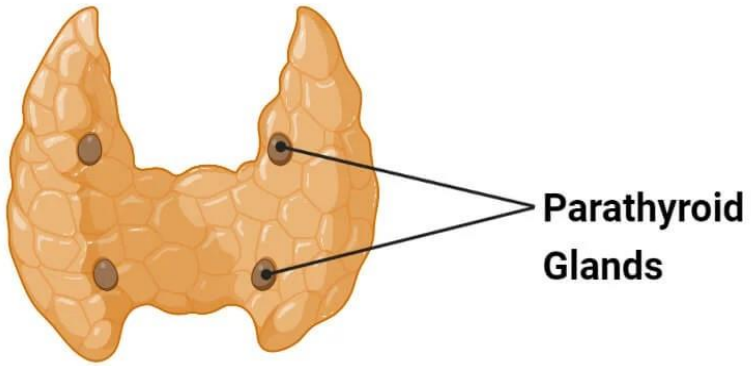
ORAL BIOLOGY AND PHYSIOLOGY

COURSE CODE: 1601106

2 CREDIT UNITS



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Week 12, Lecture 1

Intended Learning Outcomes

- To describe the relationship between PTH and minerals
- To understand the regulation of PTH secretion
- To describe the disorders of the parathyroid glands

Effect of PTH on calcium and phosphate

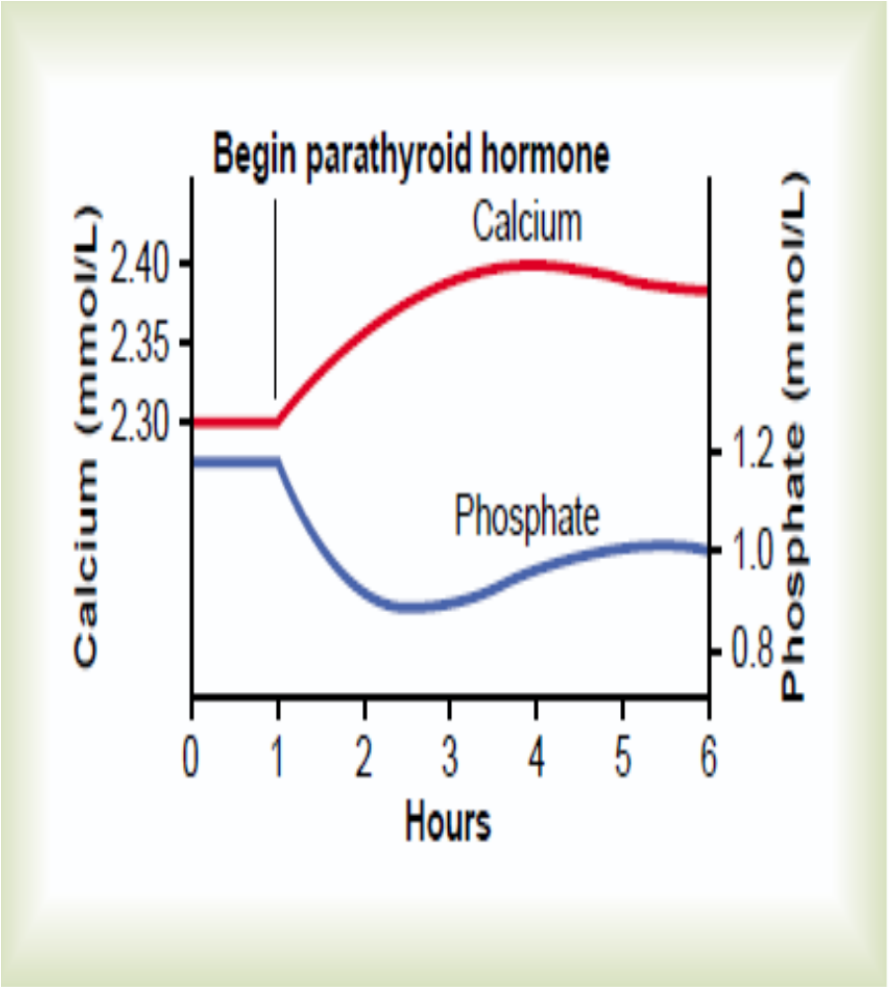
- PTH increases plasma calcium concentrations by:
  - Increasing calcium and phosphate resorption from the bone
  - Decreasing renal excretion of calcium (with its fast action)

- Rapid phase of calcium and phosphate resorption: osteolysis
- Slow phase of bone resorption and calcium phosphate release: activation of the osteoclasts

