431 PHRM
Dietary Supplements & Nutraceuticals

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Vitamin C

The water - soluble vitamin: Ascorbic Acid

Objectives

- Explore vitamin C discovery & importance as well as its functions
- Identify the difference between the two chemical forms of vitamin C and its biosynthesis.
- Know the dietary sources of Vitamin C, the different routes of administrations & RDA's.
- Understand the biological roles & Medicinal uses of vitamin C.
- Discover the stereochemistry & the metabolic pathways.
- Understand the health impact of Vitamin C deficiency as well as the high intake & toxicity .

Vitamin C

- Vitamin C was discovered in 1912, isolated in 1928, and in 1933, the first vitamin to be chemically produced. It is on the World Health Organization's List of Essential Medicines. Vitamin C is available as an inexpensive generic and over-the-counter medication.
- It is registered in SFDA in many preparations as a health product: alone & in combination with other vitamins, minerals, and trace elements.
- It is required for the functioning of several enzymes and the enzymatic production of certain neurotransmitters, and is important for immune system function. It also functions as an antioxidant.

Sources:

Guava, Citrus fruits, Spinach, Tomatoes, Green peppers, Kiwi, Broccoli, Pineapple & (Khat).

Human milk → Vitamin C → Marginal
Camel milk → Vitamin C → 10 times human milk

Vitamin C is sold as a dietary supplement.
Vitamin C may be taken by mouth or by intramuscular, subcutaneous or intravenous injection.

Vitamin C

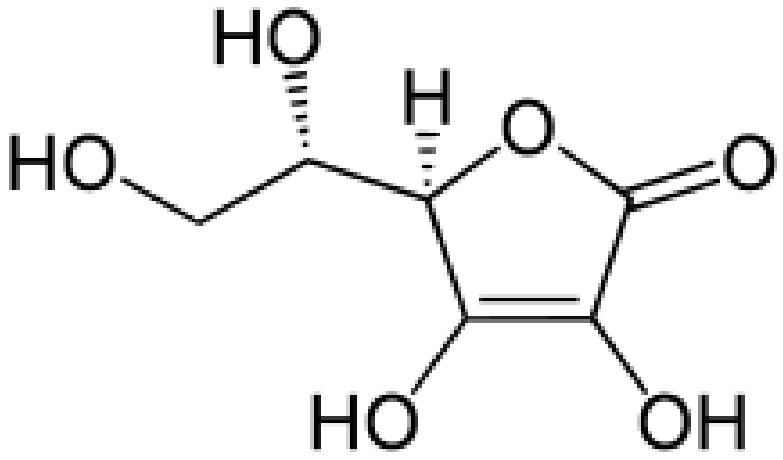

VITAMIN C FOODS
BROCCOLI
RED PEPPER
TOMATOES
GUAVA
CAULIFLOWER
BERRIES

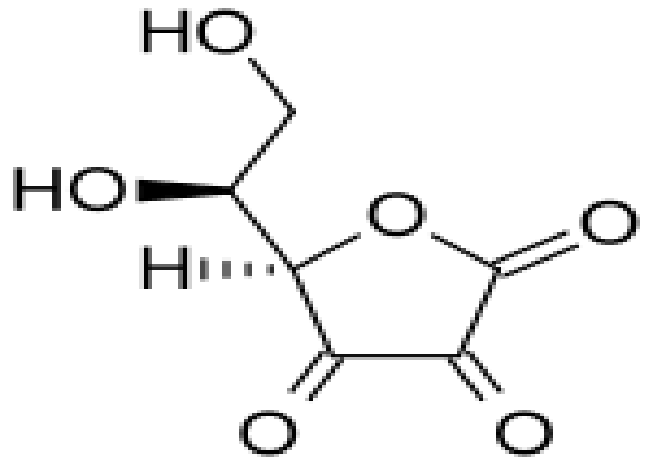

Cantaloupe
Citrus juice
Orange
Tomato juice
Kiwifruit
Dietary sources of
vitamin C
Grapefruit
Bell peppers
Broccoli
Brussels sprouts
Strawberries

Chemistry

Chemistry

- Two different chemical forms, furan ring,
- How do you know it is acidic?
- The OH next to the carbonyl group is more acidic (HOW?), what is about others?





