Anatomy and Physiology of the Endocrine System and Hormone Types and Functions

Introduction

Key functions of endocrine system:

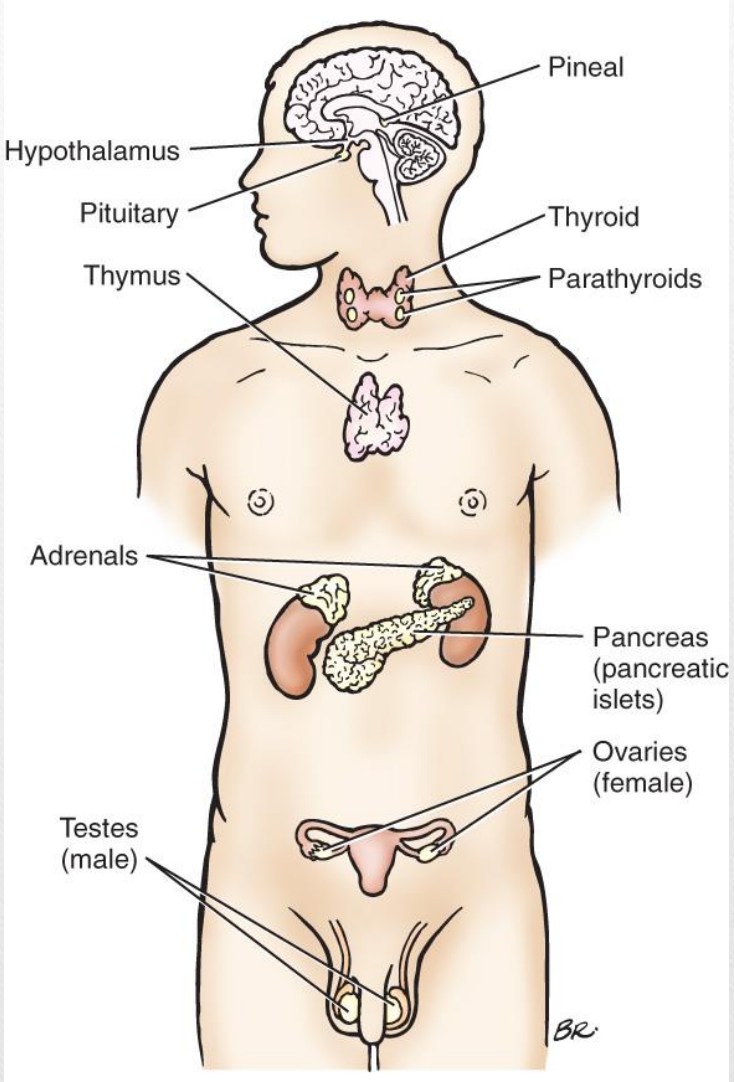
- Regulation of metabolic functions
- Regulation of chemical reactions
- Regulation of transport of substances through cell membranes

The nervous system is fast acting, with a short duration of effect. The endocrine system is slow acting, with a long duration of effect.

Major Endocrine Glands

Endocrine glands are ductless glands that secrete hormones directly into the bloodstream or surrounding tissues.

In contrast, exocrine glands, or glands with ducts, such as salivary and sweat glands, secrete their products directly into ducts that open to specific areas.



