

# vitamins





# Learning Outcomes

- At the end of this lecture, students should be able to:**
- **Define** vitamins as a micronutrient.
  - Classify **types** of vitamins.
  - Outline **dietary sources** of water-soluble vitamins.
  - Identify biological **functions** of water-soluble vitamins.
  - Recognize **deficiency diseases** of water-soluble vitamins.

# Vitamins

Vitamins are **organic nutrients** that are:

1- Required in **small amounts**

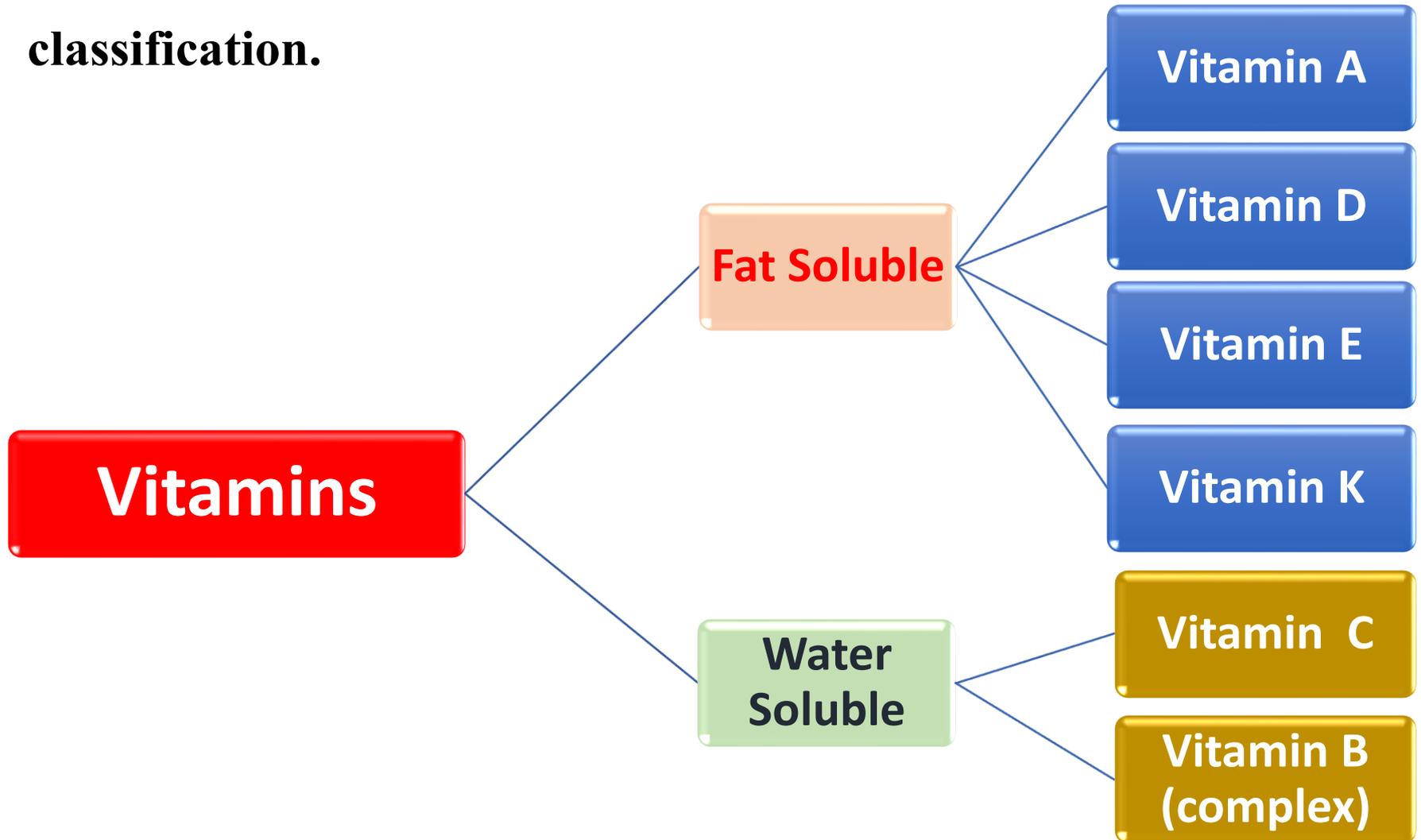
2- **Mainly not synthesized** by the body and **must** therefore be supplied by the **diet**.

3-essential for **growth and development & act as cofactors** for enzymes in biochemical reactions.

