• Endocrine system consists of many glands, including: (see p. 303 for more complete info)
  – Hypothalamus—located beneath the thalamus in the third ventricle of the brain
  – Pituitary (hypophysis)—anterior and posterior—located at the base of the brain
  – Pineal—located behind the midbrain
  – Thymus—located in the mediastinal cavity under the sternum, near the heart.
  – Thyroid—located in the neck on each side of the trachea
  – Parathyroids—usually four glands, embedded in the posterior part of the thyroid
Endocrine glands continued

Adrenals—two glands, one on top of each kidney. The cortex (secretes the steroids) of the adrenals act as one gland and the medulla (secretes epinephrine and norepinephrine) acts as another.

Pancreatic islets—embedded in the pancreas

Ovaries and testes—one ovary on each side of the uterus and one testes in each side of the scrotal sac
Hypothalamus

Contains neurosecretory cells that secrete hypothalamic hormones. These hormones regulate the function of the anterior pituitary gland. The hypothalamus also produces the two hormones stored in the neurohypophysis or posterior pituitary gland. (ADH and Oxytocin)
Pituitary (hypophysis) see p. 304

**Anterior Pituitary** (adenohypophysis) produces ACTH, TSH, STH, MSH, Prolactin, FSH, LH, ICSH.

**Posterior Pituitary** (neurohypophysis) stores two hormones that are secreted by the hypothalamus. Oxytocin (pitocin) and ADH (antidiuretic hormone or vasopressin).
Pineal gland secretes melatonin. This hormone helps maintain the circadian rhythm.

Thymus Secretes thymopoietin, a hormone that stimulates development of lymphocytes.
Thyroid gland
Secretes thyroxine (T4) triiodothyronine (T3), and calcitonin. These are released as needed in response to the thyroid-stimulating hormone secreted by the pituitary gland. T3 T4 increase metabolic activity. Calcitonin affects the regulation of calcum.
Parathyroid glands secrete parathormone, important in the regulation of calcium and phosphorus in the body.
Adrenal glands

The cortex secretes mineralocorticoids (promote sodium retention), glucocorticoids (affect the metabolism of protein, glucose and fats), and androgens (enhance masculinization), cortisol (the main glucocorticoid and is important for metabolism of carbs).

The Medulla secretes epinephrine and norepinephrine.
Pancreas

**Beta cells** secrete insulin, important for the metabolism of glucose, also promotes fatty acid synthesis and amino acid entry into cells.

**Alpha cells** secrete glucagon which helps regulate low blood sugar.
Ovaries

Secrete estrogen and progesterone, important for development and maturation and maintaining the functions of the reproductive system.
Testes

Secrete testosterone important for growth and development, secondary sex characteristics and maintaining the reproductive system functions.
qualities

• Each gland is unique and delivers secretion into bloodstream

• Negative feedback (except in the case of oxytocin) system controls amount of hormones secreted—if the concentration of the hormone in the blood is low, the sequence of events stimulates the gland to secrete more. If the concentration of the hormone is higher the mechanism triggers the gland to suppress the release of more.
Diagnostic Tests

• Thyroid and testes
  – ONLY Endocrine glands that can be physically examined

• Diagnostic Tests
  – Blood and urine testing for hormones
  – CT scan and MRI for tumors or alteration in organ size
Pituitary Gland Diseases

• Hyperpituitarism
  – Increase in activity of pituitary gland
  – Oversecretion affects *growth hormone* leading to excessive growth of bones and tissues
  – If occurs before puberty, *gigantism* occurs
  – If occurs during adulthood, *acromegaly* occurs
  • Affects small bones of hands, feet, and face by enlarging them
Pituitary Gland Diseases

• Hypopituitarism
  – Abnormal decrease in activity of pituitary gland
  – Symptoms:
    • Dwarfism
    • Abnormality of secondary sex characteristics
    • Amenorrhea and infertility in adult females
    • Lowered testosterone level, decreased libido, loss of facial and body hair in adult males
Pituitary Gland Diseases

• Hypopituitarism
  – Diagnosis of pituitary function by blood test
  – Treatment:
    • Hormone replacement
    • Monitoring—constant monitoring of hormones
    • Adjustment—of hormones as necessary
Pituitary Gland Diseases

- Diabetes insipidus
  - Caused by:
    - Defect in the pituitary gland OR defect in kidney tubules
    - Both defects result in a decrease of vasopressin or antidiuretic hormone
  - Symptoms:
    - Excessive polyuria
      - Urinating 2 to 15 gallons of urine in 24 hours
    - Polydipsia
    - Hypotension
    - Dizziness
    - Constipation
Pituitary Gland Diseases

• Diabetes insipidus—characterized by polyuria—caused by decrease in release of ADH by the posterior pituitary. It can also occur if the tubules of the kidney cannot respond to the ADH.
  – Diagnosis
    • Urinalysis — check for specific gravity
    • Water restriction test — limit intake while monitoring output
  – Treatment:
    • Administration of vasopressin
    • Medications that lower urine output
Thyroid Gland Diseases

