

# Vitamins

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## Summery of Vitamin Lectures

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# Vitamin - definition

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- An organic compound required as a nutrient in tiny amounts by an organisms.
- It cannot be synthesized in sufficient quantities by an organism, and must be obtained from the diet.
- Vitamins have diverse biological function:
  - hormone-like functions as regulators of mineral metabolism (vit. D),
  - regulators of cell and tissue growth and differentiation (some forms of vit. A)
  - antioxidants (vit. E, C)
  - enzyme cofactors (tightly bound to enzyme as a part of prosthetic group, coenzymes)

# Definition and Classification

- Non-caloric organic nutrients
- Needed in very small amounts
- Facilitators – help body processes proceed; digestion, absorption, metabolism, growth etc.
- Some appear in food as precursors or provitamins

# Definition and Classification of Vitamins



# Definition and Classification

- 2 classes
  - Fat soluble:
  - Water soluble:

# Fat vs. Water Soluble Vitamins

	Water Soluble	Fat Soluble
Absorption	Directly to blood	Lymph via chylomicrons
Transport	free	Require carrier
Storage	Circulate freely	In cells with fat
Excretion	In urine	Stored with fat
Toxicity	Less likely	More Likely
Requirements	Every 2-3 days	Every week

# Definition and Classification

## 1-Fat soluble vitamins

- Found in the fats and oils of food.
- Absorbed into the lymph and carried in blood with protein transporters = chylomicrons.
- \*Stored in liver and body fat and can become toxic if large amounts are consumed.

# Definition and Classification

## 2-Water soluble vitamins

### The Water soluble Vitamins

Include the B- Vitamins and Vitamin C. They share few common properties besides their solubility characteristics. Since they are water soluble excess can be excreted through urine.

Hyper-vitaminosis may not cause toxicity. Most of these vitamins act as coenzymes.

The B- Vitamins are essential and must be provided through diet.

- Found in vegetables, fruit and grains, meat.
- Absorbed directly into the blood stream
- Not stored in the body and toxicity is rare. Alcohol can increase elimination, smoking, etc. cause decreased absorption.

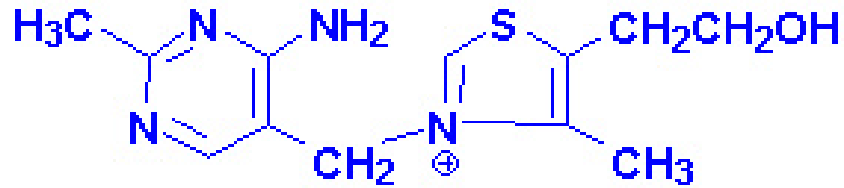


# Water soluble vitamins

## 1- The B Vitamins

**B-1, B-2, B-3, B-6, B-12**

# B-1 Thiamin



- Important in:
  - Producing energy from carbohydrates
  - nerve function
  - appetite
  - growth
  - Muscle function

# Sources of B-1

- The good sources of Thiamine are:
- Fish
- Liver
- Legumes البقوليات
- Nuts
- Whole grain or enriched breads and cereals

**RDA:** Minimum requirement 1.0mg for adults, infants and children  
0.4-1.3mg Requirement increases in conditions of Anoxia-shock, Hemorrhage, injury, illness, fever and hyperthyroidism. Also increased carbohydrate intake, pregnancy and lactation.

# Warnings

- B-1 is nontoxic even at high dosages

## B-1 Deficiency

- Loss of appetite
- Weakness & Feeling tired
- Insomnia
- Loss of weight
- Depression
- Heart & Gastrointestinal problems

# Who's at Risk?

- Malnourished
- Alcoholics
- Malabsorption

# B-2 Riboflavin

- The ability of the ring system of riboflavin to exist as a semiquinone allows the flavin coenzymes to accept electrons either singly or in pairs. NAD<sup>+</sup> and NADP<sup>+</sup> can only accept electrons in pairs.
- It is mainly used in the energy metabolism of Sugars and Lipids. The activation of FMN and FAD is an ATP-dependent

## ❖ Important in:

# energy production

# carbohydrate, fat, and protein metabolism

# formation of antibodies and red blood cells

# cell respiration

# maintenance of good vision, skin, nails,  
and hair

**RDA: 1.5-2.5mg for adults, infants**

**0.6mg, children 1.0-1.8mg**

# Sources of B-2

- ☐ Milk
- ☐ eggs
- ☐ Meats
- ☐ Fish
- ☐ leafy green vegetables
- ☐ enriched grains



