

Vitamins

Classification

• Vitamins are classified into two major groups: *related to bone health formation*

– **Fat-soluble** (4 fat soluble) Vitamin A, D, E, K. *related to vision*

– **Water-soluble** (9 water soluble)

B₁ (thiamine) *they are not requiring a fatty medium for their absorption*

B₂ (riboflavin)

B₃ or Vitamin P or Vitamin PP (niacin)

B₅ (panthotenic acid)

B₆ (pyridoxine and pyridoxamine)

B₇ or Vitamin H (biotin)

B₉ or Vitamin M (folic acid) *is based on what is the disease to be prevented when we are taken the vitamins*

B₁₂ (cobalamin)

Vitamin C *antithrombotic vitamin* *is one of the essential factors needed for the process of blood coagulation*

needed for the process of blood coagulation

is based on what is the disease to be prevented when we are taken the vitamins in a require amount

is one of the essential factors needed for the process of blood coagulation

is based on what is the disease to be prevented when we are taken the vitamins

is based on what is the disease to be prevented when we are taken the vitamins

Digesting and absorbing water-soluble vitamins

anti infertibility vitamin

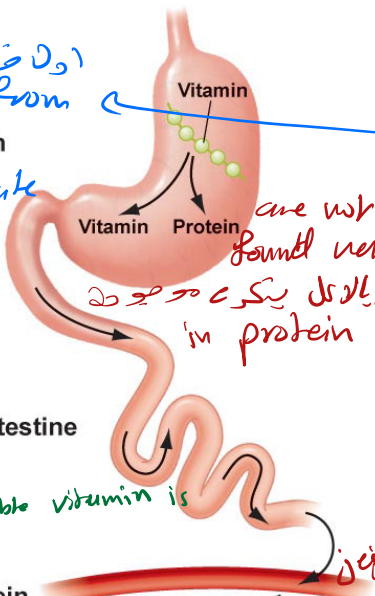
related to fertility - VE

related to vision - VA

anti blindness vitamin

vitamin

releasing the vitamins from the protein complex and this will facilitate absorption



a Vitamins are hydrolyzed in the stomach from the protein complexes found in food.

b Most of the water-soluble vitamins are absorbed in the upper small intestine with the exception of vitamin B₁₂ which is absorbed in the ileum.

c The water-soluble vitamins are absorbed directly into the portal vein and transported to the liver, where they are either stored (B₁₂) or sent out into circulation.

d Excess water-soluble vitamins are excreted through the kidneys in the urine.

are not found nature in protein complex

jejunum

fat soluble vitamins stored in liver

water soluble vitamins

which can be stored

in liver is VB12

anti Beri beri - VB1

anti pernicious anemia - VB12

anti pernicious anemia vitamin

anti pellagra - VB3

anti pellagra

chemical structure of the vitamins

excretion through the kidneys

water soluble vitamins toxicity

excess amount of vitamin toxicity of particular water soluble vitamin is very hard, very difficult

nicotinic acid or niacin

amino acid - tryptophan

diary requirement

concentration focusing and the ability to memorising information

Small intestine

Portal vein

Liver

Kidneys

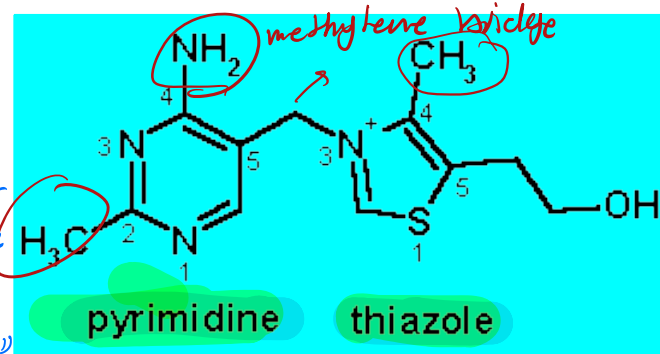
Thiamin (B 1)

Chemistry:

- A substituted **pyrimidine** joined by a **methylene bridge** to a substituted **thiazole**.

Requirements: 1-1.5 mg/day for adults.

(Higher needs in pregnancy, **high CHO diet**)



Sources:

? **Plant sources:** whole grains (unrefined cereal grains), **beans, peas, nuts and bran.**

? **Animal sources:** **liver, heart, kidney and milk.**

? **Yeast**

Activation (Co-enzyme):

? Conversion of thiamin to its active form **thiamin pyrophosphate (TPP)**

it should be converted to activated form → VB₁ ko qamir a li (TPP)

Absorption

we need to have VB1 in an activated form if the thiamine is not converted to the active form it is useless
acetyl CoA *fatly acid* *glucose 6 phosphate* *active form* *activated form*

- Thiamine is released by the action of pyrophosphatase *protein complex* *releasing*
- At low concentrations, the process is **carrier-mediated**. *intestinal mucosal cell*
- At higher concentrations, absorption also occurs via **passive diffusion**. *it will pass through the membrane of intestinal mucosal cells by*
- It can be inhibited by **alcohol consumption**: *intestinal mucosal cell* *into the blood*
- On serosal side of the intestine, its transport is **Na⁺-dependent ATPase** *mucosal cell to the circulation* *mechanism* *factors that can regulate the absorption of the vitamin*
- The majority of thiamine in serum is bound to proteins, *protein carrier* *mainly albumin* *it is not a specific carrier for VB1*
- Approximately 90% of total thiamine in blood is in **RBCs**. *VB1 after being activated in intestinal mucosal cells* *serosal surface of the intestinal mucosal cells* *Na⁺-dependent ATPase*

Cellular uptake

- Thiamine uptake and secretion appears to be mediated by a soluble thiamine transporter that is **dependent on Na⁺ [Thiamin transporter-1 & 2** (human THTR-1 & 2)]. *each molecule of thiamine to pass* *it will use one of ADP molecule* *energetic process* *it is a limiting factor to absorption of vitamin so prevented any toxicity*

Storage: of thiamine occurs in muscle, heart, brain, liver, and kidneys.

Excretion: Thiamine and its metabolites are excreted in urine

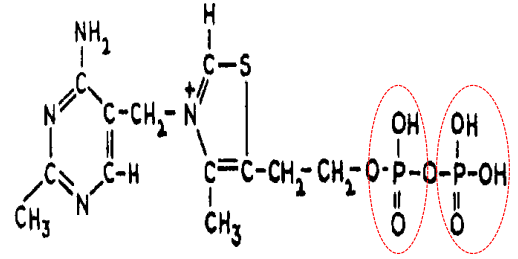
Thiamin: activation

utilizing the phosphate groups from ATP

ATP-dependent thiamin diphosphotransferase

Brain, liver

TPP



Thiamin phosphate pyrophosphate

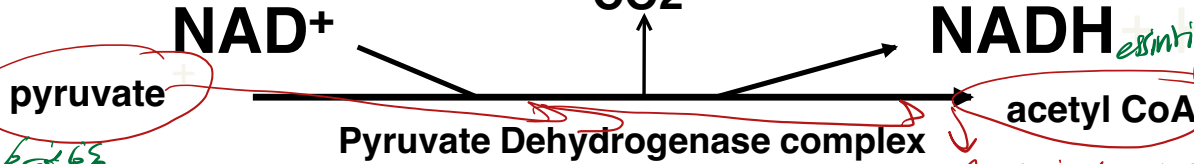
Adenosine monophosphate

Thiamin

Oxidative decarboxylation of pyruvate

the most important reaction to be used for thiamin phosphate

ATP



essential for producing energy essential for functionality for CNS

*VB1, B2, B3, B5 and lipocic acid
VB complex
يعتبر ضروري
يعمل كعامل مساعد في تفاعل
تحويل البيروفايت الى ايسيتيل كوا*

