
بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ
Bismillahirrahmanirrahim


PP
A
K
E
D
C

VITAMINS

Introduction and classification

Dr Gulnaz

Objectives

- Define vitamins
- Discuss the history of vitamins
- Classify vitamins
- Difference between fat soluble and water soluble vitamins.
- Vitamins like substances.

VITAMINS

- "VITAMIN" means "vital for life"
- VITAMINS are organic substances required in small amount for everyday healthy functioning of the body.
- OR
- These are micronutrients required in small amount, as they are not synthesised in body in amount sufficient for maintenance of normal functioning of body.

History

History

- In 17th century-sailors of British navy got scurvy on ships.
- James Lind, ship surgeon prescribed lemon juice as preventative measure.
- This experiment proved that lemon juice prevents scurvy.
- Nowadays we know that scurvy is due to vitamin C deficiency .

History of vitamins

- In 1906 Frederic Hopkin, a English biochemist said that food contains "accessory factors" needed to sustain growth and life.

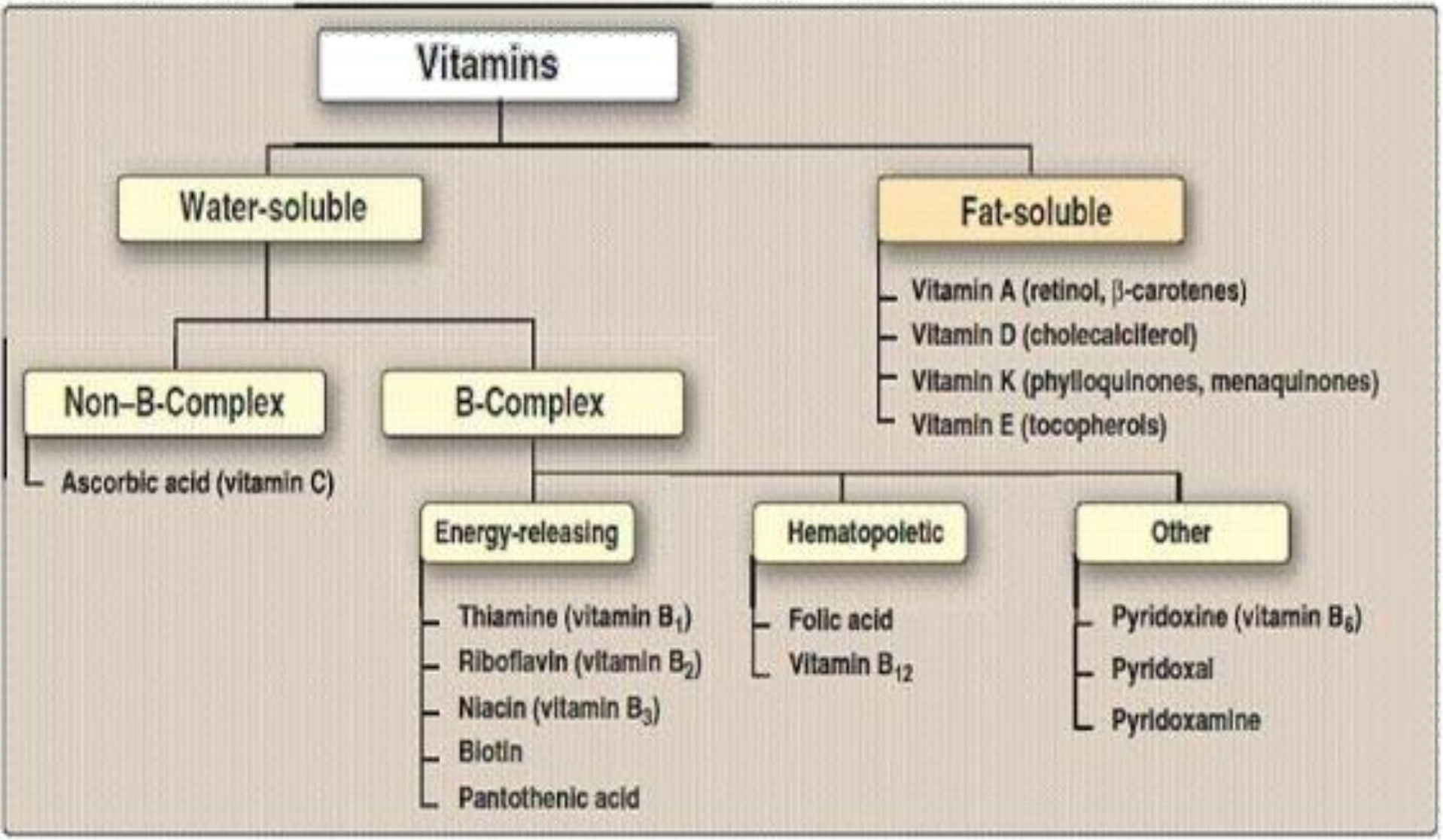
- In 1912 Casimir Funk named these growth factors VITA+AMINES because they were required for life(vita),and also contain nitrogen.
- As he found thiamine isolated from rice husk contain nitrogen(called : amine: i.e nitrogen containing).

In 1930 when the scientists identified, purified and synthesized all the vitamins.
Funk original term: vitamine: changed to ‘vitamin’

Functions

- Required for growth and reproduction e.g. vitamin A.
- They act as co enzymes in several energy transmission reactions in the body e.g. B-complex.
- Antioxidants e.g. vitamin C,E.
- Hormone like functions as regulator of mineral metabolism e.g. , vit D

Classification



Previous name[41][42]	Chemical name[41][42]	Reason for name change[41]
Vitamin B_4	Adenine	DNA metabolite
Vitamin B_8	Adenylic acid	DNA metabolite
Vitamin F	Essential fatty acids	Needed in large quantities (does not fit the definition of a vitamin).
Vitamin G	Riboflavin	Reclassified as Vitamin B_2
Vitamin H	Biotin	Reclassified as Vitamin B_7
Vitamin J	Catechol, Flavin	Protein metabolite
Vitamin L_1[43]	Anthranilic acid	Protein metabolite
Vitamin L_2[43]	Adenylthiomethylpentose	RNA metabolite
Vitamin M	Folic acid	Reclassified as Vitamin B_9
Vitamin O	Carnitine	Protein metabolite
Vitamin P	Flavonoids	No longer classified as a vitamin
Vitamin PP	Niacin	Reclassified as Vitamin B_3
Vitamin U	S-Methylmethionine	Protein metabolite

Chemical name

Thiamine (B1)

Riboflavin (B2)

Nicotinamide (niacin) (B3)

Adenine (no longer considered a vitamin)

Pantothenic acid (B5)

Pyridoxine (B6)

Biotin (B7)

Inositol

Folacin (folic acid) (B9)

p-aminobenzoic acid (PABA) / H1

L-carnitine / b-hydroxy-g-trimethylammonium butyrate

Cyanocobalamin (B12)

Water soluble

- Cannot be stored in body - regular supply needed
- Excess is excreted in urine - no danger of toxic levels
- Unstable to heat and light, leach into cooking liquids

Fat Soluble

- Can be stored in body - regular supply not needed
- Can accumulate to toxic levels if large amounts ingested
- Fairly stable at normal cooking temperatures

Water Soluble Vitamins

- Digestion, Absorption, and Transport
  - No chemical digestion needed
  - Absorbed in the blood and moves freely in capillaries and water filled compartments of body.

