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Musculoskeletal-I Module

1st Year MBBS(SGD)

Vitamin E

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Motto, Vision, Dream

- To impart evidence based research oriented medical education
- To provide best possible patient care
- To inculcate the values of mutual respect and ethical practice of medicine

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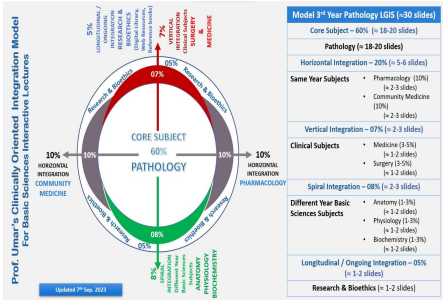
Professor Umar Model of Integrated Lecture



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SGD- MCQ Assessment

1. **The most biologically active form of vitamin E in humans is:**
   A. γ-tocopherol
   B. α-tocotrienol
   C. δ-tocopherol
   D. α-tocopherol
   E. β-tocotrienol
2. **Vitamin E functions mainly as a:**
   A. Coenzyme
   B. Hormone precursor
   C. Structural lipid
   D. Gene transcription factor
   E. Lipid-soluble antioxidant
3. **Vitamin E protects cell membranes primarily by:**
   A. Reducing DNA damage
   B. Enhancing calcium absorption
   C. Preventing lipid peroxidation
   D. Binding free iron
   E. Stimulating RBC synthesis
4. **Absorption of vitamin E in the intestine requires:**
   A. Glucose transporters
   B. Bile salts
   C. Passive diffusion only
   D. Carrier-mediated transport
   E. Water-soluble complexes

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SGD- MCQ Assessment

5. **Which of the following lipoproteins is most important for vitamin E transport in plasma?**
   A. HDL
   B. Chylomicrons
   C. VLDL
   D. LDL
   E. Albumin
6. **Vitamin E deficiency most commonly presents with:**
   A. Pellagra
   B. Hemolytic anemia
   C. Tetany
   D. Rickets
   E. Delayed wound healing
7. **Vitamin E is stored mainly in:**
   A. Bone
   B. PlasmA
   C. Adipose tissue
   D. Liver glycogen
   E. Skeletal muscle
8. **The antioxidant function of vitamin E is closely linked to the regeneration by:**
   A. Niacin
   B. Selenium
   C. Vitamin D
   D. Vitamin C
   E. Iron

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SGD- MCQ Assessment

9. **Which of the following populations is most at risk of vitamin E deficiency?**
   A. Type 2 diabetics
   B. Patients with fat malabsorption
   C. Patients on high-protein diets
   D. Athletes
   E. Those with high vitamin D intake
10. **In laboratory settings, vitamin E levels are most often assessed using:**
    A. Spectrophotometry
    B. Mass spectrometry
    C. ELISA
    D. High-performance liquid chromatography (HPLC)
    E. Western blot

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SGD- MCQ Assessment Key

1. D
2. E
3. C
4. B
5. B
6. B
7. C
8. D
9. B
10. D

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Learning Objectives

At the end of the SGD, students will be able to:

1. Understand the role of vitamin E in human health.
2. Recognize dietary sources and recommended intake of vitamin E
3. Functions of Vitamin E

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Interactive Session

A 32-year-old male with a history of **Crohn's disease** presents to the clinic with **progressive muscle weakness, difficulty walking, and numbness in his hands and feet** over the past six months. He also reports occasional **difficulty with coordination** and **frequent tripping while walking**.

His medical history includes **multiple episodes of diarrhea and unintentional weight loss over the past year.**

He **follows a strict low-fat diet** due to concerns about worsening his gastrointestinal symptoms.

Examination:

Neurological findings:

Decreased deep tendon reflexes (DTRs)

Impaired vibratory sensation and proprioception in the lower limbs

Mild ataxia on tandem walking

Laboratory tests :

Low serum α-tocopherol levels

Normal B12 and folate levels

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Core Knowledge

Introduction to Vitamins

- Vitamins are essential organic compounds required in small amounts for normal metabolism and good health.
- They are not a source of energy
- Classified into:

1. Water-Soluble (Vitamin C and B Class)
2. Fat-Soluble (A,D,E and K)

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Core Knowledge

Classification Of Vitamins

Type	Vitamin	Other Names	Functions	Sources
Fat-Soluble	A	Retinol, Retinal, Retinoic Acid	Vision, growth, immunity	Carrots, liver, dairy
	D	Cholecalciferol (D3), Ergocalciferol (D2)	Bone health, calcium balance	Sunlight, fish, milk
	E	Tocopherols, Tocotrienols	Antioxidant, cell protection	Nuts, seeds, oils
	K	Phylloquinone (K1), Menaquinone (K2)	Blood clotting, bone health	Leafy greens, liver
Water-Soluble	B1	Thiamine	Carbohydrate metabolism	Whole grains, pork
	B2	Riboflavin	Energy production	Dairy, eggs, greens
	B3	Niacin, Nicotinamide	NAD+/NADP+ coenzyme	Meat, fish, grains
	B5	Pantothenic Acid	Coenzyme A synthesis	Meat, eggs, grains
	B6	Pyridoxine	Amino acid metabolism	Bananas, poultry, fish
	B7	Biotin	Fat & carbohydrate metabolism	Nuts, eggs, liver
	B9	Folate	DNA synthesis, RBC formation	Leafy greens, beans
	B12	Cobalamin	Nerve function, RBC production	Meat, fish, dairy
	C	Ascorbic Acid	Antioxidant, collagen	Citrus fruits, peppers

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Core Knowledge

Chemistry of VITAMIN E

1.Structure – Vitamin E consists of **tocopherols** and **tocotrienols**, both having a **chromanol ring** (antioxidant site) and a **hydrophobic side chain** for membrane incorporation.

2.Forms – The most active form is **α-tocopherol**, followed by β, γ, and δ-tocopherols, each differing in methylation on the chromanol ring.

3.Antioxidant Property – Acts as a **lipid-soluble antioxidant**, scavenging free radicals and preventing lipid peroxidation in cell membranes.

4.Solubility & Stability – It is **fat-soluble**, stable to heat but sensitive to light, oxygen, and alkaline conditions, which degrade its activity.

5.Absorption & Transport – Absorbed in the intestine with dietary fats, transported in **chylomicrons**, and stored in **adipose tissue and liver**.

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Core Knowledge

Sources of Vitamin-E

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Core Knowledge

RDA of Vitamin-E

Age Group	RDA (mg/day of α-Tocopherol)
Infants (0-6 months)	4 mg (AI*)
Infants (7-12 months)	5 mg (AI*)
Children (1-3 years)	6 mg
Children (4-8 years)	7 mg
Children (9-13 years)	11 mg
Adolescents (14-18 years)	15 mg
Adults (19+ years)	15 mg
Pregnant Women	15 mg
Lactating Women	19 mg

•*AI (Adequate Intake) is given for infants as RDAs are not established for this group.*
•These values are based on **Dietary Reference Intakes (DRIs) by the Institute of Medicine (IOM).**

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Core Knowledge

Biochemical Role Of Vitamin-E

1.Antioxidant Role – Neutralizes free radicals and prevents **lipid peroxidation**, protecting cell membranes from oxidative damage.

2.Membrane Stability – Maintains **integrity of phospholipid bilayers**, especially in red blood cells, neurons, and muscle tissues.

3.Immune Function – Enhances **T-cell function** and modulates immune response, reducing inflammation.

4.Gene Expression – Regulates **gene transcription** involved in cell signaling, growth, and apoptosis.

5.Cardiovascular Protection – Prevents **oxidation of LDL cholesterol**, reducing the risk of atherosclerosis and cardiovascular diseases.

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Core Knowledge

Biochemical Role Of Vitamin-E

6.Neurological Function – Supports **nerve conduction** and prevents neurodegenerative diseases by protecting neurons from oxidative damage.
7.Reproductive Health – Essential for **sperm motility** and normal fetal development during pregnancy.
8.Skin Protection – Promotes **wound healing**, reduces UV-induced skin damage, and prevents premature aging by maintaining skin integrity.
9.Platelet Regulation – Inhibits **platelet aggregation**, reducing the risk of thrombus formation and improving blood circulation.
10.Enzyme Activity Modulation – Influences the activity of **protein kinase C (PKC)**, which regulates smooth muscle growth and immune cell function

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Horizontal Integration

Bio-physiological & Anatomical Aspects of Vitamin E

1. **Absorption & Transport** – Absorbed in the small intestine with dietary fats, transported via chylomicrons, and distributed through lipoproteins (LDL, HDL, VLDL).
2. **Storage Sites** – Primarily stored in adipose tissue, with smaller amounts in the liver, skeletal muscles, and brain
3. **Neurological Role** – Maintains myelin sheath integrity, ensuring proper nerve conduction and preventing neurodegeneration.
4. **Skin & Hair Health** – Helps maintain skin elasticity, wound healing, and hair growth by preventing oxidative stress in epidermal cells.