Chemistry

- The name "vitamin C" always refers to the L-enantiomer of ascorbic acid and its oxidized form, dehydro-ascorbate (DHA).
- Therefore, unless written otherwise, "ascorbic acid" refers in the nutritional literature to L-ascorbic acid.
- Ascorbic acid is a weak sugar acid structurally related to glucose. In biological systems, ascorbic acid can be found only at low PH.

Vitamin C

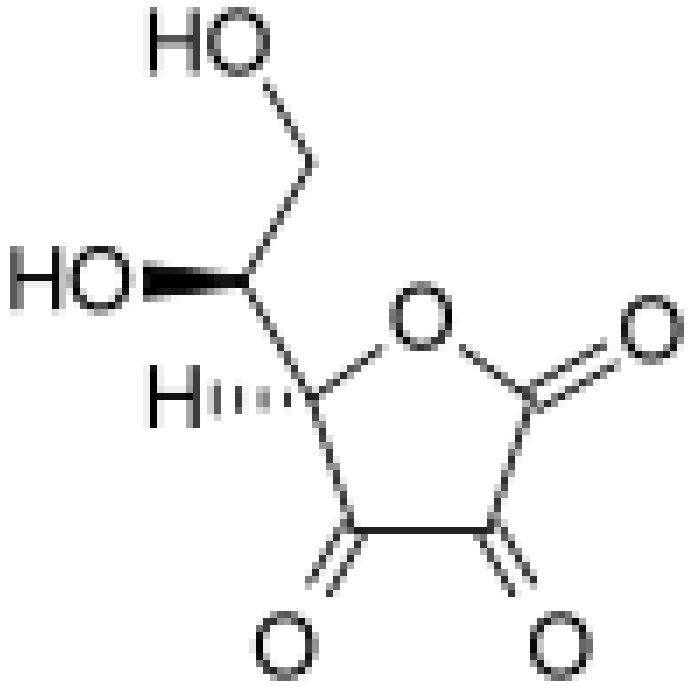
- Except for ascorbic acid, all the vitamins in this water - soluble category belong to the B - group of vitamins.
- Humans, Guinea pigs, & Primates (Monkey - type animals) can NOT synthesize their own vitamin C. However, Camel, Mouse, and other animals can.

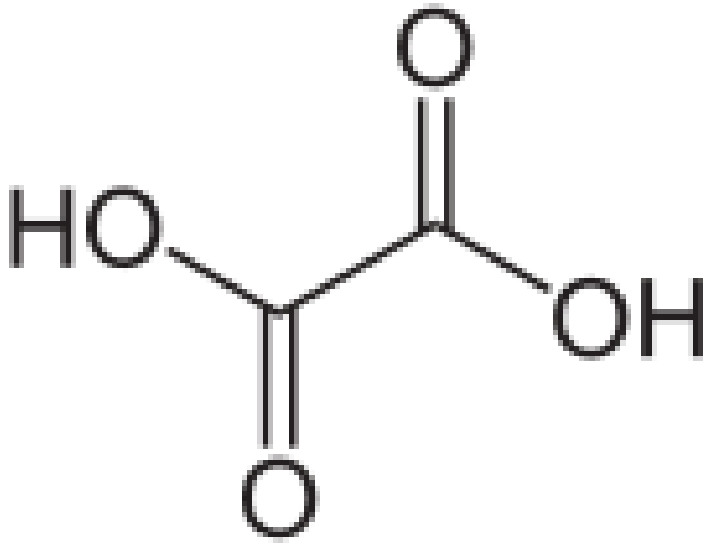
Glucose --- Enzyme system --> Vitamin C

Vitamin C

- Food vitamin C ---> absorbed from GIT (Depends on stomach acidity)
- A person who has achlorhydria = Absence of hydrochloric acid in the gastric secretions of the stomach.
- Increase stomach acidity leads to increase vitamin C absorption.
- Ascorbic acid --- Oxidases → Dehydroascorbic acid --- Oxidation in liver → Oxalic acid (Its role in plants identification !?).
- High amounts of vitamin C ---> Ca. Ox. (ppt. in kidneys). Therefore, the daily dose should not exceed 2 gm.