No carriers required for transport in the blood

  - Vitamin B12 must bind with a protein called the intrinsic factor (IF) in the stomach for absorption.

Water Soluble Vitamins

- Storage and excretion
  - Travel freely in the blood
  - Cells take up water soluble vitamins as needed
    - Limited storage beyond tissue saturation
  - Excess excreted in the urine

Water Soluble Vitamins

- Many are destroyed by light, heat, or exposure to oxygen
- Best to cook whole in a minimum amount of water

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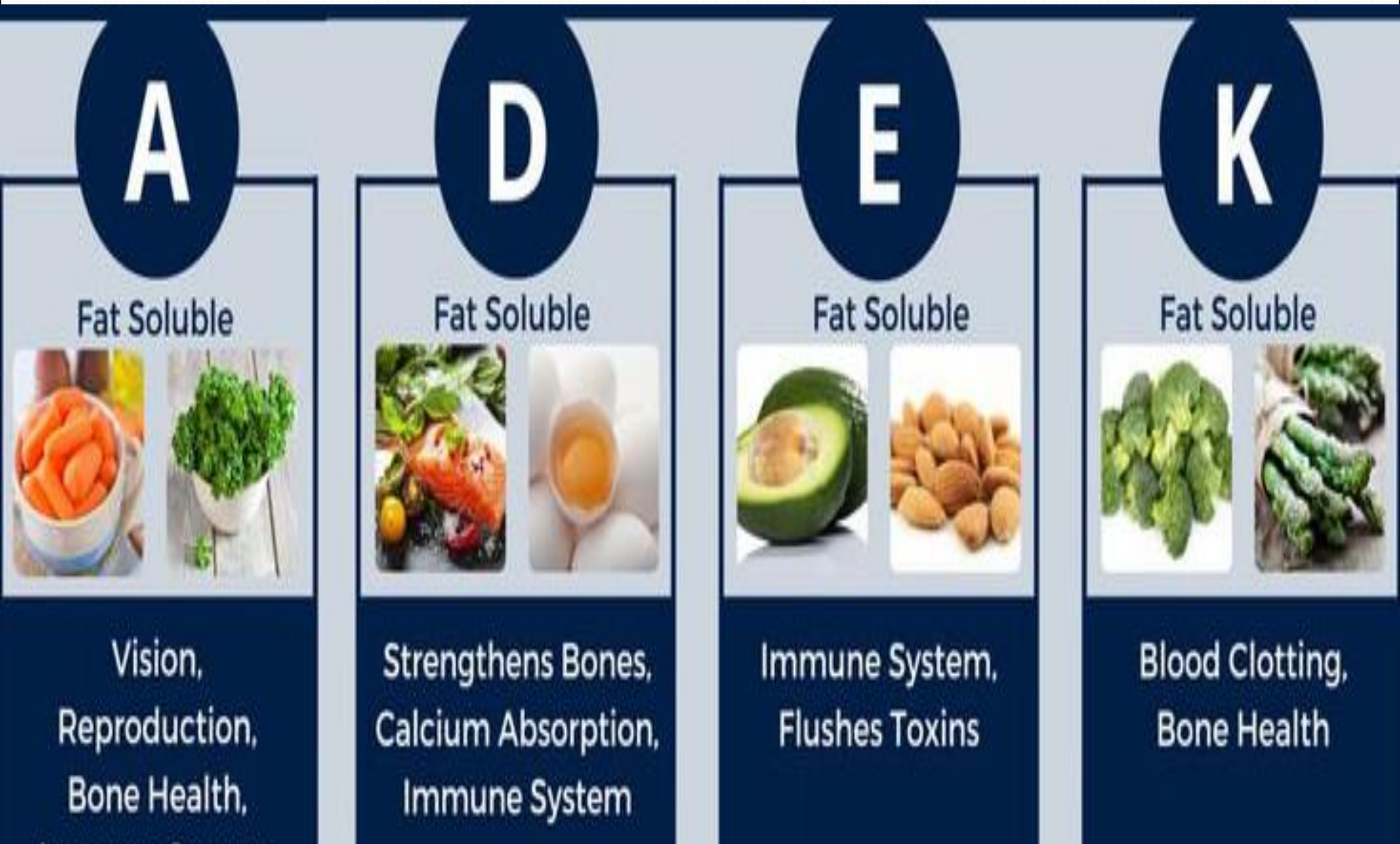
Fat soluble vitamins



Fat Soluble Vitamins

- Digestion, Absorption, and Transport
  - Bile needed to emulsify fat soluble vitamins.
  - Form chylomicrons (along with long chain fatty acids and monoglycerides)
  - Chylomicrons are absorbed into the lacteals
  - Travel through lymph system → blood → liver
  - Many require protein carriers to be transported in the blood

Fat Soluble Vitamins

- Storage
  - Stored in liver and fatty tissue
  - Unlimited stores possible
- Greater risk of toxicity than deficiency for fat soluble vitamin.

Fat Soluble Vitamins

- Found in the fatty parts of food
- Removed with the fat when low-fat products are made
  - Many low-fat foods are supplemented with these vitamins to make up for this
    - E.g. skimmed milk is fortified with vitamin A and D .

