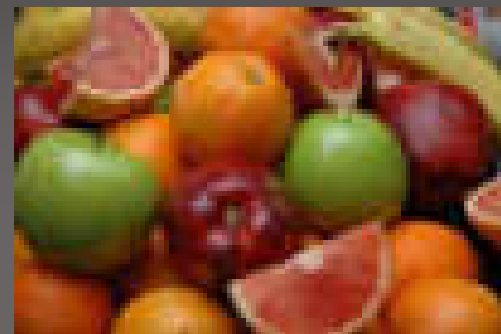


Introduction of Vitamins



G.Pulla Reddy College of Pharmacy
Food analysis

Definition

Vitamins are:

- A. Natural micronutrient organic substances.
- B. Having specific biochemical functions in the human body (essential for health maintenance).
- C. Obtained from animals, plants, and microorganisms.
- D. Required in very tiny (mcgs) and balanced amounts.
- E. Not made in the body (or not in sufficient quantity)

Exceptions are: **Provitamins**

➤ **β-carotenoids** can replace Vit. A.

➤ **Tryptophan containing proteins** can replace **Vit. B3** (niacin).

➤ **Exposure to sunlight** can replace Vitamin D.

➤ Bacteria in the human colon synthesize **Vit. K2 menaquinones**, which can be absorbed.

Their deficiency resulted in a specific diseases.

Classification of Vitamins

Vitamins are classified by their **biological** and **chemical activity**.

1- Fat soluble vitamins:

A. Vit. A (Retinol, Retinal, Retinoic acid)

B. Vit. D (Vit. D3: Cholecalciferol, Vit. D2: Ergocalciferol)

C. Vit. E (α -Tocopherol)

D. Vit. K (Vit. K1: Phylloquinones, Vit. K2: Menaquinones)

2-Water soluble vitamins:

(A) Vit. B group

B1 (Thiamin)

B2 (Riboflavin)

B3 (Niacin)

B5 (Pantothenic acid)

B6 (Pyridoxine)

B9 (Folic acid)

B12 (Cyanocobalamin)

(B) Vit. C : (l-Ascorbic acid)

Role of Vitamins in Metabolism

- Vitamins have catalytic functions (**co-factors**) in the metabolic reactions and **do not act as building substances** (that is why the daily requirement is very small).
- Since each vitamin has **very specific function** in **metabolism**, therefore, its deficiency will adversely affect one or more biochemical reactions in certain organs and very characteristic deficiency symptoms will appeared.

Cases of Vitamin Deficiency and Toxicity

(1). **Avitaminosis**: It is any disease caused by chronic or long- term vitamin deficiency or caused by a defect in metabolic conversion, such as tryptophan to niacin. It leads to well defined symptoms e.g.

➤ Xerophthalmia **due to Vitamin A deficiency.**

➤ Rickets **due to Vitamin D deficiency.**

➤ Pellagra **due to Vitamin B3 deficiency.**

➤ Beriberi **due to Vitamin B1 deficiency.**

➤ Scurvy **due to Vitamin C deficiency.**

(2). **Hypovitaminosis**: Resulted from inadequate supply of one or more vitamins. It appears in the form of well defined symptoms as **skin changes, reduced vitality and low resistance to infections.**

(3). **Latent hypovitaminosis:** A case of unrecognizable deficiency symptoms but immediately appeared under sudden stress or exposure to different environment.

(4). **Hypovitaminosis due to Anti- vitamins:**

➤ **Thiaminase** in raw fish destroy **Vit. B1**.

➤ **Avidin** in raw egg forming complex with biotin (vitamin) (biotin – avidin) prevents absorption of biotin.

➤ **Liatin** in linseed oil is antagonist to **Vit. B6**.

5. Hypervitaminosis:

A case which develops only upon prolonged use of excessive amount of vitamins.

EXAMPLES:

Hypervitaminosis A

This occurs after large over dosage of the vitamin.