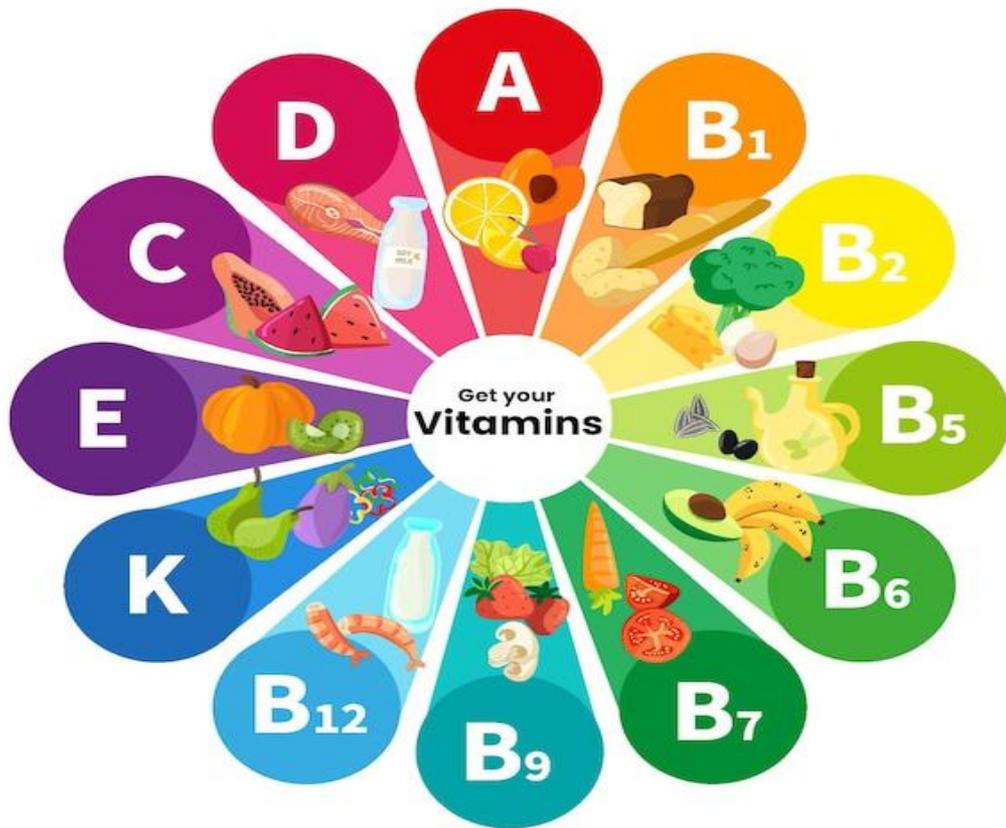
4- Absence or deficiency of vitamins in the diet leads to **specific deficiency states and disease**.

# Classification of vitamins

The **solubility of vitamins** was used as a basis for their classification.



# Water soluble vitamins



# Case Scenario

A 30-year-old male went to his doctor complaining of **loosening teeth**. Examination also revealed his **gums are swollen, purple, and spongy**. Multiple petechia were present, a wound on the patient's forearm has failed to heal properly. lab examination revealed normal serum blood glucose level, CBC showed microcytic anaemia.



# Vitamin C (L-Ascorbic acid) Anti-scurvy

## Mainly Plant Sources

Green fresh vegetables  
and fruits as lemon,  
orange, grapefruit,  
guava, cabbage.



Plum



Red pepper



Guava



Kiwifruit



Broccoli



Papaya



Strawberry



Orange



Lemon



Grapefruit

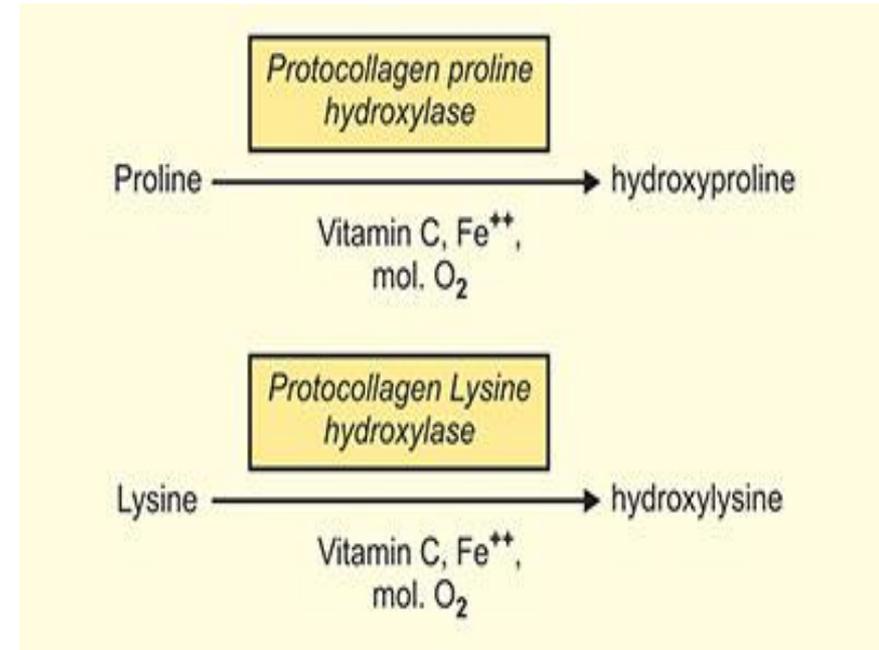


Mango

# Vitamin C (Biological functions)

## 1. Collagen synthesis

- It is required for conversion of proline and lysine into hydroxyproline and hydroxylysine



