinogen by the chief cells.
- **Hydrochloric acid**
- The gastric juice has a pH between 1.5 and 2.5 due the secretion of HCl.
- The acidity of gastric juice acts as an antiseptic and kills most bacteria and other cells.
- In addition, it causes globular proteins to undergo denaturation or unfolding at this low pH, rendering their internal peptide bonds more accessible to enzymatic hydrolysis.

Pepsinogen

- Pepsinogen, an interactive precursor or zymogen, is converted into active pepsin in the gastric juice by the enzymatic action of pepsin itself.
- In this process, 42 amino acid residues as a mixture of small peptides is cutoff.
- The rest of the pepsinogen molecule, which remains intact, is the enzymatically active pepsin.
- In the stomach, pepsin hydrolyzes the peptide bonds of ingested proteins involving the aromatic amino acids tyrosine, phenylalanine, and tryptophan, thus cleaving long polypeptide chain into a mixture of smaller peptides.

Secretion of bicarbonate by pancreas

- As the acid stomach contents pass into the small intestine, the low pH triggers the secretion of the hormone, secretin into the blood.
- Secretin stimulates the pancreas to secrete bicarbonate into the small intestine to neutralize the gastric HCl.
- The pH then rises abruptly from between pH 1.5 to 2.5 to about pH 7.
- In the small intestine the digestion of proteins continues.
- The entry of amino acids into the duodenum releases the hormone cholecystokinin, which stimulates secretion of several pancreatic enzymes, whose optimum pHs are near 7

Pancreatic enzymes

- Trypsin, chymotrypsin, and carboxypeptidase, are made by the exocrine cells of the pancreas as their respective enzymatically inactive zymogens, trypsinogen, chymotrypsinogen and procarboxy peptidase.
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- After trypsinogen enters the small intestine, it is converted into its active form trypsin by enterokinase,
- **Trypsin**
- Trypsin hydrolyzes those peptide bonds whose carbonyl groups are contributed by lysine and arginine residue.

- **Chymotrypsinogen**

- Chymotrypsinogen has a single polypeptide chain with a number of intra chain disulfide bonds.
- When it reached the small intestine, it is converted into chymotrypsin by trypsin.
- Chymotrypsin hydrolyzed those peptide bonds involving phenylalanine, tyrosine, and tryptophan residues
- Trypsin and chymotrypsin thus hydrolyze the polypeptides resulting from the action of pepsin in the stomach into smaller peptides.
- Degradation of the short peptides in the small intestine is now completed by other peptidases.

- **Carboxypeptidase**
- Carboxypeptidase, a zinc containing enzyme, which the pancreas make as its inactive zymogen, procarboxypeptidases.
- Carboxypeptidase removes successive carboxyl-terminal residues from peptides.

- **Amino peptidase**
- The small intestine also secretes an amino peptidase, which can hydrolyze off successive amino-terminal residues peptidases, ingested proteins are ultimately hydrolyzed to yield a mixture of free amino acids,
- These are then transported across the epithelial cells lining the small intestine.
- The free amino acids enter the blood capillaries in the villi and are transported to the liver.

.Enzymes involved in protein digestion and their peptide bond specificity

Enzyme	Action on peptide bond
Pepsin	Tyr, Phe, Trp; also Leu, Glu, Gln
Trypsin	Lys, Arg
Chymotrypsin	Tyr, p he, Trp
Carboxypeptidase	Successive carboxy terminal residues
Aminopeptidase	Successive amino terminal resides(except proline)

METABOLISM INVOLVING AMINO ACIDS

- The amino acids entering the liver, following absorption from the intestinal tract, also have several important metabolic routes.
- **1. Transport to other tissues**
- Amino acids may pass into the systemic blood and thus to other organs, to be used as building block in the biosynthesis of tissue proteins.

- **2. Biosynthesis of liver proteins and plasma proteins**
- The liver constantly renews its own intrinsic proteins, which have a very high turnover rate.
- The liver is also the site of biosynthesis of most of the plasma proteins of the blood.
- **3. Deamination and degradation**
- Amino acids which not needed for protein biosynthesis in the liver or other tissues are deaminated and degraded to yield acetyl CoA and citric acid cycle intermediates.
- Citric acid cycle intermediates thus formed may be converted into blood glucose and glycogen via the glyconeogenesis pathway.

4. Participation in the glucose – Alanine cycle

The liver also participates in the metabolism of amino acids arriving from other tissues.

