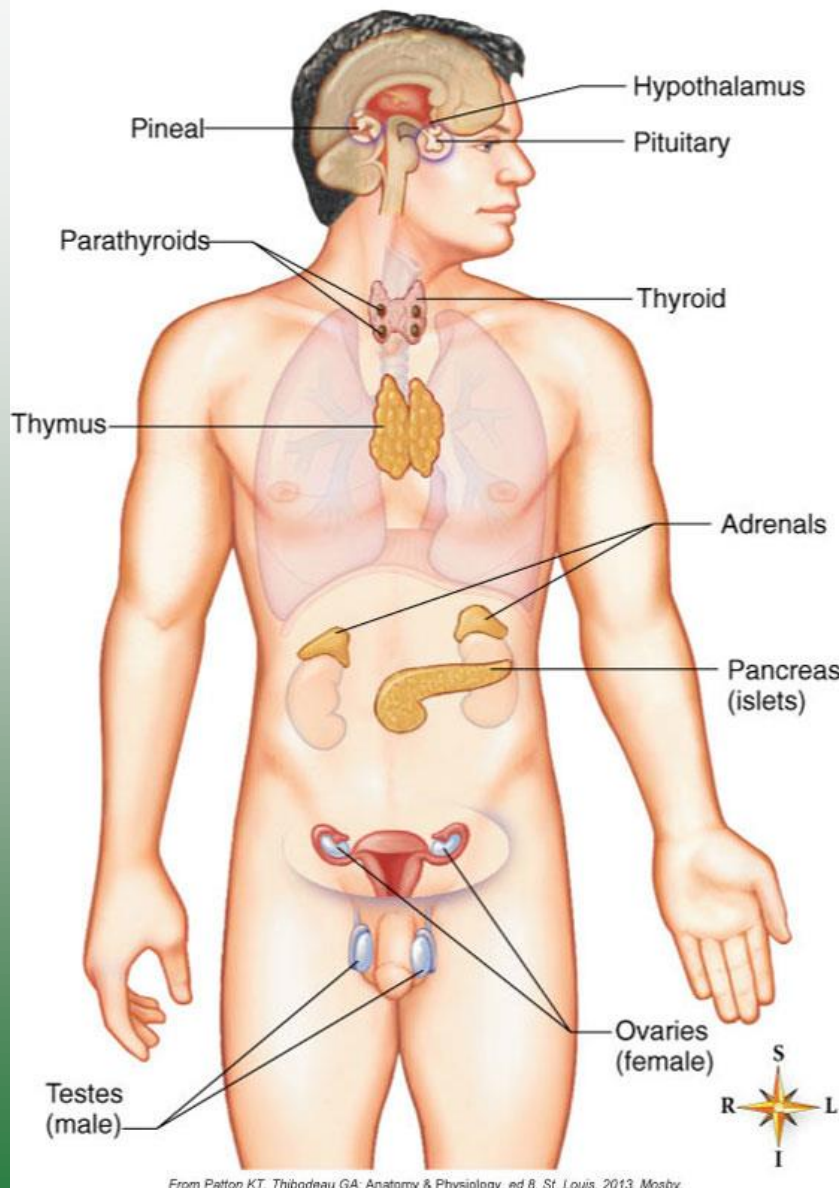


Chapter 16

Endocrine System Disorders

Location of Endocrine Glands



From Patton KT, Thibodeau GA: Anatomy & Physiology, ed 8, St. Louis, 2013, Mosby.

Endocrine vs Exocrine

Exocrine Glands produce a secretion that is dispensed locally via a duct into a cavity (saliva into mouth, pancreatic juice into small intestine).

Endocrine Glands produce hormones that are released into the blood stream and act at distant sites from the gland.

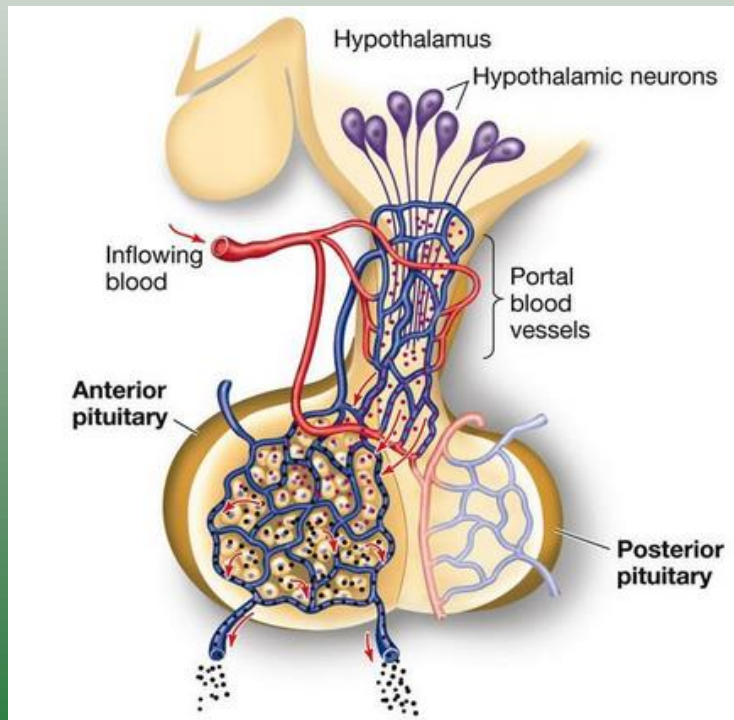
- the target tissue cells have receptors for the hormone.
- negative feedback systems are often in place.
- hormones are peptides or steroids.

