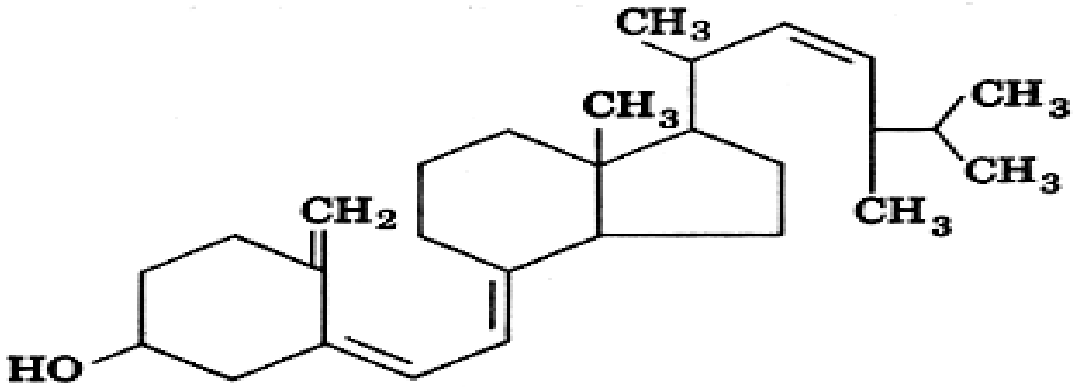
Sultan Qaboos Univeristy

College of Agricultural & Marine Sciences

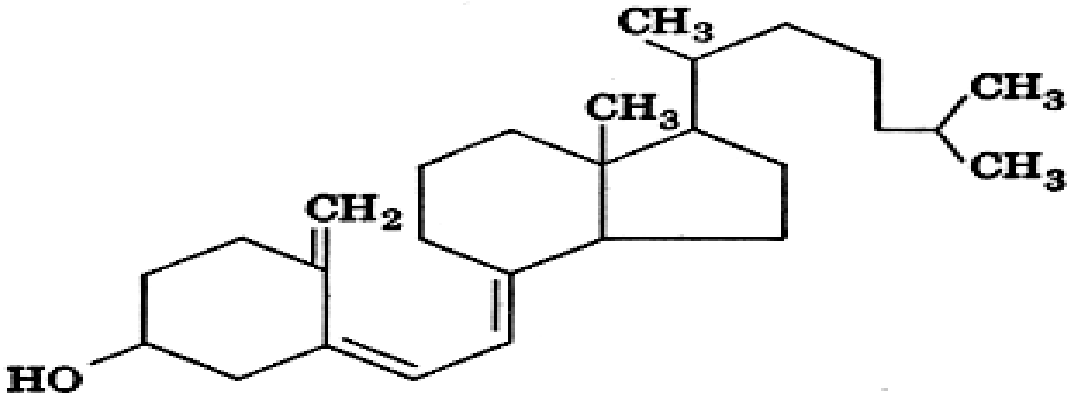
Vitamins & Human Metabolism

FSHN6026 with Dr. Amanat Ali

Lecture No. (2): Vitamin (D): Summary



Vitamin D_2 (calciferol)



Vitamin D_3

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➢ Introduction:

o Vitamin D:

Vitamin D is a prohormone and in a classical sense is not an essential nutrient. It is a group of fat-soluble vitamins and it's a steroid ring formed from precursor 7-dehydrocholesterol in the skin. It's known critically for bone maintenance and absorption and metabolism of calcium and phosphorus in the body together with the peptide hormones parathyroid hormones (PTH) and calcitonin (CT).[1-2] It was discovered in 1979 by E. V. McCollum on his extensive work of fish liver oil. Two farms of vitamin D are known; one is ergocalciferol and other is cholecalciferol. [2] Its produce in adrenal gland in the kidney by the action of enzyme of α-1-hydroxylase. [3]

o Measurement of Vitamin D:

Measures of serum level reflect endogenous synthesis from exposure to sunlight as well as intake from the diet, and it is believed that synthesis may contribute generally to the maintenance of adequate serum concentrations. Serum concentration of 25-OH-Vitamin D is considered to be the most reliable measure of overall vitamin D status and thus can be used to determine whether a patient is vitamin D sufficient.

The measurement of 25-OH-Vitamin D is important in the management of patients with various disorders of calcium metabolism associated with rickets, neonatal hypocalcemia, pregnancy, nutritional and renal osteodystrophy, hypoparathyroidism, and post meno-pausal osteoporosis. Omani reference range for vitamin D-25-OH is 23 – 94 nmol/L. Chromatographic techniques have been used for separation and purification of vitamin D. [2]

To determine 1, 25-di-OH-vitamin-D, the most active form of vitamin D is by extremely sensitive method because of very low concentration of this vitamin in body. It can be determine by using HPLC or Mass spectrometry or Immunoassay or RIA or Gas chromatography or UV absorption [2]

o Stability & Physical Properties:

Vitamin D2 and D3 are powder of white to yellowish in color. It is insoluble in water and moderately soluble in fats, oil and ethanol. Obtained in crystal form and UV absorption spectrum is 264-228 nm.

