

# **VET-113**

# **Animal Anatomy and Physiology 1**

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## **Webinar Chapter 15**

Endocrine System

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# A Warm Welcome from My Faculty TEAM and Me!!! 😊

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# The Pledge of Allegiance

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## *The Pledge of Allegiance*

*"I pledge allegiance to the flag  
of the United States of America,  
and to the republic for which it stands,  
one nation under God, indivisible,  
with liberty and justice for all."*





# New Desk! New Office! New Home! 😊

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I AM a Veterinary Technician! 😊

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*"Choose a job you love  
and you'll never work  
a day in your life."*

— Confucius

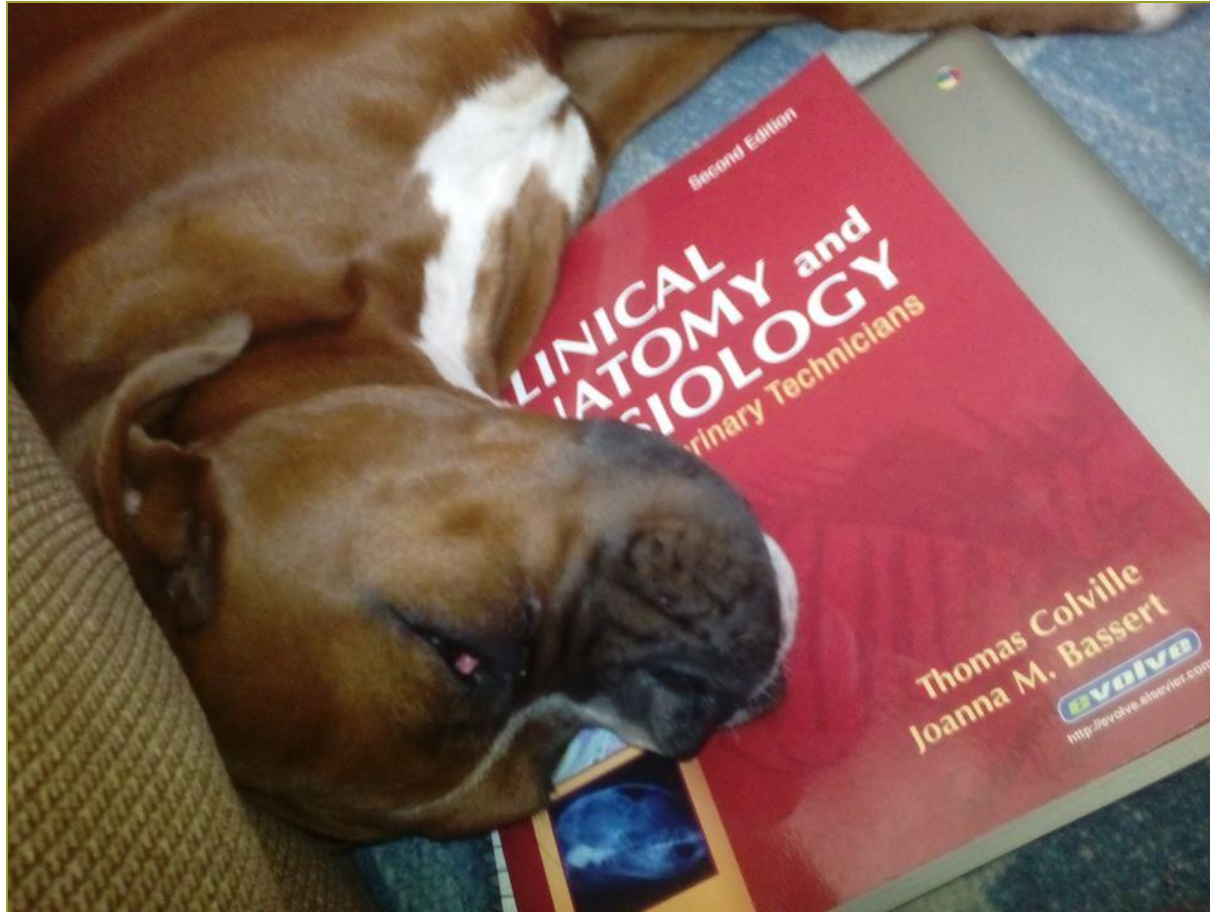


  
**Agriculture**  
*more than ever*



# Are Your Pets Helping You with A&P?

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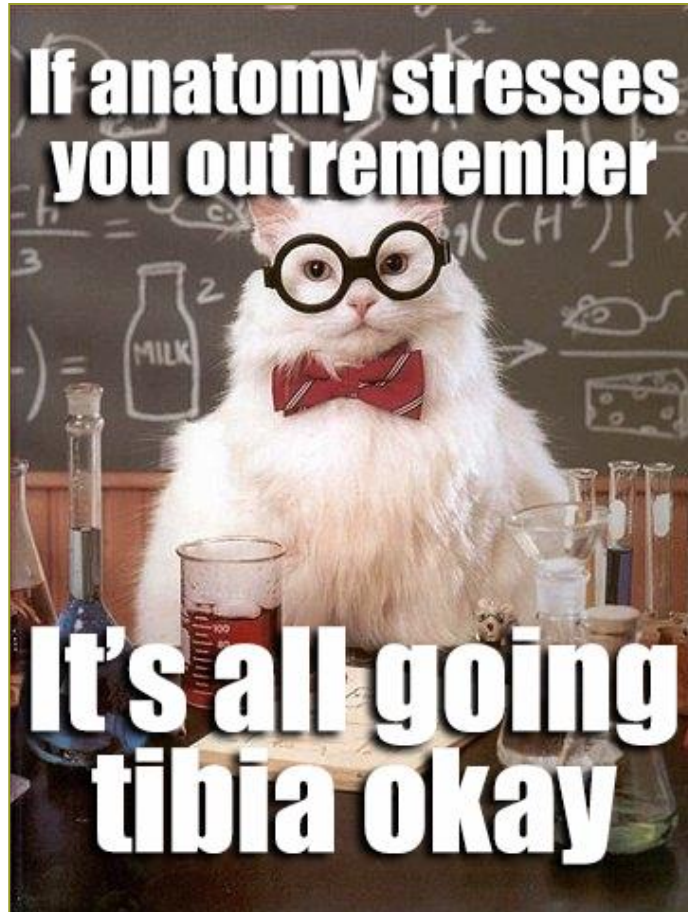


# Riley!



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**If anatomy stresses  
you out remember**



**It's all going  
tibia okay**

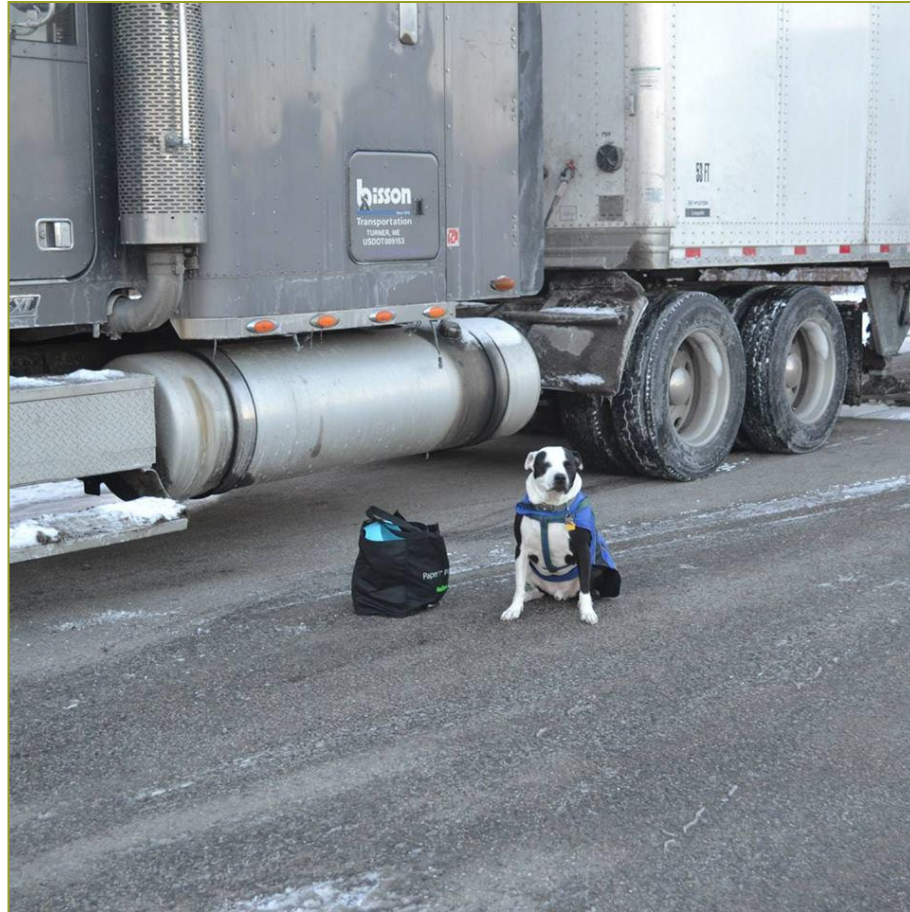


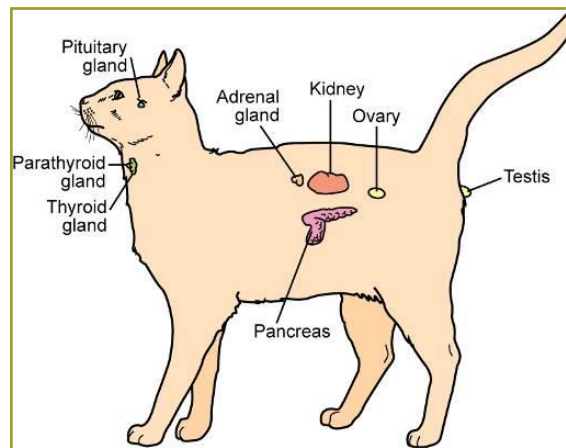
# Riley the ROCK STAR!



# Trucking with Dad! 😊

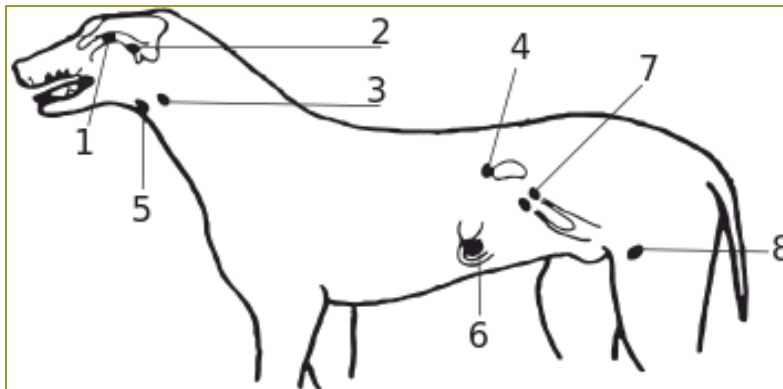
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# The Endocrine System

## Chapter 15



Pages 358-373



# Textbook Learning Objectives

## Chapter 15 – Page 358

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- Describe the negative feedback system that controls production of hormones.
- List the major endocrine glands and the hormones they produce.
- Describe the structure and functions of the pituitary gland.
- Describe the effect(s) of growth hormone, prolactin, thyroid-stimulating hormone, adrenocorticotrophic hormone, follicle-stimulating hormone, luteinizing hormone, melanocyte-stimulating hormone, antidiuretic hormone, and oxytocin.

# Learning Objectives

Page 358

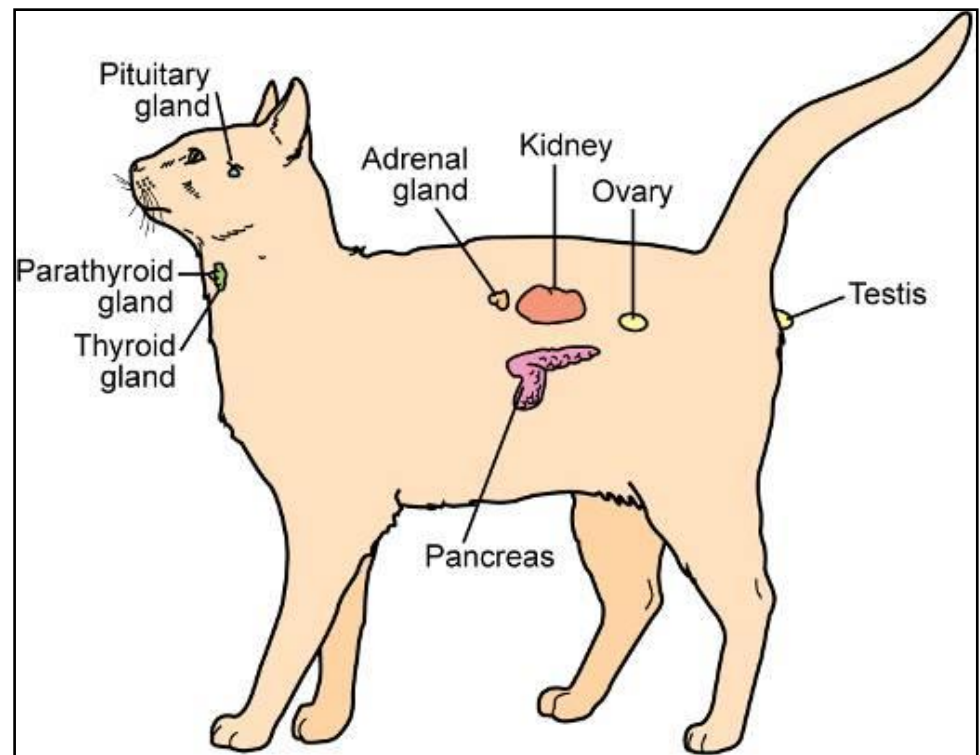
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- Describe the structure of the thyroid gland.
- Describe the effects of thyroid hormone, calcitonin, and parathormone.
- Differentiate between  $T_3$  and  $T_4$ .
- List the three categories of hormones produced by the adrenal cortex.
- List the hormones produced by the pancreatic islet cells and describe the effect(s) of each.
- Describe the effect(s) of androgens, estrogens, and progestins.
- List the hormones produced by the kidneys, stomach, small intestine, placenta, thymus, and pineal body.

