ORAL BIOLOGY AND PHYSIOLOGY

COURSE CODE: 1601106

2 credit Units

Calcium metabolism

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Intended Learning Outcomes

- **Identify the importance of calcium and normal requirements**
- **Understand the calcium metabolism regulators: VD, PTH and calcitonin**
- **List the functions of calcium**
- **Understand calcium metabolism disorders**

Importance of calcium

- **It is essential for many activities in the body such as:**

- Bone and teeth formation.
- Neuronal activity.
- Skeletal muscle activity.
- Cardiac activity.
- Smooth muscle activity.
- Secretory activity of the glands.
- Cell division and growth.
- Coagulation of blood.

Normal values

- In a normal young healthy adult, there are about 1,100 g of calcium in the body.
- It forms about 1.5% of the total body weight.
- About 99 % per cent of calcium is present in the bones and teeth.
- The rest of the calcium is present in the plasma. 1%
- The normal blood calcium level ranges between 9 and 11 mg/dL.

Types of calcium

- **Calcium is present in three forms in plasma:**
  - Ionized or diffusible calcium.
  - Non-ionized or non-diffusible calcium.
  - Calcium bound to albumin.

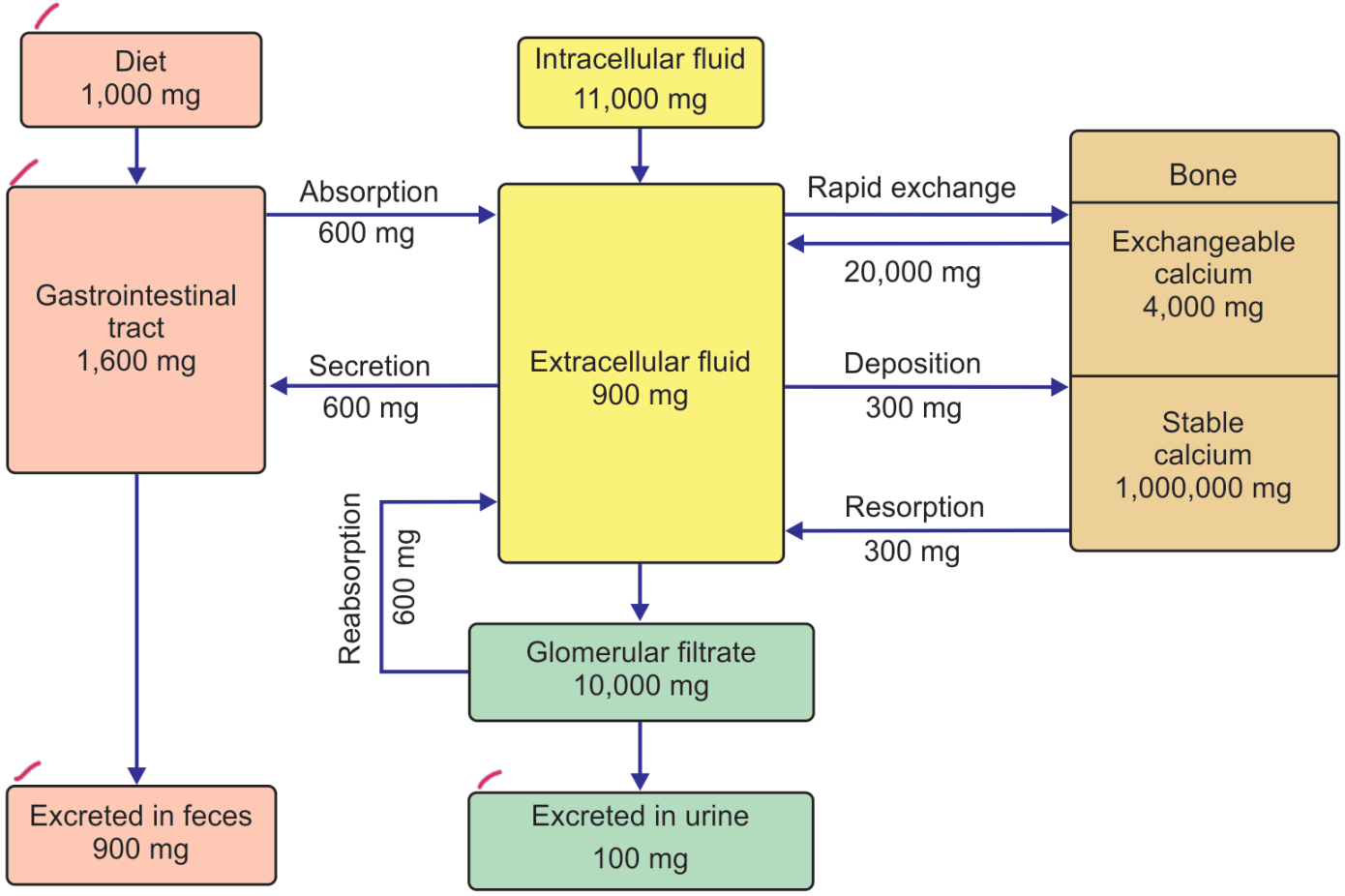
- **Ionized calcium** is found freely [Not bound] in the plasma and it forms about 50% of plasma calcium.
- It is essential for vital functions like neuronal activity, muscle contraction, cardiac activity, secretions in the glands, blood coagulation, etc.

