Chapter 17 the endocrine system worksheet

Continue

4. Hormones help balance the body's reactions differently than nerve impulses in that:

A) the reactions take longer to occur B) hormones can target specific target cells found somewhere else in the body C) the reactions can last much longer D) All of the above

5. All the following are endocrine glands, EXCEPT the:

A) sweat gland B) adrenal glands C) thyroid gland D) pituitary gland

6. Endocrine glands are different than exocrine glands in that exocrine glands:

A) release hormones into the blood B) secrete through ducts out onto the skin

C) affect many body organs D) include the reproductive organs

7. The endocrine gland(s) referred to as the "master gland" is the:

A) pancreas B) adrenal glands C) thyroid gland D) pituitary gland

8. The endocrine gland(s) that makes insulin is the:

A) pancreas B) adrenal glands C) thyroid gland D) pituitary gland

9. The endocrine gland(s) that sits on top of the kidneys and secretes both metabolic stabilizers and stress regulators:

A) pancreas B) adrenal glands C) thyroid gland D) pituitary gland

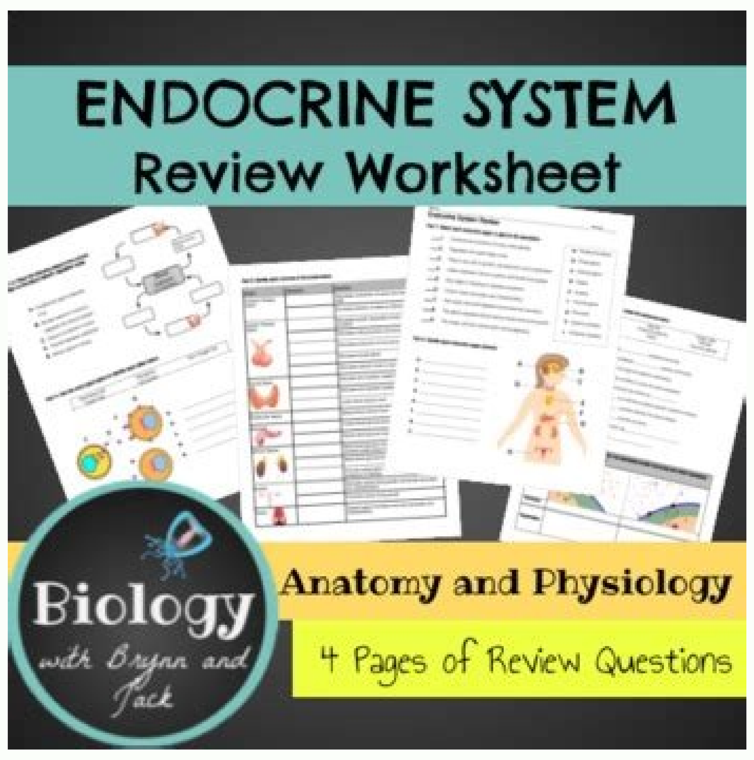
10. The largest endocrine gland(s) that makes 3 hormones that affect the metabolism is the:

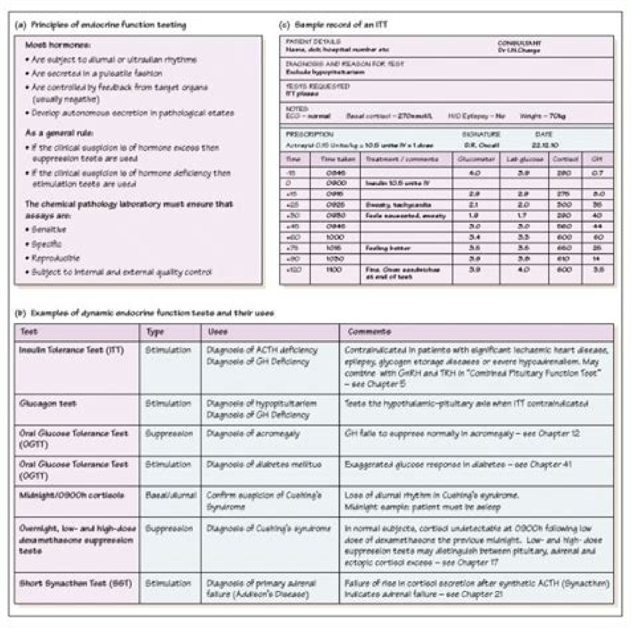
A) pancreas B) adrenal glands C) thyroid gland D) pituitary gland

ANSWER KEY:

Endocrine Organs:

A. Hypothalamus
B. Pituitary
C. Parathyroid
D. Thymus
E. Adrenal
F. Pineal
G. Thyroid
H. Pancreas
I. Ovaries
J. Testes





(a) Principles of endocrine function testing

Most hormones:
- Are subject to diurnal or ultradian rhythms
- Are secreted in a pulsatile fashion
- Are controlled by feedback from target organs (usually negative)
- Develop autonomous secretion in pathological states

As a general rule:
- If the clinical suspicion is of hormone excess then suppression tests are used
- If the clinical suspicion is of hormone deficiency then stimulation tests are used

The chemical pathology laboratory must ensure that assays are:
- Sensitive
- Specific
- Reproducible
- Subject to internal and external quality control