Chemical Structure

- Steroid
 - They are lipids and enter the cell nucleus to initiate transcription directly.
- Nonsteroid
 - Needs a secondary messenger system to activate transcription in the nucleus

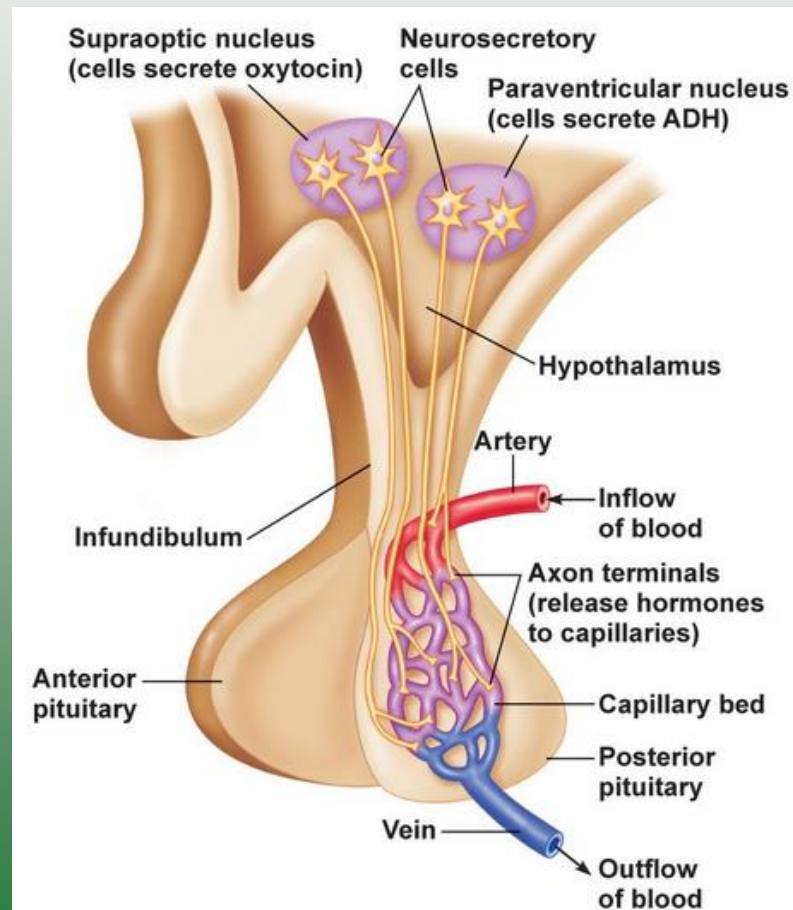
Hormones from the hypothalamus

Hormone	Primary Effects
Hypothalamic-releasing hormones	Stimuli to anterior pituitary to release specific hormone
Hypothalamic-inhibiting hormones	Decrease release of specific hormone by anterior pituitary

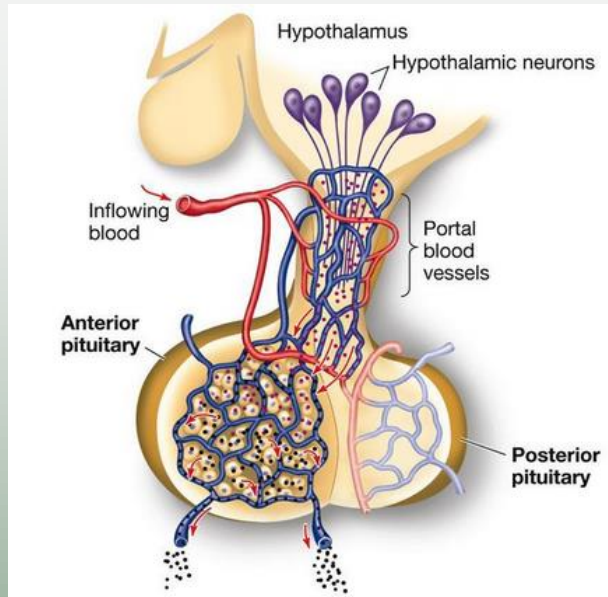


Example: GHRH, growth hormone releasing hormone, is released by the hypothalamus to cause the anterior pituitary to release growth hormone.

Antidiuretic hormone (ADH, or vasopressin)	Increases reabsorption of water in kidney
Oxytocin (OT)	Stimulates contraction of uterus after delivery

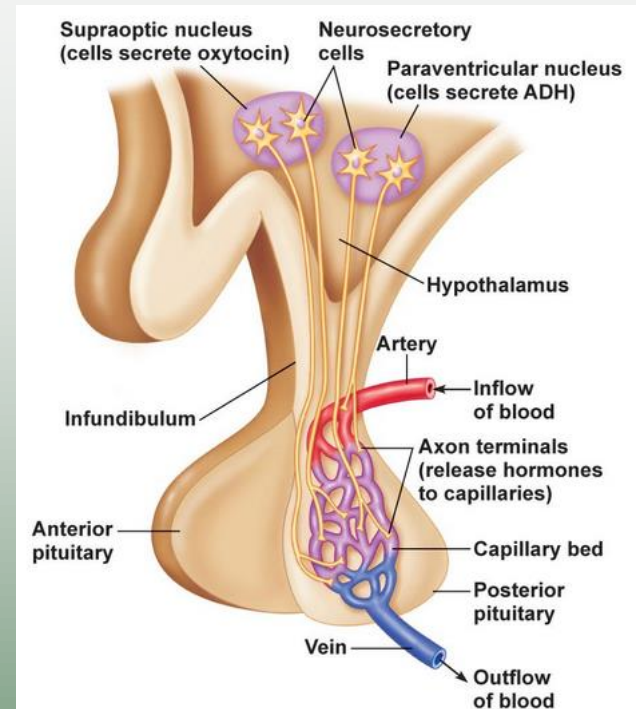


Anterior Pituitary (Adenohypophysis)



Hypothalamic neurons release hormone in the stalk and it is carried by the hypothalamic-hypophyseal portal vessels to the anterior pituitary.