## 2. Synthesis of amino acid derivatives

A- **Tyrosine**: dopamine, norepinephrine

B- **Tryptophan**: serotonin (5 hydroxytryptophan)

# Vitamin C (Biological functions)

## 3. Enhances absorption of iron



## 4. Antioxidant:

Act as a scavenger for free radicals

5. Reducing agent: as in **Reduction of folic acid to tetra-hydrofolic acid (active).**

Folic acid reductase



**Folic acid + vitamin C → Tetrahydrofolate (THF)**

# Vitamin C Deficiency

## 1- "Scurvy" Defective collagen synthesis.

- A. Soft swollen gums and loose teeth.
- B. Bleeding tendency and subcutaneous hemorrhage.
- C. Delayed wound healing.

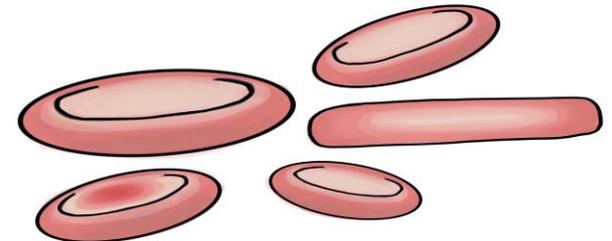


## 2- Iron deficiency anemia

*(microcytic, hypochromic):*

- A. Decreased **iron** absorption
- B. Loss of blood by hemorrhage

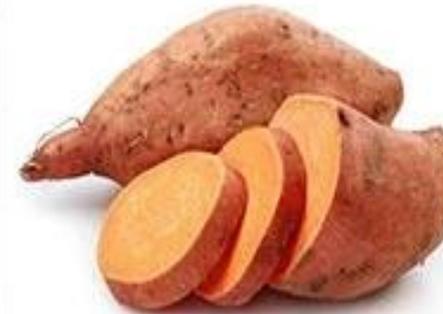
IRON DEFICIENCY ANEMIA  
(SMALLER AND MORE PALE)



# Vitamin B Complex

## Water Soluble Vitamins

Vitamin:	Name:
B1	Thiamine
B2	Riboflavin
B3	Niacin
B5	Pantothenic Acid
B6	Pyridoxine
B7	Biotin
B9	Folate
B12	Cobalamin
C	Ascorbic Acid