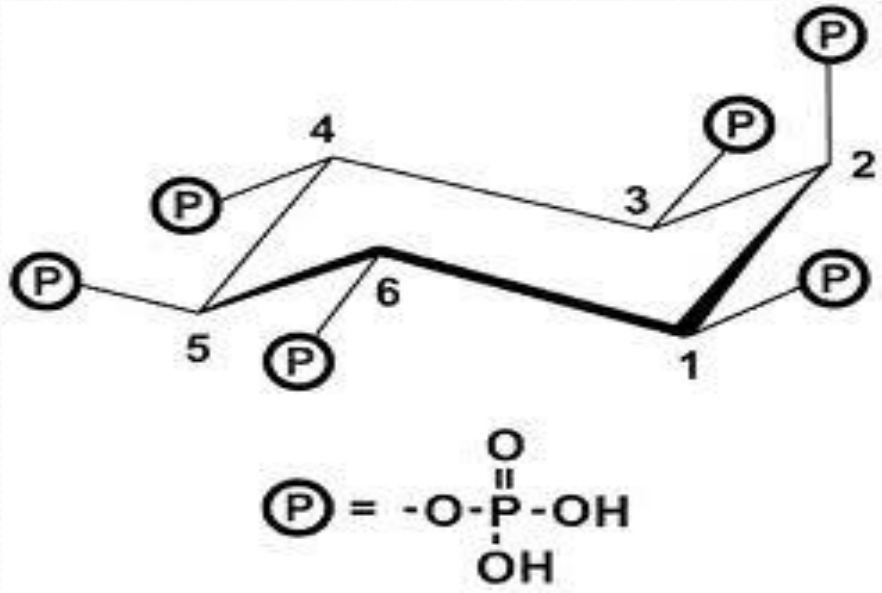
Vitamins like substances

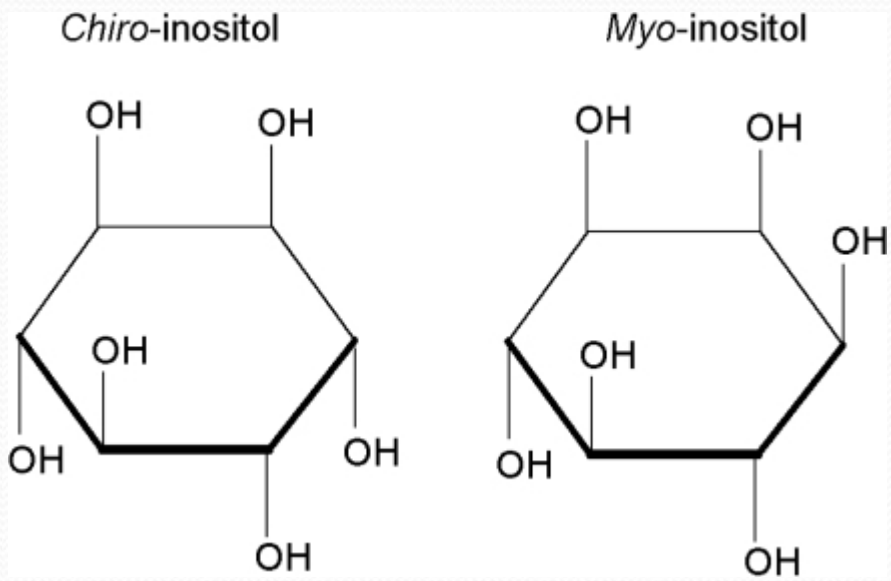
- There are substances which have vitamin like activity, they are essential for human nutrition and metabolism, but their role as true vitamin is not established.
- These are
- Inositol
- Lipoic acid
- Choline
- Para amino benzoic acid

INOSITOL

CHEMISTRY

- Hexahydroxy cyclohexane having nine stereoisomers (optically active).
- Myoinositol is biologically active form(optically inactive).
- Synthesize in the body from glucose-6-phosphate.





SOURCES

- Found both in plants and animals.
- Muscles, brain, RBCs and eyes contain inositol.
- Found in fruits, vegetables, whole grains and yeast.
- RDA: 100 mg/day.

Types of Inositol

- Free state.

  As Muscle sugar .

- Bound forms

  Mostly as phospholipids phospho inositides, present mostly in brain and liver, RBCs and tissues of eye.

In plants exist mostly in the form of PL, phytic acid and phytin.

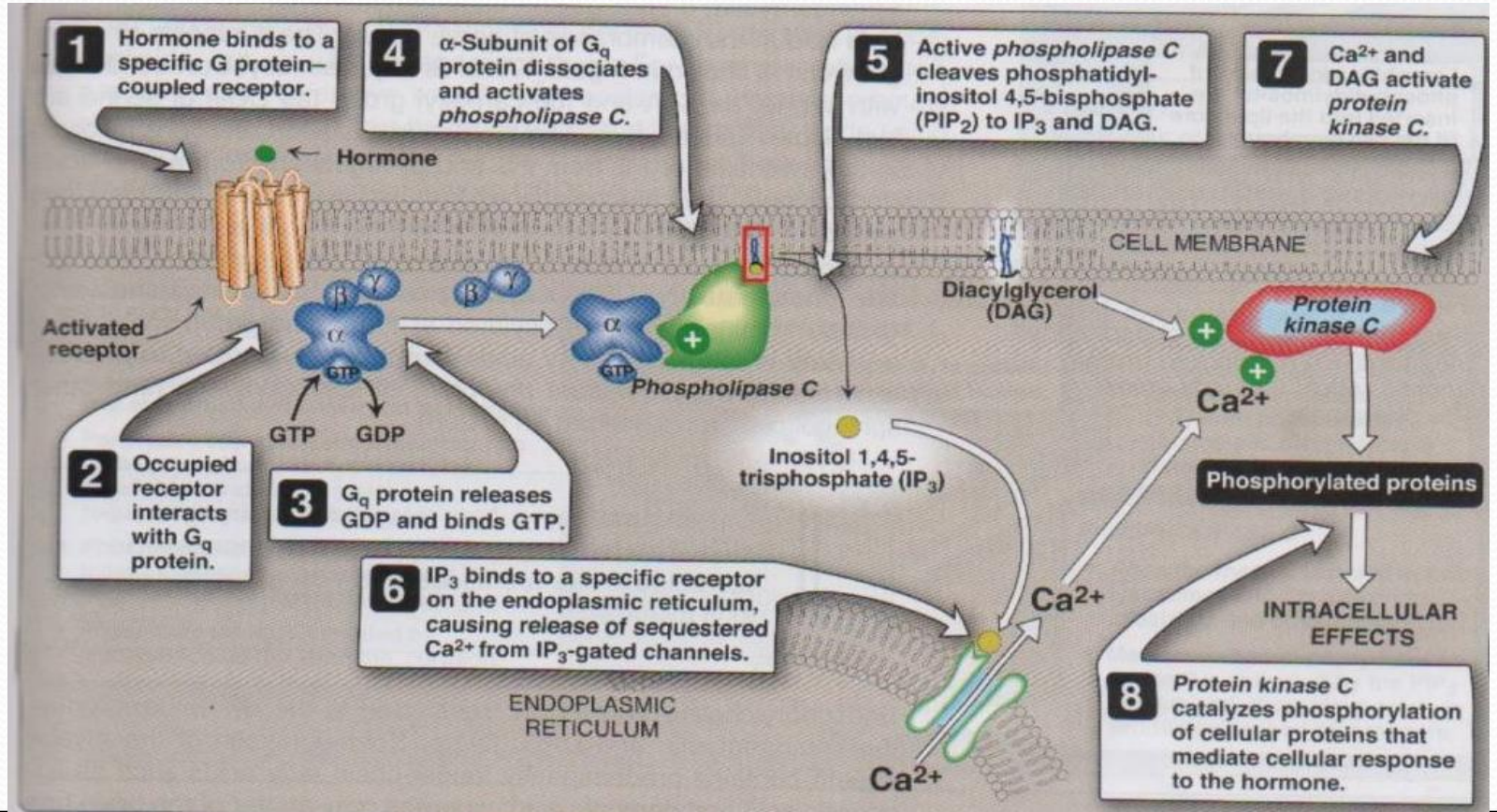
Absorption and Transport

- Absorbed in small intestine.
- Carried by portal blood to tissues.
- Not stored ,excess excreted in urine.
- Hexa phosphate of inositol is called phytin found in vegetables ,is hydrolyzed by enzyme phytase.

  It interferes with absorption of calcium and iron.

METABOLIC ROLE

- Inositol + choline produce lecithin, a type of lipid (phosphatidylinositol) constituent of cell membrane.
- Act as 2nd messenger for some hormones for the release of ca^{++} ions at the level of cell membrane.



- Required for the growth of fibroblast.
- Constituents of phospholipids.
- It occurs in large quantity in mammalian heart muscles and increases the amplitude and rate of contraction.
- keeps liver, brain and heart healthy.
- Lipotropic factor, prevents accumulation of fat in liver .

- Decrease inositol in nerve fibers is responsible for peripheral neuropathy .
- Helps in the absorption of B1 + A.
- Vital for hair growth.
- Increase effectiveness of choline and vit E.