Posterior Pituitary (Neurohypophysis)



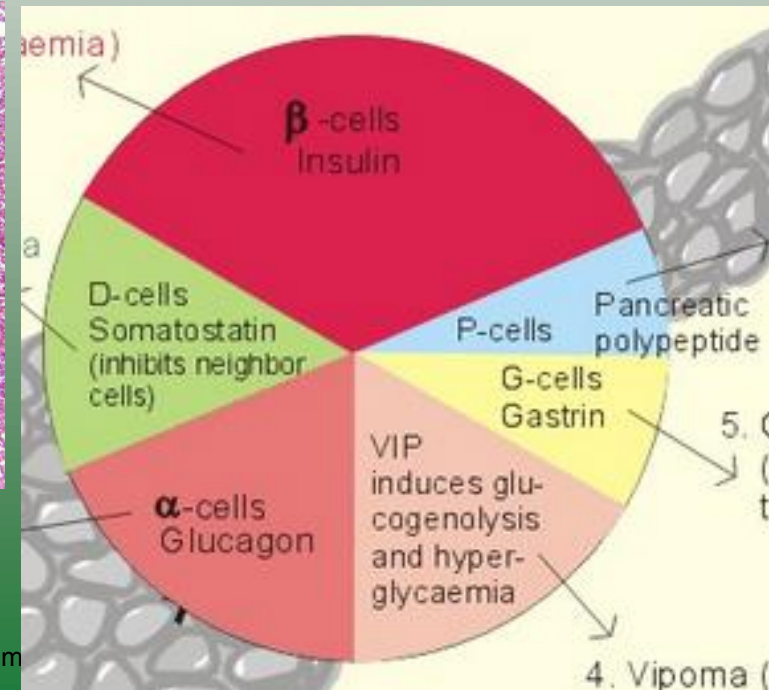
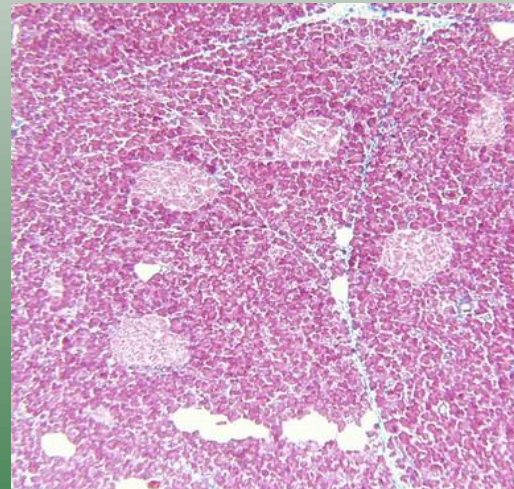
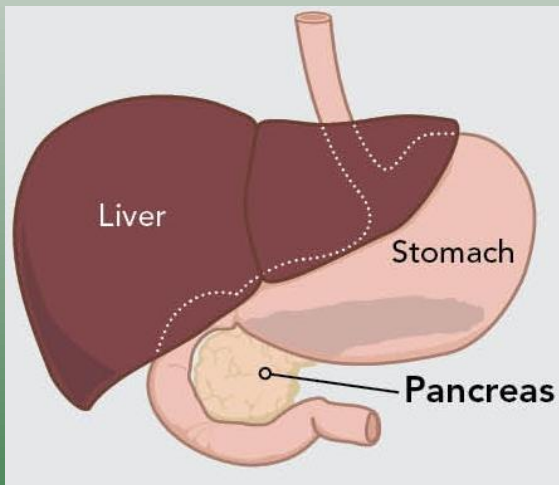
Hypothalamic neurons release hormone directly into the posterior pituitary to be picked up by capillaries there.

Anterior Pituitary Hormones

Growth hormone (GH, somatotropin)	Stimulates protein synthesis
Adrenocorticotrophic hormone (ACTH)	Stimulates adrenal cortex to secrete primarily cortisol
Thyroid-stimulating hormone (TSH)	Stimulates thyroid gland
Follicle-stimulating hormone (FSH)	Women: stimulates growth of ovarian follicles and estrogen secretion; men: stimulates sperm production
Luteinizing hormone (LH)	Women: stimulates maturation of ovum and ovulation; men: stimulates secretion of testosterone
Prolactin (PRL)	Stimulates breast milk production during lactation

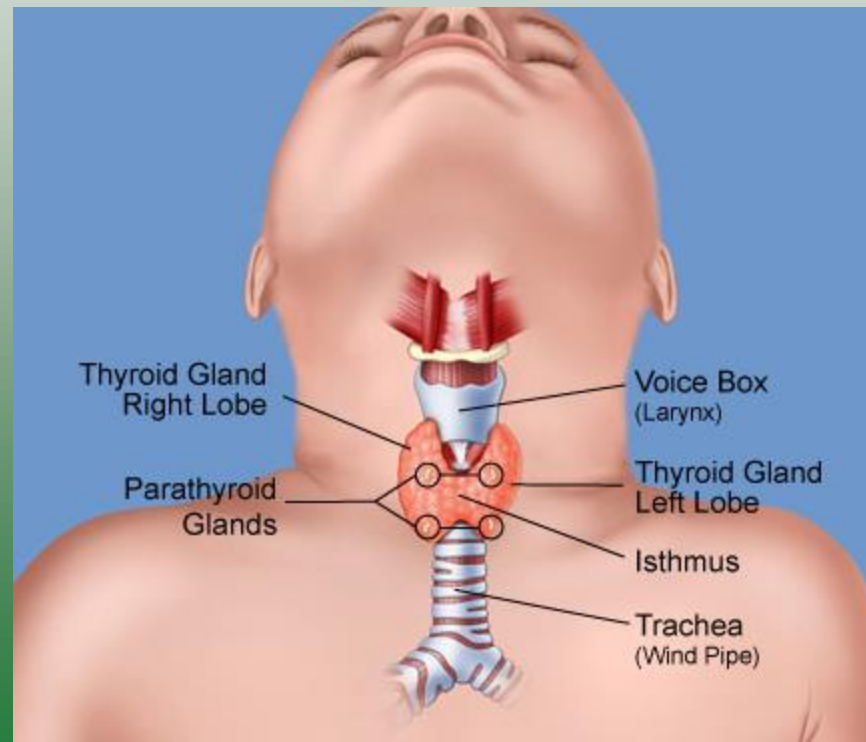
Pancreas:

Insulin	Pancreas—beta cells of islets of Langerhans	Transport of glucose and other substances into cells Lowers blood glucose level
Glucagon	Pancreas—alpha cells	Glycogenolysis in liver Increases blood glucose level



