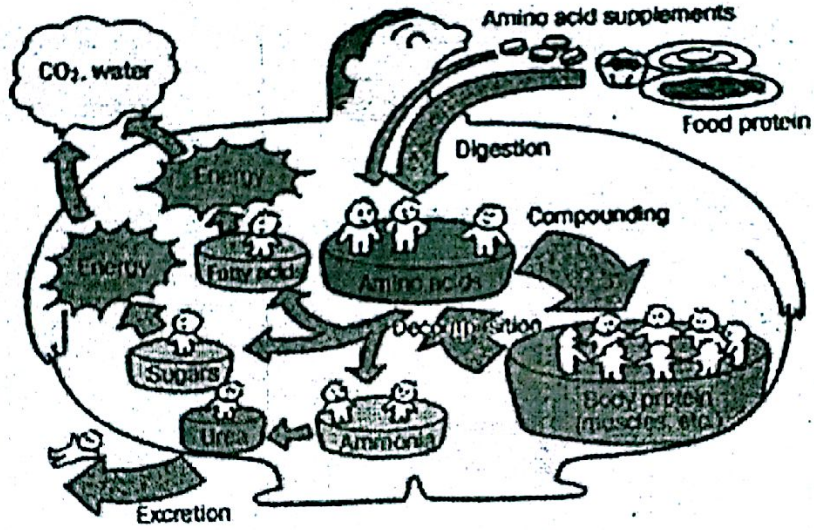
Amino acid metabolism

Metabolism of α-amino acids①



Objectives:

1. To study Amino Acid Metabolism
2. Overall Nitrogen Metabolism.
3. Digestion & Absorption of Dietary Protein.
4. Removal of Nitrogen from Amino Acids.
5. Urea cycle and Its disorders.
6. Metabolism of Ammonia.
7. Fate & Metabolism of individual Amino Acids.

Introduction

Unlike fat and carbohydrate, Amino Acids are not stored in the body, Protein that exist is to maintain the supply of AA for future use.

AA. Must be supplied from the diet(Exogenous)

OR

Catabolism of normal protein.....(Endogenous).

What about the Excess?

The excess enter 2 Phase

Phase1.....

↓

Removal of α Amino Acids

↓

Transamination&Oxidative deamination

↓

Ammonia & α Ketoacids (Carb. Skeleton)

↓

Portion of Amm. Excreted in the urine but most of it used in synthesis of Urea.

Phase2.....

↓

α Keto Acids

Common intermediate of energy producing metabolic pathway

Amino Acid Pool

AA. Present in the body cells,blood, ECF,Essential constituents of protoplasm.

Incorporated into cellular structure of protein, collagen, myosin, Hemoglobin & transferrin.

3 sources of AA:

1. AA provided by degradation of protein (Endogenous)
2. AA provided by dietary protein (Exogenous).
3. Synthesis of non essential AA.

Next Figure

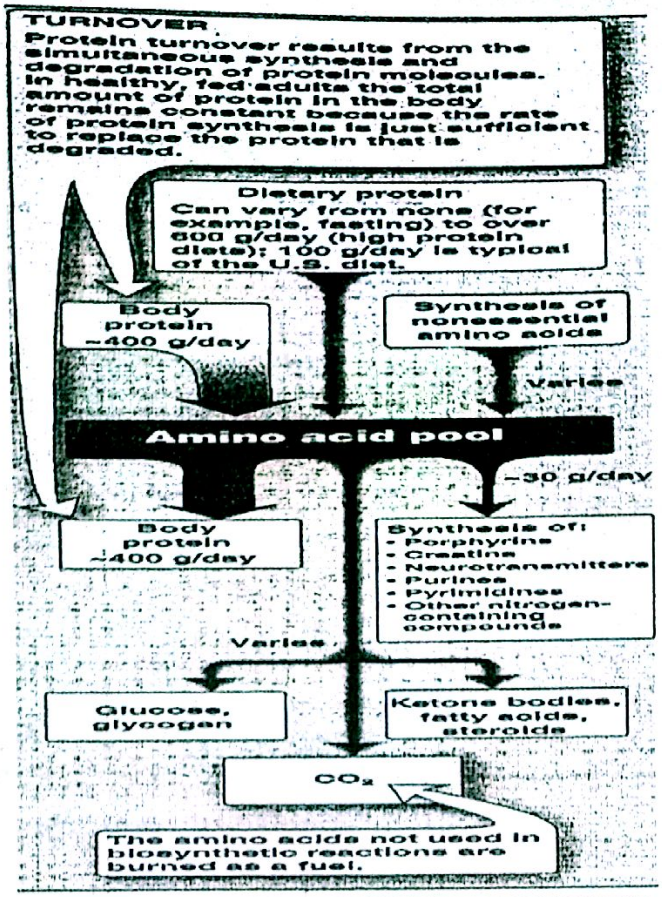
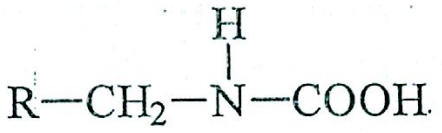
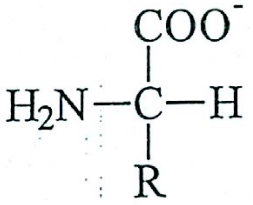