# Vitamin B<sub>1</sub> Thiamin (Anti-Beriberi)

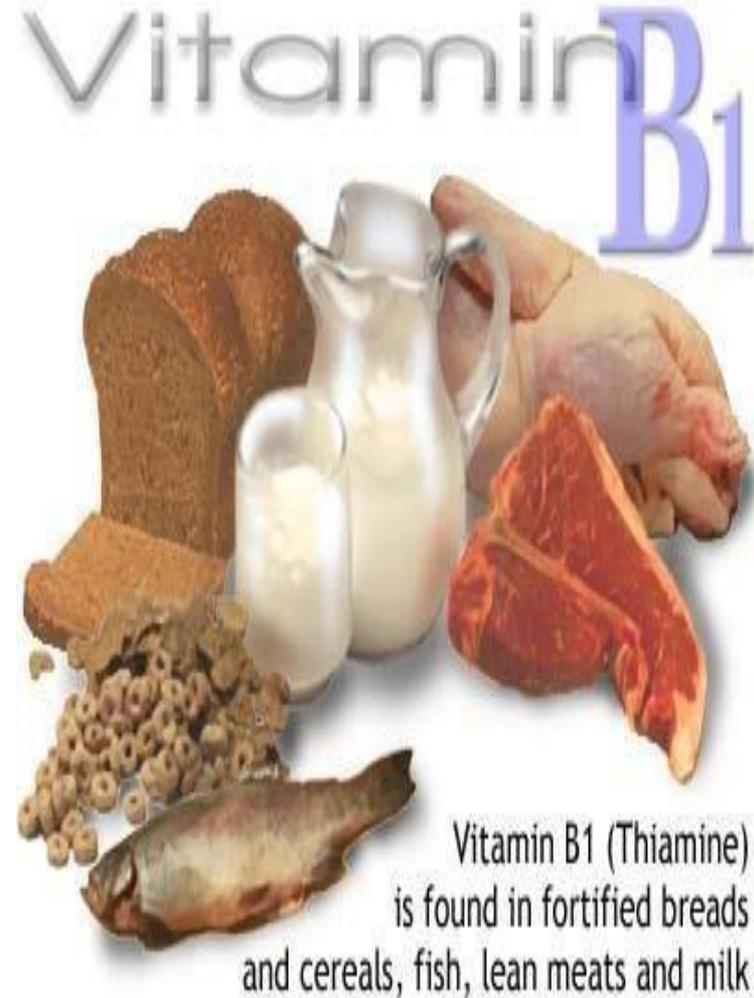
## Sources

**Plants** e.g yeast, bran, vegetables, and fruits.

**Animals** e.g liver, kidney, milk ,egg and fish.

## Functions of vitamin B1:

- 1.Thiamin is essential for **growth**.
- 2.It is essential for maintaining the **nerves** in normal condition.



Vitamin B1 (Thiamine)  
is found in fortified breads  
and cereals, fish, lean meats and milk

# Vit B1 Coenzyme Functions

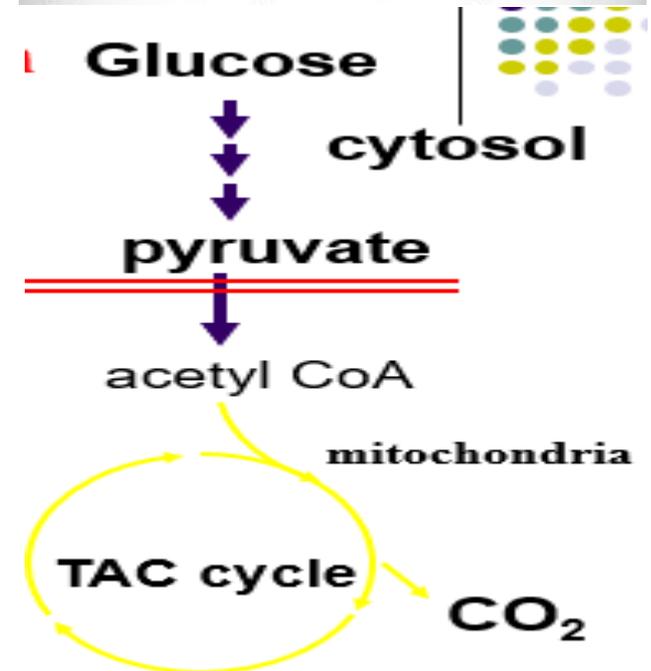
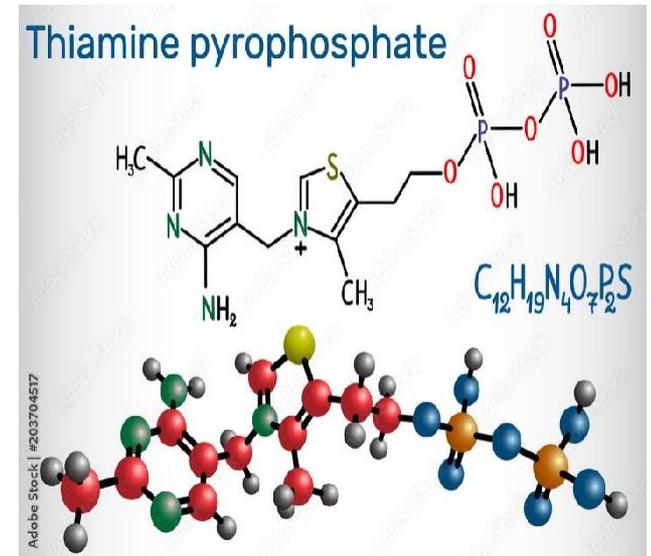
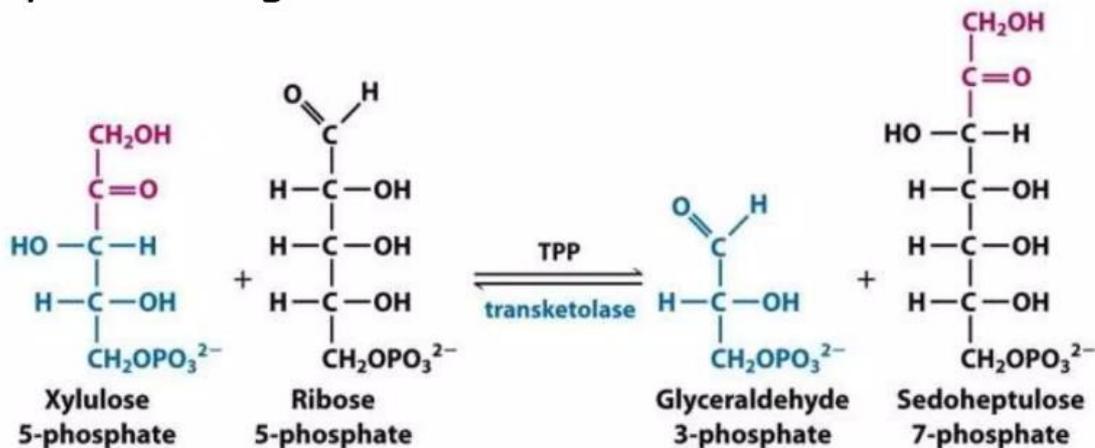
Thiamin pyrophosphate (TPP) the active coenzyme form of vit B1.