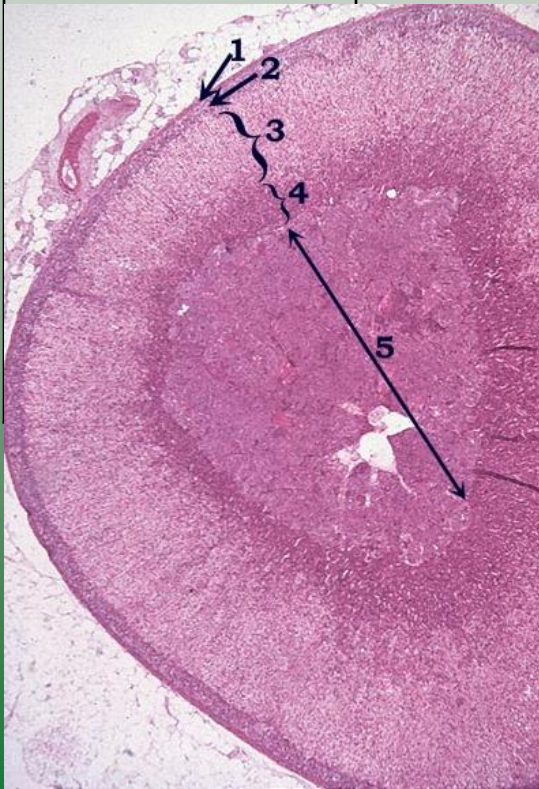
Thyroid and Parathyroid Glands

Parathyroid hormone (PTH)	Parathyroid gland	<u>Increases blood calcium</u> level by stimulating bone demineralization and increasing absorption of Ca^{++} in the digestive tract and kidneys
Calcitonin	Thyroid gland	Decreases release of calcium from the bone to <u>lower blood calcium</u> level



Adrenal Gland

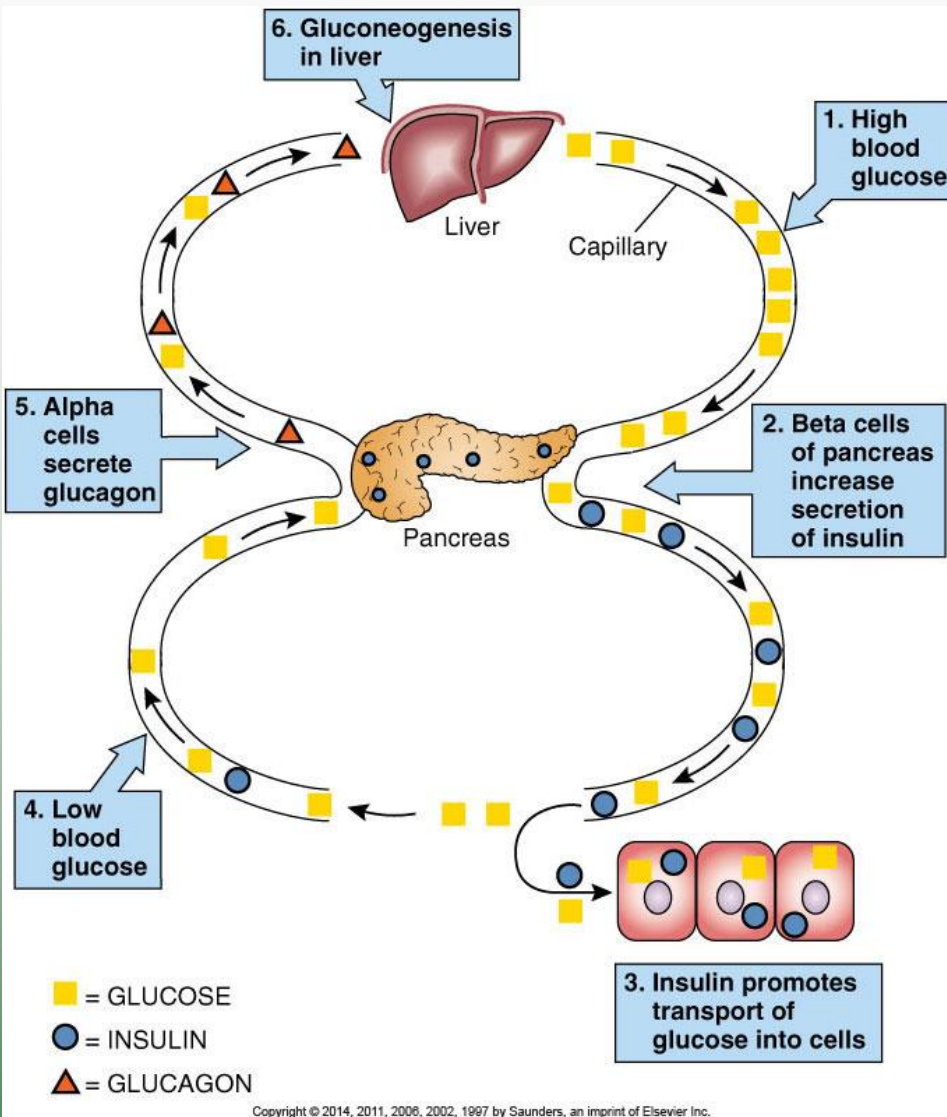
Aldosterone (a mineralocorticoid)	Adrenal cortex	Increases sodium and water reabsorption in the kidney
Cortisol (a glucocorticoid)	Adrenal cortex	Anti-inflammatory and decreases immune response Catabolic effect on tissues; stress response
Norepinephrine	Adrenal medulla	General vasoconstriction
Epinephrine	Adrenal medulla	Adrenal medulla Stress response Visceral and cutaneous vasoconstriction Vasodilation in skeletal muscle Increases rate and force of heart contraction Bronchodilation



Picture: 2,3,4 = Cortex; 5 = Medulla

Negative Feedback:
High Glucose > Insulin release //
Low glucose inhibits insulin release.

Complementary Systems:
Insulin lowers blood glucose //
Glucagon raises blood glucose.