THERAPEUTIC USES

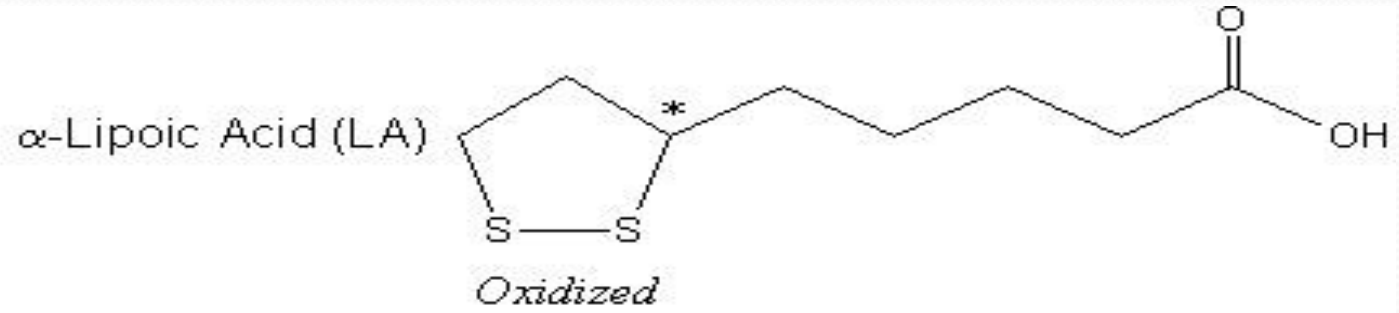
- liver problem (fatty liver).
- Depression.
- Diabetes.
- Polycystic overies.
- Alzehemir;s disease.

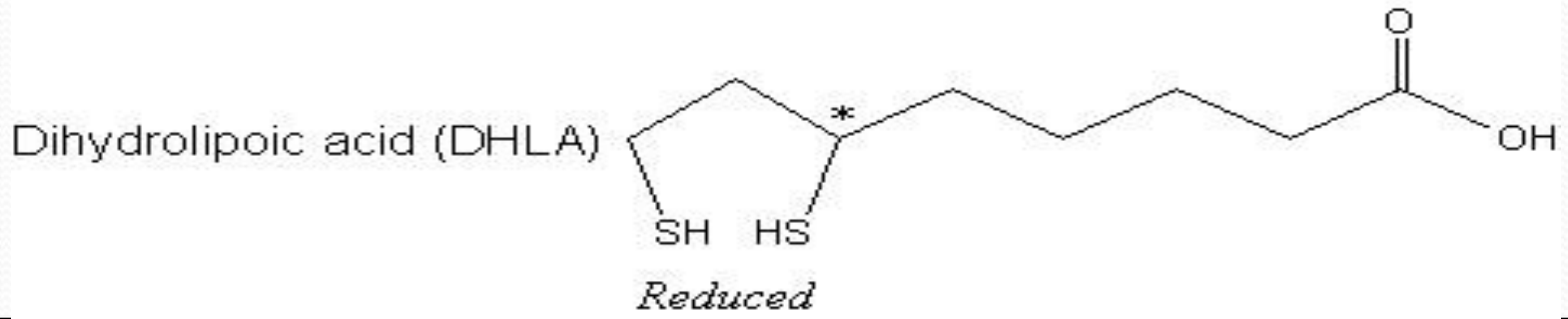
Lipoic acid

Sulpher containing fatty acid.

Chemical structure

- Sulfur containing compound (6,8-di-thio- octanoic acid).
- Contain two sulfur atoms linked by disulfide bonds.



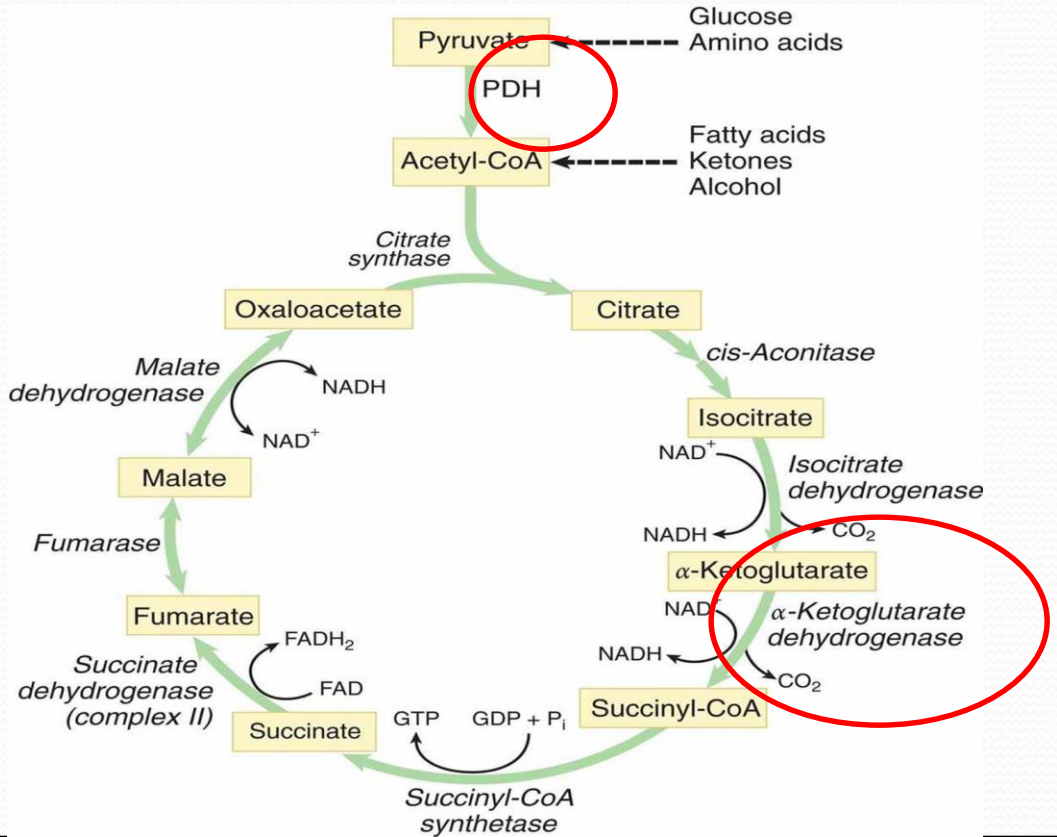


SOURCE

- Both fat soluble and water soluble.
- Found inside every cell in the body.
- Exist in oxidised and reduced form.
- Sources,
- Kidney, liver, heart, spinach and yeast.
- RDA: 50-100 mg/day.

METABOLIC ROLE

Co enzyme of pyruvate dehydrogenase complex for formation of acetyl CoA from pyruvate ,and α ketoglutarate dehydrogenase in the formation of succinyl CoA from α ketoglutarate.



- Anti oxidant, Protect brain and nerve tissue from free radical damage by producing glutathione.

- Recycle anti oxidant like vitamin C and glutathion.

