

Endocrine Anatomy and Physiology

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Purpose & Objectives

The purpose of this course is to provide information about endocrine anatomy and physiology to prepare you to provide quality care to your patients with endocrine disorders. Hormones affect certain cells and tissues to maintain homeostasis within the body. A thorough understanding of the endocrine anatomy and physiology is essential in accurately assessing and treating your patients with endocrine abnormalities.

After successful completion of this course, the participant will be able to:

1. Describe the role and function of the anterior and posterior pituitary, hypothalamus, adrenal glands, endocrine pancreas, and thyroid gland within the endocrine system.
2. Identify the target cells, function, regulation, and related pathology of selected hormones of the endocrine system.

Glossary

Definitions from Tabers® dictionary (Venes, 2013) and Mosby's dictionary (Mosby Co., 2012)

Acromegaly: A disorder marked by progressive enlargement of the head, face, hands, feet, and chest due to excessive secretion of growth hormone by the anterior lobe of the pituitary gland.

Addison's disease: A disorder involving disrupted functioning of the part of the adrenal gland called the cortex, resulting in decreased production of cortisol and aldosterone.

Adenomas: A benign epithelial tumor in which the cells form recognizable glandular structures or in which the cells are derived from glandular epithelium.

Adrenal cortex: The outer portion of the adrenal glands that produces several steroid hormones.

Adrenal glands: Triangle-shaped glands located on top of the kidneys.

Adrenalectomy: The surgical removal of one or both of the adrenal glands.

Cortisone: A hormone (glucocorticoid) produced by the adrenal cortex, which has marked anti-inflammatory properties.

Cushing's syndrome: A relatively rare endocrine disorder resulting from excessive exposure to the hormone cortisol, which leads to a variety of symptoms and physical abnormalities.

Diabetes Insipidus: A disorder that causes the patient to produce tremendous quantities of urine. The massively increased urine output is usually accompanied by intense thirst.

Dwarfism: A pathological condition of arrested growth having various causes.

Glucocorticoid: A class of steroid hormones produced by the adrenal cortex under conditions of stress and that inhibit immunological reactions.

Homeostasis: The ability or tendency of an organism or a cell to maintain internal equilibrium by adjusting its physiological processes.

Hydrocortisone: The pharmacological term for cortisol, which is the principal glucocorticoid produced by the adrenal cortex.

Hypothalamus: Brain structure that monitors internal environment and attempts to maintain balance of these systems. Controls the pituitary gland.

Insulin: A protein hormone formed from proinsulin in the beta cells of the pancreatic islets of Langerhans. The major fuel-regulating hormone, it is secreted into the blood in response to a rise in concentration of blood glucose or amino acids. Insulin promotes the storage of glucose and the uptake of amino acids, increases protein and lipid synthesis, and inhibits lipolysis and gluconeogenesis.

Islets of Langerhans: Irregular microscopic structures scattered throughout the pancreas and comprising its endocrine portion.

Medulla: The innermost part.

Nelson's syndrome: The development of an ACTH-producing pituitary tumor after bilateral adrenalectomy in Cushing's syndrome; it is characterized by aggressive growth of the tumor and hyperpigmentation of the skin.

Pancreas: A large, elongated gland lying transversely behind the stomach, between the spleen and duodenum. Its external secretion contains digestive enzymes. One internal secretion, insulin, is produced by the beta cells, and another, glucagon, is produced by the alpha cells.

Pheochromocytoma: A tumor of special cells, most often found in the middle of the adrenal gland.

Pituitary: A gland attached to the base of the brain that secretes hormones for regulation of many body functions.

Syndrome of Inappropriate ADH Secretion: A syndrome characterized by excessive release of antidiuretic hormone (ADH or vasopressin), resulting in hyponatremia, and sometimes fluid overload.

Thyroid gland: An endocrine gland consisting of two lobes, one on each side of the trachea, joined by a narrow isthmus, producing hormones (thyroxine and triiodothyronine), which require iodine for their elaboration and which are concerned in regulating metabolic rate; it also secretes calcitonin.

Introduction

Every cell in your body is under the influence of your endocrine system. The endocrine system acts to maintain homeostasis at the cellular level and is a vital link in proper body operations. Illness and death can result from an endocrine imbalance. Treatment usually requires management of the deviant hormone by either reducing or increasing its production or secretion from its associated endocrine gland. A thorough understanding of the endocrine system and how it functions is necessary in accurately assessing and treating endocrine disorders.

