Everything you Wanted to Know about the Endocrine System but were too Afraid to Ask (Ch.36)

Useful Definitions:

2004-05

•**HORMONE**—A chemical messenger within the body that is secreted by one type of cell and acts on another type of cell; they are usually carried via the bloodstream; very small amounts can produce large effects.

•**PHEROMONE**—A chemical signal, analogous to a hormone, that passes information between individuals.

•**ENDOCRINE GLANDS** vs **EXOCRINE GLANDS**—Both secrete substances. Exocrine glands have actual holes through which they secrete it (e.g. stomach, salivary), while endocrine glands are ductless and must release small amounts of their chemicals (called hormones) directly into the bloodstream. This chapter is on the endocrine glands.

SOURCE	HORMONE	TARGET	ACTION/PROBLEMS
Posterior Pituitary (brain extension)	**ADH (Antidiuretic Hormone)**	kidneys	•Increases water reabsorption/retention (& reduces urine production) (Technicality: This one is actually made by the hypothalamus & then sent to the PP via axons, which then secretes it and tries to take full credit.
Posterior Pituitary (brain extension)	**Oxytocin**	mammary glands	•Stimulates release of milk & contraction of uterine muscle during childbirth
Anterior Pituitary	***TSH (Thyroid-stimulating hormone)**	thyroid	•Triggers the secretion of Thyroxin, T4
Anterior Pituitary	***ACTH (AdrenoCortico-Tropic Hormone)**	adrenal cortex	•Triggers the secretion of glucocorticoids (steroids)
Anterior Pituitary	***FSH (Follicle-Stimulating Hormone)**	ovary/testis	•Regulates oogenesis, spermatogenesis
Anterior Pituitary	***LH (Luteinizing Hormone)**	ovary/testis	•Regulates oogenesis, spermatogenesis
Anterior Pituitary	***MSH (Melatonin-stimulating Hormone)**	skin	•Regulates pigment levels
Anterior Pituitary	**Endorphins (ENDOgenous mORPHINe)**	brain et al	•Decreases pain sensation, both physical & mental→☺ (aka Rur
Anterior Pituitary	**Prolactin**	mammary glands	•Stimulates milk production
Anterior Pituitary	**GH (Growth Hormone)**	bone, muscle, etc.	•Stimulates growth Problems -too little→dwarfism (formerly treated with GH from cadavers, now GE) -too much as child→gigantism
Pancreas (*beta* cells of Islets of Langerhans) (Note that the pancreas is also an exocrine gland because it releases digestive juices through a duct)	**Insulin**		•Increases glucose uptake by all cells but brain; slows glycogen breakdown by liver; slows conversion of AA, fatty acids to sugar Problems Too little insulin production or insensitivity to insulin→diabetes mellitus→high blood sugar→excessive glucose in urine→increased urine volume→excessive thirst; also→fat becomes primary NRG source→acidic breakdown products in blood→lowers blood pH→☹ Type I (insulin-dependent)—rare autoimmune disorder—body attacks Islets; usually occurs in childhood Type II—(non-insulin-dependent)usually after age 40; decreased production, responsiveness to insulin; often controlled by exercise, diet; largely hereditary

These 5 hormones are called the **TROPIC HORMONES**—hormones made by one gland that cause another gland to secrete a hormone