# Endocrine System

Figure 15-1, Page 359

- Works together with nervous system to maintain homeostasis
- Primary function: produces hormones
- Hormones act on specific target cells to produce specific effects

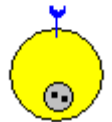


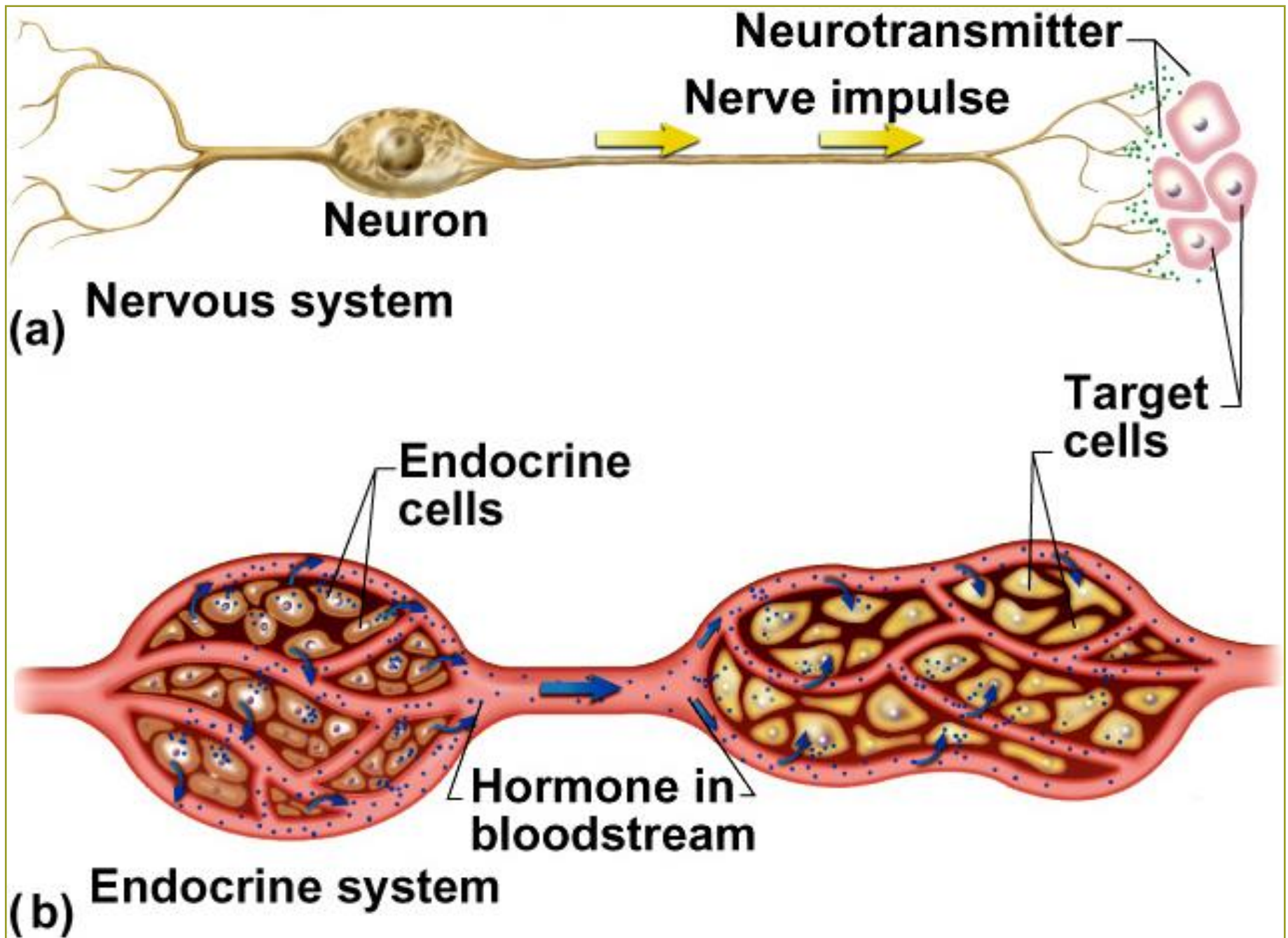


# Endocrine System & Nervous System

Table 15-1, Page 359

- Endocrine system – chemical response
  - Hormones released into the bloodstream travel throughout the body
  - Results may take hours, but last longer
- Nervous system – electrical response
  - Certain parts release hormones into blood
  - Rest releases neurotransmitters excite or inhibit nerve, muscle & gland cells
  - Results in milliseconds, brief duration of effects





# Exocrine & Endocrine Glands

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- Exocrine glands

- Secrete products into ducts which empty into body cavities or body surface
- Sweat, oil, mucous, & salivary glands;  
pancreas

- Endocrine glands

- Secrete products (hormones) into bloodstream
- Pituitary, thyroid, parathyroid, adrenal;  
pancreas



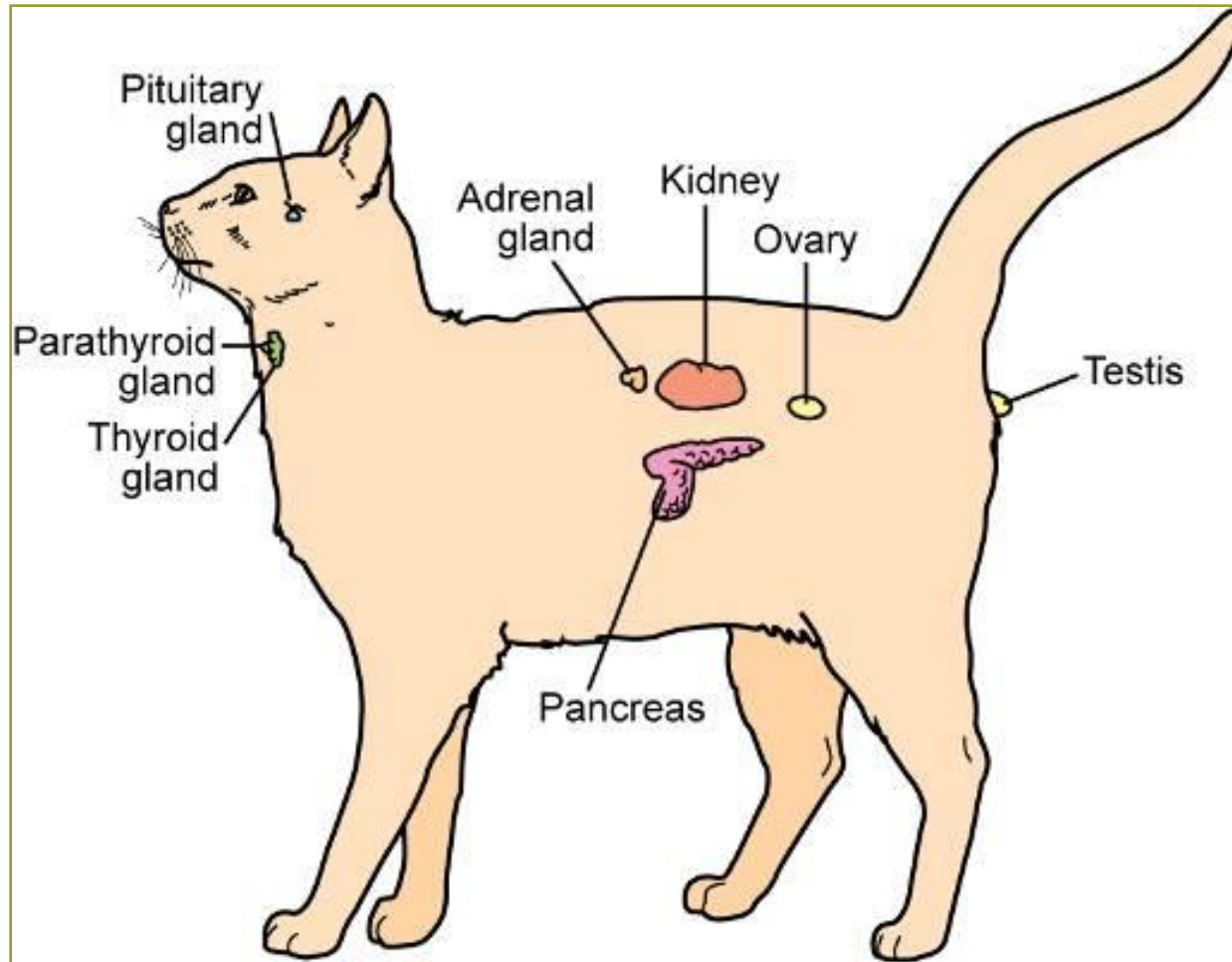
# Major Endocrine Glands

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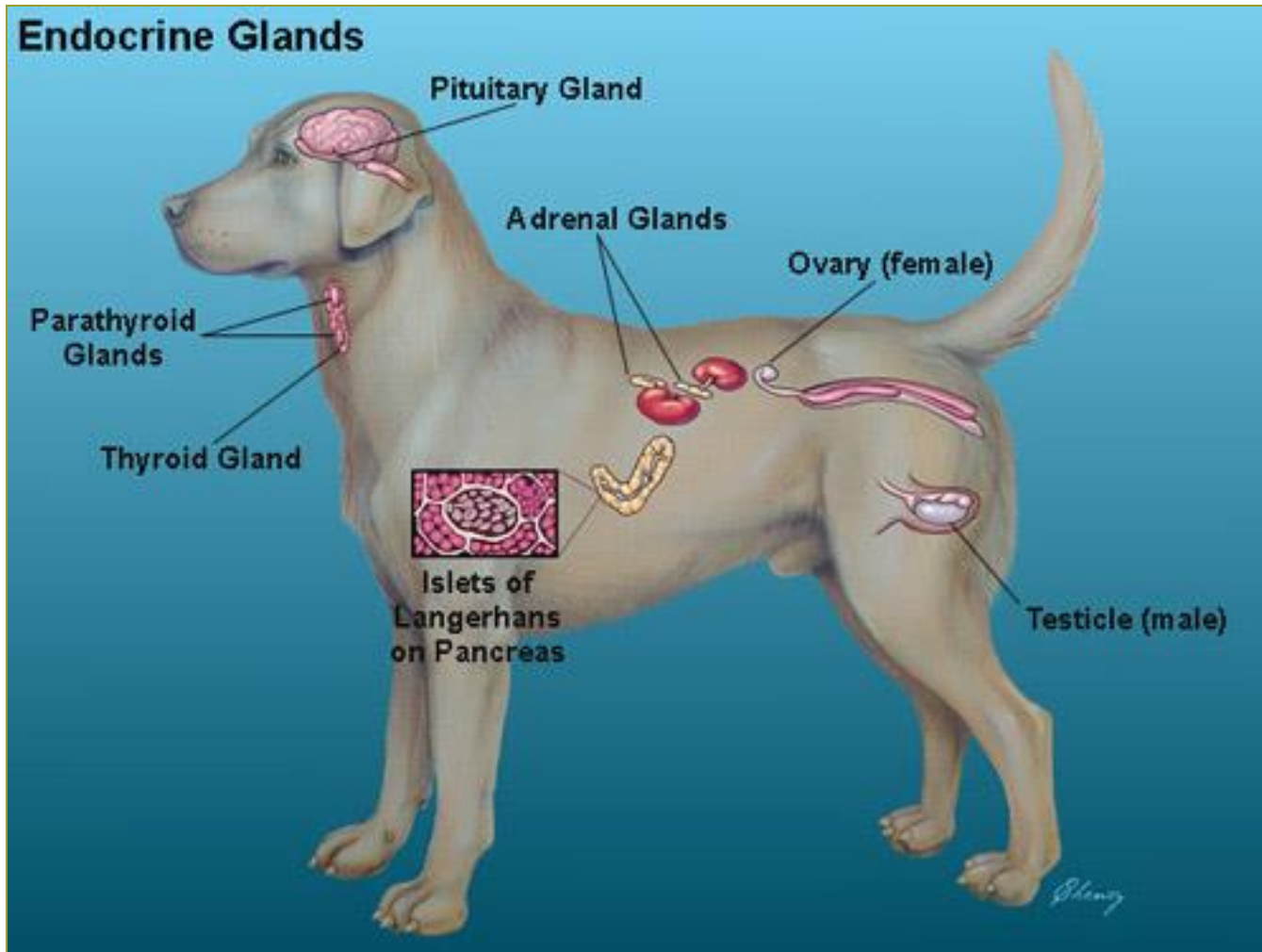
- Anterior pituitary
- Posterior pituitary
- Thyroid
- Parathyroid
- Adrenal cortex
- Adrenal medulla
- Pancreas (islets)
- Testis
- Ovary

# Feline Endocrine System

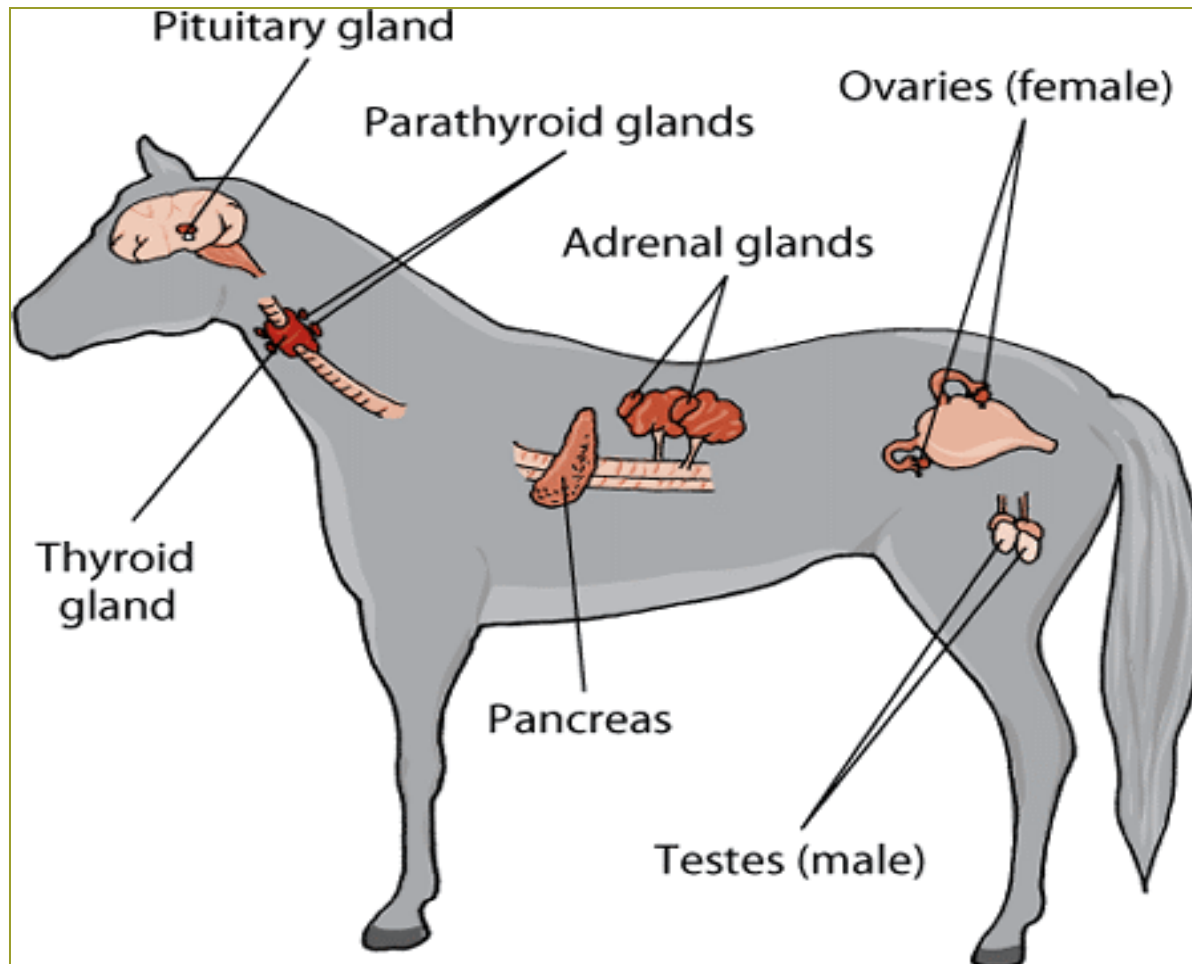
Figure 15-1, Page 359



# Canine Endocrine System



# Equine Endocrine System





# Overview

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- Endocrinology
- Homeostasis – balance
  - Narrow range of “normal”
  - “Health” within normal
  - “Disease” outside of the normal
- Negative Feedback Systems

# Hormones

(Table 15-2, Page 360)  
\*\*\*\*\* Good to Know! 😊

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- Chemical messengers produced by endocrine glands
- Travel via bloodstream
- Impact “target organs” (effectors)
  - Have receptors for hormone
- Controlled by negative feedback systems → homeostasis

# Control of Hormone Secretion

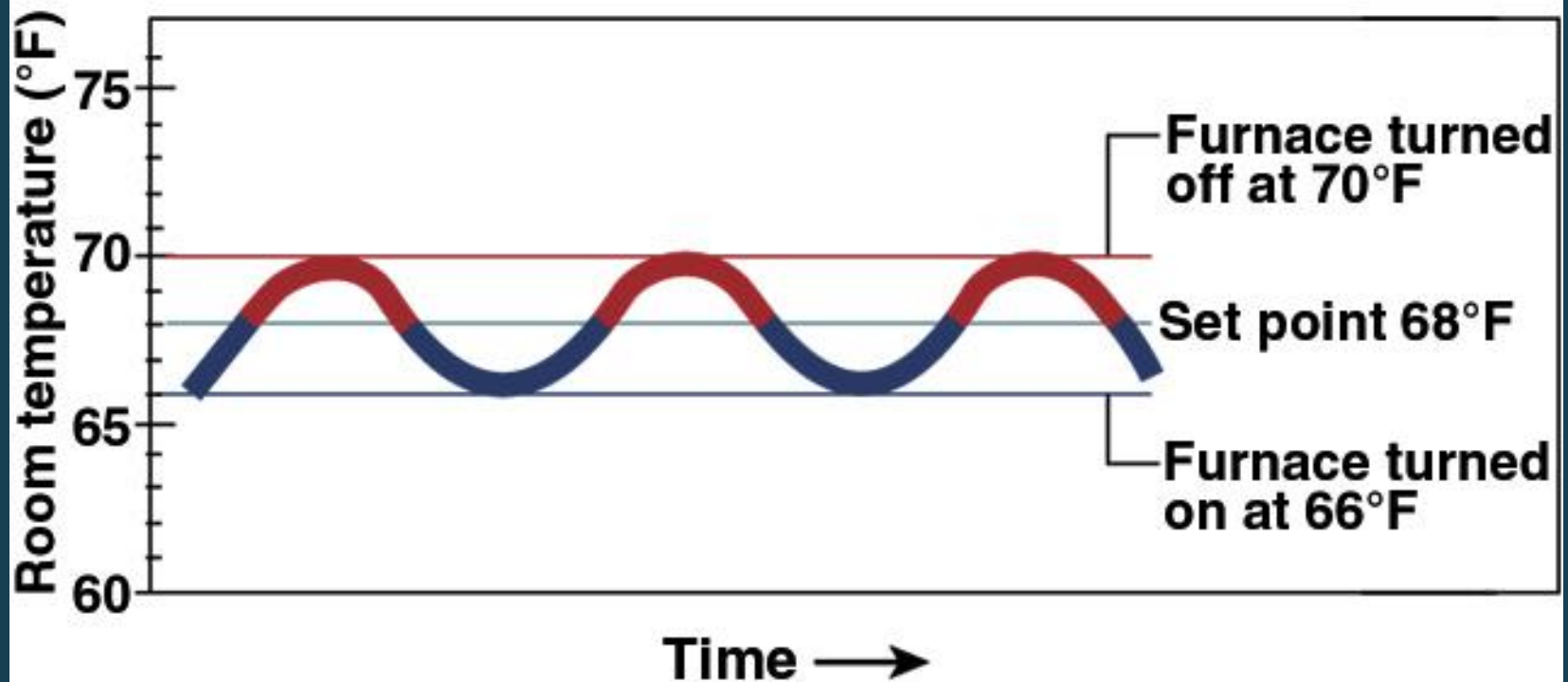
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## Negative Feedback Systems

- When the level of a specific hormone drops below needed levels, the appropriate endocrine gland is stimulated to produce more hormone.
- Once the proper hormone level is present in the bloodstream, stimulation of that endocrine gland is reduced and production of that hormone is reduced.