Major Endocrine Organs

There are five major endocrine organs in the body: the hypothalamus, the pituitary, the adrenal glands, the thyroid gland, and the pancreas. Other organs have endocrine functions as well, but will not be covered in this article. Endocrine organs secrete hormones that act on specific "target tissues" or cells. These hormones regulate particular body functions. Hormones are usually regulated by a negative feedback mechanism, an increased presence of the hormone, resulting in a decrease in its production. If there is an unregulated overproduction or underproduction of these hormones, the patient usually presents with symptoms. In this course you will learn the role and function of five endocrine organs and the role, function, regulation, and pathology of their associated hormones (Jarvis, 2011).

Hormones

Actions or Functions

The word “hormone” comes from the Greek word meaning “to arouse to activity” (Merriam Webster Online Dictionary, 2011).

A hormone is defined as a chemical messenger that acts on specific target tissues to exert some type of effect. Hormones are released in the vasculature by their organ of origin and have four major functions.

Hormones are responsible for:

- Maintaining homeostasis within the body.
- Growth and development.
- Energy production, use, and storage.
- Reproduction (Scanlon, 2011).

Target Tissues

Each individual hormone is directed at a specific tissue. This is the hormone’s “target tissue.”

Within the tissues there are distinct sites that the hormone can bind to and wield its influence. These binding sites are known as “receptor sites.”

Only hormones that match a specific receptor site can affect the tissue at that site. Once the hormone binds with its receptor, the hormone exerts its effect on that particular tissue (Jarvis, 2011).

Regulation of Hormones

In normal hormonal regulation, hormones are secreted according to the body’s need for them. Hormones are generally regulated by a negative feedback mechanism where the increased presence of the hormone decreases its production. A good example is glucose and insulin. When blood sugar (glucose) rises after a meal, insulin is released from the pancreas into the vasculature. This release results in lower glucose levels and subsequently, decreased insulin secretion.

In abnormal hormonal secretion, hormones may be secreted by tumors. When hormones are secreted by tumors, the negative feedback mechanism is not enacted. Despite adequate blood levels of the specific hormone, the tumor will continue to secrete the hormone, often leading to negative consequences (Scanlon, 2011). Thus tumors may secrete hormones independently of blood levels, leading to an imbalance in the body.

Hypothalamus

The hypothalamus is known as the “master” gland because it is the primary gland of the endocrine system. Its major role is in the production and release of hormones that stimulate the pituitary gland. This connection or relationship is referred to as the hypothalamic-pituitary axis.

Major Hormones of the Hypothalamus

GHRH: Growth hormone releasing hormone (GHRH): secreted in response to physical and emotional stress; inhibited by somatostatin. It triggers release of growth hormone from the anterior lobe of the pituitary gland.

TRH: Thyrotrophin releasing hormone (TRH): stimulates synthesis and secretion of thyrotropin (thyroid-stimulating hormone) and stimulates the secretion of prolactin from the anterior lobe of the pituitary gland.

GnRH: Gonadotropin releasing hormone (GnRH): a peptide that triggers sexual development at the onset of puberty. GnRH is essential for normal sexual physiology in both males and females. In both sexes, the secretion of GnRH occurs every one to two hours. It triggers luteinizing hormone (LH) and follicle stimulating hormone (FSH) in the anterior lobe of the pituitary gland.

CRH: Corticotropin releasing hormone (CRH): stimulates synthesis and secretion of adrenocorticotrophic hormone (ACTH) from the anterior lobe of the pituitary gland.

Somatostatin: A mixture of two peptides that inhibits the release of growth hormone (GH) and thyroid stimulating hormone (TSH) from the anterior lobe of the pituitary gland.

Dopamine: An amino acid derivative that inhibits the release of prolactin (PRL) from the anterior pituitary, modulates motor-control centers, and activates the reward-centers in the brain.

These hormones travel to the pituitary via the hypothalamic pituitary stalk. Once in the pituitary, they act to produce or release other hormones from the pituitary gland (Jarvis, 2011).

Test Yourself

The pituitary gland is stimulated by the:

- A. Cerebral cortex
- B. Hypothalamus - Correct
- C. Adrenal cortex

Pituitary Gland

The pituitary gland, also known as the hypophysis, is located at the base of the brain.

It is comprised of two very different glands: the anterior pituitary and the posterior pituitary. Each gland has a unique link to the hypothalamus.

The posterior pituitary is linked to the hypothalamus via nerve tracts, and the anterior pituitary is linked to the hypothalamus via blood vessels (Jarvis, 2011).

