Bio217: Pathophysiology Class Notes  
Professor Linda Falkow

Unit V: Endocrine System Disorders

Chap. 17: Mechanisms of Hormonal Regulation  
Chap. 18: Alterations of Hormonal Regulation

The Endocrine System

- **Components**  
  - Glands located around the body that secrete chemical messengers (________)

- **Functions**  
  - Works with _______ to regulate and integrate metabolism and maintain homeostasis

Hypothalamus ("heart of the endocrine system")

- Center for integrating endocrine and ANS  
- Regulates endocrine glands via _______ and __________ pathways

  - **Posterior Pituitary** (neural pathways)  
    - ADH (antidiuretic hormone)  
    - Oxytocin  

  - **Anterior Pituitary** (hormonal control)  
    - ACTH (adrenocorticotropic hormone)  
    - TSH (thyroid stim. hormone)  
    - LH (luteinizing hormone)  
    - FSH (follicle stim. hormone)  
    - also GH (growth horm.) and PRL (prolactin)

Negative Feedback - regulates the endocrine system by ____________ overproduction of hormones

Lipid-Soluble Hormones
**Hormone Binding at Target Cell**

**Anterior Pituitary Hormones**

**Endocrine disorders**
- May be caused by
  - Hypersecretion or hyposecretion of hormones
  - Hyporesponsiveness of hormone receptors
  - Gland inflammation
  - Tumors of glands

**Adrenal glands**
- Embedded in fat superior to each kidney
- **Adrenal cortex:**
  - 1. **Aldosterone**
    - regulates Na+ reabsorption & excretion of K+
  - 2. **Cortisol**
    - stimulates gluconeogenesis
    - protein breakdown and fatty acid mobilization
    - suppression of immune system
    - increased stress response
    - maintains BP and CV fcn.
  - 3. **Adrenal androgens & estrogens**

**Aldosterone**
- Epinephrine & Norepinephrine (catecholemines)
  - produce VC
  - ______ response (“fight or flight”)
Catecholamines

Thyroid and Parathyroid Glands

- **Thyroid gland**
  - Located in anterior neck; two lobes lie on either side of the trachea
  - Secrete Iodine-containing hormones
    - _____ – nec. for growth & dev.; increase metabolism
    - _____ – regulates blood Ca++ levels
- **Parathyroid glands**
  - 4 glands located on posterior aspect of thyroid
  - Secrete _____
    - Regulates blood Ca++ levels

Thyroid and Parathyroid Glands

- The pancreas is both an _____ and _____ gland
- Contains pancreatic islets (of Langerhans)
  - Secretion of glucagon and insulin
  - Cells
    - Alpha—glucagon (nec. when fasting → _____ BG)
    - Beta—insulin (released after a meal → _____ BG, stim. protein syn. and fatty acid uptake & storage)

Endocrine Pancreas

Concept Check

1. Organs that respond to a particular hormone are called:
   - A. target organs
   - B. integrated organs
   - C. responder organs
   - D. hormone attach organs

2. The hypothalamus controls the anterior pituitary by:
   - A. Nerve impulses
   - B. PG
   - C. Regulating hormones
   - D. None of the above
3. In a negative feedback mechanism controlling thyroid hormone secretion, which is the nonregulatory hormone?
• A. TRH
• B. TSH
• C. thyroxine
• D. All of the above are regulatory for thyroid hormone secretion

Matching:
____ 4. ACTH  a. Mammary glands
____ 5. TSH  b. Adrenal cortex
____ 6. TRF  c. Thyroid gland
____ 7. prolactin  d. Ant. pit.