These amino acids are deaminated and the resulting keto acids are converted into blood glucose via gluconeogenesis.

The NH_3 is converted into urea for excretion.

5. Conversion into Nucleotides and other Products

Amino acids are precursors in the biosynthesis of the purine and pyrimidine bases of the nucleotides and in the synthesis of specialized products such as porphyrins, hormones and other nitrogenous compounds.

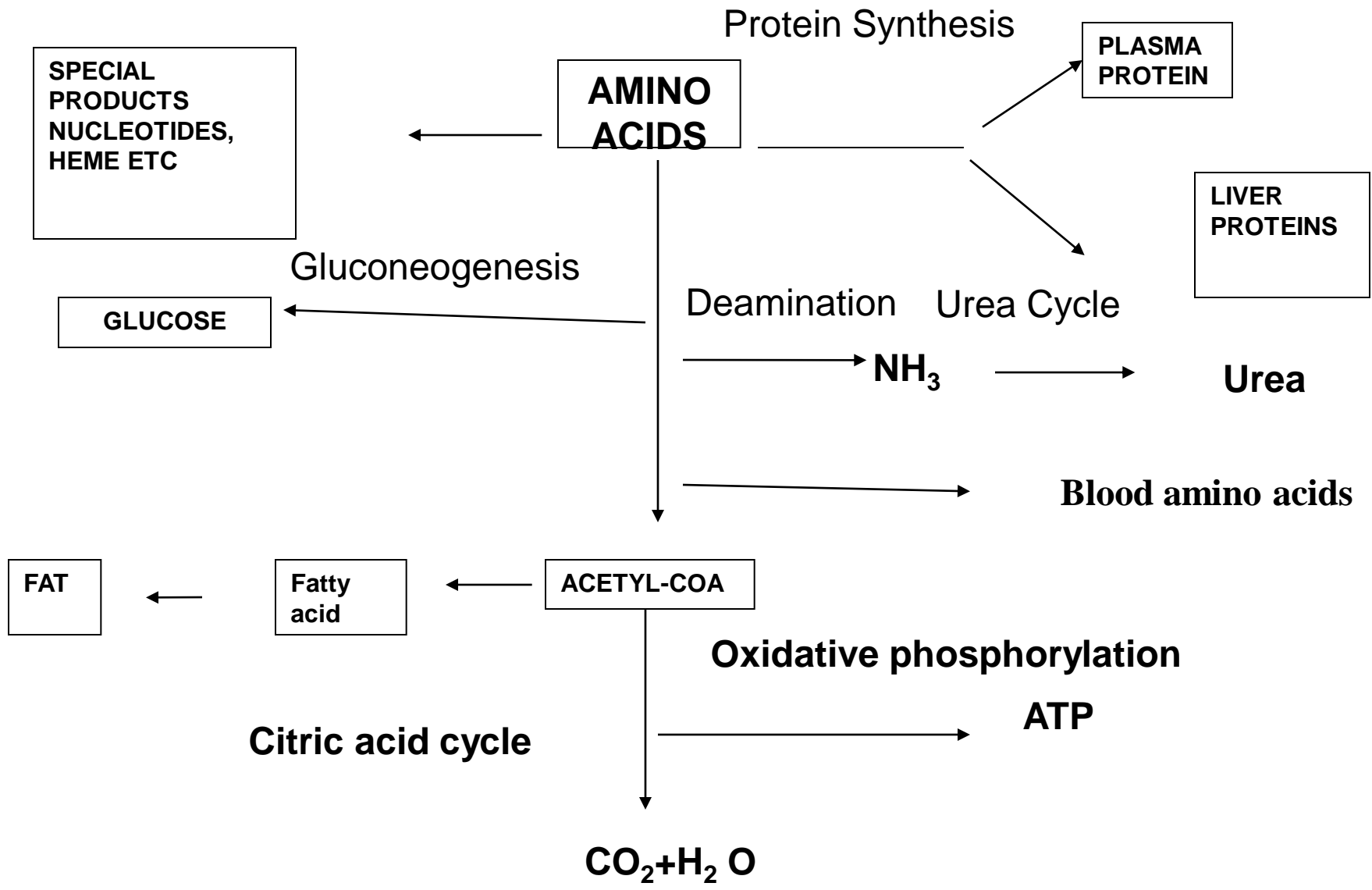


Fig.3 Metabolism of amino acids