Ch. 14: Endocrine System (updated 3/8/21)

Objectives:
1. Review anatomy - endocrine glands of body.
2. Understand how hypothalamus
   - Controls the endocrine system by controlling the pituitary gland.
   - Controls the sympathetic (fight/flight) response.
3. Learn anterior pituitary hormones & their effects on other glands of body.
4. Understand some common endocrine disorders.

2. 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 posterior diencephalon
   - Adrenal glands = located above kidneys
   - Thyroid = located on anterior trachea
   - Parathyroid glands = located on posterior thyroid
   - Gonads = ovaries & testes
   - Pancreas = secrete insulin and glucagon
   - GI tract

3. Hypothalamus controls the pituitary gland and sympathetic response
   > Controls endocrine system 3 ways:
   1) paraventricular nucleus secrete Oxytocin & supranoic nucleus secretes ADH, both released by posterior pituitary.
   2. Hypothalamus secretes 5 releasing hormones & 2 inhibiting hormones, which control anterior pituitary.
   3. Controls autonomic sympathetic secretion of epinephrine by the adrenal medulla.

4. Hypothalamic hormones: RH stands for releasing hormone, and IH stands for inhibiting hormone.
   See online practice flow diagram for hypothalamic hormones, pituitary hormones, and what target glands do!
   1) GnRH (gonadotropin-releasing hormone) – will affect gonads (testes & ovaries) Gn stands for gonad!
   2) GHRH (growth hormone releasing hormone) – will affect cell growth
   3) CRH (corticotrophin releasing hormone) – will affect a cortex (adrenal cortex)
   4) TRH (thyrotropin releasing hormone) – will affect thyroid gland
   5) PRH (prolactin releasing hormone) – stimulates mammary glands to make milk
   6) GHIH or somatomedin (growth hormone inhibiting hormone) – inhibits growth hormone
   7) PIH (prolactin inhibiting hormone) – does what it says. Inhibits prolactin secretion from pituitary, so mammary glands WON’T produce milk.

5. Anterior pituitary response to hypothalamic releasing or inhibiting hormones:

<table>
<thead>
<tr>
<th>Hypothalamic hormone</th>
<th>Pituitary hormone</th>
</tr>
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<tbody>
<tr>
<td>GnRH</td>
<td>secretes LH &amp; FSH (luteinizing &amp; follicle-stimulating hormone) – stimulates gonads</td>
</tr>
<tr>
<td>GHRH</td>
<td>secretes GH (growth hormone)</td>
</tr>
<tr>
<td>CRH</td>
<td>secretes ACTH (adrenocorticotropic hormone) – will stimulate adrenal cortex</td>
</tr>
<tr>
<td>TRH</td>
<td>secretes TSH (thyroid stimulating hormone) – does what it says</td>
</tr>
<tr>
<td>PRH</td>
<td>Prolactin</td>
</tr>
<tr>
<td>GHIH</td>
<td>inhibits GH secretion</td>
</tr>
<tr>
<td>PIH</td>
<td>inhibits prolactin secretion</td>
</tr>
</tbody>
</table>
6. **Figure of pituitary hormones & effect on target tissues** (review of earlier slides)
   - TSH – tells thyroid to produce T3 & T4, which regulate body metabolism
   - ACTH – tells adrenal cortex to make cortisol (stress hormone) & little bit of sex steroids
   - FSH – tells ovaries or testes to mature eggs & sperm
   - LH – tells ovaries or testes to make estrogen or testosterone, & ovaries to ovulate an egg
   - Prolactin – tells mammary glands to make milk
   - GH – tells body tissues to grow/repair

7. **Figure of whole system, at a glance (hypothalamic & pituitary hormones, and target organs response).**

8. **A practice blank flow diagram (and KEY) are found on the online syllabus.**
   Regulation of these hormones is through negative feedback loop.
   > If blood level of any of the target gland hormones gets too high, it tells hypothalamus and pituitary to inhibit their secretions of stimulating hormones.
   > If blood level of target gland hormones gets too low, hypothalamus & pituitary increase secretion of their stimulating hormones.

9. **Review slide**

10. **Pituitary disorders involving growth hormone**
    > **Pituitary dwarfism** = decreased growth from low GH
    > **Gigantism** = increased growth from excess GH (onset in childhood)
    > **Acromegaly** = increased growth from excess GH (onset in adulthood)

11. **Pituitary ACTH stimulates adrenal glands:**
    > **Adrenal cortex to make:**
      - **sex steroids** (T & E2) in small amounts. Disorder of this is **Congenital Adrenal Hyperplasia (CAH)** – intersex child.
      - **Mineralcorticoid** (it affects minerals or SALTS) **Aldosterone** = ↑Na+ readorption in kidney nephrons to control water retention. (Notice the word aldosterone has the letters for salt in it!)
      - **Glucocorticoid** (it affects blood glucose) **Cortisol**, which ↑ blood glucose during stress, and acts as natural anti-inflammatory
    > **Adrenal Medulla to make:**
      - **epinephrine** in response to hypothalamic autonomic sympathetic stimulation

12. **Clinical App online** - synthetic “glucocorticoids” = **prednisolone & dexamethasone** – used for anti-inflammatory BUT prolonged use can cause adrenal atrophy – so use in decreasing amts. They decrease body’s production of cortisol by negative feedback. When blood levels of synthetic glucocorticoid ↑ the hypothalmus shuts down CRH & pituitary shuts down ACTH. This makes adrenal gland atrophy from lack of stimulation.