Endocrine Disorders

- All disorders reflect impaired control or feedback.
- Excess or Deficit of Hormone
 - Tumors produce hormone
 - Problem with Complementary Hormone
 - Tissue over/under produces
 - Problem with the cells making the hormones
 - Problems with receptors that stimulate cells to produce
 - Problems with releasing hormones

Diagnostic Tests

- Blood tests
- Urine tests
- Stimulation or suppression tests
- CT, MRI, Ultrasound
- Biopsy

Treatment

- Deficit may be treated with replacement therapy.
- Excessive secretion may be treated with
 - Medications
 - Surgery
 - Radiation

Diabetes Mellitus

- Diabetes mellitus—basic problem is inadequate insulin effects in receptor tissues
 - Deficit of insulin secretion from pancreas.
 - Cells do not respond to insulin (insulin resistance)
- Diabetes results in abnormal carbohydrate, protein, and fat metabolism.
- Some tissues can transport glucose in the absence of insulin:
 - CNS, kidney, myocardium, gut, skeletal muscle

Types of Diabetes

- Type 1
 - Autoimmune destruction of beta cells in pancreas
 - Insulin replacement required
 - IDDM (insulin dependent diabetes mellitus)
 - Acute onset in children and adolescents
 - Not linked to obesity
 - Genetic factors may play a role.

Types of Diabetes

- Type 2

- Non Insulin Dependent Diabetes Mellitus (NIDDM).
- Onset is slow and insidious, usually in those older than 50 years
- Increasing incidence in teens and young adults
- Caused by decreased production of insulin and/or increased resistance by body cells to insulin
- Associated with obesity
- Oral hypoglycemic medications may be used.

General Manifestations

- Blood glucose levels rise—hyperglycemia
- Excess glucose in urine—glucosuria
 - **Dehydration** results from hyperosmolar filtrate.
 - **Polyuria**
 - **Polydipsia**
- Insulin deficit results in decreased transport and use of glucose in many cells.
 - Polyphagia (increased appetite).
 - Fatigue

Diabetes: Diagnostic Tests

- Fasting blood glucose level
- Glucose tolerance test
 - Give oral glucose
 - Watch for rise and fall in blood
- Glycosylated hemoglobin test
 - Hemoglobin A1c
 - Clinical and subclinical diabetes
 - Monitor glucose levels over several months.

Diabetes: Treatment Principles

- Maintenance of blood glucose levels in normal range
 - Helps reduce complications
- Diet and exercise
 - Exercise reduces blood glucose level as skeletal muscle uses glucose.
- Oral medication
 - Increase insulin secretion.
 - Reduce blood glucose levels.
- Insulin replacement

Type 1 Diabetes

- Metabolic changes
 - Cells can not access glucose so they burn fats and proteins.
 - Catabolism of fats and proteins
 - Excessive amounts of fatty acids and metabolites
 - Ketones (acetoacetic acid and β -hydroxybutyrate) increase in blood and subsequently in urine.
 - Ketoacidosis and Ketonuria.
 - Also known as DKA (diabetic ketoacidosis).

Complications

- Complications are directly related to duration and extent of abnormal blood glucose levels.
- Many factors lead to fluctuations in serum glucose levels.
 - Variations in diet and alcohol use
 - Change in physical activity
 - Infection
 - Vomiting
- Complications may be acute or chronic.

Diabetes: Acute Complications

- Hypoglycemia (insulin shock)
 - More common with insulin replacement treatment
 - Can occur because of excess oral hypoglycemic drugs
 - **Excess insulin in circulation**
 - Glucose deficit in blood
 - Can be life-threatening or cause brain damage if untreated
 - Often follows strenuous exercise
 - Dosage error
 - Vomiting
 - Skipping meal after taking insulin

Hypoglycemic Shock: Signs and Symptoms

- Disorientation and change in behavior
- May appear impaired
- Anxiety *or* decreased responsiveness
- Decreased blood glucose level
- Decreased BP, increased heart rate
- Decreasing level of consciousness
 - **NOTE:** Immediate administration of glucose is required to prevent brain damage.

Diabetes: Acute Complications

- Diabetic ketoacidosis
 - Occurs in insulin-dependent clients
 - More commonly seen in type 1 diabetes
 - Result of **insufficient insulin in blood**
 - High blood glucose levels
 - Mobilization and use of lipids to meet cellular needs result in production of ketoacids
 - May be initiated by infection or stress
 - May result from error in dosage, infection, change in diet, alcohol intake, or exercise

Signs and Symptoms of Diabetic Ketoacidosis

- Dehydration
 - Thirst, dry, rough oral mucosa
 - Warm, dry skin
- Rapid, deep respiration—acetone breath
 - Lethargy, decreased responsiveness
- Metabolic acidosis
 - May lead to loss of consciousness
- Electrolyte imbalances
 - Abdominal cramps, nausea, vomiting, lethargy, weakness

Acute Complications: HHNK Syndrome

- HHNK: **H**yperglycemic **h**yperosmolar **n**onketotic
- Occurs in type 2 diabetes
- Insidious in onset and diagnosis may be missed
- Often occurs in older clients and assumed to be cognitive impairment
- Results in severe dehydration and electrolyte imbalances

HHNK Manifestations

- Hyperglycemia
- Severe dehydration
 - Increased hematocrit
 - Loss of turgor
 - Increased heart rate and respirations
- Electrolyte imbalances result in:
 - Neurologic deficits
 - Muscle weakness
 - Difficulties with speech
 - Abnormal reflexes

Chronic Complications of Diabetes

- Vascular problems
 - Increased incidence of atherosclerosis
 - Changes may occur in small and large arteries.
- Microangiopathy—changes in microcirculation
 - Obstruction or rupture of small capillaries and arteries
 - Tissue necrosis and loss of function
 - Neuropathy and loss of sensation
 - Retinopathy—leading cause of blindness
 - Chronic renal failure—degeneration in glomeruli of kidney

Chronic Complications of Diabetes

- **Macroangiopathy**—affects large arteries
 - **Result of abnormal lipid levels**
 - High incidence of heart attacks, strokes, peripheral vascular disease
 - May result in ulcers on feet and legs—slow-healing
 - Frequent infections and gangrenous ulcers
 - Amputation may be necessary.
- **Peripheral neuropathy**
 - **Common complication caused by ischemia in microcirculation to peripheral nerves**
 - Impaired sensation, numbness, tingling, weakness, muscle wasting

