Vitamins:

المحاضره الأولى

WATER SOLUBLE VITAMINS

Objectives:

The students are learned to understand the following points:

-Classification of water soluble vitamins

- **Vitamin B1**: **Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**

- **Vitamin B**2: **Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**

WATER SOLUBLE VITAMINS:

comprise the following:

1- **vitamin C (ascorbic acid).**

2- **B- complex group:** include the following

a- vitamin B1 (thiamin)

b- vitamin B2 (riboflavin)

c- vitamin B3 (niacin)

d- vitamin B5 (pantothenic acid)

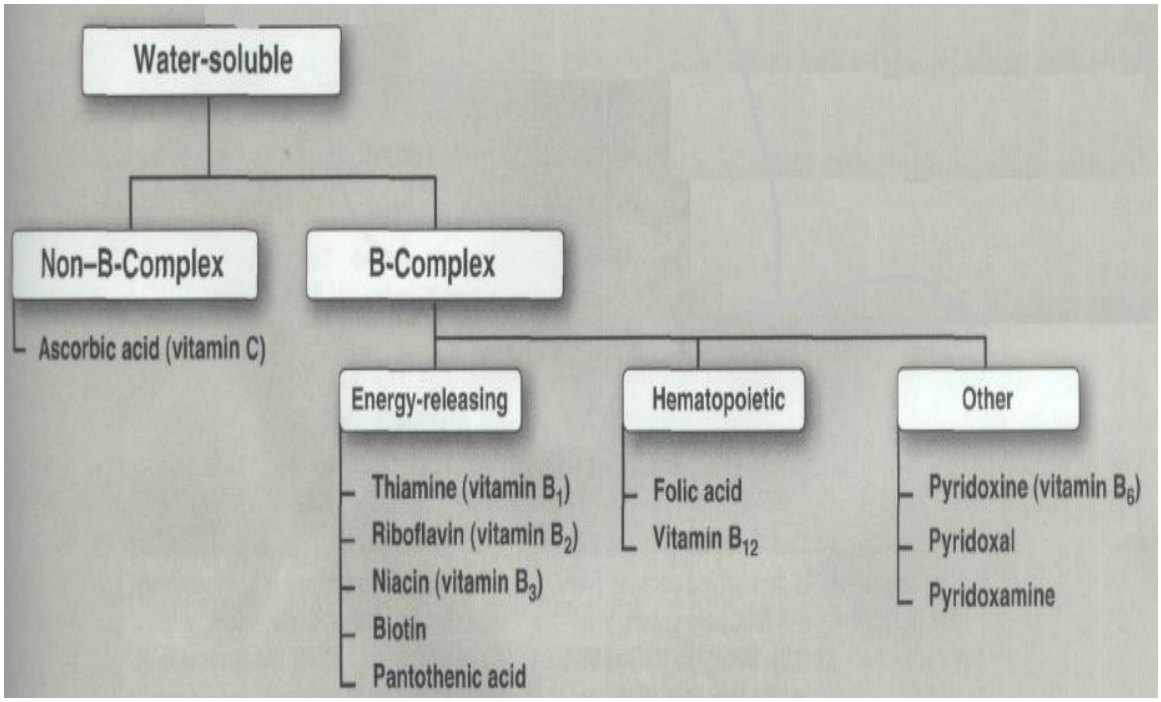
e- vitamin B6 (pyridoxine, pyridoxal,

pyridoxamine)

f- vitamin B7 (biotin)

g- vitamin B12 (cobalamin)

h- folic acid



Vitamin B1 (thiamin):

consist of a substituted pyrimidine joined by methelene bridge to a substituted thiazole.

Source:

Thiamin is present in almost all plant and animal tissues commonly used as food, but the contents usually small. Abundant sources are unrefined cereal grains, meat, liver, eggs and potatoes.

Requirement:

RDA is 0.5 / 1000 kcal taken in the diet which corresponds to 1.2 – 1.5 mg / day for normal adult.

Biochemical function:

Thiamin is utilized for the intracellular synthesis of thiamin pyrophosphate (TPP)

by the action of enzyme called thiamin diphosphotransferase

thiamin + ATP→→→ TPP + AMP

TPP is a coenzyme in enzymatic reactions in which an activated aldehyde unite is transferred ex.