(c) Sample record of an ITT

PATIENT DETAILS Name, dob, hospital number etc — CONSULTANT Dr I.N.Charge

DIAGNOSIS AND REASON FOR TEST Exclude hypopituitarism

TESTS REQUESTED ITT please

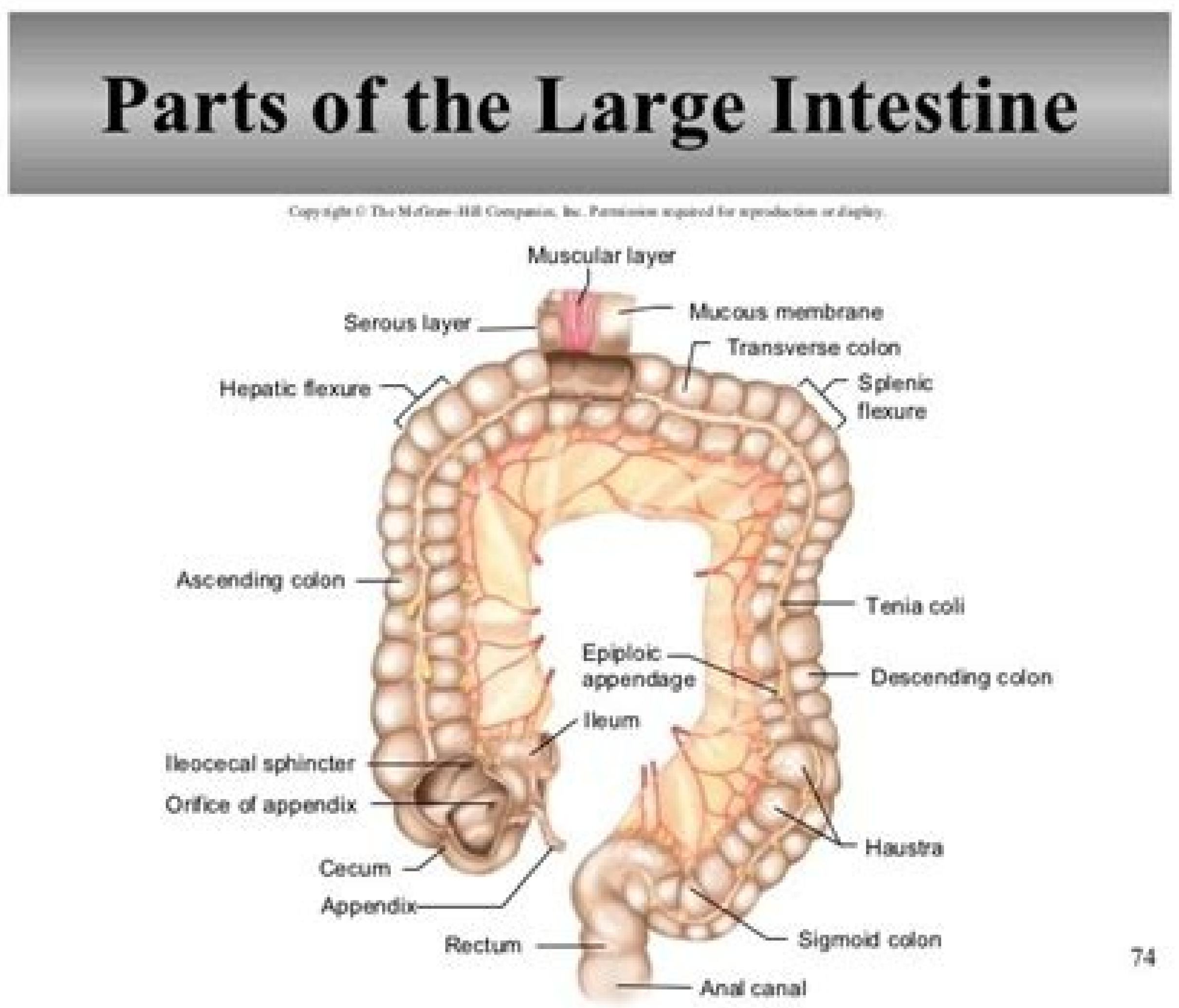
NOTES ECG – normal Basal cortisol – 270nmol/L H/O Epilepsy – No Weight – 70kg

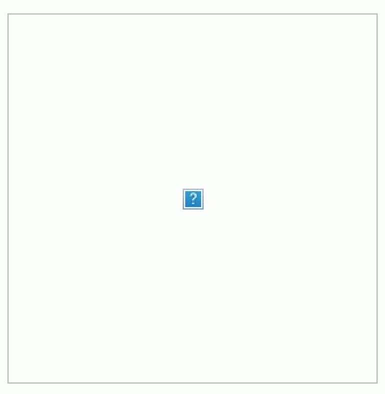
PRESCRIPTION Actrapid 0.15 Units/kg = 10.5 units IV × 1 dose — SIGNATURE D.R. Oscall — DATE 22.12.10

Time	Time taken	Treatment / comments	Glucometer	Lab glucose	Cortisol	GH
-15	0845		4.0	3.8	280	0.7
0	0900	Insulin 10.5 units IV				
+15	0915		2.8	2.8	275	8.0
+25	0925	Sweaty, tachycardia	2.1	2.0	300	36
+30	0930	Feels nauseated, sweaty	1.8	1.7	280	40
+45	0945		3.0	3.0	560	44
+60	1000		3.4	3.3	600	60
+75	1015	Feeling better	3.5	3.5	650	26
+90	1030		3.8	3.6	610	14
+120	1100	Fine. Given sandwiches at end of test	3.9	4.0	600	3.6

(b) Examples of dynamic endocrine function tests and their uses

Test	Type	Uses	Comments
Insulin Tolerance Test (ITT)	Stimulation	Diagnosis of ACTH deficiency Diagnosis of GH Deficiency	Contraindicated in patients with significant ischaemic heart disease, epilepsy, glycogen storage diseases or severe hypoadrenalism. May combine with GnRH and TRH in "Combined Pituitary Function Test" – see Chapter 5
Glucagon test	Stimulation	Diagnosis of hypopituitarism Diagnosis of GH Deficiency	Tests the hypothalamic-pituitary axis when ITT contraindicated
Oral Glucose Tolerance Test (OGTT)	Suppression	Diagnosis of acromegaly	GH fails to suppress normally in acromegaly – see Chapter 12
Oral Glucose Tolerance Test (OGTT)	Stimulation	Diagnosis of diabetes mellitus	Exaggerated glucose response in diabetes – see Chapter 41
Midnight/0900h cortisols	Basal/diurnal	Confirm suspicion of Cushing's Syndrome	Loss of diurnal rhythm in Cushing's syndrome. Midnight sample: patient must be asleep
Overnight, low- and high-dose dexamethasone suppression tests	Suppression	Diagnosis of Cushing's syndrome	In normal subjects, cortisol undetectable at 0900h following low dose of dexamethasone the previous midnight. Low- and high- dose suppression tests may distinguish between pituitary, adrenal and ectopic cortisol excess – see Chapter 17
Short Synacthen Test (SST)	Stimulation	Diagnosis of primary adrenal failure (Addison's Disease)	Failure of rise in cortisol secretion after synthetic ACTH (Synacthen) indicates adrenal failure – see Chapter 21





