INTRODUCTION

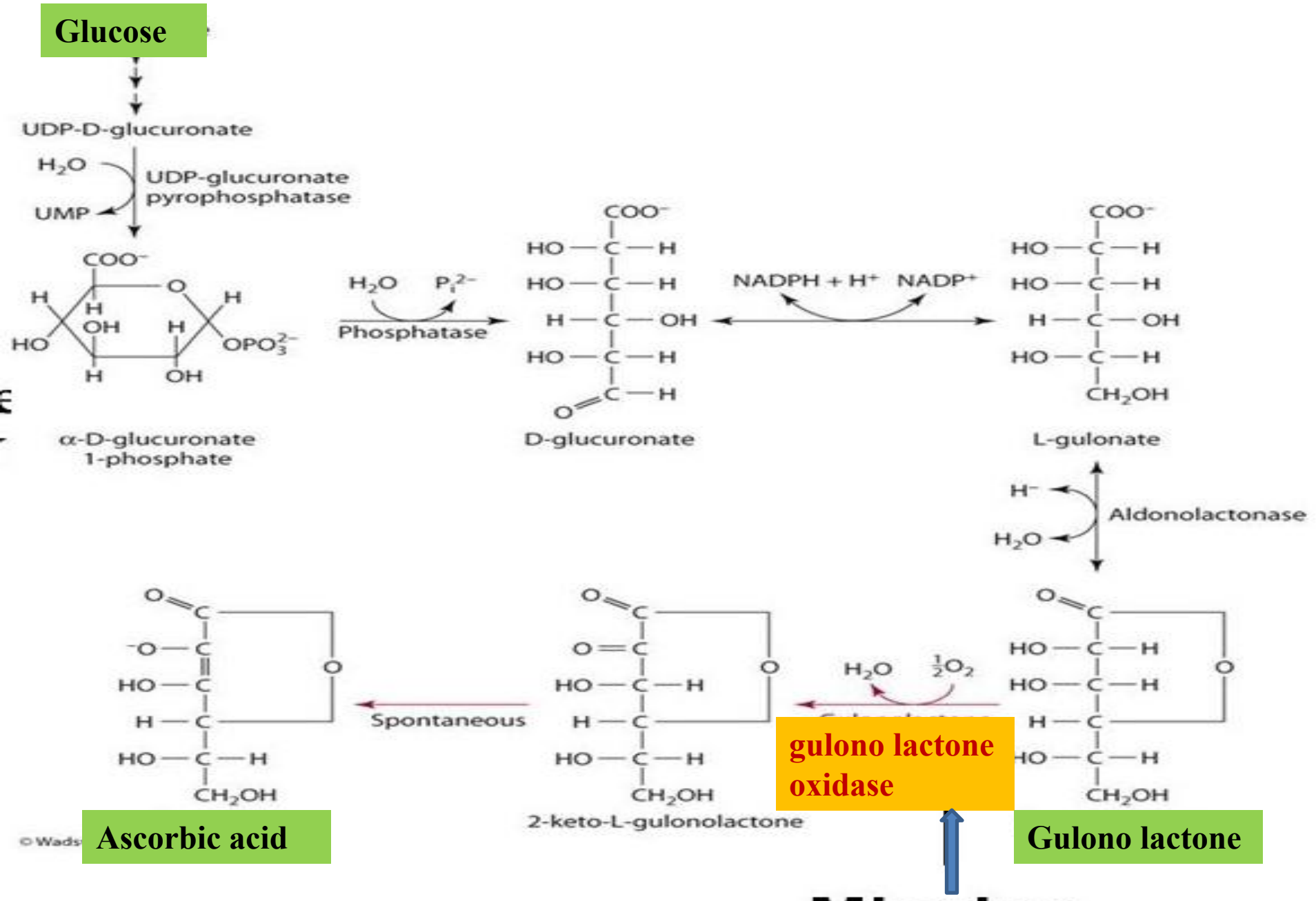
- Vitamin C is a water soluble vitamin
- Chemical name Ascorbic acid
- Also known as antiscorbutic factor
- Deficiency of vitamin C leads to scurvy (not known at that time) was discovered during famous voyage of Vasco da Gama in 1498
- Antiscorbutic factor was isolated in 1930 and named as hexauronic acid by Albert Szent Gyorgi ((Nobel prize- 1937)
- In 1933, Howarth established the structure and named it as Ascorbic acid(Nobel prize – 1937)

CHEMISTRY

- Ascorbic acid is a hexose derivative & closely resembles monosaccharide's in structure .
- It is formed as an oxidation product of L- gulunolactone
- Vitamin C exists in two forms:

  L – ascorbic acid (reduces form)

  L – Dehydro ascorbic acid (oxidized form)
- Most animals and plants can synthesize ascorbic acid from glucose.
- Man, higher primates, guinea pigs and bats are the only species which cannot synthesize ascorbic acid (block in gulono lactone oxidase step)



PROPERTIES

- Vitamin C is heat labile
- In the process of cooking about 50% of vitamin passes to water & 20% is oxidized
- Only L isomers of ascorbic acid and dehydroascorbic acid have antiscorbutic activity.
- D-ascorbic acid has no activity.
- Ascorbic acid is a strong reducing agent.
- The strong reducing property of vitamin C depends on the double bonded (enediol) carbons.
- L-ascorbic acid is the dominant form present in plasma and tissues.