Symptoms include:

Headache

Abdominal pain

Nausea or vomiting

Lethargy

Visual changes

Impaired consciousness

Hypervitaminosis D

Usually this is caused by excessive ingestion or over prescription of prescribed medications such as calcium with vit. D.

Symptoms include:

Polyuria

Vomiting

Constipation

Hypertension

Seizures - can be fatal

Medicinal applications of Vitamins

- **Elimination of hypovitaminosis.**
- **Treatment of some diseases.**
- **Prophylaxis against some diseases.**

1- Fat soluble vitamins

Vitamins	Medicinal applications
A	<ol style="list-style-type: none">1. Lowered resistance to infections.2. Dark-adaptation.
D	<ol style="list-style-type: none">1. Prophylaxis and therapy of rickets.2. Cases of bone atrophy.3. Improves tooth consistency.
E	<ol style="list-style-type: none">1. In cardiac, vascular and muscular disorders.2. Fat with high levels of unsaturated fatty acids absorption disorders.
K	<ol style="list-style-type: none">1. Disorders of blood coagulation.

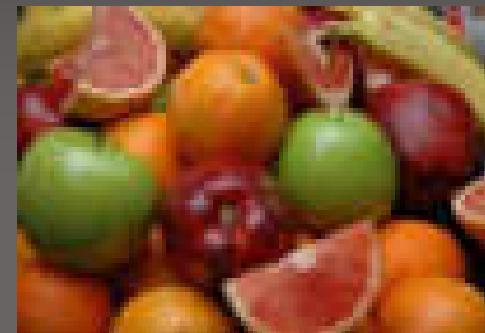
2- Water soluble vitamins

Vitamins	Medicinal applications
B1	1. Beri beri. 2. Nervous inflammations, neuralgias. 3. Cardiac dysfunction caused by alcoholism.
B2	1. Ariboflavinosis. 2. Photophobia and blurred vision. 3. Corneal vascularization and eye itching
B3	1. Pellagra. 2. Multiple B-complex deficiency syndrome.
B5	Dermatitis and seborrhea.

2- Water soluble vitamins

Vitamins	Medicinal applications
B6	<ol style="list-style-type: none">1. Irritability and convulsion.2. Hypochromic anemia.3. Peripheral neuritis..
B9	Megaloblastic anemia.
B12	<ol style="list-style-type: none">1. Juvenile pernicious anemia.2. Gastrectomy and celiac disease.3. Long term drug therapy as neomycin.4. Inflammatory lesions.
C	<ol style="list-style-type: none">1. Scurvy.2. Poor wound healing.

Fat Soluble Vitamins



(Vitamin A and Carotenoids)



Vitamin A and Carotenoids

- ❖ **Vitamin A exists in animal foods** in the form of **retinol** esterified with fatty acids (usually as **retinyl palmitate**).
- ❖ In the body **retinol** can be oxidized to **retinal** or **retinoic acid** which have 2 specific functions:
 - Retinal** plays a central role in the function of retina.
 - Retinoic acid** helps regulate gene expression and cell development.

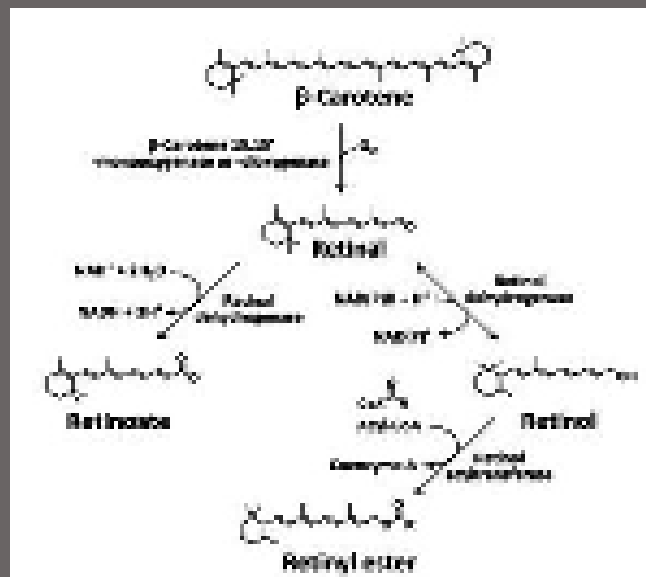
❖ The three compounds **retinol, retinal and retinoic acid** are collectively referred as **vitamin A**. Vitamin A is carried in the blood through a retinol-binding protein (RBP). **RBP is synthesized in the liver.**

