

Hormones that Affect Metabolism

- There are three main glands that affect metabolism: the thyroid gland, the parathyroid gland, and the anterior pituitary gland

The Thyroid Gland

- The thyroid gland produces several hormones, but mostly thyroxine
- These hormones help regulate body metabolism or the rate at which glucose is oxidized
- The thyroid gland is located at the base of the neck, immediately in front of the trachea
- Thyroxine (T₃) regulates body metabolism and the growth and differentiation of tissues
- Thyroxine and the regulation of metabolic rate can explain the reason why some people can eat and not gain weight and others gain weight easily

- Individuals who excrete higher levels of thyroxine oxidize sugars and other nutrients at a faster rate (hyperthyroidism)
- Approximately 60% of the glucose oxidized in the body is released as heat (which explains why these individuals usually feel warm)
- The remaining 40% is transferred to ATP (consumed quickly through activity) which is why these individuals never seem to gain weight

- Individuals who have lower levels of thyroxine do not oxidize nutrients (esp. glucose) quickly
- Excess blood sugar is eventually converted to liver and muscle glycogen
- Once glycogen stores are filled, excess sugar is converted to fat
- The slower the blood sugar is used, the faster fat stores build up
- People who secrete low amounts of thyroxine often experience muscle weakness, cold intolerance and dry skin and hair
- Not all types of weight gain are due to hypothyroidism (low thyroid secretions)

- Thyroid hormones are regulated by negative feedback (see Fig.3, p.385)
- If the metabolic rate decreases, receptors in the hypothalamus are activated
- Nerve cells secrete thyroid-releasing hormone (TRH) which stimulates the pituitary to release thyroid-stimulating hormone (TSH)
- TSH is carried by the blood to the thyroid gland, which in turn releases thyroxine, which raises metabolism
- High levels of thyroxine cause the pathway to be turned off because they inhibit the release of TRH, shutting down the production of TSH
- The thyroid gland also produce calcitonin, that acts on bone cells to lower the levels of calcium in the blood

- Iodine is a component of both thyroid hormones and it is carried from the digestive system through the blood to the follicle cells of the thyroid
- [I] in the cells can be 25 times greater than in the blood
- When inadequate amounts of iodine are obtained from the diet, the thyroid enlarges, producing a goiter (see Fig.4, p.385)
- This emphasizes the importance of a negative feedback system

Parathyroid Glands

- Four small parathyroid glands are hidden within the larger thyroid gland
- Patients who had parts of their thyroid removed (to treat goiters) would then develop rapid, uncontrolled muscle twitching (tetanus) signalling abnormal calcium levels (nerves become easily excited)
- Usually nerves, or other hormones, regulate the endocrine glands
- The parathyroid glands are an exception; they react directly to chemical changes in their immediate surroundings
- Low calcium in the blood signals the release of parathyroid hormone (PTH)
- A rise in PTH levels cause calcium levels in the blood to increase and phosphate levels to decrease (see Fig. 5, p.386)
- PTH causes the kidneys and intestines to retain calcium, while promoting calcium release from bones (98% of the body's Ca is stored in bones)
- The bone cells break down, and calcium is separated from phosphate ions
- Then calcium is reabsorbed and returned to the blood while phosphate is excreted in urine
- This helps conserve calcium that is dissolved in plasma
- Once calcium levels have risen, PTH is inhibited
- High levels of PTH cause bone breakdown, high levels of calcium can collect in blood vessels or form kidney stones
- PTH also helps activate vitamin D, preventing rickets (low levels of Ca & P)

Anterior Pituitary Gland

- The anterior pituitary produces growth hormone (GH) or somatotropin
- Low secretion of GH during childhood results in dwarfism, high secretions result in gigantism
- GH affects most cells in the body, the effect is most pronounced on cartilage and bone cells
- If production of GH continues after the cartilaginous growth plates have been fused, other bones respond
- Once the growth plates have fused, long bones can no longer increase in length, but the bones of the jaw, forehead, fingers and toes increase in width (acromegaly - broadening of the facial features)
- GH causes both an increase in the number of cells (hyperplasia) and the size of cells (hypertrophy)
- GH increases cell size in muscle cells and connective tissue by promoting protein synthesis while inhibiting protein degradation or breakdown
- As a person ages, GH production begins to decline - protein is often replaced by fat, changing the shape of the body
- GH stimulates the production of insulin-like growth factors, produced by the liver
- These factors stimulate cell division in the growth plates, breaks down fat to provide energy for growing muscles
- This additional energy source is essential because it frees up glucose for breakdown in the brain (brain cannot metabolise fat)

Homework

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