Vitamins
The Fat-Soluble Vitamins

A, D, E and K
Vitamins

Definition, history and naming:

- Organic compounds needed in small amounts in diet and body does not synthesize them.
- First vitamin discovered was thiamine or $B_1$.
- Name vitamin because they essential for life (vita) and thiamine is amine.
Vitamins

Many vitamins are cofactors, coenzymes or prosthetic groups for enzymes.

Vitamin requirements increase with growth, pregnancy and lactation.
Vitamins

Also requirements increase with malabsorptive disorders as steatorrhea, pancreatic, liver, and gall bladder disease, alcoholism and chronic nephritis.
Vitamins are divided into 2 groups:
- Fat soluble vitamins
  - A, D, E, and K
  - Soluble in fat solvents
- Water soluble vitamins
  - B vitamins ($B_1$, $B_2$, $B_3$, $B_6$, $B_7$, $B_{12}$ and pantothenic acid)
  - Ascorbic acid (vitamin C)
## Types of vitamins

<table>
<thead>
<tr>
<th>Water Soluble vitamins</th>
<th>Fat Soluble Vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Thiamin (B&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>1. <strong>Vitamin A</strong></td>
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<tr>
<td>2. Riboflavin (B&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>2. <strong>Vitamin D</strong></td>
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<tr>
<td>3. Niacin (B&lt;sub&gt;3&lt;/sub&gt;)</td>
<td>3. <strong>Vitamin E</strong></td>
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<td>4. Pantothenic Acid (B&lt;sub&gt;5&lt;/sub&gt;)</td>
<td>4. <strong>Vitamin K</strong></td>
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<tr>
<td>5. Pyridoxal, Pyridoxamine, Pyridoxine (B&lt;sub&gt;6&lt;/sub&gt;)</td>
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<tr>
<td>6. Biotin</td>
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<td>7. Cobalamin (B&lt;sub&gt;12&lt;/sub&gt;)</td>
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<tr>
<td>8. Folic Acid</td>
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<tr>
<td>9. Ascorbic Acid (vitamin C)</td>
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### Types of vitamins

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<tr>
<td><strong>Character</strong></td>
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<tr>
<td>1- Soluble in water</td>
<td>1- Soluble in fat solvent (ether)</td>
</tr>
<tr>
<td>2- Not stored in liver so deficiency appears rapidly</td>
<td>2- Stored in liver so deficiency does not appear rapidly</td>
</tr>
<tr>
<td>3- No toxicity</td>
<td>3- Toxicity appears if taken in large dose</td>
</tr>
<tr>
<td>4- Does not need bile for absorption</td>
<td>4- Needs bile for absorption</td>
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Vitamin D
Vitamin D: Cholecalciferol

Sources

1- **UV irradiation** forms cholecalciferol (vitamin D₃) from 7-dehydrocholesterol in animals and ergocalciferol (vitamin D₂) from ergosterol in plants.

2- Egg and liver.

Discovery:

- 1890 – sunlight prevents rickets
Vitamin D - Sources

- Not found naturally in many foods
- **Synthesized in body**
- **Plants** (ergosterol)
  - Sun-cured forages
- Fluid milk products are fortified with vitamin D
- Oily fish
- Egg yolk
- Butter
- Liver
- Difficult for vegetarians
Vitamin D₃ formed of 7-dehydrocholesterol by rupture of second ring by ultraviolet rays.

Vitamin D₂ formed of ergosterol by rupture of second ring by ultraviolet rays.
25-hydroxycalciferol (25-HCC)

Liver 25 hydroxylase

Renal 1- hydroxylase

VitD$_3$

ACTIVE

1,25-dihydroxyvitamin D$_3$
Biological functions

Normalization of Serum: Maintain calcium level in the blood stream by:

- **Intestinal calcium absorption**: increases calcium absorption from gut.
- **Renal calcium reabsorption**: increases calcium reabsorption from kidney.
- **Bone calcium mobilization**:
  - Release calcium in blood stream in response to low calcium levels (Stimulate osteoclast cells).
Other functions of Vitamin D

2- Mineralization of ones.

3- Absorbtion of phosphate from intestine and increases P reabsorption from kidney.
Vitamin D - Functions

- Functions
  - Bone development
    - Calcium absorption (small intestine)
    - Calcium resorption (bone and kidney)
    - Maintain blood calcium levels
    - Phosphorus absorption (small intestine)
  - Hormone
    - Regulation of gene expression
    - Cell growth
Vitamin D - Functions

- Calcium re-absorption (kidney)
- Calcium absorption (small intestine)
- Calcium binding protein
- Phosphorus absorption
- Calcium resorption (bone)
Vitamin D Functions

1,25-Dihydroxy vitamin D3

Intestines → PTH → Kidneys

Kidneys → PTH → Bone
Vitamin D Deficiency

In children (Richets)

**Manifestations:**
Softness and deformities in bone
Skull : box shape
Leg : bow leg
Thorax : rosary beads
Pelvis : contracted
Delay teething and walking
Rickets in wrist - uncalcified lower ends of bones are porous, ragged, and saucer-shaped

(A) Rickets in 3 month old infant

(B) Healing after 28 days of treatment

(C) After 41 days of treatment
Vitamin D Deficiency

In adult (Oestomalachia)

Manifestations:
Weak bone, ↓ Ca. P, occur after repeated pregnancy and lactation
Requirements

400 IU/day

Deficiency: bone demineralization:
Rickets in growing Children.
Osteomalacia in adults.
Vitamin K
Vitamin K - Sources

- **Bacteria** in the large intestine (10-15%) or rumen
- **Plant** sources
  - Green leafy vegetables
  - Some oils
  - Broccoli
- **Animal** sources
  - Liver
  - Milk
- Biological activity of vitamin K stored in vitamin premixes containing choline chloride is decreased by as much as 80% after 3 months
Food sources of vitamin K include cabbage, cauliflower, spinach and other green, leafy vegetables, as well as cereals.
Vitamin K

Vitamins belonging to the K group are polyisoprenoid-substituted naphthaquinones
Functions of Vitamin K

1- Synthesis of blood clotting factors in liver: prothrombin and factors VII, IX and X.

2- Synthesis of *(Osteocalcin)* calcium binding protein in bones.
Functions of Vitamin K

- **Clotting factors** are synthesized in the liver as inactive precursors - vitamin K converts them to their active forms

- Conversion of prothrombin to thrombin, an active enzyme
- Formation of fibrinogen to fibrin, leading to clot formation
- **Stimulates bone formation** and decreases bone resorption
Vitamin K antagonists

- Dicoumarol and warfarin are antagonists of vitamin K
- Dicoumarol found in moldy sweet clover
  - Sweet clover disease
- Warfarin
  - Rat poison
Impaired blood clotting

It occurs in:

1- New borne infants: no bacteria.

2- Long use of antibiotics.

3- Liver disease: site of synthesis of prothrombin.
Ascorbic acid

vitamin C; anti-scorbutic vitamin (scurvy)

**Sources:** citrus fruits, tomatoes, Guava
Ascorbic acid (Vitamin C)

Functions:

- Production and maintenance of collagen
- Metabolism of tyrosine
Ascorbic acid

- deficiency: scurvy
  - hemorrhage from mucous membranes, mouth and GIT, skin and muscles
  - Gingivitis
  - loosening or loss of teeth
  - swelling of joints
  - Decreased wound healing due to defective collage
Ascorbic acid

- requirements:
  - adults: 40 –80 mg

- therapeutic uses
  - scurvy