Chapter 41
Animal Hormones

Regulation
- Why are hormones needed?
  - chemical messages from one body part to another
  - communication needed to coordinate whole body
  - homeostasis & regulation
    - metabolism
    - growth
    - development
    - maturation
    - reproduction

Regulation & Communication
- Animals rely on 2 systems for regulation...
  - **endocrine system**
    - system of ductless glands
    - secrete chemical signals ‘directly’ into blood
    - slow, long-lasting response
  - **nervous system**
    - system of neurons
    - transmits “electrical” signal & release neurotransmitters to target tissue
    - fast, short-lasting response

Regulation by Chemicals
- **Neurotransmitters** released by neurons
- **Hormones** release by endocrine glands

Homology in Hormones
- What does this tell you about these hormones?
  - prolactin
    - same gene family
    - mammals, birds, fish, amphibians
    - growth hormone
    - milk production
    - fat metabolism
    - salt & water balance
    - metamorphosis & maturation
    - growth & development

Types of Hormones
- circulating hormones
  - hormones that diffuse into the blood to activate target cells far away
- local hormones
  - hormones that affect target cells close to their release site
    - **autocrine**: hormone-releasing cell affected
    - **paracrine**: hormone affects nearby cells only
**Classes of Hormones**
- **Lipid-based hormones**
  - steroids
    - modified cholesterol: sex hormones, aldosterone
  - modified cholesterol: sex hormones, aldosterone
- **Protein-based hormones**
  - polypeptides
    - small proteins: insulin, ADH
  - large proteins + carbohydrate: FSH, LH
  - amines
    - modified amino acids: epinephrine, melatonin

**How do hormones act on target cells?**
- **Lipid-based hormones**
  - hydrophobic & lipid-soluble
  - diffuse across membrane & enter cells
  - bind to receptor proteins in cytoplasm & nucleus
  - bind to DNA as transcription factors
- **Protein-based hormones**
  - hydrophilic & not lipid soluble
  - can’t diffuse across membrane
  - receptor proteins in cell membrane
  - trigger secondary messenger pathway
  - activate internal cellular response
    * enzyme action, uptake or secretion of molecules...

**Action of Lipid (Steroid) Hormones**

**Action of Protein Hormones**

**Signal Transduction Pathway**

**Benefits of a 2° Messenger System**

**Amplification!**

**FAST response!**
**Action of Epinephrine (adrenalin)**

1. Adrenalin is released into the blood from the adrenal gland.
2. It binds to a receptor protein in the liver cell cytoplasm.
3. This activates protein kinase-A, which in turn activates glycogen phosphorylase.
4. Phosphorylase catalyzes the breakdown of glycogen into glucose.
5. Glucose is released into the blood.

**Nervous & Endocrine Systems Linked**

- **Hypothalamus** = “master nerve control center”
  - nervous system
  - receives information from nerves around body about internal conditions
  - regulates release of hormones from pituitary
- **Pituitary gland** = “master gland”
  - endocrine system
  - secretes broad range of hormones regulating other glands

**Maintaining Homeostasis**

- **Negative Feedback Model**

  - When a hormone concentration is high, it signals the gland to lower its output.
  - When a hormone concentration is low, it signals the gland to raise its output.

**Regulating Metabolism**

- **Hypothalamus**
  - TRH = TSH-releasing hormone
- **Anterior Pituitary**
  - TSH = thyroid stimulating hormone
- **Thyroid**
  - produces thyroxine hormones
  - metabolism & development
    - bone growth
    - mental development
    - metabolic use of energy
    - blood pressure & heart rate
    - muscle tone
    - digestion
    - reproduction

**Managing Glucose Levels**

- **Mammals regulate use & storage of glucose**
  - **insulin reduces blood glucose levels**
    - glucose levels rise above set point, pancreas secretes insulin
    - promotes transport of glucose into cells & storage of glucose (as glycogen) in liver & muscle cells
    - drops blood glucose levels
  - **glucagon increases blood glucose levels**
    - when glucose levels drop below set point, pancreas secretes glucagon
    - promotes breakdown of glycogen & release of glucose into the blood
    - raises blood glucose levels
Regulation of Blood Sugar

- Insulin: produced by beta cells in the islets of Langerhans, reduces blood sugar level by allowing body cells to take up sugar from blood.
- Glucagon: produced by alpha cells in the islets of Langerhans, increases blood sugar level by triggering liver to release glucose.
- Liver stores glycogen and reduces appetite.
- Body cells take up sugar from blood.
- High blood sugar level triggers hunger.
- Liver releases glucose.
- Low blood sugar level triggers release of insulin.

Feedback loop:
- Insulin reduces blood sugar level.
- Glucagon increases blood sugar level.

Regulation of Blood Volume / Pressure

- **ADH (antidiuretic hormone)**
  - from pituitary
  - causes kidneys to reabsorb more water
  - Increases BP
- **Aldosterone**
  - from adrenal gland
  - causes kidneys to reabsorb Na+ & water
  - Increases BP
- **Atrial natriuretic hormone**
  - from heart (right atrium)
  - promotes excretion of Na+ in urine
  - Decreases BP
- **Nitric oxide**
  - from blood vessel cells
  - dilates blood vessels
  - nitroglycerin & Viagra release nitric oxide

Regulation of Digestion

- Coordination of nervous system & endocrine system
- Proteins, carbohydrates, fats are digested in the stomach and small intestine.
- HCl, Pepsin, Gastrin, Secretin, CCK, Gastric inhibitory peptide are involved in digestion.
- Bicarbonate and Enzymes are released by the pancreas.
- Nitroglycerin & Viagra release nitric oxide.

Endocrine System Control

- Male Reproductive Cycle
  - Testosterone: produced by testes
  - Causes sperm production
  - Increases body hair
  - Increases muscle mass

- Female Reproductive Cycle
  - Estrogen & Progesterone: produced by ovaries
  - Cause uterine lining to build up
  - Maintains pregnancy
  - Causes menstrual cycle

Feedback loop:
- GnRH from hypothalamus stimulates pituitary gland to release FSH & LH.
- Progesterone is released by corpus luteum.
- Progesterone maintains pregnancy.
- If fertilized egg is not present, corpus luteum breaks down and progesterone drops, causing menstruation.

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Any Questions??

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