❖ **Carotenoids (provitamin A) exist in plant foods.**

▪ The most common type is β -carotene which can be absorbed as such or after splitting by **intestinal cells** into vitamin A .

▪ **A large carrot contains 15 mg of β -carotene which can supply enough vitamin A for daily requirement.**

Conversion of Carotenoids to Retinoids

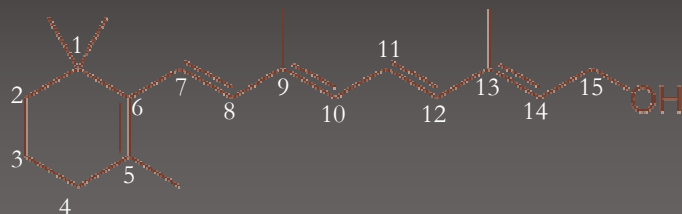


- Enzymatic conversion of carotenoids occurs in **liver or intestinal cells**, forming two molecules of retinal and finally retinol and retinoic acids.

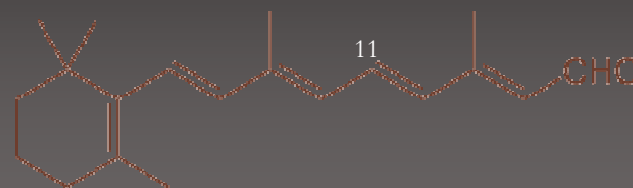
■ Provitamin A carotenoids

- Beta-carotene
- Alpha carotene
- Beta-cryptoxanthin

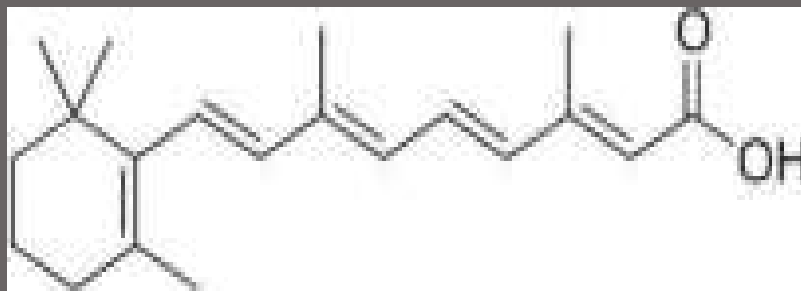
Structure of different forms of Vitamin A



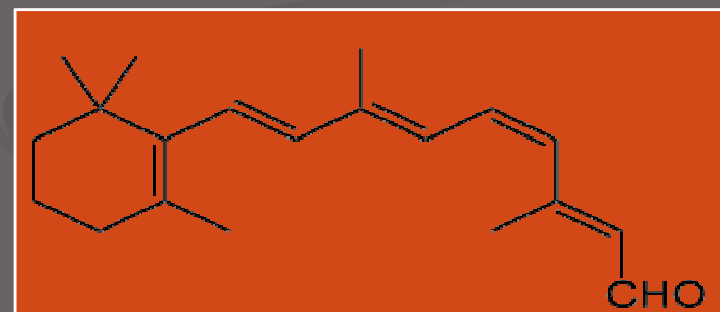
All-trans-Retinol



All-trans-Retinal



All-trans-Retinoic acid



11-cis-Retinal

Absorption of Vitamin A

■ Retinoids

- Retinyl esters broken down to free retinol in small intestine with the help of bile and digestive enzymes.
- Once absorbed, retinyl esters reformed in intestinal cells.
- 90% of retinoids can be absorbed by this mode of absorption.