Vitamins (thiamin, lipoic, riboflavin, Niacin, pantothenic acid)

Co enzymes (TPP, Lipoamide, FAD, NAD+, CoASH)

it is not one reaction
derived from VB2
derived from VB5
derived from VB3
most of the citric acid cycle
to convert pyruvate into acetyl CoA to join the citric acid cycle

Functions

• TPP serves as a coenzyme transferring an **activated aldehyde unit** in the following enzymatic reactions:

- 1. **Oxidative decarboxylation of α -keto acids.** *to convert pyruvate into acetyl CoA and others* *كحول ال* *CoA containing P1 compounds*
- 2. **Transketolase reaction** (pentose phosphate pathway; PPP). It is used for the biosynthesis of pentose sugars deoxyribose and ribose. *pentose phosphate pathway* *JMP* *Structure of DNA* *Structure of RNA*
- 3. **Acetylcholine synthesis** which is one of neurotransmitters and for myelin synthesis.

- **Important in:**
 - Producing **energy from carbohydrates**
 - **Nerve function**
 - **Muscle function**
 - **Appetite**
 - **Growth**

• **Therapy:** It can be used for treatment of Heart failure & Alzheimer disease. *فهو مهم في صبر الاعمال الجيدة*

Manifestations of thiamine deficiency

1. **Mild deficiency:** leads to
 - ? Gastrointestinal complaints
 - ? Weakness.

2. Moderate deficiency:

Wernike korsacoff , syndrome

- ? Peripheral neuropathy. *في نقص الـ B1*
- ? Mental abnormalities. *إنتاج الطاقة* → energy production

3. Severe thiamin deficiency

A. Beriberi

*نقص B1
Vitamin*

- **Dry beriberi** is characterized by advanced neuromuscular symptoms:

- ? Atrophy and weakness of the muscles
- ? Peripheral neuropathy
- ? Memory loss.

edema

- **Wet beriberi:** the previous symptoms (dry beriberi) are coupled with oedema.

B. Wernike korsacoff , syndrome

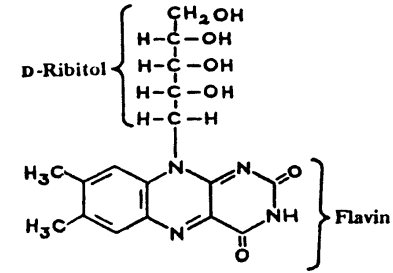


*الوذمة
التي تحدث في
الجزء السفلي من
اليد*

*pitic
Oedema
Beriberi
renal failure
heart failure
live patients
oedema*

Riboflavin (B 2)

Chemistry: It consists of a **flavin ring** attached to the sugar alcohol **D- ribitol**.



Riboflavin

Co enzyme forms

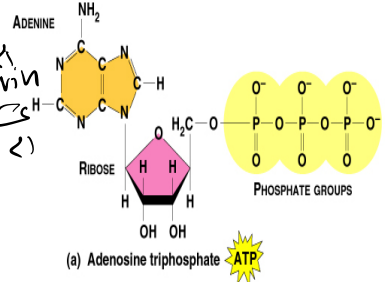
Handwritten notes: CoA , VB_1 , (TPP) , *meinen peger phosphate*

Flavin mononucleotide (**FMN**) is formed by ATP-dependent phosphorylation of riboflavin.

Handwritten notes: ATP , ADP , PP_i , *منزل في الاربعة*, *enzyme*, *في الاربعة*

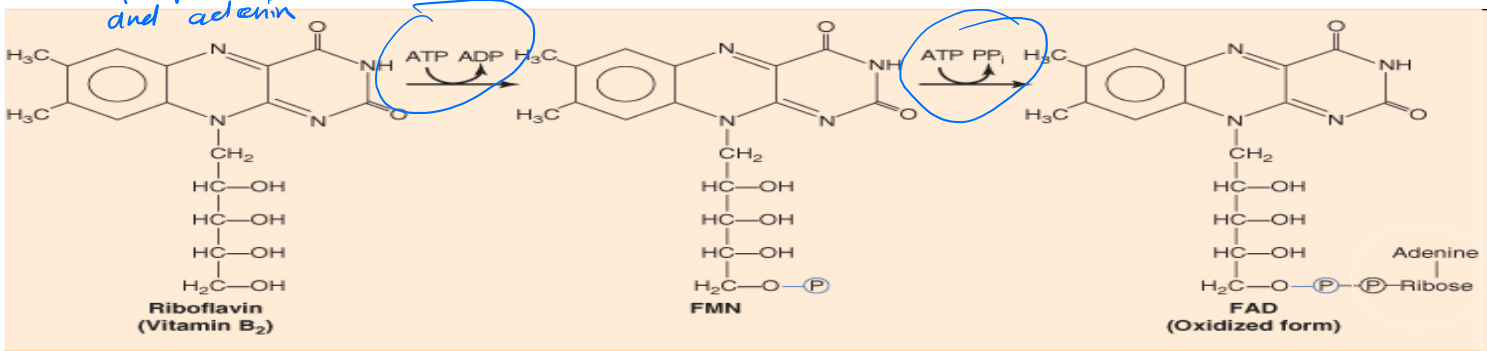
Flavin adenine dinucleotide (**FAD**) is synthesized by a further reaction with ATP in which the AMP moiety of ATP is transferred to FMN. Biosynthesis of FMN and FAD occurs in most tissues.

Handwritten notes: ATP , ADP , PP_i , *منزل في الاربعة*, *enzyme*, *في الاربعة*



(a) Adenosine triphosphate - ATP

Handwritten notes: *another phosphate and adenine gets into another source*



Absorption

In diet, riboflavin (RF) exists in the free and FMN and FAD forms. They are hydrolyzed to free Rf by intestinal phosphatases.

RF absorption in the intestines involve a **specific carrier-mediated mechanism for Rf uptake** located at the apical membrane & across the BLM.