USES

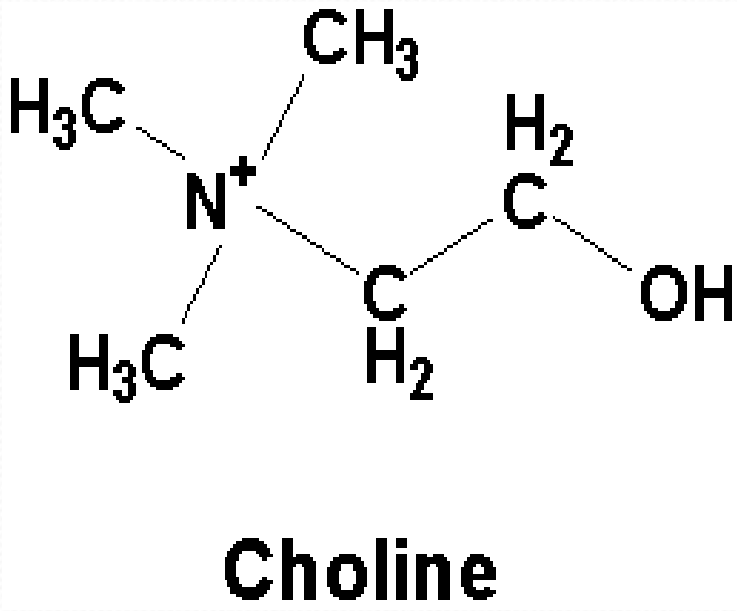
- 1. Hepatoprotective, improve liver circulation, used in liver cirrhosis, jaundice, hepatitis.
- 2. Used in myocardial infarction and stroke.
- 3. Used in multiple sclerosis, Alzheimer's disease(reduce free radicals).
- 4. Reduce insulin resistance and brings down plasma LDL.

TOXICITY

- Headach
- Tingling
- Skin rash
- Muscle cramps.

Choline

- Trimethylhydroxy ethenolamine
- Synthesized in body from serine.



Choline

Dietary sources

- Milk ,eggs , liver, brain, heart,cereals and leafy vegetables

- RDA: 400-500mg/day

Functions

- Promotes synthesis of phospholipids and lipoproteins, so component of cell membrane.
- Phospholipids are involved in the transport of fat and cholestrol from liver. It is Lipotropic factor and prevents fatty liver.
- Actively involved in one carbon metabolism after conversion to betaine by donating three methyl groups.
- Involved in transmethylation reactions.

- Myelin sheath is also made up of phospholipids, so demyelination causes severe nervous disorders.

- Precursor of acetylcholine required for transmission of nerve impulse.

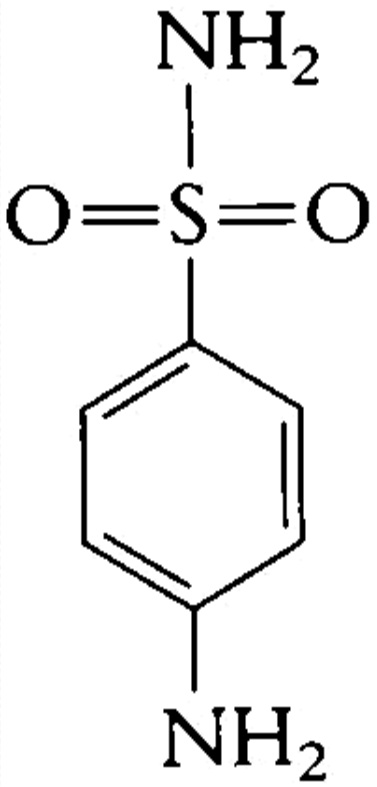
Para amino benzoic acid

Constituent of folic acid

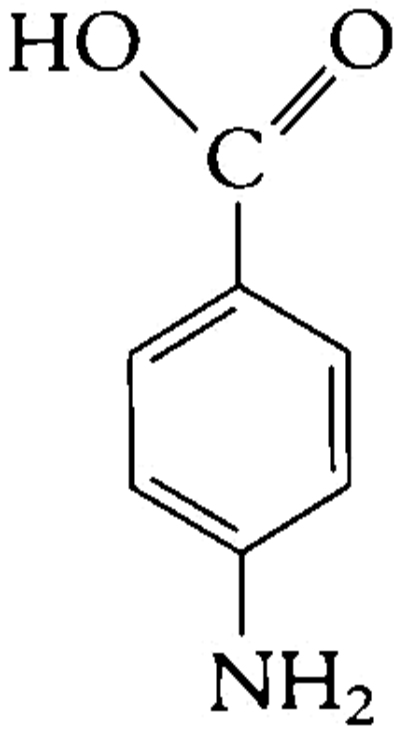
Synthesized by bacteria and is essential for their growth.

Component of sulfonamides.

Sulphonamides competes with PABA and act as bacteriostatic.



Sulfanilamide



PABA

sources: liver,yeast,rice bran and whole wheat

WATER SOLUBLE VITAMINS

Non B-complex

Vitamin C

B-complex

Energy Yeleasing

Thiamine (B_1)

Riboflavin (B_2)

Niacin(B_3)

Pantothenic Acid(B_5)

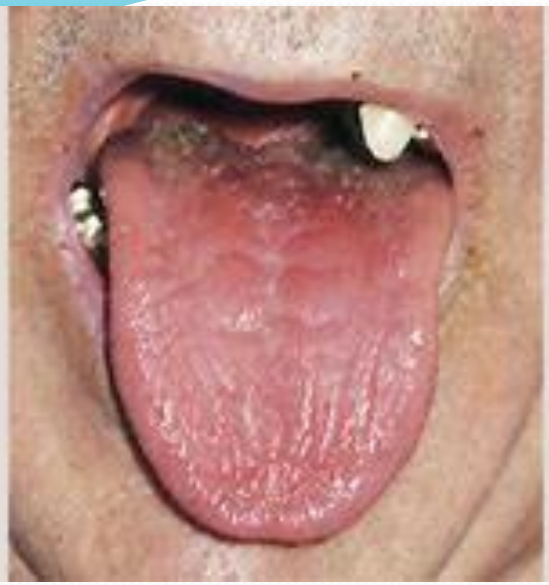
Pyridoxine(B_6)

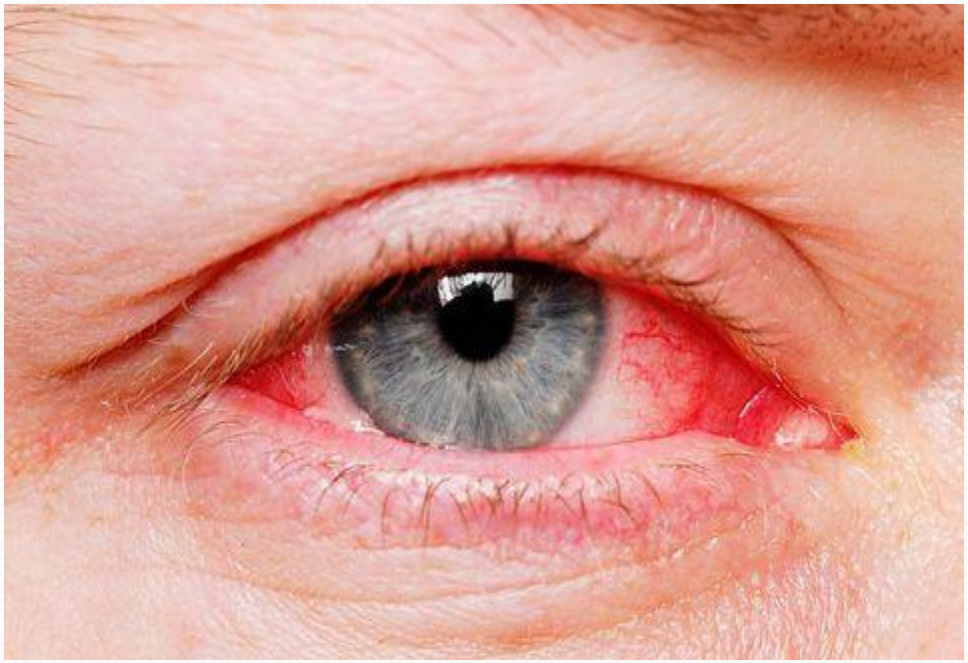
Biotin(B_7)