The endocrine system consists of cells, tissues, and organs that secrete hormones critical to homeostasis. The body coordinates its functions through two major types of communication: neural and endocrine. Neural communication includes both electrical and chemical signaling between neurons and target cells. Endocrine communication involves chemical signaling via the release of hormones into the extracellular fluid. From there, hormones diffuse into the bloodstream and may travel to distant body regions, where they elicit a response in target cells. Endocrine glands are ductless glands that secrete hormones. Many organs of the body with other primary functions—such as the heart, stomach, and kidneys—also have hormone-secreting cells. Hormones are derived from amino acids or lipids. Amine hormones originate from the amino acids tryptophan or tyrosine. Larger amino acid hormones include peptides and protein hormones. Steroid hormones are derived from cholesterol. Steroid hormones and thyroid hormone are lipid soluble. All other amino acid–derived hormones are water soluble. Hydrophobic hormones are able to diffuse through the membrane and interact with an intracellular receptor. In contrast, hydrophilic hormones must interact with cell membrane receptors. These are typically associated with a G protein, which becomes activated when the hormone binds the receptor. This initiates a signaling cascade that involves a second messenger, such as cyclic adenosine monophosphate (cAMP). Second messenger systems greatly amplify the hormone signal, creating a broader, more efficient, and faster response. Hormones are released upon stimulation that is of either chemical or neural origin. Regulation of hormone release is primarily achieved through negative feedback. Various stimuli may cause the release of hormones, but there are three major types. Humoral stimuli are changes in ion or nutrient levels in the blood. Hormonal stimuli are changes in hormone levels that initiate or inhibit the secretion of another hormone. Finally, a neural stimulus occurs when a nerve impulse prompts the secretion or inhibition of a hormone. The hypothalamus–pituitary complex is located in the diencephalon of the brain. The hypothalamus and the pituitary gland are connected by a structure called the infundibulum, which contains vasculature and nerve axons. The pituitary gland is divided into two distinct structures with different embryonic origins. The posterior lobe houses the axon terminals of hypothalamic neurons. It stores and releases into the bloodstream two hypothalamic hormones: oxytocin and antidiuretic hormone (ADH). The anterior lobe is connected to the hypothalamus by vasculature in the infundibulum and produces and secretes six hormones. Their secretion is regulated, however, by releasing and inhibiting hormones from the hypothalamus. The six anterior pituitary hormones are: growth hormone (GH), thyroid-stimulating hormone (TSH), adrenocorticotropic hormone (ACTH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), and prolactin (PRL). The thyroid gland is a butterfly-shaped organ located in the neck anterior to the trachea. Its hormones regulate basal metabolism, oxygen use, nutrient metabolism, the production of ATP, and calcium homeostasis. They also contribute to protein synthesis and the normal growth and development of body tissues, including maturation of the nervous system, and they increase the body's sensitivity to catecholamines. The thyroid hormones triiodothyronine (T3) and thyroxine (T4) are produced and secreted by the thyroid gland in response to thyroid-stimulating hormone (TSH) from the anterior pituitary. Synthesis of the amino acid–derived T3 and T4 hormones requires iodine. Insufficient amounts of iodine in the diet can lead to goiter, cretinism, and many other disorders. Calcium is required for a variety of important physiologic processes, including neuromuscular functioning; thus, blood calcium levels are closely regulated. The parathyroid glands are small structures located on the posterior thyroid gland that produce parathyroid hormone (PTH), which regulates blood calcium levels. Low blood calcium levels cause the production and secretion of PTH. In contrast, elevated blood calcium levels inhibit secretion of PTH and trigger secretion of the thyroid hormone calcitonin. Underproduction of PTH can result in hypoparathyroidism. In contrast, overproduction of PTH can result in hyperparathyroidism. The adrenal glands, located superior to each kidney, consist of two regions: the adrenal cortex and adrenal medulla. The adrenal cortex—the outer layer of the gland—produces mineralocorticoids, glucocorticoids, and androgens. The adrenal medulla at the core of the gland produces epinephrine and norepinephrine. The adrenal glands mediate a short-term stress response and a long-term stress response. A perceived threat results in the secretion of epinephrine and norepinephrine from the adrenal medulla, which mediate the fight-or-flight response. The long-term stress response is mediated by the secretion of CRH from the hypothalamus, which triggers ACTH, which in turn stimulates the secretion of corticosteroids from the adrenal cortex. The mineralocorticoids, chiefly aldosterone, cause sodium and fluid retention, which increases blood volume and blood pressure. The pineal gland is an endocrine structure of the diencephalon of the brain, and is located inferior and posterior to the thalamus. It is made up of pinealocytes. These cells produce and secrete the hormone melatonin in response to low light levels. High blood levels of melatonin induce drowsiness. Jet lag, caused by traveling across several time zones, occurs because melatonin synthesis takes several days to readjust to the light-dark patterns in the new environment. The male and female reproductive system is regulated by follicle-stimulating hormone (FSH) and luteinizing hormone (LH) produced by the anterior lobe of the pituitary gland in response to gonadotropin-releasing hormone (GnRH) from the hypothalamus. In males, FSH stimulates sperm maturation, which is inhibited by the hormone inhibin. The steroid hormone testosterone, a type of androgen, is released in response to LH and is responsible for the maturation and maintenance of the male reproductive system, as well as the development of male secondary sex characteristics. In females, FSH promotes egg maturation and LH signals the secretion of the female sex hormones, the estrogens and progesterone. Both of these hormones are important in the development and maintenance of the female reproductive system, as well as maintaining pregnancy. The placenta develops during early pregnancy, and secretes several hormones important for maintaining the pregnancy. The pancreas has both exocrine and endocrine functions. The pancreatic islet cell types include alpha cells, which produce glucagon; beta cells, which produce insulin; delta cells, which produce somatostatin; and PP cells, which produce pancreatic polypeptide. Insulin and glucagon are involved in the regulation of glucose metabolism. Insulin is produced by the beta cells in response to high blood glucose levels. It enhances glucose uptake and utilization by target cells, as well as the storage of excess glucose for later use. Dysfunction of the production of insulin or target cell resistance to the effects of insulin causes diabetes mellitus, a disorder characterized by high blood glucose levels. The hormone glucagon is produced and secreted by the alpha cells of the pancreas in response to low blood glucose levels. Glucagon stimulates mechanisms that increase blood glucose levels, such as the catabolism of glycogen into glucose. Some organs have a secondary endocrine function. For example, the walls of the atria of the heart produce the hormone atrial natriuretic peptide (ANP), the gastrointestinal tract produces the hormones gastrin, secretin, and cholecystokinin, which aid in digestion, and the kidneys produce erythropoietin (EPO), which stimulates the formation of red blood cells. Even bone, adipose tissue, and the skin have secondary endocrine functions. The endocrine system originates from all three germ layers of the embryo, including the endoderm, ectoderm, and mesoderm. In general, different hormone classes arise from distinct germ layers. Aging affects the endocrine glands, potentially affecting hormone production and secretion, and can cause disease. The production of hormones, such as human growth hormone, cortisol, aldosterone, sex hormones, and the thyroid hormones, decreases with age. 1. 