TPP acts as coenzyme for:

1-Oxidative decarboxylation of  $\alpha$ -keto

acids: such as pyruvic acid and  $\alpha$ -ketoglutaric acid.

2-Transketolation reaction in pentose shunt



# Thiamin deficiency (Beriberi)

TPP is essential for important reactions in carbohydrate metabolism, so **impairment of glucose metabolism** is the earliest sign defect of thiamine deficiency.

❑ Thiamine deficiency is known as **Beriberi**

❑ There are two types of Beriberi:

**1- 'Dry Beriberi'** (muscular weakness & peripheral neuropathy)

**2- 'Wet Beriberi'**

palpitation, dyspnea, cardiac enlargement

"the usual cause of death is heart failure"



# Vitamin B<sub>2</sub> (Riboflavin)

## SOURCES:

- Yeast
- Whole grain
- Dry beans and pea
- Green vegetables
- Liver, eggs and milk.

Vitamin B<sub>2</sub>

Food sources of Riboflavin (vitamin B2):



# Functions of Riboflavin

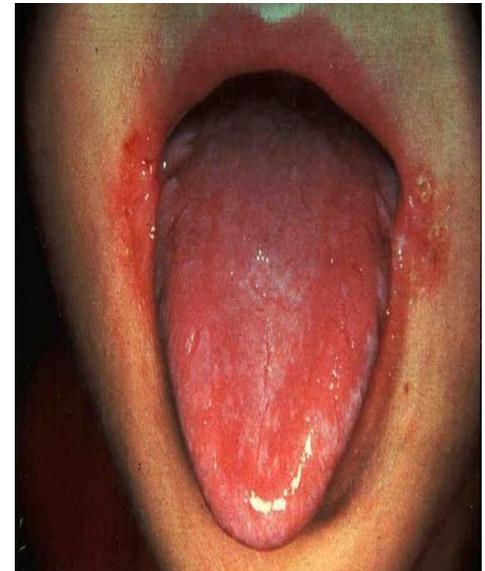
## 1. It forms 2 important coenzymes:

- **FMN**: Flavin mononucleotide    **FAD**: Flavin Adenine Dinucleotide  
act as hydrogen carriers for biochemical oxidation-reduction reaction.

## 2. Riboflavin's role in maintaining healthy skin, mucous membranes, and vision.

## Deficiency of Riboflavin (Ariboflavinosis)

1. **Cheilosis** (Cracks and redness at corners of mouth)
2. **Glossitis** (Painful, smooth, purplish red tongue)
3. **Seborrhoic dermatitis**



# Vitamin B3

## Niacin

(Anti-Pellagra vitamin)

### Sources

- 1- **Plants** e.g. yeast, leafy green vegetables.
- 2- **Animals** e.g. meat, liver, milk and milk products.



Food sources of Niacin (vitamin B3) include dairy, poultry, fish, lean meat, nuts and eggs

## *Vitamin B3 Biological Functions:*

□ **Niacin** enters in the formation of 2 coenzymes:

1- **NAD** (Nicotinamide Adenine Dinucleotide).

2- **NADP** (Nicotinamide Adenine Dinucleotide Phosphate).

Hydrogen and electron carriers in catabolic pathways  
in metabolism

# Deficiency of Niacin

## Pellagra (3Ds)

1-Dermatitis (skin is dry, scaly and brown).

2-Diarrhea.

3-Dementia (loss of mental power and loss of ability of concentration )

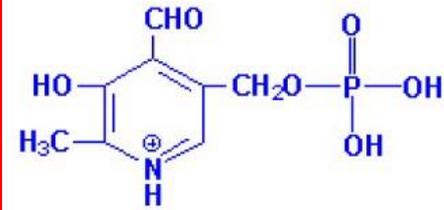


# Vitamin B<sub>6</sub> (pyridoxine)

## SOURCES

- Yeast, seeds.
- Egg yolk, meat, and liver.

