Hormones and regulation

Major Endocrine Glands

Male

- Pituitary gland
- Thyroid gland
- Adrenal gland
- Testis

Female

- Pineal gland
- Thymus
- Pancreas
- Ovary

Hormones

- Cholesterol
- Cortisone

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The thyroid gland produces two amine hormones

- $T_4$ and $T_3$

- These regulate development and metabolism

- Negative feedback maintains homeostatic levels of $T_4$ and $T_3$ in the blood
• Thyroid imbalance can cause cretinism, metabolic disorders, and goiter
Hyperthyroidism

- Hyperthyroidism or Grave’s Disease
- This disease causes excess production of thyroid hormones
- Weight loss and exophthalmic goiter

Figure 26.6A, B
Hormones from the thyroid and parathyroids maintain calcium homeostasis

- Blood calcium level is regulated by a tightly balanced antagonism between
  - calcitonin from the thyroid
  - parathyroid hormone from the parathyroid glands
Calcium homeostasis – page 434

**Figure 26.7**

- **Thyroid gland** releases calcitonin.
- **Calcitonin**
  - Stimulates Ca\(^{2+}\) deposition in bones.
  - Reduces Ca\(^{2+}\) uptake in kidneys.

**STIMULUS:**
- **Rising blood Ca\(^{2+}\) level (imbalance)**
- **Calcium homeostasis:** Normal blood calcium level (about 10 mg/100 mL).

**STIMULUS:**
- **Falling blood Ca\(^{2+}\) level (imbalance)**

**Parathyroid glands** release parathyroid hormone (PTH).
- **PTH**
  - Stimulates Ca\(^{2+}\) release from bones.
  - Increases Ca\(^{2+}\) uptake in kidneys.
  - Increases Ca\(^{2+}\) uptake in intestines.
  - Increases Ca\(^{2+}\) uptake in kidneys.

**Active vitamin D**
- Stimulates Ca\(^{2+}\) release from bones.
Blood glucose levels are controlled by two antagonistic hormones secreted by the pancreas:

- Insulin signals cells to use and store glucose as glycogen
- Glucagon signals cells to release stored glucose into the blood
Glucose homeostasis page 438

Figure 26.8

- **STIMULUS:** Rising blood glucose level (e.g., after eating a carbohydrate-rich meal)
- **Insulin:**
  - Beta cells of pancreas stimulated to release insulin into the blood
  - Body cells take up more glucose
  - Blood glucose level declines to a set point; stimulus for insulin release diminishes
  - Liver takes up glucose and stores it as glycogen

- **Homeostasis:** Normal blood glucose level (about 90 mg/100 mL)

- **STIMULUS:** Declining blood glucose level (e.g., after skipping a meal)
- **Glucagon:**
  - Alpha cells of pancreas stimulated to release glucagon into the blood
  - Liver breaks down glycogen and releases glucose to the blood
  - Blood glucose level rises to set point; stimulus for glucagon release diminishes
  - Liver takes up glucose and stores it as glycogen

- **Blood glucose level** declines to a set point; stimulus for insulin release diminishes
Connection: Diabetes is a common endocrine disorder

• Diabetes mellitus is a serious hormonal disease
  – Body cells are unable to absorb glucose from the blood

• There are two types of diabetes
• Type I (insulin-dependent) diabetes
  – Autoimmune disease in which pancreatic beta cells are destroyed and thus not enough insulin is produced
  – Often develops before age 15
  – Patient requires insulin supplement, often by injection
• Type II (non-insulin-dependent) diabetes
  – Pancreatic cells function properly and there are sufficient amounts of insulin produced
  – Body cells fail to respond to insulin
  – Accounts for 90% of diabetes cases in the United States
  – Associated with obesity
  – Often develops after age 40
  – Manageable
• The diagnostic test for diabetes is a glucose-tolerance test
The adrenal glands mobilize responses to stress

- Hormones from the adrenal glands help maintain homeostasis when the body is stressed

- Adrenal medulla
  - Nervous signals from the hypothalamus stimulate secretion of epinephrine and norepinephrine
  - These quickly trigger the fight or flight response
Adrenal cortex

- Chemical signals (ACTH) stimulate secretion of corticosteroids, including glucocorticoids and mineralocorticoids
- Corticosteroids boost blood pressure and energy in response to long-term stress
• How the adrenal glands control our responses to stress

Figure 26.10

**SHORT-TERM STRESS RESPONSE**
1. Glycogen broken down to glucose; increased blood glucose
2. Increased blood pressure
3. Increased breathing rate
4. Increased metabolic rate
5. Change in blood-flow patterns, leading to increased alertness and decreased digestive and kidney activity

**LONG-TERM STRESS RESPONSE**
1. Retention of sodium ions and water by kidneys
2. Increased blood volume and blood pressure
3. Proteins and fats broken down and converted to glucose, leading to increased blood glucose
4. Immune system may be suppressed
Connection: Glucocorticoids offer relief from pain, but not without serious risks

• Athletes often take glucocorticoids
  – They relieve pain and inflammation
  – But they also mask the injury and suppress immunity
  – Example: cortisone

Figure 26.11
The gonads secrete sex hormones

- The gonads secrete sex hormones
  - Secretion is controlled by the hypothalamus and the pituitary

- The steroid hormones are found in both sexes but in different proportions
  - estrogens
  - progestins
  - androgens
• Estrogen and progestins
  – maintain the female reproductive system
  – stimulate the development of female characteristics
Androgens, such as testosterone, trigger the development of male characteristics

- In male elephant seals, androgens account for bodies weighing 2 tons or more, a thick hide, and aggressive behavior

Figure 26.12
Pineal Gland
Pineal Gland

- Its principal hormone is melatonin.
- Synthesis and release of melatonin is stimulated by darkness and inhibited by light.
- Levels of melatonin in the blood rises and falls on a daily (circadian) cycle with peak levels occurring in the wee hours of the morning.
- Ingesting even modest doses of melatonin raises the melatonin level in the blood. These levels appear to promote going to sleep and thus help insomnia.
Cushing’s Syndrome

• Cushing's syndrome is a hormonal disorder caused by prolonged exposure of the body's tissues to high levels of the hormone cortisol.

• Symptoms vary, but most people have upper body obesity, rounded face, increased fat around the neck, and thinning arms and legs. Children tend to be obese with slowed growth rates.

• Treatment depends on the specific reason for cortisol excess and may include surgery, radiation, chemotherapy or the use of cortisol-inhibiting drugs.
Addison Disease

- Addison's disease is characterized by weight loss, muscle weakness, fatigue, low blood pressure, and sometimes darkening of the skin.

- Addison's disease occurs when the adrenal glands do not produce enough of the hormone cortisol and, in some cases, the hormone aldosterone. The disease is also called adrenal insufficiency, or hypocortisolism (hyposecretion).
Gigantism

- Acromegaly/Gigantism is a very rare disease and syndrome results from a chronic exposure to GH (Growth Hormone) leading to the classic clinical features that the diagnosis seems to be easy.

- High exposure to GH produces **gigantism** in youths prior to epiphyseal fusion and **acromegaly** in adults.

- In adults, the syndrome is characterized by local overgrowth of bone (skull, mandible).
Dwarfism

• Dwarfism results from growth hormone deficiency. A pituitary dwarf has too little growth hormone. The achondroplastic dwarf has an orthopedic reason for having short limbs and a short spinal column.

• Cause of this is unknown, a tumor or cyst in the pituitary area may cause dwarfism.
Dwarfism
• HEY! Quiz next day on page 422 (diagram) and one of the three feedback loops (thyroxine, calcitonin / PTH or insulin/glucagon).