# Warnings

□ **B-2 is nontoxic at supplemental and dietary levels.**

□ **Light can destroy riboflavin, so purchase milk in opaque containers.**

□ **A degree of photophobia may be due to its light sensitivity, because Riboflavin is colored, fluorescent and decompose in visible light but heat stable.**

□ **Erythrocyte enzyme activity measurements (Glutathione reductase) is used to determine**

□ **Nutritional status of Riboflavin.**

# B-2 Deficiency

- Itching and burning eyes
- Cracks and sores in mouth and lips
- Dermatitis
- Oily skin

# Who's at Risk?

- People with Sickle Cell Anemia
- Alcoholics
- Malnutrition

# B-3 Niacinamide & Niacin

- Niacin is not a vitamin in a strictest sense of the word, since it can be synthesized from Tryptophan. However, conversion of Tryptophan to Niacin is relatively inefficient (60 mg of
- Tryptophan is required to produce 1mg of Niacin) and occurs only after all the body
- requirements for Tryptophan is met. Thus most people require dietary sources of both
- Tryptophan and Niacin.

## □ **Important in:**

- energy production
- maintenance of skin and tongue
- improves circulation
- maintenance of nervous system
- health of the digestive track
- Lowers cholesterol when used in higher doses

## **Warnings:**

- In very high doses some times (“niacin flush”) occurs

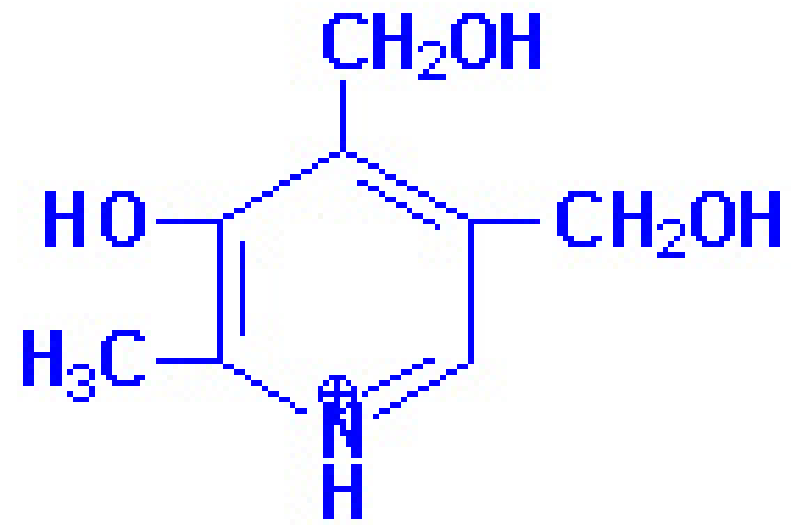
# Who's at Risk?

- Most people get plenty of B-3 from their diet because it is added to white flour.

**RDA:** Adults 17-21mg, infants 6mg. The requirement increases with increased intake of calories, illness, severe injury, infection, burns, high corn (maize) diet, pregnancy and lactation.

**Deficiency:** Deficiency leads to Pellagra, a disease involving GIT and CNS. The disease is characterized by intense irritation and inflammation of the mucous membranes of the mouth and other parts of the GIT, leading to gastro-intestinal hemorrhage, Dermatitis, Dementia & Diarrhea. (the “3-D’s” cardinal features). Skin lesions develop when exposed to sunlight, become red, thickened and become scaly. The patient develops gingivitis and stomatitis (Tongue gets swollen) General effects of deficiency are Failure of growth, loss of weight and anemia.