Dehydroascorbic acid (Oxidized form) & Oxalic acid



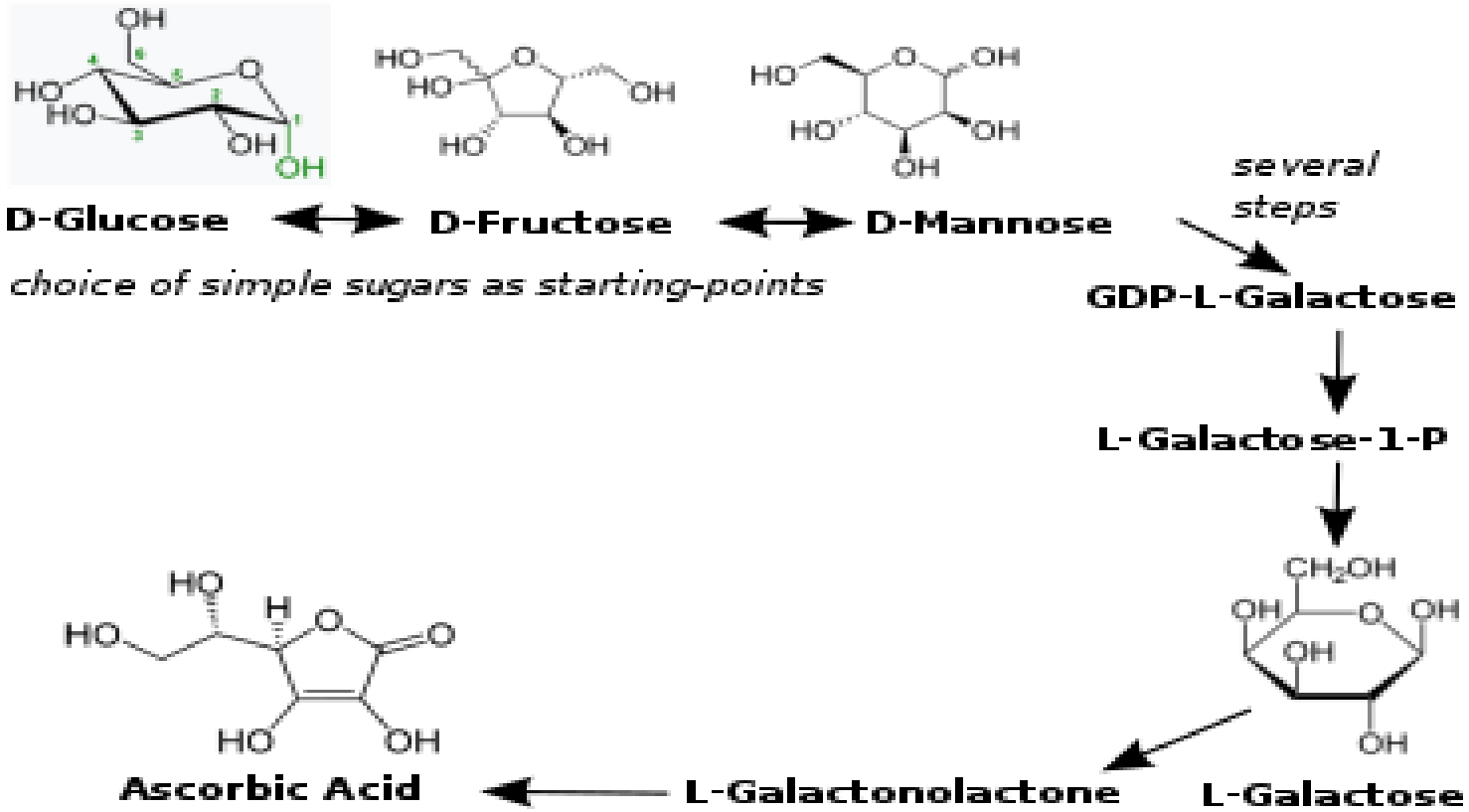


Vitamin C Supplements

Biosynthesis

- Most animals and plants are able to synthesize vitamin C through a sequence of enzyme-driven steps, which convert monosaccharides to vitamin C.
- In plants, synthesis is accomplished through the conversion of mannose or galactose to ascorbic acid.

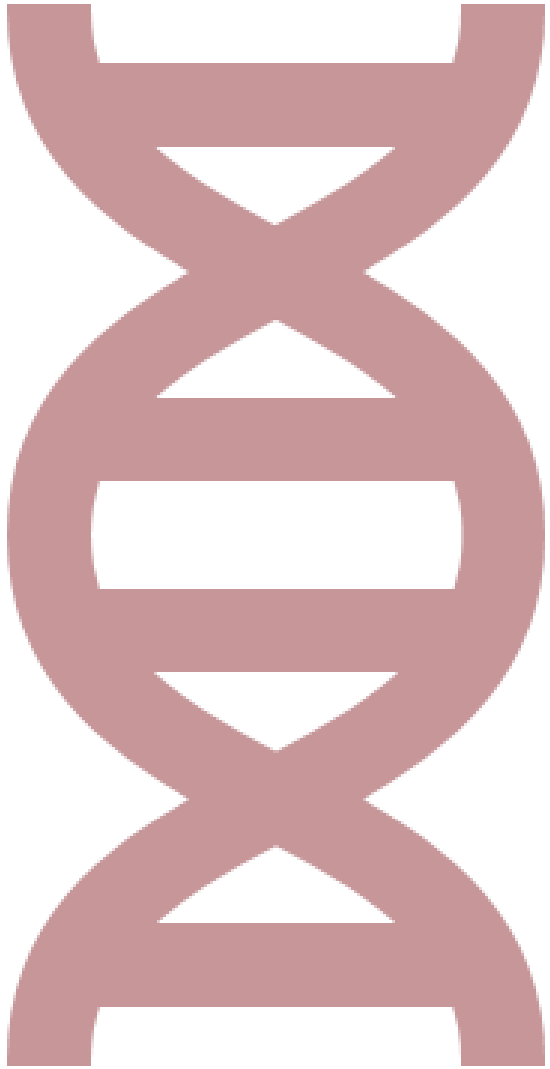
Biosynthesis in plants



Recommended Daily Allowances (RDA)

US vitamin C recommendations (mg per day)	
RDA (children ages 1–3 years)	15
RDA (children ages 4–8 years)	25
RDA (children ages 9–13 years)	45
RDA (girls ages 14–18 years)	65
RDA (boys ages 14–18 years)	75
RDA (adult female)	75
RDA (adult male)	90
RDA (pregnancy)	85
RDA (lactation)	120
UL (adult female)	2,000
UL (adult male)	2,000

Biological Roles



Biological Roles

- Vitamin C has a definitive role in treating scurvy, which is a disease caused by vitamin C deficiency.
- Scurvy can be treated with vitamin C-containing foods or dietary supplements or injections. It takes at least a month of little to no vitamin C before symptoms occur. Early symptoms are malaise and lethargy, progressing to shortness of breath, bone pain, bleeding gums, susceptibility to bruising, poor wound healing, and finally fever, convulsions and eventual death. Until quite late in the disease the damage is reversible, as healthy collagen replaces the defective collagen with vitamin C repletion. Scurvy was known to Hippocrates in the classical era.