■ Carotenoids

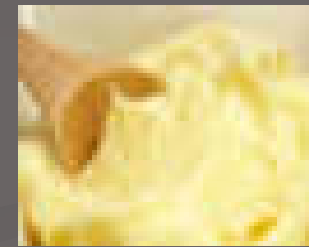
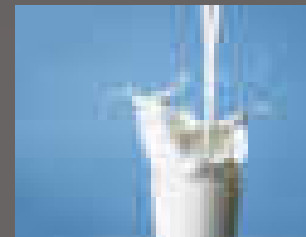
- Absorbed intact but the absorption rate is much lower.
- Intestinal cells can convert carotenoids in to retinoids.

Source and Concentration of Vit. A and β -Carotene

Foods rich in vitamin A (retinol)

	Serving size	μg
Beef liver	100g	9100
Cod liver oil (very rich source)	10g	2550
Egg	1 whole	110

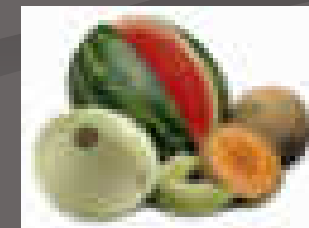
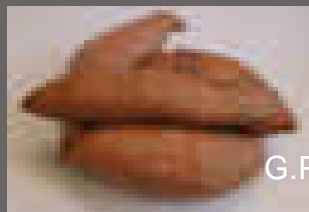
Others: kidney, dairy products, butter, fortified margarine.



Foods rich in β - and other carotenoids

	Serving size	μg Vit. A
Carrot	1, large	810
Sweet potato	1, large	920
Spinach and broccoli	100mg	460

Others: red palm oil apricots, peaches, melon, pumpkin.



Functions of Vitamin A

1. Vision:

Vit. A plays a central role in the transformation of light energy into nerve impulses which are perceived by the brain as vision.

Deficiency: Night blindness

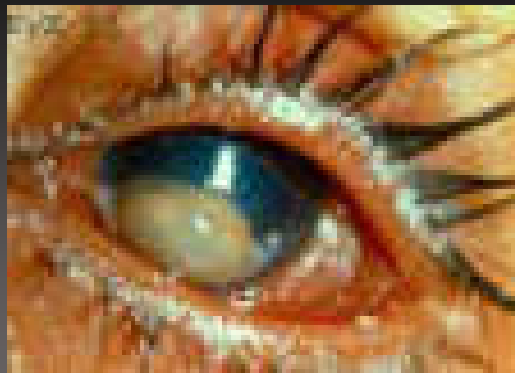
Role of Vitamin A in Vision

- Retinal turns **visual light into nerve signals** in retina of eye.
- **Retinoic acid** required for structural components (Cones and Rods) of eye :
 - **Cones in the retina**
 - Responsible for vision under bright lights
 - Translate objects to color vision
 - **Rods in the retina**
 - Responsible for vision in dim lights
 - Translate objects to black and white vision

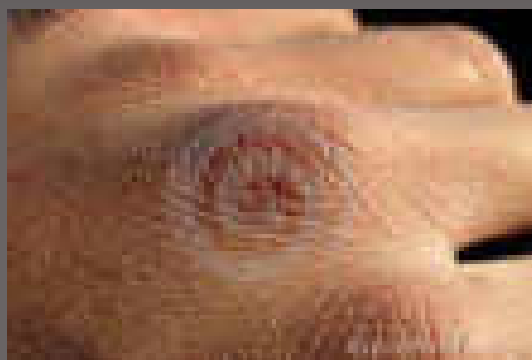
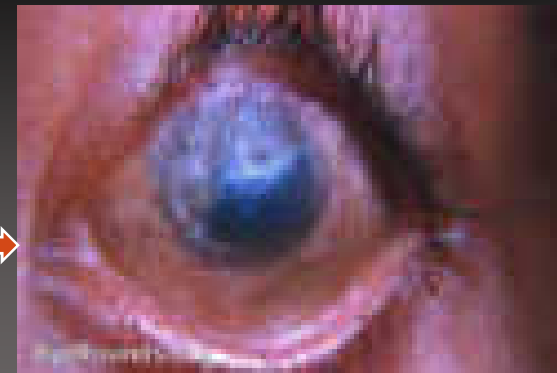
2. Skin and mucus membrane health :