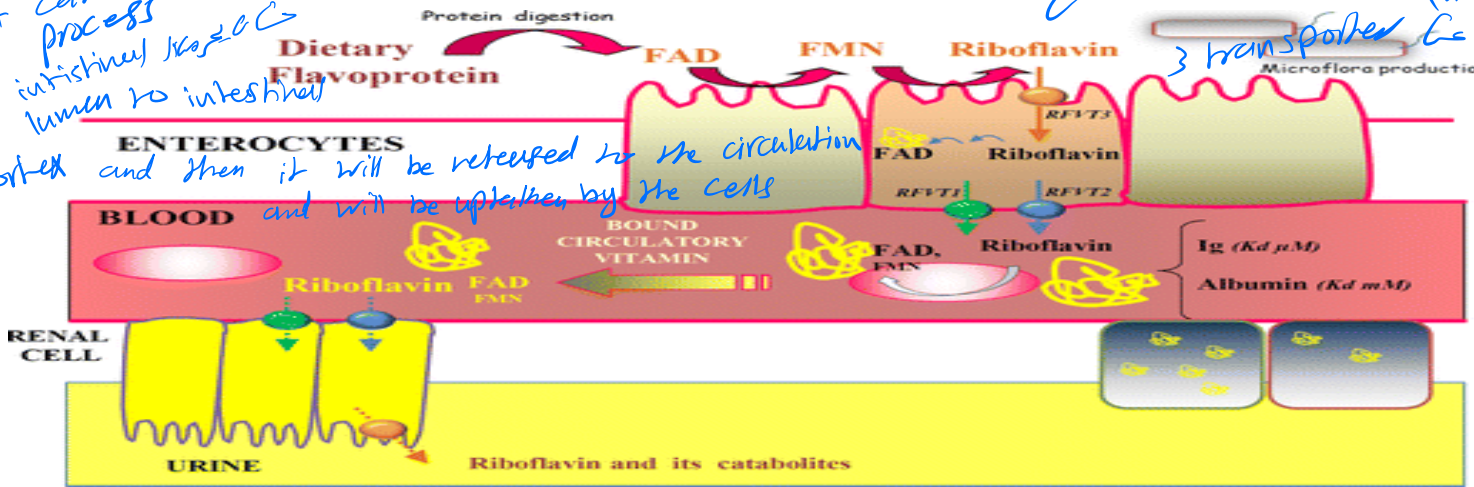
Both **RFT-1** (RF transporter1) and **RFT-2** are expressed in intestine.

RFT-3 is more brain- specific.

Riboflavin in **blood** associates with **albumin or globulins**.

*protein complex
it should be released
in VB1
release
pyrophosphatase
enzyme
for
release
phosphatase
enzyme
+ carrier mediated
process
intestinal brush border
lumen to intestinal
cortex and then it will be released to the circulation and will be uptaken by the cells*

*2 human thymine transporter (1,2)
3 transporter
Es clo*



Sources

- ? **Animal origin:** liver and beef, milk, dairy products, fish, eggs, nuts
- ? **Yeast**
- ? **Plant origin:** Green leafy vegetables, nuts, of smaller quantities in cereals.

Function:

- **Involved in energy metabolism (ATP production):** Participate in

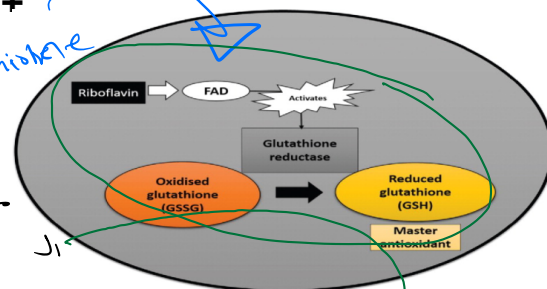
- ? **Oxidative decarboxylation** → 5 CoA enzymes → 5 CoA → FAD → which is VB2 derivative
- ? **Citric acid cycle**
- ? **Beta-oxidation of fatty acids**
- ? **Electron transport**

- **Associated with antioxidant glutathione reductase** (utilizes an **FAD** prosthetic group and **NADPH** to reduce GSSG to two GSH.)



tripeptide consisted of three amino acid glutamic acid, cysteine and glycine it is very important as anti oxidant agent

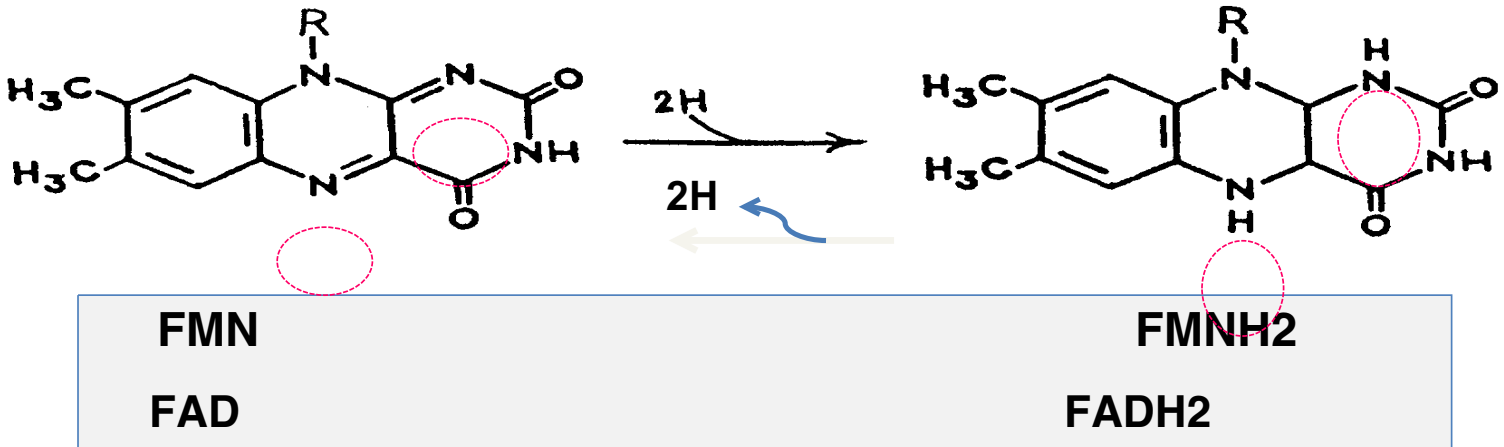
which is responsible for reducing the oxidized glutathione into reduced glutathione



unstable compound as free radical

1. Chemical **structure** of vitamin B2 is
 [flavin + ribitol], fluorescent, light sensitive, heat stable.
2. Active form (**Co-enzyme**) of vitamin B2 is
 [FMN & FAD]
3. Its **function** is to act as
 [prosthetic groups of oxidoreductases]
4. **Reactions** requiring **FAD** are:

- a- [**oxidative decarboxylation** of a keto acids as PDH] \longrightarrow Energy (ATP)
- b- [**C.A.C.**] \longrightarrow Energy (ATP)
- c- [**b-oxidation of F.A.**] \longrightarrow Energy (ATP)



يتكون من
 glutathione
 oxidized form $\xrightarrow{2H}$ reduced form
 Hydrogen peroxide molecule
 to be converted into 2 water
 molecules
 to protect us.
 * so this co enzyme acting with
 as antioxidant agent.

symptoms of deficiency

Related to Energy production (skin & mucous membrane inflammation).

- **Glossitis & angular stomatitis** (Inflammation of the lining of mouth and tongue). *inflammation of the angle of the mouth → redness & fissuring*
- Keratitis, dermatitis (Dry and scaling skin). *التهاب الجلد*
- **Cheilosis** (cracked and red lips). *التهاب الشفتين*
- **Ocular manifestations** (vascularization of cornea)



* it's light labile vitamin (will be degraded by light).

N.B. :

- Deficiency occurs in **newborn infants with hyperbilirubinemia** who are treated by phototherapy.

treated by photons inside container (حاوية) *معالجة*

bilinubin into water soluble molecule to be excreted. *البيروبين في الماء الذائب الجزيء ليتم إفرازه*

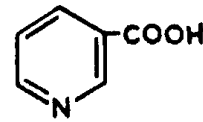
will be associated with deficiency of **vitamin B2**

in which it's under photosensitivity *يتأثر بالضوء*

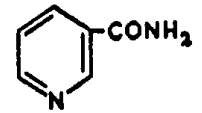
→ it will be cleaved into flavin molecule.