METABOLIC ROLE

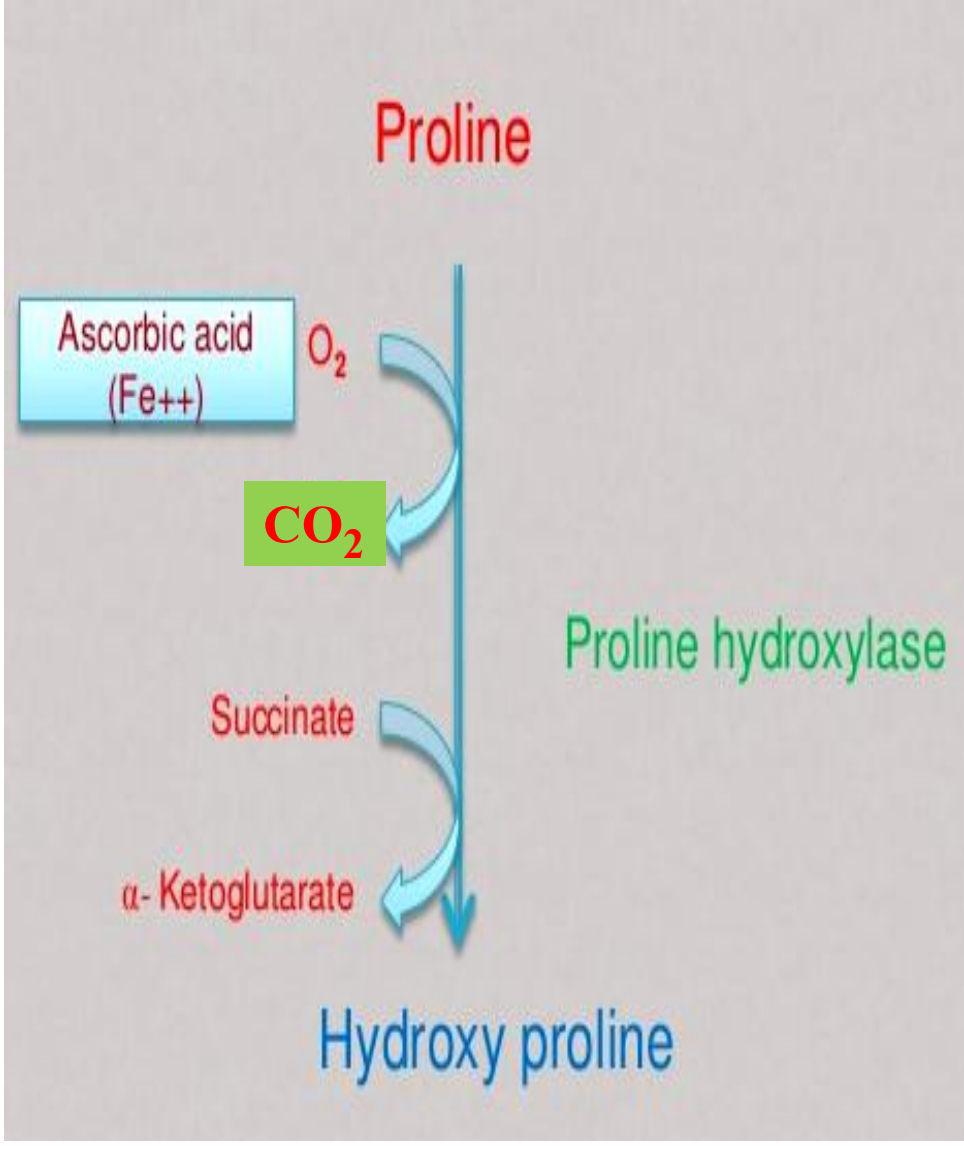
- Ascorbic acid and Dehydroascorbic acid form a very good redox system.
- Ascorbic acid has specific roles in the copper-containing hydroxylases and the α-ketoglutarate-linked iron-containing hydroxylases
- It has a number of nonenzymic effects as a result of its action as a reducing agent and oxygen radical quencher

1. Hydroxylation of Proline and Lysine

- Ascorbic acid is necessary for the post-translational hydroxylation of proline and lysine residues in proteins such as collagen.
- Hydroxyproline and hydroxylysine are essential for the formation of cross links in the collagen, which gives the tensile strength to the fibers.
- This process is absolutely necessary for the normal production of supporting tissues such as osteoid, collagen and intercellular cement substance of capillaries.
- Ascorbic acid & ferrous iron are cofactors
- Ascorbic acid is essential to keep the iron in ferrous form