• Hyperthyroidism
  – Thyroid gland secretes excessive thyroxine

  – Cause
    • Tumor of thyroid gland
    • Heredity
    • Excessive intake of iodine
    • Excessive thyroid hormone medication
    • Graves’ disease is most common cause
Thyroid Gland Diseases

• Hyperthyroidism
• Graves’ disease is an autoimmune condition where antibodies stimulate the thyroid gland to produce hormone—excessive secretion of T3 and T4
  – Symptoms:
    • Goiter
    • Tachycardia
    • Nervousness
    • Hyperactivity
    • Weakness
    • Excessive excitability
    • Tremendous appetite with weight loss (more next slide)
Thyroid Gland Diseases

• Hyperthyroidism

– Symptoms: (continued)
  • Diarrhea
  • High heat production - moist skin
  • Extreme thirst
  • Exophthalmos—(“bugging out of eyes”)
  • Diagnosis—H&P and blood test showing elevated TSH

– Treatment
  • Medication
  • Radiation
  • Surgery    (more next slide)
Thyroid Gland Diseases

• Simple goiter
  – Enlargement of thyroid
  – Cause:
    • Family history
    • Eating goitrogenic foods
    • Iodine deficiency
  – Symptoms:
    • Thyroid enlargement
    • May be asymptomatic until gland is quite large
  – Treatment:
    • Potassium iodide followed by iodine in diet
    • Surgery to decrease dysphagia and dyspnea
Thyroid Gland Diseases

• Hypothyroidism
  – Decrease in thyroxine normal T4
    • Advanced Hypothyroidism in adult – myxedema
    • Congenital hypothyroidism (at birth) – cretinism
  – Symptoms:
    • Fatigue
    • Sensitivity to cold temperatures
    • Thin nails and brittle hair
    • Excessive weight gain
  – Diagnosis: by blood hormone level of T3, T4, and free T4
  – Treatment:
    • Hormone replacement
Parathyroid Gland Diseases

• Hyperparathyroidism
  – Overproduction of parathormones by one or more of the four parathyroid glands
  – Causes hypercalcemia (excessive blood calcium levels, calcium pulled from bones) leading to kidney stones, bone weakness, and hyperactivity of heart
  – Diagnosis by blood tests
  – Treatment directed at cause
  – Prognosis good with proper treatment
Parathyroid Gland Diseases

• Hypoparathyroidism
  – Decrease in parathormone leading to low blood calcium
    • Causing irritability of muscles called tetany
    • Uncontrolled contraction of muscles in face and hands is common
  – Diagnosis:
    • Blood tests
    • Chvostek’s sign—(tapping over facial nerve of face caused muscle spasm)
    • Trousseau’s sign—(pressure to nerves and vessels of upper arm causes muscle spasm)
  – Treatment:
    • Vitamin D
    • Calcium
Adrenal Gland Diseases

- Adrenal glands
  - Also known as suprarenals
  - Have two distinct parts:
    - Inner
      - Medulla releases epinephrine and norepinephrine
        » Fight-or-flight hormones these hormones have a direct effect on the vascular system.
    - Outer
      - Cortex controlled by ACTH from the pituitary gland
Adrenal Gland Diseases

- Adrenal glands secrete mineralocorticoids, glucocorticoids, and sex hormones
  - Mineralocorticoids: primary is aldosterone, monitors salt balance
  - Glucocorticoids: primary is cortisol (hydrocortisone), regulates carbohydrate metabolism
  - Sex hormones: androgens and estrogens, provide male and female characteristics, respectively.

- Cortisone
  - Glucocorticoid used to treat inflammatory

  - Should be used short-term only—prolonged use can be fatal
Adrenal Gland Diseases

- Cortisone side effects:
  - Hypertension
  - Ulcers
  - Moon face
  - Drowsiness
  - May mask symptoms of infection
Adrenal Gland Diseases

• Hyperadrenalism p. 312
  – Oversecretion of adrenal cortex hormones

• Conn’s syndrome
  – Overproduction of mineralocorticoid aldosterone (hyperaldosteronism)—leads to hypokalemia, alkalosis and HTN

• Cushing’s syndrome
  – Overproduction of glucocorticoid cortisol—What are the symptoms?
Adrenal Gland Diseases

• Androgenital syndrome  p. 313
  – Overproduction of sex hormones—also known as adrenal virilism (masculinization or feminization)—

• Hypoadrenalism or Addison’s disease
  – Low secretion of hormones by adrenal cortex—low sodium leading to diarrhea and dehydration, hypoglycemia from deficiency in glucocorticoids. Increased ACTH levels lead to hyperpigmentation.
Pancreatic Islets of Langerhans Diseases