- pyruvate dehydrogenase enzyme
- α- ketoglutarate dehydrogenase enzyme
- transketolase reaction in pentose phosphate pathway

Deficiency:

can result in three distinct syndromes:

1- a chronic peripheral neuritis which may occur alone (**dry beriberi**) or may be associated with heart failure and edema (**wet beriberi**)

2- acute **pernicious beriberi** in which heart failure and metabolic abnormalities predominate without peripheral neuritis

3- **Wernicke's encephalopathy** with **korsakoff's psychosis** which is associated especially with chronic alcoholic and drug abuse.

Vitamin B2 (Riboflavin):

consist of heterotricyclic structure attach to the sugar alcohol called ribitol.

Sources :

good sources include liver, eggs, milk, and Green leafy vegetable.

Requirement:

RDA: 1.5 mg / day

Biochemical function:

vitamin B2 is required for the production of the flavin nucleotides FAD, and FMN Which are serve as coenzymes for several oxidoreductases enzymes (flavoprotein enzymes).

Deficiency:

In spite of the numerous vital functions of flavoprotein enzymes, no specific disease can be attributed to riboflavin deficiency, however when there is deficiency various symptoms are seen including angular stomatitis, cheilosis, glossitis, dermatitis, and photophobia.

المحاضره الثانية

Objectives:

The students are learned to understand the following points:

- **Vitamin B**3: **Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**

- **Vitamin B**5: **Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**

-Vitamin B6: **Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**

Vitamin B3 (niacin):

Niacin is the generic name for nicotinic acid and nicotinamide*. Nicotinic acid is* monocarboxylic acid derivative of pyridine.

Sources:

niacin is found widely in most animal and plant foods ex. Liver, meat, milk, whole grain cereals, and leafy vegetable. However assessment of niacin value of food must take in account that the amino acid tryptophan can be converted to niacin. For every 60 mg of tryptophan taken, 1 mg of niacin can be generated. This pathway require vitamin B6 as coenzyme.

Requirement :

RDA: 14 – 18 mg / day.

Biochemical function:

Niacin provides a structural component for the coenzymes NAD and NADP which are coenzymes for many oxidoreductase enzymes.

Deficiency:

result in disease called **pellagra** (also called disease of **four D** because their symptoms include dermatitis, diarrhea, dementia and if untreated death.

the diet should be poor in both niacin and tryptophan for the disease to occur.

Other condition leading to pellagra like disease include:

- Drugs such as **isoniazid.**
- **Carcinoid tumor**: tryptophan metabolism is diverted to serotonin.
- **Hartnup disease**: tryptophan absorption is impaired.

Vitamin B5 (pantothenic acid):

is formed by the combination of pantoic acid and β- alanine

Sources:

It is widely distributed in foods particularly of animal sources, whole grain cereals, and legumes.

Requirement:

It appear that 5 – 10 mg fulfills the daily need.

Biochemical function:

It required for the structure of the following:

1- coenzyme A (CoA – SH)

2- acyl carrier protein (ACP – SH)

The thiol group act as carrier of acyl radicals In both CoA and ACP ex. In fatty acid oxidation and synthesis.

Deficiency:

It is rare because this vitamin is widely distributed in food.

Vitamin B6:

consist of three closely related pyridine derivative: pyridoxine, pyridoxal, and pyridoxamine and their corresponding phosphate derivative. All three can serve as precursor for the coenzyme pyridoxal phosphate.

Sources

good sources include liver, meats, wheat, corn, and eggs.

Requirement:

the RDA is 2 mg/ day

Biochemical function:

1- Coenzyme in transamination which is most notable function of pyridoxal phosphate.

2- It is also the cofactor of the enzyme glycogen phosphorylase.

3- also vitamin B6 is important in steroid hormone action where it removes the hormone receptor complex from DNA binding, terminating the action of the hormones

Deficiency:

deficiency of B6 alone is rare (usually occur as part of generalize nutritional deficiency), however deficiency of B6 alone could occur in the following conditions:

- nursing infant whose mother are depleted of the vitamin owing to long term use of oral contraceptive pills (estrogen induces transaminase enzymes).
- alcoholics: ethanol metabolized to acetaldehyde which in turn stimulate the hydrolysis of the phosphate of the coenzyme.
- antituberculous drug (isoniazid) can induce B6 deficiency by forming a hydrazone with pyridoxal phosphate which excreted in urine.

