Ch 8: 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 secretory glands & chemical messengers (hormones)

**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
- Pancreas
- GI tract

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

Controls endocrine system 3 ways:
1. Hypothalamic nuclei secrete neuro-hormones through posterior pituitary.
   - Nuclei = supraventricular, paraventricular
   - Neurohormones = ADH & oxytocin

2. Hypothalamus secretes releasing or inhibiting hormones which controls anterior pituitary

3. Hypothalamus controls autonomic sympathetic secretion of
   - epinephrine by the adrenal medulla

Hypothalamus Directs Anterior Pituitary Secretions

Know hypothalamic hormone (acronym) and what it causes anterior pituitary to secrete!

Hypothalamus secretes:

- CRH (Corticotropin)
- GnRH (Gonadotropin)
- TRH (Thyrotropin)
- GHRH (Growth hormone)
- PRLH (Prolactin)
- GHIH (Growth hormone inhibiting hormone) (somatostatin)
Anterior Pituitary Secretions (in response to hypothalamus)

Anterior Pituitary Response:

1. ACTH  adrenocorticotropic
2. LH & FSH  Luteinizing hormone
3. TSH  Thyroid stimulating h.
4. GH  growth hormone
5. Inhibition of prolactin
6. INHIB'N of GH

Hypothalamus Directs Anterior Pituitary Secretions

Know hypothalamic hormone (acronym) and what it causes anterior pituitary to secrete!

Table 11.7 | Hypothalamic Hormones Involved in the Control of the Anterior Pituitary

<table>
<thead>
<tr>
<th>Hypothalamic Hormone</th>
<th>Structure</th>
<th>Effect on Anterior Pituitary</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRH</td>
<td></td>
<td>Stimulates secretion of adrenocorticotropic hormone</td>
</tr>
<tr>
<td>GnRH</td>
<td></td>
<td>Stimulates secretion of follicle-stimulating hormone (FHS) and luteinizing hormone (LH)</td>
</tr>
<tr>
<td>PIH</td>
<td></td>
<td>Inhibits prolactin secretion</td>
</tr>
<tr>
<td>GHIH</td>
<td></td>
<td>Inhibits secretion of growth hormone</td>
</tr>
<tr>
<td>TRH</td>
<td></td>
<td>Stimulates secretion of thyroid-stimulating hormone (TSH)</td>
</tr>
<tr>
<td>GHRH</td>
<td></td>
<td>Stimulates growth hormone secretion</td>
</tr>
</tbody>
</table>

NOT IN BOOK!
### Anterior Pituitary Hormones

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Target Tissue</th>
<th>Principal Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTH</td>
<td>Adrenocorticotropic hormone</td>
<td>Stimulation of adrenal cortex for the release of glucocorticoids (cortisol)</td>
</tr>
<tr>
<td>TSH</td>
<td>Thyroid-stimulating hormone</td>
<td>Stimulation of thyroid hormones</td>
</tr>
<tr>
<td>GH</td>
<td>Growth hormone</td>
<td>Promotes protein synthesis and growth; lipolysis and increased blood glucose</td>
</tr>
<tr>
<td>FSH</td>
<td>Follicle-stimulating hormone</td>
<td>Promotes gamete production and stimulates anterior pituitary secretion</td>
</tr>
<tr>
<td>PRL</td>
<td>Prolactin</td>
<td>Stimulates milk production in lactating females; additional actions in other organs</td>
</tr>
<tr>
<td>LH</td>
<td>Luteinizing hormone</td>
<td>Stimulation of sex hormone secretion; ovulation and corpus luteum formation in females; stimulates testosterone in males</td>
</tr>
</tbody>
</table>

### Table 11.6

- **ACTH**: Stimulated by 
- **TSH**: Inhibited by 
- **GH**: Stimulated by 
- **FSH**: Inhibited by 
- **PRL**: Stimulated by 
- **LH**: Inhibited by

