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 (anti-diuretic hormone)
  - Oxytocin
- **Anterior Pituitary** (hormonal control)
  - ACTH (adrenocorticotropic hormone)
  - TSH (thyroid stimulating hormone)
  - LH (luteinizing hormone)
  - FSH (follicle stimulating hormone)
  - GH (growth hormone)
  - PRL (prolactin)

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

Lipid-Soluble Hormones

Blood vessel
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

- Adrenal medulla
  - 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
  - Secretes iodine-containing hormones
    - **TSH** - necessary for growth & development; increases metabolism
    - **T3** - regulates blood Ca++ levels
- **Parathyroid glands**
  - 4 glands located on posterior aspect of thyroid
  - Secrete ________

Thyroid and Parathyroid Glands

- **Thyroid and Parathyroid Glands**

Endocrine Pancreas

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

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:  

- 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
- ➔ abnormal hormone levels

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 (Addison’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 ADH (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 duct 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**
Hyperthyroidism or thyrotoxicosis (Graves Disease)

Graves’ Disease

• How grave is Graves’ disease?
• Graves’ disease is 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

**Cushing Disease**

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

- **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

**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