Hypothalamus

Neuroendocrine organ

Link in the body/mind, nerve/endocrine function

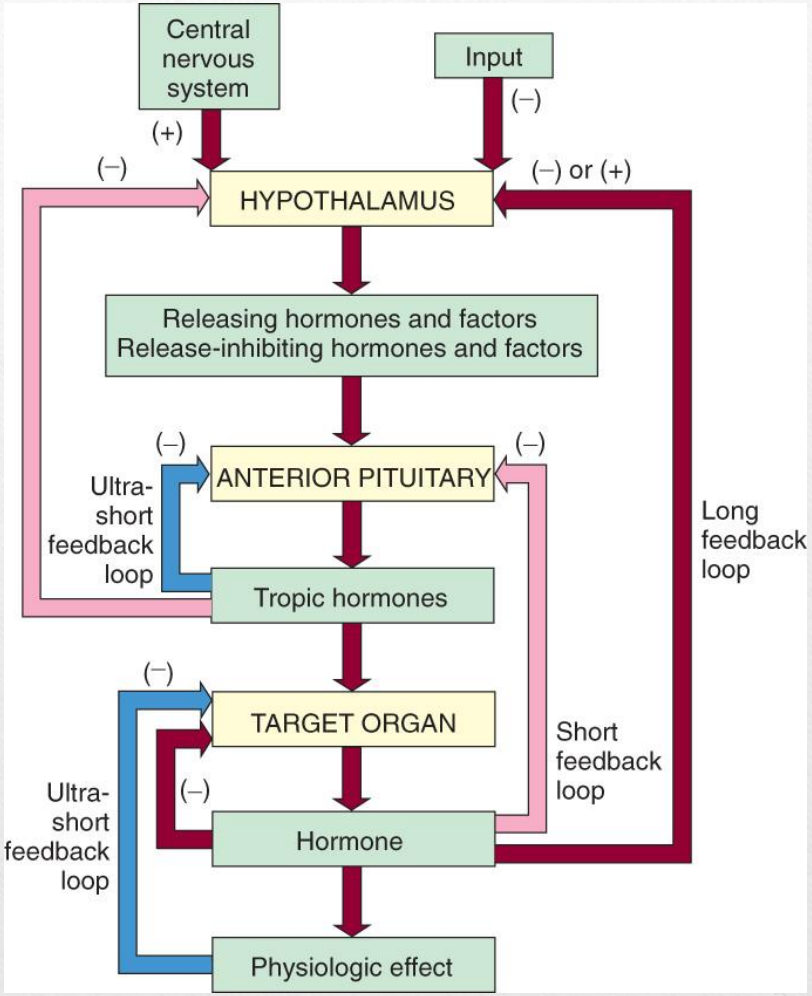
Main purpose: to maintain homeostasis

Pathologic conditions are found mainly with hyposecretion (not enough) and hypersecretion (too much).

This pattern now should seem familiar as the elegance of the body shows itself in the repetition of basic patterns.

Feedback Loops

This diagram is a general model for control and negative feedback to hypothalamic-pituitary organ systems.



Hypothalamus

Functions:

- Controls blood pressure
- Regulates body temperature, energy metabolism, and reproduction
- Directs responses to stress

The hypothalamus also plays a role in the awareness of pleasure and pain, the expression of emotions, and sexual behaviors.

Exerts influence over the pituitary gland

Pituitary controls other hormones with tropc hormones.

Tropic hormones cause secretion of other hormones.

The hypothalamus releases growth hormone-releasing hormone. It tells the pituitary gland to release growth hormone into the bloodstream.

Other Endocrine Tissues

Placenta

Heart

Kidney

Brain

Intestine

Adipose tissue

In addition to the endocrine glands, numerous cells and tissues throughout the brain, gut, and cardiovascular system produce hormones as well.

Adipose tissue serves important endocrine functions, secreting hormones that are involved in metabolic processes. One of its hormones is leptin, which is involved in appetite and obesity. Leptin resistance may be a factor in some types of obesity.

Endocrine Axis and General Adaptation Syndrome (GAS)

Hypothalamic-pituitary-adrenal axis (HPA axis)

