Homeostasis and Hormones

Bio 11
homeostasis

- A steady state of body functioning - i.e. the body keeps a constant environment no matter what is happening in the external environment.
- Example is temperature
Homeostasis

- Dynamic equilibrium
- Feedback systems
- Negative feedback seen in shivering when the body reaches temp - stop shivering
- Positive feedback seen in labor
Hormones

- Chemical signals that is carried by the circulatory system.
- Secreted by endocrine glands which make up the endocrine system.
- Target cells
Hormones to target cell - target cell can be anywhere in body

Diagram showing:
- Secretory vesicles
- Blood vessel
- Target cell
- Hormone molecules
Neurosecretory cells - both nerve impulses and hormone release.
Hormones

- Protein and peptides - 3 to 30 amino acids
- Amines - derived from amino acids
- Steroids
Water soluble hormones and their receptors
Steriod hormones and their receptors

Lipid-soluble hormone (testosterone)
Target cell
Receptor protein
Hormone receptor complex
DNA
Transcription
mRNA
New protein

Cellular response: activation of a gene and synthesis of new protein
Hormones

- Different target cells may have different responses
- Example epinephrine effects on cardiac and liver tissue
Some of the hormone secreting glands

- Hypothalamus
- Pineal gland
- Pituitary gland
- Thyroid gland
- Parathyroid glands
- Thymus
- Adrenal glands (atop kidneys)
- Pancreas
- Ovary (female)
- Testes (male)
<table>
<thead>
<tr>
<th>Gland</th>
<th>Hormone</th>
<th>Chemical Class</th>
<th>Representative Actions</th>
<th>Regulated by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothalamus</td>
<td>Hormones released by the posterior pituitary and hormones that regulate the anterior pituitary (see below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>Prolactin (released by the posterior pituitary)</td>
<td>Peptide</td>
<td>Stimulation of growth of mammary glands</td>
<td>Nervous system</td>
</tr>
<tr>
<td>Anterior pituitary gland</td>
<td>Growth hormone (GH)</td>
<td>Protein</td>
<td>Stimulates growth (especially bones) and metabolic functions</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>Antidiuretic hormone (ADH)</td>
<td>Peptide</td>
<td>Promotes retention of water by kidneys</td>
<td>Water balance</td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>Melanocyte stimulating hormone (MSH)</td>
<td>Protein</td>
<td>Stimulates production of ova and spermar</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>Ursin hormone (UH)</td>
<td>Protein</td>
<td>Stimulates growth and destruction of testes</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>Thyroid-stimulating hormone (TSH)</td>
<td>Protein</td>
<td>Stimulates thyroid gland</td>
<td>Thyroid in blood, hypothalamic hormones</td>
</tr>
<tr>
<td>Pineal gland</td>
<td>Melatonin</td>
<td>Aamine</td>
<td>Involved in rhythmic activities (daily and seasonal)</td>
<td>Light/dark cycles</td>
</tr>
<tr>
<td>Thyroid gland</td>
<td>Thyroxine (T₄) and triiodothyronine (T₃)</td>
<td>Aamine</td>
<td>Stimulates and maintains metabolic processes</td>
<td>TSH</td>
</tr>
<tr>
<td>Parathyroid glands</td>
<td>Parathyroid hormone</td>
<td>Peptide</td>
<td>Lowers blood calcium level</td>
<td>Calcium in blood</td>
</tr>
<tr>
<td>Thymus</td>
<td>Thymosin</td>
<td>Peptide</td>
<td>Stimulates T cell development</td>
<td>Not known</td>
</tr>
<tr>
<td>Adrenal glands</td>
<td>Adrenal medulla</td>
<td>Epinephrine and norepinephrine</td>
<td>Increases blood glucose; increases blood pressure; constricts certain blood vessels</td>
<td>Nervous system</td>
</tr>
<tr>
<td>Adrenal cortex</td>
<td>Glucocorticoids</td>
<td>Steroid</td>
<td>Increases blood glucose</td>
<td>ACTH/K⁺ in blood</td>
</tr>
<tr>
<td>ADH</td>
<td>Insulin</td>
<td>Protein</td>
<td>Lowers blood glucose</td>
<td>Glucose in blood</td>
</tr>
<tr>
<td>Glands</td>
<td>Glucagon</td>
<td>Protein</td>
<td>Maintains blood sugar level</td>
<td>Glucose in blood</td>
</tr>
<tr>
<td>Islets</td>
<td>Androgens</td>
<td>Steroid</td>
<td>Support sperm formation; protects development and maintenance of male secondary sex characteristics</td>
<td>FSH and LH</td>
</tr>
<tr>
<td>Ovaries</td>
<td>Estrogens</td>
<td>Steroid</td>
<td>Stimulates uterine lining growth; promotes development and maintenance of female secondary sex characteristics</td>
<td>FSH and LH</td>
</tr>
<tr>
<td>Prostate</td>
<td>Progesterone</td>
<td>Steroid</td>
<td>Promotes uterine lining growth</td>
<td>FSH and LH</td>
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</table>

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Two hormones made by hypothalamus and secreted by pituitary
Anterior pituitary—regulated by hypothalmas—produces releasing and inhibiting hormones
Negative feedback of thyroxine

- Hypothalamus
  - TRH
  - Anterior pituitary
    - TSH
      - Thyroid
      - Thyroxine

Inhibition
Thyroid

- Thyroxine - T4 (4 iodines)
- Triiodothyronine - T3 (3 iodines)
Calcium regulation

- Parathyroid glands (4)
- Parathyroid hormone (PTH)
- Calcitonin (thyroid)
- Antagonistic hormones
Calcium regulation

- Stimulus: Rising blood Ca²⁺ level (imbalance)
- Blood Ca²⁺ rise
  - Active vitamin D
  - Parathyroid glands release parathyroid hormone (PTH)
  - Parathyroid gland

- Stimulus: Falling blood Ca²⁺ level (imbalance)
- Parathyroid glands release parathyroid hormone (PTH)

- Homeostasis: Normal blood calcium level (about 10 mg/100 mL)
- Calcium regulation diagram
- Thyroid gland releases calcitonin
- Stimulates Ca²⁺ deposition in bones
- Reduces Ca²⁺ uptake in kidneys

- Stimulates Ca²⁺ release from bones
- Increases Ca²⁺ uptake in kidneys
- Increases Ca²⁺ uptake in intestines

- PTH
Blood glucose levels

- Insulin
  - Stimulator: Rising blood glucose level (e.g., after eating a carbohydrate-rich meal)
  - Effect: Body cells take up more glucose
  - Stimulus: Declining blood glucose level (e.g., after skipping a meal)
  - Effect: Liver breaks down glycogen and releases glucose to the blood
  - Alpha cells of pancreas stimulated to release glucagon into the blood
  - Glucagon
  - Stimulus: Declining blood glucose level (e.g., after skipping a meal)
  - Effect: Liver takes up glucose and stores it as glycogen

Homoeostasis: Normal blood glucose level (about 90 mg/100 mL)

- Blood glucose level declines to a set point; stimulus for insulin release diminishes
Sugar uptake

- **Diabetic**
- **Normal**

**Axes:**
- **Y-axis:** Blood glucose (mg/100mL)
- **X-axis:** Hours after glucose ingestion

**Graphs:**
- Red line: Diabetic
- Blue line: Normal
Adrenal glands

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:

- Mineralocorticoids
  1. Retention of sodium ions and water by kidneys
  2. Increased blood volume and blood pressure

- Glucocorticoids
  1. Proteins and fats broken down and converted to glucose, leading to increased blood glucose
  2. Immune system may be suppressed