# A Negative Feedback System

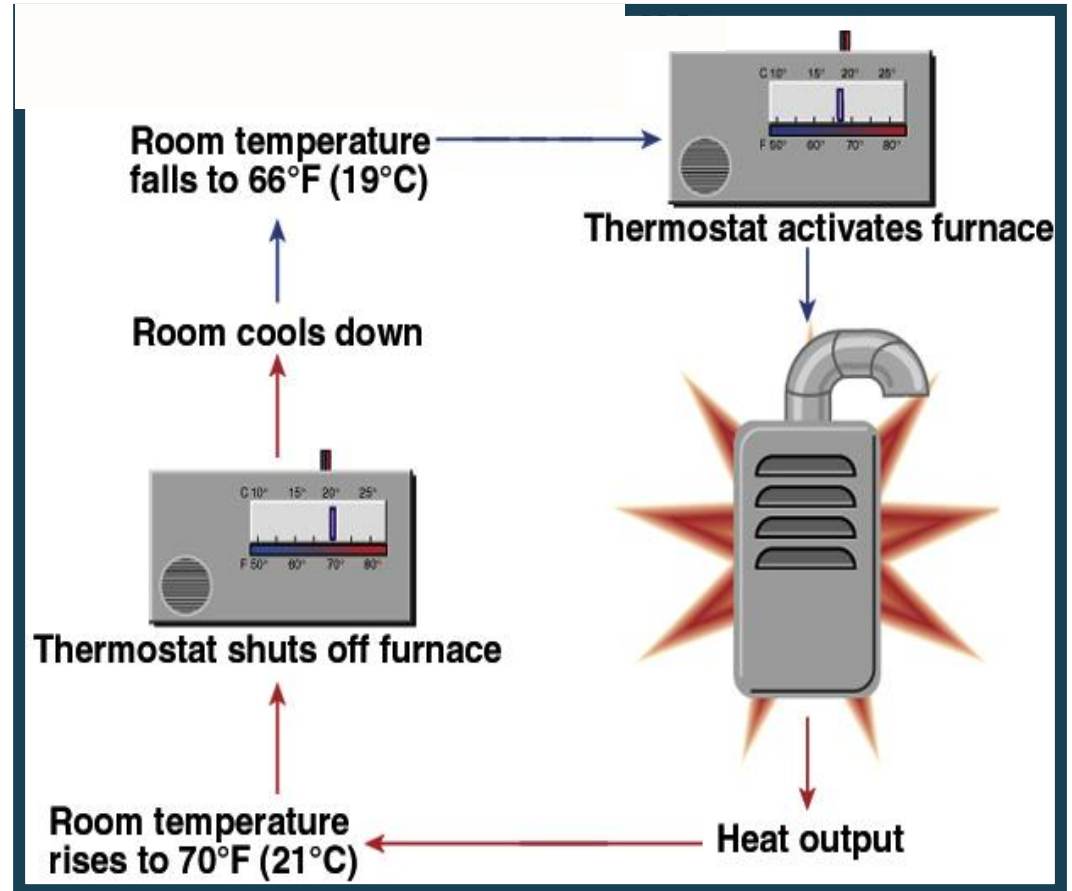
- Thermostat/Air Conditioner/Furnace
  - Receptor/Control Center/Effector



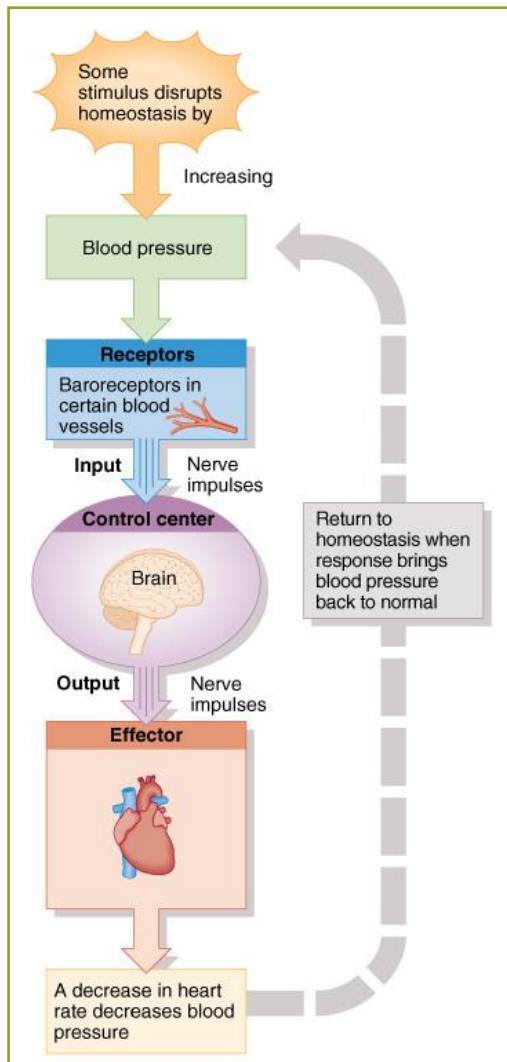


# Homeostasis Examples

- Body
- Heart rate
- Blood pH
- Levels of hormones
- Blood pressure



# Homeostasis of Blood Pressure

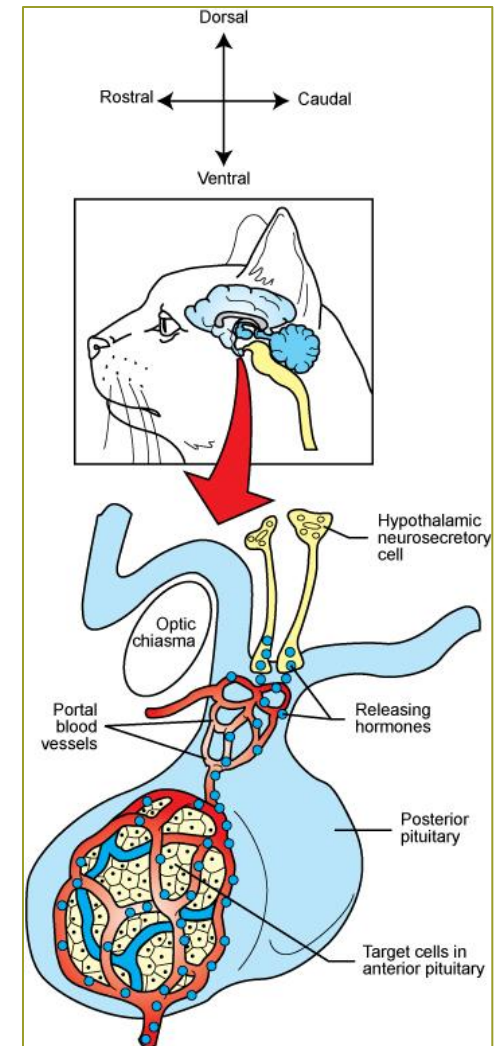


- Pressure **Receptors** in walls of certain arteries detect an increase in BP
  - Blood Pressure = force of blood on walls of vessels
- Brain (**Control Center**) receives input and signals heart and blood vessels
- **Effector** – Heart rate slows and arterioles dilate (increase in diameter)
- BP returns to normal

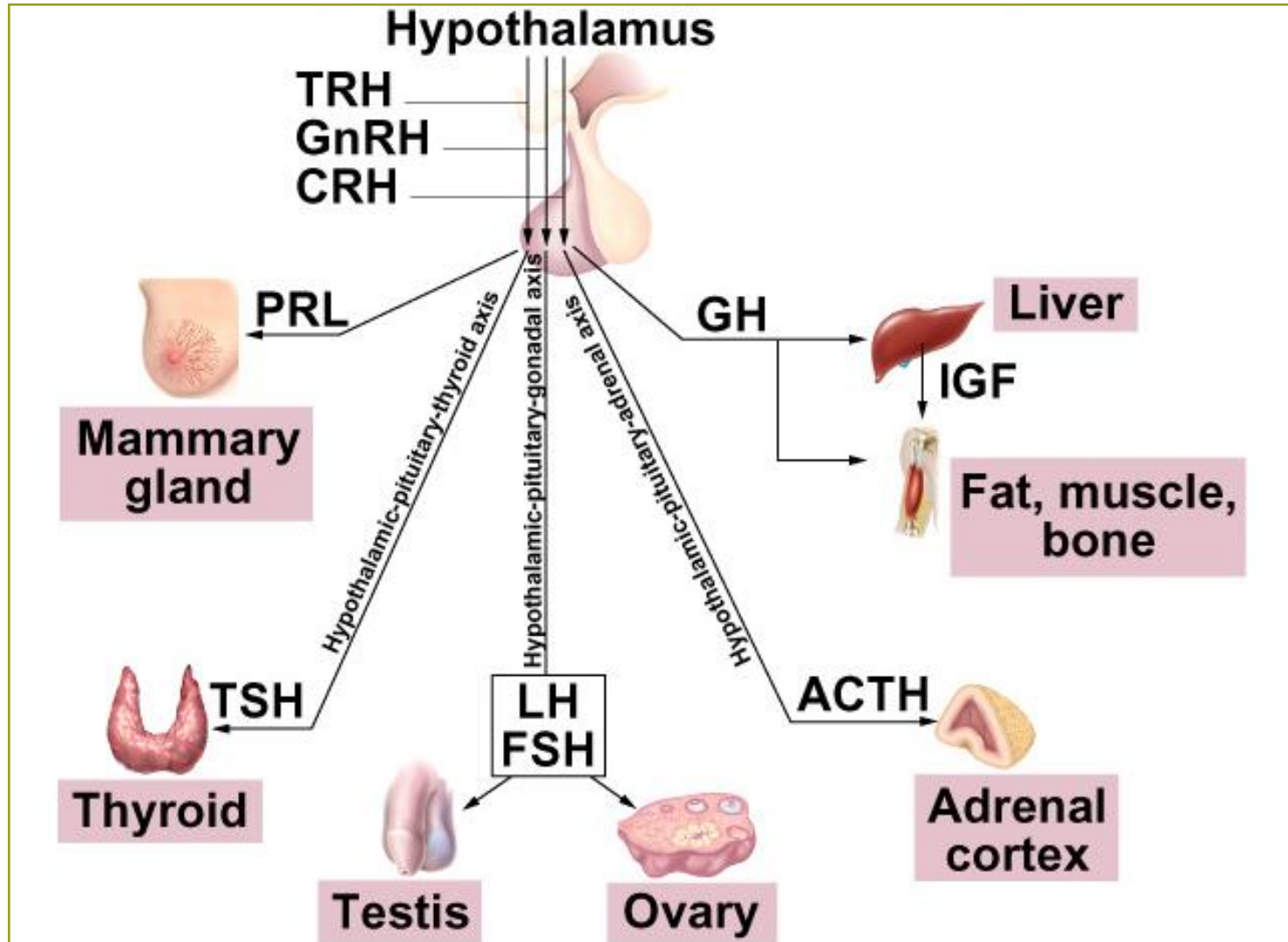
# Hypothalamus

## Figure 15-2, Page 361

- Part of diencephalon section of brain
- Controls activities of pituitary gland
- Portal system of blood vessels links hypothalamus with **anterior** lobe of pituitary gland