Feedback interactions among hypothalamus, pituitary, and adrenal glands

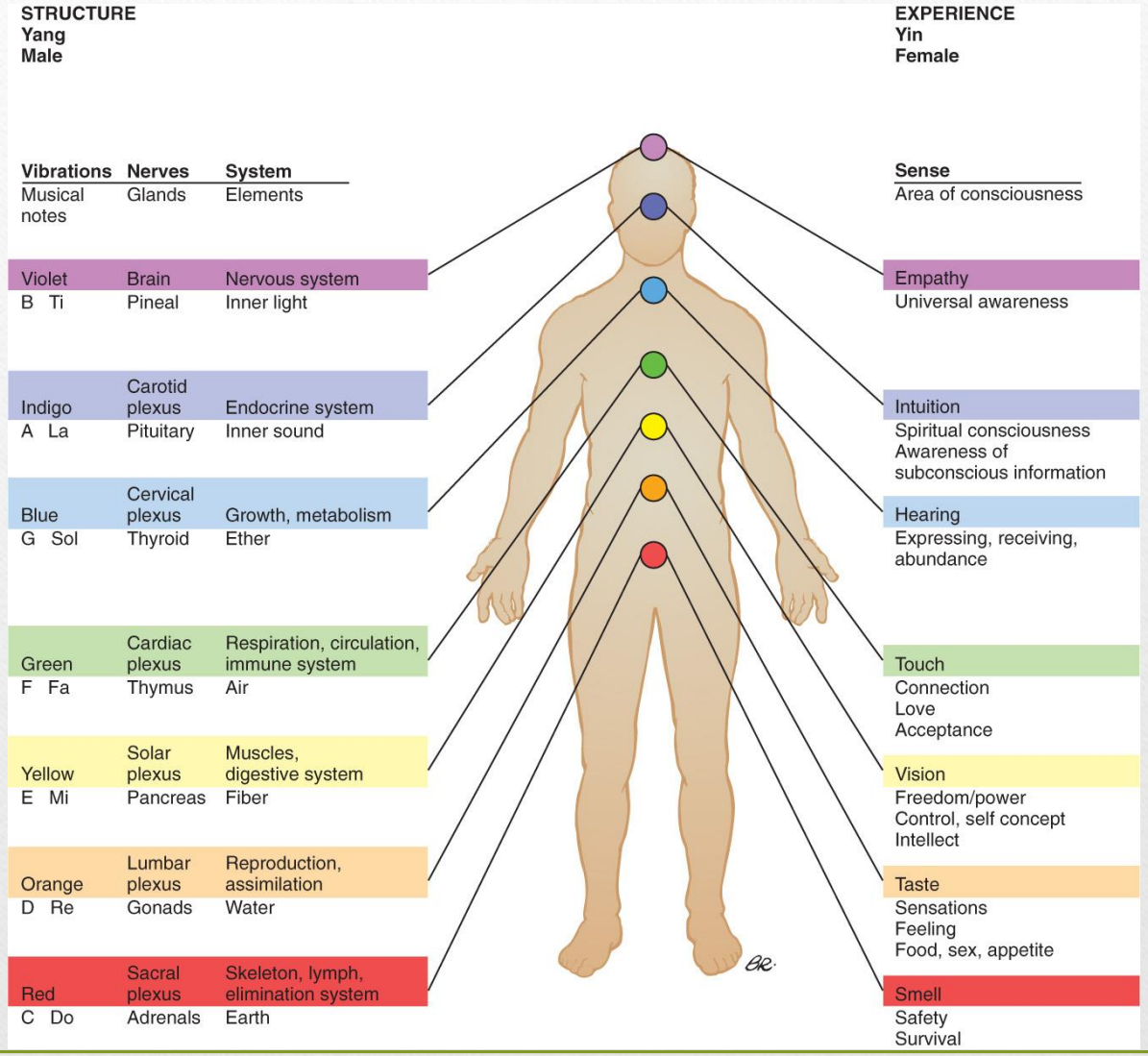
GAS stages:

1. Alarm
2. Resistance
3. Exhaustion

The HPA axis controls the general adaptation syndrome (GAS) described by Dr. Selye.

Endocrine Glands and Chakras

Endocrine function correlates with the traditional chakra system.



Hormones

Derived from amino acids or steroids

Influence in blood lasts from seconds to 30 minutes.

Half-life: time required for half the hormone to be eliminated from the bloodstream

Secreted by endocrine glands and other specialized cells

Epinephrine's effect on the heart is almost immediate, while testosterone's or estrogen's effects can take hours or days to make themselves known.

Main Hormone Types

Amines – simple molecules

Proteins and peptides – chains of amino acids

Steroids – derived from cholesterol

Table 6-2 Categories of Hormones

Structural Category	Examples
Water Soluble	
Peptides	Growth hormone
	Insulin
	Leptin
	Parathyroid hormone
	Prolactin
Glycoproteins	Follicle-stimulating hormone
	Luteinizing hormone
	Thyroid-stimulating hormone
Polypeptides	Adrenocorticotropic hormone
	Antidiuretic hormone
	Calcitonin
	Endorphins
	Glucagon
	Hypothalamic hormones
	Lipotropins
	Melanocyte-stimulating hormone
	Oxytocin
	Somatostatin
	Thymosin
	Thyrotropin-releasing hormone
Amines	Epinephrine
	Norepinephrine
Lipid Soluble	
Thyroxine (an amine but lipid soluble)	Thyroxine (both thyroxine [T_4] and triiodothyronine [T_3])
Steroids (cholesterol is a precursor for all steroids)	Estrogens
	Glucocorticoids (cortisol)
	Mineralocorticoids (aldosterone)
	Progestins (progesterone)
	Testosterone
Derivatives of arachidonic acid (autocrine or paracrine action)	Leukotrienes
	Prostacyclins
	Prostaglandins
	Thromboxanes