Hematopoietic

Folic Acid

Vitamin B_{12} / Cyanocobalamin





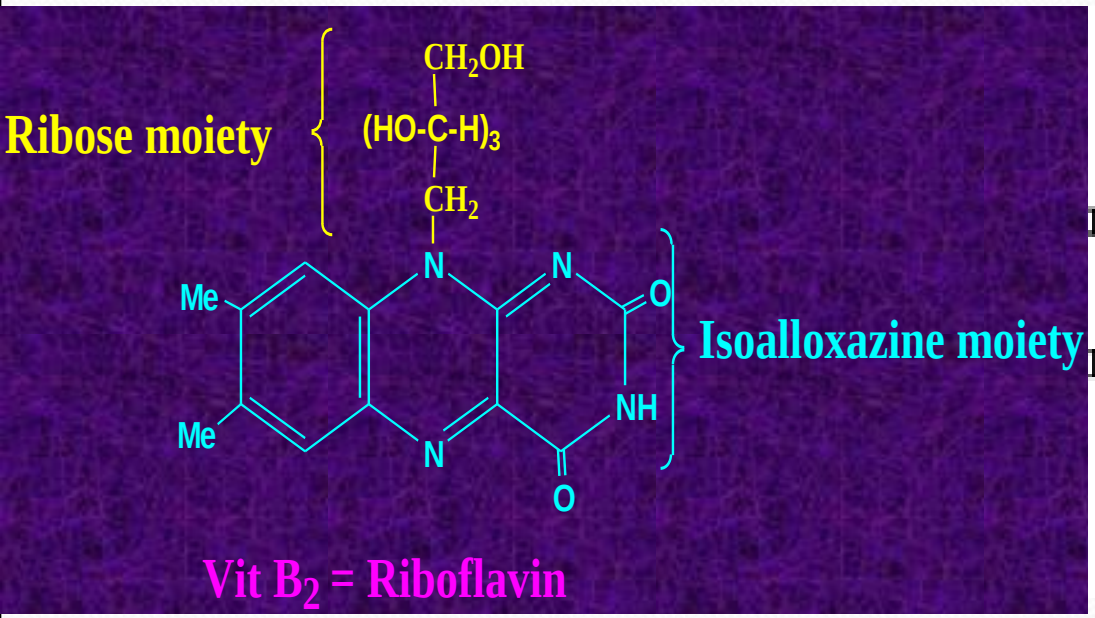

VITAMIN
B2

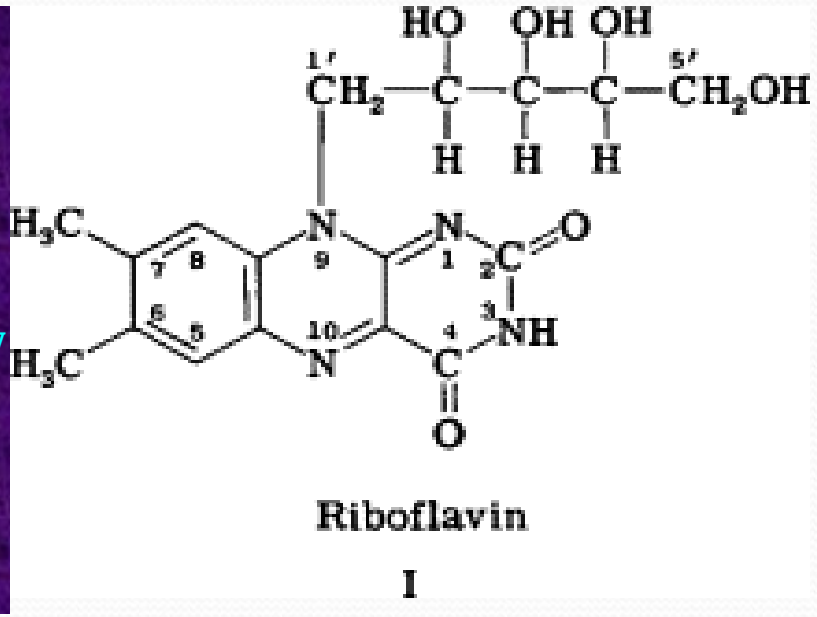
Objectives

- Chemical structure of Riboflavin
- Sources of Riboflavin
- Absorption of Riboflavin
- Biologically active form of Riboflavin
- Biochemical role of Riboflavin
- Deficiency manifestation & causes of deficiency of Riboflavin

Vitamin B_2

Riboflavin, lactoflavin, Vitamin G





➢**It chemically has a three rings structure (isoalloxazine) linked to ribityl moiety. I carbon of ribityl attached to 9 position of isoalloxazine.**

➢**Riboflavin is a yellow to orange- yellow powder, soluble in water. Heat stable.**

Stability

When exposed to UV light, converted to lumiflavin which emits yellow fluorescence.

Vitamin B_2 is unstable to light in both acidic and basic medium.

- **Under acidic condition light produce lumichrome.**
- **In alkaline PH light produce lumiflavin.**

Both are inactive biologically.

Natural Sources

- **milk, kidney, eggs, liver and meat.**
- **whole grains, peas,nuts, germinating seeds and green leafy vegetables**
- **Yeast**

RDA

1.2- 1.8 mg/day.