17-1 Chapter 17 Endocrine System 2. 17-2 Endocrine System • Overview • Hypothalamus and pituitary gland • Other endocrine glands • Hormones and their actions • Stress and adaptation • Eicosanoids and paracrine signaling • Endocrine disorders 3. 17-3 Overview of the Endocrine System Necessary for integration of cell activities 4 Mechanisms of cell communication: 1. gap junctions • pores in cell membrane allow signaling chemicals to move from cell to cell; 1. neurotransmitters • released from neurons to travel across synaptic cleft to 2nd cell; 1. paracrine (local) hormones • secreted into tissue fluids by a cell, diffuse to affect nearby cells; 1. hormones • chemical messengers that travel in the bloodstream & stimulate distant organs. 4. 17-4 Overview of the Endocrine System Endocrine glands secrete hormones into the blood stream to influence target organs elsewhere in the body; Cells with receptors can accept these hormones are called target cells; Difference between exocrine & endocrine: Exocrine – secrete secretions into ducts (sweat glands) or cavity (digestion); have extracellular effects (digestion); Endocrine – no ducts but have dense capillary networks; their secretions have an intercellular effect (metabolism of target cells). 5. 17-5 Endocrine Organs • Major organs of endocrine system 6. 17-6 Nervous vs. Endocrine Systems Communication – nervous - both electrical and chemical – endocrine - only chemical Speed and persistence of response – nervous - reacts quickly (1 - 10 msec), stops quickly – endocrine - reacts slowly (hormone release in seconds or days), effect may continue for weeks Adaptation to long-term stimuli – nervous - response declines (adapts quickly) – endocrine - response persists Area of effect – nervous - targeted and specific (one organ) – endocrine - general, widespread effects (many organs) 7. 17-7 Nervous vs. Endocrine Systems Similarly some chemicals function as both neurotransmitters & hormones; – NE, cholecystokinin, thyrotropin-releasing hormone, dopamine and ADH Some hormones produce an overlapping effect on the same target cells; – NE and glucagon cause glycogen hydrolysis in liver The NS & Endocrine system are constantly regulating each other as they coordinate activities; Neurons trigger hormone secretions & hormones can stimulate or inhibit neurons. 8. 17-8 9. 17-9 Hormone Nomenclature 10. 17-10 Before We Go On 1. Define the word hormone and distinguish a hormone from a neurotransmitter. Why is this an imperfect distinction? 2. Describe some differences between endocrine and exocrine glands. 3. List some similarities and differences between the endocrine and nervous system. 11. 17-11 The Hypothalamus & Pituitary Gland No "master control center" of the endocrine system, but are widely influenced by the hypothalamus and the pituitary gland; 12. 17-12 Anatomy Hypothalamus: Shaped like a flattened funnel, forms floor and walls of third ventricle of the brain; Regulates primitive functions from water balance to sex drive; Many functions carried out by pituitary gland, which is closely associated with it. 13. 17-13 Pituitary Gland (Hypophysis) Suspended from hypothalamus by stalk (infundibulum) Location and size - housed in sella turcica of sphenoid bone Composed of two structures (develop from different parts of the embryo): 1. Adenohypophysis (anterior pituitary) - arises from hypophyseal pouch (grows upward from the pharynx); 2. Neurohypophysis - Arises as a downward growth from brain (neurohypophyseal bud). 14. 17-14 Embryonic Development 15. 17-15 Anatomy The adenohypophysis (anterior pituitary) contains two parts: 1. Large anterior lobe (called the pars distalis) 2. Pars tuberalis 16. 17-16 Anatomy Anterior pituitary has no nervous connection to the hypothalamus but is connected to it by a complex of blood vessels called hypophyseal portal system; HPS begins with the 10 capillaries to 20 capillaries to the anterior pituitary; so hormone released from the hypothalamus picked up by these capillaries and sent to anterior pituitary affecting those cells (fenestrated capillaries). 17. 17-17 Anatomy Neurohypophysis (posterior ¼ of pituitary gland) has 3 parts: 1. median eminence 2. stalk 3. posterior lobe (pars nervosa) Not a true gland but a mass of nerve fibers & cells; The nerve fibers arise from the hypothalamus & travel down the stalk as a bundle called the hypothalamo-hypohyseal tract. 18. 17-18 19. 17-19 Histology of Pituitary Gland 20. 17-20 21. 17-21 Hypothalamic Hormones Produces 9 hormones; 7 affect AP, 2 affect PP Travel to & activate the anterior pituitary via hypophyseal portal system; 5 are releasing hormones that stimulate Ant. Pit. - thyrotropin-releasing hormone (TRH) - Corticotropin-releasing hormone (CRH) - Prolactin-releasing hormone (PRH) - Growth hormone-releasing hormone (GHRH) - Gonadotrophin releasing hormone (GRH) 2 inhibiting hormones (suppress pituitary secretion) - Prolactin-inhibiting hormone (PIH) - Somatostatin 22. 17-22 Hypothalamic Hormones 2 hormones that are made in the hyothalamus but stored in the Posterior pituitary: - oxytocin (OT) – paraventricular nuclei - Antidiuretic hormone (ADH) – supraoptic nuclei 23. 17-23 Hypothalamic Hormones 24. 17-24 Pituitary gland secrets the following: Anterior lobe: -FSH (follicle stimulating hormone) -LH (luteinizing hormone) -TSH (thyroid stimulating hormone) -ACTH (adrenocorticotropic hormone) -PRL (prolactin) -GH (growth hormone) Pituitary Hormones gonadotrophins 25. 17-25 Posterior lobe produces NO hormone it is only a stores & releases: OT (oxytocin) and ADH -produced in hypothalamus -transported by hypothalamo-hypophyseal tract to posterior lobe (stores then releases hormones) Pituitary Hormones 26. 17-26 Pituitary Hormones The relationship between the hypothalamus, pituitary, and the remote endocrine gland is called an AXIS; 3 types of axis: 1. hypothalamo-pituitary –gonadal axis 2. hypothalamo-pituitary – thyroid axis 3. hypothalamo-pituitary – adrenal axis 27. 17-27 28. 17-28 Actions of Pituitary Hormones FSH (secreted by gonadotrope cells) - stimulates production of egg or sperm cells; LH (secreted by gonadotrope cells) -females - stimulates ovulation and corpus luteum to secrete progesterone and estrogen, important for pregnancy; -males - stimulates interstitial cells of testes to secrete testosterone; TSH (secreted by thyrotropes) -stimulates growth of gland and secretion of TH 29. 17-29 Adrenocorticotrophic (ACTH)(secreted by corticotropes) - stimulates the adrenal cortex to secrete its hormone (corticosteroids); - regulate glucose, fat and protein metabolism, role in bodies response to stress; PRL (secreted by lactotropes) female – level rise during pregnancy but milk synthesizes after birthing; male - ↑ LH sensitivity in testies, thus indirectly ↑ testosterone secretion; Actions of Pituitary Hormones 30. 