* so we have to supplement them with vit. B2

Niacin (B 3)



Niacin (nicotinic acid)



Niacinamid (nicotinamide)

Chemistry:

- Nicotinic acid is a carboxylic acid derivative of pyridine.

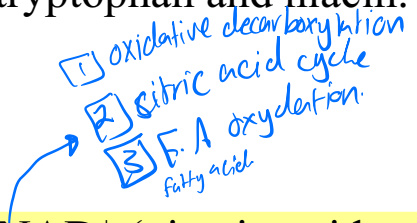
Synthesis: PLP (vit. B6)

derived from Tryptophan → → → → → → → Niacin (vit. B3) (insufficient)

- most people require dietary sources of both tryptophan and niacin.

Sources:

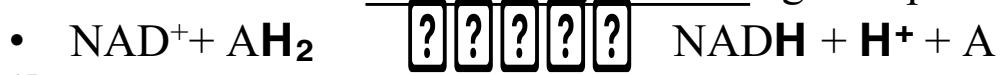
- Food stuffs containing nicotinic acid: as B₁
- Tryptophan containing proteins



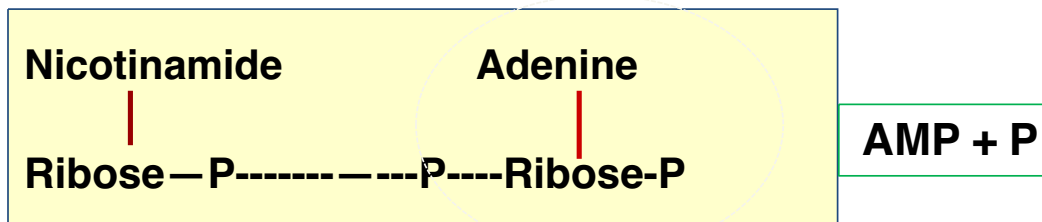
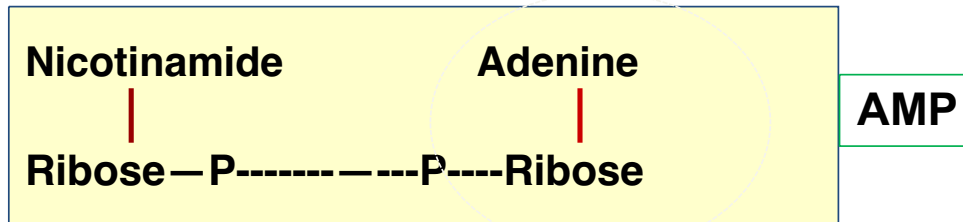
Functions: niacin required for the synthesis of NAD⁺ (nicotinamide adenine dinucleotide) and NADP⁺ (nicotinamide adenine di-nucleotide phosphate)

oxidative + reduction reaction (reduction synthesis)

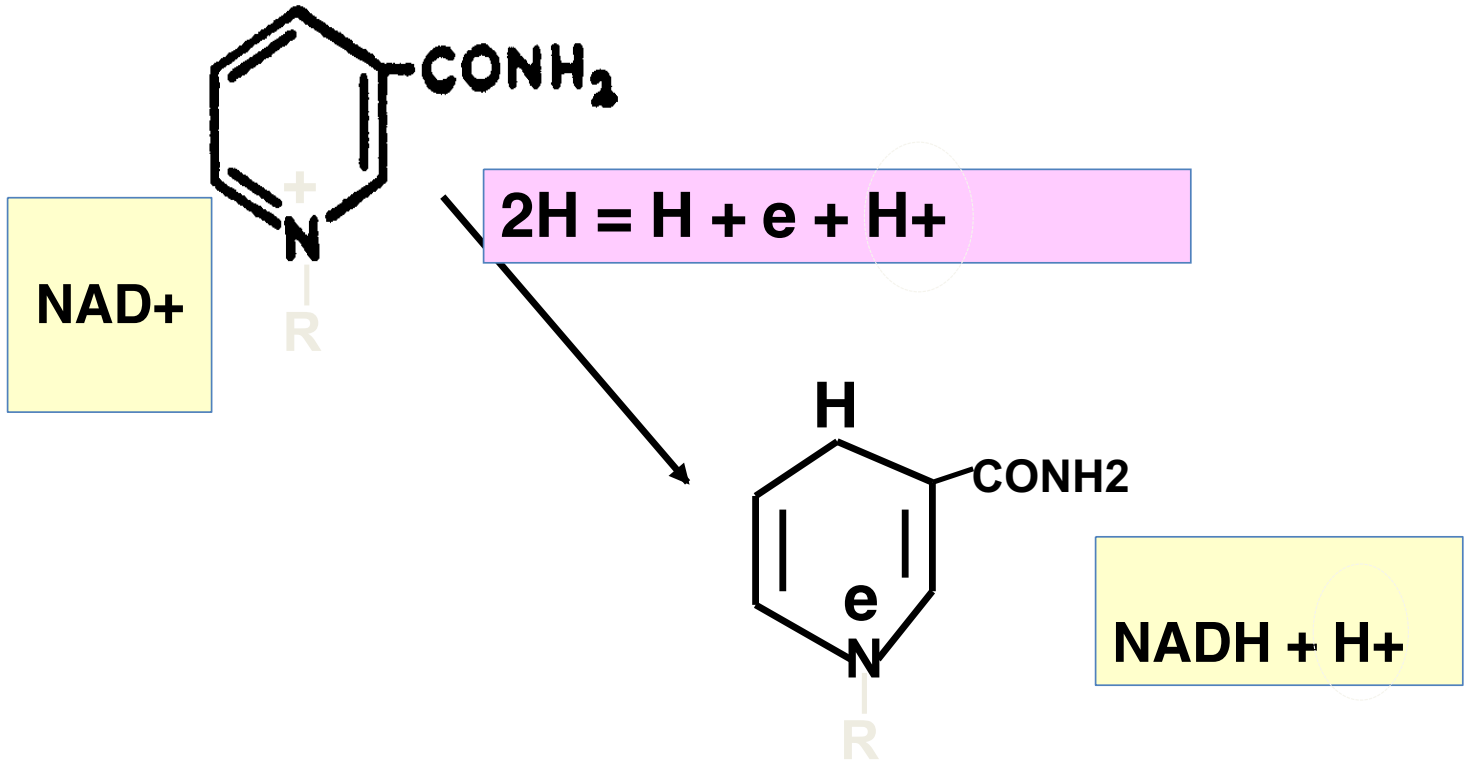
- NAD⁺ and NADP⁺ are coenzymes of many oxidoreductase enzymes.
- Generally, NAD⁺-linked dehydrogenases catalyze oxidoreduction reactions in oxidative pathways, e.g. the citric acid cycle.
- Whereas NADP⁺-linked dehydrogenases are often found in pathways concerned with reductive synthesis e.g. the pentose phosphate pathway.



+Structure of NAD



reduction of NAD⁺



• Reactions requiring **NAD+** are:

a- [oxidative decarboxylation of a keto acids as PDH] → Energy (ATP)

b- [C.A.C.] → Energy (ATP)

c- [beta oxidation of F.A.] → Energy (ATP)

• **Reactions** requiring co-enzyme **NADP+** as:

? **Glucose-6-phosphate dehydrogenase (NADP+)**

? **Folate reductase (NADPH+H+)**

competitive inhibition
1 trimethoprim (antibiotic)
2 pyrimethamin (antimalarial)
3 methotrexate (anticancer) ←

dihydrofolate reductase enzyme

& pentose phosphate pathway

Convert the folic acid into the activated form which is tetrahydrofolate

intestinal niacin absorption process: intracellular **protein-tyrosine-kinase-mediated pathway** regulates vitamin uptake.