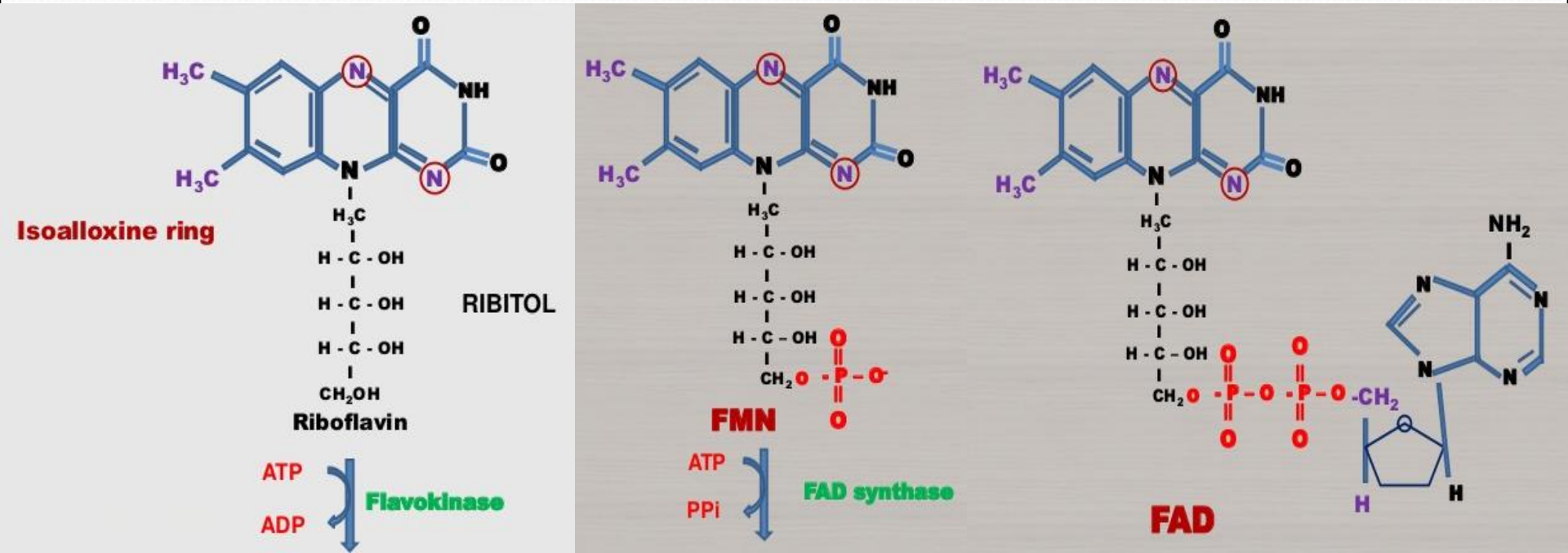
Absorption

- **Riboflavin is absorbed in the proximal intestine.**
- **Passes to all tissues through general circulation**
- **Riboflavin is not stored, mainly present in the liver, kidney and heart in the form of FAD (70-90%) or FMN or Riboflavin.**

Biologically active forms

Riboflavin is converted to the active forms by enzyme flavo-kinase

- Riboflavin-Mononucleotide (FMN) ,
- Riboflavin-Monophosphate .
- Riboflavin-Adenine Dinucleotide (FAD) ,
- Riboflavin-Adenine Diphosphate



Role of Vitamin B_2

Flavoproteins

Enzymes which use Flavin as coenzymes are called flavoproteins.

Metalloflavoproteins

Many flavoproteins contain metal atoms (iron, molybdenum) which are known as metalloflavoproteins.

The Active forms work as co-enzymes for about 150 oxidation-reduction reactions involved in:

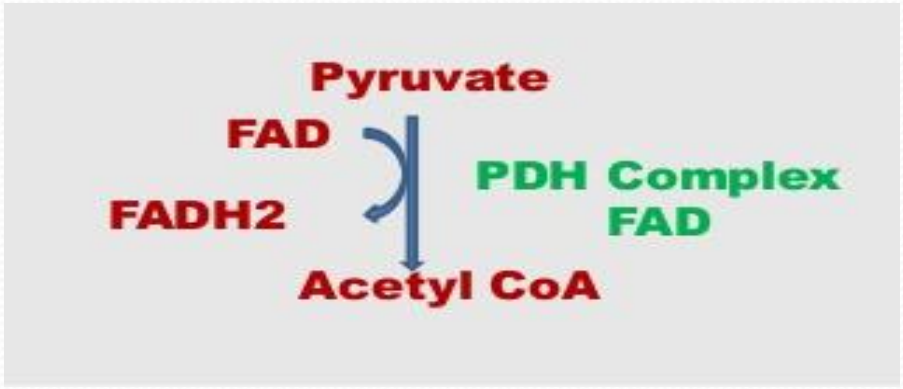
- Carbohydrate, Proteins and fat metabolism
- Activation of vitamin B_{12} and folate.
- Protection of erythrocytes and other cells from oxidative stress.

