

The Proteins

The name protein is derived from Greek word Proteios which **means first** because proteins **essential for growth and maintenance of life**.

Proteins: are complex nitrogenous polymers present in all living matter, contain C,H,O and nitrogen, also contain sulfur, phosphorous, zinc, copper and iron.

-- are made up of hundreds or thousands of smaller units called amino acids which are attached to one another in long chains.

-- there are 20 different types of amino acids that can be combined to make a protein.

-- the sequence of amino acids determines each protein's unique 3-dimensional structure and its specific function.

We need protein in diet

1. repair cells and make new ones.
2. important for growth and development in children, teens, and pregnant women.

Amino acids

Amino acids : are organic acids containing an amino group (**NH₂**) and a carboxylic acid (**COOH**) group. The side chain can be, aliphatic, aromatic, heterocyclic, containing sulphur group .

All amino acids are L-amino acids configuration.

Proteins are made up of 20 amino acids in different sequences and numbers.

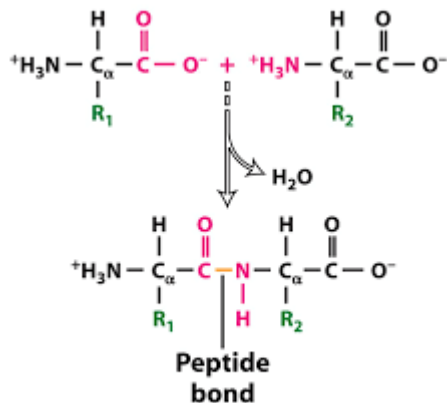
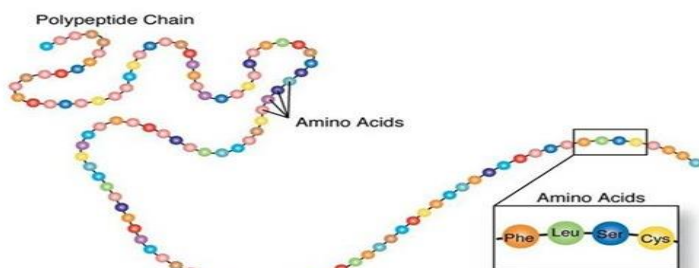
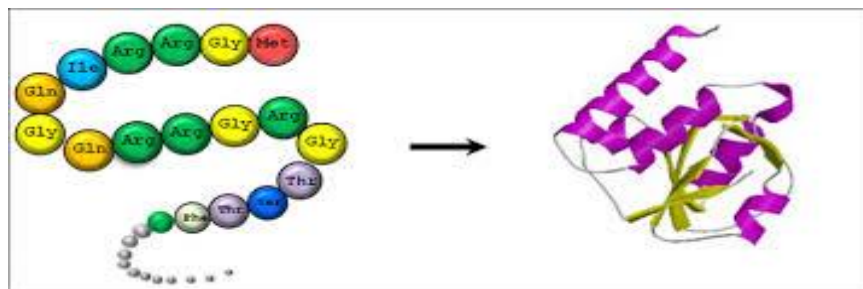


Figure 3.34
Molecular Cell Biology, Sixth Edition
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Amino Acids

Ala: Alanine	Gln: Glutamine	Leu: Leucine	Ser: Serine
Arg: Arginine	Glu: Glutamic acid	Lys: Lysine	Thr: Threonine
Asn: Asparagine	Gly: Glycine	Met: Methionine	Trp: Tryptophane
Asp: Aspartic acid	His: Histidine	Phe: Phenylalanine	Tyr: Tyrosine
Cys: Cysteine	Ile: Isoleucine	Pro: Proline	Val: Valine

Classification:

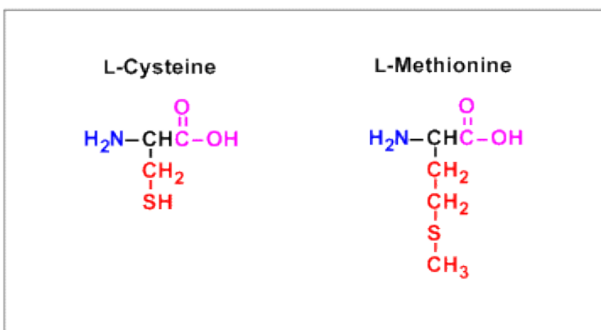
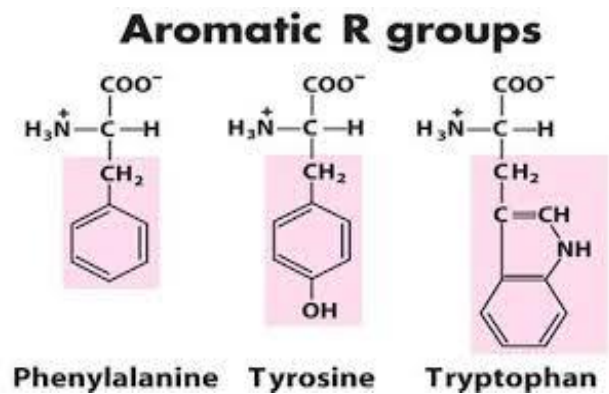
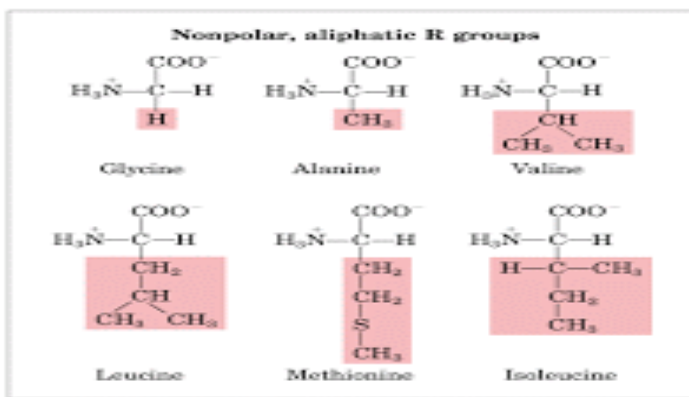
Amino acids are classified into three groups:

1. neutral amino acids: are the largest group which are divided into:

- aliphatic amino acids (glycine, valine, alanine, leucine, isoleucine).
- aromatic amino acids (tyrosine, phenylalanine).
- heterocyclic amino acids (tryptophan, histidine).
- sulphur containing amino acid (cystine , cysteine , methionine)

2. Acidic amino acids (aspartic acid , glutamic acid)

3. Basic amino acids (Lysine , arginine).



Essential amino acids: Amino acids are not synthesized in the body and are essential as constituents of tissue proteins, therefore it must be supplied in food. (valine, phenylalanine, lysine, tryptophan, leucine, isoleucine, methionine).

The Chart of
Amino Acids

Essential		
Isoleucine	Methionine	Tryptophan
Leucine	Phenylalanine	Valine
Lysine	Threonine	

Nonessential		
Alanine	Cysteine	Proline
Asparagine	Glutamic acid	Serine
Aspartic acid	Glutamine	Tyrosine
	Glycine	

Semi-essential	
Arginine	
Histidine	

Graphic by Bent On Better

Functions or importance of amino acids

Amino acids are monomeric constituents of proteins peptides and many

1. Some amino acids converted to CHO , called as glucogenic a.a.
2. Some amino acid are converted to acetyl COA called ketogenic amino acids.
3. Glycine and cysteine help in synthesis of bile salts.
4. Thyroid hormone, epinephrine, nor epinephrine , and pigment melanine are synthesis from tyrosine.

Digestion and Absorption of Proteins:

Digestion:

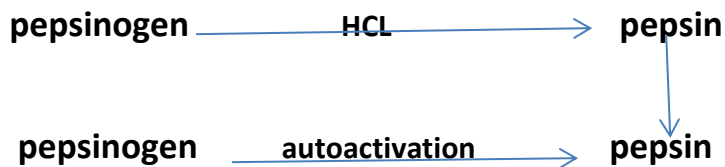
A. In stomach : enzyme are: **1. Rennin** **2. Pepsin**

-- **Rennin** is active in infants and is involved in curdling of milk (milk- clotting enzyme). acts on casein converting it to soluble para casein, optimum PH=4.