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Horizontal Integration

Bio-physiological & Anatomical Aspects of Vitamin E

8. **Eye Protection** – Prevents oxidative damage in the retina, reducing the risk of age-related macular degeneration (AMD).
9. **Aging & Longevity** – Delays cellular aging by protecting tissues from oxidative damage, especially in the brain and skin.
10. **Muscle Function** – Supports muscle strength and endurance, reducing oxidative stress during physical activity.
11. **Bone Health** – Plays a role in bone remodeling by influencing osteoblast and osteoclast activity, helping maintain bone density.

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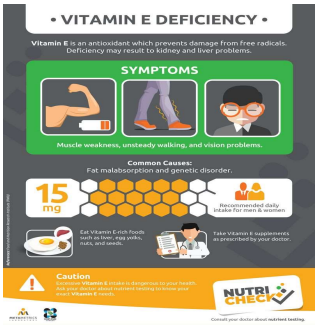
Vertical Integration

Clinical Correlates



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Vertical Integration

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Spiral Integration

Family Medicine

Management of Vit –E Deficiency

- **Essential nutritional counseling** to families, emphasizing the importance of a balanced diet that includes adequate amounts of fat-soluble vitamins (A, D, E, and K).
- Patients with certain chronic conditions, such as **malabsorption** disorders, liver diseases, or pancreatic disorders, may be prone to fat-soluble vitamin deficiencies. Family physicians can **monitor** these patients closely, recommend appropriate supplementation, and adjust treatments as needed.
- High Performance Liquid Chromatography for Detection of Vit E levels.
- **Community education initiatives**, raising awareness about the importance of fat-soluble vitamins and promoting healthy nutrition practices for all age groups.

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Spiral Integration

Artificial intelligence

Role of AI in Management

- Personalized Nutrition Guidance
- Early Deficiency Detection
- Remote Monitoring
- Drug-Nutrient Interaction Analysis

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Spiral Integration

Bioethics

Ethical Considerations

- Equitable Access to Supplements.
- Ethical practices in nutritional genomics when utilizing genetic testing.
- Cultural Sensitivity in Dietary Recommendations:
- Transparent Communication on Supplementation: discussions about the risks and benefits

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Spiral Integration

Research Article

Fat-Soluble Vitamins A, D, E, and K: Review of the Literature and Points of Interest for the Clinician

Andrès, E.; Lorenzo-Villalba, N.; Terrade, J.-E.; Méndez-Bailon, M.

J. Clin. Med. **2024**, *13*(13), 3641; https://doi.org/10.3390/jcm13133641

Fat-soluble vitamins, including vitamins A, D, E, and K, are energy-free molecules that are essential to the body's functioning and life. Their intake is almost exclusively exogenous, i.e., dietary. As a result, fat-soluble vitamin deficiencies are rarer in industrialized countries than in countries with limited resources. Certain groups of people are particularly affected, such as newborns or growing children, pregnant or breastfeeding women, and elderly or isolated individuals. Deficiencies in vitamins A, D, E, and K are also relatively frequent in subjects with digestive tract disorders, liver diseases, chronic pathologies, or in intensive care patients. Deficiencies or excesses of fat-soluble vitamins are responsible for a variety of more or less specific clinical pictures. Certain syndromes are typical of fat-soluble vitamin deficiency, such as the combination of ophthalmological and immunity impairments in the case of vitamin A deficiency or hemorrhagic syndrome and osteopenia in the case of vitamin E deficiency. This is also the case for osteomalacia, muscular weakness, even falls, and rickets in the case of vitamin D deficiency. Diagnosis of a deficiency in one of the fat-soluble vitamins relies on blood tests, which are not always essential for routine use. In this context, a therapeutic test may be proposed. Treatment of deficiencies requires vitamin supplementation, a well-balanced diet, and treatment of the cause.

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Learning Resources

- Textbook of Biochemistry, Lippincott 8th edition, chapter no.28 , pages no. 441-444
- Google scholar
- Google images

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