Ch 14: Endocrine Physiology

Objectives

1. Review endocrine glands of body.

2. Understand how hypothalamus controls endocrine system & sympathetic epinephrine response.

3. Learn anterior pituitary hormones & their effects on glands of body.

4. Understand some endocrine disorders.

1. Endocrine Glands of the Body

Endocrine System = system involving regulation of body functions through use of chemical messengers (hormones) secreted by glands.

Endocrine glands of body:

- Pituitary = master endocrine gland
- Pineal gland = located in diencephalon
- Adrenal glands = located above kidneys
- Thyroid = located on anterior trachea
- Parathyroid glands = located on posterior trachea
- Gonads = ovaries & testes
- GI tract
- Pancreas
- Liver

**Most of these glands controlled by hypothalamus!**
**2. Hypothalamus controls endocrine system!**

> Hypothalamus part of both nervous & endocrine systems

**Controls endocrine system 3 ways:**

1. Hypothalamic nuclei secrete neuro-hormones through posterior pituitary. Pg 266-267 Wiki text
   - Supraoptic nucleus secretes ADH (anti-diuretic hormone)
   - Paraventricular nucleus secretes oxytocin

2. Hypothalamus secretes releasing hormones (RH) or inhibiting hormones (IH) which controls anterior pituitary.

3. Hypothalamus controls autonomic sympathetic secretion of epinephrine by the Adrenal glands (medulla).

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**Hypothalamus Directs Anterior Pituitary Secretions**

Know hypothalamic hormone (acronym) and what it causes anterior pituitary to secrete!
Pg 267 Wiki text.

Hypothalamus secretes:

1. GnRH (gonadotropin releasing hormone)
2. GHRH (growth hormone RH) CRH (corticotropin RH)
3. CRH (corticotropin RH)
4. TRH (thyrotropin RH)
5. PRH (Prolactin RH)
6. GHIH or somatomedin (growth hormone inhibiting hormone)
7. PIH (prolactin inhibiting hormone)
**Anterior Pituitary Secretions (in response to hypothalamus)**

Hypothalamic hormones

**GnRH**
1. Secretes LH & FSH (luteinizing & follicle stimulating hormone)

**GHRH**
2. Secretes GH (growth hormone)

**CRH**
3. Secretes ACTH (adreno-corticotropic hormone)

**TRH**
4. Secretes TSH (thyroid stimulating hormone)

**PRH**
5. Secretes prolactin (PRL)

**GHIH**
6. Inhibits of GH secretion

**PIH**
7. Inhibits prolactin secretion (most women have inhibited PRL unless they are late in pregnancy, and then during breast feeding.)

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**Anterior Pituitary secretions & their effects on target organs or glands:**

**Effects:**

- Stimulates mammary glands to make milk (lactation)
- Stimulates body tissues to grow!

**Produce T3 & T4 to regulate metabolism**

**Produce Sex steroids - Cortisol**

**Produce mature eggs & sperm**

**Produce estrogen & testosterone**
**Endocrine hormone regulation is through negative feedback.**

Pg 265 – 266
Wiki text

If blood levels of a hormone are too low, hypothalamus increases RH secretion & pituitary increase its hormone secretions.

If blood levels of a hormone are too high, hypothalamus decreases RH secretion & increases IH secretion, then the pituitary decreases its hormone secretions.

**Ques:**
*Can you think of a hormone that is not regulated through negative feedback, but by positive feedback??*
How hypothalamus & neg. feedback regulates anterior pituitary secretions:

**QUES:**

If the hypothalamus “senses” GH in blood is too high what does it do? \( \downarrow \) GHRH secretion

What happens to anterior pituitary secretions of GH? \( \downarrow \) GH secretion

If GH in blood is too low, hypothalamus does what? \( \uparrow \) GHRH secretion

What does pituitary then do? \( \uparrow \) GH secretion

If hypothalamus “senses” high estrogen or testosterone in blood it \( \downarrow \) GnRH secretion

What does pituitary then do? \( \downarrow \) LH & FSH secretion

If hypothalamus “senses” low thyroid hormones it \( \uparrow \) TRH secretion

What does pituitary then do? \( \uparrow \) TSH secretion

**Clinical Apps:**

- Anabolic steroid abuse & negative feedback
- Corticosteroid use & negative feedback

**Review**

- Endocrine glands of body
  - Pituitary, adrenals, thyroid, parathyroids, gonads, pineal gland, pancreas, GI tract, pancreas, liver.

- Hypothalamic controls endocrine system
  - Nuclei secrete ADH & oxytocin
  - 5 Releasing hormones (CRH, GnRH, TRH, GHRH, PRH)
  - 2 Inhibiting hormones (PIH, GHIH)
  - Controls adrenal medulla secretion of epinephrine

- Anterior pituitary secretions & their target organs
  - ACTH, TSH, GH, FSH, LH, PRL

- Negative feedback regulation of endocrine system
Growth Hormone (GH) Disorders: Clinical App ONLINE

1. Insufficient GH = insufficient body growth
   > Pituitary dwarfism

2. Excessive GH – excessive body growth
   > Gigantism – when onset in childhood
   > Acromegaly – when onset in adulthood

Pg 272 – 274 Wiki text

Pituitary ACTH stim. Adrenal Cortex to make:

1. Sex steroids (small amount)
   Ex. - estrogen, testosterone

2. Mineralcorticoids
   Ex. - Aldosterone
   (tells kidney tubules to increase salt, & then water retention)

3. Glucocorticoids
   Ex. - cortisol

Clinical App ONLINE
Exogenous glucocorticoids and negative feedback on adrenal cortex