17-30 Growth Hormone (GH) or Somatotropin: Secreted by somatotropes of anterior pituitary Promotes tissue growth - mitosis and cellular differentiation, thus promoting wide spread tissue growth; - stimulates liver to produce IGF-I and II (insulin-like growth factors) GH-IGF mechanism of actions include: protein synthesis ↑ DNA transciption for ↑ mRNA production, proteins synthesized enhances amino acid transport into cells, ↓ protein catabolism lipid metabolism stimulates FFA and glycerol release from adipocytes, protein sparing CHO metabolism glucose sparing effect = less glucose used for energy Electrolyte balance promotes Na^+ , K^+ , Cl^- retention, Ca^{2+} absorption Actions of Pituitary Hormones 31. 17-31 Posterior Lobe Hormones ADH - targets kidneys ↑ water retention, reduce urine - also functions as neurotransmitter (vasopressin) Oxytocin Stimulate uterine smooth muscles to contract during labor; - stimulates muscle-like cells of the mammary glands to force milk to the nipple; - sexual arousal (both sexes); - sperm propulsion through male reproductive tract - emotional bonding, sexual satisfaction. 32. 17-32 Control of Pituitary secretion The timing and amount of secretion are regulated by hypothalamus, other brain centers, and feedback from target organs; Hypothalamic & Cerebral Control Anterior lobe control – is regulated by releasing hormones and inhibiting hormones from the hypothalamus; - I.e. in cold weather, hypothalamus stimulates the pituitary to secrete TSH = body heat; Posterior lobe control - controlled by neuroendocrine reflexes; – hormone release in response to nervous system signals; • suckling infant→ stimulates nerve endings → hypothalamus → posterior lobe → oxytocin → milk ejection – hormone release in response to higher brain centers • milk ejection reflex can be triggered by a baby's cry ADH release in response to neuroendocrine reflexes. 33. 17-33 Control of Pituitary: Feedback from Target Organs • Negative feedback ↑ target organ hormone levels inhibits release of tropic hormones Positive feedback - stretching of uterus ↑ OT release, causes more stretching of uterus, until delivery 34. 17-34 What do you think? Q: If the thyroid gland were removed from a cancer patient, would you expect the level of TSH to rise or fall? Why? 35. 17-35 What do you think? A: If the thyroid gland is removed, TSH level rises because the hypothalamus and pituitary gland no longer receive negative feedback inhibition from the thyroid 36. 17-36 Before We Go On (group) 1. What are two good reasons for considering the pituitary to be two separate glands? 2. Name three anterior lobe hormones that have reproductive functions and three that have non- reproductive roles. What target organs are stimulated by both of them. 3. Briefly contrast hypothalamic control of anterior pituitary with its control of the posterior pituitary. 37. 17-37 Pineal Gland Located roof of the 3rd ventricle of the brain, beneath the corpus collosum; Peak secretion ages 1-5; by puberty 75% lower; Produces serotonin by day and melatonin at night; May regulate timing of puberty in humans; - tumors of pineal gland cause premature puberty; Melatonin ↑ in SAD & PMS; ↓ by phototherapy depression, sleepiness, irritability and carbohydrate craving 38. 17-38 Thymus Location: mediastinum, superior to heart Involution after puberty Secretes hormones that regulate development of the thymus and later activation of T-lymphocytes - thymopoietin and thymosins 39. 17-39 Thyroid Gland Anatomy Largest endocrine gland; high rate of blood flow - arises root of embryonic tongue Consists of 2 lobes connected by a isthmus Fig. 17.9a 40. 17-40 Thyroid Gland Thyroid follicles (histologically) filled with colloid and lined with simple cuboidal epithelial (follicular cells) that secretes two hormones: 1.T3 (triiodothyronine) 2.T4 (tetraidothyronine) Thyroid hormone -↑ body's metabolic rate and O2 consumption calorigenic effect - ↑ heat production; -↑ heart rate and contraction strength; -↑ respiratory rate; -stimulates appetite and breakdown CHO, lipids and proteins; -promotes alertness, bone growth & remodeling; development of hair, skin, teeth, fetal NS & skeletal development. Thyroid hormones 41. Thyroid Gland Thyroid also produces: Calcitonin – by the C (calcitonin) cells Secreted in response to high calcium levels in the blood; Thus promotes Ca^{2+} deposition and bone formation by stimulating osteoblast activity; Antagonizes the action of the parathyroid gland; Especially important in children; 17-41 42. 17-42 Histology of the Thyroid Gland 43. 17-43 Parathyroid Glands Releases PTH (parathyroid hormone) In response to hypocalcemia; PTH blood Ca^{2+} levels by: 1. Promoting the synthesis of calcitriol - which intestinal absorption of Ca^{2+} ; 2. ↓ urinary excretion of Ca^{2+} 3. promotes Phosphate extcretion - P binds with Ca^{2+} & is deposited into bone; 4. Indirectly stimulating osteoclast to: Resorb bone. 44. 17-44 Adrenal (Suprarenal) Gland Like the pituitary gland it is formed from two different fetal glands with different origin & functions. Inner core = adrenal medulla Outer = adrenal cortex 45. 17-45 Adrenal Medulla Part of the sympathetic nervous system -consists of modified neurons called chromaffin cells; -stimulation causes release of catecholamines; (epinephrine (85%), NE); Result from release of hormone: -Increases alertness, anxiety, or fear; -increases BP, heart rate and airflow; -raises metabolic rate; -Mobilizes high energy fuels (lactate, fatty acids, glucose); -Glucose levels are boosted by glyconeogenesis & gluconeogenesis; - Epinephrine inhibits insulin secretion ("glucose-sparing effect); - Inhibits digestion & urination. 46. 17-46 Adrenal Cortex • 3 Layers glandular tissues: – zona glomerulosa (outer) – globular cells; – zona fasciculata (middle) – cell columns separated by blood sinuses; – zona reticularis (inner) 47. 17-47 Adrenal Cortex Cortex synthesizes > 25 steroid hormones called: Corticosteroids: – mineralocorticoids (zona glomerulosa) • Acts on kidneys to control electrolyte balance, aldosterone promotes Na^+ retention and K^+ excretion – glucocorticoids (zona fasciculata) • especially cortisol, stimulates fat and protein catabolism, gluconeogenesis (from a.a.'s and FA's) and release of fatty acids and glucose into blood; • anti-inflammatory effect (ointments), relieve swelling; – sex steroids (zona reticularis) • Weak androgens (including DHEA which other tissues convert to testosterone); • Adrenal estrogen (estradiol) only important after menopause; • Both sexes androgen stim. Pubic & axillary hair, scent glands after pubity, sustains libido throughout adult life. 48. 17-48 What do you think? Q: Which could a person more easily live without – the adrenal medulla or adrenal cortex? Why? 49. 17-49 What do think? • Loss of the adrenal cortex would be more critical than loss of the adrenal medulla. The adrenal medulla secretes epinephrine and norepinephrine, merely supplementing the effects of the sympathetic nervous system. The adrenal cortex, however, secretes mineralocorticoids and glucocorticoids that are vital to electrolyte balance and metabolism and are secreted by no other organ in the body. Serious disturbances of homeostasis would result from the loss of the adrenal cortex. 50. 17-50 Pancreas • Retroperitoneal, inferior and dorsal to stomach • Mostly an exocrine gland but scattered throughout are clusters of endocrine cells called pancreatic islets (islets of Langerhans) 51. 17-51 Pancreatic Hormones 1-2 million islets that produce hormones; - They only constitute 2% pancreatic tissues (endocrine); - 98% of organ produces digestive enzymes (exocrine); The islets secret about 5 different hormones & paracine products: (Most important…) 1. Insulin 2. Glucagon 3. Somatostatin 52. Pancreatic Hormones Insulin (from β cells): -secreted after meal and the level of glucose and AA in the blood rise; Functions: - Stimulates cells to absorb nutrients from the blood; - Stimulates muscles and adipose tissue to store glycogen & fat; -

