

Vitamin K

Biochemistry Team work



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N.B; Almost all the vitamins are co-enzymes, they help in different reactions in body
 N.B Vitamin k becomes → (gamma-carboxylate) By carboxylase enzymes

very important =Red
 additional info =Green

Types and Chemistry

Occurs in several forms:

- Vitamin K₁ (Phylloquinone) in plants
- Vitamin K₂ (Menaquinone) in animals
- Vitamin K₃ (Menadione) – synthetic form

K₁ and K₂ are natural, lipid soluble, non-toxic forms of vitamin K,
 While vitamin K₃ is a man-made, water soluble toxic form.

Sources of Vitamin K

- Phylloquinone: Green leafy vegetables e.g. Watercress, Molokhia
- MENAQUINONE: INTESTINAL BACTERIA → Vitamin K₂
 → Intestinal bacterial synthesis meets the daily requirement of vitamin K even without dietary supplement
- Menadione: synthetic form



RDA for Vitamin K (µg/day)

Age Group	Amount
Infant (0-1 year)	2 - 2.5
Children (1-8)	30 - 55
Men (+19)	120
Woman (+19)	90
Pregnancy/lactation	90/90
Upper Limit	Not established

* g-carboxyglutamate has the carboxyl group on its gamma (γ) carbon

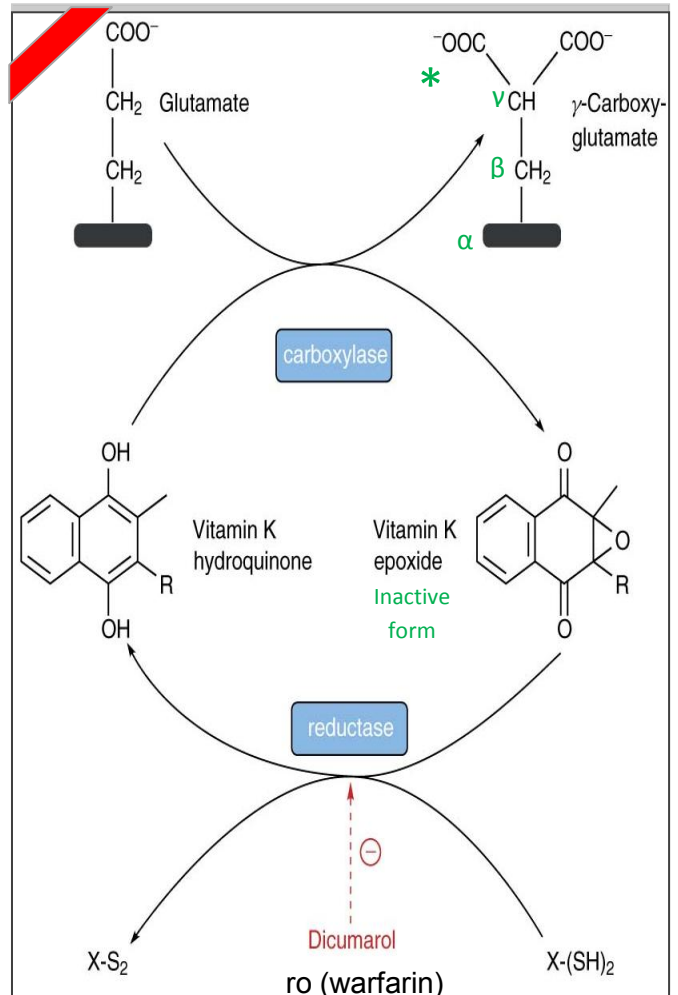
Functions of vitamin K

- Coenzyme for the synthesis of prothrombin and blood clotting factors in the liver
- Prothrombin and clotting factors are protein in nature
- Synthesis of **prothrombin (clotting factor II), clotting factors VII, IX, X** require **CARBOXYLATION** of their glutamic acid (Glu) residue
- **Mature** prothrombin and clotting factors contain g-carboxyglutamate (Gla) **after carboxylation reaction**
- **Vitamin K is essential for the carboxylase enzyme involved** → **DIHYDROQUINONE** form of vitamin K is essential for this reaction

