Thyroid hormones, primarily thyroxine (T4) and triiodothyronine (T3), are fundamental regulators of metabolic rate and energy production in the body. The thyroid gland produces these hormones under the control of thyroid-stimulating hormone (TSH) from the pituitary gland, which in turn is regulated by thyrotropin-releasing hormone (TRH) from the hypothalamus, forming a complex feedback system known as the hypothalamic-pituitary-thyroid axis.

The synthesis of thyroid hormones requires several steps and adequate iodine intake. Thyroid follicular cells trap iodine and incorporate it into thyroglobulin, a protein that serves as the precursor for T3 and T4. The majority of hormone produced is T4, which is considered a prohormone and must be converted to the more active T3 in peripheral tissues through the action of deiodinase enzymes.

These hormones influence nearly every organ system, controlling how quickly the body uses energy, makes proteins, and regulates body temperature. At the cellular level, thyroid hormones enter cells and bind to nuclear receptors, directly influencing gene transcription and protein synthesis. This affects numerous physiological processes, including:

* Basal metabolic rate and heat production
* Cardiac function and heart rate
* Skeletal muscle protein synthesis and breakdown
* Bone development and maintenance
* Central nervous system development
* Gastrointestinal motility
* Reproductive function
* Growth and development

Thyroid disorders can manifest as either overproduction (hyperthyroidism) or underproduction (hypothyroidism) of hormones. Common causes include autoimmune conditions like Graves' disease and Hashimoto's thyroiditis, iodine deficiency or excess, medications, and radiation exposure. Diagnosis typically involves measuring TSH and free hormone levels, while treatment options range from hormone replacement therapy to anti-thyroid medications.