Chronic Complications of Diabetes

- Infections

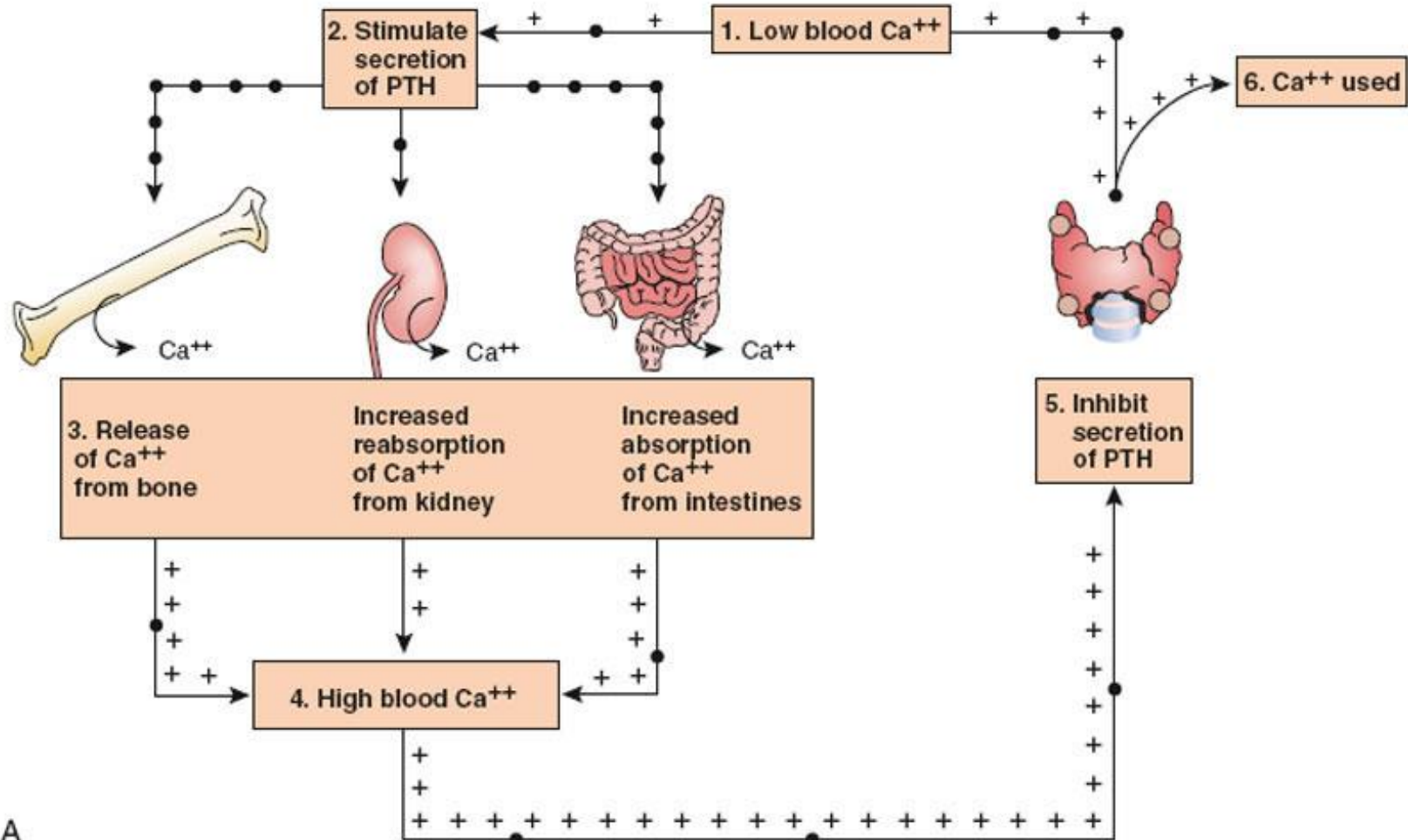
- Common and often more severe in diabetics
- **Infections** in feet and legs caused by vascular and neurological impairment, **poor wound healing.**
- Fungal infections common
 - Caused by *Candida*
 - In vagina and/or oral cavity
- Urinary tract infections
- Dental caries
- Gingivitis and periodontitis

Chronic Complications of Diabetes (Cont.)

- Cataracts
 - Opacity of lens in eye
 - Related to abnormal metabolism of glucose
- Pregnancy
 - Complications in both mother and fetus may occur.
 - Increased incidence of spontaneous abortions
 - **Infants born to diabetic mothers:**
 - Increased size (**macrosomia**) and weight for date
 - May experience hypoglycemia in first hours postnatally

Calcium: Normal Control and Feedback

NORMAL CONTROL AND FEEDBACK OF CALCIUM



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Parathyroid Hormone and Calcium

- Hypoparathyroidism

- Leads to hypocalcemia

- Weak cardiac muscle contractions
 - Increased excitability of nerves—spontaneous contractions of skeletal muscle

- Causes

- Congenital lack of parathyroid
 - Surgery or radiation in neck region
 - Autoimmune disease
 - Tumor in bone producing hypercalcemia leads to negative feedback on parathyroid hormone production.

Parathyroid Hormone and Calcium (Cont.)