In childhood can result in poor growth, anaemia, decrease immunity, and convulsion in infant.In adult there is no characteristic syndrome for ex. may lead dermatitis and polyneuritis.

Increased sensitivity to steroid hormone action may be important in the development of hormone dependent cancer ex. breast cancer.

المحاضره الثالثة

Objectives:

The students are learned to understand the following points:

- **Vitamin B**7: **Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**
- **Folic acid: Structure**, **Sources, Daily requirement**, **Biochemical functions**, **Deficiency**

Vitamin B7 (biotin):

is an imidazol derivative

Sources:

widely distributed in natural foods. In addition, biotin is produce by intestinal flora which may provide most or all of the required amounts.

Requirement :

in human about 150 μg / day seem to be required.

Biochemical function:

Biotin is a coenzyme for carboxylase enzymes and serve as carrier of activated carboxyl group ex. acetylCoA carboxylase.

Deficiency:

Rare except among people maintained for many months on parenteral nutrition and a very small number who eat abnormally large amount of uncooked eggs white, which contains avidin, a protein that binds biotin and renders it unavailable for absorption.

Folic acid (Folate, Folacin):

consist of the base pteridin, PABA, and glutamate.

Sources:

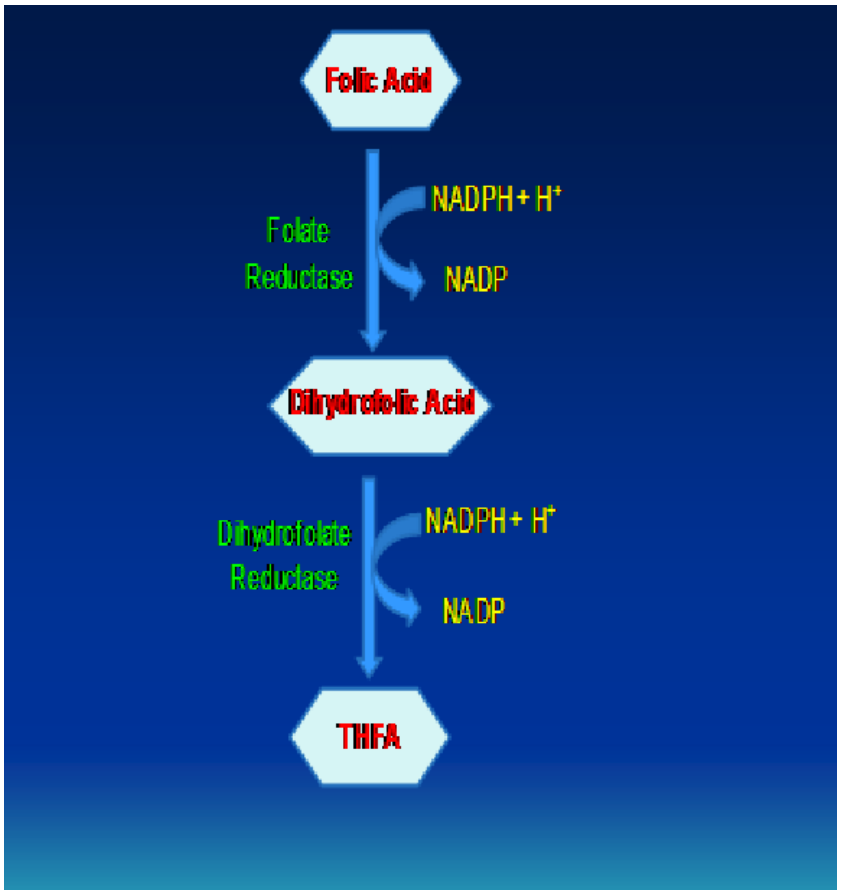
Animals are not capable of synthesizing PABA or attaching glutamate to pteroic acid and therefore require folate in their diet. Liver and green leafy vegetable are major sources.

Requirement:

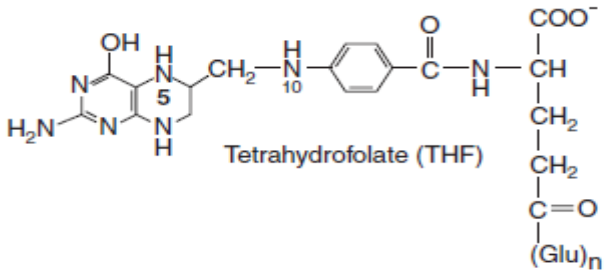
RDA for adult is 400 µg. Higher amount should be ingested during growth,pregnancy, and lactation.