# Nervous/Endocrine System Connection

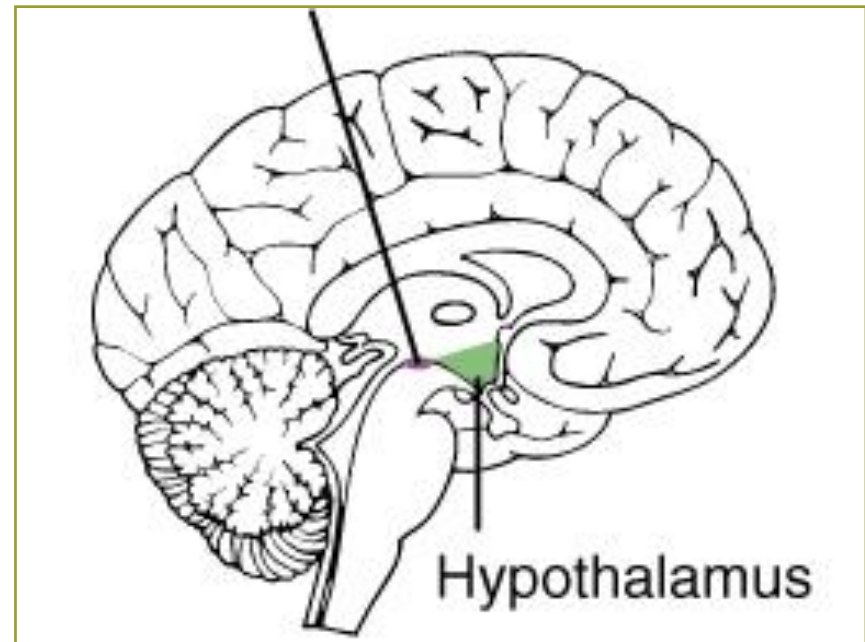


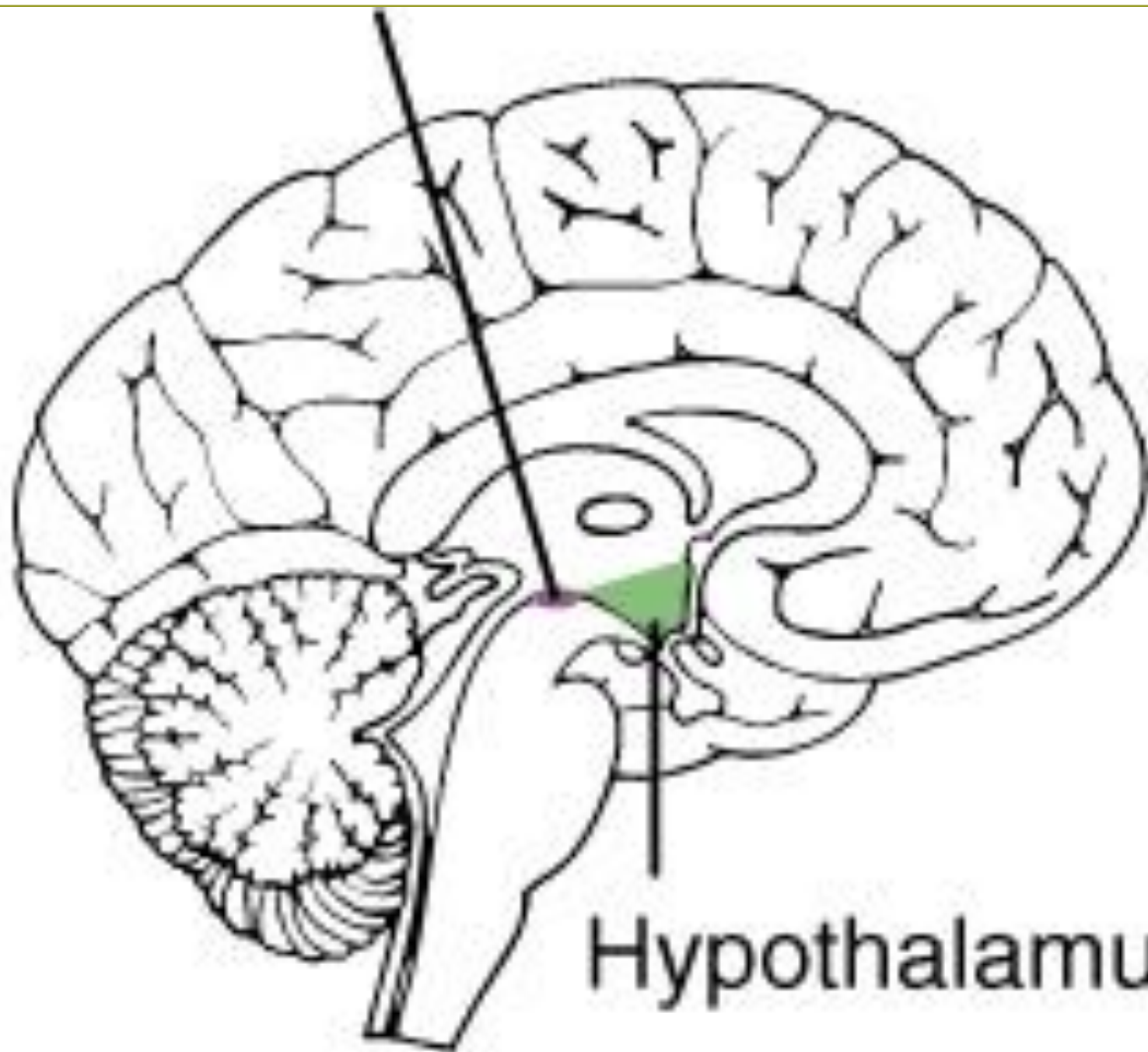


# Hypothalamus

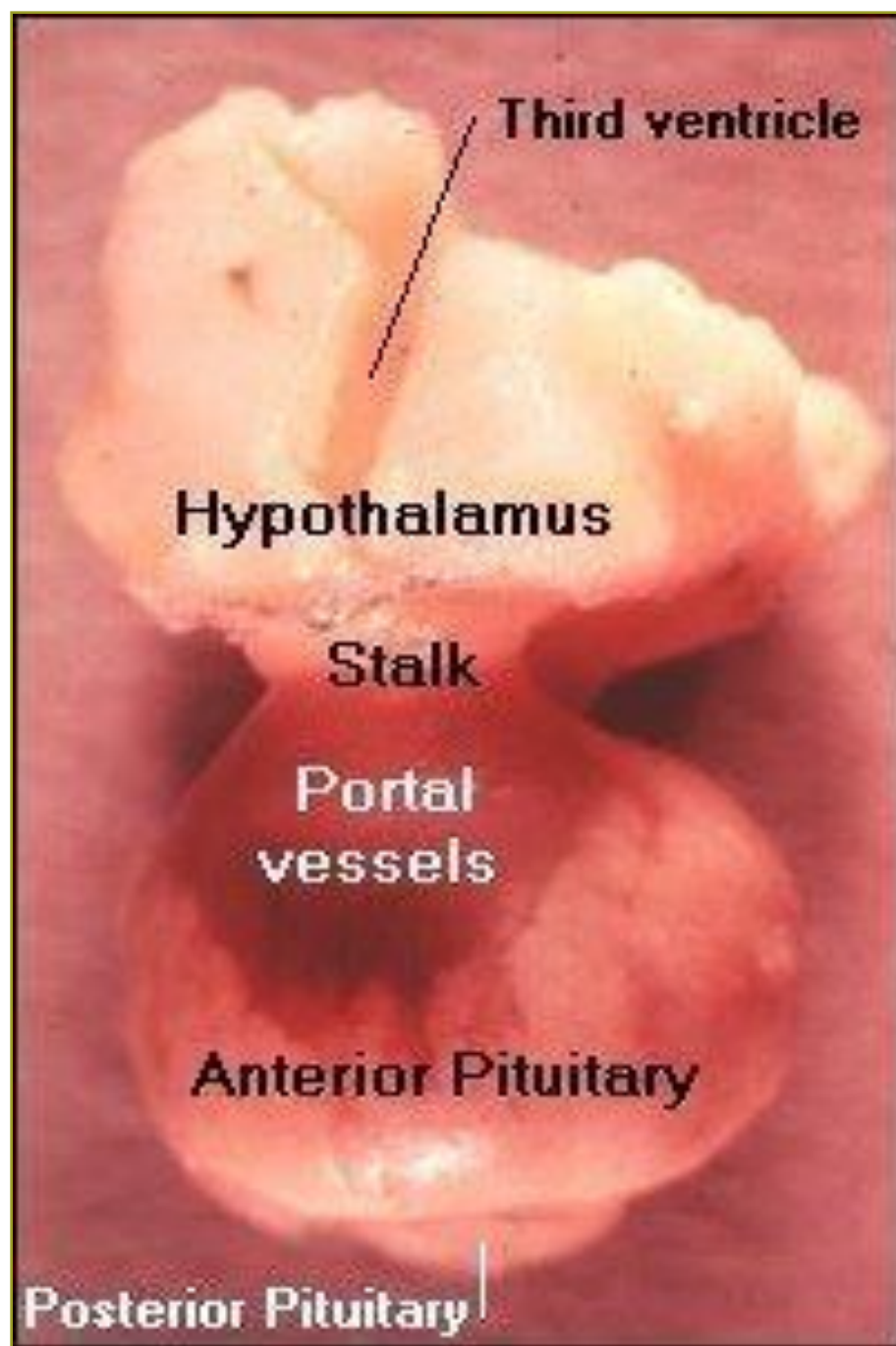
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- Part of brain
- Links conscious mind with rest of body
- Links cerebrum with endocrine system by [regulating pituitary gland](#)
- **SECRET OF LIFE!!!!**





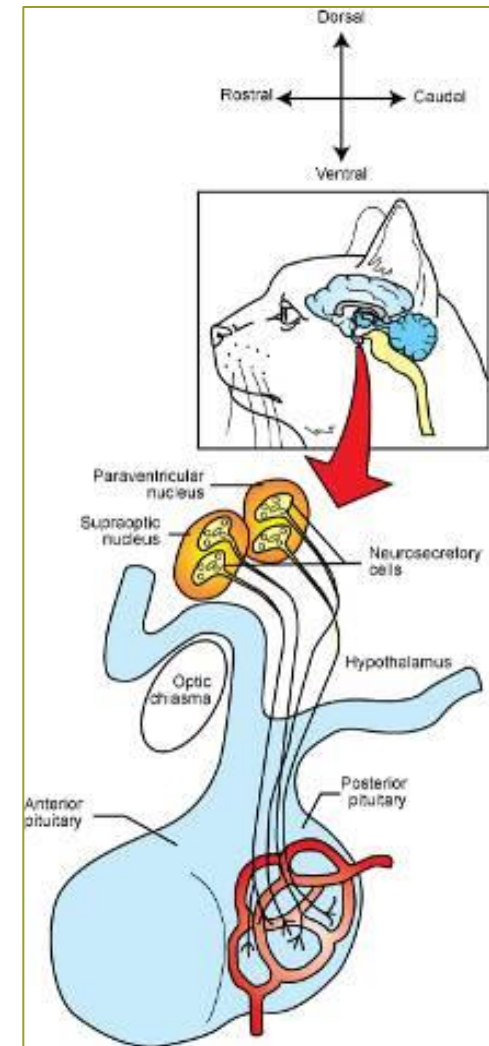
Hypothalamus



# Hypothalamus → Pituitary Gland

Figure 15-3, Page 362

- Modified neurons in hypothalamus also secrete antidiuretic hormone (ADH) and oxytocin
  - Transported to posterior pituitary for storage
- Released into the bloodstream by nerve impulses from the hypothalamus





# Pituitary Gland (Hypophysis)

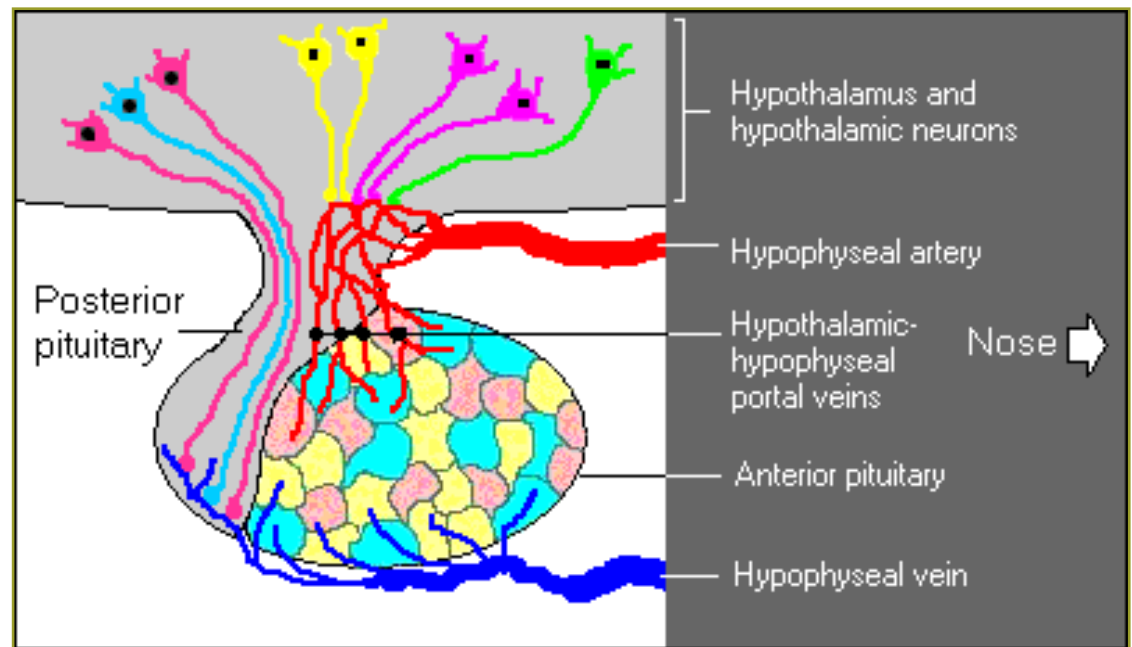
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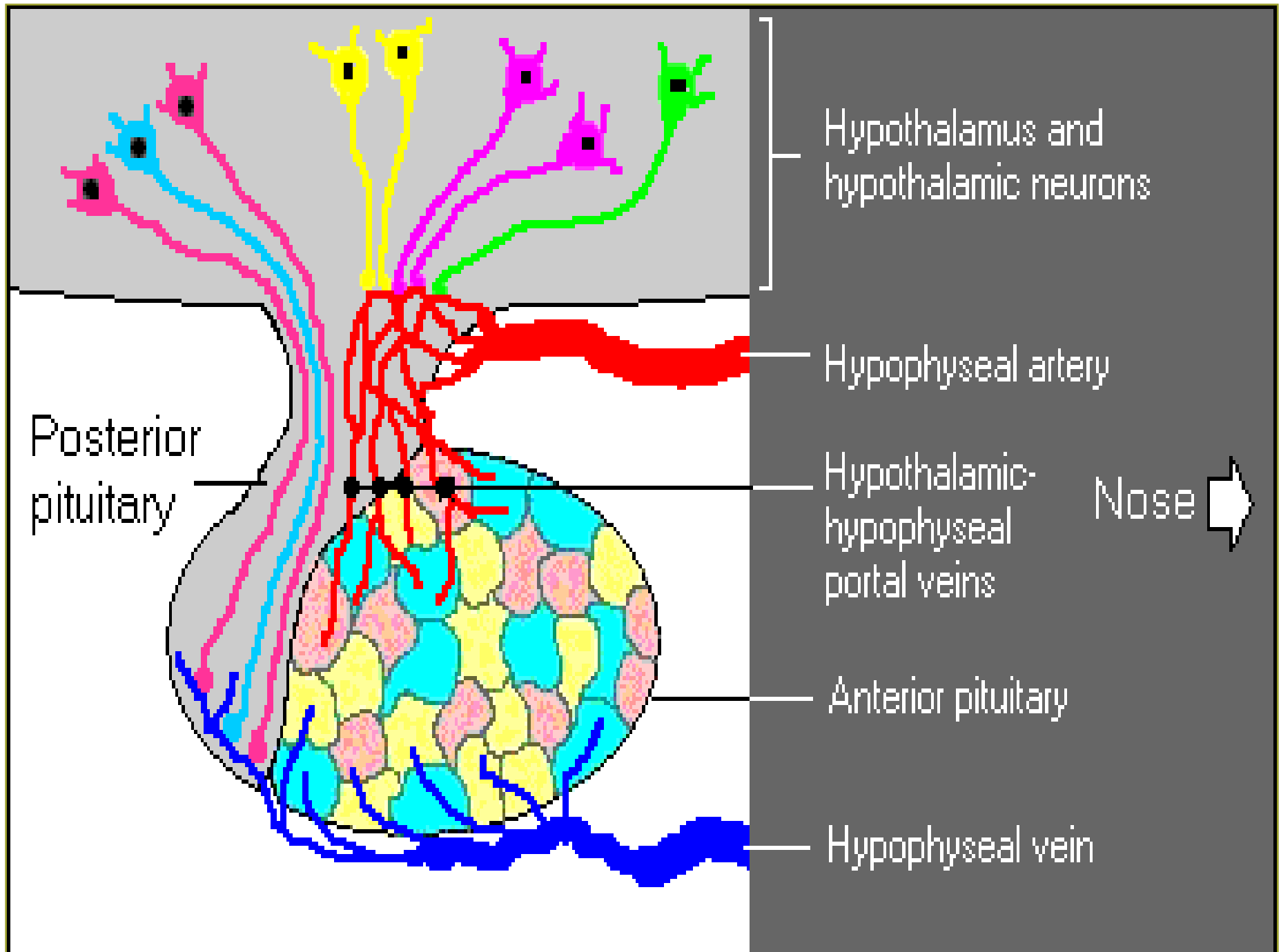
- Two separate glands with different structures, functions, and embryological origins
- Anterior pituitary – adenohypophysis; rostral portion
  - Stimulated by hypothalamus and direct feedback from target organs and tissues to produce its hormones
- Posterior pituitary – neurohypophysis; caudal portion
  - Stores and releases hormones produced in hypothalamus – ADH, oxytocin

# Pituitary Gland (Hypophysis)

Figures 15-2 & 15-3, Pages 361 & 362

- Master endocrine gland
  - Regulated by hypothalamus
- Impacts other endocrine glands
- Anterior lobe
  - Stimulating
  - “Trophic hormones”
  - “Tropins”
- Posterior lobe

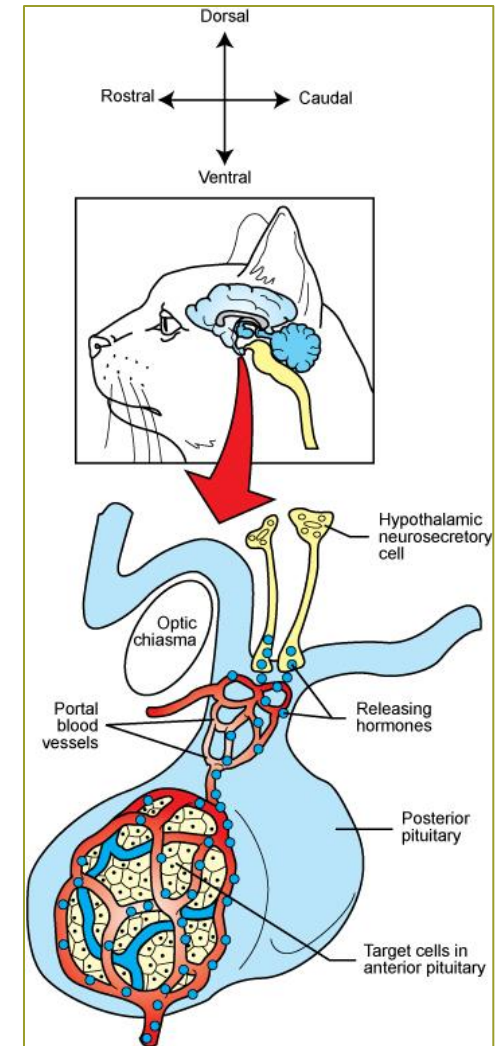




# Anterior Pituitary (Adenohypophysis)

Figure 15-2, Page 361, Table 15-2, Page 360

- Follicle stimulating hormone (FSH)
- Luteinizing hormone (LH)
- Thyroid stimulating hormone (TSH)
- Adrenocorticotrophic hormone (ACTH)
- Growth Hormone (Somatotropin) (GH)
- Prolactin (PRL)
- Melanocyte stimulating hormone