Hormones

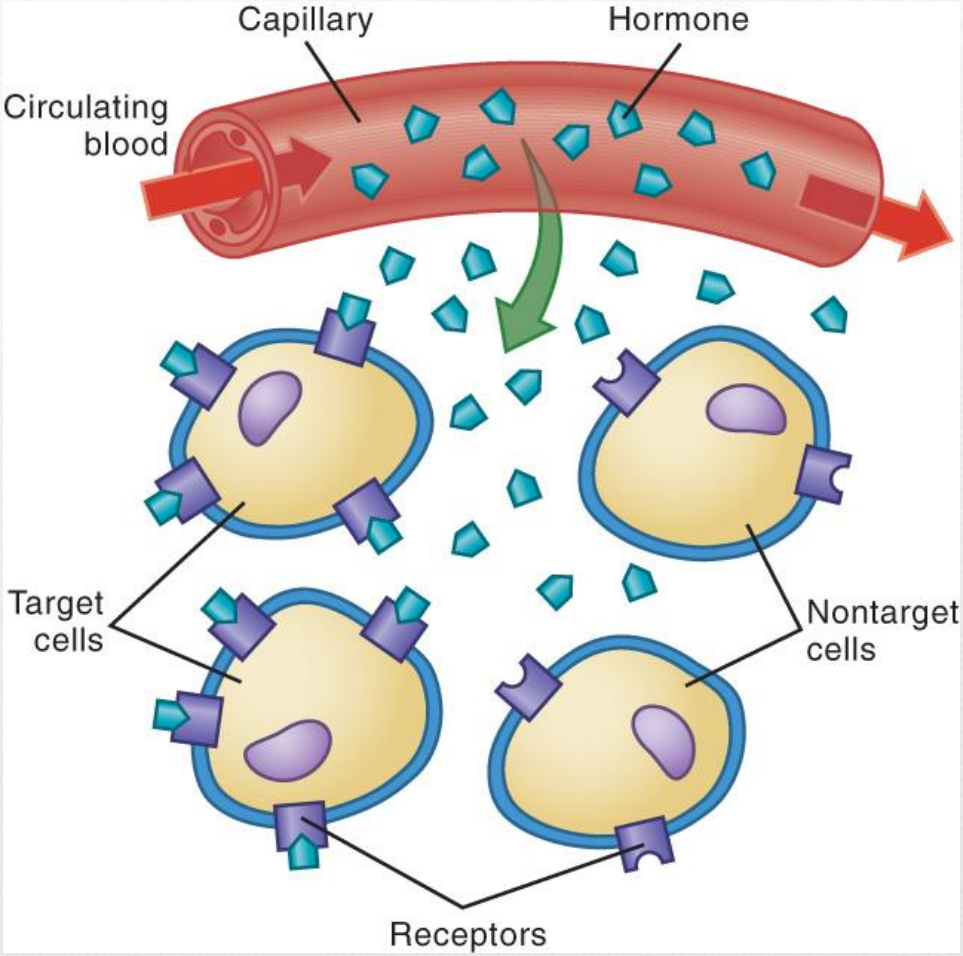
Hormones released in response to three types of stimuli:

- Shift in body fluid concentration
  - E.g., parathyroid → calcium level in blood
- Larger endocrine gland receives instructions from another endocrine organ.
- Nerves stimulate an endocrine gland.

Target Cell Concept

A hormone acts only on cells that have receptors specific to that hormone because the shape of the receptor determines which hormones can react with it.

This diagram is an example of the lock-and-key model of biochemical reactions.



Endocrine Glands and their Associated Hormones and Pathologic Conditions of the Endocrine System

Pituitary Gland

Has an anterior lobe and a posterior lobe

Secretes hormones that regulate growth, fluid balance, lactation, and childbirth

Main source of tropic hormones

According to tradition, the pituitary gland and its regulating counterpart, the hypothalamus, are related to the crown or brow chakra, with primary functions of integration of energetic patterns and realization of the total self.