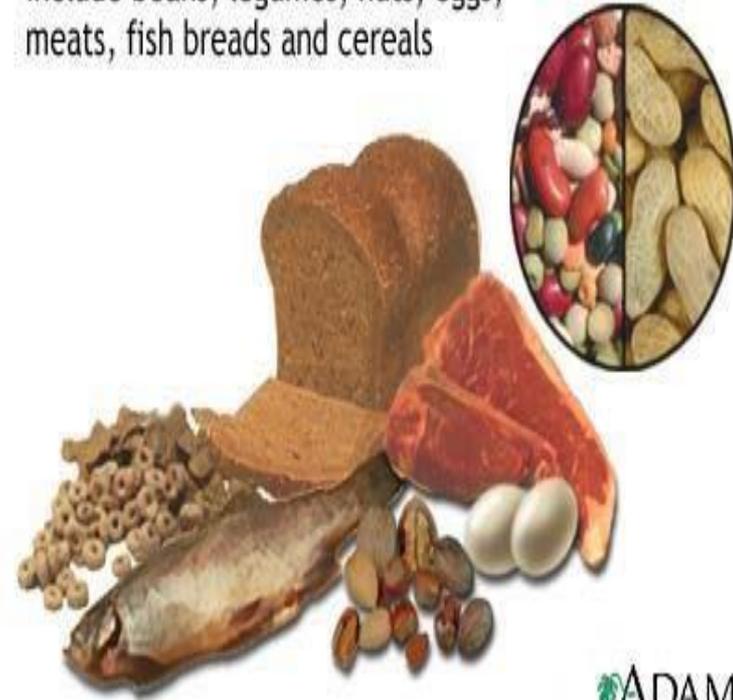
**Pyridoxal phosphate** "the biologically active form of vit. B6" acts as a very important coenzyme in amino acid metabolism.



Pyridoxal Phosphate

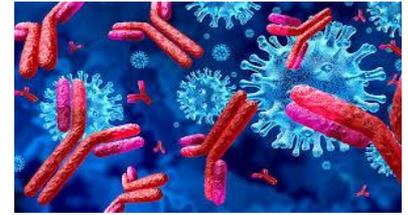
The active form

Vitamin B<sub>6</sub>  
Food sources of vitamin B6 (pyridoxine) include beans, legumes, nuts, eggs, meats, fish breads and cereals



## Functions of vitamin B6:

- Catalyzes conversion of tryptophan to niacin (B3).
- Required for formation of antibodies.
- Required for synthesis of hemoglobin.
- Important for nervous system.



## vitamin B6 deficiency:

Anemia, skin lesions, seizures, and decreased antibody production.



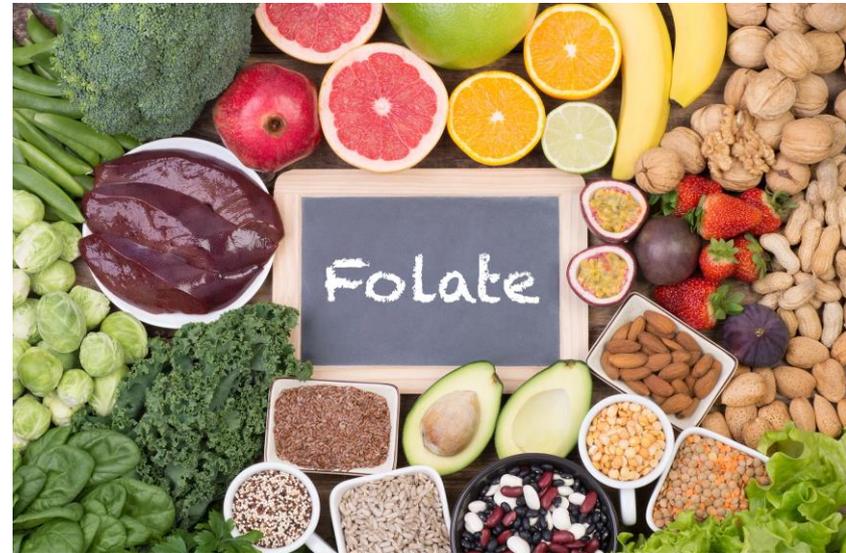
# Vitamin B9 (Folic acid) Anti-megaloblastic anemia

## Sources of Folic Acid

Rich sources : yeast,  
green leafy vegetables.

Moderate sources :  
cereals, pulses, oil seeds  
and egg.

poor source : Milk



The active form of folic acid is: **tetrahydrofolate THF**

# Functions Of Folate

1. The various forms of folate function as a **single-carbon donor-acceptors** in a variety of biosynthetic reactions.
2. Along with vitamin B12, it is essential for **DNA synthesis** and for **RBC's formation**.
3. Folate supplementations are given before conception to reduce the incidence of **neural tube defects**.