Anterior Pituitary

The anterior pituitary is known as the adenohypophysis. There are six major hormones released from this gland:

- Growth hormone (GH)
- Thyroid stimulating hormone (TSH)
- Adrenocorticotropin (ACTH)
- Follicle stimulating hormone (FSH)
- Luteinizing hormone (LH)
- Prolactin (PRL)

Anterior Pituitary: Growth Hormone (GH)

Growth hormone (GH) or somatotropin targets all cells in the body.

It stimulates growth of all tissues, especially bone and cartilage. It also increases the rate of protein synthesis, increases the mobilization of fatty acids, and decreases the rate of carbohydrate metabolism (Scanlon, 2011). It is regulated by the hypothalamus, or more specifically by GRH (somatoliberin) and growth hormone releasing inhibitory hormone (somatostatin).

When there is not enough of growth hormone produced or secreted, dwarfism results. When there is an overproduction or secretion of this hormone, acromegaly results (Jarvis, 2011; Scanlon, 2011).

Anterior Pituitary: Thyroid Stimulating Hormone (TSH)

Thyroid stimulating hormone (TSH) targets only the thyroid gland. It speeds the process of the production of the two thyroid hormones, thyroxine (T4) and triiodothyronine (T3). TSH is regulated by TRH (thyroid regulatory hormone) from the hypothalamus, growth hormone inhibitory hormone (somatostatin), and negative feedback mechanisms (Jarvis, 2011).

Although TSH deficiency is rare, it does occur sometimes in patients with chronic renal failure. More often, TSH underproduction is usually a manifestation of the overall pituitary dysfunction. Pituitary adenomas or thyroid resistance to circulating thyroid hormones may cause the overproduction of TSH (Scanlon, 2011).

Anterior Pituitary: Adrenocorticotropin (ACTH)

Adrenocorticotropin (ACTH) is also known as corticotropin. ACTH stimulates the adrenal cortex to produce and release glucocorticoids, mineralocorticoids, and androgenic steroids.

Cortisol is the primary glucocorticoid that is stimulated by ACTH. Aldosterone is the primary mineralocorticoid stimulated by ACTH. ACTH is regulated by corticotropin releasing hormone (CRH) in from the hypothalamus.

Anterior Pituitary: Adrenocorticotropin (ACTH)

ACTH peaks in the morning and declines as the day progresses. Decreased cortisol levels (via negative feedback mechanisms) and increased stress including the stress of pain, fever, surgery, injury, hypoxia, and acute hypoglycemia are all reasons that increase the production and secretion of ACTH from the anterior pituitary (Jarvis, 2011; Scanlon, 2011).

Decreased production of this ACTH is rare. When ACTH is chronically deficient, it may manifest with symptoms similar to Addison's disease.

When ACTH is acutely deficient, adrenal crisis usually results. In acute deficiencies, you should suspect either panhypopituitarism or the presence of a pituitary tumor. Excess hormone production is manifested as Cushing's disease or Nelson's Syndrome (Scanlon, 2011).

Anterior Pituitary: Follicle Stimulating Hormone (FSH)

The follicle stimulating hormone (FSH) is a gonadotropin, which is triggered and released by the gonadotropin-releasing hormone (GnRH). In females, FSH stimulates the release of estrogen which promotes ovulation. In males, FSH assists in stimulating sperm production (Scanlon, 2011).

Anterior Pituitary: Luteinizing Hormone (LH)

The luteinizing hormone (LH) is also triggered and released by GnRH. In females, LH triggers egg development and release with ovulation. In males, LH works on the testes for synthesizing and secretion of testosterone (Scanlon, 2011).

Anterior Pituitary: Prolactin (PRL)

Prolactin (PRL) is stimulated by thyrotropin-releasing hormone (TRH) and suppressed by dopamine and estrogens. PRL prepares the breast and promotes production of breast milk (Scanlon, 2011).

Posterior Pituitary

The posterior pituitary, or neurohypophysis, releases hormones from the electrical stimulation of the cells in the nerve tracts connecting it with the hypothalamus.

Hormones produced by the posterior pituitary are vasopressin (also known as ADH or antidiuretic hormone), and oxytocin.