Under sympathetic response - hypothalamus stim. Adrenal Medulla to make Epinephrine
Adrenal Cortex Disorders:

A. Cushing’s Disease (“hypercortisolism”) – Excess Cortisol

   Clinical App ONLINE

Causes:
- Excess hypothalamic CRH or pituitary ACTH
- Adrenal gland tumor

Clinical Presentation:
- Hyperglycemia = high blood glucose
- Hyperlipidema = high blood triglycerides & fatty acids
- Hypervolemia = high blood volume (retaining water) (“moon face”)
- Hypertension = high blood pressure

Adrenal Cortex Disorders:

B) Addison’s Disease – Insufficient Aldosterone & Cortisol

Causes:
- ↓hypothalamic CRH or pituitary ACTH.
- Adrenal cortex tumor or autoimmune disorder

Clinical Presentation:
- Hyponatremia = low blood sodium (Na+)
- Hyperkalemia = high blood potassium (K+)
- Hypovolemia = low blood volume (retaining water)
- Hypotension = low blood pressure (from losing body water)
- Anorexia = usually loss of body water
- Hypoglycemia = too little cortisol
- Skin bronzing = (overstimulation of melanocytes)
Adrenal Cortex Disorders:

C) Conn’s syndrome (hyperaldosteronism)

**Causes:**
- usually adrenal cortex tumor

**Clinical Presentation:**
- **Hypernatremia** = high blood sodium (Na+)
- **Hypokalemia** = low blood potassium (K+)
- **Hypervolemia** = high blood volume (retaining water)
- **Hypertension** = high blood pressure (from retaining water)
- **Weight gain** = usually retaining body water

Adrenal Medulla Disorders:

**Pheochromocytoma** = excessive norepinephrine/epinephrine

**Clinical App** ONLINE

**Causes:**
- adrenal medulla tumor

**Clinical Presentation:** “fight or flight” symptoms

- Tachycardia
- Hypertension
- Hyperventilation
- Hyperglycemia
- Hyperlipidemia
- Nervousness, sweating, anxiety
Thyroid Gland

Produce:
1. T3 (tri-iodothyronine)  
   - Increase body metabolism
2. T4 (thyroxine)
3. Calcitonin - ↓ blood Ca+2

Parathyroid Glands

Produce:
- Parathyroid hormone - ↑ blood Ca+2

Thyroid gland disorders – Clinical App

A. Hyperthyroidism = excessive thyroid hormones
   Causes:
   - thyroid tumor
   - Graves disease = autoimmune attack, over-stimulates thyroid receptors.
   Clinical presentation:
   - High metabolism & anxiety
   - Intolerant to heat (sweating)
   - Tachycardia
   - Hypertension
   - ↑ fluid behind eyes ("exophthalmos")

B. Hypothyroidism = insufficient thyroid hormones
   Causes: thyroid tumor, goiter, insufficient dietary iodine.
   Clinical presentation:
   - Low metabolism, depression
   - Intolerance to cold, dry skin,
   - Enlarged thyroid gland
   - When in children called "cretanism"
“Goiter” = thyroid can’t make thyroid hormones, it over-grows (swells)

Gonads Pg 276-277 Wiki text

**Testes**
- Response to LH = Make testosterone
- Response to FSH = Mature sperm

**Ovaries**
- Response to LH = Make estrogen &
- And cause ovulation &
  - Form corpus luteum, make progesterone
- Response to FSH = Mature egg each month
**Sex Steroid Disorders:**

**A. Kallmann Syndrome (Hypogonadism)** = insufficient hypothalamic GnRH production. Results in less pituitary LH & FSH. Causes ↓testes growth and ↓testosterone and estrogen production.

In male child – can interfere with development of penis, testes, sperm production, and other masculine traits.

**B. Androgen Insensitivity Syndrome (AIS)**

= in male fetus, failure of tissues to respond to testosterone. Causes feminization.

**Partial AIS** - Micropenis or enlarged clitoris, partial or no closure of scrotum.

**Complete AIS** – Clitoris rather than penis, hip & breast development at puberty. No female repro structures inside. Testes retained in abdomen (must be removed!)

Partial AIS – partial fusion of scrotal skin, micropenis or enlarged clitoris  
Complete AIS
Pineal gland
- Makes **melatonin** at night
- Helps regulate circadian rhythm
Pg 277 Wiki text

Pancreas
- Makes **insulin** and **glucagon**
Pg 268, 272-274 Wiki text

Clinical App ONLINE
Diabetes mellitus

Liver
- Makes **erythropoietin** – stimulates RBC production
- Responds to pancreatic glucagon by engaging in Glycogenolysis (break glycogen into glucose & release into blood).
GI Tract

1. **Gastrin (stomach)** = stimulates HCL production (by parietal cells)

2. **Secretin (sm. intestine)** = stimulate water and bicarbonate secretion from pancreas

3. **Cholecystokinin (sm. intestine)**
   - stimulates gallbladder contraction
     (get bile into duodenum)
     Bile is made from cholesterol
   - stimulates pancreatic enzyme secretion

4. **Gastric inhibitory peptide (sm. intestine)** =
   - slows gastric motility (slow down) to help digestion
   - stimulates pancreatic insulin.

Review

- Endocrine glands of body
  - Pituitary, adrenals, thyroid, parathyroids, gonads, pineal gland, pancreas, liver, GI tract

- Endocrine disorders

- Hormones produced by each gland