# Hypothalamus

TRH  
GnRH  
CRH

PRL

GH

Liver

IGF

Fat, muscle, bone

ACTH

Adrenal cortex

LH  
FSH

Testis

Ovary

TSH

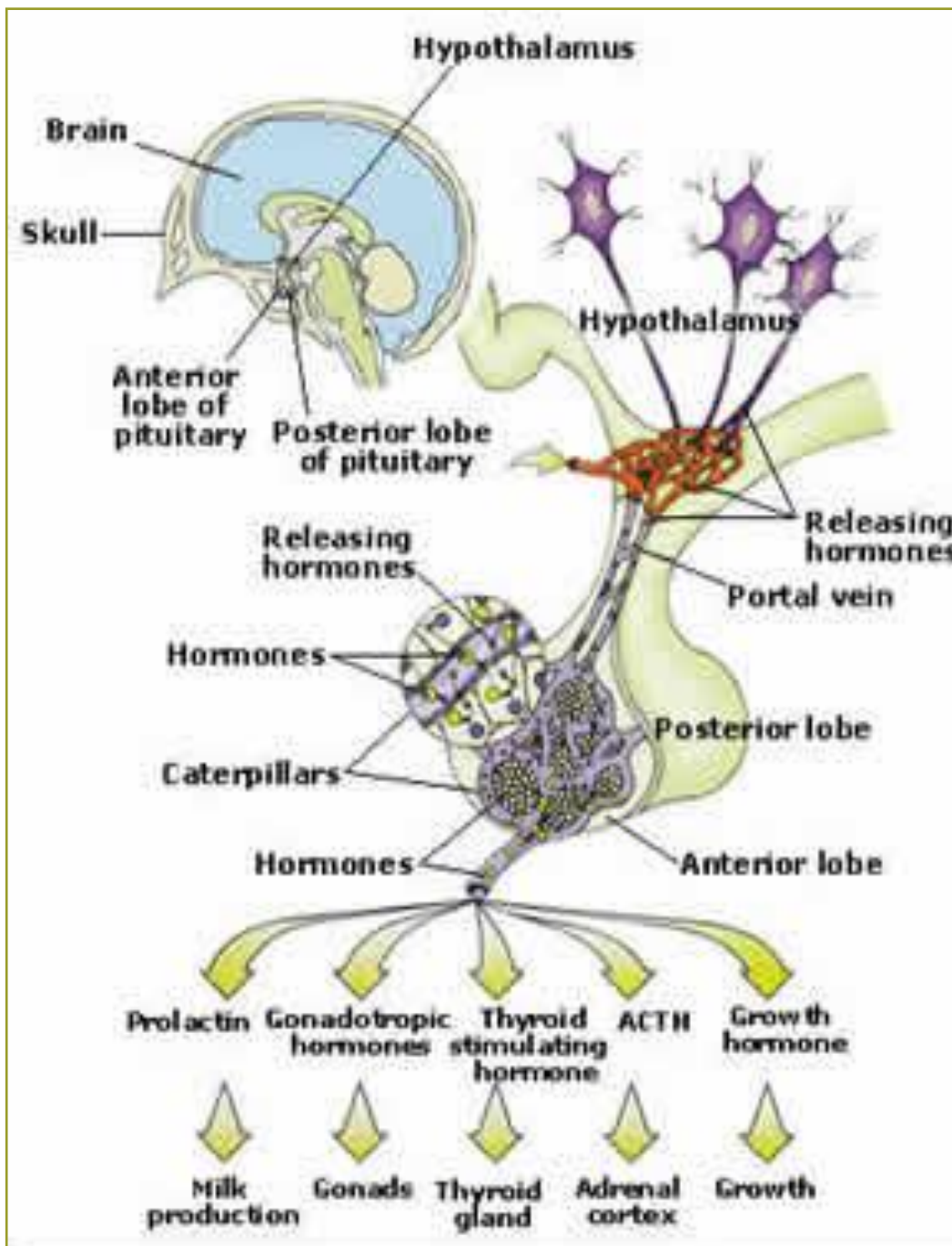
Thyroid

Mammary gland

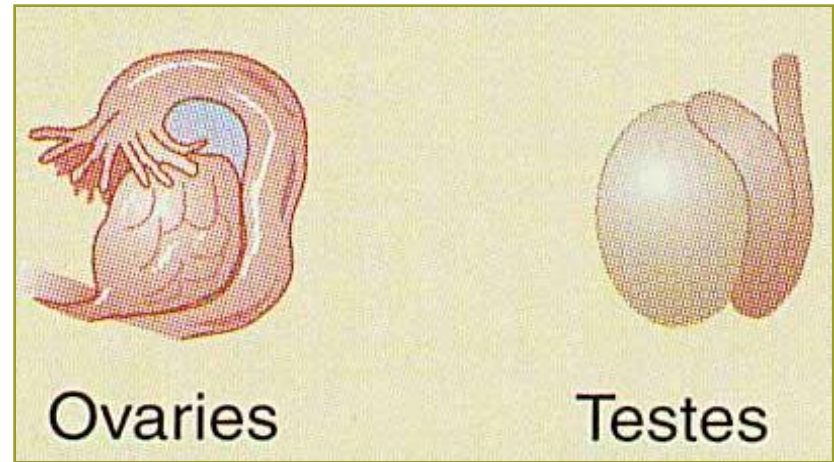
Hypothalamic-pituitary-thyroid axis

Hypothalamic-pituitary-gonadal axis

Hypothalamic-pituitary-adrenal axis



# Anterior Lobe Hormones



- FSH

- Ovaries, stimulates development of eggs and follicles → oogenesis
- Testes, stimulates production of sperm → spermatogenesis

- LH

- Female → stimulates ovulation and corpus luteum to secrete progesterone
- Male → stimulates production of testosterone

# Prolactin

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- Female → trigger & maintain lactation
  - Continues as long as teat or nipple is stimulated by nursing or milking (cows)
  - When prolactin stimulation stops, milk production stops, and the mammary gland shrinks back to its non-lactating size
- Male → no known effect

# TSH (Thyroid-Stimulating Hormone)

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- Also known as thyrotrophic hormone
- Stimulates growth of thyroid gland and secretion of thyroid hormone
- Secretion is regulated by feedback from the thyroid gland



# ACTH (Adrenocorticotrophic Hormone)

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- Regulates response to **STRESS!!!**
- Stimulates **adrenal cortex**
- Regulated by feedback from hormones of adrenal cortex
- ACTH can also be released quickly as a result of stimulation of hypothalamus by other parts of brain
  - **Thoughts are things!** 😊

# Growth Hormone (GH)

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- Also known as somatotropin and somatotrophic hormone
- Promotes body growth in young animals
- Helps regulate metabolism of proteins, carbohydrates, and lipids in animal's cells
  - Anabolism – proteins
  - Catabolism – fats, carbohydrates

# Melanocyte-Stimulating Hormone (MSH)

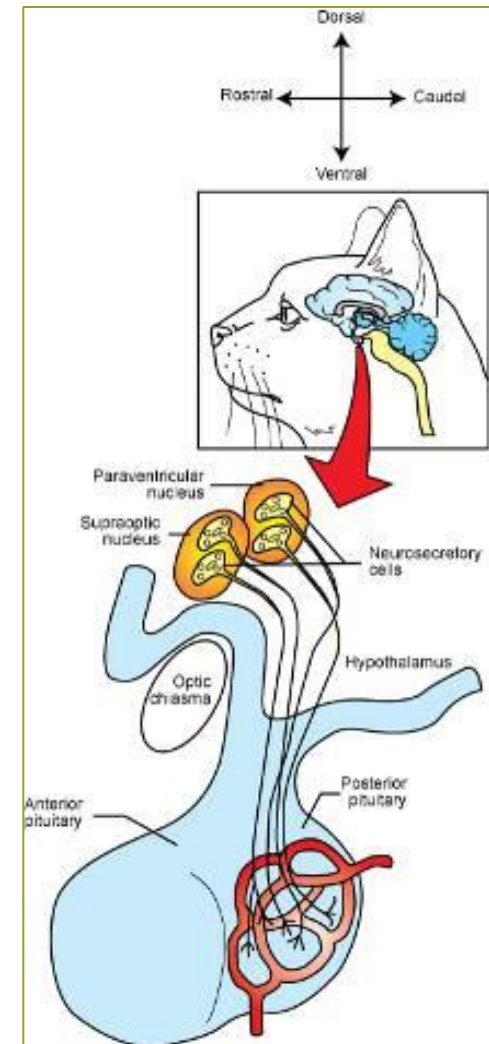
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- Associated with control of color changes in the pigment cells (melanocytes) of reptiles, fish, and amphibians
- Administration of artificially large amounts of MSH to higher mammals can cause darkening of the skin from melanocyte stimulation

# Posterior Pituitary (Neurohypophysis)

Figure 15-3, Page 362, Table 15-2, Page 360

- Antidiuretic hormone (ADH)
- Oxytocin

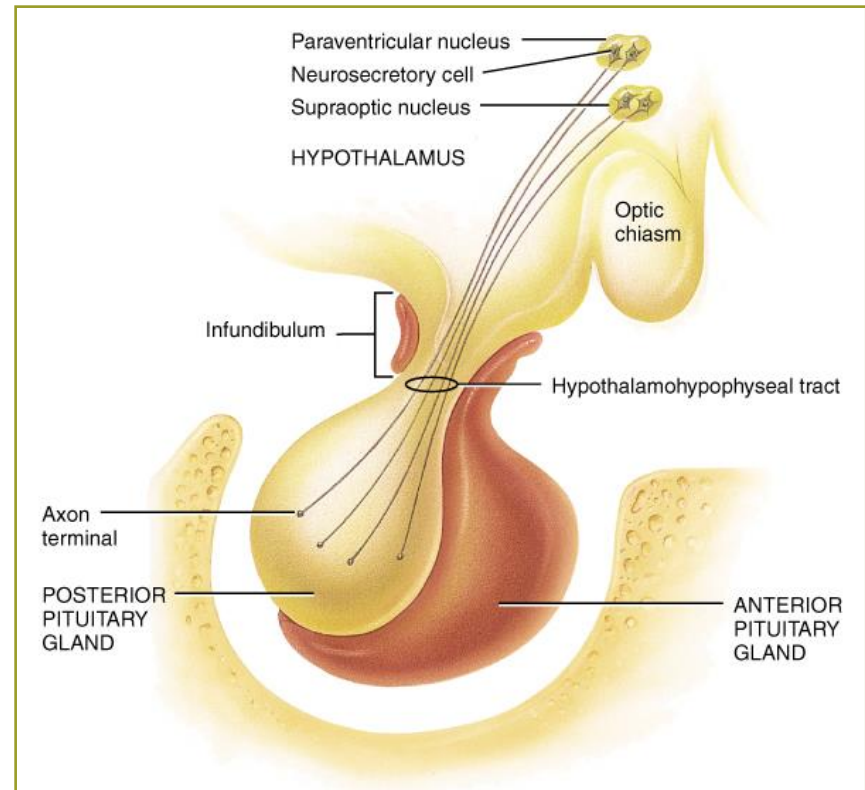
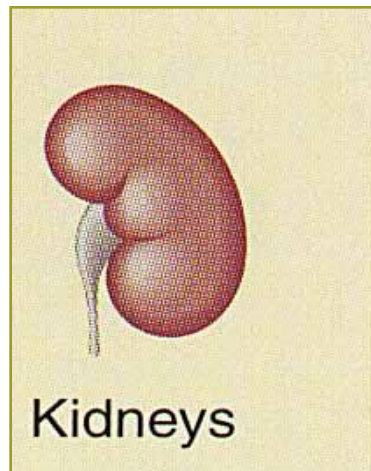
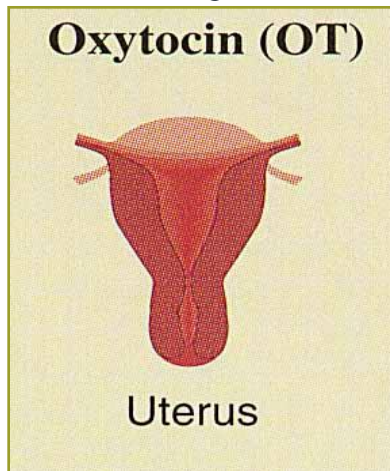


# Posterior Pituitary (Neurohypophysis)

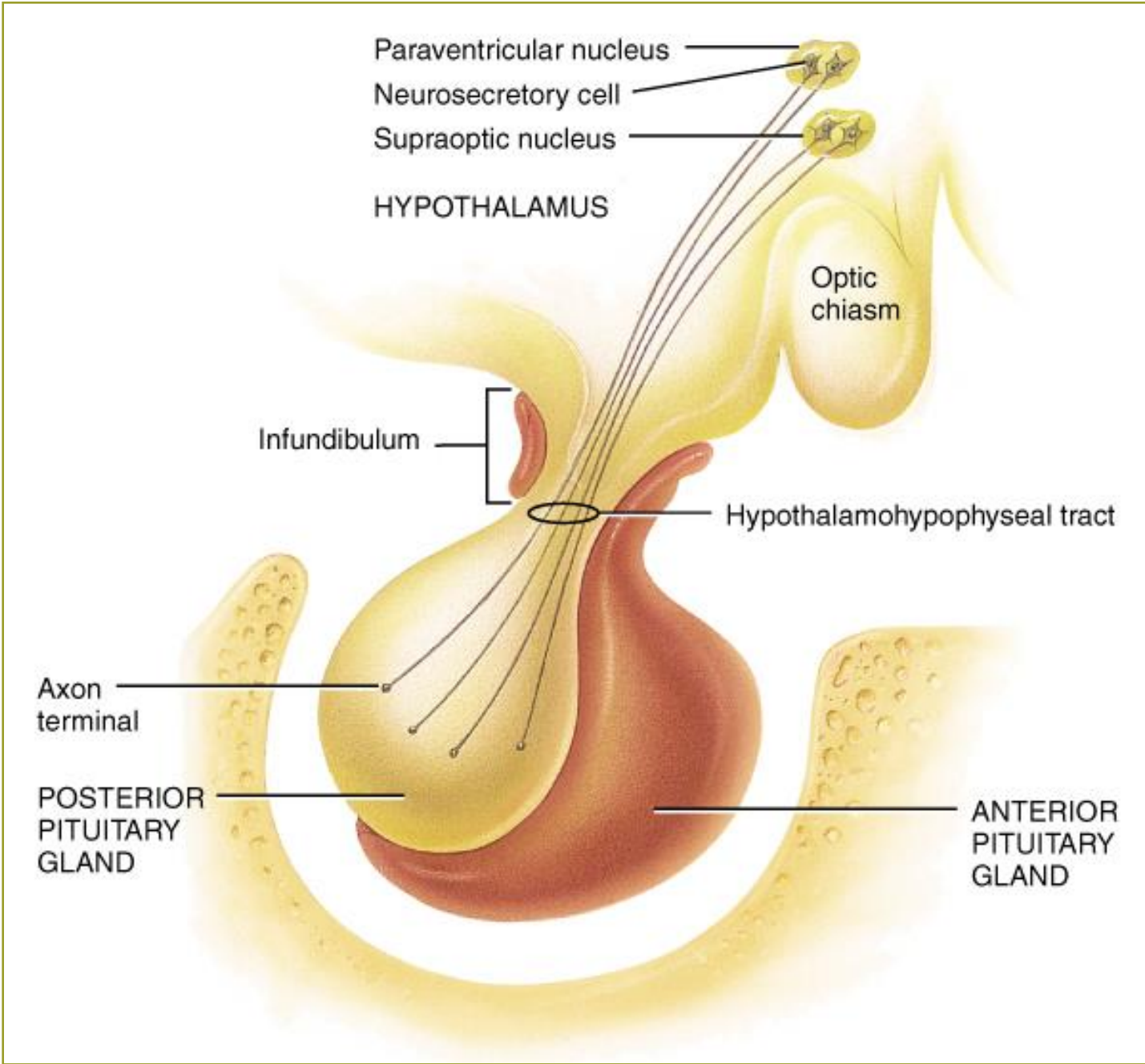
Figure 15-3, Page 362

- 2 hormones produced in hypothalamus, transported down nerve fibers, and are stored here

