Chapter 18  Endocrine glands

Major endocrine glands and their hormones

Pituitary gland

Has two major parts

Anterior lobe called the **adenohypophysis**
- is epithelial in origin

Posterior lobe called the **neurohypophysis**
- is an outgrowth of the hypothalamus
  - neural in origin

Adenohypophysis

The adenohypophysis is functional connected to the **hypothalamus** by a complex of blood vessels called the **hypothalamo-hypophyseal portal system**

Hormones released from the hypothalamus are picked up by capillaries and carried down the infundibulum to the anterior pituitary where they leave a second capillary bed and stimulate the release of hormones from the anterior pituitary

Hormones of the anterior lobe (adenohypophysis)

1. **Growth hormone or somatotropin**
   - a. Stimulates release of **somatomedins** or insulin-like growth factors from the liver which stimulate **cell division and growth**
   - most conspicuous effect is on bone and cartilage
   - b. GH stimulates protein synthesis in most cells
     - stimulates transcription and translation
     - stimulates amino acid transport into cells
     - suppresses protein catabolism
   - c. GH stimulates lipid metabolism
     - Stimulates release of fats from adipocytes
     - Has a protein-sparing effect
   - d. GH effects carbohydrate metabolism
     - stimulates the conversion of glucose to glycogen
     - Has a glucose-sparing effect
   - e. GH effects electrolyte balance
GH promotes Na, K, and Cl retention by the kidneys and enhances Ca absorption by the small intestine

Necessary for growth

**Growth Hormone release**

GH release is stimulated by growth hormone releasing hormone (GHRH) from the hypothalamus

Which is released in response to

a. strenuous exercise
b. low blood sugar levels (gestational diabetes)
c. high amino acid levels

**2. Prolactin**

Initiates and maintains milk production by the mammary glands

Released in response to prolactin releasing hormone from the hypothalamus

is released in response high estrogen and progesterone levels during pregnancy and to suckling by the baby

**3. Thyroid-stimulation hormone (TSH)**

Stimulates the thyroid gland to produce thyroid hormone (see thyroid gland)

Released in response to thyrotropin releasing hormone (TRH) from the hypothalamus

TRH is released when blood levels of thyroid hormone drops

Release is inhibited by high thyroid levels

Negative feedback

**4. Adrenocorticotropic hormone (ACTH)**

Stimulates the release of several different hormones from the adrenal cortex (see adrenal gland)

Released in response to corticotropin releasing hormone (CRH) from the hypothalamus
CRH release is controlled by a negative feedback mechanism when adrenal cortex hormone levels fall

Also released during sympathetic stimulation and stress in general

5. Follicle-stimulating hormone and 6. Luteinizing hormone
   
   In females they stimulate ovarian follicle development and estrogen production

   In males they stimulate sperm production and testosterone production

   **Released in response to gonadotropin releasing hormone (GnRH) from the hypothalamus**
   
   GnRH release is controlled by a negative feedback loop
   
   High testosterone or estrogen = low GnRH
   
   (More latter during reproduction)

**Hormones of the posterior lobe (neurohypophysis)**

1. **antidiuretic hormone**
   
   made by neurons that have their cell bodies in the hypothalamus but extend axons into the neurohypophysis (stored in pituitary)

   stimulate the kidney to retain water from the urine
   
   this helps control blood volume and thus blood pressure

   **released when osmoreceptors in the hypothalamus sense a drop in the water content of blood**

   release is inhibited by high blood pressure

2. **oxytocin**
   
   also made by neurons in the hypo

   released during childbirth and strengthens smooth muscle contraction
release during suckling and stimulates milk ejection
both are positive feedbacks
also released during sexual arousal and orgasm
propulsion of semen
uterine contractions to move semen up repro tract
emotional bonding

Pineal gland
Located beneath the posterior end of the corpus collossum
Secretions peak between 1 to 5 years old and are 75% lower in adults
Releases Serotonin during the day and melatonin at night
May control onset of puberty
Regulate day night cycles

Thyroid gland
Located just below the larynx
Is largest endocrine gland

Releases T4 (Thyroxine) and T3 (triiodothyronine)
T4 is Two tyrosine residues with 4 iodines attached
T3 is Two tyrosine residues with 3 iodines attached
Are released in response to TSH from the pituitary gland
T3/T4 effects every cell in the body
Increases metabolic rate
Promotes protein synthesis
Stimulates growth during childhood
Enhances neuron function
Enhances neuron growth during childhood
Cretinism occurs if on thyroid homones

Calcitonin
Released from c-cells (clear cells) or parafollicular cells of the thyroid gland
Released in response to high blood calcium levels
More important in children
Effects are to lower blood calcium
Stimulates osteoblasts to make bone
Inhibits osteoclasts
Blocks absorption of calcium from diet and reabsorption by kidneys

**Parathyroid gland**
Located on the posterior surface of the thyroid gland

Secrete parathyroid hormone (PTH)
*Is released in response to low blood calcium levels*