Biological Roles

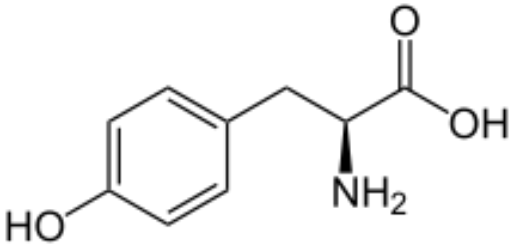
- One of the causes of iron-deficiency anemia (Hypochromic anemia) is reduced absorption of iron. Iron absorption can be enhanced though ingestion of vitamin C alongside iron-containing food or supplements. Vitamin C helps to keep iron in the reduced ferrous state (Fe++), which is more soluble and more easily absorbed.
- Vitamin C increases absorption of Fe++ 20 times.

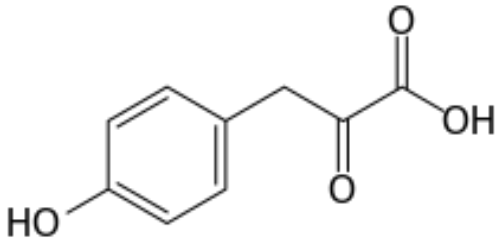
Biological Roles

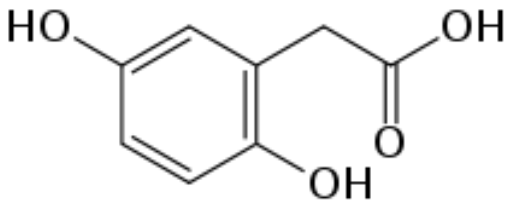
- Vitamin C is needed for the formation of collagen protein, that presents in elastic body tissues e.g. blood vessels, skin and eye tissues.
- Less vitamin C leads to decrease the formation of collagen protein ---> decrease in blood vessels elasticity that in case of a person has hypertension may lead to internal bleeding.
- Low vitamin C intake in a long run may cause eye bags & sagging.
- Smokers should take extra vitamin C and folic acid as well to repair the damaged tissues.

Biological Roles

- Vitamin C is needed for metabolism of the amino-acid “Tyrosine”
- Food milk, rich in tyrosine -- metabolized -> source of energy.
- Tyrosine -- transamination -> p-hydroxyl-phenyl pyruvic acid -- hydroxylase & vitamin C -> homogentisic acid ---> fumaric acid + acetoacetic acid.
- Reduction in blood level conc. of vitamin C may lead to tyrosinemia !!







Other uses:

- Vitamin C functions as a cofactor in many enzymatic reactions in animals (including humans) that mediate a variety of essential biological functions, including wound healing and collagen synthesis.
- Viral infections, Common cold, & flu: 1gm a day, it is not viricidal but it supports the immunity. Proper function of WBC needs an adequate level of vitamin C.
- Vitamin C is required after surgery to facilitate the healing process of cut blood vessels.
- Vitamin C as well as D are required in case of bone fracture to enhance matrix formation.
- Normal doses are safe during pregnancy. The United States Institute of Medicine recommends against taking large doses.

Other uses:

- The European Food Safety Authority found a cause and effect relationship exists between the dietary intake of vitamin C and functioning of a normal immune system in adults and in children under three years of age.
- A review concluded there was no evidence that vitamin C supplementation decreases the risk cardiovascular disease. An earlier review reported an association between higher circulating vitamin C levels or dietary vitamin C and a lower risk of stroke, and another review found a positive effect of vitamin C on endothelial dysfunction when taken at doses greater than 500 mg per day. The endothelium is a layer of cells that line the interior surface of blood vessels.

Other uses:

- In April 2021, the US National Institutes of Health (NIH) COVID-19 Treatment Guidelines stated that "there are insufficient data to recommend either for or against the use of vitamin C for the prevention or treatment of COVID-19. In an update posted December 2022, the NIH position was unchanged:
- There is insufficient evidence for the COVID-19 Treatment Guidelines Panel (the Panel) to recommend either for or against the use of vitamin C for the treatment of COVID-19 in non-hospitalized patients.
- There is insufficient evidence for the Panel to recommend either for or against the use of vitamin C for the treatment of COVID-19 in hospitalized patients.