→ to participate in nucleotide synthesis
DNA replication, RNA transcription
& HMG reductase enzyme
which is utilized in the synthesis

malnutrition

↓ intake ← لقل المتوفرة
 ↑ requirement ← يسير الطلب
 ← malabsorption ← يعيق الامتصاص
 مشاكل الامعاء

of cholesterol

Deficiency

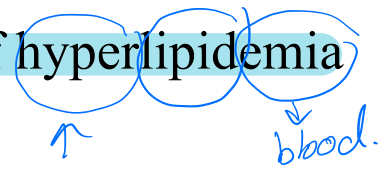
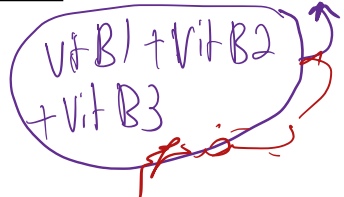
Causes of deficiency:

- in elderly on very restricted diet.
- malabsorption.
- in **maize-dependant population**. *because it's not containing sufficient amount of tryptophan*
 انا سايب بوجلو زينة حتم
- in vit. B6 def. *لا تتحول الى tryptophan*
 Vit B6 to Vit B3
- **Hartnup disease (decreased tryptophan absorption)**
- **Malignant carcinoid syndrome (increased tryptophan metabolism to serotonin)** *neurotransmitter stimulatory*
- **INH (anti-TB) (decreased B6)** *tuberculosis. د*

و مارج يظل
 كانه كايون
 tryptophan
 فوله ل
 Vit. B3

so we have to supplement them with vitamins

Clinical use: Treatment of hyperlipidemia



why? *bec. because* all of them participating in β -oxidation of fatty acid
 يعي بتقل ال FFA ال
 fatty acid

- Deficiencies found in southeast if subsisting on diet of corn ; niacin is bound by protein. Pellagra is very rare now

- **Deficiency:**

- **Milder deficiencies of niacin** cause:

[?] Poor appetite, fatigue.

[?] Dermatitis, Diarrhea.

- **Severe deficiencies** lead to **pellagra** which is characterized by “the four Ds”: **dermatitis**, **diarrhea**, **dementia** (lack of concentration) and **death**.

- Dermatitis is usually seen in skin areas exposed to sun light and is symmetric.

- **The neurologic symptoms start by nervous disorders and mental disturbances.**



dermatitis

يدي بالرجلين
المتكف

استسار

in the exposed areas
(المناطق المعرضة للشمس)
symmetrical (both feet)
ايضاً في القدمين

↓ myosin means that there is def. in tryptophan →
so we have two neurotransmitters are produced from tryptophan
stimulatory

هو
شعاع
الوقود لل
niacine

- ① serotonin
- ② melatonin → secreted from pineal gland (الغدة الصنوبرية)

Pantothenic acid (B 5)

Absorption *it's not absorbed alone*

• For the intestinal cells to absorb pantothenic vitamin, it must be converted into free pantothenic acid.

• Free **Pantothenic acid** and **Biotin** is absorbed into intestinal cells via a saturable, sodium-dependent active transport system.

1 none to balance ← 2 vitamins are transported together

[Sodium-dependent multivitamin transporter (SMVT)]

** if i take extra amount of pantothenic acid → it will decrease the absorption of biotin and vice versa.*

• At high levels of intake, when this mechanism is saturated, some pantothenic acid may also be absorbed via passive diffusion. **As intake increases 10-fold, however, absorption rate decreases to 10%.**

Both of them are absorbed through one transporter

the difference between α -alanine & β -alanine.
 (amino group) → NH₂ group
 in α -alanine → NH₂ group located on α -carbon
 in β -alanine → NH₂ group located on β -carbon.

vitamin?

في حال زيادة كمية فيتامين B5، فإنه سيقاوم بامتصاص فيتامين B7 (البيوتين) من الجسم. آلية الجسم ستمنع امتصاصه من خلال آلية النقل المشتركة. بمعنى آخري، إذا تناولت فيتامين B5 بكمية عالية، فسيقل امتصاص البيوتين، والعكس صحيح.

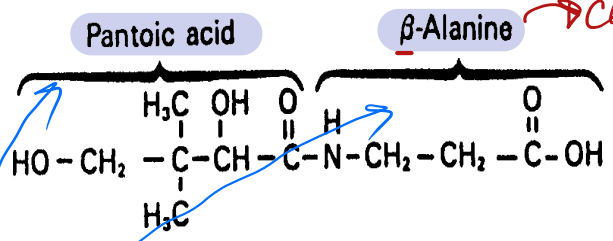
it will compete with the other vitamins inhibiting its absorption and from the body mechanism will try to inhibit the absorption of vitamin to

give the chance for absorption.

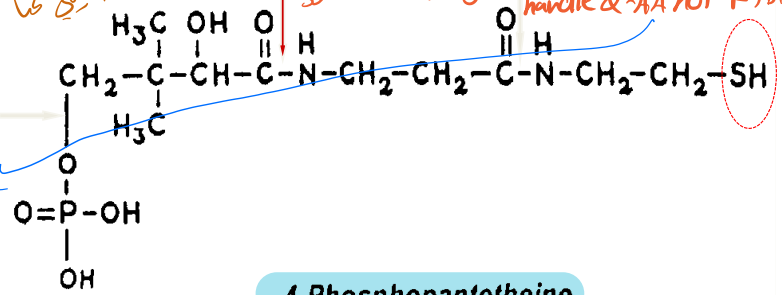
1. Chemical **structure** is [Pantoic & β - Alanine]
2. **Active pantothenic** acid is [4-phosphopantotheine]
3. Active form enters in the structure of
 - **CoASH** = 4-phosphopantotheine + AMP
 - **ACP**; acyl carrier protein
4. Its **active** group is: [Thiol group]
5. Its **function** as is: [Carrier of acyl radicals]. coenzyme A used in energy metabolism

تفاعلات

CO enzyme A → Citric acid cycle
oxidative decarboxylation



can't be utilized by our cells (stereospecificity)
D isomers (Aminoacids) و كل انواع ال
so our enzymes are designated to handle α -AA not β -AA

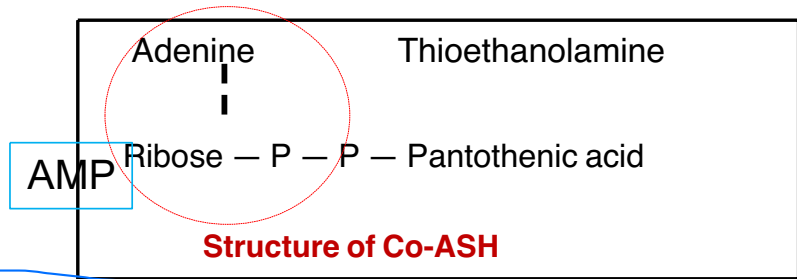


Pantothenic acid

4-Phosphopantotheine

active form

تفاعل تركيبه
CoASH, ACP



6- Sources are: [as B1]