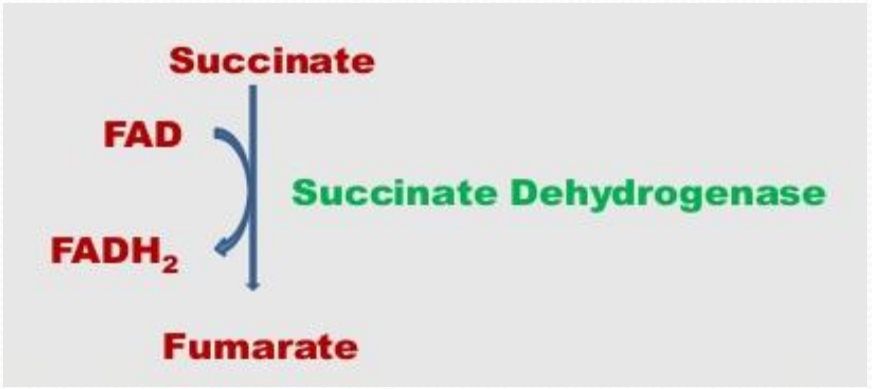
Reactions requiring FMN

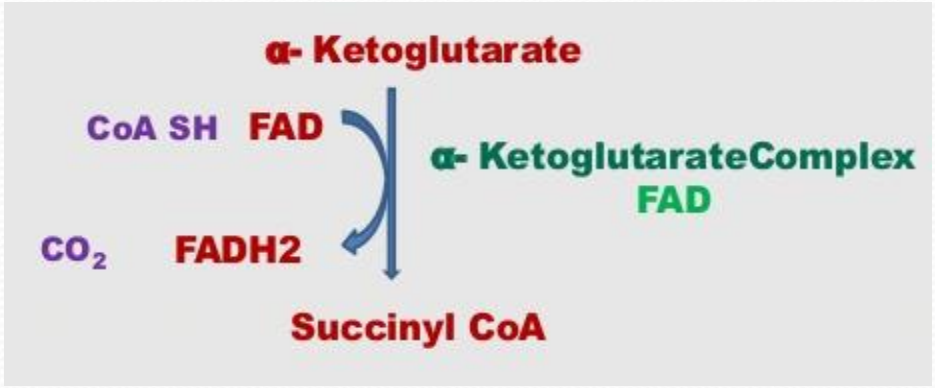
- Coenzyme for

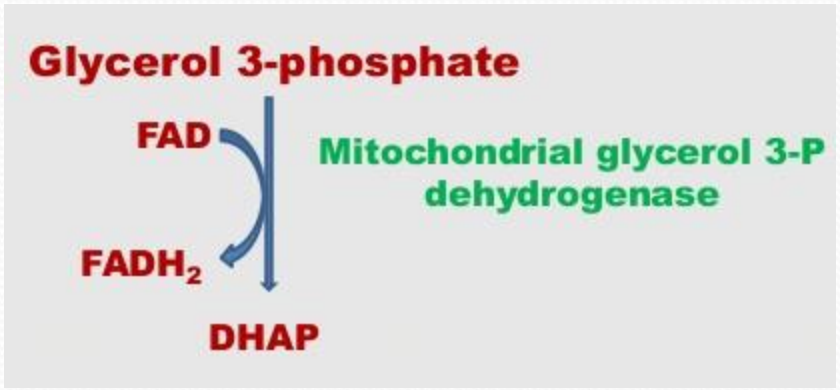
Reactions requiring FAD

- Carbohydrate metabolism





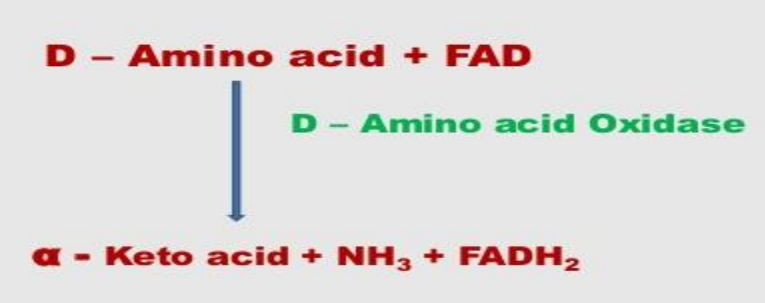




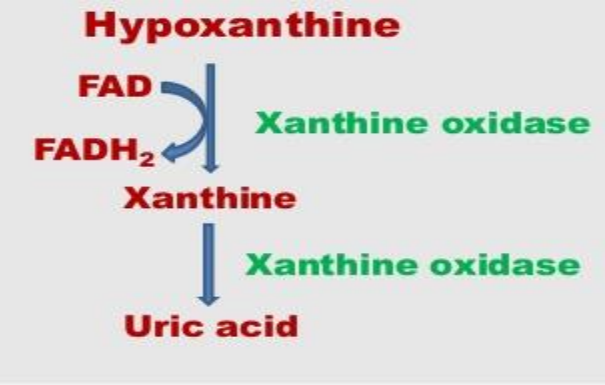
Protein metabolism

- Glycine cleavage system require FAD.

- α-aminoacid oxidase: conversion of D-aminoacid to α ketoacid.



- Xanthine oxidase : conversion of hypoxanthine to xanthine.



Lipid metabolism

- Coenzyme for Acyl-CoA dehydrogenase in fatty acids oxidation.

- It also helps in maintaining mucosal epithelial cell and ocular tissues.
- Involved in the protection against peroxidation in the metabolism of xenobiotics.
- It regenerate glutathione.

Causes of Riboflavin Deficiency

- **Not getting enough of the vitamin from the diet.**
- **A result of conditions that affect absorption in the intestine.**
- **The body not being able to use the vitamin.**
- **An increase in the excretion of the vitamin from the body.**

Risk Factors for Deficiency

- **People under high stress, including those experiencing surgery, chronic illnesses, liver disease, or poor nutritional status.**
- **Diabetics have a tendency to be low on riboflavin as a result of increased urinary excretion.**
- **Athletes, and anyone else with a high-energy output will need additional vitamin B_2.**
- **The elderly due to nutritional inadequacy as well as problems with absorption.**

- **Smokers and alcoholics are at higher risk for deficiency as tobacco and alcohol suppress absorption.**

- **Birth control pills may possibly reduce riboflavin levels, as can phenothiazine tranquilizers, tricyclic antidepressants, and probenecid.**

DEFICIENCY

Symptoms of riboflavin deficiency:

- **Cracked and red lips.**
- **Inflammation of the lining of mouth and tongue(glositis).**

cheilitis and glossitis

- **<u>Angular cheilitis:</u>**

is an inflammatory lesion at the corner of the mouth. Usually associated with a fungal (*Candidal*) or bacterial(*Staphylococcal*) infection. The condition manifests as deep cracks or splits. In severe cases, the splits can bleed when the mouth is opened.

DEFICIENCY

Symptoms of riboflavin deficiency:

Seborrheic dermatitis

- **Dry and scaling skin (dermititis) and iron-deficiency anemia.**

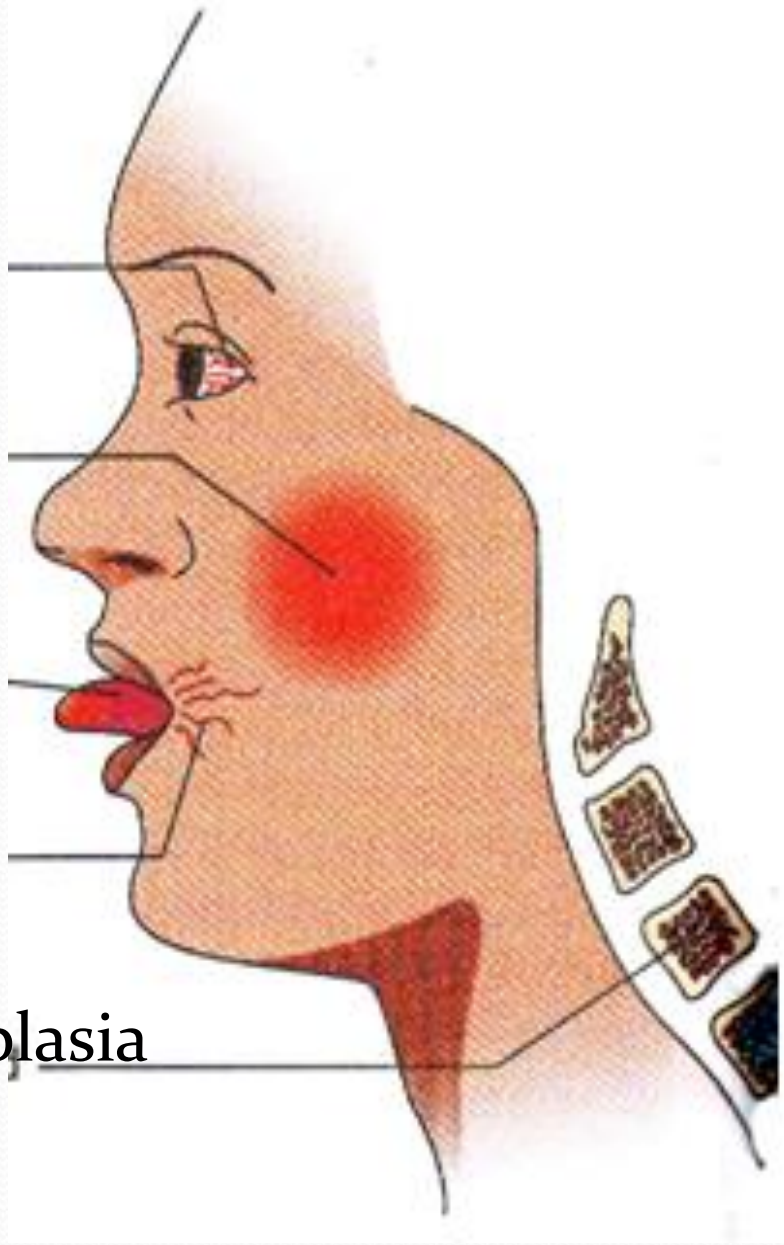
- **The eyes become bloodshot, itchy and sensitive to bright light.**

- Corneal vascularisation
- Dermatitis

Glossitis

Cheilosis

Anemia,erytheroid hypoplasia



Diagnostic Testing of B_2 Deficiency

1. **A positive diagnostic test of serum riboflavin by measuring glutathione reductase levels of erythrocytes.**

2. **Flourimetric assay of riboflavin in RBCs(15-30 µgm/dl).**

3. **Excretion in urine.**

4. **Riboflavin content of blood plasma(2.5-4µgm/dl).**

Uses

- **High doses of riboflavin(400 mg/day) have been shown to reduce the frequency and severity of migraine headaches by half in susceptible people.**
- **Riboflavin help decrease the incidence of cataracts.**
- **Improve memory.**
- **Riboflavin and vitamin C both help boost the body's level of glutathione which is an antioxidant.**
- **Healthy development of the fetus.**

Refrences

- Chatterjea
- Lippincott's
- Satyanarayana


Thank you!