Pituitary Hormones

Anterior pituitary hormones:

- Growth
- Thyroid-stimulating
- Adrenocorticotropic
- Follicle-stimulating
- Luteinizing
- Prolactin
- Melanocyte-stimulating

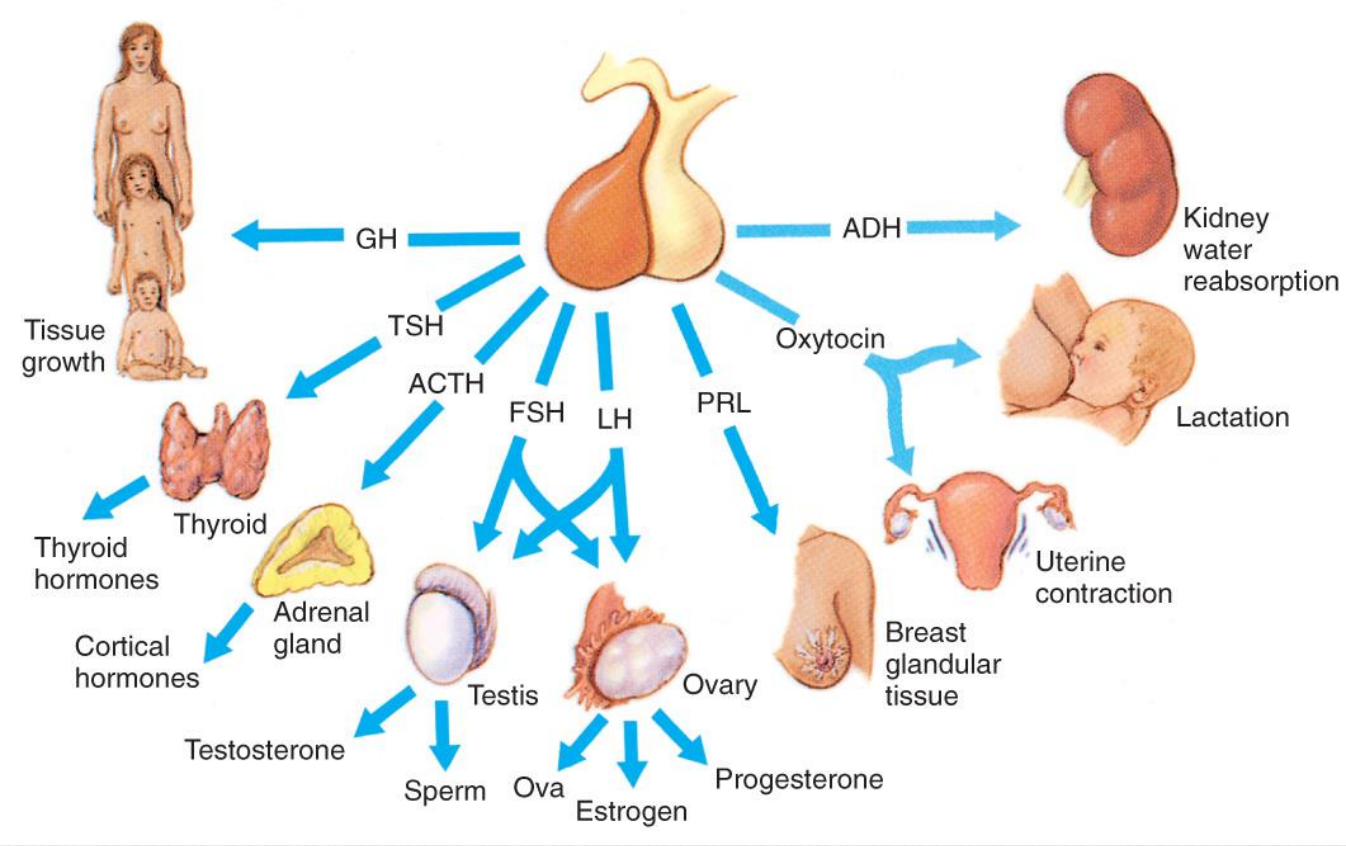
Posterior pituitary hormones:

- Oxytocin
- Antidiuretic

The anterior (front) portion is larger and produces three times as many hormones as the posterior (rear) portion.

Effect of Pituitary on Target Tissues

ADH (antidiuretic hormone) stimulates the kidneys to remove water from urine and release it into the bloodstream.



Thyroid Gland

Regulates metabolism in the body

Two principal hormones:

- Thyroxine
- Triiodothyronine

Additional hormone:

- Calcitonin

The thyroid gland lies on the trachea below the thyroid cartilage and consists of a right and left lobe, not unlike a butterfly in shape.