7- Reactions requiring **CoASH**:

- a- oxidative decarboxylation of a keto acids → Energy. Acetate → Acetyl CoA
- b- oxidation of Fatty acid glutamic acid → α-glutamin CoA.
- e- acetylating reactions as acetyl choline. neurotransmitter at the nerve indier. با س. بنیح

8- Reaction requiring **ACP** is : [Fatty acids synthesis]

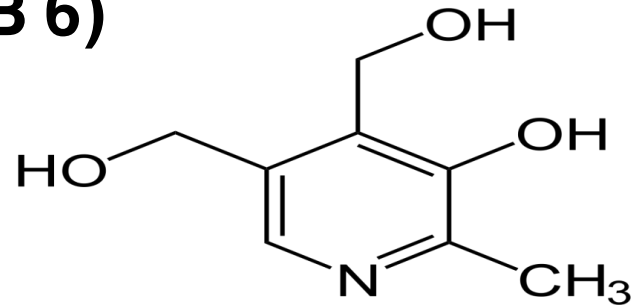
- **Destruction:** Easily destroyed by food processing. بنيح عند شفا على ريش
- **Functions:** Part of **coenzyme A** used in **energy metabolism**.
- **Deficiency:** rare because it is very widespread in natural food.
- Nausea, vomiting. -Easy fatigability. -Dermatitis.
- Depression, neurological symptoms (disorders of the synthesis of acetylcholine). Numbness, muscle cramps, inability to walk.
- **Burning foot syndrome** (severe burning and excessive sweating).

↓ ↘ painful feeling of hotness in feet

3 vitamins can cause the same syndrome in addition to the def in vit B5:

1	vitamin C	5	vit B12 (cobalamine).
2	folate (B9)		

Pyridoxine (B 6)



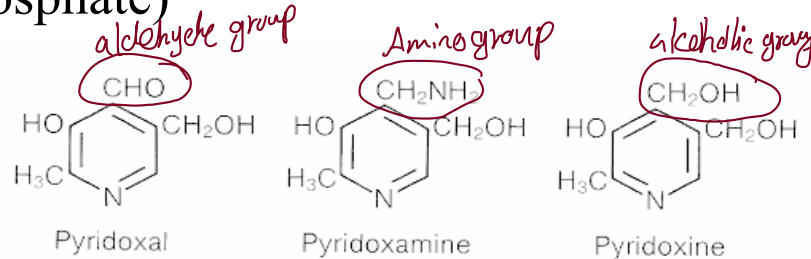
Chemistry:

- It is a water soluble vitamin
- A pyridoxine derivative
- Consists of 3 closely related compounds equally effective as precursors of its coenzyme PLP (pyridoxal phosphate)

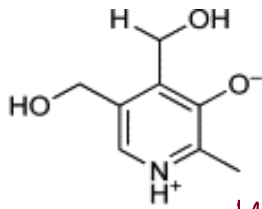
① - Pyridoxine (alcohol)

② - Pyridoxal (aldehyde)

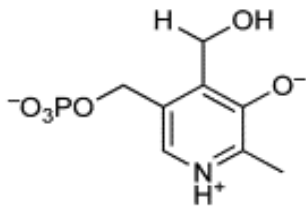
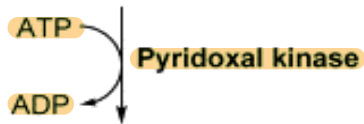
③ - Pyridoxamine (amine)



- Pyridoxamine is mostly present in plants
- Pyridoxal & pyridoxine is present in animal foods
- Pyridoxine can be converted pyridoxal & pyridoxamine
- Pyridoxal phosphate (PLP) is the active form of Pyridoxine
- PLP is synthesized by pyridoxal kinase, utilizing ATP

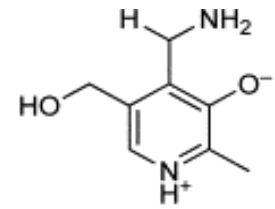
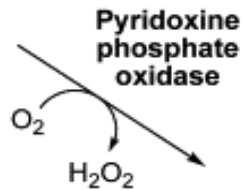


Pyridoxine *aldehyde forme*

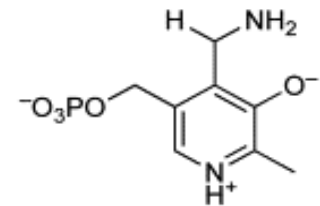


Pyridoxine 5'-phosphate

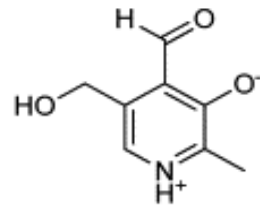
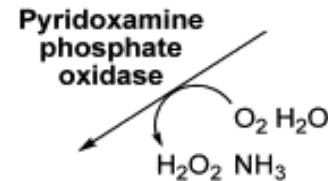
PIP



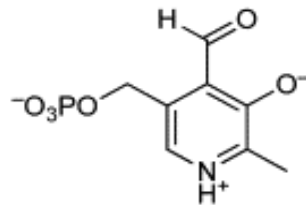
Pyridoxamine



Pyridoxamine 5'-phosphate



Pyridoxal



Pyridoxal 5'-phosphate

participating in different reactions

if we are taking excessive amount of one of them, it will decrease the uptake of others by the cells.

* most of water-soluble vitamins are absorbed in the upper part of the small intestine (duodenum) bound to the albumin in the circulation
non-specific carrier
B6

Metabolism

B12 → absorbed from the ileum.

Absorption: It occurs in proximal jejunum by passive diffusion

- In the mucosal cells, all forms of pyridoxine are converted pyridoxal
- Transport: It transported in the circulation bound to albumin
- Storage: It is stored in the tissues as its coenzyme form, PLP
- Mainly stored in liver, brain, kidney & muscle
- Excretion: 4 – pyridoxic acid excreted in urine

Biochemical functions

PLP is the coenzyme of B6 is found attached to ε –amino group of lysine in the enzyme

- PLP is associated with Amino acid metabolism
- PLP is involved in:

1- Transamination

2- Decarboxylation

3- Deamination

4- Transsulfuration

5- Condensation

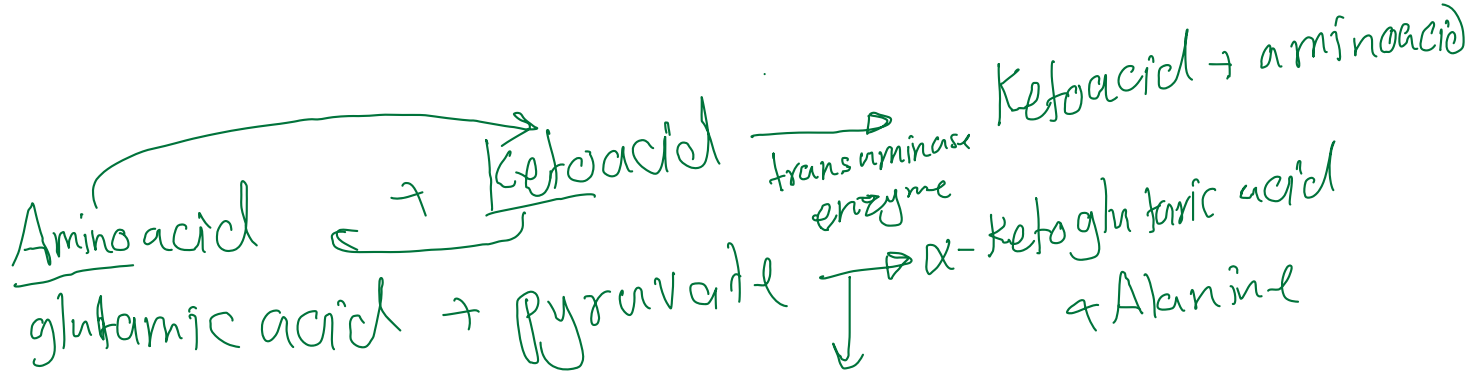
transfer of amino group from amino acid to α-keto acid to produce new amino acid & new α-keto acid
Removal of CO₂
Removal of amino group

