INE | INSTITUTE OF NUTRITIONAL ENDOCRINOLOGY

Micronutrients: Vitamin K

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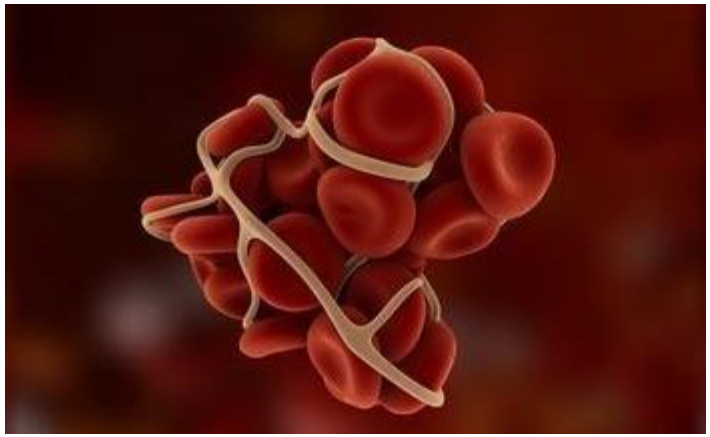
Medical Disclaimer: The information in this presentation is not intended to replace a one-on-one relationship with a qualified health care professional and is not intended as medical advice. It is intended as a sharing of knowledge and information from the research and experience of Dr. Ritamarie Loscalzo, drritamarie.com, and the experts who have contributed. We encourage you to make your own health care decisions based upon your research and in partnership with a qualified health care professional.

Vitamin K Basics

- ✓ Vitamin K is a fat soluble vitamin – stored in fat, tissue, and the liver
- ✓ It is best known for its role in helping blood clot
- ✓ The "K" comes from its German name, Koagulationsvitamin
- ✓ Vitamin K also plays an important role in bone health
- ✓ Vitamin K is found in leafy green foods
- ✓ The bacteria in your intestines makes vitamin K

Vitamin K Activity

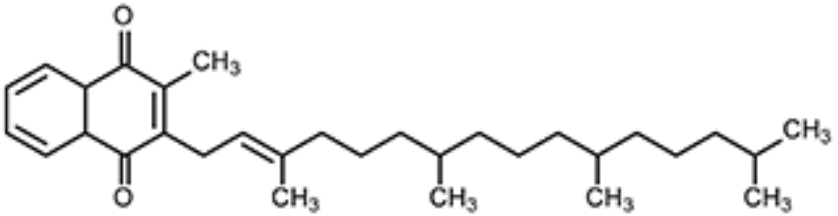
- ✓ Essential cofactor for the carboxylation of glutamic acid residues in many vitamin K-dependent proteins (VKDPs)
- ✓ VKDPs are involved in blood coagulation, bone metabolism, prevention of vessel mineralization, and regulation of various cellular functions



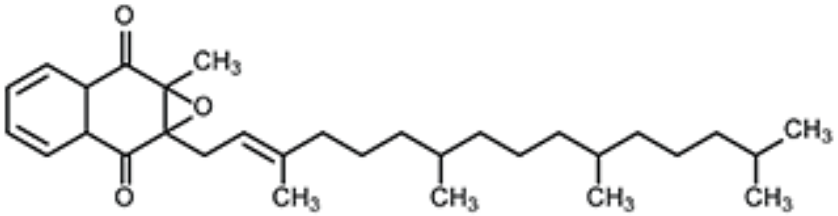
Forms of Vitamin K

- ✓Three basic types of vitamin K: K1, K2, and K3
- ✓Vitamin K1: phylloquinone
  - ➢Found in leafy green vegetables
  - ➢Predominant form in the diet
- ✓Vitamin K2: menoquinones
  - ➢Synthesized by your intestinal bacteria
  - ➢Found in fermented foods and animal products
- ✓Vitamin K3: menadione
  - ➢Synthetic compound
  - ➢Needs to be converted to MK-4 to be active