Types of calcium

- About 8 to 10% of plasma calcium is present in **non-ionized** form such as calcium bicarbonate.
- About 40 to 42% of calcium is bound with plasma protein particularly, albumin.

Calcium in bones

- Calcium is constantly removed from the bone and deposited in bone.
- The process of calcium metabolism is explained schematically in the following figure



Schematic diagram showing calcium metabolism. The values belong to adults

Sources of calcium

- **Dietary Source**
- Available in several foodstuffs such as milk, cheese, vegetables, meat, egg, grains, sugar, coffee, tea, chocolate, etc.

- **From Bones**
- Besides dietary calcium, blood also gets calcium from bone by resorption.

Daily requirements of calcium

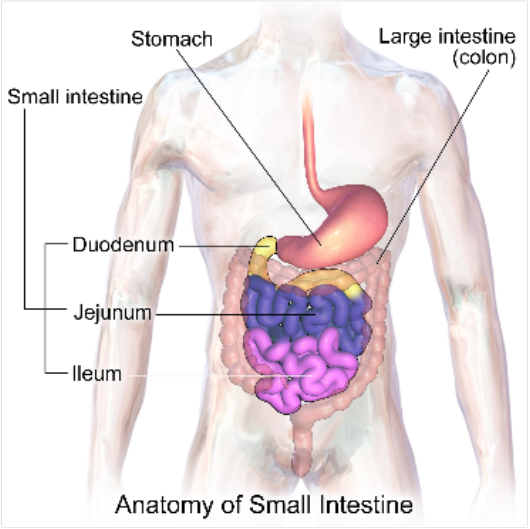
- 1 to 3 years = 500 mg
- 4 to 8 years = 800 mg
- 9 to 18 years = 1,300 mg
- 19 to 50 years = 1,000 mg
- 51 years and above = 1,200 mg
- Pregnant ladies and lactating mothers = 1,300 mg

Absorption and excretion of calcium

- Calcium taken through dietary sources is absorbed from the GI tract into the blood and distributed to various parts of the body.
- Depending upon the blood level, the calcium is either deposited in the bone or removed from the bone (resorption).
- Calcium is excreted from the body through urine and faeces.

Absorption from GI Tract

- Calcium is absorbed from the duodenum by **carrier-mediated active transport**
- It is absorbed from the rest of the small intestine by **facilitated diffusion**.
- Vitamin D is essential for the absorption of calcium from the GI tract.



Excretion

- While passing through the kidney, a large quantity of calcium is filtered in the glomerulus.
- From the filtrate, 98 to 99% of calcium is reabsorbed from renal tubules into the blood.
- Only a small quantity is excreted through urine.

- Most of the filtered calcium is reabsorbed in **the ascending limb of the loop of Henle and distal convoluted tubules**

Excretion

- In the distal convoluted tubule parathormone increases the reabsorption of calcium.
- In the collecting duct vitamin D increases reabsorption and calcitonin decreases reabsorption.
- About 1,000 mg of calcium is excreted daily.
- Out of this, 900 mg is excreted through faeces and 100 mg through urine.