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

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

**Effects:**
- Produce T3 & T4 to regulate metabolism
- Produce sex steroids - Cortisol
- Mature eggs & sperm
- Produce estrogen & testosterone

**Fig 8.6**
### How hypothalamus & neg. feedback regulates anterior pituitary secretions:

**QUES:**

- If the hypothalamus "senses" GH in blood is too high what does it do? 
- What happens to anterior pituitary secretions of GH? 
- If GH in blood is too low, hypothalamus does what? 
- What does pituitary then do? 
- If hypothalamus “senses” high estrogen or testosterone in blood it 
- What does pituitary then do? 
- If hypothalamus “senses: low thyroid hormones in blood it 
- What does pituitary then do?
Review

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

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

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

Growth Hormone (GH) Disorders: Clinical App Pg 203 & 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
ACTH stim. Adrenal Cortex to make:

1. Sex steroids
   Ex. - estrogen, testosterone, progesterone

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

2. Mineralcorticoids
   Ex. - Aldosterone
   (↑ salt retention in kidneys)

3. Glucocorticoids
   Ex. - Cortisol

Clinical App Pg 209 & ONLINE
Exogenous glucocorticoids and negative feedback on adrenal cortex

Fig 8.9

Adrenal Cortex Disorders:
A. Cushing’s Disease (“hypercortisolism”) – Excess Cortisol
   Clinical View Pg 206 & ONLINE

Causes:
- Excess hypothalamic CRH or pituitary ACTH
- Adrenal gland tumor
- taking anti-inflammatory (steroid)

Clinical Presentation:
- Hyperglycemia = high blood glucose
- Hyperlipidemia = high blood lipids (Cortisol & triglycerides & fatty acids)
- Hypervolemia = high blood volume (“moon face”)
- Hypertension = high BP
Adrenal Cortex Disorders:

B. Addison’s Disease – Insufficient Aldosterone

Clinical View Pg 206 & ONLINE

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

Clinical Presentation:
- Hyperkalemia = high blood potassium (K⁺)
- Hypovolemia = low blood volume
- Hypotension = low BP
- Anorexia = low body weight
- Skin bronzing (overstimulation of melanocytes)

Adrenal Medulla Disorders:

Pheochromocytoma = excessive norepinephrine/epinephrine

Causes:
- adrenal medulla tumor

Clinical Presentation: “fight or flight” symptoms
- Tachycardia = high HR
- Hypertension =
- Hyperventilation = fast breathing
- Hyperglycemia = hi blood glucose
- Hyperlipidemia = hi blood lipids
- Nervousness, sweating
Thyroid Gland

**Produces:**

1. **T3 (tri-iodothyronine)**
   - Increase body metabolism

2. **T4 (thyroxine)**

3. **Calcitonin - \( \downarrow \) blood Ca+2**
   - **Cut down Ca+2**

Parathyroid Glands

**Produce:**

**Parathyroid hormone - \( \uparrow \) blood Ca+2**
   - **Presses Ca+**

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Thyroid gland disorders – Clinical App **ONLINE**

**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
- \( \uparrow \) 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

**Testes**
- Response to LH = **testosterone**
- Response to FSH = **mature sperm**

**Ovaries**
- Response to LH = **estrogen & ovulation**
- Response to FSH = **mature egg**
**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!)
Pineal gland

- Makes melatonin at night
- helps regulate circadian rhythm

Pancreas

- Makes insulin and glucagon

Clinical App ONLINE
Diabetes mellitus & Physiology in Health & Disease Pg 220

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)
   - stimulates pancreatic enzyme secretion

4. Gastric inhibitory peptide (sm. intestine) =
   - slows gastric motility (slow down)
   - stimulates pancreatic insulin.
Review

• Endocrine glands of body
  – Pituitary, adrenals, thyroid, parathyroids, gonads, pineal gland, pancreas, GI tract

• Endocrine disorders