Posterior Pituitary: Antidiuretic Hormone

Antidiuretic hormone (ADH), also known as vasopressin, is the major hormone secreted by the posterior pituitary. ADH acts on the distal renal tubules and collecting ducts of the kidneys to retain water. ADH is released when one of four things happen:

- There is an increase in serum osmolarity. Osmoreceptors in the hypothalamus decrease their rate of discharge when there is a 1-2% increase in serum osmolarity. When this happens, this stimulates the release of ADH from the posterior pituitary.
- There is a decrease in circulating blood volume such as in hemorrhage, shock, or dehydration.
- There is a decrease in blood pressure sensed by baroreceptors in the aortic arch, baroreceptors in the bifurcation of the carotid arteries, or by stretch receptors in the left atrium.
- Drugs, pain, nausea, and trauma may also cause ADH release and subsequent water retention.

Diabetes Insipidus results when there is below normal ADH release. Syndrome of Inappropriate ADH (SIADH) results when there is too much ADH production or release (Scanlon, 2011).

Pituitary Gland and Hormones Table

Gland	Hormone	Target	Effects
Anterior pituitary	Growth hormone (GH)	All cells	<ul style="list-style-type: none">• Stimulates growth of all tissues, especially bone and cartilage• Increases rate of protein synthesis• Increases mobilization of fatty acids• Decreases rate of carbohydrate metabolism
Anterior pituitary	Thyroid stimulating hormone (TSH)	Thyroid gland	<ul style="list-style-type: none">• Speeds process of the production of thyroxine (T4) and triiodothyronine (T3)

Anterior pituitary	Adrenocorticotropin (ACTH)	Adrenal cortex	<ul style="list-style-type: none"> Stimulates the production and release of glucocorticoids, mineralocorticoids, and androgenic steroids
Anterior pituitary	Follicle stimulating hormone (FSH)	Ovaries (female) Seminiferous tubules (male)	<ul style="list-style-type: none"> In females, stimulates the release of estrogen which promotes ovulation. In males, assists in stimulating sperm production
Anterior pituitary	Luteinizing hormone (LH)	Ovaries (female) Testes (male)	<ul style="list-style-type: none"> In females, triggers egg development and release with ovulation. In males, works on the testes for synthesizing and secretion of testosterone
Anterior pituitary	Prolactin	Breasts	<ul style="list-style-type: none"> Prepares the breast and promotes production of breast milk
Posterior pituitary	Antidiuretic hormone (ADH)	Kidneys	<ul style="list-style-type: none"> Acts on the distal renal tubules and collecting ducts of the kidneys to retain water
Posterior pituitary	Oxytocin	Uterus and mammary glands	<ul style="list-style-type: none"> Causes contraction of the smooth muscle of the uterus Causes contraction of the cells lining the duct of the mammary gland, producing secretion of milk

Test Yourself

Which hormone stimulates the production and release of glucocorticoids?

- A. Oxytocin
- B. Growth hormone
- C. Adrenocorticotropin - Correct

Thyroid Gland

The thyroid gland lies in the anterior portion of the neck and straddles the trachea. It secretes two hormones that play a major role in the body's metabolism: thyroxine (T4) & triiodothyronine (T3).

Absence of these hormones may decrease the body's basal metabolic rate by 60% and an excess of these hormones may increase the body's basal metabolic rate by 100% (Scanlon, 2011).

Thyroid Gland: Thyroid Hormones T4 & T3

The thyroid hormones, thyroxine (T4) and triiodothyronine (T3), are stored in the thyroid gland with thyroglobulin. T4 & T3 function in essentially the same capacity, except that T3 is about four times more potent than T4. T4 has a longer life span (6-7 days) versus 2 days for T3. These hormones are carried in the blood, and almost 100% bound to protein molecules. Less than 1% of the hormones are considered "free" or physiologically active, and act within the cells of the liver and peripheral tissues. Negative feedback regulates T4 and T3 production and secretion (Scanlon, 2011).

T4 and T3 contribute to adequate growth in children, maintenance of body temperature, maintaining adequate metabolic rate, movement of potassium and sodium ions across cell membranes, carbohydrate and protein metabolism, mobilization and oxidation of free fatty acids, and vasodilation. They influence other endocrine secretions also such as insulin and cortisol (Jarvis, 2011; Scanlon, 2011).

Thyroid Gland: Thyroid Hormones T4 & T3

When there is a long-term decrease in circulating T4 and T3, hypothyroidism results. When there is an acute decrease in T4 and T3, myxedema coma results. When there is a chronic increase in the amounts of T4 and T3 hyperthyroidism results. When there is an acute increase in the amounts of T4 and T3, thyrotoxicosis or thyroid storm results (Jarvis, 2011; Scanlon, 2011).

Did You Know?

For symptoms and treatment of increased or decreased thyroid hormones, see RN.com's course Focused Endocrine Assessment.