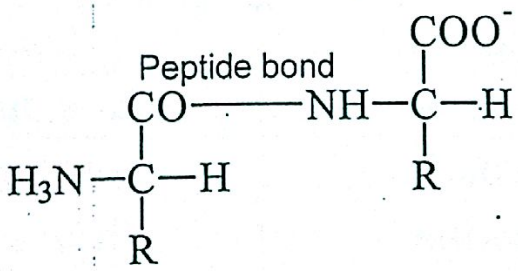
Figure 19.2
Sources and fates of amino acids.

General formula





R= alkyl or heterocyclic group



Peptide bond : 2 or more AA

Poly peptide > 10 AA

Formation of Peptide bond:

The bond formed between two amino acid is called peptide bond.

When 2 A.A. are joined together di-peptide will form , if 3 A.A. are joined together tri-peptide will form.

If 2-10 A.A. are joined together oligo-peptide is formed

If it is more than 10 it is called poly-peptide.

Poly peptide are large peptide chain containing large no. of peptide bond less than 100 A.A. residue.

If the A.A. residue is more than 100 A.A. it is called protein.

Classification 3 groups

A-non migrating neutral(mono amino – mono carboxylic)

* aliphatic straight chain and branched chain glycine , alanine ,valine
* aromatic phenyl alanine tyrosine tryptophan
* sulfur containing AA cysteine cystine methionine

B-basic AA lysine arginine histidine

C-Acidic AA Aspartic A. Glutamic A.

Imino Group(Heterocyclic AA)Proline Hydroxyproline

Nonessential	Essential
Alanine	Arginine*
Asparagine	Histidine *
Aspartate	Valine
Cysteine	Lysine
Glutamate	Isoleucine
Glutamine	Leucine
Glycine	Phenylalanine
Proline	Methionine
Serine	Threonine
Tyrosine	Tyrptophan

*The amino acids Arg, His are considered "conditionally essential"

Digestion Of Dietary Protein

Proteins are generally too large to be absorbed by the intestine, they must be hydrolysed to give their constituent AA which can be absorbed.

Stomach Pancreas Intestine

Stomach: the gastric juice and the HCL PH(2-3) too dilute to hydrolysed, In the serus cells pepsinogen is activated to pepsin or auto catalytically by other pepsin molecules that have already activated. Pepsin releases peptides and few AA.

Pancreas: large polypeptides produced in the stomach are further hydrolysed or cleaved into oligopeptide and AA by the action of pancreatic proteases, these enzymes activated by 2 hormone cholecystokinin and secretin

Trypsinogen activated into trypsin.

Intestine: In the intestine luminal surface contain aminopeptidases that repeatedly cleaves the oligopeptide to produce free AA and small peptide.

