17.6 The Parathyroid Glands Secrete Parathyroid Hormone, which Regulates Calcium, Magnesium, and Phosphate Ion Levels

Partially embedded in the posterior surface of the lateral lobes of the thyroid gland are several small, round masses of tissue called the parathyroid glands (*para-* = beside). Each parathyroid gland has a mass of about 40 mg (0.04 g). Usually, one superior and one inferior parathyroid gland are attached to each thyroid lobe (Figure 17-12a, d).

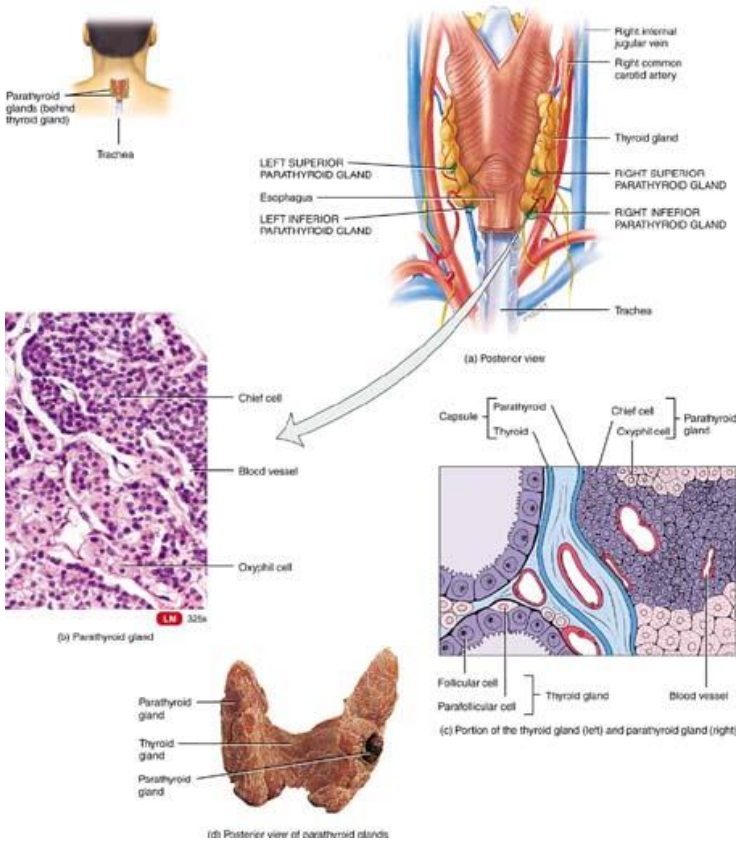


FIGURE 17-12 Location and histology of the parathyroid glands

The parathyroid glands, normally four in number, are embedded in the posterior surface of the thyroid gland.

Microscopically, the parathyroid glands contain two kinds of epithelial cells (Figure17-12b, c). The more numerous cells, called chief cells, produce parathyroid hormone (PTH). The function of the other kind of cell, called an *oxyphil cell*, is not known.

Parathyroid Hormone

Parathyroid hormone is the major regulator of the levels of calcium (Ca^{2+}), magnesium (Mg^{2+}), and phosphate (HPO_4^{2-}) ions in the blood. Blood calcium level directly controls the secretion of both calcitonin and parathyroid hormone through negative feedback, and the two hormones have opposite effects on blood Ca^{2+} level (Figure 17-13):

1A higher-than-normal level of calcium ions (Ca^{2+}) in the blood stimulates parafollicular cells of the thyroid gland to release more calcitonin.

2Calcitonin inhibits the activity of osteoclasts, decreasing the release of Ca^{2+} into the blood from bone extracellular matrix, resulting in decreased blood Ca^{2+} level.

3A lower-than-normal level of Ca^{2+} in the blood stimulates chief cells of the parathyroid gland to release more PTH.

4PTH promotes resorption of bone extracellular matrix by osteoclasts, which releases Ca^{2+} into the blood, and slows loss of Ca^{2+} in the urine, raising the blood level of Ca^{2+}.

5PTH also stimulates the kidneys to synthesize calcitriol, the active form of vitamin D.

6Calcitriol stimulates increased absorption of Ca^{2+} from foods in the gastrointestinal tract, which helps increase the blood level of Ca^{2+}.