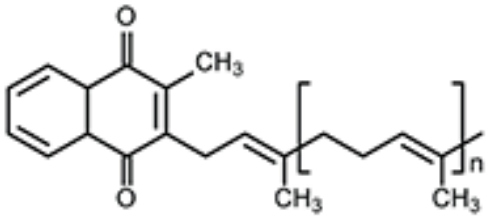
Vitamin K Structure



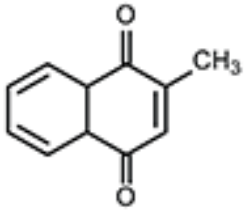
phylloquinone (K_1)



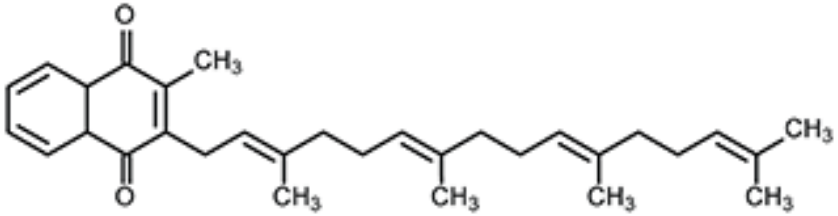
phylloquinone epoxide (K_1O)



menaquinone-n
(K_2 family)



menadione
(K_3)



menaquinone-4
(MK-4; menatetrenone; K_2 family)

Forms of Vitamin K2

- ✓ 15 different types of menoquinones
- ✓ The number refers to the number of isoprene residues comprising the side chain of the molecule
  - ➢ Isoprene – fancy name for a tail
- ✓ MK4 and MK7 most common
- ✓ MK7 sources: fermented foods like natto
- ✓ MK4 sources: animal fats and organs

MK-4

- ✓ Produced via vitamin K1 conversion
  - ➢ In the testes, pancreas, arterial walls
- ✓ Has a short biological half-life
  - ➢ One hour
- ✓ Remains mostly in your liver
- ✓ Useful in synthesizing blood clotting factors
- ✓ Adjunctive therapy for the pain of osteoporosis