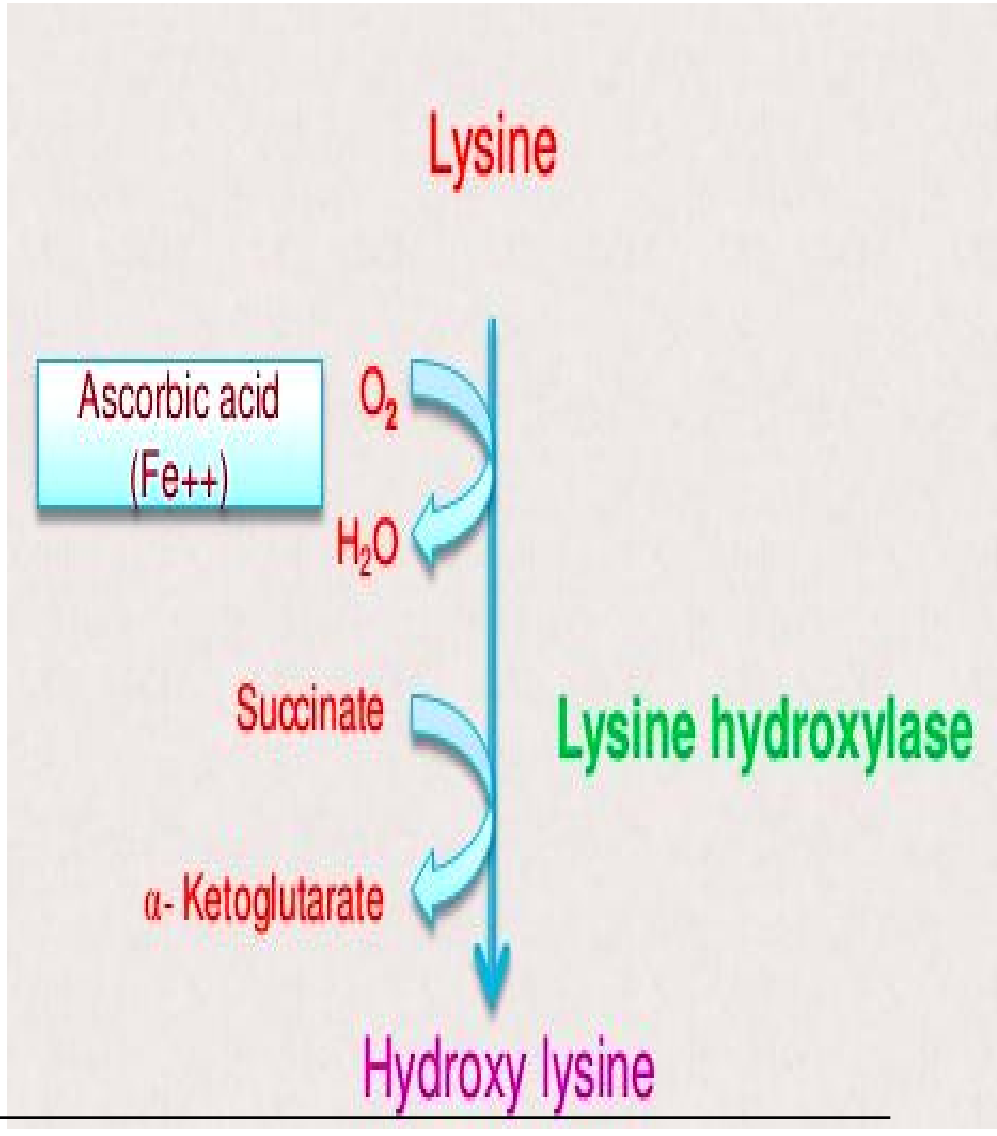
Hydroxylation of Proline

- Proline hydroxylase catalyzes the hydroxylation of proline on collagen.
- Ascorbic acid & ferrous iron are cofactors .
- Ascorbic acid is essential to keep the iron in ferrous form.
- It essential for maturation &cross-linking of collagen.



Hydroxylation of lysine

- Hydroxylation occurs after the peptide chain synthesis (posttranslational modifications)
- Lysine hydroxylase catalyzes the hydroxylation of lysine residues present on collagen.
- It helps in formation of osteocalcin and the C1q component of complement

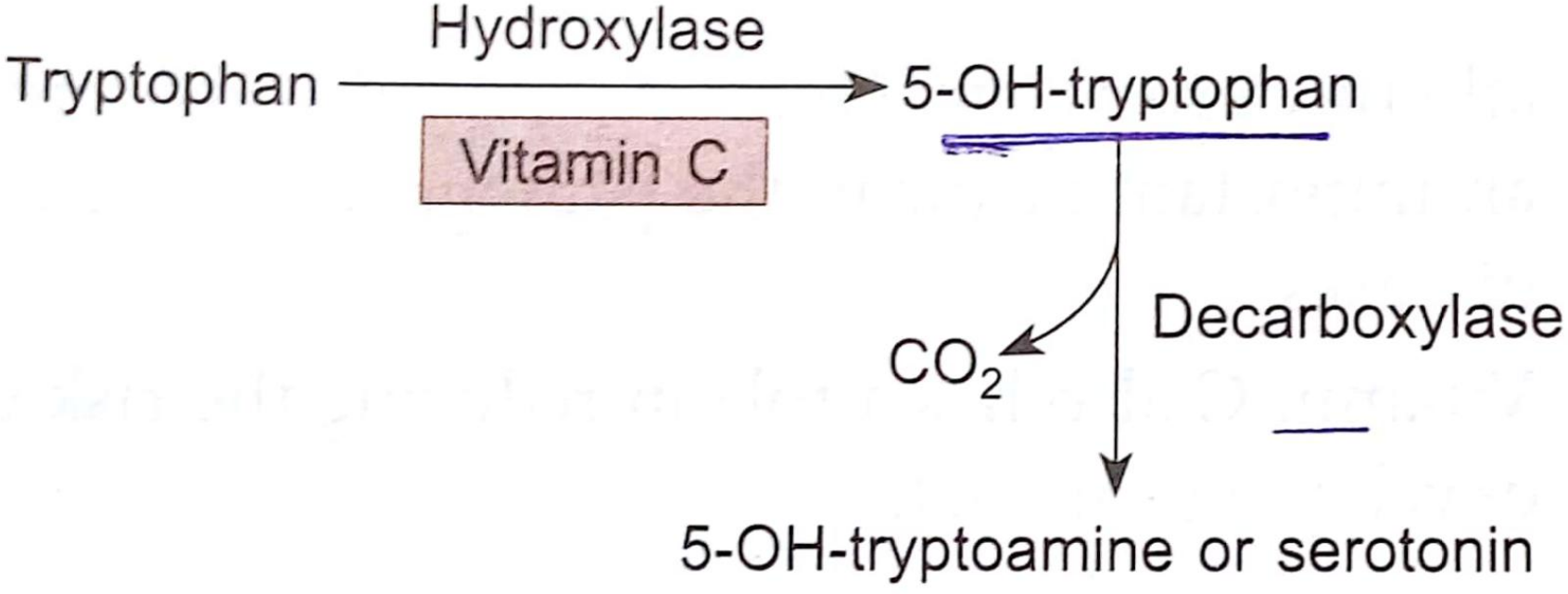


2. Absorption of iron

- Ascorbic acid enhances the iron absorbtion from the intestine
- Ascorbic acid reduces ferric iron to ferrous state, which is preferentially absorbed.