# B-6 Pyridoxine



## □ Important in:

- Production of red blood cells
- conversion of tryptophan to niacin (B-3)
- immunity
- nervous system functions
- reducing muscle spasms
- maintaining proper balance of sodium and phosphorous in the body



# Warnings

- nerve damage.
- Caution for Pregnant women

# B-6 Deficiency

- **nervousness, insomnia**
- **loss of muscle control, muscle weakness**
- **arm and leg cramps**
- **water retention**
- **skin lesions**

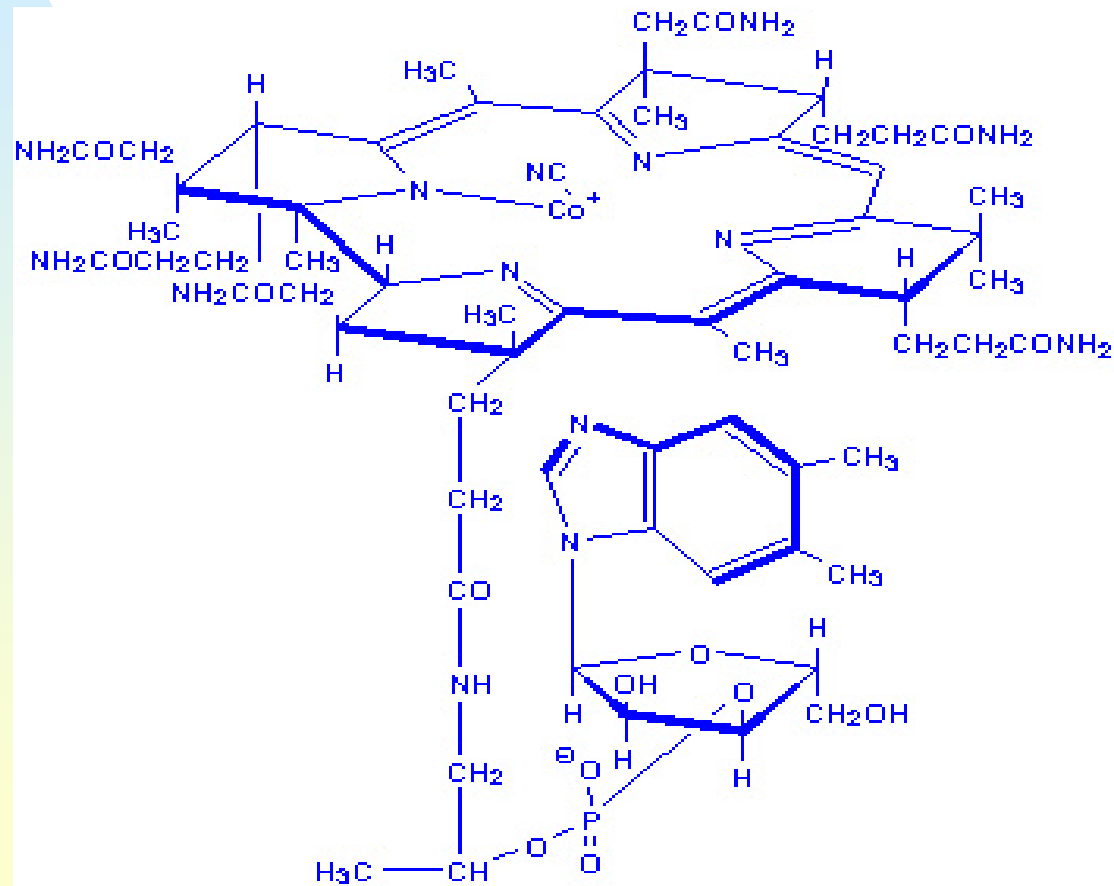
**Sources:** Wheat, corn, egg yolk, Liver and muscle meat

**RDA:** 1.4 - 2.2mg for Adults, children 0.3-0.4mg.  
Patients with anti-tubercular treatment needs more Vitamin B<sub>6</sub>.

# Who's at Risk?

- **very rare**
- **alcoholics**
- **patients with kidney failure**
- **women using oral contraceptives**

# B-12 Cobalamin



The metal cobalt in **vitamin B12** is coordinated with a tetrapyrrole ring system, called a corrin ring, which is similar to the porphyrin ring of **heme** compounds. The cyanide attached to the cobalt in the structure is an artifact of the isolation and is replaced by water or a hydroxyl group in cells. The presence of cobalt and amide nitrogens gives **B12** compounds the name cobamides or cobalamins. Only two reactions occur to a significant extent in mammalian metabolism: the synthesis of **methionine** from **homocysteine**

Pernicious anemia arises from a B12 deficiency. Gastric tissue secretes a glycoprotein called intrinsic factor, which complexes with ingested **B12** in the digestive tract and promotes its absorption through the small intestine into the blood stream. Pernicious anemia results from insufficient secretion of intrinsic factor. Outlines a probable explanation for why failure to absorb **B12** leads to the deficiency of red blood cells that define anemias.