Parathyroid Glands

Four round, pea-sized bodies

Produce parathormone

Combines with vitamin D to decrease the amount of calcium excreted

Result: increase in blood levels of calcium and phosphorus

Pancreas

Long, slender gland located behind the stomach

Releases insulin when levels of blood sugar, amino acids, and fatty acids rise

Releases glucagon to increase blood glucose

Hyperfunction can result in an insulin reaction.

Hypofunction can result in diabetes mellitus.

The islets of Langerhans are areas of the pancreas that produce insulin and glucagon.

Adrenal Glands

Adrenal medulla

- Secretes epinephrine (adrenaline)
- Secretes norepinephrine (noradrenaline)

Adrenal cortex

- Secretes three major hormones derived from cholesterol
  - Cortisol
  - Aldosterone
  - Gonadocorticoids

The adrenal cortex produces sex hormones as well, but in smaller levels than the ovaries and testes.

Testes and Ovaries

Produce sex hormones identical to those of the adrenal cortex, except in larger amounts

Female sex hormones: estrogen and progesterone

Male sex hormone (androgen): testosterone

Major influence at pubert

How do the female sex hormones aid in labor in delivery?

The ovaries produce relaxin, a hormone that relaxes and dilates the cervix, and relaxes pelvic and pubic ligaments to aid in childbirth.

Pineal Gland

Tiny gland inside the brain, surrounded by pia mater

Major function: secrete melatonin

Tied to biological clock – sleep/wake cycle

Thymus

Located deep between the lungs

Master gland of the immune system, but with endocrine secretions as well

Hormones include:

- Thymopoietin
- Thymic humoral factor
- Thymic factor
- Thymosin

Hormones aid in growth of T cell lymphocytes.

The thymus is related to the heart and spleen chakras.

Other Hormones

Endorphins

Atrial Natriuretic Factor

Erythropoietin

Insulin-like growth factor

Gastrointestinal hormones

- Gastrin, secretin, and cholecystokinin

Tissue hormones

- Prostaglandins (14 unsaturated fatty acid hormones)

Endorphins can produce a mild euphoric feeling, such as a "runner's high."

Primary Mechanisms of Endocrine Disease

Hypersecretion

Too much hormone released

Causes include tumors, autoimmunity, and failure of feedback mechanisms.

Hyposecretion

Not enough hormone released

Causes include tumors, tissue death, abnormal operation of regulatory feedback loops, and insensitivity of target cells to tropic hormones.

Men who take anabolic steroids increase their levels of testosterone unnaturally; their bodies decrease the production of the hormone, and a deficiency is the result.

Nonglandular Disorders of the Endocrine System

Some cancers produce hormonelike substances.

Number of hormone receptors can decrease, blocking hormonal action.

Target cells may have abnormal metabolic responses to the hormone-receptor complex.

Some endocrine disorders are not caused by the glands themselves. These are other possible causes of endocrine disorders.

Pharmacologic Use of Synthetic Adrenocorticosteroids

Synthetic steroids

- Used to decrease effects of inflammation
- Prevent release of vasoactive substances (histamine and kinins)
- Treat autoimmune disorders, as well as other disorders

Indications/Contraindications

- Avoid frictioning
- Massage contraindicated over injection sites.

Common side effects of synthetic steroid use include symptoms as diverse as mood changes, insomnia, high blood pressure, increased susceptibility to infection, glaucoma, headache, reduced wound healing, sweating, fragile skin, vertigo, stunted growth in children, osteoporosis, and an increased risk of bone breakage.

Pituitary Pathologic Conditions

Gigantism

Treatment includes surgery, radiation, or drug therapy.

Dwarfism

< Growth hormone = < height

Treatment includes synthetic GH.

The term gigantism refers to the condition if it begins in infancy or early childhood. The condition results in excessive growth of the entire body. Acromegaly is an abnormality that occurs in adults in whom the excessive hormone thickens bones and enlarges organs.

Pituitary Pathologic Conditions

Diabetes insipidus

- Insufficient vasopressin
- Usually caused by head injuries
- Treatment includes increased fluid intake and synthetic vasopressin.

If the inability of the kidney to respond to vasopressin causes diabetes insipidus, the normal treatment is reducing salt intake and taking medications focused on kidney function.

Radiation therapy, surgery, or both are indicated in those rare cases in which a tumor causes diabetes insipidus.