Matching:
____ 8. Epi  a. Influence inflam. response
____ 9. Glucocorticoids  b. Causes fight or flight response
____ 10. Mineralcorticoids  c. Controls Na+, H+, K+
____ 11. Gonadocorticoids  d. Act as minor sex hormones

Alterations of Hormonal Regulation

Chapter 18

Elevated or Depressed Hormone Levels
• Failure of feedback systems
• Dysfunction of an endocrine gland
• Secretory cells are unable to produce, obtain, or convert hormone precursors
• The endocrine gland synthesizes or releases excessive amounts of hormone

Endocrine Disorders
• Pituitary disorder of water metabolism (diabetes insipidus)
• 3 Thyroid gland disorders (goiter, hyperthyroidism, hypothyroidism)
• Pancreatic disorder (diabetes mellitus: type 1 and type 2)
• 2 Adrenal disorders (Addisons’s and Cushing’s syndrome)
Elevated or Depressed Hormone Levels

- Increased hormone degradation or inactivation
- Ectopic hormone release

Diseases of the Posterior Pituitary

- **Diabetes insipidus**
  - Deficiency of ___ (aka vasopressin)
  - Polyuria (4-16 L/day) and polydipsia
  - Partial or total inability to concentrate urine
  - Causes: drugs or injury to posterior pituitary; lesions in hypothalamus, infundibulum or post. pit.
  - Normally ADH is syn. in hypothalamus and stored in post. pit. ADH is released when plasma osmolality increases → increased permeability to dct and cd in kidney → increased reabsorption of water.
  - When ADH is missing: results in increased excretion of water → large amt. of dilute urine

Diabetes Insipidus

- **Pathophysiology:**
  - Patients not able to concentrate urine
  - Deficiency of ADH → __________ vol. of dilute urine
  - __________ if fluids are not replaced
  - Treatment: replacement of ADH

Alterations of Thyroid Function

- **Goiter** = enlargement of thyroid gland
  - not due to inflammation or neoplasm
  - Classified as:
    - nontoxic (increased demand for TH during adolescence, pregnancy or menopause) and
    - toxic (due to long term nontoxic, occurs in elderly)
  - Please pass the iodine
    - Endemic goiter due to insufficient dietary iodine → insufficient production of TH
    - Too much of a good thing
      - Sporadic goiter due to ingestion of goitrogenic foods* (inhibit thyroxine) or drugs

Goiter

- **Pathophysiology**
  - Decreased iodine plus impaired synthesis of TH → responsiveness of thyroid to TSH
  - Increased mass and cell activity may overcome mild thyroid impairment (Patient has goiter but normal fcn.)
  - If severe impairment → goiter and hypothyroidism

Alterations of Thyroid Function

- **Hyperthyroidism**

*goitrogenic foods - foods that can cause goiter by inhibiting the production of thyroxine or by suppressing the thyroid gland.
Hyperthyroidism or thyrotoxicosis (Graves Disease)

Graves’ Disease

- How grave is Graves’ disease?
- Graves’ disease is the most common type
- Autoimmune, 30-60 years old, family history of thyroid abnormalities
- Thyroid-stimulating antibodies bind to TSH receptors
- Thyroid storm (thyrotoxic crisis)
  Overproduction of T3 and T4 → increased SNS activity
  (tachycardia, vascular collapse, hypotension, coma, death)

Graves’ disease

- Signs & Symptoms
  - Enlarged thyroid
  - Exophthalmos
  - Nervousness, weight loss w/ increased appetite
- Treatment
  - Antithyroid drugs (propylthiouracil, methimazole)
  - 131 I (radioactive iodine therapy)
  - Surgery

Alterations of Thyroid Function

- Hypothyroidism
  - Thyroid deficiency (decreased T3 and T4) → metabolic processes slow (may be problem with thyroid, pituitary, or hypothalamus)
  - Primary hypothyroidism – due to disorder of thyroid
  - Secondary hypothyroidism – due to failure to stimulate thyroid
  - Causes: thyroidectomy, radiation, not enough TSH (from pituitary) or TRH (from hypothalamus)
  - Symptoms: fatigue, wt. gain, facial puffiness, dry skin, bleeding tendencies

Pathophysiology

- Loss of thyroid tissue → decreased TH, increased TSH and goiter (primary)
- Decreased TSH from pituitary most commonly due to tumors (secondary)
- Myxedema - composition of dermis is changed (puffiness)
- Myxedema coma - depressed respiratory system, decreased cardiac output, bradycardia & hypotension
- Treatment: TH replacement gradually (levothyroxine)