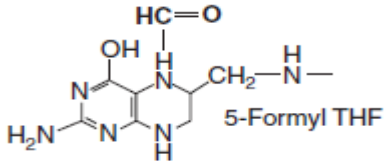
Biochemical function:

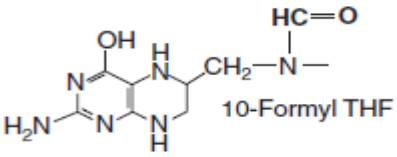
active folate is THFA

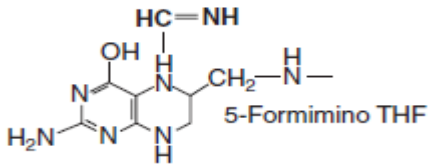


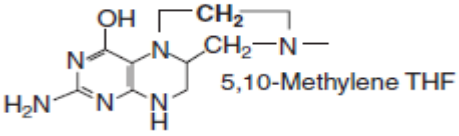
THFA is the carrier of activated one carbon units which may be methyl, methylene, methenyl, formyl, or formimino.

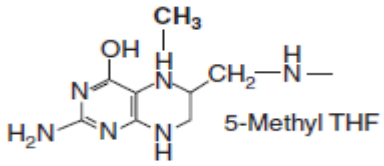


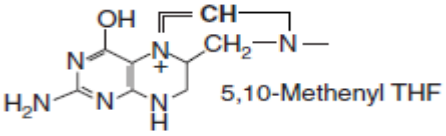




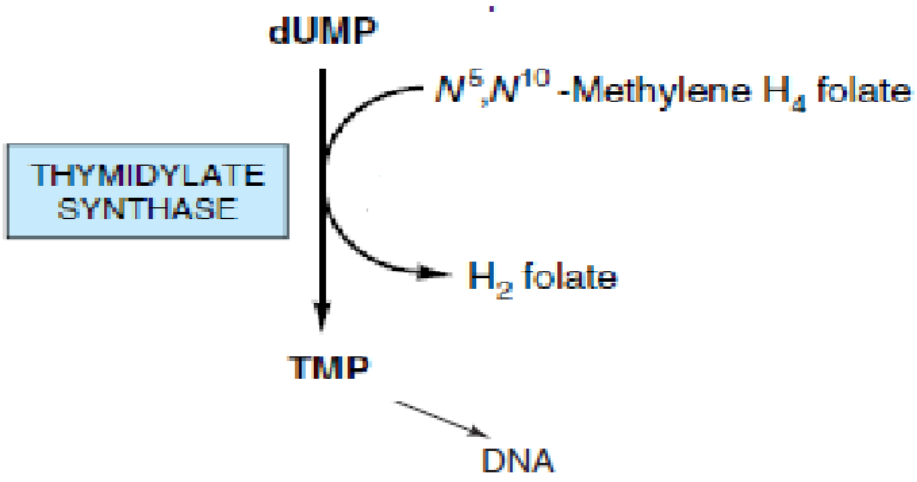








The single carbon units carried by THFA utilized for nucleotide synthesis ex.



Deficiency:

- Inadequate dietary intake
- Drug ex. Methotrexate which inhibit the enzyme folate reductase.
- Alcohol interfere with absorption and metabolism of folic acid.

The metabolic effects of folic acid deficiency are block the synthesis of purine nucleotide and in the conversion of dUMP to dTMP as consequence the synthesis of DNA can not proceed normally.

Tissues with high degree of cell multiplication are therefore first affected such as bone marrow leading to Megaloblastic anaemia. Other cells that are prone to be affected are leukocyte and epithelial cells lining the gastrointestinal tract.

المحاضره الرابعة

Objectives:

The students are learned to understand the following points:

- **B12 : Structure**, **Sources, Daily requirement**, **absorption, Biochemical functions**, **Deficiency and phenomenon of folate trap**

- **Vitamin C : Structure**, **Sources, Daily requirement**, **Biochemical functions, Role of vitamin C in collagen synthesis**, **Deficiency**

Vitamin B12 (Cobalamin):

It has a complex ring structure called corrin ring to which is added cobalt ion at its center.