Test Yourself

Which thyroid hormone has a longer half-life?

- A. T3
- B. T4 - Correct
- C. TSH

Adrenal Glands

The adrenal glands are two organs located atop of each kidney.

They are responsible for the secretion of mineralocorticoids, glucocorticoids and the corticosteroids, epinephrine, and norepinephrine.

The adrenal glands have two structures, the adrenal cortex and the adrenal medulla.

Adrenal Glands: Mineralocorticoids

Mineralocorticoids affect plasma concentrations of sodium and potassium. Aldosterone accounts for 95% of all mineralocorticoids produced and secreted by the adrenal cortex.

Aldosterone targets the cells in the distal renal tubules. In the tubules aldosterone increases sodium and water re-absorption while also increasing potassium excretion. This results in increased extracellular volume, increased cardiac output, and increased blood pressure.

Increased serum potassium levels regulate secretion of aldosterone, decreased serum sodium levels, activation of the renin-angiotension system (due to low blood flow to the kidneys), and increased stress.

Addison's disease results from a long-term decrease in aldosterone production or secretion. When there is an acute decrease in aldosterone production or secretion, adrenal crisis results. Over-production of aldosterone results in primary aldosteronism (Jarvis, 2011; Scanlon, 2011).

Adrenal Glands: Glucocorticoids

Glucocorticoids primary functions are to influence fat, glucose and protein metabolism, and in times of extreme stress, produce an anti-inflammatory effect. Cortisol is the primary glucocorticoid secreted by the adrenal cortex. Most of the body's cells are influenced by cortisol. Cortisol has four major functions:

- Produces glucose in the liver
- Decreases protein stores in all cells except for the liver
- Increases fatty acid mobilization
- In large amounts, produces an anti-inflammatory effect

Cortisol is regulated by a negative feedback mechanisms and ACTH from the anterior pituitary. The negative feedback mechanisms are superseded under stressful conditions, and cortisol levels surge during these times. When there is a decreased production or secretion of cortisol, Addison's disease or adrenal insufficiency result. When there is an overproduction or oversecretion of cortisol, Cushing's syndrome may result (Jarvis, 2011).

Adrenal Glands: Epinephrine & Norepinephrine

Epinephrine and norepinephrine are hormones secreted from the adrenal medulla. These two hormones function to defend cells against stress responses. They play a great role in activation of the autonomic nervous system as well. When fear, pain, hemorrhage, trauma, or other stressors are influencing the body, epinephrine and norepinephrine are released in response to the release of acetylcholine (which is released when the sympathetic nervous system is activated). Cortisol, also released in times of stress, enhances the conversion of norepinephrine to epinephrine (Jarvis, 2011; Scanlon, 2011).

Norepinephrine vasoconstricts blood vessels, decreases the motility of the GI tract, increases cardiac activity, and dilates the pupils. Epinephrine further increases cardiac excitation and contractility, increases blood flow to the skeletal muscles, and increases the mobilization and use of glucose. Decreased production of these hormones usually only occurs in patients receiving steroid therapy following an adrenalectomy. Pheochromocytomas (adrenal gland tumors) are the primary cause of increased levels of norepinephrine and epinephrine (Jarvis, 2011; Scanlon, 2011).

Did You Know?

For symptoms and treatment of increased or decreased adrenal hormones, see RN.com's course Focused Endocrine Assessment.

Test Yourself

What is the function of glucocorticoids?

- A. Influence the metabolism of fat, glucose, and protein - Correct
- B. Defend cells in response to stress
- C. Affect plasma concentrations of sodium and potassium

Pancreas

The endocrine pancreas produces and secretes insulin, glucagon, and somatostatin. All three of these hormones play a significant role in carbohydrate, fat, and protein metabolism.

Pancreas: Insulin

The beta cells in the Islets of Langerhans in the pancreas secrete insulin. Insulin secretion and production is stimulated by the presence of glucose.

Insulin is also regulated primarily via negative feedback mechanisms, however, sympathetic and parasympathetic nervous system stimulation may also cause the production and subsequent release of insulin from the pancreas. Insulin affects most all cells of the body by increasing the usage of carbohydrates for energy.

Additionally, insulin converts glucose in the liver to fatty acids, increases the uptake and storage of glucose as glycogen, and promotes the transport of amino acids into the cells which reduces the breakdown of these proteins.

Decreased production of insulin occurs in Type I Diabetes. Resistance of cells to the effects of circulating insulin results in Type II Diabetes. Hypoglycemia results when there is an overproduction or secretion of insulin (Jarvis, 2011; Scanlon, 2011).