-- **Pepsin** is secreted from chief cells of stomach as inactive pepsinogen, optimum PH = 1.5- 2.2, activated by HCL.

Role of gastric HCL.

1. It causes denaturation of proteins.
2. Converts proteins to meta proteins, which are easily digested.
3. Activate pepsinogen to pepsin.

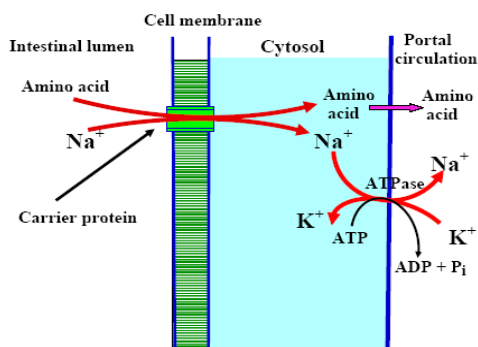


(the end products of proteins digestion in the stomach are proteases, peptones, and Large polypeptides).

B. Pancreatic juice : contain **trypsin , chymotrypsin , elastas etc .**

C. Intestinal juice: **complete digestion of the small peptides to amino acids.**

Absorption of amino acids: is mainly in small intestine, the process require of an energy.



Carrier Protein Transport System

Dynamic Equilibrium:

It means there are balance in **synthesis** and **Break down** of tissues (protein).

All tissues and blood have constant **1. composition** and **2. size** of proteins

In man 70 k gm, about **400 gm** of protein is **synthesized** daily and **much** is also **degraded**.

Nitrogen balance: means amount of nitrogen intake in food (mainly as protein) is equal to the amount of nitrogen excretion in urine as urea, uric acid ,creatinine.

ex: healthy adult.

Positive nitrogen: means amount of nitrogen intake in food is more than nitrogen excretion in urine.

ex: growing periods , pregnancy , adolescence

Negative nitrogen: means nitrogen intake in food is less than nitrogen excretion in urine. ex: starvation, malnutrition, low protein intake, old age.

Pathway of protein metabolism

1. Anabolism: synthesis of

- tissue proteins, blood proteins, enzymes, hormones.
- synthesis of non protein nitrogen compound.
like creatinine , urea, purine, pyrimidine.

2. Catabolism: break down

- transamination
- oxidative deamination
- decarboxylation
- formation of urea
- utilization of nitrogen to glutamine

Amino acids in the blood:

All amino acids occur in blood in varying concentration.

In post absorptive state: **30- 50 mg/ dl** of total amino acids is present in the blood (amino acid contain **4- 5 mg/dl** of nitrogen).

Following protein containing meal: the total level of amino acids rise to **45- 100 mg/dl** and (amino acid nitrogen **6-10 mg/dl**).

Amino acids in the tissues:

The amount of **amino acids** in **tissues** at any moment = amino acids **absorbed** from **intestine (diet)** + amino acids result from **break down of tissue**.

In starvation: The amount of amino acids increased in tissue due to **tissue break down** only because no absorption from intestine (no diet).

Catabolism of amino acids

Proteins from diet and tissue, break down in to the amino acids.

Amino acids \longrightarrow keto acids + NH₃

NH₃ \longrightarrow urea , creatinine, uric acid, etc---
 \longrightarrow new a.as (non essential a.as).