Promotes glycogen, fat, and protein synthesis which enhances cell growth & differentiation. 17-52 53. 17-53 Pancreatic Hormones Glucagon (from α cells) -secreted when blood glucose [ ] drop between meals; -stimulates glycogenolysis, gluconeogenesis & the release of glucose into circulation; -stimulates fat catabolism in adipose cells & the release of FFA; -promotes AA absorption (high protein meal) thus providing cells with the raw material for gluconeogenesis; 54. Pancreatic Hormones Somatostatin (from delta (δ) cells) -secreted with rise in blood glucose, amino acids, and fatty acids after a meal; -travels briefly in blood and inhibits various digestive functions; paracrine secretion = inhibits secretion of glucagon & insulin by α and β cells, respectively; Reason: serves to prolong the absorption of nutrients by the tissues, preventing quick depletion of blood-borne nutrients. 17-54 55. 17-55 Pancreatic Hormones • Hyperglycemic hormones raise blood glucose; – GH, epinephrine, NE, cortisol and corticosterone • Hypoglycemic hormones lower blood glucose – insulin 56. 17-56 The Gonads Both exocrine and endocrine - exocrine – eggs, sperm; - endocrine – gonadal hormones (steroid); 57. 17-57 Ovary • Each follicle contains an egg that is surrounded by granulosa cells; – These cells produces estradiol, first half of menstrual cycle; • After ovulation the corpus luteum: – produces estradiol and progesterone for 12 days or 8-12 weeks if pregnancy; • Functions of estradiol and progesterone – development of female reproductive system and physique including bone growth; – regulate menstrual cycle, sustain pregnancy; – prepare mammary glands for lactation; • Both follicle & corpus luteum secrete inhibin: – suppresses FSH secretion via negative feedback to anterior pituitary. 58. 17-58 Histology of Ovary 59. 17-59 Testes • Interstitial cells (between seminiferous tubules) – produce testosterone and weaker amounts of estrogen; • Functions – development of male reproductive system and physique – sustains sperm production and sex drive; • Sustentacular (sertoli) cells – secrete inhibin which suppresses FSH secretion which stabilizes sperm production rates; – Provide nourishment & waste removal for developing sperm. 60. 17-60 Endocrine Functions of Other Organs • Heart – – atrial natriuretic peptide released with an increase in BP, ↓ blood volume and ↓ BP by ↑ Na^+ and H_2O loss by kidneys, • Skin – Kerotinocytes produce vit. D3, • Liver – produces 5 hormones: – Erythropoietin – stim. red bone marrow to produce RBC, – Angiotensinogen – raises blood pressure, • precursor of angiotensin II; – IGF 1– mediates the action of GH; – Calcitriol – raises blood Ca^{2+} [ ] & convert vit. D to calcidiol – Hepcidin – promotes intestinal absorption & mobilization of iron for hemoglobin absorption; – Kidneys – secrete EPO (85%), convert angiotensinogen to angiotensin I, convert calcidiol into calcitriol (active form of Vit. D). 61. 17-61 Endocrine Functions of Other Organs • Stomach and small intestines – Enteroendocrine cells secrete at least 10 enteric hormones; – coordinate digestive motility and secretion • Placenta – secretes estrogen, progesterone and others • regulate pregnancy, stimulate development of fetus and mammary glands. 62. 17-62 Hormone Chemistry • Steroids – derived from cholesterol – sex steroids, corticosteroids • Peptides and glycoproteins – OT, ADH; all releasing and inhibiting hormones of hypothalamus; most of anterior pituitary hormones • Monoamines (biogenic amines) – derived from amino acids • catecholamines (norepinephrine, epinephrine, dopamine) and thyroid hormones 63. 17-63 Oxytocin and ADH 64. 17-64 Hormone Synthesis: Steroid Hormones • Synthesized from cholesterol – differs in functional groups attached to 4-ringed steroid backbone 65. 17-65 Hormone Synthesis: Peptides • Cellular steps – RER removes segment, forms prohormone – Golgi complex further modifies it into hormone – e.g. insulin formation • preproinsulin converted to proinsulin in RER • proinsulin split into insulin and C peptide in golgi complex 66. 17-66 Hormone Synthesis: Monoamines • All are synthesized from tyrosine – except melatonin which is synthesized from tryptophan • Thyroid hormone is unusual – composed of two tyrosine molecules – requires a mineral, iodine 67. 17-67 Thyroid Hormone Synthesis Fig. 17.18 68. 17-68 T3 and T4 Synthesis • Follicular cells – absorb I- from blood and store in lumen as I- – synthesize thyroglobulin and store in lumen • contains tyrosine – tyrosine and Iodine form T3 and T4 • TSH – stimulates follicular cells to remove T3 and T4 from thyroglobulin for release into plasma 69. 17-69 Chemistry of Thyroid Hormone Fig. 17.19 MIT contains one iodine atom, DIT has two T3 = combination of MIT plus DIT T4 = combination of two DITs 70. 17-70 Hormone Transport • Monoamines and peptides are hydrophilic – mix easily with blood plasma • Steroids and thyroid hormone are hydrophobic – must bind to transport proteins for transport – bound hormone - attached to transport protein, • prolongs half-life to weeks • protects from enzymes and kidney filtration – unbound hormone leaves capillary to reach target cell (half-life a few minutes) • Transport proteins in blood plasma – albumin, thyretin and TGB (thyroxine binding globulin) bind to thyroid hormone – steroid hormones bind to globulins (transcortin) – aldosterone - no transport protein, 20 min. half-life 71. 17-71 Hormone Receptors • Located on plasma membrane, mitochondria, other organelles, or in nucleus • Usually thousands for given hormone – hormone binding turns metabolic pathways on or off • Exhibit specificity and saturation 72. 17-72 Hormone Mode of Action • Hydrophobic hormones – penetrate plasma membrane – enter nucleus • Hydrophilic hormones – must bind to cell-surface receptors 73. 17-73 Thyroid Hormone Effects • TH binds to receptors on – mitochondria ∀ ↑ rate of aerobic respiration – ribosomes and chromatin ∀ ↑ protein synthesis • Na^+ -K^+ ATPase produced – generates heat 74. 17-74 Hydrophilic Hormones: Mode of Action cAMP as Second Messenger 1) Hormone binding activates G protein 2) Activates adenylate cyclase 3) Produces cAMP 4) Activates kinases 5) Activates enzymes 6) Metabolic reactions: – synthesis – secretion – change membrane potentials 75. 17-75 Hydrophilic Hormones: Mode of Action Other 2nd and 3rd Messengers Hormones may use different second messengers in different tissues. 76. 17-76 Enzyme Amplification 77. 17-77 Hormone Clearance • Hormone signals must be turned off • Take up and degraded by liver and kidney • Excreted in bile or urine • Metabolic clearance rate (MCR) • Half-life - time required to clear 50% of hormone 78. 