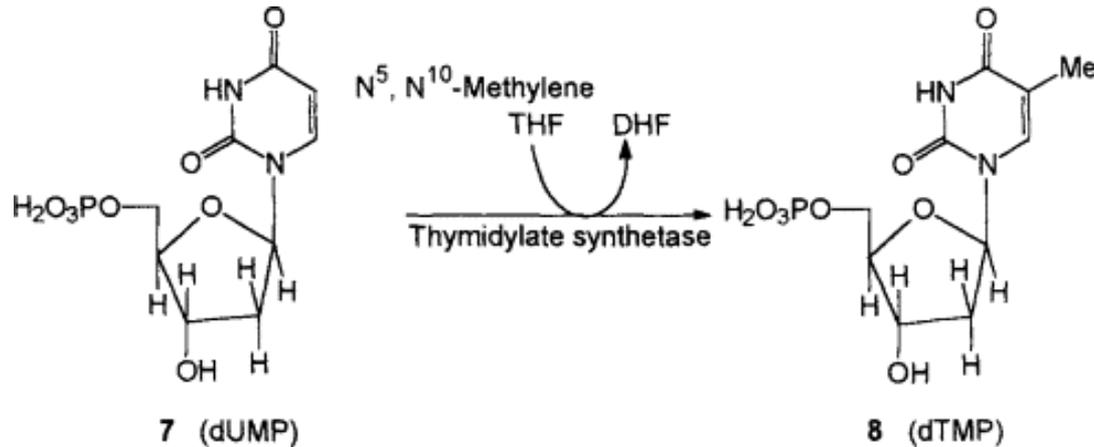
The requirements of folic acid are increased in a pregnant woman



# Folate Deficiency

## a- Reduced DNA synthesis

And cell division is arrested.



## b- Megaloblastic anemia

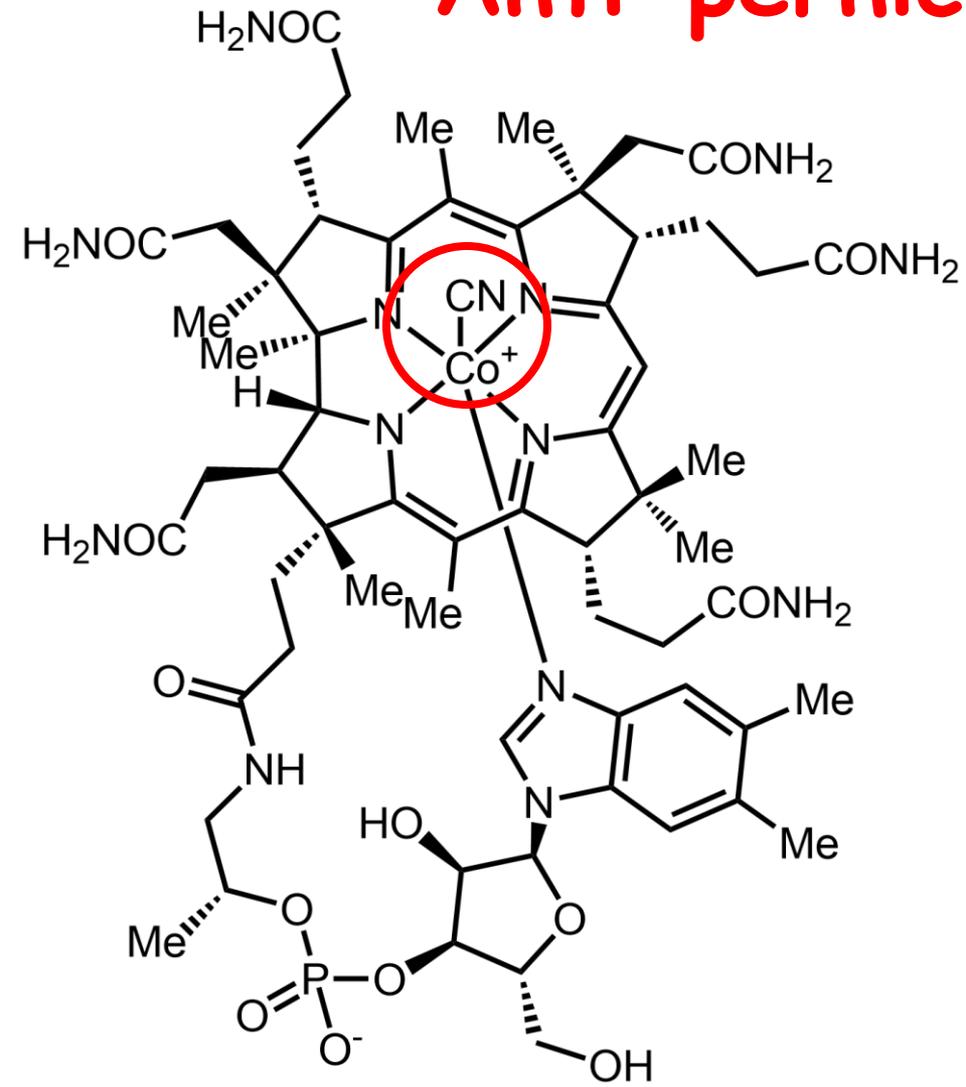
abnormal large immature RBCs are synthesized and rapidly destroyed in spleen.