- Antidiuretic hormone (ADH)
- Oxytocin







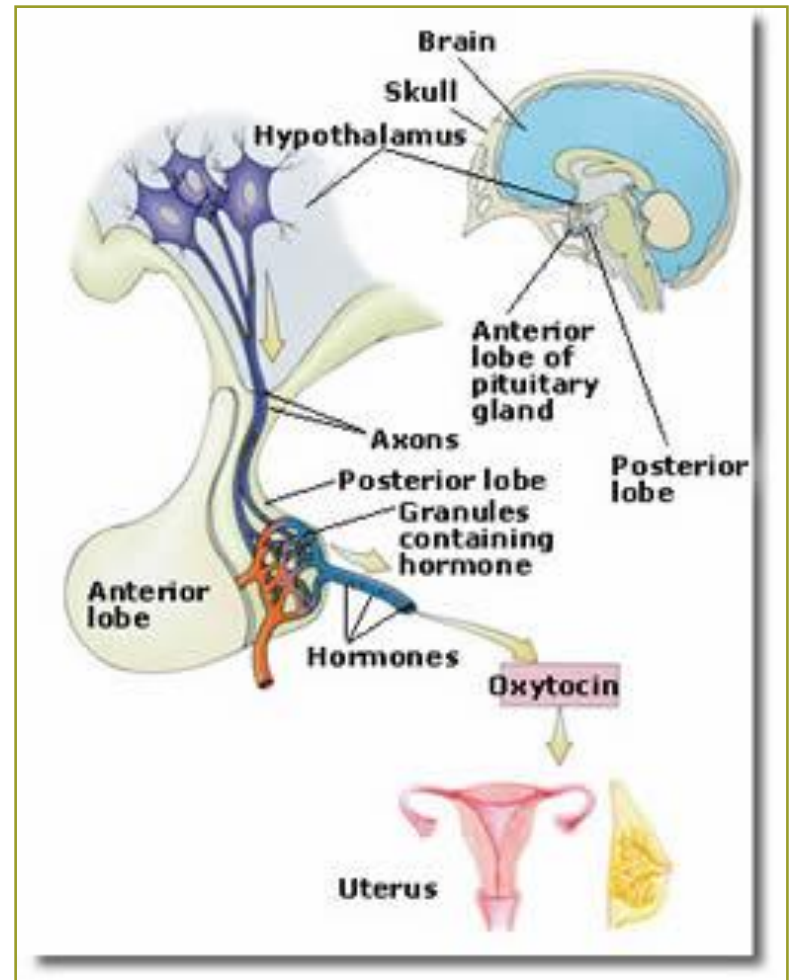
# ADH (Antidiuretic Hormone)

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- Helps prevent diuresis
- Receptors in hypothalamus detect changes in dehydration/hemoconcentration
- ADH travels to the kidney – causes kidneys to reabsorb more water (**WHERE?**) from the urine and return it to the bloodstream
- ADH deficiency causes [diabetes insipidus](#)

# Oxytocin

- Uterine contractions
- Milk letdown



# Oxytocin

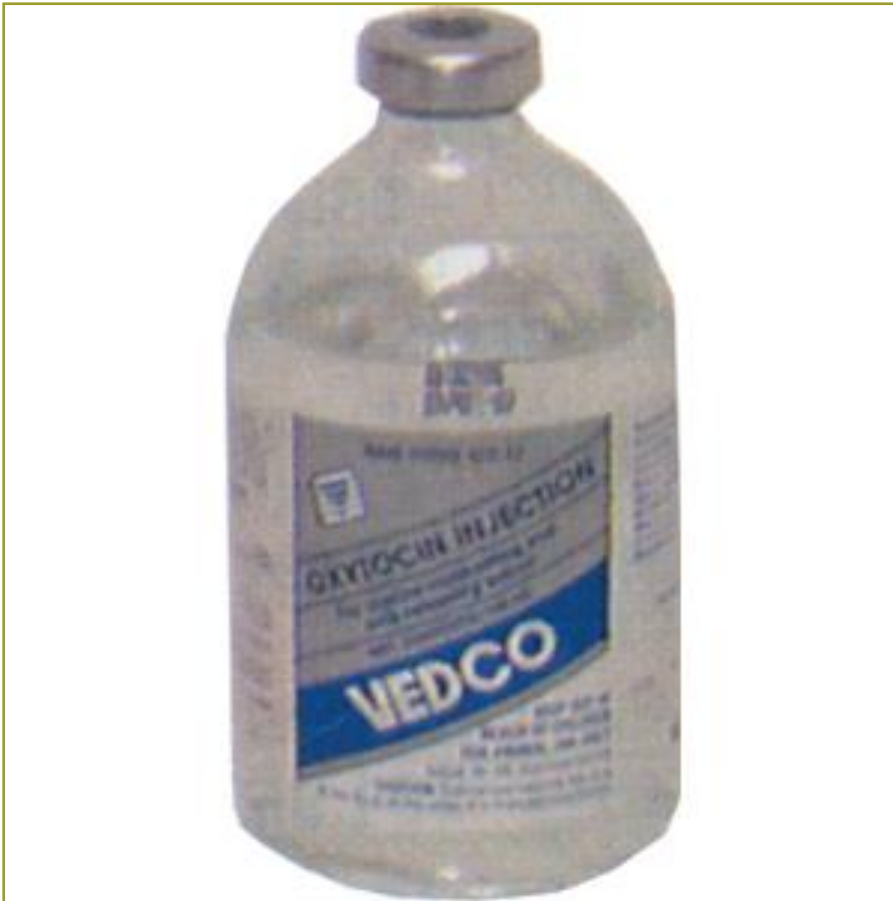
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- Effects on uterus – causes contraction of the myometrium at the time of breeding and at parturition
  - Aid transport of spermatozoa to oviducts
  - Aid in delivery of the fetus and placenta
- Effect on active mammary glands – (milk letdown)
  - Stimulation of teat or nipple by nursing or milking causes oxytocin to be released into bloodstream





# Oxytocin As a Drug



# Effects of Oxytocin

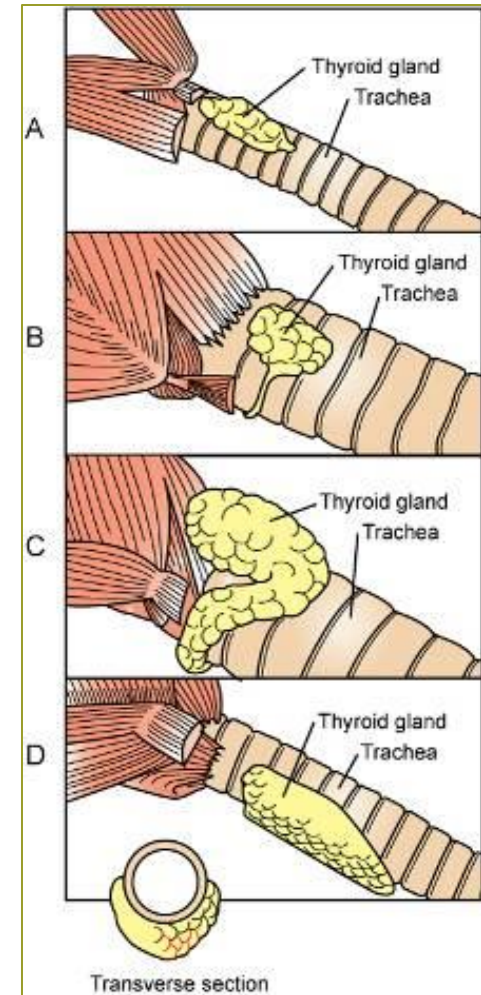
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# Thyroid Gland

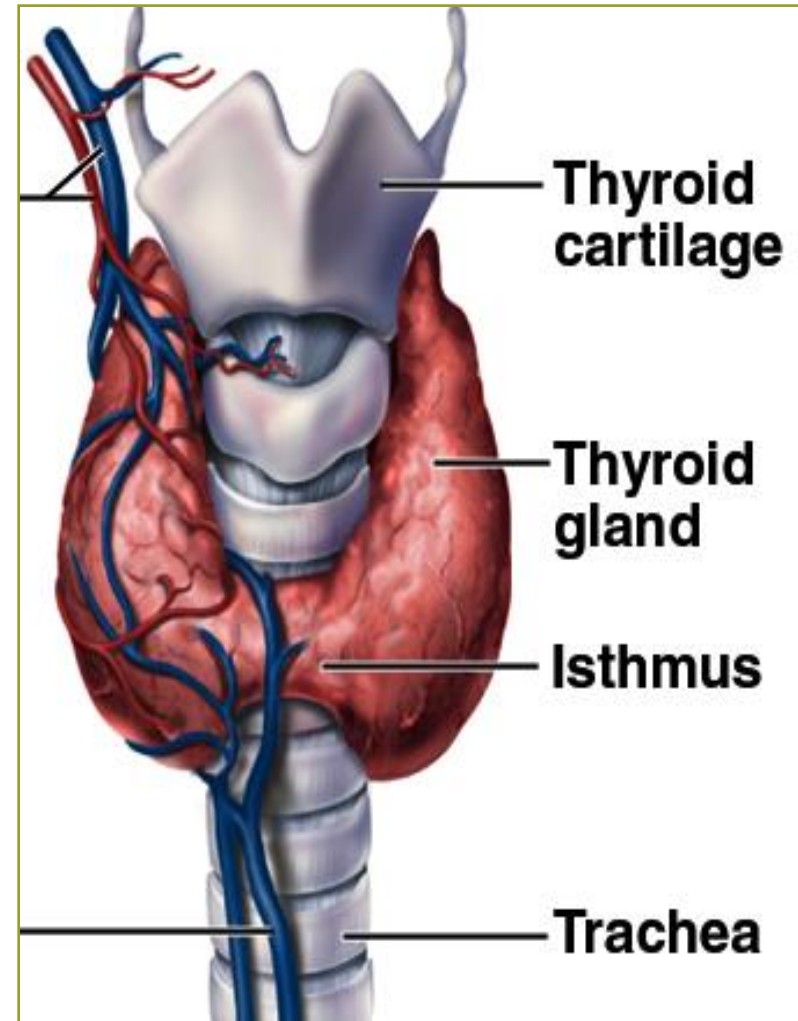
## Figure 15-4, Page 365

- Consists of two lobes on either side of larynx
  - Lobes may be connected by isthmus
- Comparative anatomy in figure at right
- Thyroid hormone is produced in follicles
  - Simple cuboidal glandular cells surrounding globule of thyroid hormone precursor

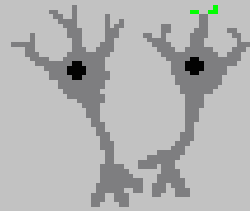


# Thyroid Gland

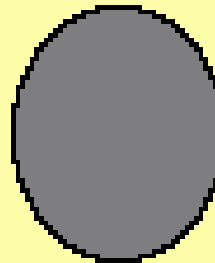
- In neck region
- Hormones
  - T<sub>3</sub> – triiodothyronine
  - T<sub>4</sub> – thyroxin
    - Metabolism homeostasis
    - Body's temperature setting
  - Calcitonin
    - Prevents hypercalcemia



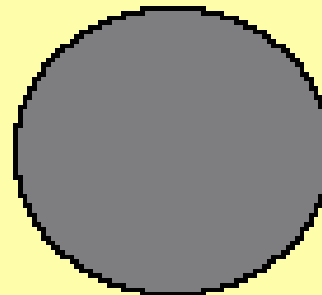
**Hypothalamus  
(TRH)**



**Anterior  
Pituitary  
(TSH)**



**Thyroid  
Gland  
(T3 and T4)**



# Hypothyroidism in Dogs

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- Relatively common in dogs
- Rare in cats
- Treatment – thyroxine ( $T_4$ )







# Clinical Signs of Hypothyroidism

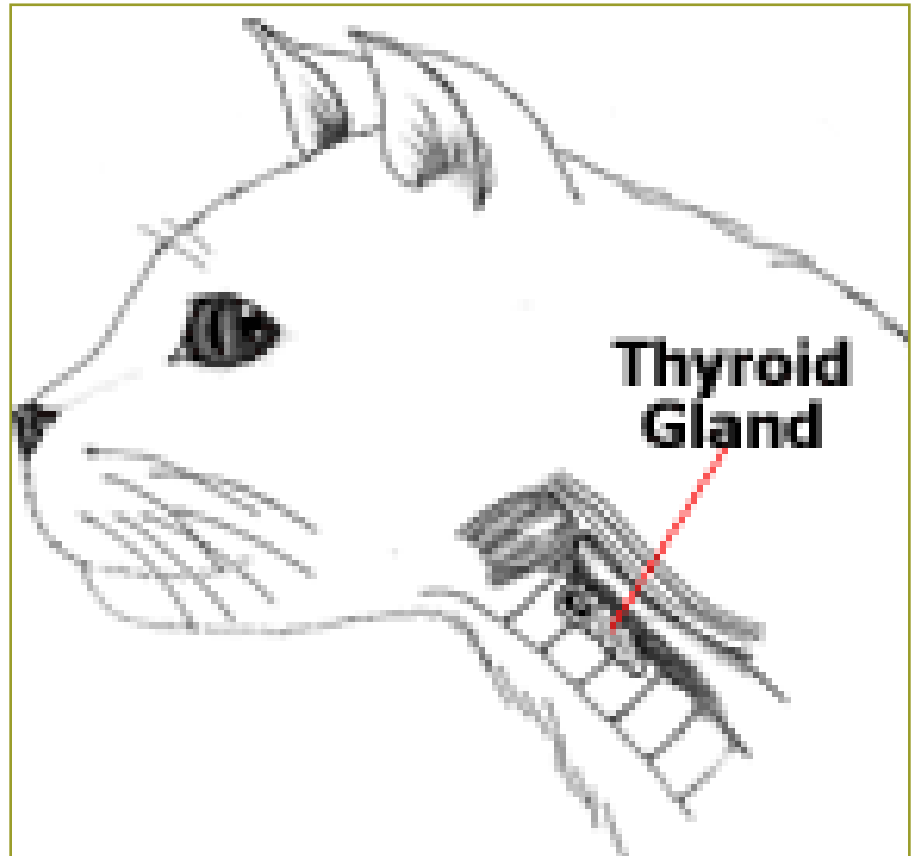
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- Lethargy (very little activity)
- Excessive sleeping
- Appears to be cold all the time
- Gaining weight, very little appetite, etc.
- Hair thinning on body
- Allergies
- Infertile???

# Hyperthyroidism in Cats

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- Most common endocrine disease of cats
- Rare in dogs
- Treatment
  - Radioactive iodine?
  - Surgery?



# Clinical Signs

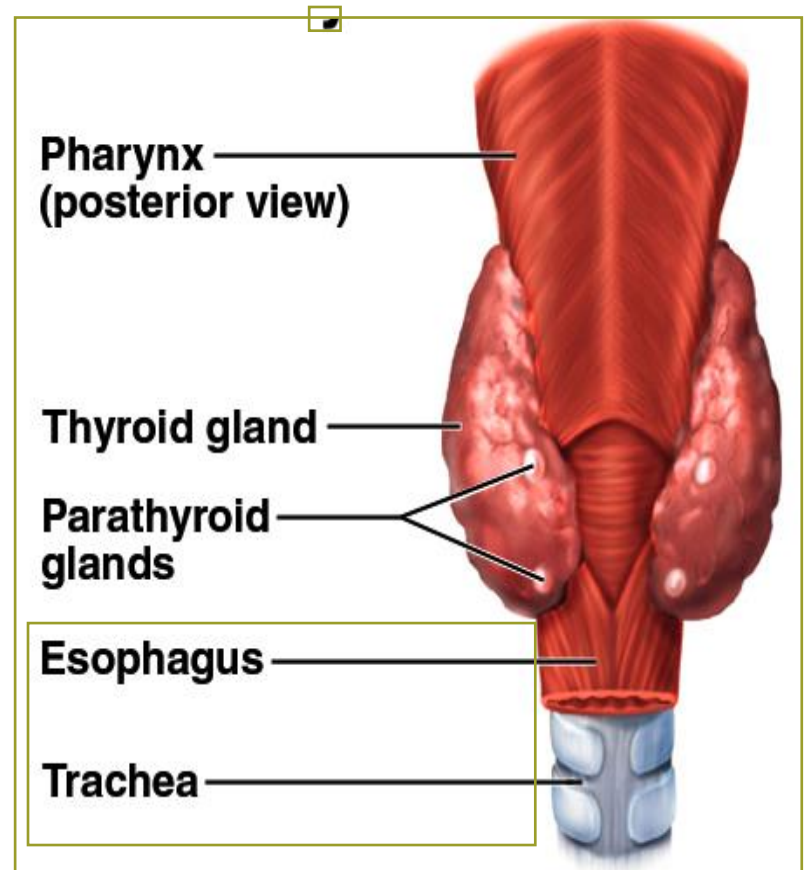
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- Weight loss
- Hyperactive
- Ravenous appetite
- Ages 7-12



# Parathyroid Glands

- 4 small glands posterior to thyroid gland
- Parathyroid hormone (parathormone)
  - Opposite effect of calcitonin
  - Prevents hypocalcemia