MK-7

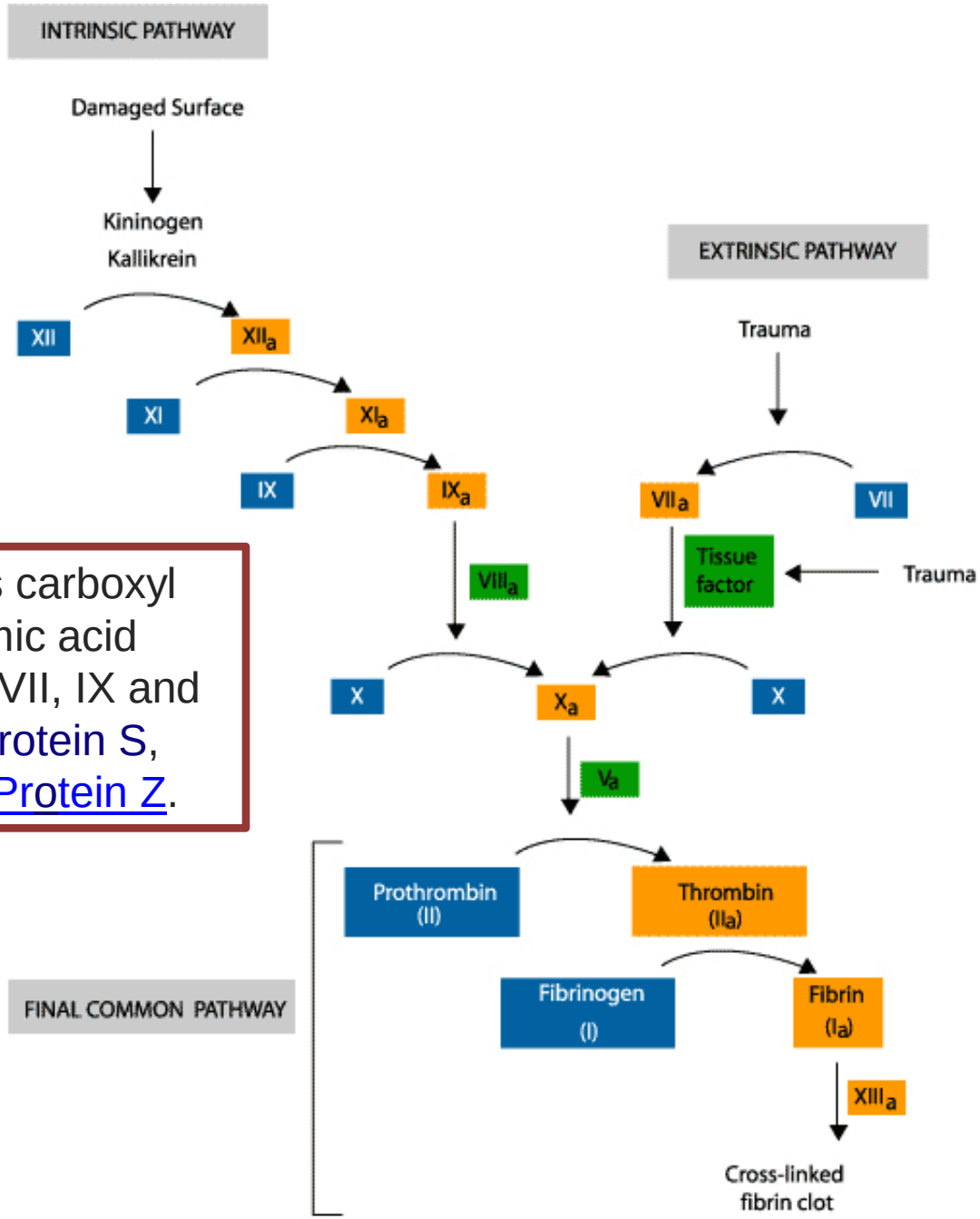
- ✓ Richest source of natural K2
- ✓ Natto has the most available
  - ➢ Natto – fermented soybeans and Bacillus subtilus
- ✓ Keeps calcium in the bones and out of the arteries
- ✓ Highly absorbed and long lasting in the body