Vit. A promotes proper growth of skin epithelial cells and mucous membranes of the respiratory, gastrointestinal, and genitourinary tracts.

Deficiency: Xerosis (mucus-secreting cells are replaced by keratin producing cells) **dry skin and dry eye (xerophthalmia).**



← **Xerophthalmia** →



← **Dry Skin** →



Stages of xerophthalmia: (Early signs of xerophthalmia include dry conjunctiva and night blindness).

The first occurrence of **Conjunctival xerosis** (glistening white plaques formed of thickened epithelium, usually triangular) → **Corneal xerosis** (haziness or a granular pebbly dryness of the cornea) → **Corneal ulceration (keratomalacia)** → dryness of conjunctiva and later of cornea.

3. Immune system.

Vit.A increases resistance to infection by:

- Maintaining the integrity of the skin epithelial cells and **mucous membrane barriers** against bacteria, viruses, and parasites.
- **Enhancing antibody production.**
- Increasing number and activity of macrophages, T cells and natural killer (NK) cells and enhance production of tumor necrosis factor-alpha (TNF- α).

Deficiency: Impaired Immunity (frequent infections, especially in respiratory system). **In countries where children are not immunized, infectious disease like measles have relatively higher fatality rates.**

4. Hormone synthesis.

Vit. A is required for synthesis of steroid hormones (corticosteroids, androgens and estrogens) and production of human growth hormone (GH).

5. Reproduction.

Vit. A maintains sperm count and sperm motility in males. In females, **deficiency is associated with infertility and spontaneous abortion.**

6. Cell growth and development.

7. Formation of red blood cells.

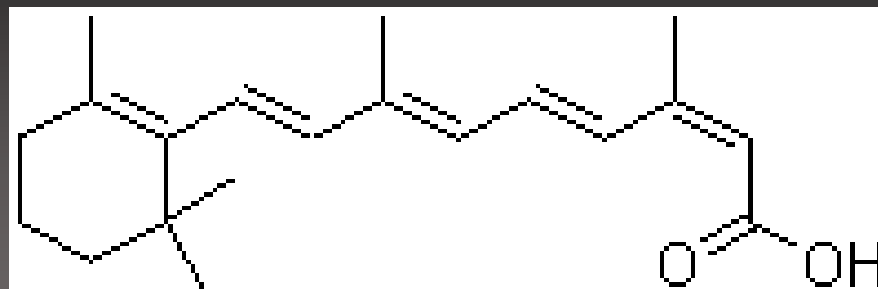
Vit. A plays an important role in mobilizing iron stores to build new red blood cells.

Uses of Vitamin A in Prevention & Therapy

1. **Treatment of Night blindness.**
2. **Treatment of Skin /scalp Disorders:** e.g Psoriasis, Acne vulgaris, Dandruff, Eczema, Premature aging of skin
3. Help in treatment of **ear infections, conjunctivitis, bronchitis, pneumonia, and infectious diarrheal disease.**
4. **Cancer treatment:** large doses of retinoic acid may reduce growth and recurrence of certain forms of skin cancer.