# Parathyroid Hormone (PTH)

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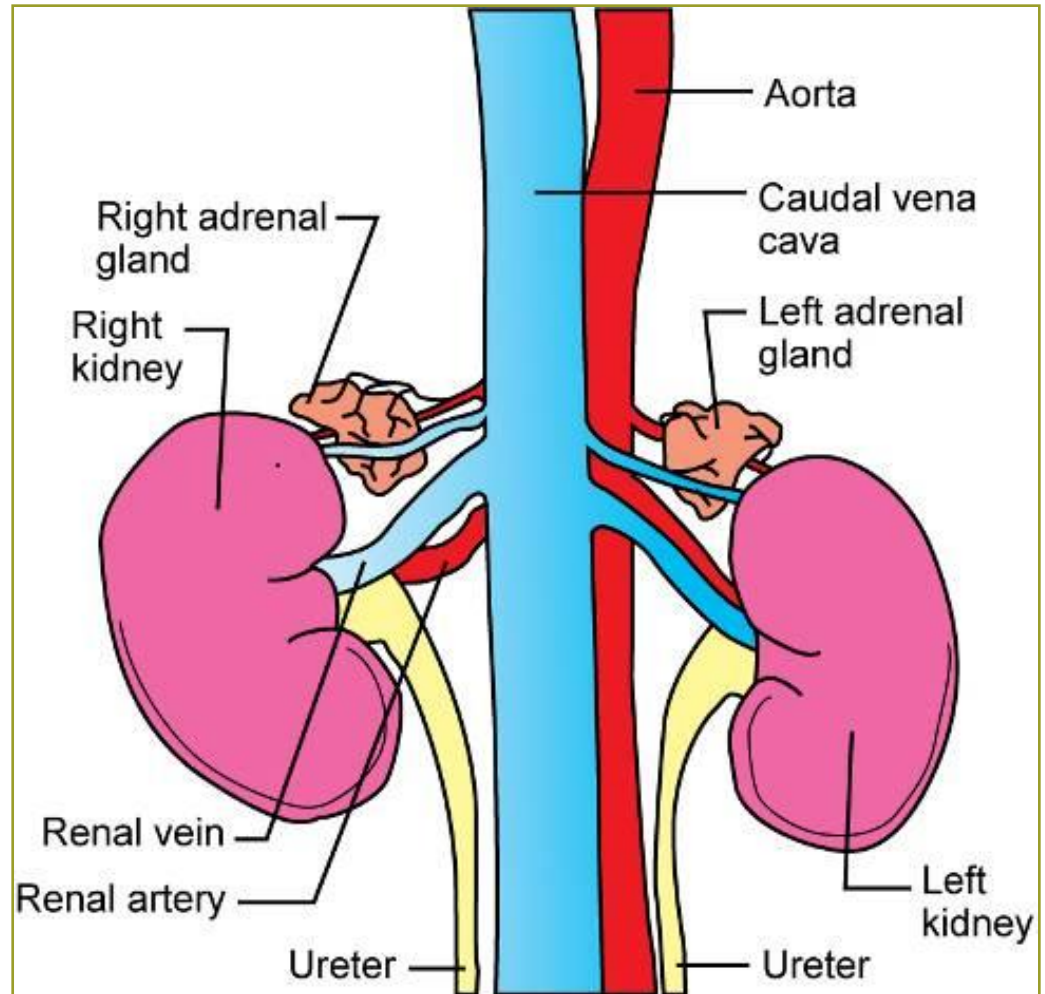
- Also called parathormone
- Produced by the parathyroid glands
  - Small, pale nodules in, on, or near the thyroid glands
- Helps maintain blood calcium levels
- Prevents hypocalcemia
  - Causes kidneys to retain calcium and intestine to absorb calcium from food; withdraws calcium from bones



# Adrenal Glands

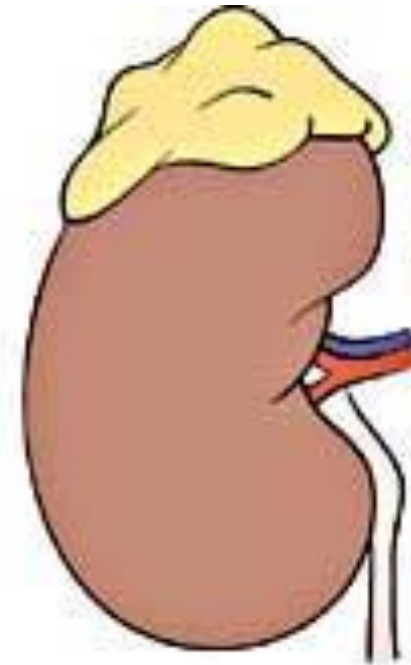
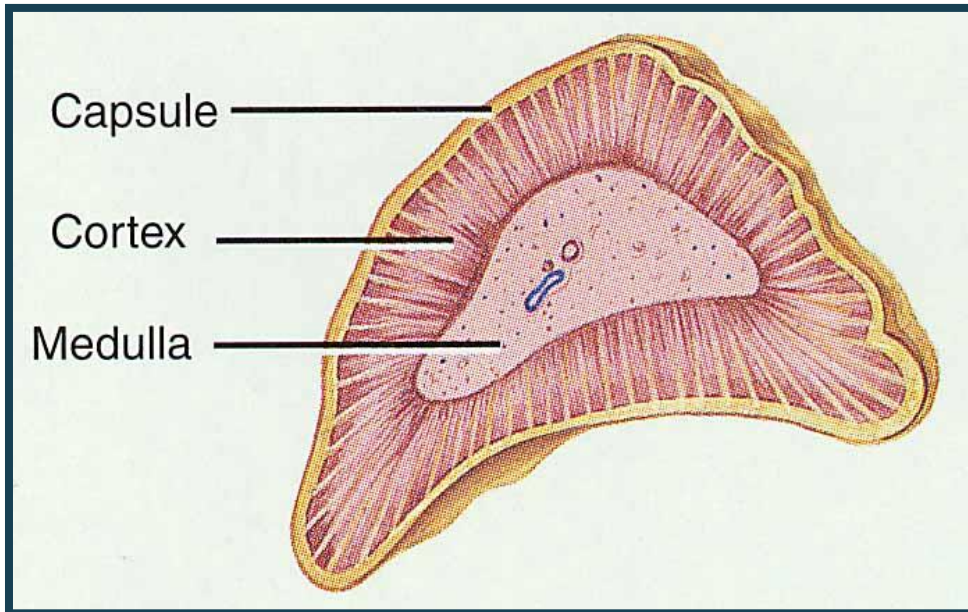
Figure 15-5, Page 367

- Located near the cranial ends of the kidneys
- Consist of two glands:
  - Adrenal cortex
  - Adrenal medulla



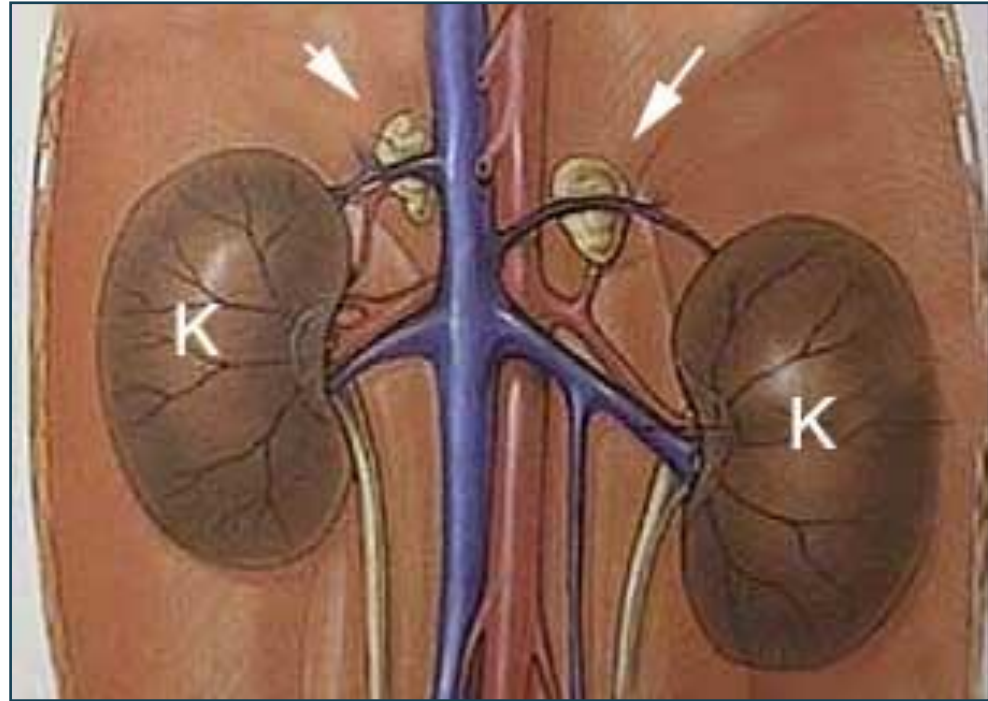
# Adrenal Glands

- Close to kidneys



The **adrenal glands** are triangular in shape and are located on top of the kidneys. They are responsible for making cortisol, adrenaline, sex hormones and hormones necessary for fluid and electrolyte balance.

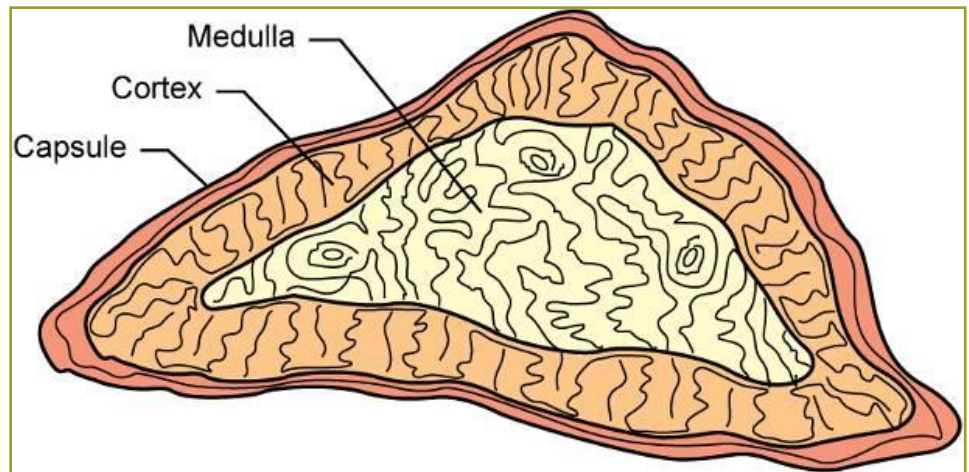
# Adrenal Gland Location



# Adrenal Cortex

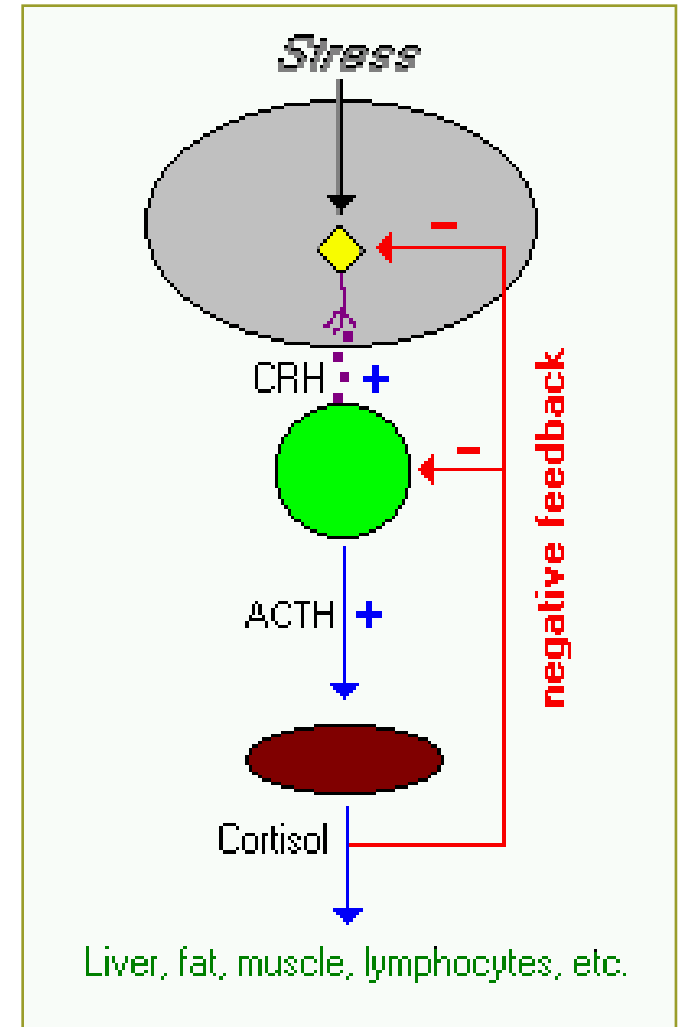
Figure 15-6, Page 367

- Produces numerous steroid hormones classified into three main groups:
  - Glucocorticoids
  - Mineralocorticoid
  - Sex hormones (very small amounts of both in both sexes)



# Glucocorticoids

- Cortisone, cortisol
- Gluconeogenesis
  - **Hyperglycemic effect**
- Helps maintain blood pressure
- Helps animal's body resist effects of stress

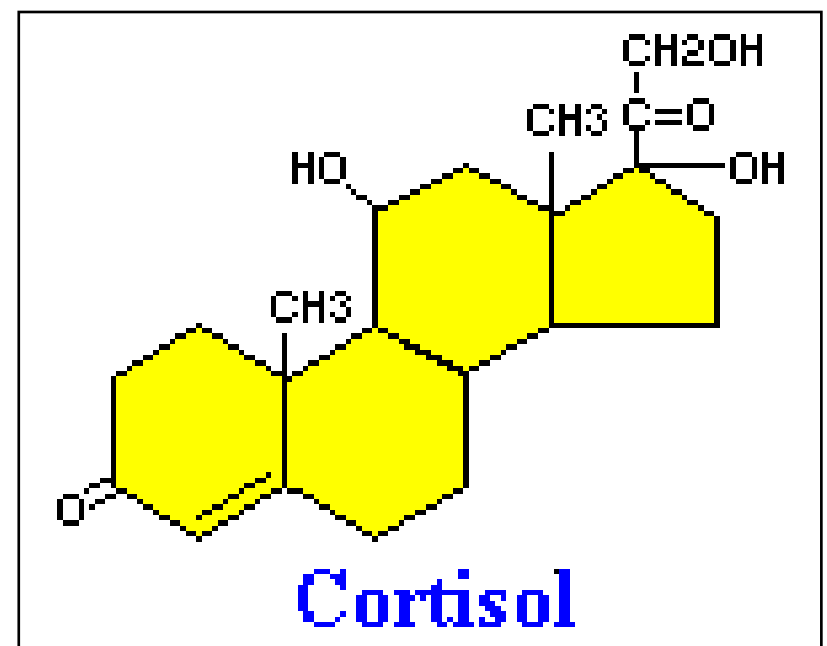
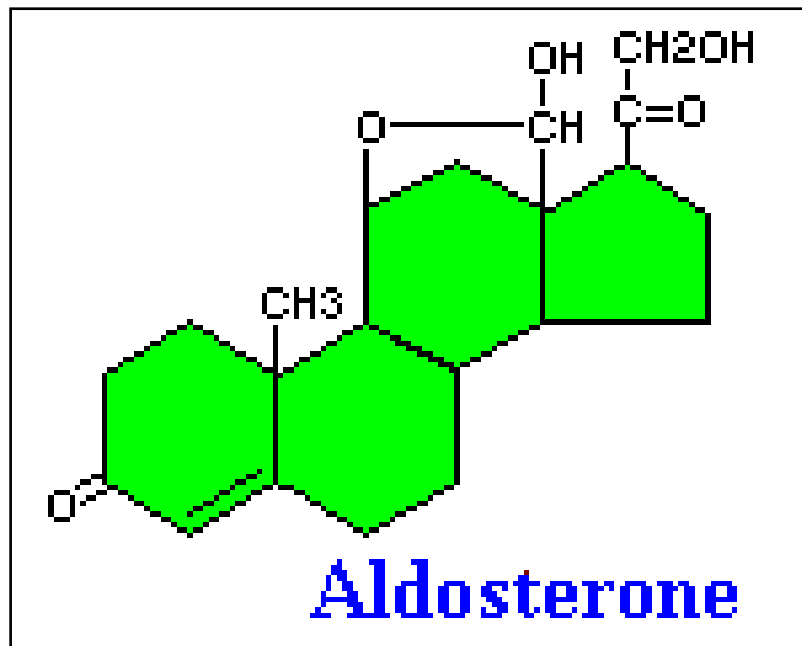
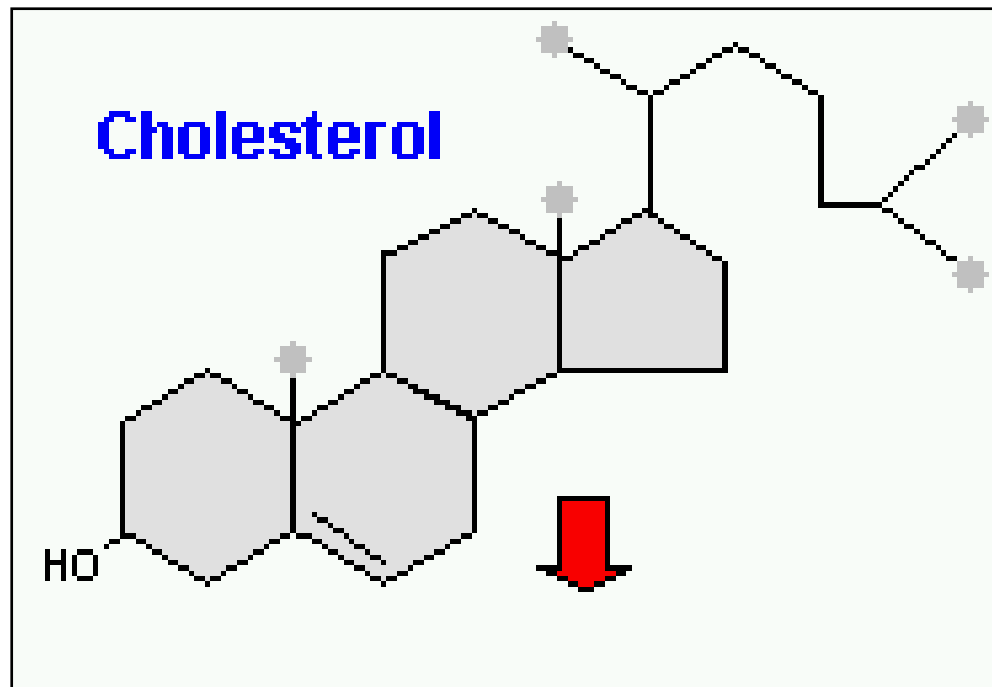