SOURCE	HORMONE	TARGET	ACTION
Pancreas (*alpha* cells of Islets)	**Glucagon**	liver	•This works with insulin to maintain a set point of about 90 mg/100mL blood, by signaling liver to hydrolyze glycogen, & convert AA, fatty acids into sugar
Adrenal Gland (medulla)	**Epinephrine (adrenaline) & Norepinephrine (Noradrenaline)**	just about everything	•Causes the FIGHT-OR-FLIGHT RESPONSE: In response to nervous system signals of either positive or negative stress→increases BMR (increase glycogen breakdown, blood glucose, release of fatty acids; increase rate & stroke volume of lungs; increase HR; dilate bronchioles; shunt blood supply away from skin, digestive system & kidneys, toward heart, brain & muscles;
Adrenal Gland (cortex)	**glucocorticoids (e.g. Cortisol) (aka the "stress hormones")**		•Increase blood glucose level Problems -high levels→reduced immune function→usually ☹ -Reduce inflammatory reaction (e.g. cortisone)→☺
Adrenal Gland (cortex)	**Aldosterone**	kidneys	•Increases reabsorption of Na & water from filtrate
Thyroid	**Thyroxin (T4--tetraiodothyronine) & T3 (triiodothyronine)**	general	•Increases cellular metabolism Problems -hyperthyroidism→high body temp & BP; weight loss→☹ -hypothyroidism→lethargy,weight gain,cold intolerance→☹; hypothyroidism in children→cretinism (incl. stunted skeletal, mental development)→☹ -iodine deficit→continued TSH release→continued thyroid stimulation, but no thyroxin to turn it off→goiter→☹
Thyroid	**Calcitonin**	bone, kidney	•Lowers blood Ca2+ by: -reducing Ca reabsorption by kidney, increasing bone deposition, & reducing Ca uptake by intestines
Parathyroid (4 of them embedded in the thyroid)	**Parathyroid Hormone (PTH)**	kidney	•Raises blood Ca2+ by: -increasing Ca reabsorption by kidney, triggering osteoclasts to decompose bone, & increasing Ca uptake in intestines Problems Lack of vitamin D→inability of PTH to increase intestinal absorption of Ca→abnormally high blood Ca levels→skeletal muscle contraction (Tetany), possible death→☹
Testis	**androgens (e.g. Testosterone)**	testes et al	•Development & maintenance of male reproductive system •Causes development of the 2ary male sex characteristics (the ones you get in puberty)
Ovary	**Estrogens (e.g. estradiol)**	uterus et al	•Development & maintenance of female reproductive system •Causes development of the 2ary female sex characteristics (the ones you get in puberty)
Ovary	**Progesterone**	uterus	•Preparing & maintaining uterus for menstrual cycle & pregnancy
Pineal	**Melatonin**	everything	Controls our **CIRCADIAN RHYTHMS** because its source gland—the pineal gland—is sensitive to light/dark periods.

Dr. House's house calls

Imagine you are one of the stars of the hit new fox TV show House. While studying for an AP Biology quiz on the endocrine system, several high school students have come down with mysterious ailments. You must diagnose them by determining which hormone is messed up, whether they have too much or too little, and finally what gland is defective.

Patient #1: Doc, Everything hurts! If I even press too hard when turning a doorknob I get this painful sensation in my hand. And on top of that I feel such anguish for hours afterward. Aaargh!

Patient #2: Doc, I'm almost eleven months pregnant but each time I think I'm ready to give birth, I try to push but just can't seem to make it happen. Aaargh!

Patient #3: Doc, I've had nearly 3 gallons of Gatorade so far today, but haven't been able to squeeze out a drop. I feel puffy and waterlogged but can't pee! Aaargh!

Patient #4: Doc, I'm pretty jumpy. If I hear so much as a car door slamming outside my heart starts racing and I crush any glass or utensil I'm holding at the time. Aaargh!

Patient #5: Doc, I am so excited for prom. I have appointments for my hair, my nails (finger and toe), my facial, and a special dress fitting, but I've started to develop a 5 o'clock shadow and my voice has been getting lower by the minute. Aaargh!

Patient #6:
DocI'mfeelingsohungryallthetimeandIcan'tseemtoslowdownnomatterwhatIdoIguessI'msortofgladIdon'tneedtogotoWeightWatchersthisweekbutIthinkImightwastea wayifyoucan'tfixmeAaargh!

Patient #6: Doc, I can't count! Aaargh!

Patient #7: Doc, I've been trying to have a baby for two years now. We had my wife checked out and everything is fine with her. Everything seems to…uh, go okay but never a pregnancy! Aaargh!

Patient #8: Doc, I thought I'd get my growth spurt when I hit high school but I'm still 3 feet tall. Although my mom says it makes me special, I don't like it. Can you help? Aaargh!

Patient #9: Doc, I keep waking up at midnight, and then I can't sleep until morning. Aaargh!