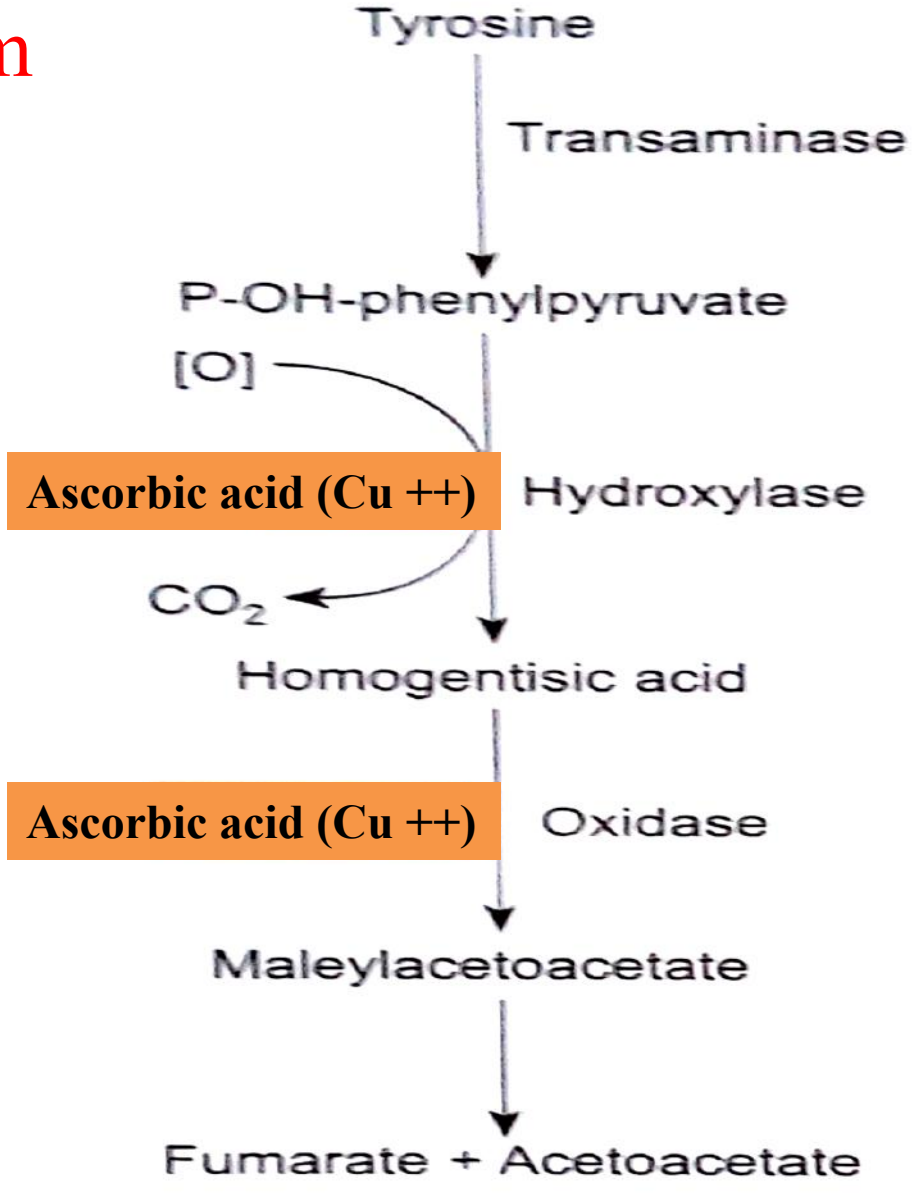
3. Tryptophan Metabolism

- Ascorbic acid is necessary for the hydroxy lation of tryptophan to 5-hydroxy tryptophan.
- This is required for the formation of serotonin