Regulation of blood calcium level

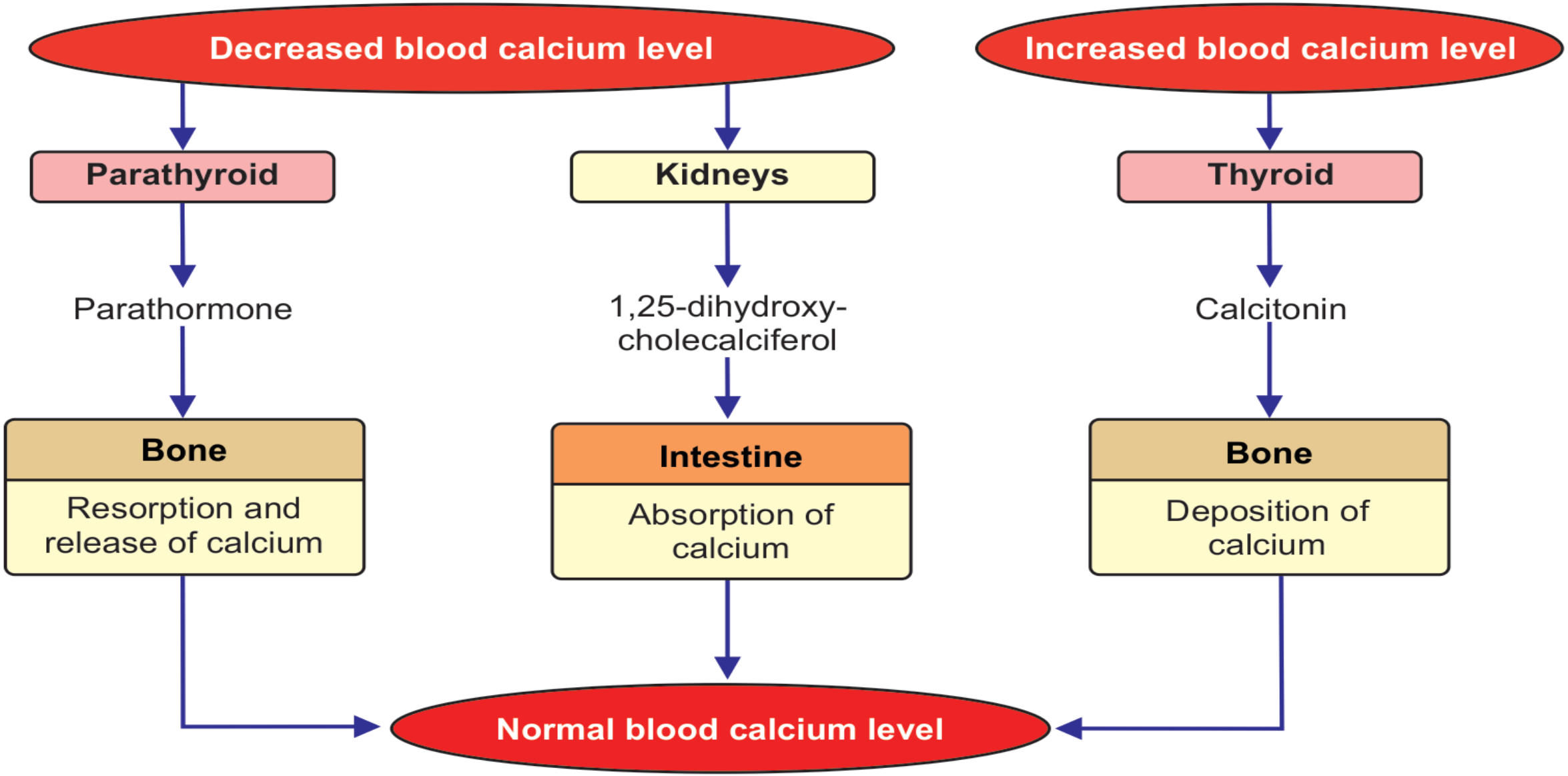
- Calcium metabolism is regulated mainly by three hormones:
- Parathormone.
- 1,25-dihydroxycholecalciferol (calcitriol).
- Calcitonin.

- **Parathormone**
- It is a protein hormone secreted by the parathyroid gland
- Its main function is to increase the blood calcium level by mobilizing calcium from bone (resorption)