Keto acid $\xrightarrow{\text{TCA cycle}}$ CO₂ + H₂O
 \longrightarrow glucogenic a.as (**Glucose**)
 \longrightarrow ketogenic a.as (**Acetyl CoA**)

glucogenic a.as

ketogenic a.as

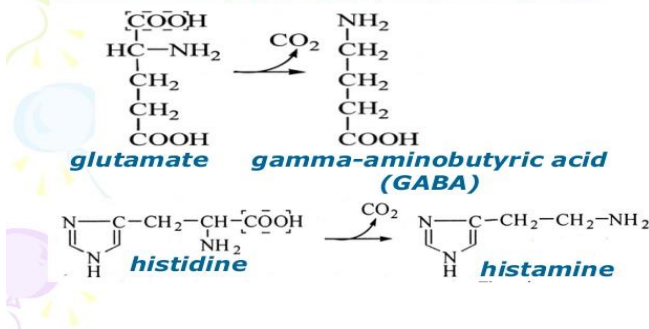
glucogenic and ketogenic a.as

Removal of carboxyl group from amino acids gives rise to some of the biologically active amines. The enzyme is decarboxylase and phosphate as coenzyme.

- histidine histamine (powerful vasodilator)
- tyrosine tyramine (increase blood pressure)
- glutamic acid amino butyric acid (stimulates neuronal activity).
- tryptophan tryptamine

Significance of amino acid decarboxylation

1. Formation of physiologically active compounds

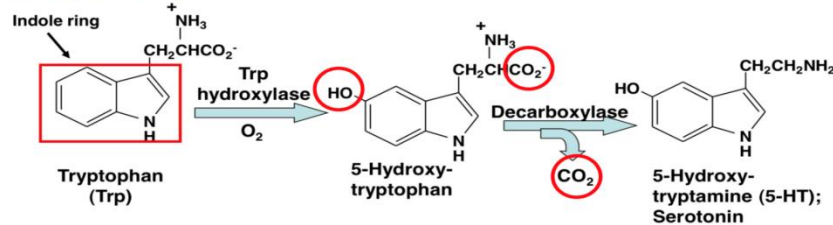


Serotonin Synthesis

The synthesis of serotonin is very similar to that of norepinephrine from tyrosine. Note, serotonin is a neurotransmitter but is not a catecholamine.

Tryptophan serves as the initial substrate for synthesis, and is hydroxylated by the BH₄-dependent enzyme **tryptophan hydroxylase**.

The product, 5-hydroxytryptophan, is decarboxylated by **amino acid decarboxylase** (see slide 12) to yield **5-hydroxy tryptamine (5-HT)**, also called **serotonin**.



Blood Proteins: includes

1. Albumin(A)
2. Globulin(G)
3. Fibrinogen

Normal value:

A = 3.5 - 5.0 mg/dl (53%)

G = 2.3 - 3.5 mg/dl (47%)

Normal ratio A/ G = 1.2 / 1

Hyperproteinemia : increase level of plasma protein from their normal value (**increase both A and G**). is shown in :

1. dehydration
2. multiple myeloma.
3. **after a stressful exercise**. It is a physiological process without any disease.
4. **Amyloidosis**: in this condition there is an abnormal production of protein in the bone marrow. The condition is called amyloidosis. Liver, spleen and kidney are generally affected.
5. **Inflammation in the tissues** as it occurs in **bacterial infection**, or **in burns**, or **due to certain diseases** such as **HIV** and **AIDs** can give rise to increased protein level in the blood.
6. **Kidney failure** and **eclampsia during pregnancy** are known causes of hyperproteinemia.

Side Effects

1. high protein concentration in the blood causes extra burden for the kidney to filter it.
2. Kidney stones can form when there is too high protein level in blood for a long duration.
3. Dehydration: It occurs as a result of accumulation of ketones in the blood. The condition is referred as ketosis.
4. Osteoporosis is another side effect of too much of protein in blood.

Treatment: 1. eating vitamin C rich foods such as citrus fruits, and other vegetables will help the kidney to flush excess amount of protein in the blood

hypoproteienemia: decrease level of plasma protein from their normal value (decrease both A and G). A/G also decrease. Is shown in: **1. malnutrition 2. malabsorption**

- 3. hemorrhage 4. kidney disorder 5. liver disease.**

Side effect:

- muscle loss
- slowed growth
- weakened immune system
- weakened heart and lungs

A severe protein deficiency can be life-threatening.