Vitamin K and Clotting – The Coagulation Cascade

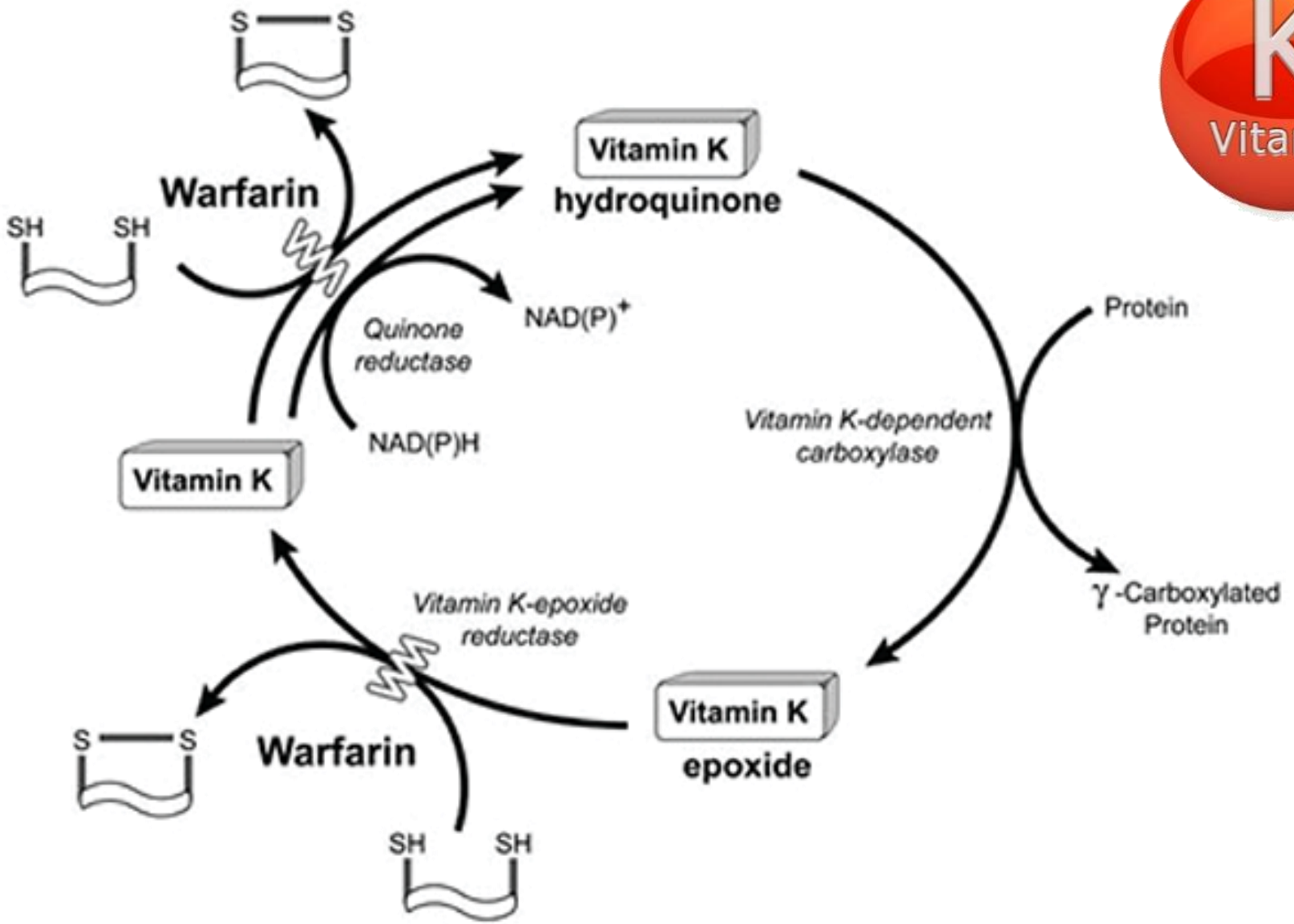
- ✓ Series of events, each dependent on the other, that stop bleeding through clot formation.
- ✓ The ability to bind calcium ions (Ca2+) is required for the activation of the several vitamin K-dependent clotting factors,
- ✓ Vitamin K-dependent γ-carboxylation of specific glutamic acid residues in those proteins makes it possible for them to bind calcium.
- ✓ Factors II (prothrombin), VII, IX, and X make up the core of the coagulation cascade.

Vitamin K and Clotting – Coagulation Details

- ✓ Protein Z appears to enhance the action of thrombin (the activated form of prothrombin) by promoting its association with phospholipids in cell membranes.
- ✓ Protein C and protein S are anticoagulant proteins
- ✓ Protein Z also has an anticoagulatory function.
- ✓ Control mechanisms for the coagulation cascade exist since uncontrolled clotting may be as life threatening as uncontrolled bleeding.
- ✓ Vitamin K-dependent coagulation factors are synthesized in the liver.
- ✓ Severe liver disease results in an increased risk for uncontrolled bleeding



Vitamin K adds carboxyl group to glutamic acid residues on II, VII, IX and X, as well as Protein S, Protein C and Protein Z.



http://www.drritamarie.com/go/OSUVitaminK

Excess Vitamin K

- ✓ Abnormal clotting is not related to excessive vitamin K intake
- ✓ There is no known toxicity associated with vitamin K_1 or vitamin K_2
- ✓ Some oral anticoagulants, such as warfarin (Coumadin, Jantoven), inhibit coagulation by antagonizing the action of vitamin K. Large quantities of dietary or supplemental vitamin K can overcome the anticoagulant effect of vitamin K antagonists
- ✓ Daily supplementation of low-dose phylloquinone may improve the stability of anticoagulation therapy

Vitamin K and Heart Protection

- ✓Vitamin K2 prevents hardening of the arteries
- ✓Vitamin K2 binds to calcium and deposits it into bones and teeth, and away from soft tissues, such as artery linings
- ✓Vitamin K is the essential cofactor for the carboxylation of glutamic acid residues in many vitamin K-dependent proteins that are involved in blood coagulation, bone metabolism, and prevention of vessel mineralization

