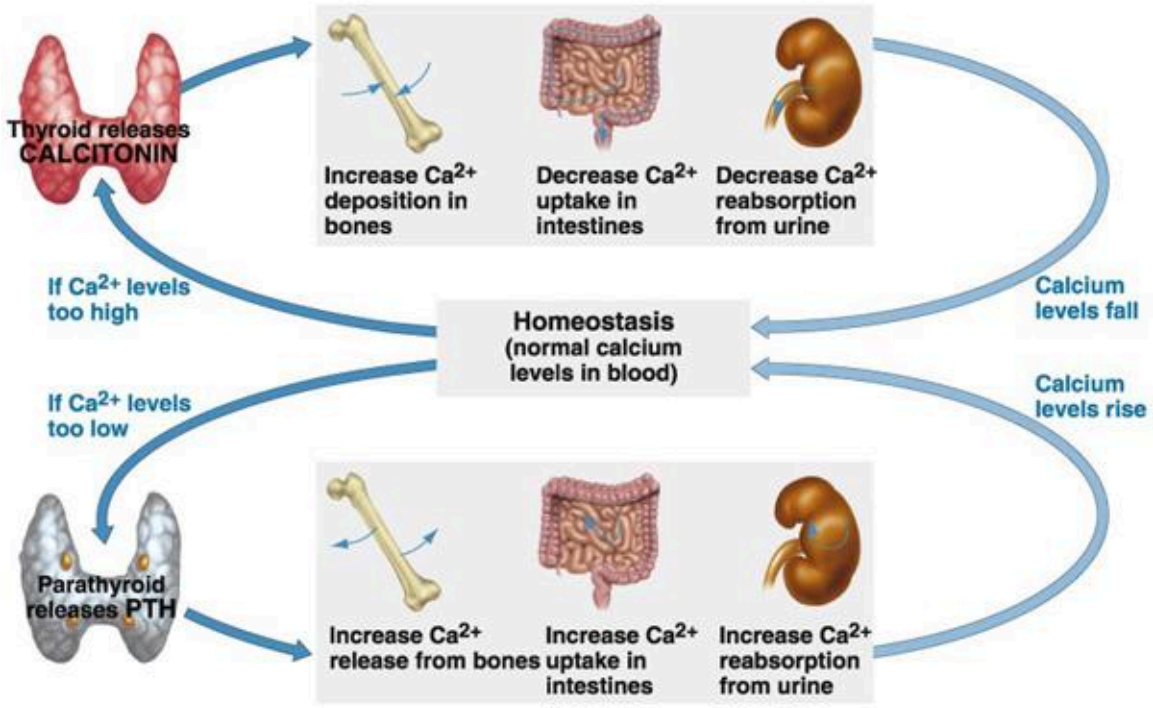
6.1.6

Bone and Blood Calcium Levels

In addition to providing the mineral matrix for bone, calcium is important in many other cellular functions. For example, it is required for muscle contraction and for proper functioning of the nervous system. Because of its many important functions in the body, blood calcium levels are carefully regulated. Fortunately, our bodies have a large reserve of calcium stored in the bones. Release of this calcium is a function of osteoclast vs osteoblast activity. If the osteoblasts form new bone at the same rate that the osteoclasts break it down then there would be no net change in blood calcium. However, if osteoclast activity were to exceed the osteoblast activity then there would be an increase in blood calcium and if osteoclast activity were less than osteoblast activity there would be a reduction in blood calcium. One important regulator of blood calcium levels is parathyroid hormone (PTH), which is secreted by the parathyroid glands. PTH secretion is regulated via negative feedback based on blood calcium levels. Reduced blood calcium levels trigger the release PTH whereas increases in blood calcium reduced PTH release. PTH has several actions that tend to increase blood calcium levels. First, in the kidneys it decreases calcium excretion in the urine by increasing its reabsorption in the kidney tubules. Second, it stimulates vitamin D production. Vitamin D is important for absorption of calcium in the small intestine. In the kidneys vitamin D works with PTH to increase calcium reabsorption. Finally, PTH increases osteoclast activity to increase resorption of calcium from the bone. However, osteoclasts do not have PTH receptors, therefore PTH brings about this action indirectly. Unlike osteoclasts, osteoblasts do have PTH receptors and when PTH binds to these receptors it triggers the release of cytokines that increase the activity of the osteoclasts. These cytokines also act on the osteoclast precursor cells (monocytes) resulting in the formation of new osteoclasts. These actions result in an increase in bone resorption, which raises blood calcium levels. The maintenance of blood calcium is so important that under conditions of chronic low blood calcium, PTH will continue taking calcium from the bones causing the bones to become weak. This is the main cause of osteoporosis seen in elderly people.

Another hormone involved in calcium metabolism is calcitonin. Calcitonin secretion is stimulated by high blood calcium levels and inhibited by low calcium levels. Calcitonin binds to receptors on the osteoclasts and inhibits their activity thus decreasing resorption of calcium from the bone. Having said that, it is not clear if this action is physiologically significant. With total thyroidectomy which removes all of the calcitonin secreting cells, blood calcium levels remain normal, provided the parathyroid glands are not removed. Also, in the presence of calcitonin secreting tumors, which greatly elevate calcitonin levels, there is no decrease in blood calcium levels.

See the next image that illustrates the calcium regulation process in our bodies.



Calcium regulation through PTH and Calcitonin. *http://image.wikifoundry.com/image/1/NplUgQNu_rqU5FbkHzP59w127697*