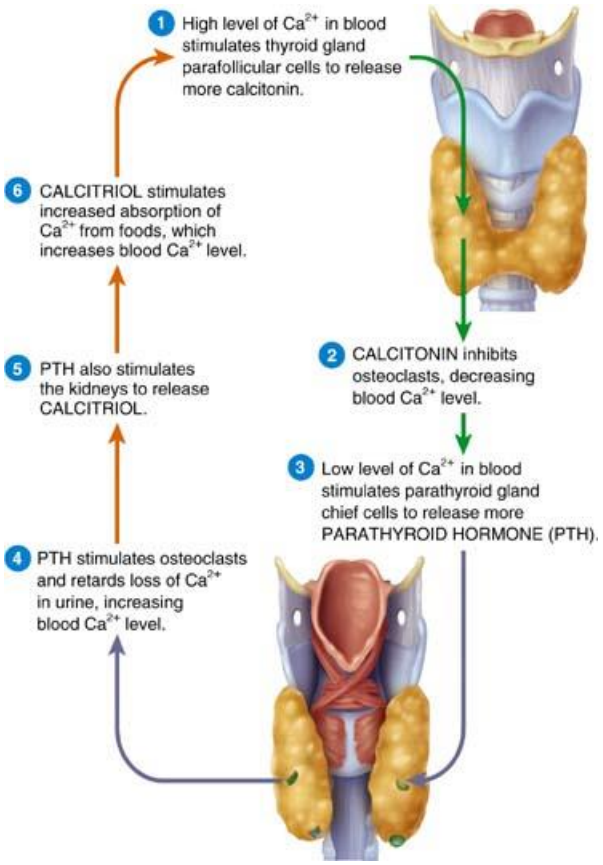


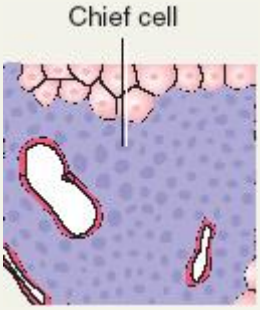
FIGURE 17-13 The roles of calcitonin (green arrows), parathyroid hormone (blue arrows), and calcitriol (orange arrows) in homeostasis of blood calcium levels

Calcitonin and PTH have opposite effects on the level of calcium ions (Ca^{2+}) in the blood.

PTH increases the number and activity of osteoclasts, which releases calcium (Ca^{2+}) and phosphates (HPO_4^{2-}) in bone to the blood. PTH also acts on the kidneys. First, it slows the rate at which Ca^{2+} and Mg^{2+} are lost from blood into the urine. Second, it increases loss of HPO_4^{2-} from blood into the urine. Because more HPO_4^{2-} is lost in the urine than is gained from the bones, PTH decreases blood HPO_4^{2-} level and increases blood Ca^{2+} and Mg^{2+} levels. A third effect of PTH on the kidneys is to promote formation of the hormone calcitriol, the active form of vitamin D. Calcitriol acts on the gastrointestinal tract to increase the rate of Ca^{2+}, HPO_4^{2-}, and Mg^{2+} absorption from food within the gastrointestinal tract into the blood.

Table 17-7 summarizes control of secretion and the principal actions of parathyroid hormone.

Table 17-7 Summary of Parathyroid Gland Hormone

Hormone and Source
Parathyroid hormone (PTH) from chief cells

Control of Secretion
Low blood Ca^{2+} levels stimulate secretion. High blood Ca^{2+} levels inhibit secretion.
Principla Actions
Increases blood Ca^{2+} and Mg^{2+} levels and decreases blood phosphate level; increases bone resorption by osteoclasts; increases Ca^{2+} reabsorption and phosphate excretion by kidneys; and promotes formation of calcitriol (active form of vitamin D), which increases rate of dietary Ca^{2+} and Mg^{2+} absorption.

Check Point

32. What are the primary target tissues for PTH and calcitriol?

33. How is secretion of parathyroid hormone regulated?

34. In which ways are the actions of PTH and calcitriol similar and different?

35. If you received a thyroidectomy, should you have any concern regarding your skeletal system?

36. What is the benefit of adding vitamin D to various food products such as milk?

37. Would hypopituitarism affect calcium balance in the body?