26 ↳ transfer of sulfate group

القفا على التواله لبيت
الحفظ

Transamination

- PLP is involved in transamination reaction converting amino acids to keto acids
- Keto acids enter the TCA cycle and get oxidized to generate energy
- During transamination, PLP interacts with amino acids to form Schiff base
- The amino group is handed over to PLP to form Pyridoxamine phosphate and ketoacid is liberated.



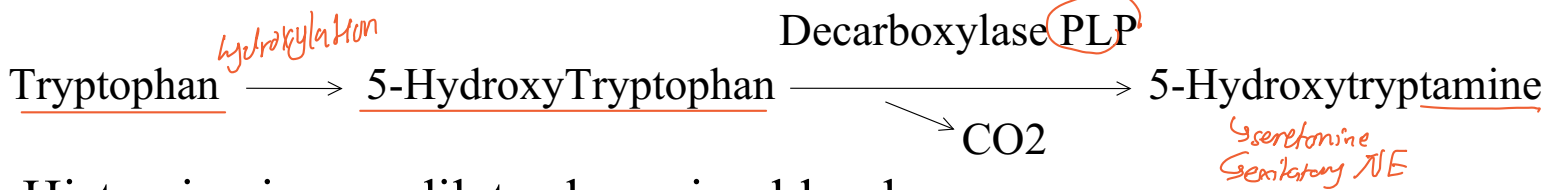
For diagnosis
& prognosis of infective hepatitis

alanine transaminase
alanine amino transferase.

ALT

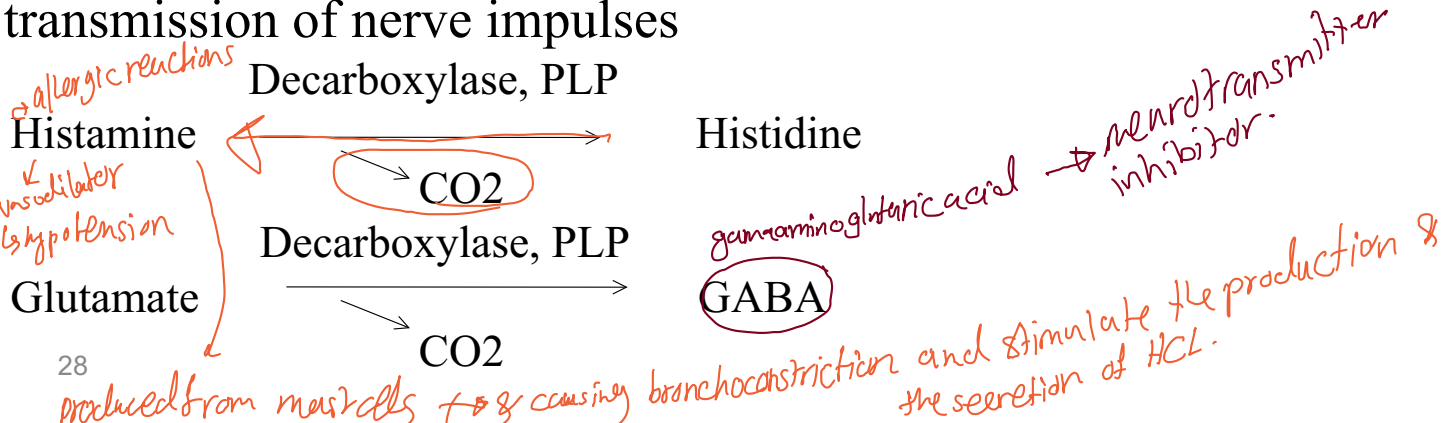
Decarboxylation

- α - Amino acids undergo decarboxylation to form respective amines
 - The reaction is carried out by decarboxylases which require PLP
- 1- Serotonin produced from tryptophan is important in nerve impulse transmission. It regulates sleep, behavior, blood pressure.



- 2- Histamine is vasodilator lowering blood pressure
- It stimulates gastric HCl secretion and is involved in inflammation and allergic reactions

- 3- Glutamate on decarboxylation gives GABA which inhibits transmission of nerve impulses



- PLP Plays an important role in metabolism of sulfur containing A.A.s
- Transsulfuration from homocysteine to serine occurs in the synthesis of cysteine

- PLP dependent enzyme cystathionine synthase

- Deamination of hydroxyl group containing A.A.s requires PLP

PLP, dehydratase → *removal of water molecule.*



- Synthesis of serine from glycine require PLP.

- Glycogen phosphorylase contains PLP for converting glycogen to glucose 1-phosphate

- PLP is needed for the absorption of amino acids from intestine

- B6 is useful to prevent urinary stone formation

RDA (Recommended Dietary allowance) of vitamin B 6

- Adult men – 2 - 2.2 mg/day
- Adult women - 2.0 mg/day
- Pregnancy and lactation - 2.5 mg/day

Dietary sources:

- Animal sources: egg yolk, fish, milk, meat
- Vegetable sources: wheat, corn, cabbage, roots & tubers

Deficiency

- Decreased dietary intake
- Alcoholism
- Impaired absorption → malabsorption.
- Antivitamins: chronic administration of drugs such as isoniazid and penicillamine → prevent the absorption of Vit. B6 so they must be supplemented with Vit B6.

Clinical features

- Neurological manifestations due to B6 deficiency, serotonin, epinephrine, norepinephrine and GABA are not produced properly

لا نه يصنع
التفاعل

- The synthesis of niacin from tryptophan is impaired
- Xanthurenic acid, produced in high quantities is excreted in urine and can be used as reliable index of B6 deficiency
- Decreased Hb levels, associated with hypochromic microcytic anemia seen in B6 deficiency

↳ because pyridoxal phosphate is the co enzyme in the first reaction of heme biosynthesis which is catalysed by ALA synthase enzyme.

