

- The normal plasma calcium concentration is 10 mg/dL (range 9 - 11).
- About half of this amount is ionized and diffusible ( $\text{Ca}^{2+}$ ), the other half is non diffusible calcium, bound to plasma proteins - mainly albumin.
- It is the ionized calcium which is biologically active and strictly adjusted by the controlling systems.

# Vitamin D and Calcitriol

- Vitamin D is a term that refers to a group of closely related steroids, the most important members of this group to the human body are vitamins  $D_2$  (ergocalciferol) and  $D_3$  (cholecalciferol). A variable amount of them is taken in the diet.
- The active derivative of vit  $D_2$  and  $D_3$  is calcitriol (1,25- dihydroxycholecalciferol).

- **2. In the liver:**
- 25-hydroxylase enzyme converts vit D<sub>2</sub> and D<sub>3</sub> to 25-hydroxycholecalciferol.
- **3. In the cells of the proximal tubules of the kidney:** 1 $\alpha$ -hydroxylase enzyme converts 25-hydroxycholecalciferol to 1,25-dihydroxycholecalciferol (calcitriol).
- 1 $\alpha$ -hydroxylase enzyme is stimulated by low plasma calcium or phosphate, parathormone, growth hormone, sex hormones, and prolactin.

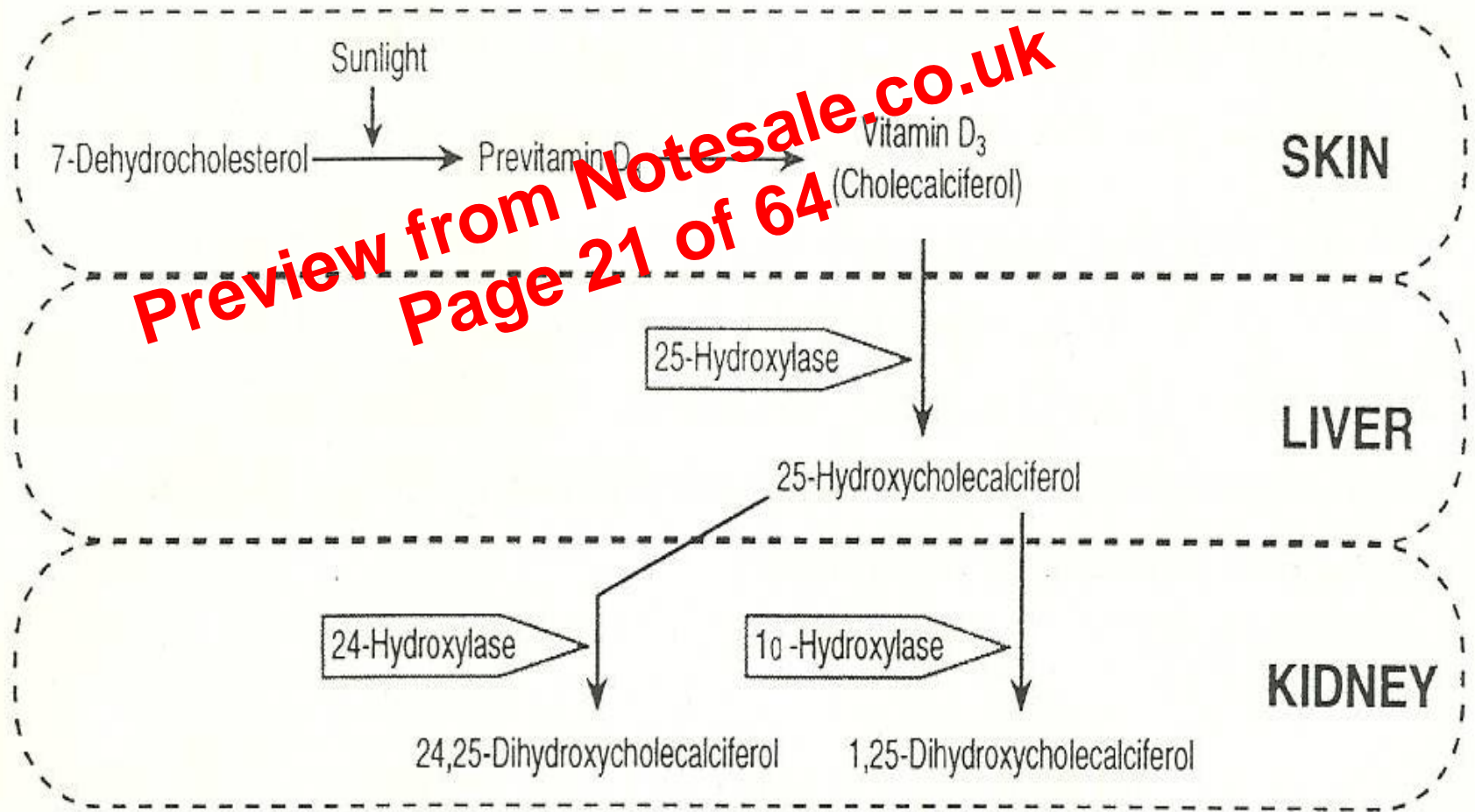


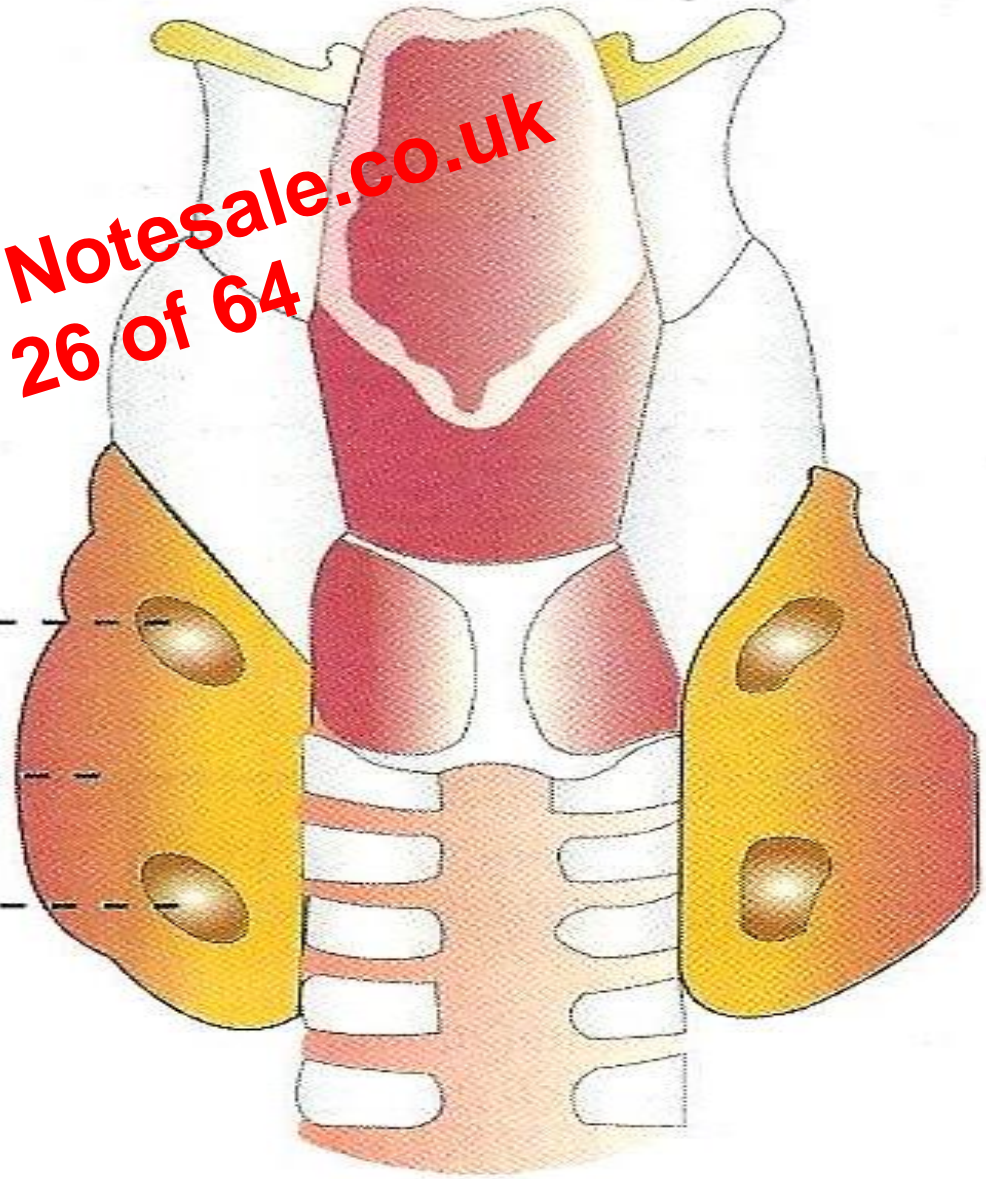
Figure 5 - 2: The steps of formation of 1,25-dihydroxycholecalciferol (the active form of vit. D).

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Superior ---  
parathyroid gland

Thyroid ---

Inferior ---  
parathyroid gland



**FIGURE 68-1:** Parathyroid glands on the posterior surface of thyroid gland

- **On the bone:**