- Hyperparathyroidism
 - Results in hypercalcemia
 - Forceful cardiac contractions
 - Osteoporosis
 - Predisposition to kidney stones
 - Causes
 - Parathyroid Hyperplasia
 - Paraneoplastic syndrome (PTH secreting tumor).
 - Secondary to renal failure
 - Decreased activation of vitamin D > decreased calcium absorption > elevated PTH
 - Increased Phosphate retention > hypocalcemia > elevated PTH

Pituitary Hormones

- Adenomas are the most common cause of pituitary disorders.
- Effect of mass
 - May cause pressure in the skull
 - Headaches, seizures, drowsiness, **visual deficits (pressure on optic chiasm)**
- Effect on hormone secretion
 - Dependent on cells and location involved
 - May cause excessive or decreased release of hormones

Growth Hormone (GH)

- Dwarfism
 - Deficit in growth hormone production and release
- Gigantism
 - Excess GH prior to puberty and fusion of epiphysis
- Acromegaly
 - Excess GH secretion in adults
 - Often associated with adenoma
 - Bones become broader and heavier.
 - Soft tissue grows.
 - Enlarged hands and feet, change in facial features

Acromegaly:

Big hands, Large Mandible

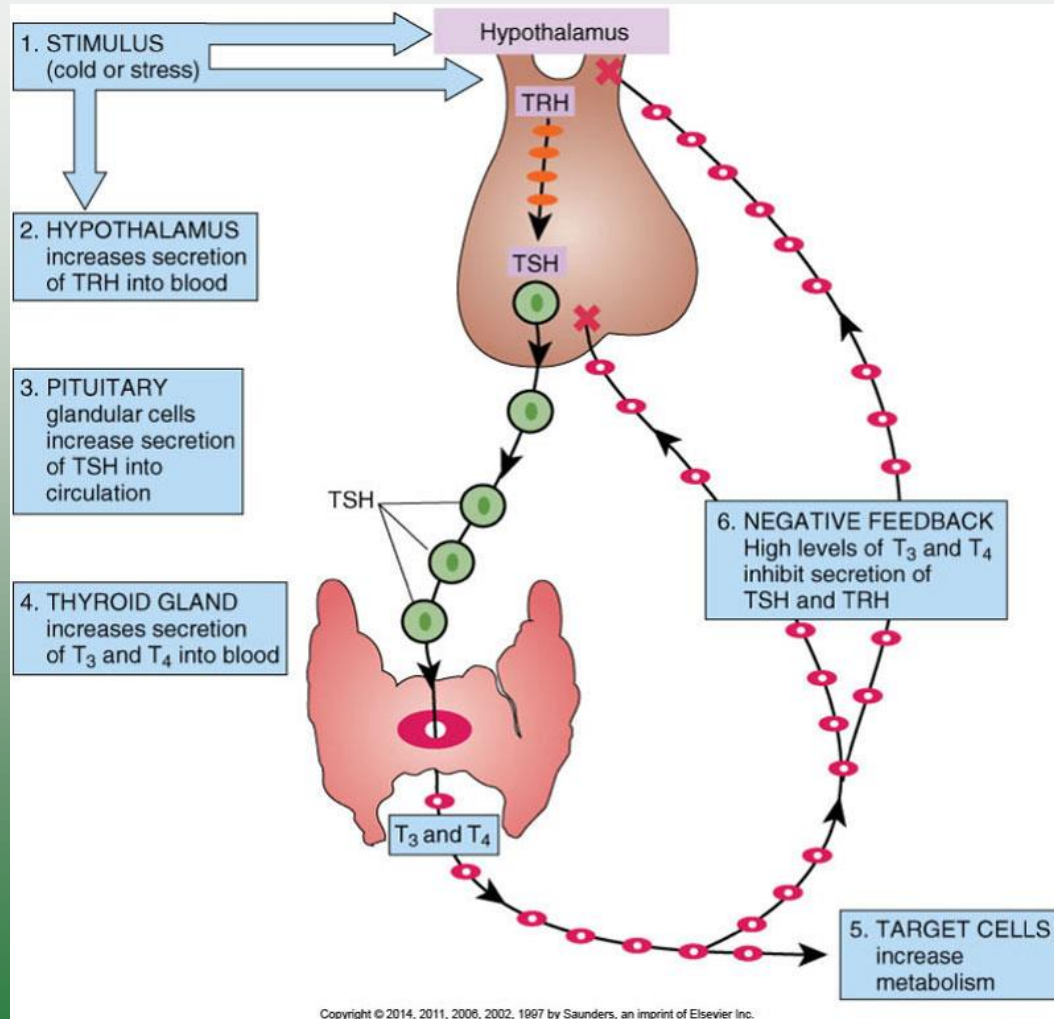


Antidiuretic Hormone (ADH)

- Diabetes insipidus—deficit of ADH
 - Adenoma
 - May originate in the neurohypophysis
 - Head injury or surgery
 - Possible genetic problem
 - Replacement treatment required
- Inappropriate ADH syndrome
 - Excess ADH
 - May be temporary, triggered by stress; may be secreted by an ectopic source, such as a tumor
 - Produces fluid retention and hyponatremia.
 - Treatment
 - Diuretics and Sodium supplements

Thyroid Hormones T3 and T4

Hypothalamus-Pituitary-Thyroid Gland Feedback



Thyroid Disorders

- Goiter—enlargement of thyroid gland
 - Toxic goiter
 - Results from primary **hyperactivity** of thyroid gland
 - Endemic goiter
 - **Hypothyroid condition** in regions with low iodine levels in soil and food (iodine needed to make T₃ and T₄).
 - Low T₃-T₄ > elevated TSH > goiter.
 - Goitrogens
 - Foods that contain elements to block synthesis of triiodothyronine (T₃) and thyroxine (T₄) (cabbage, turnips, and other related vegetables)

Thyroid Disorders: Hyperthyroidism

- Hyperthyroidism (Graves' disease)
 - Autoimmune disease with antibodies that mimic TSH and stimulate the TSH receptors in the thyroid resulting in elevated T3 and T4.
 - Hypermetabolism and increased stimulation of SNS
 - Increased body temperature
 - Sweating
 - Soft silky hair and skin
 - Reduced BMI
 - Insomnia
 - Hyperactivity

Graves Disease



- Toxic goiter
- Exophthalmos
 - Presence of protruding, staring eyes, decreased blink and eye movement
 - Result of increased tissue mass in the orbit
 - May result in visual impairment

Hypothyroidism

- Hypothyroidism
 - Iodine deficit
 - Hashimoto's thyroiditis
 - Autoimmune disorder, destruction of thyroid tissue.
 - Tumor
 - Surgical removal or treatment of gland
 - Cretinism
 - Untreated congenital hypothyroidism
 - Results in short stature and severe cognitive deficits
 - May be related to iodine deficiency during pregnancy