لما توخذ كمية كبيرة من فيتامين B6 الا انها صحت لانها ما بتقدر عنده عدد Vit B12

very very rare

Toxicity of B6

- Excess use of B6 (2.5 g/day) may lead to sensory neuropathy
- It is manifested by imbalance, numbness, muscle weakness and nerve damage

Biotin (B 7)

- It is formerly known as **anti-egg white injury factor** or **vitamin H**
- It is water soluble sulfur containing B-complex vitamin
- Biotin mainly **participates in the carboxylation reactions**

ليشتغل مع ال carboxylases

Chemistry

- It is a **heterocyclic sulfur containing monocarboxylic acid**
- Biotin is **imidazole derivative** formed by fusion of imidazole and thiophene rings with a valeric acid side chain
- Biotin covalently bound to ϵ - amino group of lysine to form **biocytin**

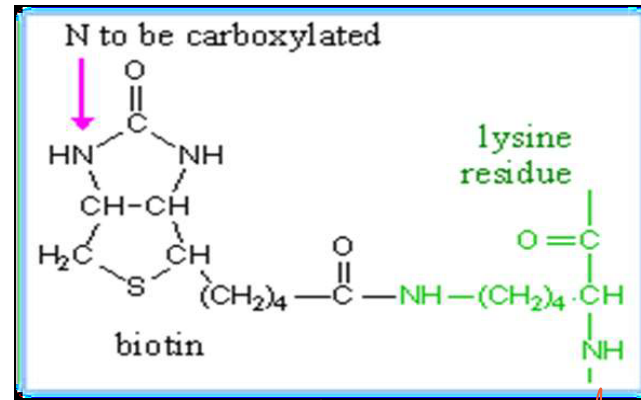
اندماج

ايسلون ←

the activated form

Coenzyme form

- **Biocytin** is the coenzyme form of Biotin
- Biotin is a prosthetic group of carboxylase

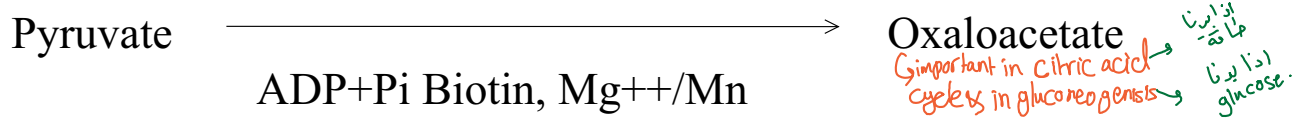


Biochemical functions

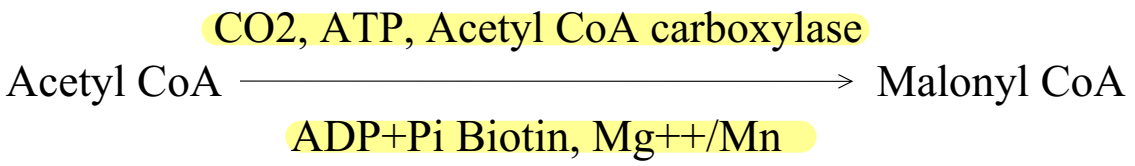
any carboxylase enzyme need 4 compounds to work :-
 1 source of CO₂ → HCO₃⁻ (bicarbonate)
 2 Biotin
 3 manganese
 4 ATP → لا توفرننا ج نؤخذ عنى من 8 phosphate group

- Biotin is required for carboxylation reactions
- Biotin is required for the enzymes
 - Pyruvate carboxylase
 - Acetyl CoA carboxylase
 - Propionyl carboxylase
 - β - Methyl crotonyl CoA carboxylase

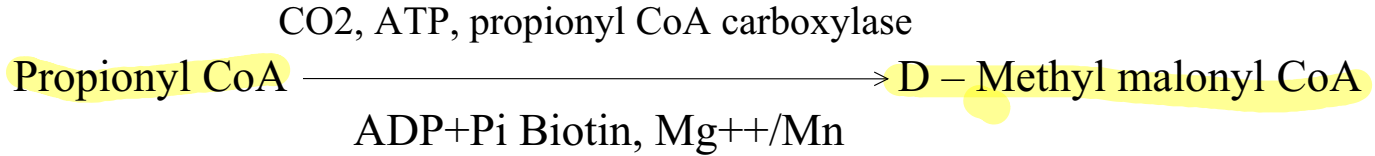
- Pyruvate carboxylase catalyzes conversion of pyruvate to oxaloacetate
 CO₂, ATP, pyruvate carboxylase



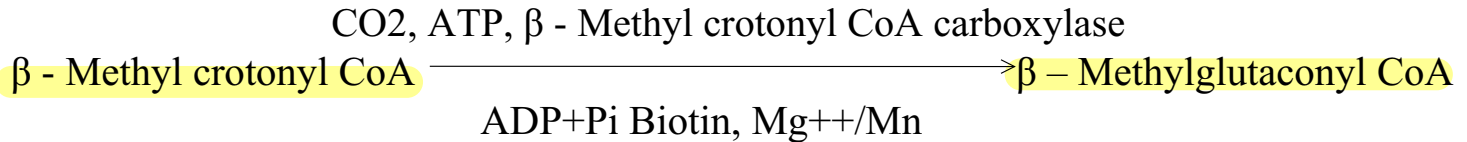
-- Acetyl CoA carboxylase catalyzes the formation of malonyl CoA from acetyl CoA, the reaction provides acetate molecule for fatty acid synthesis
 2 carbon atoms CH₃COOH



- Propionyl CoA carboxylase catalyzes the formation of D – Methyl malonyl CoA from propionyl CoA (from odd chain FA & methionine)
- It required for entry of Propionyl CoA to TCA cycle via succinyl CoA



- β - Methyl crotonyl CoA carboxylase catalyzes the formation of β – Methylglutaconyl CoA from β - Methyl crotonyl CoA
- It is essential for leucine catabolism



- Not all carboxylation reactions in the biological system are biotin dependent, few carboxylation reactions which do not require biotin
- Formation of carbamoyl phosphate in urea cycle
- Incorporation of CO₂ in purine synthesis

فوسفات
 3 CO₂ لیس
 Extra amount
 of amino group P

De novo synthesis of purine.

Dietary sources

- Rich sources are eggs, liver, kidney, & yeast, pulses, nuts, vegetables
- Poor sources are cereals & dairy products

RDA

- Adults - 200 – 300 mg/day

Deficiency

- Biotin deficiency is generally not seen in man because of

1- Its wide distribution in foods

2- Synthesis of vitamin by the bacterial flora in the gut

ايبينس يا اناضعق يار بالاصحط الطليقة

can synthesize
vit. K, B7, B9 → folic acid.

لبيك
صعب ليه
بعض مينا
تظهر

Clinical features

- Severe dermatitis, weakness, & nausea
- In animals muscle weakness, dermatitis & loss of hair around the eye

- Avidin-biotin system is commonly utilized for detection of pathogenesis in **ELISA test** → used in diagnosis of different diseases (like COVID-19)

- DNA is generally labelled by radioactive nucleotides

- Recently, biotin labelling of DNA is becoming more popular

- Biotin is added to nucleotides, which will be incorporated into the newly synthesized DNA

- The fixed biotin can be identified by reaction with **Avidin**

bind to biotin
absorption ال
vitamin ال
نضنا ال

- Intake of 20 raw eggs/day will produce **Biotin deficiency** in humans

- Prolonged use of antibacterial drugs such as sulfonamides

بالجسم
body building

لأنها لوح
تقتل ال
bacteria
flora
وتمتد البكتريا
رح بغير السح
Vit. B1, B7, K.

Biotin antagonists

- Avidin (Raw egg white injury factor)
- Raw egg white injury factor is a heat labile protein known as avidin and is present in raw egg white
- Avidin binds to biotin & makes its unavailable for absorption
↳ converting it to insoluble compound.
- Avidin is inactivated by boiling the eggs & biotin is readily absorbed when boiled eggs are used in the diet
- One molecule of avidin can combine with four molecules of biotin
- Egg white contains Avidin & egg yolk contains biotin
- The affinity of Avidin to biotin is greater than most of the usual antigen-antibody reactions