- Osteoclasts do not themselves have membrane receptors for PTH

PTH decreases calcium excretion and increases phosphate excretion by the kidneys

- PTH causes rapid loss of phosphate in the urine, by decreasing its tubular reabsorption
- In contrast, PTH increases tubular reabsorption of calcium
- The increased calcium absorption occurs mainly in the late distal tubule and collecting tubules
- PTH increases intestinal absorption of calcium and phosphate (Vitamin D)

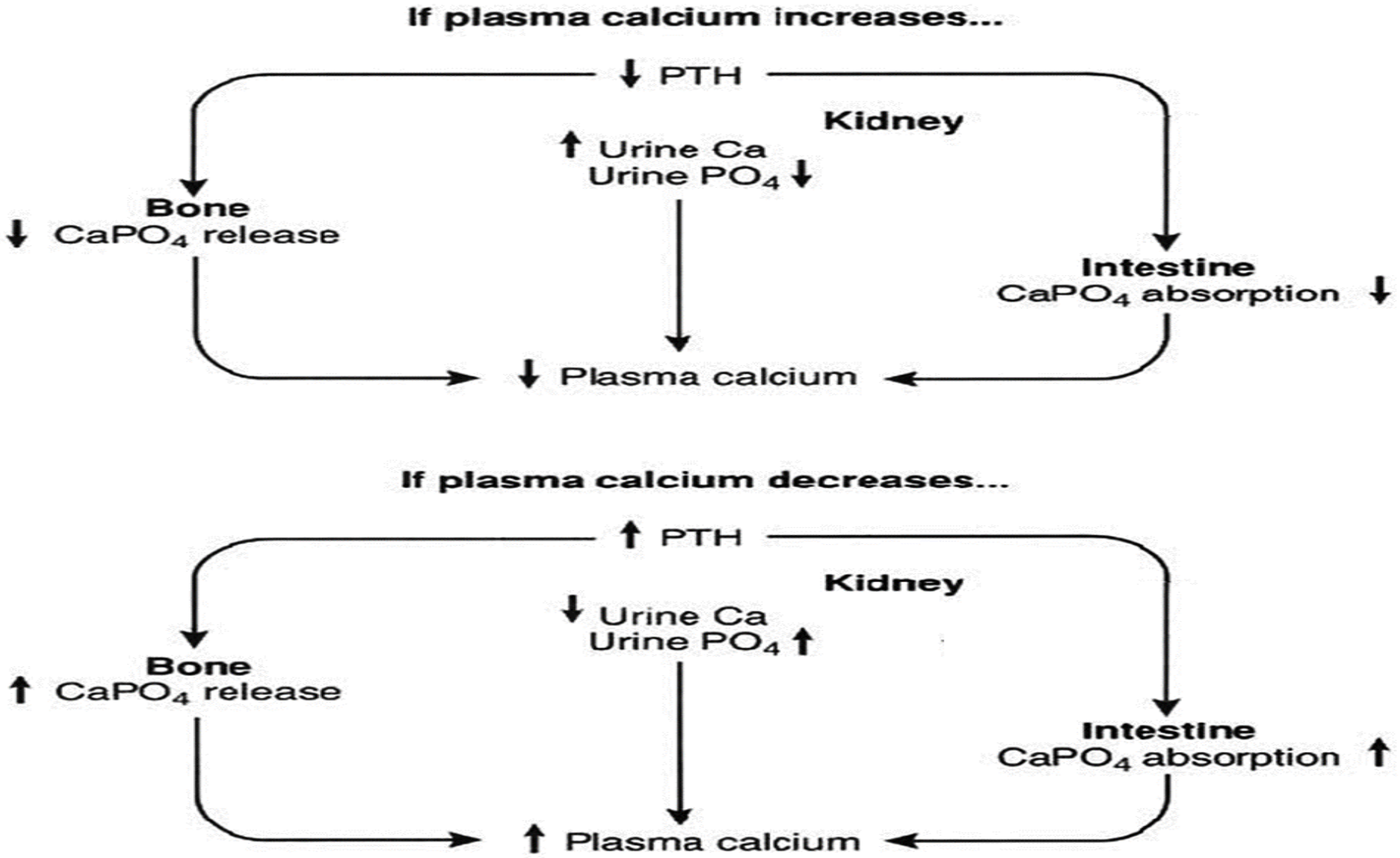


Regulation of PTH secretion

- Blood level of calcium is the main factor that regulates the secretion of PTH.
- *PTH secretion is inversely proportional to blood calcium level*.
- Increase in blood calcium level decreases PTH secretion.
- *PTH secretion is directly proportional to blood phosphate level.*
- Whenever the blood level of phosphate increases, it combines with ionized calcium to form calcium hydrogen phosphate.