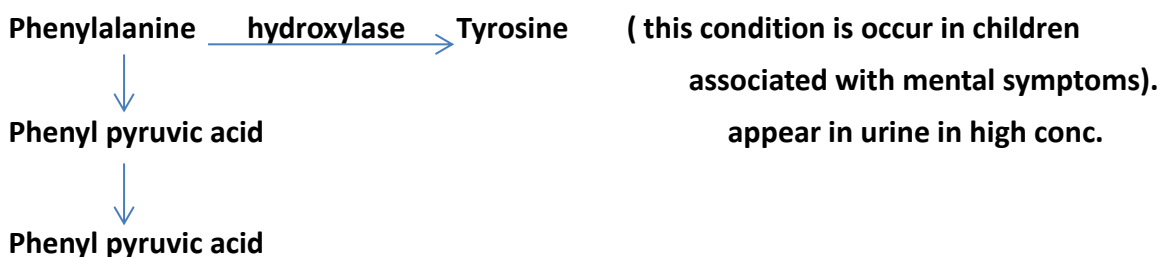
Disturbance in protein metabolism:

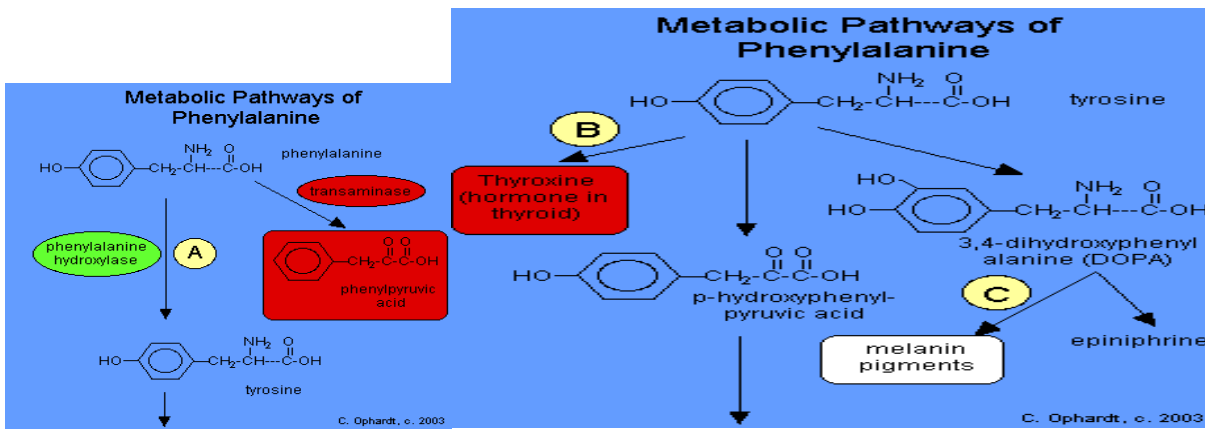
Occur due to :

1. lower or inadequate protein intake(especially E.A.A).
2. Incomplete digestion and absorption of proteins.
3. Disorder in CHO and lipids metabolism.
4. Genetic impairment . **Ex: abnormal hemoglobin, clotting factor deficiency).**

Inborn error metabolism of amino acids

1. **phenyl ketonuria:** accumulation of phenylketonic compound **due to absence of enzyme phenylalanine hydroxylase in liver**, which responsible for conversion of phenylalanine into tyrosine lead to formation of phenyl pyruvic acid and phenyl acetic acid appear in urine.





2. Tyrosinosis:

a rare condition resulting from a defect in amino acid metabolism and transmitted . It is characterized by the excretion of an excessive amount of parahydroxyphenylpyruvic acid tyrosyl metabolites in the urine.

caused by defective formation of hydroxyphenylpyruvic acid oxidase or of tyrosine transaminase.

3. Albinism:

Greek word, albino means, white. it is disease with an incidence of one in 20.000 population

Albinism : is defect in melanin synthesis due to completely absent of tyrosinase enzyme. (the skin has low pigmentation and sensitive to UV rays, iris may be grey, hair white).