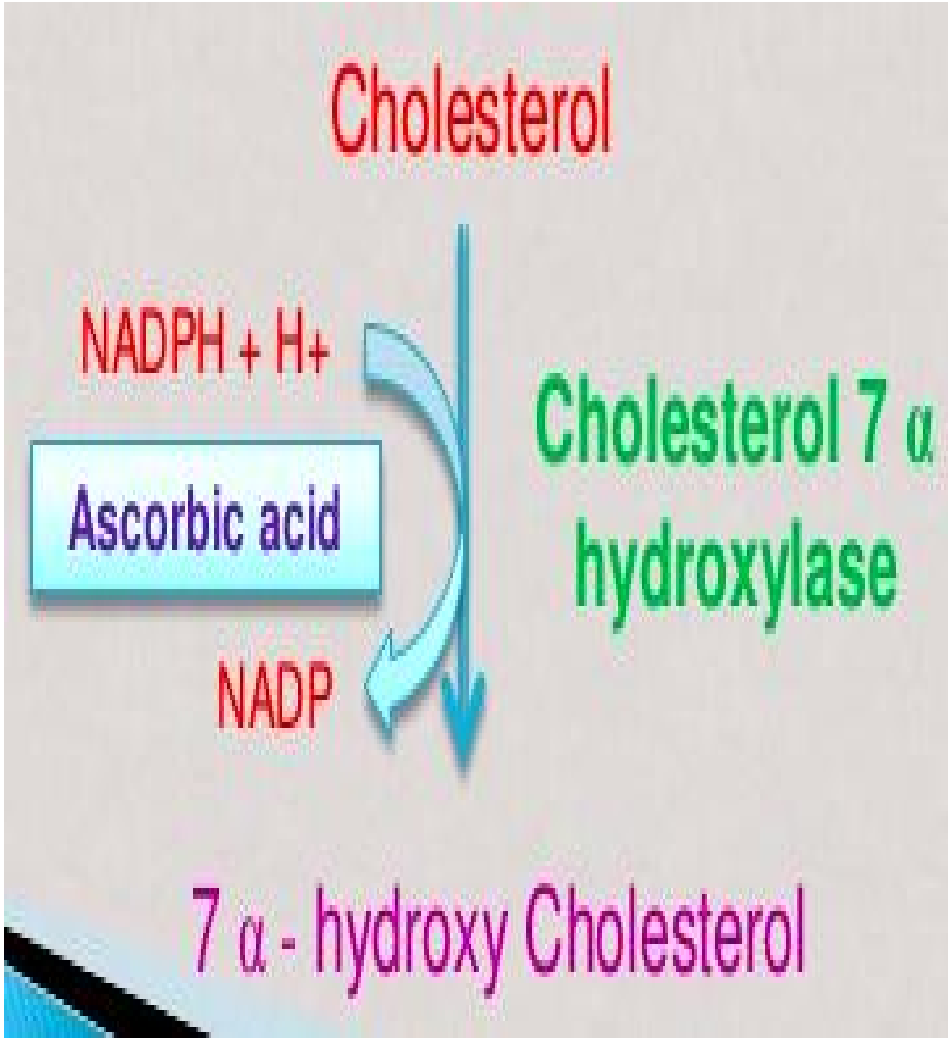
4. Tyrosine Metabolism

- Vitamin C helps in the oxidation of parahydroxyphenyl pyruvate to homogentisic acid
- It also helps in the oxidation of homogentisic acid



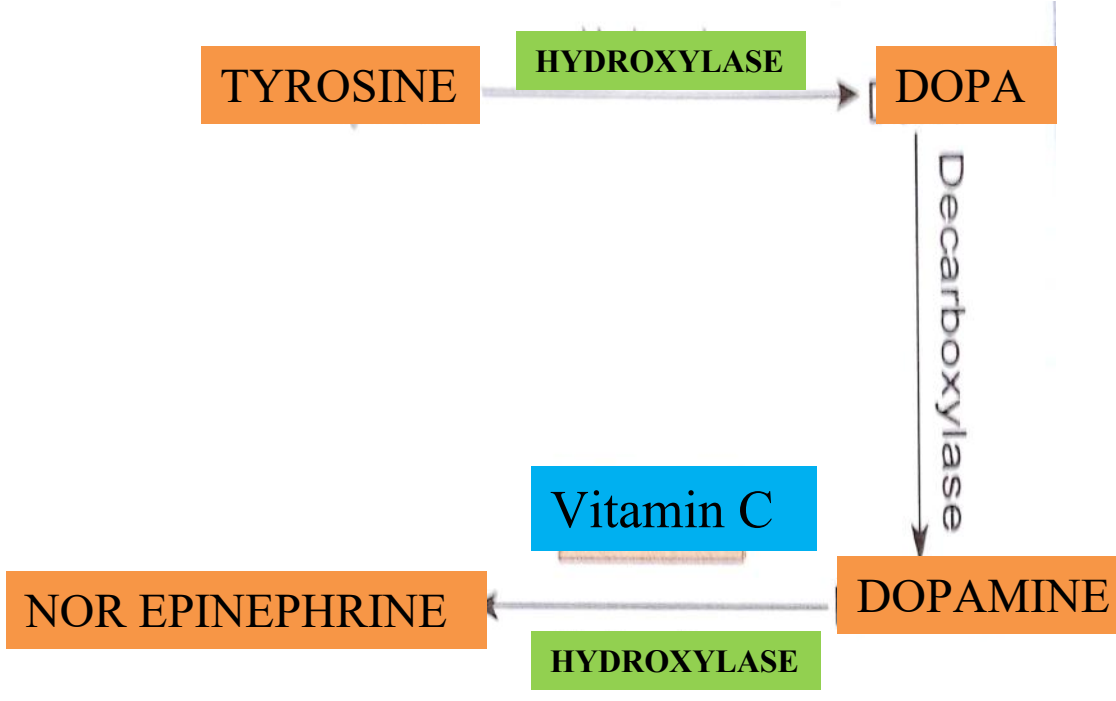
5. Synthesis of Bile acids

- In the biosynthesis of bile acids Cholesterol 7 α–hydroxylase, catalyzes the formation of 7 α – hydroxycholesterol from cholesterol.
- In this vitamin C is a cofactor
- It is a rate limiting step in bile acid synthesis



6. Synthesis of Norepinephrine

- Dopamine conversion into norepinephrine requires vitamin C as the Co enzyme.
- This is essential for synthesis of catecholamines
- Adrenal medulla is rich in vitamin C



7. Synthesis and release of adreno -cortical steroid hormone

- Adrenal gland possesses high levels of ascorbic acid
- Ascorbic acid is necessary for hydroxylation reactions in the synthesis of corticosteroid hormones.

8. Reduction of methemoglobin

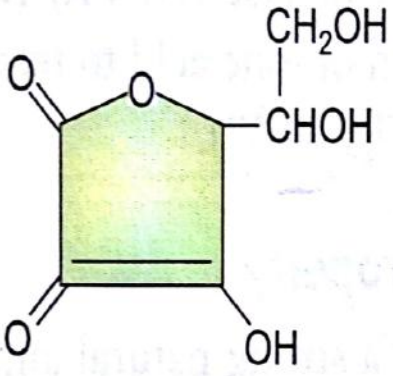
- It is useful for re-conversion of met-hemoglobin to hemoglobin.

