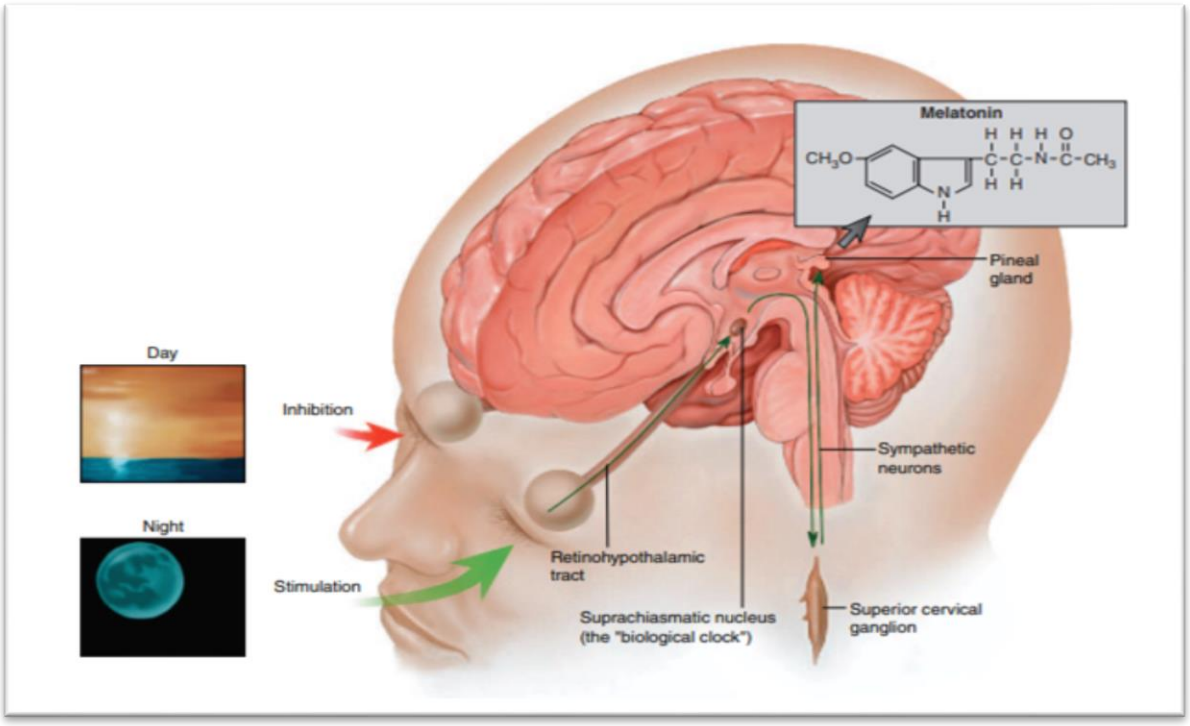
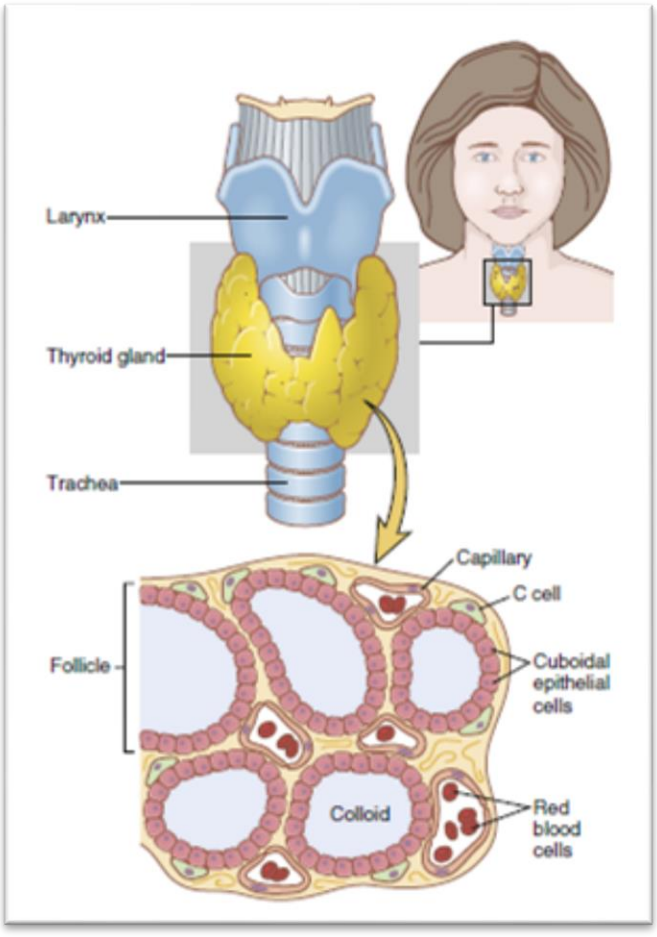
Pineal Gland:

- The small, cone-shaped pineal gland is located in the roof of the third ventricle of the diencephalon, where it is encapsulated by the meninges covering the brain.
- The pineal gland secretes the hormone melatonin.
- Production and secretion of this hormone is stimulated by activity of the suprachiasmatic nucleus (SCN) in the hypothalamus of the brain via activation of sympathetic neurons to the pineal gland.
- The SCN is the primary center for circadian rhythms in the body: rhythms of physiological activity that follow a 24- hour pattern. The circadian activity of the SCN is automatic, but environmental light/dark changes are required to entrain (synchronize) this activity to a day/night cycle. Activity of the SCN, and thus secretion of melatonin, begins to increase with darkness and peaks by the middle of the night. During the day, neural pathways from the retina of the eyes to the hypothalamus act to depress the activity of the SCN, reducing sympathetic stimulation of the pineal and thus decreasing melatonin secretion.



Thyroid Gland:

- Thyroid gland is situated in the neck, immediately below the larynx on each side of and anterior to the trachea,
- It consists of two lobes joined by an isthmus.
- A section of the thyroid shows, under the microscope, clusters of follicles lined by epithelium. The follicles are filled with ‘colloid’, the secretions of the epithelial cells.
- An active thyroid has cuboidal or columnar epithelial cells, but very little colloid in the follicles because the secretions are released promptly into the bloodstream. On the other hand, an inactive (‘resting’ or ‘lazy’) thyroid has follicles lined with flat squamous epithelial cells and full of colloid because whatever secretions are there are stored rather than released. Thus, paradoxical though it may seem, a thyroid having follicles full of colloid is actually inactive. Scattered in the connective tissue between the follicles are cells called parafollicular cells. Parafollicular cells contain numerous secretory granules.
- The epithelium of thyroid follicles produces two hormones: triiodothyronine (T3) and thyroxine (T4). Both of these hormones profoundly increase the metabolic rate of the body. About 93% of the metabolically active hormones secreted by the thyroid gland is thyroxine and 7% is triiodothyronine. However, almost all the thyroxine is eventually converted to triiodothyronine in the tissues, so both are functionally important.



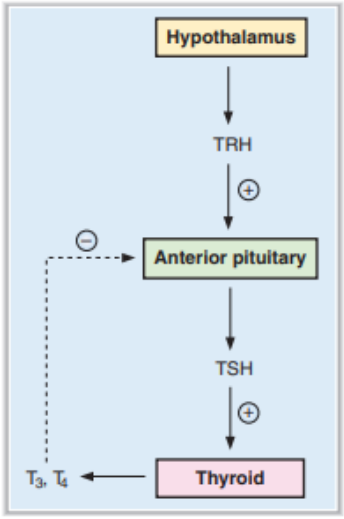
Regulation of thyroid hormone secretion:

1. Hypothalamic–pituitary control—TRH and TSH

   a. TRH is secreted by the hypothalamus and stimulates the secretion of TSH by the anterior pituitary.

   b. TSH increases both the synthesis and the secretion of thyroid hormones by the follicular cells. Chronic elevation of TSH causes hypertrophy of the thyroid gland.

   c. T3 down-regulates TRH receptors in the anterior pituitary and thereby inhibits TSH secretion.



2. Thyroid-stimulating immunoglobulins

■ are components of the immunoglobulin G (IgG) fraction of plasma proteins and are antibodies to TSH receptors on the thyroid gland.