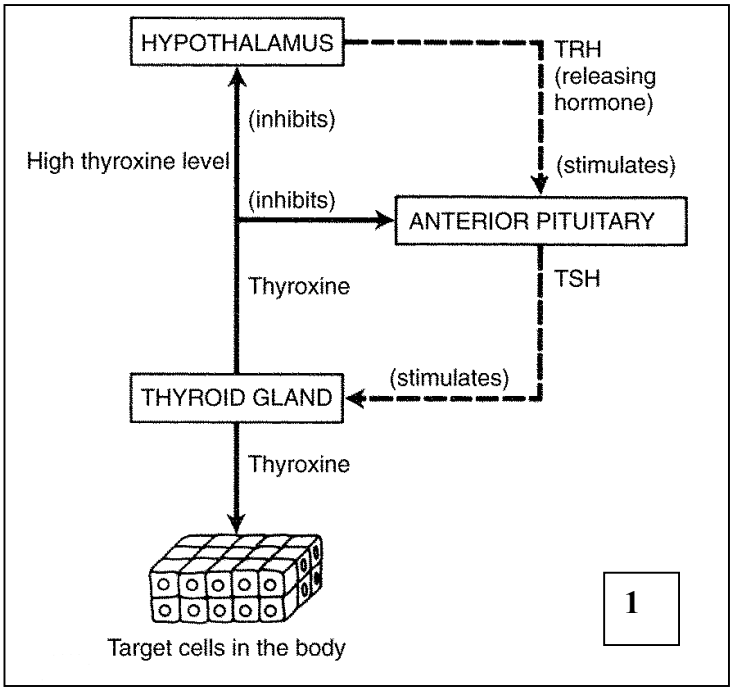
Patient #10: (Make up your own!)

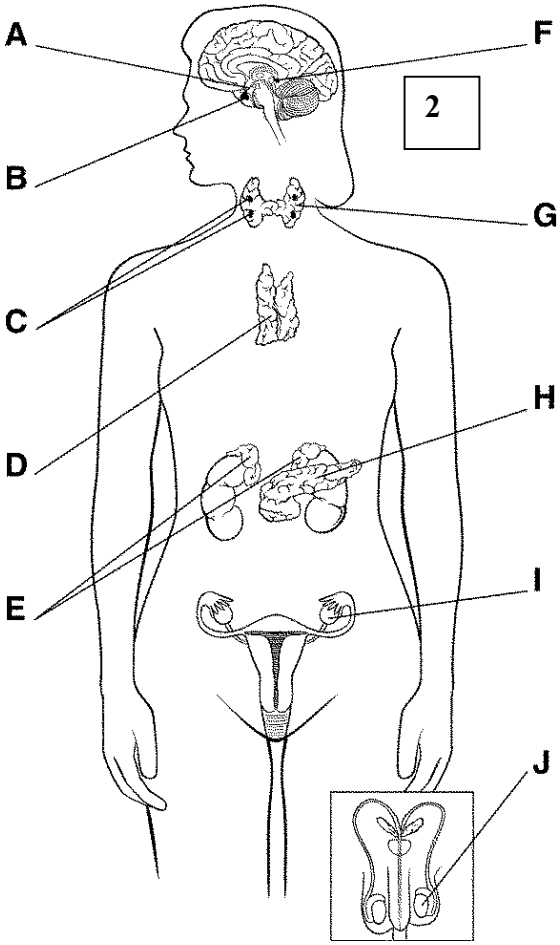
Patient #11: (Make up your own!)

Patient #12: (Make up your own!)

Endocrine System Diagrams

An example of negative feedback in the endocrine system:





Label the glands in diagram 2→

A. _____

B. _____

C. _____

D. _____

E. _____

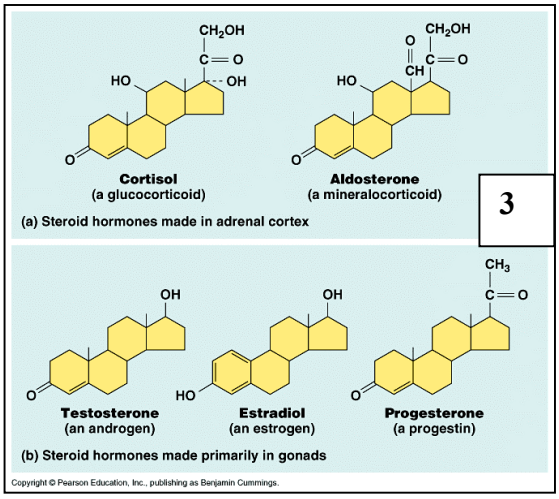
F. _____

G. _____

H. _____

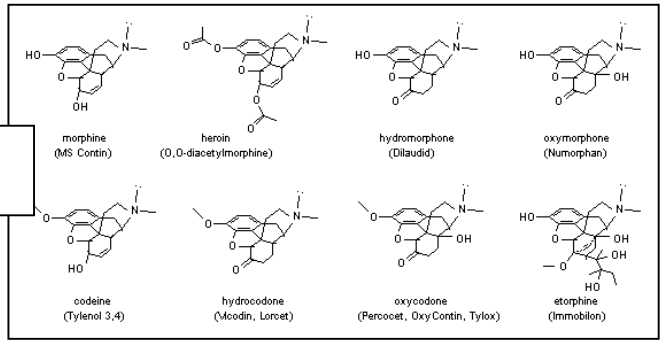
I. _____

J. _____



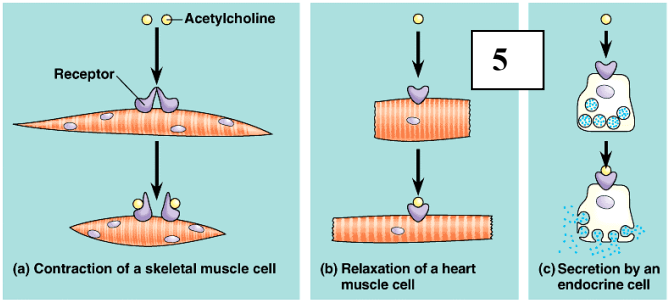
- ↑Note the similar 4-ring structure among all steroid hormones, male & female.
- Remember—while most hormones are proteins, steroid hormones are lipids.

4



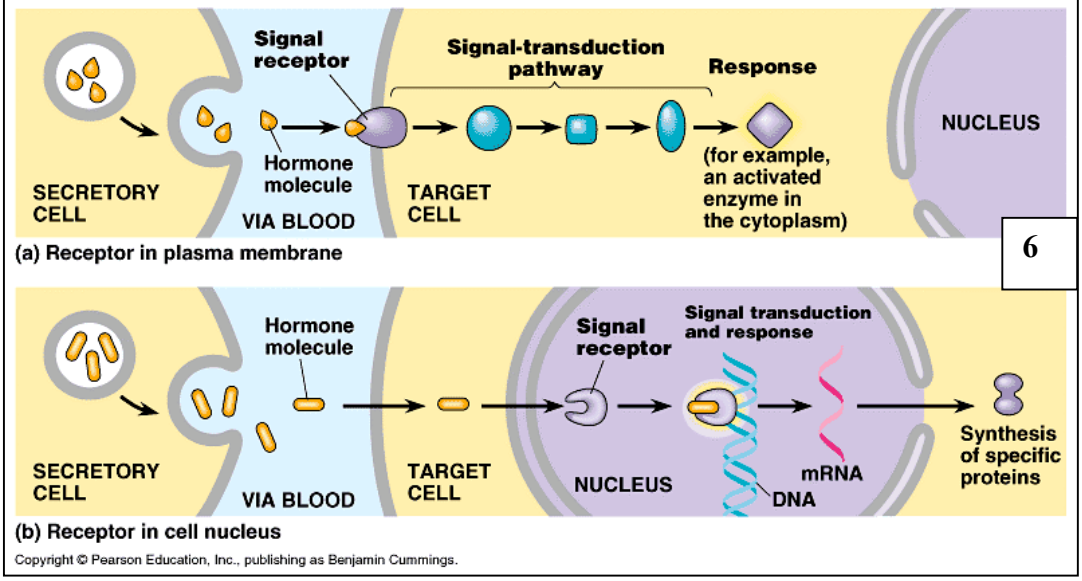
↑ Note how much the 7 opiates resemble the original (and only) innate molecule—the endorphin. All hail the endorphin.

5



A hormone's effect depends on the receptor of the target cell, so the same hormone can trigger 3 different responses in 3 different types of target cell, as with acetylcholine above. ↑

6



←This shows the 2 possible mechanisms by which a hormone can enter and trigger a response in a target cell. The top one attaches to a receptor on the cell surface, while the bottom one enters the cell to attach to a receptor INSIDE the cell's nucleus. The top one must be a _____, while the bottom must be a _____.

This shows a more detailed version of the negative feedback loop we looked at a few chapters ago.→ In it the 2 competing hormones are _____ & _____, both of which are produced by the _____.

7