9. Folic Acid Metabolism

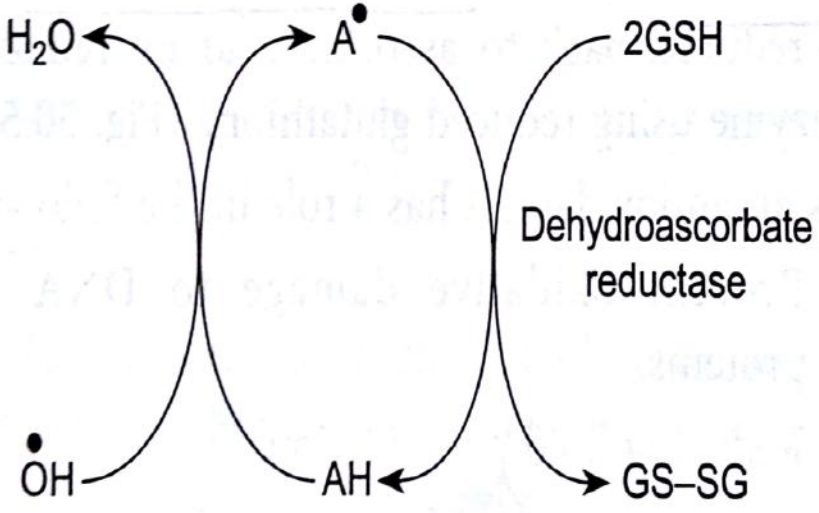
- Ascorbic acid is helping the enzyme folate reductase to reduce folic acid to tetrahydrofolic acid
- Thus it helps in the maturation of RBC.

9. Antioxidant property

- It acts as a hydrophilic, chain breaking antioxidant like vitamin E.
- It also form a relatively stable radical form, the semidehydroascorbate.
- This is reduced back to ascorbic acid by reductase enzyme using reduced glutathione.

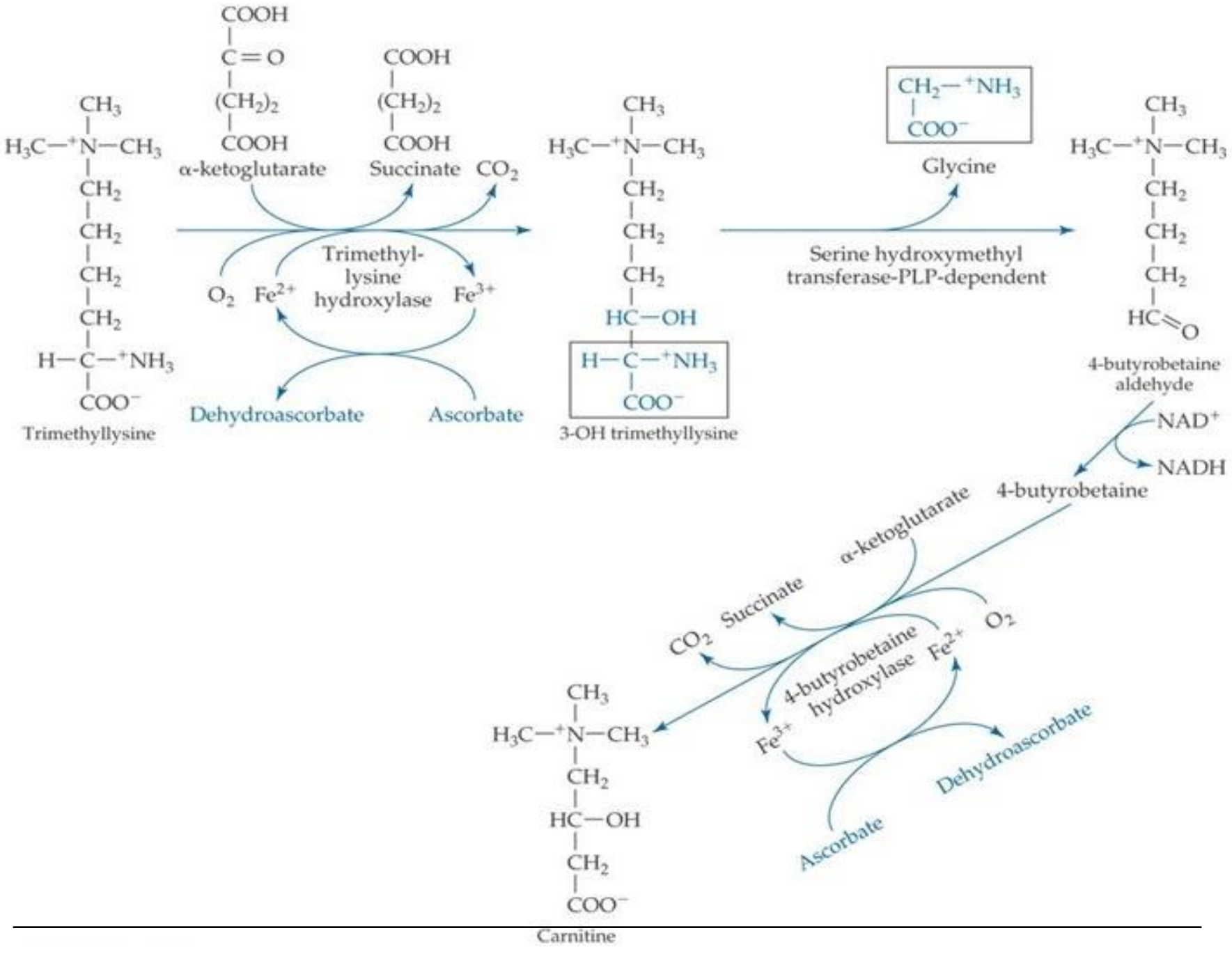


Semi dehydroascorbic acid



10. Synthesis of Carnitine.

- Vitamin C needed for Trimethyllysine and γ-butyrobetaine hydroxylases which are required for the synthesis of carnitine



11. Peptide hormone synthesis

- A number of peptide hormones have a carboxy terminal amide that is derived from a terminal glycine residue.
- Hydroxylation of this glycine is carried out by a copper-containing enzyme peptidyl glycine hydroxylase, which requires vitamin C

12. Phagocytosis

- Ascorbic acid stimulates phagocytic action of leukocytes and helps in the formation of antibodies.

13. Sparing action of other vitamins:

- Ascorbic acid is a strong antioxidant
- It spares vitamin A, E and some B-complex vitamins from oxidation

14. Immunological function:

- Vitamin C increases the synthesis of immunoglobulins & increases the cell mediated immunity.