13. **Adrenal Cortex Disorders**
    A) **Cushing’s Syndrome** (hypercortisolism) = excess **Cortisol** (excess hypothalamic CRH or pituitary ACTH)
      ↑ blood glucose (hyperglycemia), ↑ blood lipids (hyperlipidemia), abdominal fat
      ↑ fluid retention (moon face), hypervolemia (high blood volume), hypertension, muscle weakness.
14. B) **Addison’s disease** = insufficient Aldosterone & (and to some extent low Cortisol)
   - ↓ Na+ retention by kidneys, excess K+ retention- **Hyponatremia** = low blood sodium (Na+)
   - Hyperkalemia = high blood potassium (K+)
   - Hypovolemia = low blood volume (retaining water)
   - Hypotension = low blood pressure (from retaining water)
   - Anorexia = usually loss of body water
   - Hypoglycemia - too little cortisol
   - skin bronzing

15. C) **Conn’s Syndrome** (hyperaldosteronism) = excess aldosterone, excess salt & water reabsorption. Hypertension.
   - ↑ Na+ retention by kidneys, excess K+ excretion in urine
   - Hypernatremia = high blood sodium (Na+)
   - Hypokalemia = low blood potassium (K+)
   - Hypervolemia = low blood volume (retaining water)
   - Hypertension = low blood pressure (from retaining water)
   - weight gain = usually retaining body water

16. **Pheochromocytoma** = excessive epinephrine/norepinephrine (Clinical App Pg 340)
   - hypertension, hyperglycemia, increased metabolism, nervousness, sweating.

17. **Thyroid Gland** = responds to pituitary TSH
   1) T4 (thyroxine)
   2) T3 = tri-iodothyronine [both T3 & T4 Requires iodine to be produced]
      - Regulates body metabolism and growth
   3) Calcitonin = Decreases blood calcium concentrations

**Parathyroid glands** – produce parathyroid hormone to ↑ blood Ca+2 (by increasing intestinal absorption and pull of Ca+2 from bones).

18. **Thyroid Disorders**
   A) **Hyperthyroidism** – too much T3 & T4. Metabolism on hyperdrive.
      Caused by: tumor or
      **Graves Disease** - autoimmune attack on thyroid overstimulates receptors causing it to swell.
      Presentation:
      - High metabolism & anxiety
      - Intolerant to heat (sweating)
      - Tachycardia
      - Hypertension
      - ↑ fluid behind eyes (“exophthalmos”)

   B) **Hypothyroidism** – too little thyroxine. Metabolism depressed If occur <6 mos age = “cretinism” – dwarfism
      Causes: thyroid tumor, goiter, insufficient dietary iodine
      Presentation:
      - Low metabolism, depression
      - Intolerance to cold, dry skin,
      - Enlarged thyroid gland
      - When in children called “cretanism”

19. **Goiter** – can’t make thyroxine due to iodine deficient diet.
20. Gonads (Testes and Ovaries)
   Testes  > respond to FSH by sperm production (by sertoli cells in seminiferous tubules)
   > respond to LH by producing testosterone (by leydig cells in seminiferous tubules)

   Ovaries > respond to FSH by developing new eggs (within follicles)
   > respond to LH by producing estrogen, and LH at day 14 of 28 day menstrual cycle causes ovulation.
   > respond to FSH by maturing an egg each month.

Disorders
21. Kallman’s Syndrome (Hypogonadism) = insufficient hypothalamic GnRH. \( \downarrow \) LH/FSH = \( \downarrow \) T = feminized male (intersex)
22. Androgen Insensitivity Syndrom (AIS) = tissues don’t respond to T (DHT). Feminized male (intersex)


24. Pancreas
   > beta cells make insulin. Causes tissues take up blood glucose (\( \downarrow \) blood glucose), & glycogenesis in liver & muscle
   > Alpha cells make glucagon. Causes glycogenolysis in liver (\( \uparrow \) blood glucose)

26. GI Tract
   > Gastrin (stomach) = stimulates HCL production (by parietal cells)
   > Secretin (sm. intestine) = stimulate water and bicarbonate secretion from pancreas
   > Cholecystokinin (sm. intestine)
     - stimulates gallbladder contraction (get bile into duodenum)
     - stimulates pancreatic enzyme secretion
   > Gastric inhibitory peptide (sm. intestine) = inhibits gastric motility (slow down) & stimulates pancreatic insulin.