Sources:

The vitamin is synthesize exclusively by microorganisms, thus it is absent from plant, but is conserved in animals in the liver, where it is found as ethylcobalamin,adenosylcobalamin, and hydroxycobalamin. Liver is therefore a good source as is yeast.

The commercial preparation is cyanocobalamin

Requirement:

RDA is 3 µg

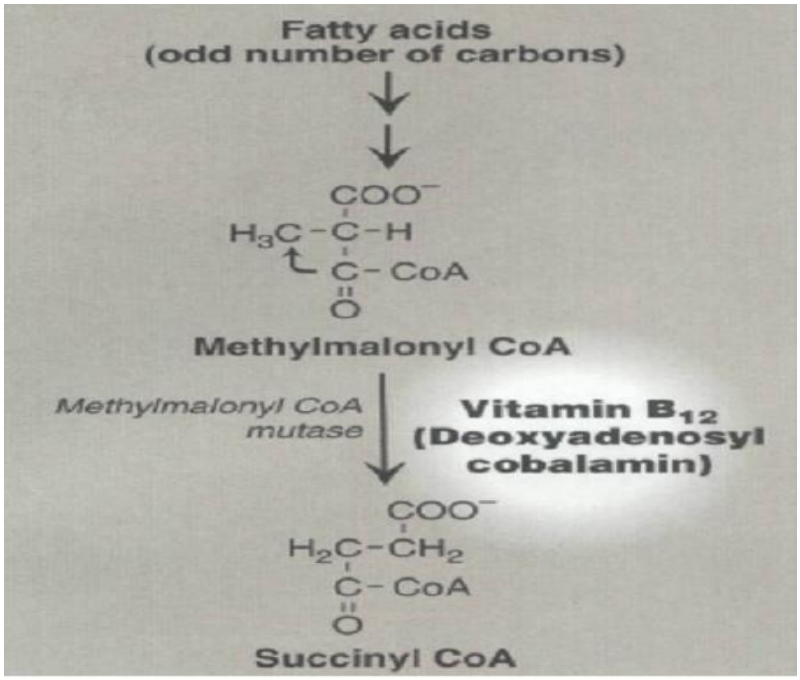
Absorption:

The intestinal absorption of vitamin B12 is mediated by receptor sites in the terminal ileum that require the vitamin B12 to be bounded by a highly specific glycoprotein called intrinsic factor which is secreted by gastric parietal cells.

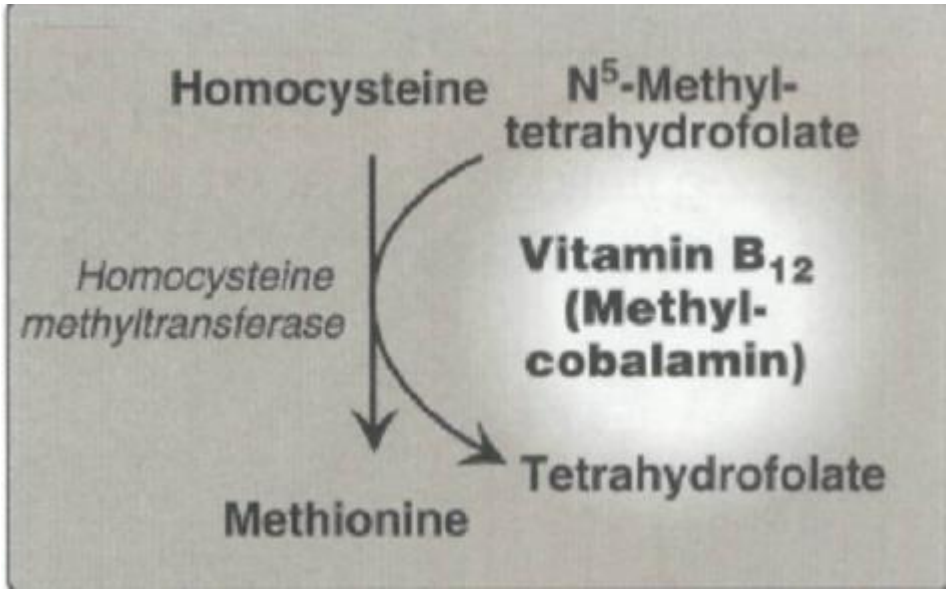
Biochemical function:

The active vitamin B12 are methylcobalamin and deoxyadenosylcobalamin

1- In mitochondria



2- In cytoplasm



The metabolic benefit of this reaction are:

1- synthesis of methionine from homocysteine .