Hypothyroidism
Diabetes Mellitus

- Body does not produce or use _______ properly
- Results in hyperglycemia

Type 1 (IDDM = insulin-dependent)
Type 2 (NIDDM = non-insulin-dependent)

Type 1 diabetes

- Pathophysiology (Type 1)
  - Islet cell (beta cell) destruction → no insulin production
  - Autoimmune (genetic & environmental)
  - Nonautoimmune (idiopathic)

- Symptoms
  - Lack of insulin → __________ occurs w/ 89-90% destruction of beta cells; excess glucagon by alpha cells
  - Glucosuria, polyuria, polydipsia
  - Ketoacidosis due to fat and protein metabolism → DKA coma

- Treatment: Insulin, meal planning and exercise, Hb A1C

Type 2 diabetes mellitus

- Pathophysiology
  - Idiopathic, genetic and environmental factors
  - Insulin resistance in target tissues
  - Overproduction of glucose via gluconeogenesis
  - Obesity

- Symptoms
  - Recurring skin infections
  - Visual changes (blurred vision, retinopathy)
  - Paresthesias
  - Fatigue (poor eating)
- Treatment
  - Personalized meal plan & exercise

Acute Complications of Diabetes Mellitus

- Hypoglycemia (insulin shock- decr. BG levels)
- Diabetic ketoacidosis _______ – dec. insulin levels → elevated BG levels → fat mobilized
- Somogyi effect – hypoglycemia followed by hyperglycemia (rebound)
- Dawn phenomenon – early morning elevated BG

Diabetic Ketoacidosis

Chronic Complications of Diabetes Mellitus

- Hyperglycemia
- Microvascular disease
  - Retinopathy
  - Diabetic nephropathy
- Macrovascular disease
  - Coronary artery disease
  - Stroke
  - Peripheral arterial disease
- Diabetic neuropathies
- Infection
Alterations of Adrenal Function

- Disorders of the adrenal cortex
  - Cushing disease
    • Excessive anterior pituitary secretion of ________
  - Cushing syndrome
    • Cluster of abnormalities due to excessive levels of cortisol (glucocorticoid)
    • Wt. gain, muscle weakness, fatigue, buffalo hump, thin extremities, bruise easily
  - Treatment:
    • Radiation, drugs, surgery depending on cause

Addison's disease

- (adrenal insufficiency or hypofunction)
- Mineralcorticoid, glucocorticoid, and androgen secretion
- Cause — usually from autoimmune process
  • Idiopathic, TB, removal of adrenals, neoplasms, infections
- Adrenal crisis
  • Inadequate or nonresponsive hormone therapy
  • Extreme stress
  • hypoglycemia, hypotension → coma → death

Cushing Disease

- A. Before onset of Cushing syndrome
- B. 4 months later

Concept Check

- 1. Which clinical symptoms are shared by DM and diabetes insipidus?
  - A. Elevated blood and urine glucose levels
  - B. Inability to produce ADH
  - C. Inability to produce insulin
  - D. Polyuria

- 2. Graves disease is:
  - A. Hyperthyroidism
  - B. Associated with autoimmunity
  - C. Characterized by ophthalmopathy
  - D. All of the above

- 3. A 24-year old female with a history of “juvenile onset” diabetes is found in a stupor. She has cold, clammy skin, what is most likely the cause of her condition?
  - A. Hyperglycemia
  - B. Insulin shock
  - C. Renal failure
  - D. retinopathy

- 4. Common signs and symptoms of DM include all of the following except:
  - A. Hyperglycemia
  - B. Blurred vision
  - C. Increased muscle anabolism
  - D. polyuria

Matching:

- ____ 5. Cushing disease — A. Excess cortisol
- ____ 6. Goiter — B. Enlarged thyroid
- ____ 7. Addison disease — C. Adrenal hypofunction