The action of B12 and folic acid, are interrelated.

Deficiency of both produce similar signs and symptoms and Anemias.

**Source:** Synthesized by Microorganisms

**RDA:** 3mg/day.



# B-12 Cobalamin

- **Important in:**
  - **proper nerve function**
  - **production of red blood cells**
  - **metabolizing fats and proteins**
  - **prevention of anemia**
  - **DNA reproduction**
  - **energy production?**

# Warnings

- **Vegetarians**
- **Malabsorption**

# B-12 Deficiency

- **anemia**
- **nerve damage**
- **hypersensitive skin**

# Who's at Risk?

- pernicious anemia
  - B-12 injections often taken regularly
- HIV فيروس العوز المناعي البشري



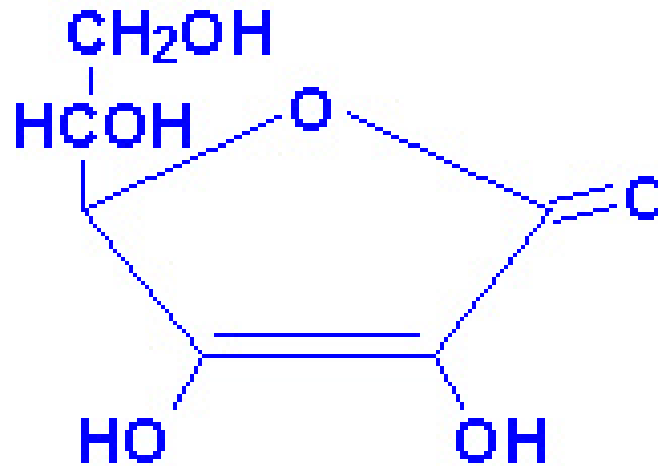
**Sources:** Eggs, Liver, Animal tissue, Whole grain cereals, Yeast and Legumes

**RDA:** 4-7mg/day

**Deficiency:** rare due to its wide distribution

The burning foot syndrome in prisoners which is associated with reduced capacity for acetylation is ascribed to pantothenic acid deficiency.

# Vitamin C (Ascorbic Acid)



- **Vitamin C is a water-soluble vitamin.**
- **Ascorbic acid (Toxic to viruses, bacteria, and some malignant tumor cells)**
- **Antioxidant**

- **The hydroxylation reactions in collagen involve vitamin C. A symptom of extreme vitamin C deficiency, called scurvy, is the weakening of collagen fibers caused by the failure to hydroxylate proline and lysine.**



# What are C's functions in the body?

- **Protects you body from free radicals**
- **helps form connective tissue (Collagen)**
- **Helps healing of wounds**
- **Helps in absorbing iron**
- **keep your gums healthy**
- **Immunity**
- **prevention of heart disease**
- **prevention of cancer**

In general hydroxylation reactions require Vit C.  
Example: Hydroxylation of cholesterol.

### **Functions:**

- Collagen biosynthesis
- Degradation of Tyrosine
- Absorption of Iron
- Steroidogenesis
- Adrenaline synthesis
- Bile acid formation
- Degradation of tyrosine
- Bone mineral metabolism
- Potent anti oxidant

WBC's are rich in vit C and plays an important role in Immunity.

# Harmful effects in larger doses: (over 1000mg/ dose)

- **Diarrhea**
- **Avoid chewable tablets (may cause damage to teeth)**

- **Since Vitamin C is water-soluble excess amounts that the body does not need will be excreted, but larger doses can cause some problems. . .**

# Deficiency of C causes:

- **Weight loss**
- **fatigue and joint pain**
- **scurvy (bruising easily, bleeding gums, and tendency for bones to fracture) الاسقربوط (كدمات بسهولة، نزيف اللثة، وميل للعظام إلى الكسر)**
- **reduced resistance to colds and infections**
- **slow healing of wounds and fractured bones**