- Pancreas
  - Both exocrine and endocrine gland
  - Islets of Langerhans secrete (beta cells) insulin and (alpha cells) glucagon
  - Insulin lowers blood sugar
  - Glucagon increases blood sugar
  - Sugar or glucose
    - Primary source of energy for all tissue cells
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Commonly known as diabetes
  – Is the most common major disease of the system
  – Affects carbohydrate and sugar utilization due to lack of insulin
  – Symptoms:
    • Polydipsia—excessive thirst
    • Polyuria—excessive urination
    • Polyphagia—increased appetite
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Types:
    • Type 1
    • Type 2
  – Type 1
    • Previously known as insulin-dependent diabetes mellitus
    • Most serious type
    • Affects children and young adults before age 25 (usually)
    • Requires daily blood sugar checks and injections of insulin
    • Thought to be autoimmune disorder
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Type 1
    • Individuals do not usually secrete insulin
      – Making blood glucose control difficult

• Individuals with type 1 diabetes must
  – Follow a strict diet
  – Monitor blood levels
  – Administer daily insulin
  – Exercise and stress can alter insulin needs
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Type 2
    • Formerly known as non-insulin-dependent diabetes
    • Most common form of diabetes
    • Gradual onset occurring most often in obese females over age 40
    • Now frequently seen in younger obese persons
    • Thought to be caused by wearing out of pancreatic islets of Langerhans
    • Usually controlled with diet, exercise, and oral medication to stimulate insulin secretion
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Complications:
  – Both coma and shock are a result of improper insulin administration
    • Diabetic coma
      – Progresses slowly
      – Hyperglycemia
      – Result of not taking enough insulin or eating too much carbohydrate
      – Symptoms: polyuria, polydipsia, dehydration, ketoacidosis.
        Symptoms of coma are a slow, deep breathing pattern, fruity or sweet-smelling breath
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Complications:
    • Diabetic shock
      – Progresses quite rapidly
      – Hypoglycemia
      – Too much insulin or not enough carbohydrates in diet
      – Symptoms: diaphoresis, light-headedness, trembling, and state of confusion followed by coma
      – Coma from insulin shock is a medical emergency
Pancreatic Islets of Langerhans Diseases

• Diabetes mellitus
  – Complications:
    • Atherosclerosis
    • Diabetic retinopathy
    • Kidney damage
  – Diagnosis
    • History and physical
    • Blood glucose testing
  – Treatment
    • No cure; individual must follow treatment plan for life
Diabetic Ketoacidosis

Diabetic coma can occur when the blood sugar gets too high. The individual will have slow deep-breathing and fruity sweet smelling breath. The emergency treatment with insulin and sodium bicarbonate to bring blood sugar down and correct the acidosis of the blood.
Insulin Shock occurs rapidly as is the result of too much insulin, not enough food or excessive exercise. Symptoms are diaphoresis, light-headedness, trembling, and possibly altered mental status. The individual needs food or in emergency cases, intravenous glucose.
Pancreatic Islets of Langerhans Diseases

• Gestational diabetes
  – Occurs only during pregnancy
  – Usually discovered with routine urine testing during prenatal visits
  – Treatment:
    • Diet
    • Exercise
    • Medications
Pancreatic Islets of Langerhans Diseases

- **Gestational diabetes**
  - Injectable insulin controls sugar levels
  - Usually disappears after delivery
  - Women often affected later in life by adult-onset diabetes
  - The infants should be monitored throughout life as they are also more prone to develop diabetes
  - Prevention: No preventative measures, but women who observe a healthy lifestyle and normal weight at conception are at less risk
Pancreatic Islets of Langerhans Diseases

• Hypoglycemia
  – Abnormally low blood sugar
    • Less than 60
  – Symptoms:
    • Light-headedness
    • Diaphoresis
    • Trembling
  – Diagnosis: blood glucose test
  – Treatment: dependent on cause
Reproductive Gland Diseases

• Hypergonadism
  – Increased hormone production before puberty leads to early sexual development in both the male and the female.

  – Diagnosis by blood test for elevated hormones

  – Treatment:
    • Removal or radiation of tumors to suppress hormones
    • Administration of hormones to suppress or counteract the sex hormone
Reproductive Gland Diseases

• Hypogonadism
  – Decreased hormone production by the age of puberty leads to the absence of normal sexual development
  – Diagnosis by blood test for hormones levels
  – Treatment:
    • Administration of testosterone and estrogen
Trauma

- Head injury can lead to multiple organ dysfunction
- Organ destruction and failure can be life-threatening
Rare Diseases

• Most diseases of the endocrine system are relatively uncommon, with the exception of thyroid problems and diabetes
Effects of Aging

- Decreased secretions from glands—ex: menopause, loss of testosterone
- Lessened glucose tolerance—can lead to NIDDM
- Digestive and metabolism problems are common—slowed digestive tract
- Diabetes mellitus common—due to lessened insulin sensitivity