**Body control systems**

- **Nervous system**
  - Controls body activities thru nerve impulses and neurotransmitters
  - Quick
  - Sends message directly to target organ

- **Endocrine system**
  - Controls body activities by releasing hormones
  - Slower responses
  - Broader influence

**Endocrine System**

- Endocrine glands release hormones into bloodstream
- Hormones are carried to all cells of the body, but only affect certain cells
- Regulate the metabolism of target cells

**Why do hormones only affect certain cells?**

- Hormones only affect target cells, cells that have receptors for that specific hormone

**Classes of hormones**

- **Peptide hormones**
  - Short chains of amino acids
  - Most common type of hormone
  - Water soluble, circulate in a "free" form (not attached to plasma proteins)

- **Steroid hormones**
  - Lipid-soluble, can diffuse thru cell membranes
  - Bind to transport proteins in blood
**Action of peptide hormones**
- Hormone binds to a plasma membrane receptor
- Activates a signal transduction pathway in the cell
- Alters cell functions

**Action of steroid hormones**
1. Diffuse thru membrane
2. Bind to receptors inside target cells
3. The hormone-receptor complex binds to the DNA and alters gene expression
4. New proteins are made → changes the cell’s activity

**Mechanism of action: estrogen**
- Estrogen stimulates cell growth in the breast and other parts of the body
- Binds to estrogen receptors inside the cell
- Switches on/off gene transcription

**“Master” endocrine glands: the hypothalamus and pituitary**
- Hypothalamus — major link between nervous and endocrine system
- Hypothalamus secretes 9 hormones, the pituitary secretes 7.
- Together these hormones regulate all aspects of growth, development, metabolism, and homeostasis

**The Hypothalamus**
- Is the main control center of the endocrine system.
- Integrates nervous and endocrine control
  - Receives information from the nervous system
  - Secretes hormones
- It controls secretion of hormones by the pituitary gland

**Pituitary Gland**
- The pituitary gland is located in the sphenoid bone
- Two lobes
  - Anterior pituitary
  - Posterior pituitary
The posterior pituitary
- Is actually an extension of the hypothalamus
- It stores and secretes hormones made in the hypothalamus
  - Such as ADH

The anterior pituitary
- Synthesizes and secretes several hormones directly into the blood
  - FSH, LH, and prolactin
- Secretion regulated by hormones from the hypothalamus
  - Negative feedback

Control of Hormone Secretion
- Most hormones are released in short bursts
- Hormone secretion is controlled by:
  1. Signals from the nervous system
  2. Chemical changes in the blood
  3. Other hormones
- Most hormone secretion is regulated by negative feedback

Human growth hormone
- Has a broad effect on the body
- Causes cells in liver, muscles, bones and other tissues to grow and multiply
- Increase breakdown of fat in adipose tissue
- Releases fatty acids for ATP production

Pituitary gland disorders
- Disorders of hGH secretion
  - Overproduction of hGH during childhood
    - Giantism
  - Overproduction of hGH during adulthood results in acromegaly
    - Enlarged bones in hands, feet and face

Pituitary gland disorders
- Disorders of hGH secretion
  - Underproduction of hGH during childhood
    - Dwarfism
Hormones regulate the rate of metabolism

- Thyroxine (T3/T4)
  - Secreted by the thyroid gland
  - Increases the metabolic rate
- hGH
- Insulin

Thyroid Gland

- Located in the neck
- Thyroid follicles produce thyroid hormones
  - T4 = Thyroxine
  - T3 = Triiodothyronine
  - Both increase BMR, stimulate cell metabolism

Thyroid Gland Disorders: hypothyroidism

- Too little thyroid hormone
- Results from dietary deficiency of iodine or from a defective thyroid gland
- Sx: Goiter • enlargement of the thyroid gland
- Congenital hypothyroidism during fetal life or infancy → severe mental retardation (cretinism)

T3 and T4 production

- Low blood T3/T4 or low metabolic rate
- Release of TRH
- Release of TSH
- Synthesis of T3 and T4 by thyroid gland
- Negative feedback

Actions of T3/T4

- Affect most body cells • have receptors for thyroid hormones
- Increase basal metabolic rate (BMR)
- Increase body temperature
- Growth and development
  - Stimulate protein synthesis
  - Increase use of glucose and fatty acids for ATP production

Why does the thyroid gland enlarge?
Hyperthyroidism
- Excess thyroid hormones
- The most common form of hyperthyroidism is Graves' disease
- An autoimmune disease
- Produce antibodies that mimic the action of TSH and continually stimulate the thyroid gland
- Sx: enlarged thyroid, protruding eyes (exophthalmos)

Hormones and homeostasis
- Control of blood glucose
  - Insulin
  - Glucagon
- Calcium homeostasis
  - Calcitonin
  - Parathyroid hormone (PTH)
  - Vitamin D (calcitriol)

Pancreas
- Produces two antagonistic hormones that regulate the body's energy supplies:
  - Insulin
    - ↓ blood sugar levels
  - Glucagon
    - ↑ blood sugar levels

Pancreatic Disorders
- Diabetes Mellitus
  - Most common endocrine disorder
  - Caused by an inability to produce or use insulin
  - Sx: high blood glucose, glucose "spills" into urine
- Type 1 diabetes (insulin-dependent diabetes)
  - Insulin level is low because the person's immune system destroys the pancreatic beta cells
- Type 2 diabetes
  - Target cells are less sensitive to insulin
  - due to lower # of insulin receptors
  - Gestational diabetes

How insulin stimulates glucose uptake
- In the absence of insulin, the glucose transporters reside within the cell
- Insulin binds to its receptor
- Glucose transporters are moved to plasma membrane
- They are inserted in the membrane, and glucose transport is activated
Type I Diabetes
- Autoimmune disease
- Occurs most often in children and young adults
- Without insulin, cells use fatty acids for energy
- Complications: damage to blood vessels in retina and kidneys
- Rx: insulin injections

Type 2 diabetes
- Most common form
- 90% of diabetics
- 55% are obese
- Insulin resistance
  - body tissues more resistant to the actions of insulin
  - Lower uptake of glucose
- Can be controlled by diet, exercise and weight loss

Gestational diabetes
- Pregnant women who have never had diabetes before but who have high blood glucose levels during pregnancy
- Affects about 4% of all pregnant women
- It may precede development of type 2 diabetes

Calcium homeostasis
- Three hormones regulate blood calcium levels
  - Calcitonin
  - Parathyroid hormone (PTH)
  - Calcitriol (vitamin D)

Why is calcium important?
- Bone formation
- Muscle contraction
- Cardiac muscle action potential
- Blood clotting
- Neurotransmitter release