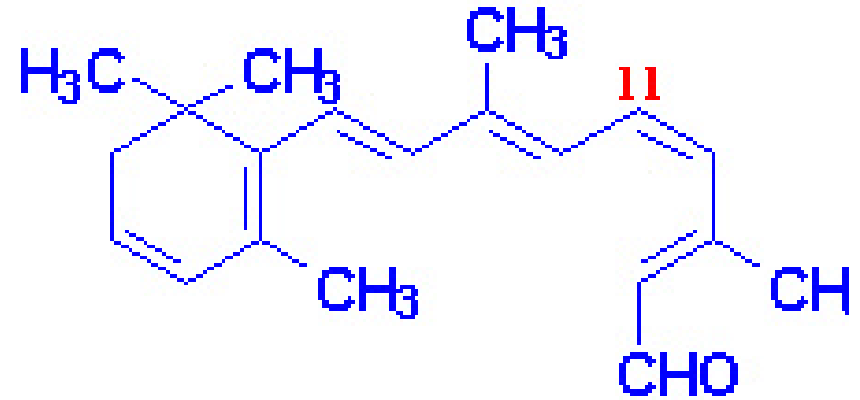
# Sources of Vitamin C

- **Leafy Greens vegetables.**
- **Citrus Fruits**
- **Potato**
- **tomato**
- **& green vegetables**

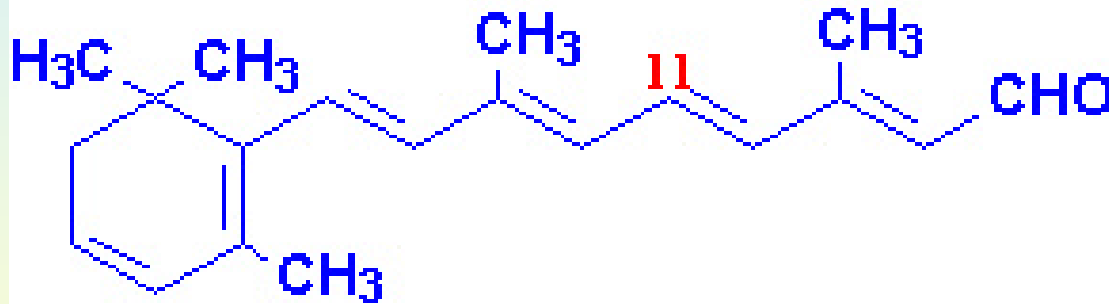
**RDA:** 60mg/day

**Deficiency:** scurvy symptoms are spongy gums and bleeding of gums due to defective collagen synthesis.

# Vitamin A



11-*cis*-retinal



All-*trans*-retinal



# What is Vitamin A?

- Fat-soluble
- Retinol
  - One of the most active, usable forms
- Found in animal and plant sources

**The vitamin A** is present in the diet as retinol or as  $\beta$ -carotene some of which is hydrolyzed in the intestine to form retinol. It is a general term for a collection of three forms of Vitamins, retinol, retinal and retinoic acid (Retinoids) all of which are found from animal and plant sources.

Pre-Albumin and specific binding proteins on cell surface membranes are involved in the uptake of Vitamin A ester from the plasma into the tissues. Owing to the fat soluble nature, transport is effected by a specific proteins – serum retinol binding protein (SRBP), cytosolic retinol binding protein (CRBP) and Albumin as well as a specific retinoic acid binding protein (RABP).

The vitamin is stored in the liver, mainly as its ester. Some other derivatives of Vit A are stored in the Liver as retinol palmitate.

In natural sources VitA is present as esters of fatty acids .These as well as their precursors are readily absorbed from the intestine via the lymphocytics.

Pancreatic lipase liberates the free Vitamin from the ester during digestion, but it is re-esterified in the intestinal mucosa. Carotenone are converted to vitamin in the liver.

# What does it do?

## □ Vision

- Generates pigments for the retina
- Maintains surface lining of eyes

□  $\beta$ -carotene has an antioxidant role and prevents the development of diseases in which the action of free radicals is implicated .

□ It plays a protective role against Cancer and cardiovascular disease.

□ As the normal proliferation of epithelial cell growth and differentiation depends on retinoids.

# Where does it come from?

## □ Animal Sources

- Eggs
- Meat
- Cheese
- Milk
- Liver
- fish

# Plant Sources

- Carrots
  - Potatoes
  - Pink Grapefruit
  - Spinach
- Beta-Carotene is precursor of Vitamin A

# Signs of Deficiency

- Night blindness
- Decreased resistance to infections
- Extremely dry skin, hair or nails

## **Hypervitaminosis:**

Excessive intake of vitamin A, in humans cause head ache, nausea, vomiting and dizziness. This might be related to increased spinal fluid pressure. Patient suffers from dry itchy skin, cracking of lips. On withdrawal of vit., patient feels relief. It is virtually impossible to develop vit.A toxicity by ingesting natural foods. When people consume supplements, there might be hypervitaminosis.