- **Requirements & Sources:**

Fish liver oils and salt water fish (tuna, salmon, and herring) are the rich dietary sources of vitamin D. Plant foods are poor sources of vitamin D.[4] In United State the major source of vitamin D is fortified milk, cheese, and butter. The US recommended daily allowance (RDA) for vitamin D is 400 IU (10 ug of cholecalciferol) for all healthy food.[3] Elderly people, infants, vegetarians, individual with limited ultraviolet light absorption, may be at risk of poor vitamin D status. [1] A supplement of 5 ug is advised for both pregnant and lactating women. [3]

- **Deficiency:**

Rickets, the disease caused by poor vitamin D status in children, is characterized by bowed legs, spinal curvature, joint enlargement and deformities of the ribs and pelvis.[1] Vitamin D resistance Rickets (Familial hypophosphataemia) are X-linked disease (mother side) and will lead to increase renal tubular phosphate loss, hypophosphataemia. The characteristic x-ray appearance usually precedes clinical signs of Rickets. [5] In adult it results in **osteomalacia** (when epiphyses are fused), which can cause bone pain, tenderness, skeletal deformity and muscle weakness. Both conditions are the results of bone loss. [1, 3] Low vitamin D levels are associated with some **cancers**. When supplementation is used to treat people with prostate cancer, however, there does not appear to be a benefit. Results for a protective or harmful effect of vitamin D supplementation in other types of cancer are inconclusive.

People who use excessive sunscreens to protect them self from ultra-violet light may develop vitamin D deficiency and also who wear continuously covered cloth without being expose to sun light. Elderly people also of risk of vitamin D deficiency because of low vitamin D rate production in their body. Malabsorption of food containing vitamin D in gastrointestinal tract may interfere in vitamin D absorption into blood system. [5]

- **Toxicity:**

It can be very toxic when taken at high dosage. In healthy adults, sustained intake of more than 1250 ug/day (50,000 IU) can produce overt toxicity after several months. Pregnant or breastfeeding women should consult a doctor before taking a vitamin D supplement. [5] For infants (birth to 12 months), the tolerable upper limit (maximum amount that can be tolerated without harm) is set at 25 ug/day (1000 IU). One thousand micrograms (40,000 IU) per day in infants has produced toxicity within one month. Vitamin D overdose causes hypercalcemia, and the main symptoms of vitamin D overdose are those of hypercalcemia: anorexia, nausea, and vomiting can occur, frequently followed by polyuria, polydipsia, weakness, nervousness, and, ultimately, renal failure.[5] Proteinuria, urinary casts, azotemia, and metastatic calcification may develop. Vitamin D toxicity is treated by discontinuing vitamin D supplementation and restricting calcium intake. Kidney damage may be irreversible. Renal disease; decrease conversion of 25-(OH) vitamin D into 1, 25 $(OH)_2$ D Exposure to sunlight for extended periods of time does not normally cause vitamin D toxicity because skin destroys excess unabsorbed provitamin and vitamin D.

Vitamin D excess has been reported to take two forms: mild and severe. For mild farm the symptoms as described in above paragraph. However; in severe farm which is seen in infants and could causes mental retardation and stenosis of the aorta. [5]

- **Metabolism and Function:**

The endogenous provitamin, 7-dehydrocholesterol, and ergocalciferol (vitamin D_2), the form used in food fortification, are converted to cholecalciferol (vitamin D_3) by radiation. This conversion takes place in skin exposed to sunlight or to an artificial source of ultraviolet light. [1]

Dietary vitamin D is absorbed in the same manner as other lipids, and with about 50% efficiency (Miller and Norman, 1984). After being taken up by the liver, both the vitamin D_2 and D_3 forms circulate in the blood attached to a vitamin D-binding protein (VDBP). Hepatic disease; less common and will decrease the level of 1, 25-$(OH)_2$ D. The major storage sites are adipose tissue and muscle (Mawer *et al.*, 1972)

The most widely recognized vitamin D function is its role in the maintenance of calcium and phosphorus homeostasis. Vitamin D enhances calcium and phosphorus absorption and promotes bone formation. Vitamin D_3 is converted to 25-OH-Vitamin-D_3 in the liver. The conversion to 1, 25-di-OH-Vitamin-D_3 takes place in the kidney. [1] In addition, intestinal absorption of calcium and phosphate. [2]

After synthesis in the kidneys, the biologically-active form of vitamin D, called **calcitriol** circulates as a hormone, regulating the concentration of calcium and phosphate in the bloodstream and promoting the healthy growth and remodeling of bone. Vitamin D prevents **rickets** in children and **osteomalacia** in adults, and, together with calcium, helps to protect older adults from **osteoporosis**. Vitamin D also affects neuromuscular function, inflammation, and influences the action of many genes that regulate the proliferation, differentiation and apoptosis of cells.

Epidemiological evidence indicates that adequate vitamin D status can reduce the risk of osteoporosis. It's also play major role in regulating blood pressure thus indirectly preventing from cardiovascular disease. Moreover; it's suggested that it may have anti-carcinogenic function mainly in colon cancer. [1,5] In 1998, it was found that malignant cells have α-1-hydroxylase activity and cancer cells is inhibited by the addition of 25-OH-Vitamin D_3. [5]

Two main mechanisms (genomic and non-genomic) by which calcitriol exert its functions are known. Vitamin D is thought to function through signal transduction pathways linked to cell membrane VDR. It also functions by influencing nuclear VDR to promote gene expression. [4]

➢ References:

1. Suzanne K. Gaby, *et al.*, Vitamin Intake and Health-Scientific Review, 1st ed.270 Madison Avenue, New York: Marcel Dekker, Inc. USA; 1991.

2. Wilhelm Friedrich. Vitamins, 1st ed. Berlin. New York: Walter de Gruyter. 1988.

3. John Marks. The vitamins – their role in medical practice. 1st ed. Lancaster, England-Falcon House. MTP press limited. UK. 1985.

4. Sareen S. Gropper, *et al.*, Advance Nutrition and Human Metabolism. 4th ed. 10 Davis Drive Belmont, CA 94002-3098, Thomson-Wadsworth.USA. 2005.

5. Maurice E. Shils, *et al.*, Modern Nutrition in Health and Disease. 10th ed. 530 Walnut Street, Philadelphia, PA 19106. Lippincott Williams & Wilkins.USA. 2006.

6. http://en.wikipedia.org/wiki/Vitamin_D