- Parathormone stimulates osteoclasts → bone resorption → mobilization of  $\text{Ca}^{2+}$  from bone → rise in plasma  $\text{Ca}^{2+}$  level.
- Without parathormone, and adequate calcium intake, the exchangeable calcium in bone can maintain plasma calcium level around 7 mg/dL.
- It is the parathormone which keeps the hormonal plasma calcium at its normal level of 10 mg/dL

- **2. Thyroid hormones:** In high concentrations promote  $\text{Ca}^{2+}$  mobilization from bone → hypercalcemia → osteoporosis. → hypercalcuria →
- **3. Growth hormone:** Stimulates  $\text{Ca}^{2+}$  absorption from the intestine and calcium excretion in urine, but the absorption is more than the excretion.
- IGF-I stimulates protein synthesis in bone.

- Ossification is retarded or stopped, but the epiphyseal plates continue to grow producing swellings near the joints and at the costochondral junctions.
- Bone remodeling is impaired which could lead to bone deformities.
- Pelvis deformity in girls could lead subsequently to difficult childbirth.
- In adults, vit D deficiency produces the disease “osteomalacia”.
- The bone becomes brittle; tender or painful:

- In the early stages of hypovitaminosis D, plasma calcium level is in the normal range, but in later stages the calcium stores in bone are exhausted, plasma calcium falls down to low levels that leads to tetany which could be a very serious consequence.

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- Parathormone preparations are available but are not usually used because they are expensive, short acting (for few hours only), should be taken parentally, and the tendency of the body to produce antibodies against them.