**Effects**
Promotes reabsorption of calcium from diet

Simulates the kidneys to convert vitamin D to the hormone **calcitriol**
Stimulates absorption of calcium from small intestine

Promotes removal of calcium from bone (osteoclasts activity)
Inhibits osteoblast activity

**Effects of low blood calcium**
Increases sodium permeability and cells become hyper excitable
Leads to convulsions or muscular spasms

**Thymus gland**
Located over the heart

Is large in infants and children very small in adults

Is the site of T-lymphocyte maturation

Releases a hormone thymosin and thymopoietin

**Effects of thymosin and thymopoietin**
Stimulates the development and maturation of T-lymphocytes

**Adrenal glands**
Located on top of each kidney

Functions like two glands in one

**Adrenal cortex**
**Adrenal medullae**

**Adrenal cortex**
Secretes three types of hormone (all are steroids)
There is three layers to the adrenal cortex

1. outer layer the **zona glomerulosa**
   releases **Mineralocorticoids**
   Main one is **aldosterone**

   Effects
   Stimulates reabsorb sodium and secretion of potassium

   Targets
   Kidneys, sweat glands, salivary glands and the digestive system

   Increases water reabsorption by kidney thus has effect on blood volume and pressure

   Also stimulates the consumption of salty foods

   **Released in response to**
   Low blood sodium
   High blood potassium
   Low blood pressure and volume
   Presence of angiotensin II
   Also releases by presence of ACTH from pituitary
   Minor effect

2. middle layer the **zona fasciculata**

   releases **Glucocorticoids**
   Main one is cortisol

   Effects
   Help regulate glucose concentration in the blood by promoting the conversion of noncarbohydrates to glucose

   Help body respond to stress by making glucose available to cells

   High concentrations depresses immune reactions to reduce inflammation
Releases by presence of ACTH from pituitary

3. inner layer the **zona reticularis**

releases **Adrenal sex hormones**
Both androgens and estrogens are released in men and women
Effects are insignificant in males because most
androgens come from testes

In females this accounts for 50% of the androgens
May sustain libido in females

Stimulate development of pubic and axillary hair
and stimulate skeletal growth

Releases by presence of ACTH from pituitary but only slightly

**Adrenal medulla**
Chromaffin cells secretes epinephrine (75%) and norepinephrine

*Is released when sympathetic nervous system is activated* (stress)

**Effects**
Mimic the effects of the sympathetic nervous system
Effects last much longer

Decrease blood flow to viscera and skin
Increase blood flow to skeletal muscle, lungs, cardiac muscle, nervous system

Stimulates the conversion of glycogen to glucose and the breakdown of glucose

Stimulates the adipocytes to convert stored fats to fatty acids

Stimulate cellular metabolism

Increases heart rate and force of contraction

**Pancreas**
Located posterior to the stomach

Has both endocrine and exocrine function
Endocrine function comes from the islets of Langerhans

Islets secret two major hormones

**Glucagon**
Released from the alpha cells of the islets

**Released when blood glucose levels drop**

Effects
Increase the concentration of glucose in the blood stream
Stimulates cells to convert glycogen to glucose and convert certain amino acids to glucose

In the liver the glucose can be released into the circulation

Ability to raise glucose levels are similar to epinephrine and norepinephrine

**Insulin**
Released from the beta cells of the islets

**Released when blood glucose levels are high and weakly by high blood amino acid levels**

Effects
Decreases blood glucose levels by stimulating the uptake of glucose by the liver, skeletal muscle, and adipocytes

Stimulates cells to convert glucose to glycogen

Stimulates the fat cells to produce fats from glucose

Stimulates protein syntheses, cell growth, and differentiation

**Ovaries**
Located in the pelvic cavity

Function starts at puberty when FSH and LH release from the anterior pituitary increases
Ovaries release two major types of hormones

**Estrogens**

Is the primary female sex hormone

Released from the developing ovarian follicles (has the egg)

Effects

- Stimulate the development and maturation of the female sex organs
- Stimulates the formation of secondary sexual characteristics
  - Female fat distribution
  - Breasts
  - Broad hips
  - Prepare the uterus to receive the fertilized egg
  - Maintain pregnancy
  - Prepare breasts to produce milk

**Releases in response to rising FSH and LH levels during the ovarian cycle (mostly FSH)**

**Progesterone**

Released from the empty follicle after the egg has been released during ovulation

Effects

- Prepares the uterus for receiving an embryo and maintains the pregnancy
- Prepares the mammary glands for milk production

Released in response to FSH and LH (mainly LH) and by HCG from the placenta if pregnancy occurs

**Testes**

Located outside the pelvic cavity in the scrotum

Releases testosterone from the interstitial cells

**Releases in response to rising FSH and LH (mostly FSH)**

Effects

- Development and maturation of male sex organs
Development of secondary sex characteristics
  Growth of facial and body hair
  Low voice
  Narrow hips
  Heavy muscles and bones
  Sex drive
Stimulates sperm production