# Who Is At Risk For Deficiency?

- Young children
- Malabsorption
- Malnutrition



# Too Much Can Be Toxic!!

- **Hypervitaminosis A** leads to toxic symptoms:
  - Dry, itchy skin
  - Headaches and fatigue
  - Hair loss
  - Liver damage
  - Blurred vision
  - Loss of appetite
  - Skin coloration

## Vitamin A, Beta-Carotene, and Cancer

- Cancer prevention



# Vitamin E

# Vitamin E

What is it?

- Fat soluble
- Antioxidant
  - minimize the damage of free radicals

**Vit E is fat soluble vitamins required in the human diet but deficiency is rare, except in pregnancy and the new born, where it is associated with hemolytic anemia. It exists in the diet as a mixture of eight closely related compounds called Tocopherols.**

# Functions

The main function of Vit E is as an antioxidant, in particular a membrane antioxidant associated with lipid membrane structure. It provides protection from the action of peroxides by converting them to a product that is conjugating with glucuronic acid and excreted in bile. This protective phenomenon is very much evident in the prevention of hemolysis of RBCs by  $H_2O_2$  .

Also acts as scavenger of free radical damage to polyunsaturated fatty acids in cell membranes and help prevent oxidation of low –density lipoprotein (LDL).

Oxidized LDL may be more atherogenic than native LDL, and there is some evidence that Vit.E may protect against atheromatous coronary heart disease.

# Vitamin E

*What does it do?*

- **Protects cell membranes**
- Promotes normal growth and development
- Promotes normal RBC formation
- Acts as anti-blood clotting agent
- Helps in wound healing

# Vitamin E

*What's the difference?*

- Tocopherol
  - Alpha, beta, gamma

# Vitamin E

*Where does it come from?*

- vegetable oils
- nuts and seeds
- whole grains
- egg yolk
- leafy green vegetables



# Vitamin E

*Other effects:*

- **'E'** Enhances immune system

# Vitamin E

*Who is likely to be deficient?*

- Severe vitamin E deficiencies are rare
- Lethargy سبات
- Inability to concentrate
- Muscle weakness

# Vitamin E

*Miscellaneous:* متنوع

- ❑ Freezing may destroy Vitamin E
- ❑ Avoid too much frying foods that are natural sources of Vitamin E

# Vitamin D

Vitamin D is the only vitamin that is usually not required in the diet, for this reason it is rather classified as a hormone since under conditions of inadequate exposure to sunlight that dietary intake is required. The sterol, 7-dehydrocholesterol is present below the deeper layer of epidermis, which is the precursor, produces under the influence of UV rays from sunlight. The first pro-vitamin D<sub>3</sub> (cholecalciferol) with rupture of the bond between C<sub>9</sub> and C<sub>10</sub>. The product is directly related to the intensity of exposure to Uv. Rays and inversely to pigmentation of the skin. It is a photolytic process involving no enzyme and slows down with aging because of the decrease of 7-dehydrocholesterol.

Bound to specific D-binding protein, cholecalciferol moves via circulation directly to the liver. Hydroxylation at C<sub>21</sub> takes place in the endoplasmic reticulum of hepatocytes in a non-regulating process. The 25 (OH)-cholecalciferol is a potent Vit.D<sub>3</sub> and is also produced in a smaller proportion in the kidney.

Vit D<sub>3</sub> is also found in the diet where its absorption is associated with other fats, and is transported to the liver by chylomicrons. A significant proportion of 25 (OH)-D<sub>3</sub> is excreted in the bile and is reabsorbed in the small bowel, producing an enterohepatic circulation.

- Vitamin D – precursor is cholesterol, converted by UV from sunlight exposure, therefore is a “non-essential” vitamin.
  - Roles:
    - Increases calcium removal from bone, absorption from intestines, re-absorption from kidney.
    - Promotes bone growth and maintenance.
    - Stimulates maturation of cells – heart, brain, immune system, etc.