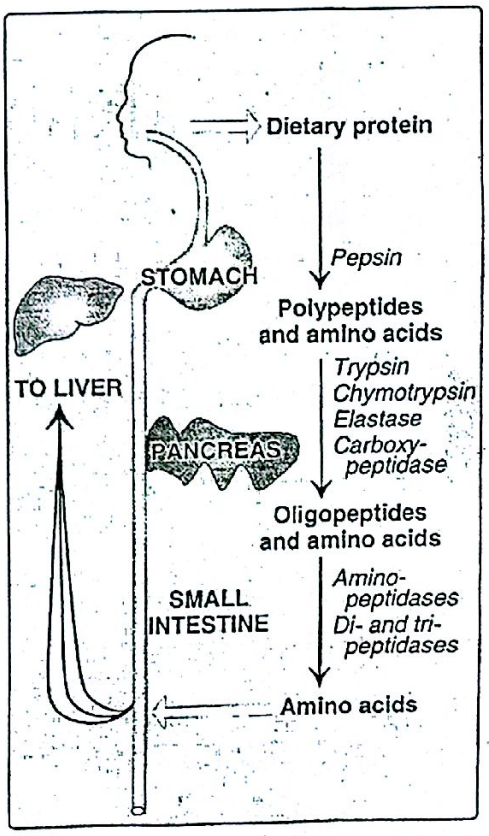
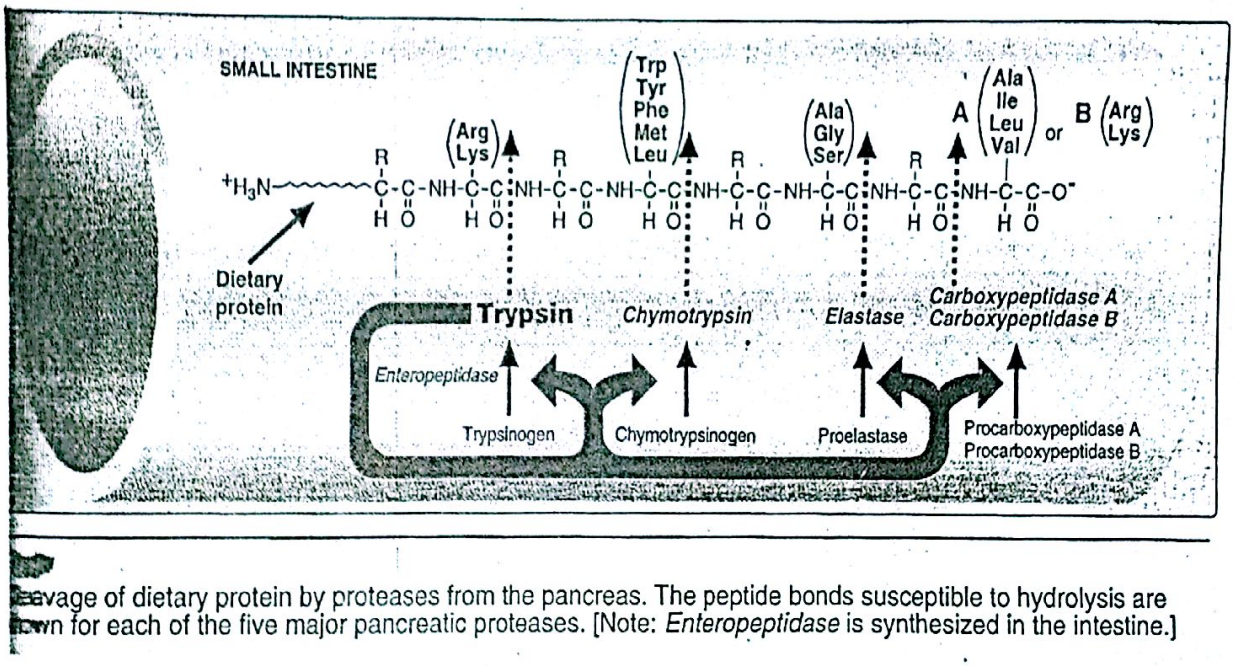


Figure 19.4
Digestion of dietary proteins by the proteolytic enzymes of the gastro-intestinal tract.

Absorption

Free AA are taken into the intestinal cells by Na-linked secondary transport system. Di-and tri peptides are taken up by H+- linked transport system. The peptides are hydrolyzed in the cytosol to AA before beingreleased in to the portal system Thus, only free AA are found in the portal vein after meal containing protein .

These AA are either metabolized by the liver or released into the general circulation. Branched chain AA are important examples of AA that are not metabolized by the liver and sent from the liver into the blood.



Cleavage of dietary protein by proteases from the pancreas. The peptide bonds susceptible to hydrolysis are shown for each of the five major pancreatic proteases. [Note: *Enteropeptidase* is synthesized in the intestine.]

Glucogenic &Ketogenic Amino Acid

Glucogenic AA: whose catabolism produce pyruvate or one of the intermediates of the citric acid cycle.These intermediates are substrate for gluconeogenesis,which can give rise to glucose or glycogen in the liver or glycogen in the muscles.

Ketogenic AA: whose catabolism produce acetoacetate or one of its precursor acetyl coAor acetoacetyl coA.

Acetoacetate is one of the ketone bodies which also include B-hydroxybutyric acid and acetone.

only leucine and lysine are purely ketogenic .

Glucogenic &Ketogenic Amino Acid

	Glucogenic	Glucogenic and Ketogenic	Ketogenic
Nonessential	Alanine Arginine Asparagine Aspartate Cysteine Glutamate Glutamine Glycine Proline Serine	Tyrosine	
Essential	Histidine Methionine Threonine Valine	Isoleucine Phenyl-alanine Tryptophan	Leucine Lysine

In conclusion the catabolism of the AA. Found in protein pass through different steps

1. Removal of α AA.
2. Break down of the resulting carbon skeleton.

These pathways form seven intermediate products.

oxaloacetate	α ketoglutarate
Pyruvate	Fumarate
Succinyl CoA	Acetyl CoA

Acetoacetate