■ bind to TSH receptors and, like TSH, stimulate the thyroid gland to secrete T3 and T4 .

■ circulate in high concentrations in patients with Graves disease, which is characterized by high circulating levels of thyroid hormones and, accordingly, low concentrations of TSH (caused by feedback inhibition of thyroid hormones on the anterior pituitary).

Actions of thyroid hormone

T3 is three to four times more potent than T4 . The target tissues convert T4 to T3 (

1. Growth

■ Attainment of adult stature requires thyroid hormone.

■ Thyroid hormones act synergistically with growth hormone and somatomedins to promote bone formation.

■ Thyroid hormones stimulate bone maturation as a result of ossification and fusion of the growth plates. In thyroid hormone deficiency, bone age is less than chronologic age.

2. Central nervous system (CNS)

a. Perinatal period ■ Maturation of the CNS requires thyroid hormone in the perinatal period.

■ Thyroid hormone deficiency causes irreversible mental retardation. Because there is only a brief perinatal period when thyroid hormone replacement therapy is helpful, screening for neonatal hypothyroidism is mandatory.

b. Adulthood

■ Hyperthyroidism causes hyperexcitability and irritability.

■ Hypothyroidism causes listlessness, slowed speech, somnolence, impaired memory, and decreased mental capacity.

3. Autonomic nervous system

■ Thyroid hormone has many of the same actions as the sympathetic nervous system because it up-regulates β1 -adrenergic receptors in the heart. Therefore, a useful adjunct therapy for hyperthyroidism is treatment with a β-adrenergic blocking agent, such as propranolol.

4. Basal metabolic rate (BMR)

■ O2 consumption and BMR are increased by thyroid hormone in all tissues except the brain, gonads, and spleen. The resulting increase in heat production underlies the role of thyroid hormone in temperature regulation.

■ Thyroid hormone increases the synthesis of Na+ , K+ -ATPase and consequently increases O2 consumption related to Na+ –K+ pump activity.

5. Cardiovascular and respiratory systems

■ Effects of thyroid hormone on cardiac output and ventilation rate combine to ensure that more O2 is delivered to the tissues.

a. Heart rate and stroke volume are increased. These effects combine to produce increased cardiac output. Excess thyroid hormone can cause high output heart failure.

b. Ventilation rate is increased.

6. Metabolic effects

■ Overall, metabolism is increased to meet the demand for substrate associated with the increased rate of O2 consumption.

a. Glucose absorption from the gastrointestinal tract is increased.

b. Glycogenolysis, gluconeogenesis, and glucose oxidation (driven by demand for ATP) are increased.

c. Lipolysis is increased.

d. Protein synthesis and degradation are increased. The overall effect of thyroid hormone is catabolic.

Parathyroid hormone (PTH)

■ is the major hormone for the regulation of serum [Ca2+].

■ is synthesized and secreted by the chief cells of the parathyroid glands which lie just behind the thyroid glands in the neck.

■ Actions of PTH are coordinated to produce an increase in serum [Ca2+] and a decrease in serum [phosphate].

a. PTH increases bone resorption, which brings both Ca^{2+} and phosphate from bone mineral into the ECF. Alone, this effect on bone would not increase the serum ionized [Ca^{2+}] because phosphate complexes Ca^{2+} .

■ Resorption of the organic matrix of bone is reflected in increased hydroxyproline excretion.

b. PTH inhibits renal phosphate reabsorption in the proximal tubule and, therefore, increases phosphate excretion (phosphaturic effect). As a result, the phosphate resorbed from bone is excreted in the urine, allowing the serum ionized [Ca^{2+}] to increase.

■ cAMP generated as a result of the action of PTH on the proximal tubule is excreted in the urine (urinary cAMP).

c. PTH increases renal Ca^{2+} reabsorption in the distal tubule, which also increases the serum [Ca^{2+}].

d. PTH increases intestinal Ca^{2+} absorption indirectly by stimulating the production of 1,25-dihydroxycholecalciferol in the kidney

Calcitonin

■ is synthesized and secreted by the parafollicular cells of the thyroid.

■ secretion is stimulated by an increase in serum [Ca^{2+}].

■ acts primarily to inhibit bone resorption.

■ can be used to treat hypercalcemia.