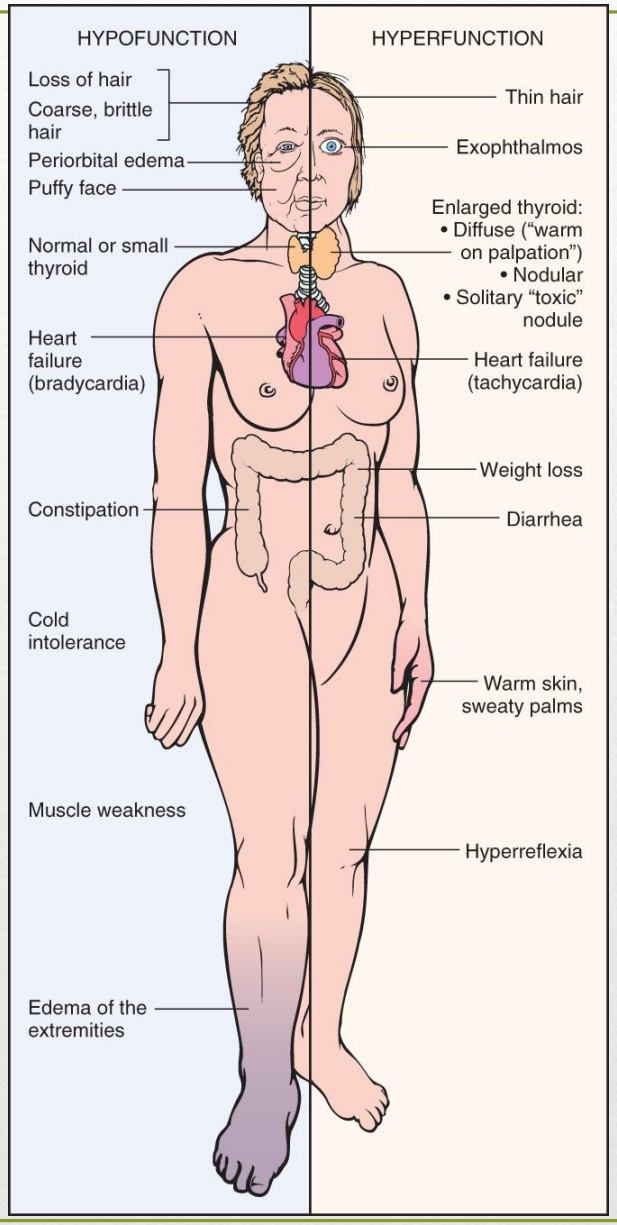
Thyroid Pathologic Conditions

- Hyperthyroidism
  - Mostly affects women
  - Caused by autoimmune dysfunction
  - Goiter often present
- Hypothyroidism
  - Can result from treatment for hyperthyroidism
  - Caused by autoimmune dysfunction
  - Goiter often present
  - Common in perimenopausal women

Hyperthyroidism, or thyrotoxicosis, is the second most common endocrine disorder after diabetes mellitus. Symptoms include increased metabolic rate, excessive sweating, weight loss even with increased food intake, fatigue, nervousness, loose stools, tachycardia, warm and moist skin, hand tremor, and hyperactivity.

Comparison of Hyperthyroidism and Hypothyroidism

This diagram shows the effects of hyperfunction and hypofunction of the thyroid.



Thyroid Pathologic Conditions

Indications/Contraindications

Cold water hydrotherapy and moderate exercise

Exposure to cold triggers release of TSH.

Refer clients for medical assessment when hyper- or hypothyroid symptom patterns present

Therapeutic massage may be beneficial in managing symptoms of hyperthyroidism and hypothyroidism.

Parathyroid Pathologic Conditions

Too much parathormone can result in weak bones.

Treatment includes calcium and vitamin D.

Hyperparathyroidism more common than hypoparathyroidism

Indications/Contraindications

- Provide referral to determine cause of skeletal pain and osteoporosis

A deficiency of parathormone can result in hypocalcemic tetany, the symptoms of which include loss of sensation, muscle twitches, uncontrolled spasm, and convulsion.

Pancerious Pathologic Conditions

Hyperfunction

- High insulin levels usually seen in diabetic clients, but may also be caused by benign tumor
- Reactive hypoglycemia – diet-induced condition

When the brain is deprived of glucose, confusion and weakness result.

A deficient production of glucagon may cause hypoglycemia.