C- can also result in birth defects during pregnancy.

# Vitamin B12

## Cyanocobalamin

### Anti-pernicious anemia



Since vitamin B<sub>12</sub> contains a cobalt atom and a cyanide group, it is called cyanocobalamin

# Vitamin B12

## Cyanocobalamin

### Anti-pernicious anemia

#### Sources

**Animal** sources only as eggs, meat, liver and fish.

{can only be synthesized by microorganisms (intestinal flora)}

#### Absorption of vitamin B12:

Vitamin B12, is absorbed in the ileum requiring an **intrinsic factor** (Glycoprotein) secreted by the stomach.

Vitamin B12

Food sources of vitamin B12:



Eggs, meat, poultry, shellfish, milk and milk products

- ✓ Generally, Vitamin B complex vitamins are not stored in the body, **ONLY B12 is stored in liver.**
- ✓ Vitamin B12 deficiency is seen **after gastrectomy.**
- ✓ Vitamin B12 deficiency is very common among **vegetarians** of low socioeconomic group.

### Functions of vitamin B12:

1. Important for synthesis of **DNA**
2. Required for formation of **red blood cells** with folate and iron.
3. Involved in formation of **myelin sheath** surrounding the nerve fiber.

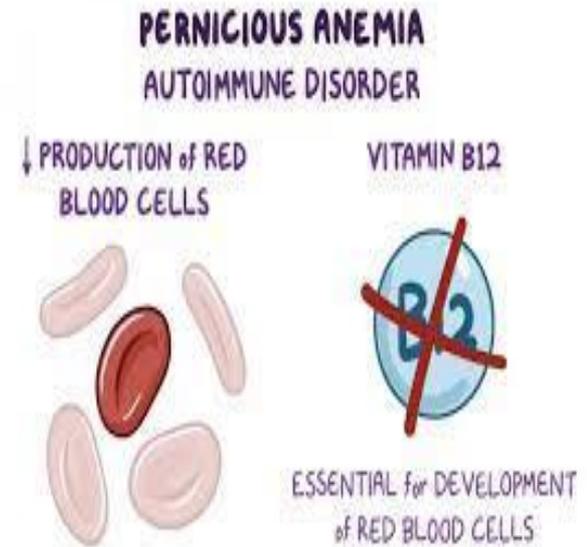
# Vitamin B12 Deficiency

## Pernicious anemia

*i. Megaloblastic anemia*

*ii. peripheral neuropathy:*  
(due to demyelination)

-numbness and tingling  
of extremities



**Case  
discussion**



# Case Scenario

A 30-year-old male went to his doctor complaining of **loosening teeth**. Examination also revealed his **gums are swollen, purple, and spongy**. Multiple petechia were present, a wound on the patient's forearm has failed to heal properly. lab examination revealed normal serum blood glucose level, CBC showed microcytic anaemia.



1. Which vitamin is expected to be deficient in this child?
2. Do you expect other nutritional deficiency in this patient? If yes, what is it?
3. Is there any relation between this deficiency and the microcytic anaemia?
4. What is the underlying cause of bleeding gums and loosen teeth in this patient?
5. How could you treat this patient?



## Case Answer

**1. Which vitamin is expected to be deficient in this child?**

✓ **Vitamin C deficiency (A case of Scurvy)**

**2. Do you expect other nutritional deficiency in this patient?**

✓ **Yes , vitamin C deficiency also associated with Fe deficiency as vit C is important for Fe absorption**

**3. Is there any relation between this nutritional deficiency and the microcytic anaemia?**

✓ **Yes as vitamin C is essential for Fe absorption.**

✓ **Deficiency of vitamin C → decreased absorption of Fe → microcytic hypochromic anaemia (characteristic of Fe deficiency anemia)**

## Case Answer

**4. What is the underlying cause of bleeding gums and loosen teeth in this patient?**

- ✓ **Vitamin C is required for the hydroxylation of proline and lysine residues in collagen synthesis**
- ✓ **Vit C deficiency → lack of hydroxylation leads to altered connective tissue formation → bleeding gums and loosen teeth.**

**5. How could you treat this patient?**

- ✓ **Vitamin C and Fe supplement (oral/IV according to the severity of the case)**



**Thank You!**