Analogs of Vitamin K

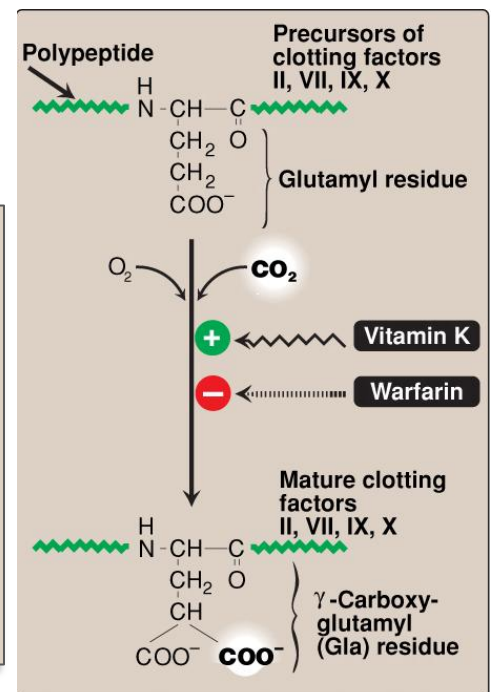
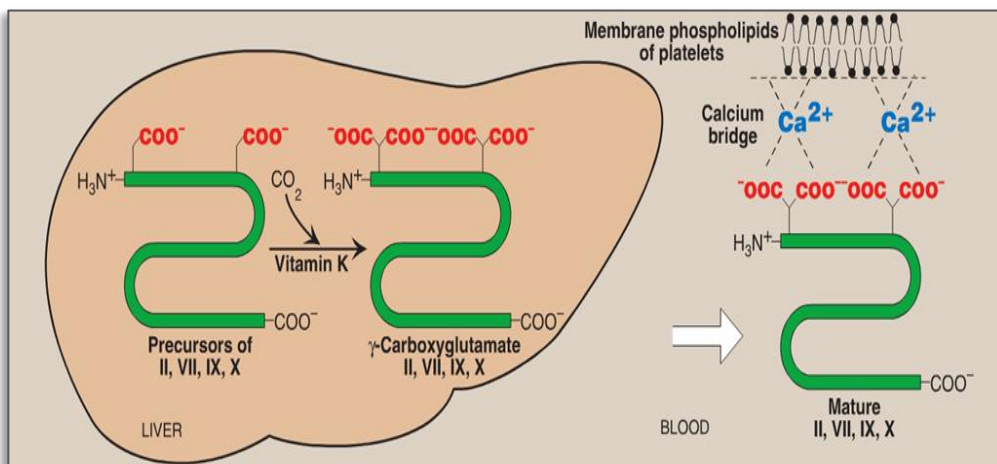
- Anticoagulant drugs: warfarin and dicoumarol → Structural analogs of vitamin K
- **They inhibit the activation of vitamin K to hydroquinone form**

ACT on reductase enzymes → it cannot form the hydroquinone



- Hence prothrombin and clotting factors are not carboxylated
- Blood coagulation time **increases** upon injury

Prothrombin – platelet interaction



- Prothrombin – platelet interaction
- Carboxylated prothrombin **contains two carboxylate groups (COO⁻)**
- **These groups bind to Ca²⁺ forming prothrombin-calcium complex**
- The complex then binds **to phospholipids on the surface of platelets** (important for blood clotting)
- Converting prothrombin to thrombin and initiating clot formation

Synthesis of gamma-carboxyglutamate in osteocalcin

- Osteocalcin is a bone protein
- May have a role in bone formation and mineralization
- gamma-carboxyglutamate is required for osteocalcin binding to hydroxyapatite (a mineral) in the bone
- The function of bone osteocalcin is unclear

under carboxylated osteocalcin is known to be associated with an increase in bone fracture tendency.

Deficiency of Vitamin K

- Deficiencies are rare: it is synthesized by **the intestinal bacteria**
- Hypoprothrombinemia: increased blood coagulation time
- May affect bone growth and mineralization
- **Malabsorption of lipids leads to vitamin K deficiency**
- Prolonged antibiotic therapy (**especially broad spectrum antibiotics- we need to give vit K supplements with the therapy**)
- **Gastrointestinal INFECTIONS with diarrhea**
→ Both of the above destroy the bacterial flora leading to vitamin K deficiency

DEFICIENCY MOST COMMON IN NEWBORN INFANTS:

- Newborns **lack** intestinal flora
- Human milk **cannot** provide enough vitamin K
- Supplements are given by injection

Clinical Manifestations of the Deficiency

- Hemorrhagic disease of the newborn
- **Bruising tendency**, ecchymotic patches (bleeding underneath the skin)
- Mucus membrane hemorrhage
- **Post-traumatic bleeding** / internal bleeding
- Prolonged prothrombin time

Questions

- 1) The Warfarin & Dicumarol are
 - a. Inhibit the activation of vitamin K to hydroquinone form
 - b. Structural analogs of vitamin K
 - c. Decrease absorption of vitamin K in intestine
 - d. a & b are correct

- 2) A deficiency in vitamin K results in a decreased level of
 - a. Prothrombin
 - b. Thrombin
 - c. Fibrin
 - d. Fibrinogen

- 3) Prolonged use of broad-spectrum antibiotics would most likely result in what vitamin deficiency
 - a. Vitamin A
 - b. Vitamin K
 - c. Vitamin E
 - d. Vitamin D

- 4) Vitamin K
 - a. Plays an essential role in preventing thrombosis
 - b. Increase the coagulation time in newborn infants with hemorrhagic disease
 - c. Is present in high concentration in cow or breast milk
 - d. Is synthesized by intestinal bacteria
 - e. Is a water-soluble vitamin

- 5) A fat soluble vitamin that regulates blood clotting
 - a. Vitamin A
 - b. Vitamin K
 - c. Vitamin C
 - d. Niacin

Answers

- 1) d
- 2) a
- 3) b
- 4) d
- 5) b