Pancerious Pathologic Conditions

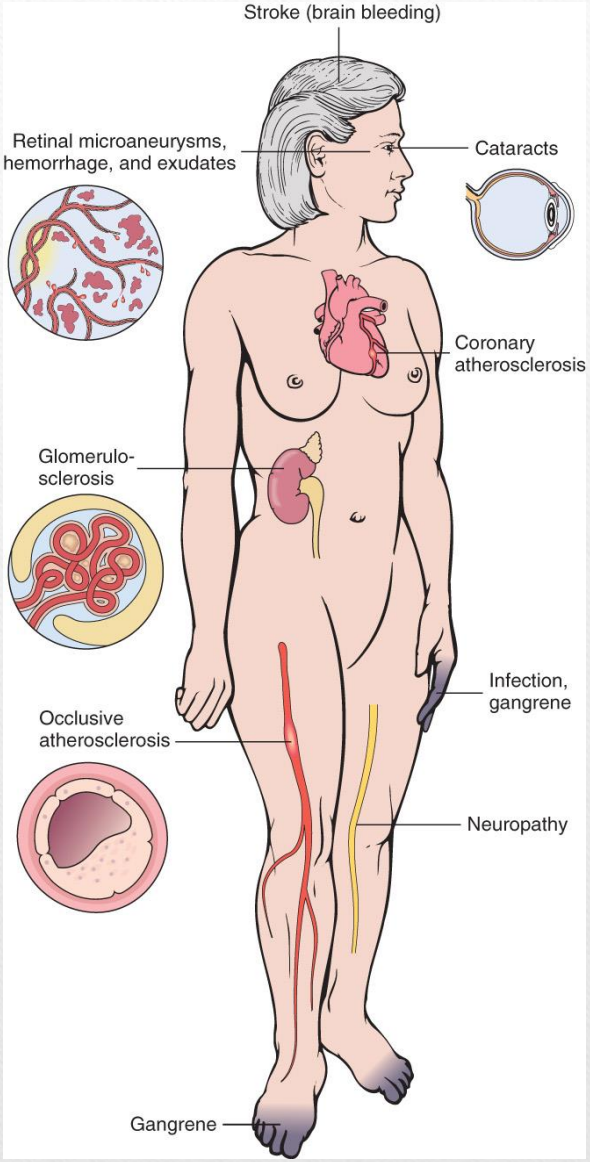
Hypofunction (diabetes mellitus)

- Type I – insulin-dependent diabetes
  - Severe and quick developing symptoms
  - Occurs at young age
- Type II – non-insulin-dependent diabetes
  - Usually milder
  - Begins in adulthood, but starting to occur in younger persons due to heredity and obesity

Some of the first symptoms of diabetes include dehydration, increased thirst (polydipsia), increased urination (polyuria), and an increased appetite (polyphagia).

Complications of Diabetes Mellitus

Treatment of diabetes usually begins with dietary changes and exercise. One of the primary goals is to lose excess weight. Oral medications and insulin treatment are also used, though the latter is generally a temporary measure



Pancreatic Pathologic Conditions

Indications/Contraindications

- General stress management program, including therapeutic massage
- Bodywork with overall medical supervision
- Careful observation of feet
- Refer for immediate medical care when any tissue changes noted

Treatment for the complications of diabetes includes meticulous attention to the hygiene of the feet and an exercise program for weight loss and fitness.

Adrenal Pathologic Conditions

Cushing's syndrome

- Caused by prolonged use of corticosteroids

Conn's syndrome

- Caused by adrenal tumor

Addison's disease

- Opposite of Cushing's disease
- Can be life-threatening

Indications/Contraindications

- Stress management including therapeutic massage

Cushing's disease is a secondary condition and usually caused by a pituitary tumor.

Symptoms of both Cushing's syndrome and disease are fat accumulation, edema, hyperglycemia, muscle weakness, suppressed immunity, osteoporosis, acne, and increased facial hair.

The onset of Addison's disease is gradual and may be mistaken for general stress symptoms.

Pineal Pathology

Seasonal affective disorder

- Exaggerated mood swings
- Other symptoms: irritability, anxiousness, sleepiness, socially withdrawn, insatiable appetite, rapid weight gain

Indications/Contraindications:

- Relaxation methods, including therapeutic massage (supports effective sleep patterns)
- Regular bed/wake time and eating schedules
- Moderate exercise and stretching

Seasonal affective disorder heightens the normal emotions felt due to the changing length of days and corresponding amount of sunlight.

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