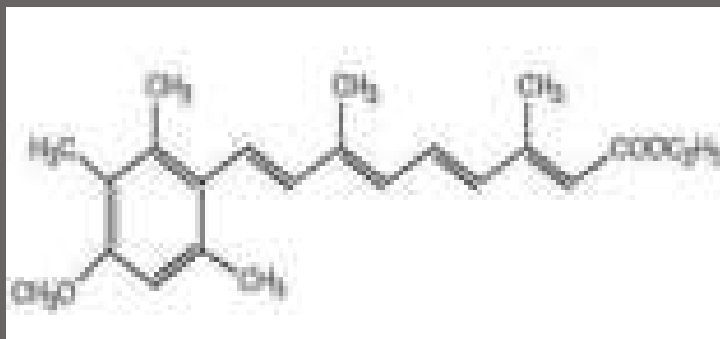
5. **Cosmetics:** Vitamin A derivatives are used as anti-aging, being absorbed through the skin and increases the rate of skin turnover, and a temporary increase in collagen giving a more youthful appearance.
6. **Gastric ulcers:** Vit. A maintain gastric mucus production and reduce stress ulceration in traumatized or burned patients.
7. **Combination of iron + Vit. A** may be effective than iron alone in treating iron-deficiency **anemia**.

Some Products of Synthetic Retenoids (orally or topically)

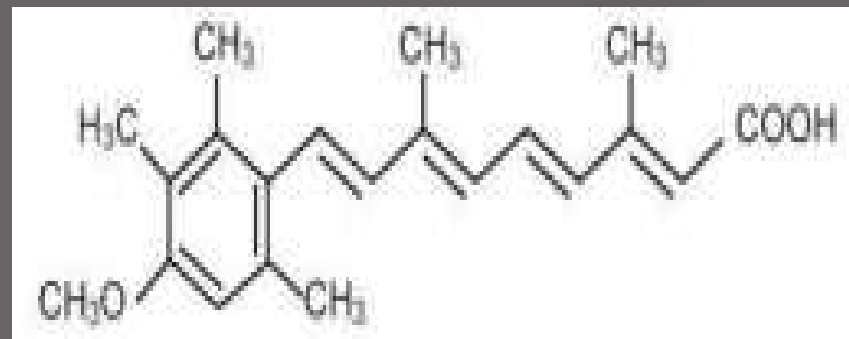


13-cis-Retinoic acid (Tretinoin or Accutane)

Used in treatment of acne



Etretinate



Acitretin

Used in treatment of psoriasis

PEOPLE AT GREATER RISK OF DEVELOPING VITAMIN A DEFICIENCY

- 1. Consumers of alcoholic beverage are liable to vitamin A deficiency .**
- 2. Patients taking some medications (birth control pills, methotrexate, drugs sequestering bile acids e.g. cholestyramine or chitosan).**
- 3. Chronically ill people or recovering from surgery.**
- 4. Patients under cancer treatment (radiation and chemotherapy).**
- 5. Cases that may impair Vit. A balance (chronic diarrhea, cystic fibrosis, and kidney or liver disease).**

Vitamin A Toxicity

1. **Infants** and **children** are more susceptible than adults to vitamin A toxicity.
2. Vitamin A is a **teratogen** and high doses (**more than 10000 µg retinol**) may produce birth defects, even with exposure for 1 week in early pregnancy.
3. **Pregnant women should avoid excess intake of vitamin A** from supplements and from vitamin A-rich foods, such as liver (100 g contains nearly 10000 µg retinol).
4. **Daily dose should not exceed 2500 µg during pregnancy** or better replaced by carotenoids (their conversion to Vit. A in the body is tightly regulated, thus **carotenes do not produce vitamin A toxicity**).

Signs and Symptoms of Vitamin A toxicity

- 1. Bone pain and joint swelling.**
- 2. Nausea , vomiting and diarrhoea.**
- 3. Dry skin and lips.**
- 4. Hair loss.**
- 5. Headache and blurred vision.**
- 6. Enlargement of the liver and spleen.**
- 7. Reduced thyroid activity.**
- 8. High blood calcium**