Vitamin K and Osteoporosis

- ✓ Vitamin K is related to osteocalcin
  - ➢ Osteocalcin – bone Gla protein
  - ➢ Gla protein – calcium binding protein synthesized by osteoblasts, bone building cells
- ✓ Works with vitamin D to regulate osteoclasts
  - ➢ Osteoclasts – cells that remove old bones
- ✓ Osteocalcin is activated when it is chemically altered through a vitamin K-dependent process known as carboxylation.

Vitamin K and Cancer

- ✓ Vitamin K2 – inhibits cancer cell growth
- ✓ Vitamin K1 – in liver cancer restores normal clotting and stopped cancer cell growth
- ✓ Cancer studies show benefits of vitamin K
  - ➢ Prostate cancer – K2
  - ➢ Leukemia – K2 – specifically MK-4
  - ➢ Colon cancer – K2
  - ➢ Lung cancer – K2
  - ➢ Ovarian cancer – K2
  - ➢ Breast cancer – K2

Additional Health Benefits

- ✓ Relief from menstrual pain
- ✓ Protection from internal bleeding
- ✓ Aid in stroke prevention
- ✓ Improve insulin sensitivity
  - ➢ Related to osteocalcin affecting glucose metabolism
- ✓ Prevent Alzheimer's
  - ➢ Dysregulated calcium in the brain
  - ➢ Patients prone to broken bones have APOE gene

Vitamin K Needs

Table 1. Adequate Intake (AI) for Vitamin K			
Life Stage	**Age**	**Males (mcg/day)**	**Females (mcg/day)**
Infants	0-6 months	2.0	2.0
Infants	7-12 months	2.5	2.5
Children	1-3 years	30	30
Children	4-8 years	55	55
Children	9-13 years	60	60
Adolescents	14-18 years	75	75
Adults	19 yearsand older	120	90
Pregnancy	18 years and younger	-	75
Pregnancy	19 years and older	-	90
Breast-feeding	18 years and younger	-	75
Breast-feeding	19 years and older	-	90

Food Sources of Vitamin K1

- ✓ Kale
- ✓ Spinach
- ✓ Mustard greens
- ✓ Collard greens
- ✓ Beet greens
- ✓ Swiss chard
- ✓ Turnip greens
- ✓ Parsley
- ✓ Broccoli
- ✓ Brussels sprouts

Food Sources of K2

- ✓ MK4
  - ➢ Grass fed butter – cows fed on rapidly growing grass
  - ➢ Organ meats
  - ➢ Egg yolks
  - ➢ Raw cheese
- ✓ MK7
  - ➢ Natto
  - ➢ Miso

World's Healthiest Foods ranked as quality sources of vitamin K						
Food	Serving Size	Cals	Amount (mcg)	DRI/DV (%)	Nutrient Density	World's Healthiest Foods Rating
Kale	1 cup	36.4	1062.10	1180.11	583.6	excellent
Spinach	1 cup	41.4	888.48	987.20	429.2	excellent
Mustard Greens	1 cup	36.4	829.78	921.98	455.9	excellent
Collard Greens	1 cup	62.7	772.54	858.38	246.4	excellent
Swiss Chard	1 cup	35.0	572.77	636.41	327.3	excellent
Turnip Greens	1 cup	28.8	529.34	588.16	367.6	excellent
Parsley	0.50 cup	10.9	498.56	553.96	911.4	excellent
Broccoli	1 cup	54.6	220.12	244.58	80.6	excellent
Brussels Sprouts	1 cup	56.2	218.87	243.19	77.9	excellent
Romaine Lettuce	2 cups	16.0	96.35	107.06	120.6	excellent
Asparagus	1 cup	39.6	91.08	101.20	46.0	excellent
Basil	0.50 cup	4.9	87.94	97.71	360.4	excellent
Cabbage	1 cup	43.5	71.40	79.33	32.8	excellent