Pancreas: Glucagon

Glucagon is produced and secreted by the alpha cells of the pancreas. Glucagon is stimulated by lack of glucose associated with fasting states and by sympathetic stimulation. Alternatively, glucagon is inhibited by insulin secretion, by eating, or by the presence of hyperglycemia. Glucagon increases serum glucose and fatty acid concentration, stimulates glycogenesis (formation of glucose from glycogen, fats, and proteins in the liver) and gluconeogenesis (conversion of glycogen to glucose in the liver), and increased lipid breakdown. In patients with a long history of diabetes or those whom have had a total pancreatectomy, there is an absolute glucagon deficiency. In these cases, catecholamines take over the role of glycogen – specifically epinephrine and cortisol (Jarvis, 2011; Scanlon, 2011).

Pancreas: Somatostatin

In addition to being produced by the hypothalamus, somatostatin is also produced by the pancreas. Somatostatin is a mixture of two peptides that inhibits the secretion of glucagon and insulin (Scanlon, 2011).

Did You Know?

For symptoms and treatment of increased or decreased pancreatic hormones, see RN.com's course Focused Endocrine Assessment.

Test Yourself

Which pancreatic hormone converts glucose to fatty acids in the liver?

- A. Somatostatin
- B. Glucagon
- C. Insulin - Correct

Major Endocrine Glands

The Five Major Endocrine Glands and their Hormones		
Name	Also known as	Hormones
Hypothalamus	The master gland	GRH,TRH,CRH
Pituitary	hypophysis	anterior / posterior hormones
Anterior Pituitary	adenohypophysis	GR,TSH,ACTH
Posterior Pituitary	neurohypophysis	ADH, oxytocin
Adrenal glands	adrenal glands	Aldosterone, cortisol
Thyroid	thyroid	T3, T4
Pancreas	pancreas	Insulin, glucagon, somatostatin

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Adrenals	Cortisol	Fatigue, weight loss, inability to fight stress, poor immunity	Weight gain, stretch marks, fatigue
	Aldosterone	Fatigue, dizziness on standing	High blood pressure
	DHEA (Dehydroepiandrosterone)	Fatigue, depression, decreased libido	Excess hair growth (women), breast enlargement (men)

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Adrenals/ovaries (women)	Testosterone	Fatigue, decreased libido, decreased muscle mass	Excess hair growth
	Estrogens – E1 (estrone), E2 (estradiol), E3 (estriol)	Fatigue, decreased libido, hair loss, osteoporosis, heart disease	Irritability

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Adrenals/testes (men)	Testosterone	Fatigue, decreased libido, decreased muscle mass, difficulty with erections	Balding, prostate enlargement
	Estrogens	Fatigue, osteoporosis	Breast enlargement, infertility

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Pancreas	Insulin	Diabetes	Weight gain, fatigue
	Glucagon	Hypoglycemia, weight gain	Diabetes
	GLP-1	Diabetes	Weight gain

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Thyroid	T4 (thyroxine), T3 (triiodothyronine)	Fatigue, depression, weight gain	Fatigue, anxiety, sweating

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Pituitary	GH (growth hormone)	Fatigue, depression, weight gain	Arthritis, diabetes
	ACTH (adrenocorticotrophic hormone)	Fatigue, weight loss, inability to fight stress	Weight gain, stretch marks, fatigue
	Prolactin	Irregular periods, breast discharge	Irregular periods, breast discharge
	TSH (thyroid stimulating hormone)	Underactive thyroid	Overactive thyroid
	LH (luteinizing hormone), FSH (follicle stimulating hormone)	Underactive gonads	Overactive gonads

Overview of Glands, Hormones and Symptoms of Deficiency or Overproduction			
Endocrine Gland	Hormone Name	Symptoms of Deficiency	Symptoms of Overproduction
Parathyroids	PTH (parathyroid hormone)	Tingling, depression	Abdominal pain, fatigue, depression
Kidneys	Vitamin D	Muscle pain, fatigue	Fatigue, depression, bone pain

Conclusion

The endocrine system is comprised of multiple organs, hormones and counter-regulatory hormones all working to maintain homeostasis.

Hormones influence growth and development, energy production, metabolism and the reproductive process. Although this course does not cover all endocrine and hormonal actions in the body, it does provide useful baseline information.

Nurses caring for patients with endocrine disorders will benefit from understanding endocrine anatomy, physiology, and pathophysiology.

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