15. Prevention of Cataract

- Vitamin C is concentrated in the lens of eye. Regular intake of ascorbic acid reduces the risk of cataract formation.

16. Activation of Protein C

- Vitamin C is required for postsynthetic modification of the precursor of protein C, the vitamin K-dependent protease that hydrolyzes activated factor V in the blood-clotting cascade.

17.Sparing action of other vitamins

- Ascorbic acid is a strong antioxidant
- It spares vitamin A, E and some B-complex vitamins from oxidation.

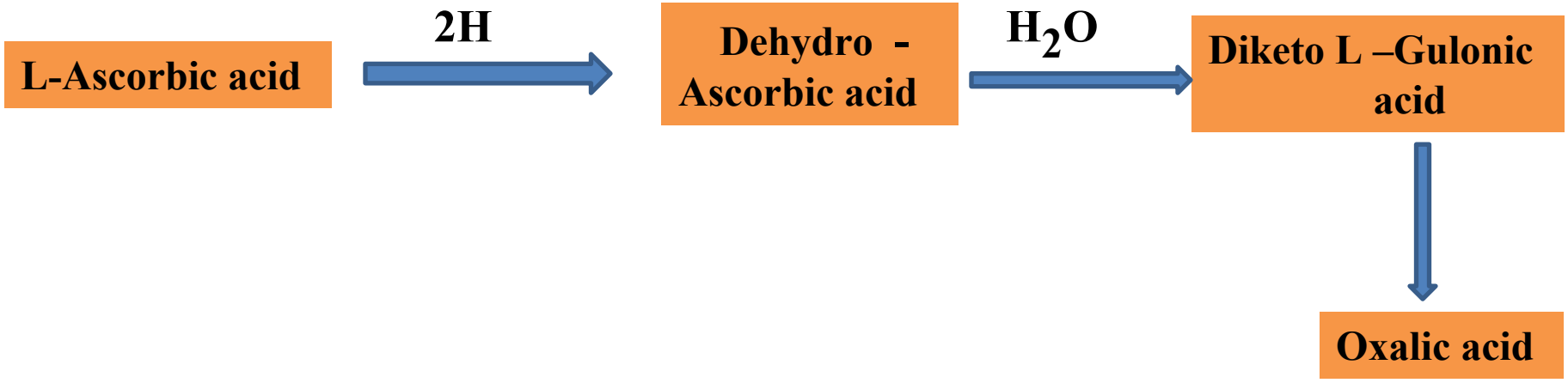
18. Preventive role of vitamin C

- Vitamin C helps in the prevention of cancer, atherosclerosis and delays ageing process.

Metabolism

- Ascorbic acid is readily absorbed from gastrointestinal tract.
- The vitamin is excreted in urine.
- Since vitamin C is a strong reducing agent, the Benedict's test will be positive in the urine sample after the vitamin administration.
- Plasma ascorbic acid level - 0.7 to 1.2 mg/dl

- Oxidation of ascorbic acid yields dehydro ascorbic acid, which is oxidized further to oxalic acid through diketo-L-gulonic acid
- Ascorbic acid is partly excreted unchanged and partly as oxalic acid.
- Most of the oxalates in urine are derived from ascorbic acid, and the rest from glycine metabolism.



Dietary Sources of Vitamin C

- Rich sources are amla (Indian gooseberry),guava ,lime, lemon,Cabbage and green leafy vegetables.
- Germinating pulses contain large amount of vitamin C.

RDA

- Recommended daily allowance is 60 - 75 mg/day (equal to 40-50 mL orange juice).
- During pregnancy, lactation, and in aged people requirement may be 100 mg/day
- Smokers, chronic alcoholics and women on oral contraceptives require up to125 mg/day.