- This decreases ionized calcium level in the blood which stimulates PTH secretion

Regulation of PTH secretion

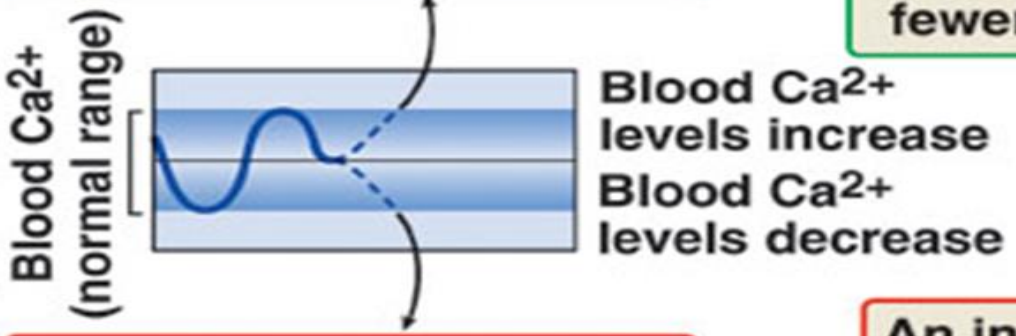


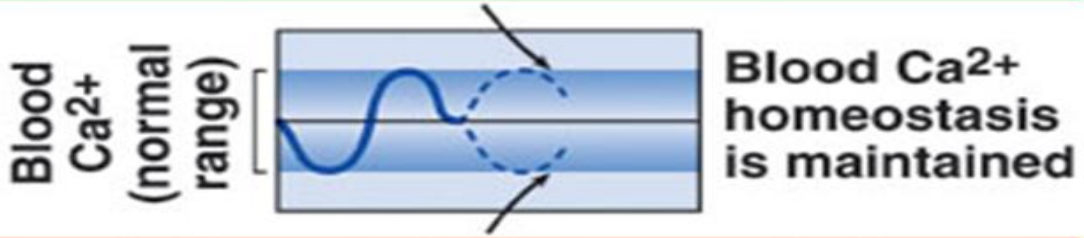
Decreased secretion of PTH from the parathyroid glands results.

- Decreased breakdown of bone by osteoclasts results in decreased release of Ca^{2+} from bone.
- Decreased reabsorption of Ca^{2+} by the kidneys results in increased Ca^{2+} loss in the urine.
- Decreased synthesis of active vitamin D by the kidneys results in decreased Ca^{2+} absorption from the small intestine.

An increase in blood Ca^{2+} levels is detected by the cells of the parathyroid glands.

A decrease in blood Ca^{2+} levels results because fewer Ca^{2+} enter the blood than leave the blood.





A decrease in blood Ca^{2+} levels is detected by the cells of the parathyroid glands.

An increase in blood Ca^{2+} levels results because more Ca^{2+} enter the blood than leave the blood.

An increased secretion of PTH from the parathyroid glands results.

- Increased breakdown of bone by osteoclasts results in increased release of Ca^{2+} from bone.
- Increased reabsorption of Ca^{2+} by the kidneys results in decreased Ca^{2+} loss in the urine.
- Increased synthesis of active vitamin D by the kidneys results in increased Ca^{2+} absorption from the small intestine.

DISORDERS OF THE PARATHYROID GLANDS

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Hypoparathyroidism

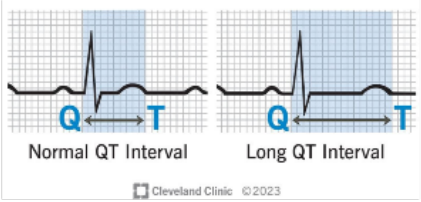
- **Causes**
- Surgical removal of the parathyroid glands (parathyroidectomy).
- Removal of the parathyroid glands during surgical removal of thyroid gland (thyroidectomy).
- Autoimmune disease
- Deficiency of receptors for PTH in the target cells.
- *In this, PTH secretion is normal or increased but the hormone cannot act on the target cells. This condition is called pseudohypoparathyroidism.*

Hypocalcemic Tetany

- Tetany is an abnormal condition characterized by painful muscular spasm in the feet and hand due to calcium deficiency.
- The signs and symptoms of hypocalcemic tetany are :
  - Hyperreflexia and convulsions
  - Carpo-pedal spasm in the hands and feet: During the spasm, the hand shows a peculiar attitude with flexion at wrist joint and metacarpophalangeal joints, adduction of the thumb, and extension of interphalangeal joints
  - Laryngeal stridor. It means a loud crowing sound during inspiration which occurs mainly due to laryngospasm.

