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 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!

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).

Hypothalamic nuclei secrete neuro-hormones through posterior pituitary. Pg 266-267 Wiki text.

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)

Anterior Pituitary Response:

1. Secretes LH & FSH (luteinizing & follicle stimulating hormone)
2. Secretes GH (growth hormone)
3. Secretes ACTH (adreno-corticotropic hormone)
4. Secretes TSH (thyroid stimulating hormone)
5. Secretes prolactin (PRL)
6. Inhibits of GH secretion
7. Inhibits prolactin secretion (most women have inhibited PRL unless they are late in pregnancy, and then during breast feeding).

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

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??*  
*Oxytocin*
### How hypothalamus & neg. feedback regulates anterior pituitary secretions:

<table>
<thead>
<tr>
<th>QUES:</th>
<th></th>
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<tbody>
<tr>
<td>If the hypothalamus “senses” GH in blood is too high what does it do?</td>
<td>↓ GHRH secretion</td>
</tr>
<tr>
<td>What happens to anterior pituitary secretions of GH?</td>
<td>↓ GH secretion</td>
</tr>
<tr>
<td>If GH in blood is too low, hypothalamus does what?</td>
<td>↑ GHRH secretion</td>
</tr>
<tr>
<td>What does pituitary then do?</td>
<td>↑ GH secretion</td>
</tr>
<tr>
<td>If hypothalamus “senses” high estrogen or testosterone in blood it</td>
<td>↓ GnRH secretion</td>
</tr>
<tr>
<td>What does pituitary then do?</td>
<td>↓ LH &amp; FSH secretion</td>
</tr>
<tr>
<td>If hypothalamus “senses” low thyroid hormones it</td>
<td>↑ TRH secretion</td>
</tr>
<tr>
<td>What does pituitary then do?</td>
<td>↑ TSH secretion</td>
</tr>
</tbody>
</table>

### 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 Gland
Kidney
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:**
- Hypertension = high blood pressure (from retaining water)
- Hypokalemia = low blood potassium (K+)
- Hypervolemia = high blood volume (retaining water)
- Hypernatremia = high blood sodium (Na+)
- 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

Produces:
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 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
- ↑ 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!)
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