2- THFA is made available to participate in nucleotide synthesis. Because the N5 – methyl THFA is the predominant form of folic acid in human serum and liver.

Deficiency:

- Poor dietary intake
- Vegans are at special risk
- Impaired secretion of intrinsic factor (pernicious anaemia)
- Gastrectomy
- Terminal ileal resection

A deficiency in vitamin B12 produce in its effect a deficiency in folic acid as folate being trapped as methyl THAF a phenomenon called folate trap. So in both B12 and folate deficiency there is impaired nucleotides and DNA synthesis leading to **Megaloblastic anaemia**. There is also relative deficiency of methionine which may account for the neurological disorder associated with vitamin B12 deficiency (**subacute combined degeneration of the spinal cord**).

Vitamin C (Ascorbic acid):

Ascorbic acid is an enediol derivative of L – gulonalactone

Sources:

The best sources are citrus fruits, tomatoes, melons, and fresh vegetable.

The vitamin is thermolabile.

Requirement:

MRR is 30 – 50 mg

Biochemical function:

The following are documented processesrequiring ascorbic acid. In many of these processes ascorbic acid does not participate directly but it is required to maintain a metal cofactor of the enzymes in the reduce state such as Cu^{+} and Fe^{++}

1- collagen synthesis (most important function of vitamin C).

2- degradation of amino acid tyrosine.

3- synthesis of epinephrine from tyrosine.

4- bile acid formation.

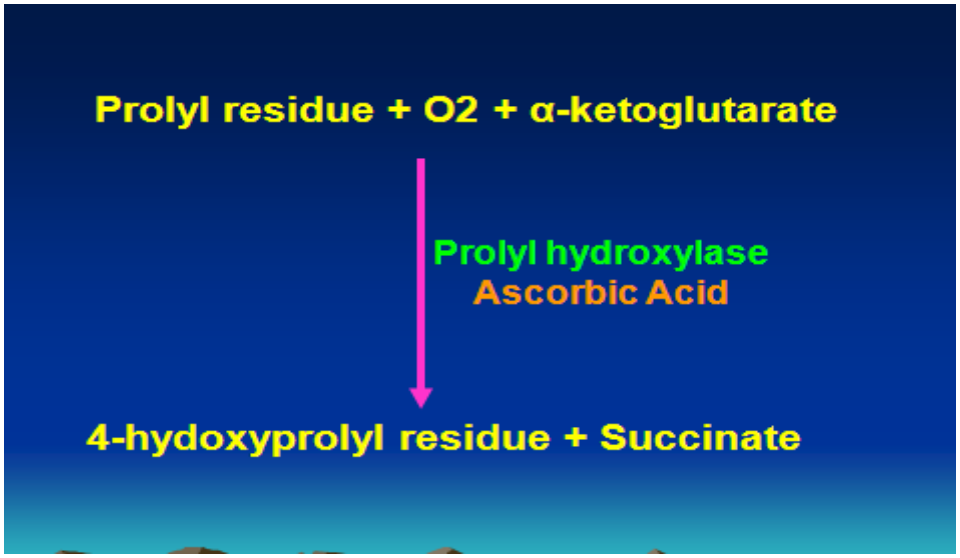
5- steroid hormones synthesis by adrenal cortex.

6- absorption of dietary iron is significantly increase by ascorbic acid by maintain iron in the gastrointestinal tract in ferrous state.

7- vitamin C is water soluble antioxidant.

Role of vitamin C in collagen synthesis:

the structure of collagen consist of three protein chains coiled around each other to form triple helix. The stability of collagen triple helix require the posttranslational conversion of some of the prolyl and lysyl residues to hydroxyprolyl and hydroxylysyl residues. Prolyl and lysyl hydroxylases are required for the postsynthetic modification of procollagen to collagen.



The enzyme prolyl hydroxylase contain ferrous ion at its active site. Ascorbic acid is needed as reducing agent to maintain the iron atom in ferrous state.Similarly some lysyl residues become hydroxylated by the action of lysyl hydroxylase.

Deficiency:

Results in disease called scurvy. The symptoms includes bleeding due to capillaries fragility, swollen gums, defective bones structure, and impaired wounds healing. These lesions can be ascribed to physical weakness of the supporting collagen at these sites.