Hypocalcemic Tetany

- Cardiovascular changes
  - Dilatation of the heart, hypotension and heart failure.
  - Arrhythmias and ECG changes (prolonged duration of ST segment and QT interval).
  - Other features
  - Decreased permeability of the cell membrane, dry skin with brittle nails, seizures, hair loss and mental retardation in children or dementia in adults.



➢ *NB: During such severe hypocalcemia conditions, tetany occurs so quickly that a person develops spasm of different groups of muscles in the body. Worst affected are the laryngeal and bronchial muscles which develop respiratory arrest resulting in death.*

SIGNS OF HYPOCALCEMIA

NORMAL CALCIUM LEVEL 8.6-10.3 MILIIGRAM/DL

CHOVSTEK SIGN

TAPPING ON THE COURSE OF FACIAL NERVE, BETWEEN ZYGOMATIC ARCH & ANGLE OF MANDIBLE GIVES CONTRACTION OF FACIAL MUSCLES ALONG ONE SIDE OF FACE.

MEANS POSITIVE CHOVSTEK SIGN.

TROUSSEAU SIGN

BP CUFF WHEN INFLATED HIGHER THEN PERSON'S SYSTOLIC BP FOR 2 MINUTES IT GIVES SPASM OF HAND. (CARPOPEDAL SPASM)

ERB'S SIGN

HYPER-EXCITABILITY OF MUSCLE BY SUB-THRESHOLD ELECTRICAL STIMULUS CALLED ERB'S SIGN.

LARYNGEAL STRIDOR

HEARD IN CHRONIC HYPOCALCEMIA.

RJD'S MEDIX

Latent Tetany

- Latent or subclinical tetany is the neuromuscular hyperexcitability due to hypocalcemia that develops before the onset of tetany.
- It is characterized by general weakness and cramps in the feet and hands.
- The hyperexcitability in these patients is detected by some signs, which do not appear in normal persons:

- Trousseau's sign: It is the spasm of the hand that is developed after 3 minutes of arresting the blood flow to lower arm and hand.
- The blood flow to the lower arm and hand is arrested by inflating the blood pressure cuff 20 mm Hg above the patient's systolic pressure.

Trousseau's sign

Trousseau sign of latent tetany is a medical sign observed in patients with low calcium.

Latent Tetany

- Chvostek's sign: it is the twitch of the facial muscles caused by a gentle tap over the facial nerve in front of the ear.

❖ It is due to the hyperirritability of facial nerve.

- Erb's sign: hyperexcitability of the skeletal muscles even to a mild electrical stimulus is called Erb's sign.

❖ It is also called Erb-Westphal sign.

Hyperparathyroidism

- Hyperparathyroidism results in hypercalcemia
- **Causes:**
  - Tumor in the parathyroid glands.
  - Compensatory hypertrophy of the parathyroid glands in response to hypocalcemia which occurs due to other pathological conditions such as chronic renal failure, vitamin D deficiency and rickets.
  - Hyperplasia (abnormal increase in the number of cells) of all the parathyroid glands.

Signs and symptoms

- Depression of the nervous system and reflex activities
- Reduced ST segment and QT interval in ECG.
- Lack of appetite.
- Constipation.

- The depressive effects of hypercalcemia are noticed when the blood calcium level increases to 12 mg/dL.
- The condition becomes severe with 15 mg/dL and it becomes lethal when blood calcium level reaches 17 mg/dL.

Parathyroid poisoning

- It is a condition characterized by severe manifestations that occur when blood calcium level rises above 15 mg/dL along with increase in phosphate level leading to formation of calcium-phosphate crystals.
- The calcium-phosphate crystals may be deposited in the tubules of the kidneys, thyroid gland, alveoli of lungs, gastric mucosa and in the wall of the arteries.
- Calcium deposition results in dysfunction of these organs.
- Renal stones are formed when it is deposited in kidney.

Useful links

- https://www.youtube.com/watch?v=nko-JXU-c28&t=149s