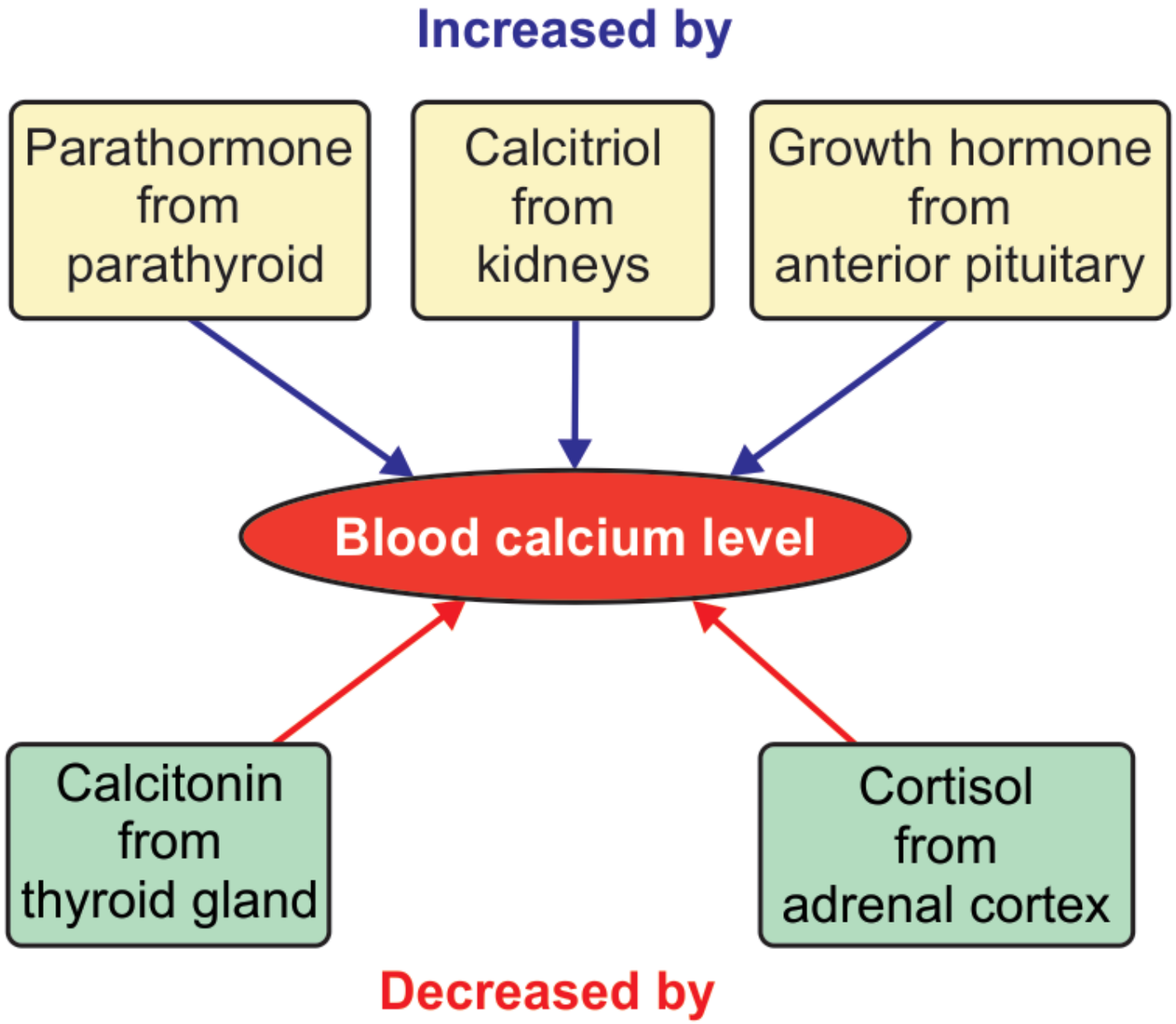
Regulation of blood calcium level

- **1,25-dihydroxycholecalciferol – Calcitriol**
- It is a steroid hormone synthesized in the kidney.
- It is the activated form of vitamin D.
- Its main action is to increase the blood calcium level by increasing the calcium absorption from the small intestine.

- **Calcitonin**
- It is a protein hormone secreted by parafollicular cells of the thyroid gland.
- It is a calcium-lowering hormone.
- It reduces the blood calcium level mainly by decreasing bone resorption.



Schematic diagram showing regulation of blood calcium level



Effect of hormones on blood calcium level

Effects of Other Hormones

- In addition to the above-mentioned three hormones, growth hormone and glucocorticoids also influence the calcium level.

- **Growth hormone:** It increases the blood calcium level by increasing the intestinal calcium absorption.
- **Glucocorticoids:** Glucocorticoids (cortisol) decrease blood calcium by inhibiting intestinal absorption and increasing the renal excretion of calcium.
- **Thyroid hormone:** It increases the blood calcium level

Calcium metabolism disorders

These have been discussed in the last lecture under disorders of the parathyroid gland!

- **Hypocalcemic tetany**
- **Latent tetany**
- **Hypercalcemia**

Useful links

- https://www.youtube.com/watch?v=SWv-aY4RH3c
- https://www.youtube.com/watch?v=lLXTn5gsNUw
- https://www.youtube.com/watch?v=aJ1I8LR-b7c
- https://www.youtube.com/watch?v=JYQL7JEsF_4