17-78 Modulation of Target Cell Sensitivity • Long-term use of high pharmacological doses – bind to receptor sites of related hormones – target cell may convert to different hormone 79. 17-79 Hormone Interactions • Most cells sensitive to more than one hormone and exhibit interactive effects • Synergistic effects • Permissive effects – one hormone enhances response to a second hormone • Antagonistic effects 80. 17-80 Stress and Adaptation • Stress – caused by any situation that upsets homeostasis and threatens one's physical or emotional well-being • General adaptation syndrome – way body reacts to stress – occurs in 3 stages 1. alarm reaction 2. stage of resistance 3. stage of exhaustion 81. 17-81 Alarm Reaction • Initial response ∀↑ epinephrine and norepinephrine levels ∀↑ HR and ↑ BP ∀↑ blood glucose levels • Sodium and water retention (aldosterone) 82. 17-82 Stage of Resistance • After a few hours, glycogen reserves gone ∀↑ ACTH and cortisol levels • Fat and protein breakdown • Gluconeogenesis • Depressed immune function • Susceptibility to infection and ulcers 83. 17-83 Stage of Exhaustion • Stress that continues until fat reserves are gone • Protein breakdown and muscle wasting • Loss of glucose homeostasis • Hypertension and electrolyte imbalances (loss of K^+ and H^+) • Hypokalemia and alkalosis leads to death 84. 17-84 Paracrine Secretions • Chemical messengers that diffuse short distances and stimulate nearby cells – unlike neurotransmitters not produced in neurons – unlike hormones not transported in blood • Examples and their functions – histamine • from mast cells in connective tissue • causes relaxation of blood vessel smooth muscle – nitric oxide • from endothelium of blood vessels, causes vasodilation – somatostatin • from gamma cells, inhibits secretion of alpha and beta cells – catecholamines • diffuse from adrenal medulla to cortex 85. 17-85 Eicosanoids: a Paracrine Secretion • Leukotrienes – converted from arachidonic acid (by lipoxygenase) – mediates allergic and inflammatory reactions • Prostacyclin (by cyclooxygenase) – inhibits blood clotting and vasoconstriction • Thromboxanes (by cyclooxygenase) – produced by blood platelets after injury; override prostacyclin, stimulates vasoconstriction and clotting • Prostaglandins (by cyclooxygenase): diverse; includes – PGE: relaxes smooth muscle in bladder, intestines, bronchioles, uterus and stimulates contraction of blood vessels – PGF: opposite effects 86. 17-86 Eicosanoid Synthesis 87. 17-87 Endocrine Disorders • Variations in hormone concentration and target cell sensitivity have noticeable effects on body; • Hyposecretion – inadequate hormone release – tumor or lesion destroys gland; – Inability to receive signals from another gland; • head trauma affects pituitary gland's ability to secrete ADH – diabetes insipidus = chronic polyuria • Hypersecretion – excessive hormone release – tumors or autoimmune disorder • Pheochromocytoma • toxic goiter (graves disease) – antibodies mimic effect of TSH on the thyroid = elevated metabolic rate & heart rate, nervousness, weight loss, exophthalmos. 88. 17-88 Pituitary Disorders • Hypersecretion of growth hormones (GH) – acromegaly – thickening of the bones and soft tissues – If begins in childhood or adolescence... • Hypersecretion = gigantism • Hyposecretion = pituitary dwarfism 89. 17-89 Thyroid Gland Disorders • Congenital hypothyroidism (↓ TH) – infant suffers abnormal bone development, thickened facial features, low temperature, lethargy, brain damage • Myxedema (adult hypothyroidism, ↓ TH) – low metabolic rate, sluggishness, sleepiness, weight gain, constipation, dry skin and hair, cold sensitivity, ↑ blood pressure and tissue swelling • Endemic goiter (goiter = enlarged thyroid gland) – dietary iodine deficiency, no TH, no (-) feedback, ↑ TSH • Toxic goiter (Graves disease) – antibodies mimic TSH, ↑TH, exophthalmos 90. Thyroid Gland Disorders 17-90 91. 17-91 Parathyroid Disorders • Hypoparathyroid – surgical excision during thyroid surgery – Rapid decline in blood calcium [ ]... – fatal tetany 3-4 days • Hyperparathyroid = excess PTH secretion – tumor in gland – causes soft, fragile and deformed bones ↑ blood Ca^{2+} & Phosphate ions; – renal calculi (composed of calcium phosphate) 92. 17-92 Adrenal Disorders • Cushing syndrome - excess cortical secretion – Disrupts protein and carbohydrate metabolism resulting in: – hyperglycemia, hypertension, weakness, edema; – muscle and bone loss occurs with protein catabolism; – buffalo hump and moon face = fat deposits (shoulders & face). • Adrenogenital syndrome (AGS) – adrenal androgen hypersecretion; accompanies Cushing; – enlargement of external sexual organs in children and early onset of puberty; – masculinizing effects on women (deeper voice and beard growth). 93. Adrenal Disorders 17-93 94. 17-94 Diabetes Mellitus Defines as the disruption of carbohydrate, fat, & protein metabolism from hyposecretion or inaction of insulin; • Signs and symptoms: – polyuria, polydipsia, polyphagia Signs & symptoms from blood test: – hyperglycemia, glycosuria, ketonuria – osmotic diuresis • blood glucose levels rise above transport maximum of kidney tubules, glucose remains in urine (ketones also present) • increased osmolarity draws water into urine 95. 17-95 Types of Diabetes Mellitus • Type I (IDDM) - 10% of cases – some cases have autoimmune destruction of β cells, diagnosed about age 12 – treated with diet, exercise, monitoring of blood glucose and periodic injections of insulin • Type II (NIDDM) - 90% – insulin resistance • failure of target cells to respond to insulin – 3 major risk factors are heredity, age (40+) and obesity, gradual onset; – treated with weight loss program of diet and exercise – oral medications improve insulin secretion or target cell sensitivity 96. 17-96 Pathology of Diabetes • Acute pathology: cells cannot absorb glucose, rely on fat and proteins (weight loss, weakness) – fat catabolism ↑ FFA's in blood and ketone bodies – ketonuria promotes osmotic diuresis, loss of Na^+ and K^+ - results in electrolyte imbalance = abdominal pain, vomiting, neurological dysfunction; – ketoacidosis occurs as ketones ↓ blood pH • Kussmaul respiration – gasping breathing; • if continued causes dyspnea and eventually diabetic coma • Chronic pathology – chronic hyperglycemia leads to neuropathy and cardiovascular damage from atherosclerosis • retina and kidneys (common in type I), atherosclerosis leads to heart failure (common in type II), and gangrene 97. 17-97 Hyperinsulinism • From excess insulin injection or pancreatic islet tumor • Causes hypoglycemia, weakness and hunger – triggers secretion of epinephrine, GH and glucagon • side effects: anxiety, sweating and ↑ HR • Insulin shock – uncorrected hyperinsulinism with disorientation, convulsions or unconsciousness