# Vitamin D deficiencies:

- rickets (children)
- osteomalacia (adults)

## Vit D toxicity:

Excess Vit. D level enhances calcium absorption leading to hypercalcemia and metastatic calcium deposits. There is a tendency to develop kidney stones from the hypercalciuria, secondary to hypercalcemia.

# Vitamin K

- Vitamin K – produced by bacteria in large intestine
  - Roles
    - Clotting mechanism
  - Deficiencies are rare but seen in infants,
  - after prolonged antibiotic therapy, and in patients with decreased bile production.
  - Toxicities (>1000 mg/day): rupture of RBCs and jaundice



There are three types, Menaquinone (K<sub>2</sub>) present in animals, Phylloquinone (K<sub>1</sub>) present in Plants.

Like vit E, the absorption of Vitamin k is dependent on appropriate fat absorption.

### **Functions:**

It is the only one acting as co-enzyme from the group of Fat soluble vitamins. This vitamin is also synthesized by intestinal bacteria. It is required for post translational modifications of several proteins required in the coagulation cascade.

## Deficiency

It is widely distributed in nature and produced by the intestinal micro flora. Virtually ensures that dietary deficiency does not occur in man. However, it is found in patients suffering from Liver diseases (obstructive jaundice), in new born infants and in patients with malabsorption. It is associated with bleeding disorders. The placenta is inefficient at passing maternal Vit K to the fetus and immediately after birth the circulation concentration drops, but recovers on absorption of foods. In addition the gut of the new born is sterile, so that the intestinal micro flora does not provide a source of vit K for several days after birth. This is the reason why adults who are on prolonged antibiotic treatment require supplementation of Vit.E.

# Diseases due to Vitamins

Scurvy: Vitamin C deficiency

Beriberi: Thiamin deficiency

Rickets: Vitamin D deficiency

Pellagra: Niacin deficiency

# Riboflavin deficiency



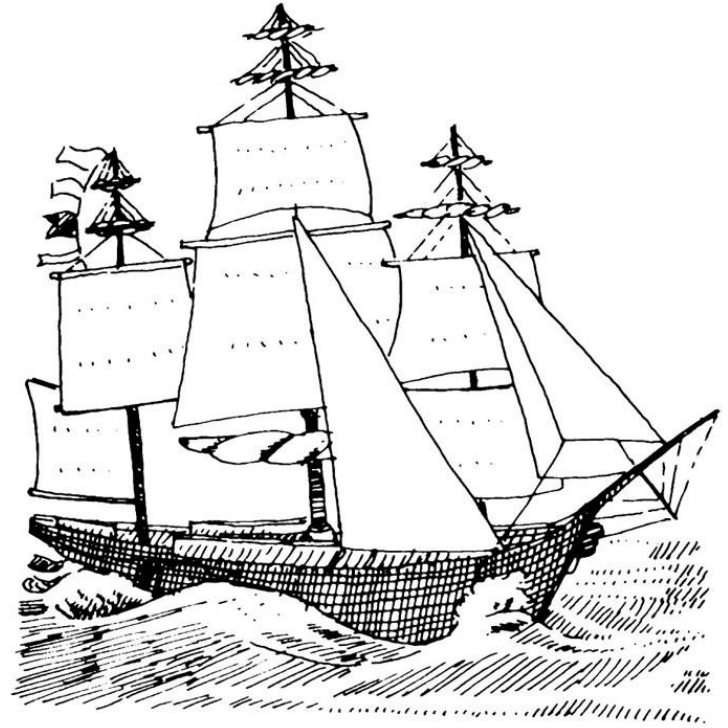
## Sources of Vitamin K

- Vitamin K can be made by intestinal bacteria.
- Newborns are given a dose of vitamin K at birth.



# Vitamin C

- More than 200 years ago, any man who joined the crew of a seagoing ship knew he might contract scurvy, which would end up killing as many as  $\frac{2}{3}$  of the crew.



Long voyages without fresh fruits and veggies spelled death by scurvy for the crew

## ***Deficiency Symptoms***



# Consumer Corner: Vitamin C and the Common Cold

- In drug-like doses, vitamin C may act like a weak antihistamine.



**Can vitamin C ease the suffering of a person with a cold?**



## *Thiamin Deficiency*



# Niacin

- Pellagra symptoms: 4 “D’s”
  - Diarrhea
  - Dermatitis
  - Dementia مرض عقلي
  - Death