Deficiency

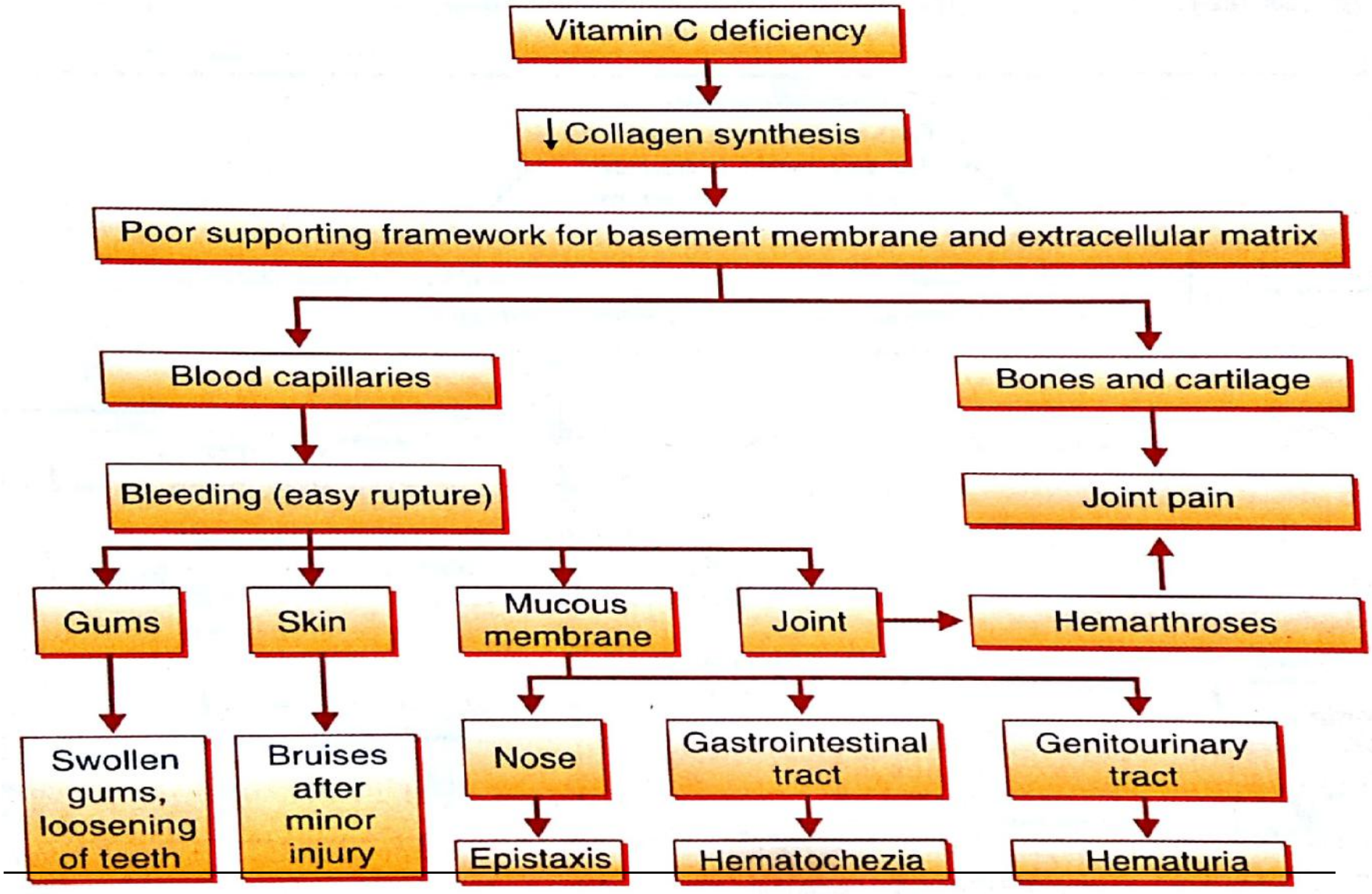
CAUSES

- Scurvy is caused by a dietary deficiency of vitamin C.
- The body's pool of vitamin C can be depleted in 1-3 months.

Risk factors include the following:

- Babies who are fed only cow's milk during the first year of life
- Alcoholism
- Cigarette smokers
- Pregnant and lactating women
- Thyrotoxicosis
- Elderly individuals who eat a tea-and-toast diet
- Economically disadvantaged persons
- Refugees
- People with disease of the small intestine
- Those on hemodialysis and peritoneal dialysis.

DEFICIENCY MANIFESTATION



DEFICIENCY MANIFESTATION

1. Scurvy

- The deficiency of ascorbic acid results in scurvy
- It is due to impaired collagen formation and poor blood vessel support.
- Swollen, spongy and Bleeding gums are the characteristic feature

DEFICIENCY MANIFESTATION

2. Infantile Scurvy (Barlow's Disease)

- In infants between 6 to 12 months of age (period in which weaning from breast milk)
- Infants loose appetite and weight.
- Painful tenderness of the extremities.
- Bleeding from gums and mucous membrane.

DEFICIENCY MANIFESTATION

3. Hemorrhagic Tendency

- *Capillary fragility* enhances hemorrhagic tendencies resulting in bleeding under the skin even on slight pressure.
- Small dots like patches called petehiae and relatively large patches as ecchymoses
- Large accumulation of blood in subcutaneous tissues is called haematoma.
- In severe cases bleeding may occur from nose (epistaxis), eye (retinal hemorrhage), urethra (hematuria), intestine (malena) etc.

DEFICIENCY MANIFESTATION

4. Bones

- Ground substance formed by osteoblasts is defective. So the bones become weak and fracture easily with slightest of trauma or even pressure.
- Such bones are called Scorbutic bones.
- There may be bleeding into the joints leading to hemarthrosis.

DEFICIENCY MANIFESTATION

5. Anemia

- In vitamin C deficiency, microcytic, hypochromic anemia is seen.
- Poikilocytosis and anisocytosis are also common in anemia due to deficiency of vitamin C.
- The reasons for anemia may be:
    a. Loss of blood by hemorrhage
    b. Decreased iron absorption
    c. Decreased tetrahydrofolic acid
    d. Accumulation of met-hemoglobin.

DEFICIENCY MANIFESTATION

6. Poor wound healing

- Vitamin C deficiency is associated with poor wound healing.
- Because of its power to heal wounds, vitamin C has been recommended for treatment of ulcer, trauma, and burns.

7. Myalgia

- Myalgias may occur because of reduced carnitine production.

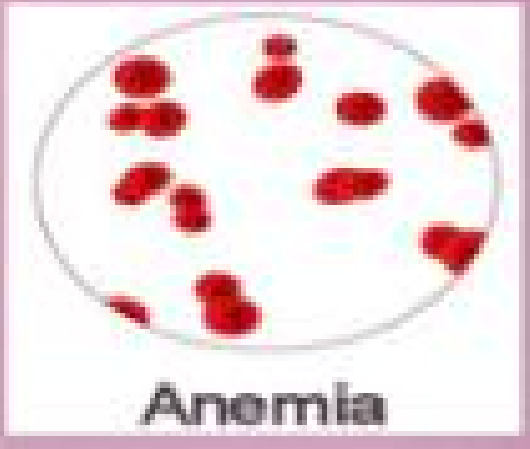
Bleeding gums

Petechiae & ecchymosis

Perifollicular haemorrhages

Splinter haemorrhages

Joint Effusion



Therapeutic Use of Vitamin C

- The beneficial effect of vitamin C is used in the treatment of TB
- Clinical dose is 500 mg/day
- Vitamin C is recommended for treatment of ulcer, trauma and burns
- There is very little good evidence that high doses of vitamin C prevent the common cold, although they may reduce the duration and severity of symptoms.

Toxicity of vitamin C

- Excess vitamin C is excreted, and is not accumulated in the body
- More than 2000 mg may cause iron over load.