Some of the worksheets for this concept are Chapter 7 nervous system Nervous system work The nervous system Nervous system crossword puzzle answer key Chapter 12 the nervous system answer key Name block date Chapter 20 the nervous and endocrine systems. Nerves can be motor sen-. ... chapter 25 nuclear chemistry worksheet answers, chapter 17 ... This quiz and worksheet will assess your grasp of pharmacokinetics and the functions that makeup this process. Quiz question cover the metabolism and absorption of ... Energy in the earth system. Abilities of technological design. Personal and community health. Science as a human endeavor. Geochemical cycles. Understandings about science and technology. Population growth. Nature of scientific knowledge. Origin and evolution of the earth system . Natural resources. Historical perspectives. Origin and evolution ... " (Emphasis in original) The AMA's Guides organize ratable organ or body function by chapter e.g., respiratory, cardiovascular, nervous, endocrine etc. 4. General Requirements for Impairment Ratings. a. Covered Employees. The employee is a covered Department of Energy (DOE) contractor or subcontractor employee, or Radiation Exposure ... On May 17, 2022, the Biden Administration announced that COVIDTests.gov is open for a third round of ordering. The Postal Service Reform Act of 2022. Learn what this Act means to the NALC Health Benefit Plan and its Postal Members. AAAHC Survey Notice. AAAHC Survey Notice for members and employees. Over-the-Counter (OTC) COVID-19 Diagnostic Tests Chapter 18. The Endocrine System. 18.1 Types of Hormones. 18.2 How Hormones Work. 18.3 Regulation of Body Processes. 18.4 Regulation of Hormone Production. 18.5 Endocrine Glands. ... Figure 24.17 visually compares the ovarian and uterine cycles as well as the commensurate hormone levels. Figure 24.17. 17.4 Hearing and Vestibular Sensation. 17.5 Vision. Chapter 18. The Endocrine System. 18.1 Types of Hormones. 18.2 How Hormones Work. 18.3 Regulation of Body Processes. 18.4 Regulation of Hormone Production. 18.5 Endocrine Glands. ... The XY system is also found in some insects and plants. Cardiovascular System - Blood Vessels and Blood. 14. Lymphatic and Immune Systems. 15. Digestive System. 16. Skeletal System. 17. Muscular System. 18. Sensory Systems. 19. Nervous System. 20. Endocrine System. Building a Medical Terminology Foundation. 1 Identifying Word Parts in Medical Terms Word Parts. Medical terms are built from word parts.

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