Hypothyroidism Manifestations

- Goiter if cause is endemic iodine deficiency
- Intolerance to cold
- Increased BMI
- Lethargy and fatigue
- Decreased appetite
- Myxedema in severe, untreated hypothyroidism
 - Nonpitting edema in face, thickened tongue
 - Myxedema coma—acute hypotension, hypoglycemia, and hypothermia result in loss of consciousness; life-threatening if untreated

Adrenal Glands

- Adrenal medulla
 - Pheochromocytoma
 - Benign tumor of the adrenal medulla—secretes epinephrine, norepinephrine, and possibly other substances
 - Occasionally, multiple tumors
 - Headache, heart palpations, sweating, intermittent or constant anxiety, **severe hypertension.**

Adrenal Glands: Adrenal Cortex

- Cushing's syndrome
 - Caused by an excessive level of glucocorticoids; possible result of:
 - Adrenal adenoma (making cortisol)
 - Pituitary adenoma (making ACTH > cortisol)
 - Ectopic carcinoma (making hormone).
 - Iatrogenic conditions (glucocorticoid-steroid administration, cortisol and hydrocortisone)

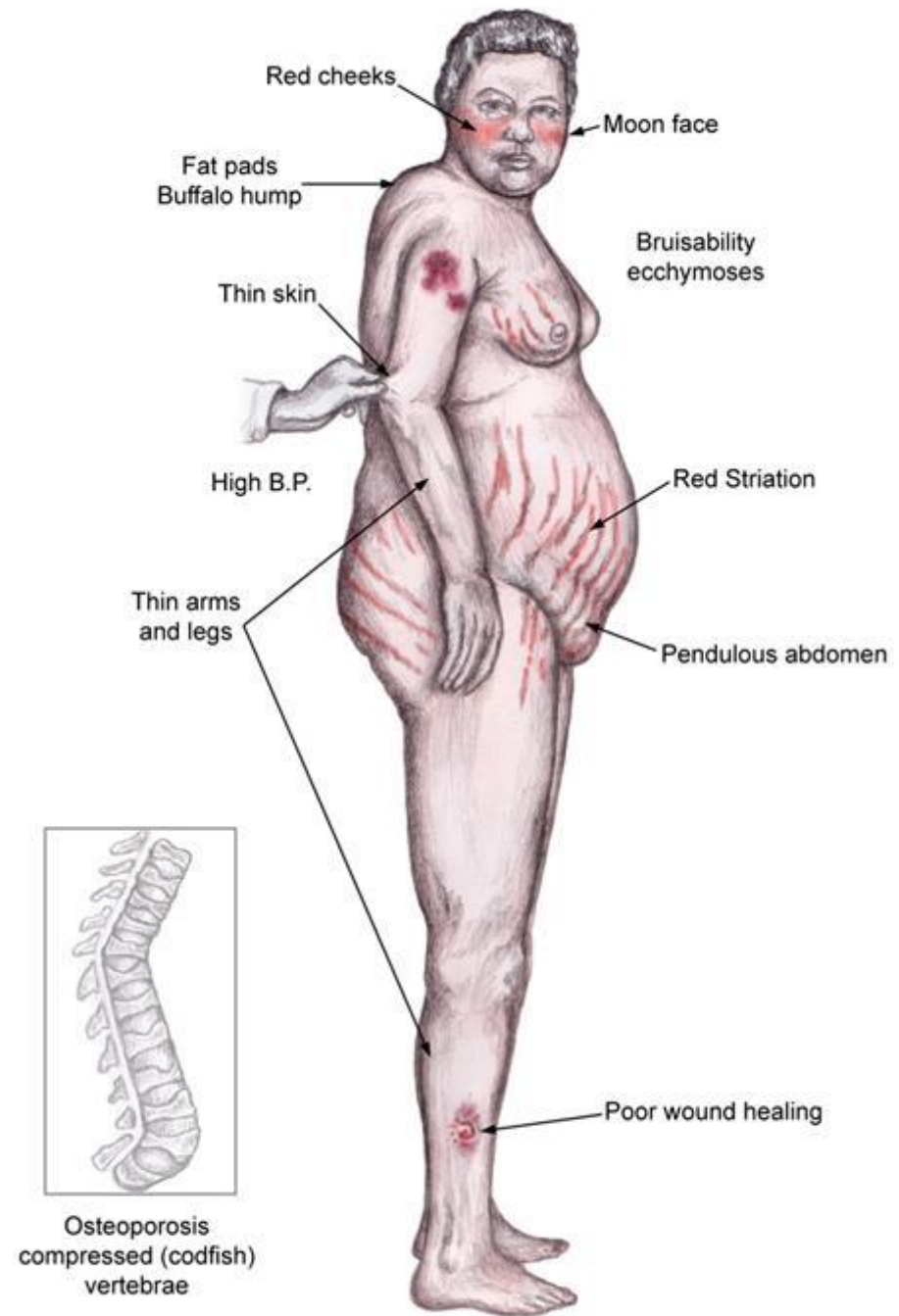
Cushing's Syndrome

- Changes associated with Cushing's syndrome
 - Change in person's appearance
 - Round “moon” face, with ruddy color
 - Truncal obesity, with fat pad between scapulae, “buffalo hump”
 - Thin limbs
 - Thin hair
 - Fragile skin, striae

Cushing's Syndrome (Cont.)

- Retention of sodium and water
- Suppression of the immune response
- Stimulation of erythrocyte production
- Emotional lability and euphoria
- Increased catabolism of bone and protein
- Delayed healing
- Increased insulin resistance and possible glucose intolerance

Cushing's Syndrome



Addison's Disease

- Deficiency of adrenocorticoid secretions
 - Both glucocorticoid – cortisol and mineralocorticoid – aldosterone.
- Autoimmune reaction is a common cause.
- Adrenal gland may be destroyed by hemorrhage or infection

Addison's Disease (Cont.)

- Manifestations

- Decreased blood glucose levels
- Inadequate stress response
- Fatigue
- Weight loss, frequent infections
- Low serum sodium concentration and loss of water retention.
 - Decreased blood volume
 - Hypotension
 - High potassium levels