# Mineralocorticoids

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- Aldosterone
  - Works with ADH
- Electrolyte homeostasis
  - Regulate levels of important electrolytes (mineral salts) in animal's body
- Targets kidneys to ↑ Na<sup>+</sup> retention, reduce urine volume





# Adrenal Cortex Pathology

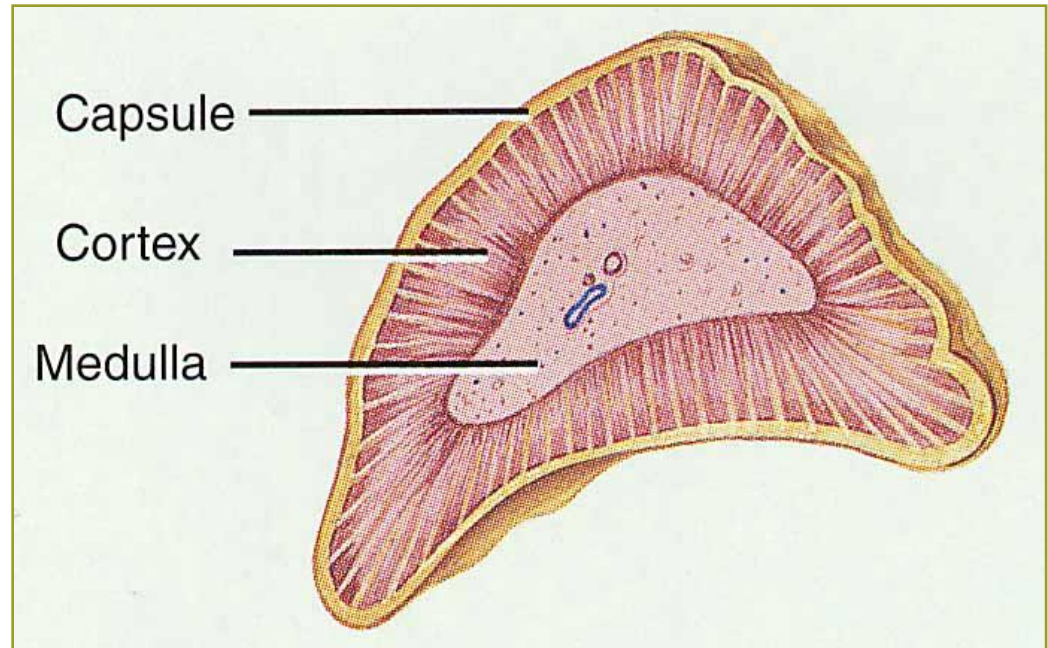
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- Cushing's Syndrome
  - Hyperadrenocorticism
  - Excessive cortisone production
  - **Iatrogenic???**
- Addison's Disease
  - Hypoadrenocorticism
  - Decreased cortisone production



# Adrenal Medulla Hormones

- Epinephrine
- Norepinephrine
- “Fight or Flight” response
- 2 places in animal body where epinephrine is found???



# Adrenal Medulla Functions

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- Secretion is controlled by sympathetic portion of autonomic nervous system
  - **“Fight or flight” response**
- Increases heart rate and output, increases blood pressure, dilates air passageways in lungs, and decreases GI function







Stimulus (input)

Response (output)

Skeletal muscle

Cardiac muscle,  
smooth muscle,  
and glands

Somatic  
nervous system

Autonomic nervous  
system

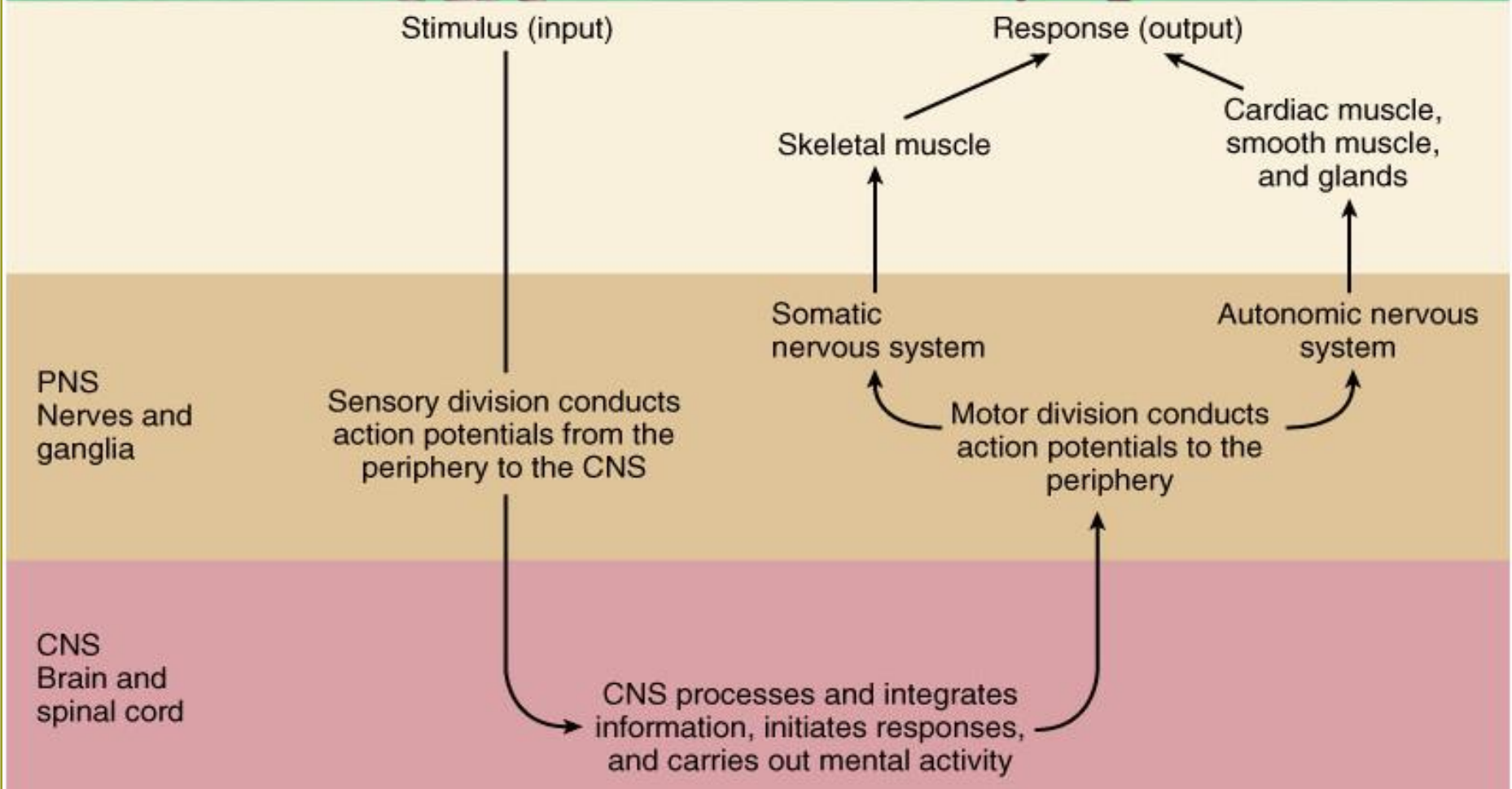
PNS  
Nerves and  
ganglia

Sensory division conducts  
action potentials from the  
periphery to the CNS

Motor division conducts  
action potentials to the  
periphery

CNS  
Brain and  
spinal cord

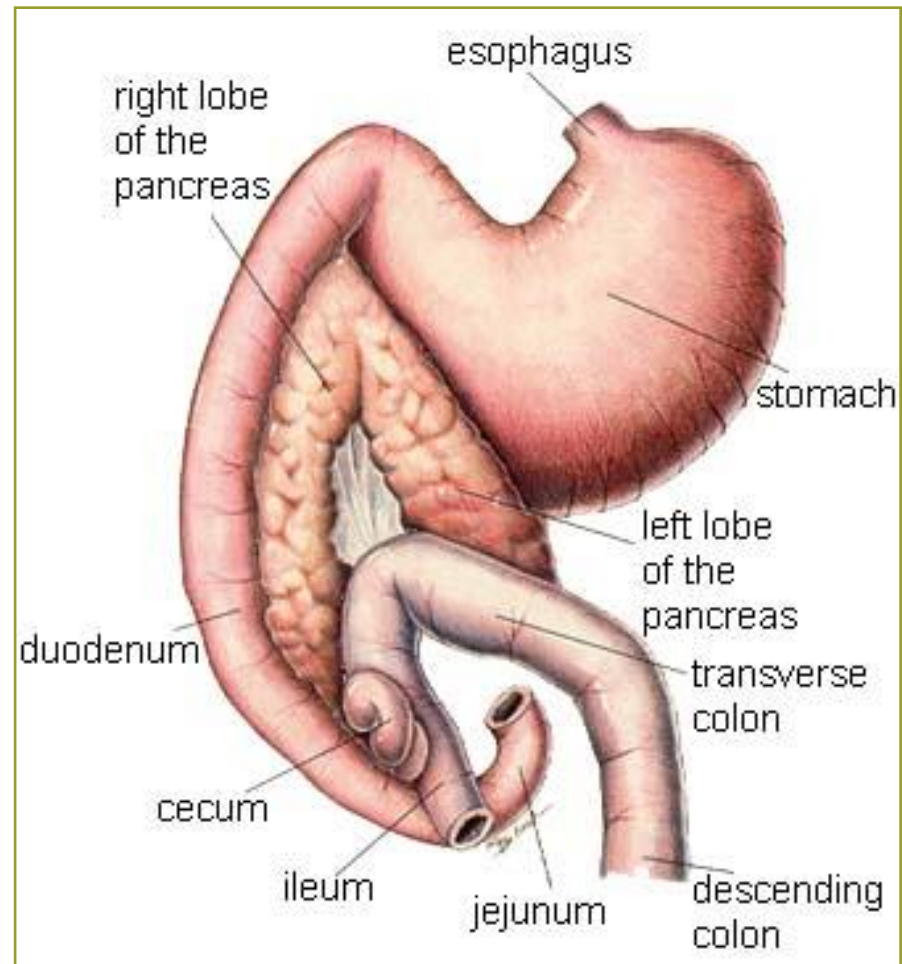
CNS processes and integrates  
information, initiates responses,  
and carries out mental activity

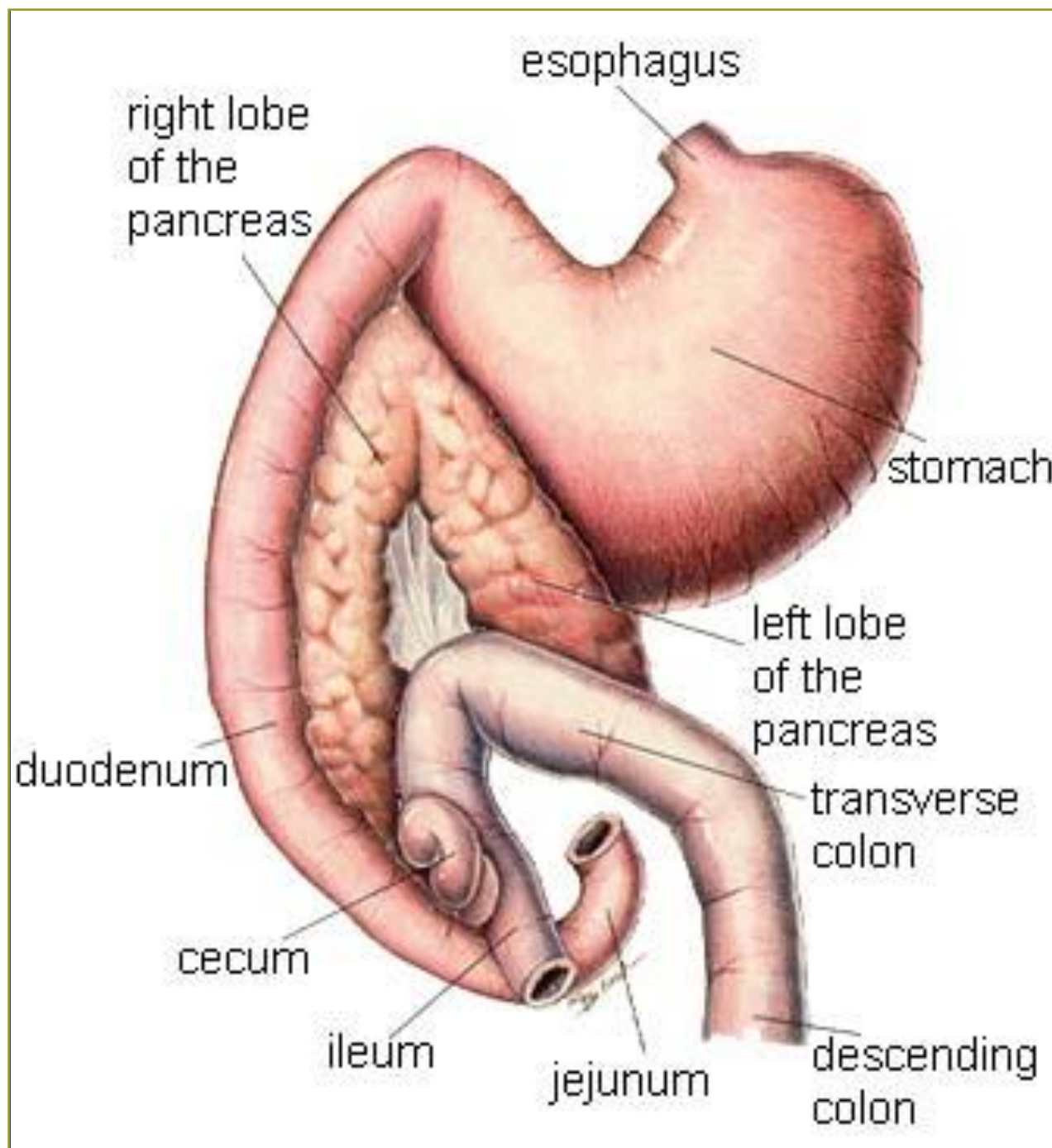




# Pancreas

- Only gland in body with **exocrine** and **endocrine** function
- Exocrine – digestive enzymes
- Endocrine – small % of pancreas
  - Hormones **regulating glucose**
  - Islets of Langerhans





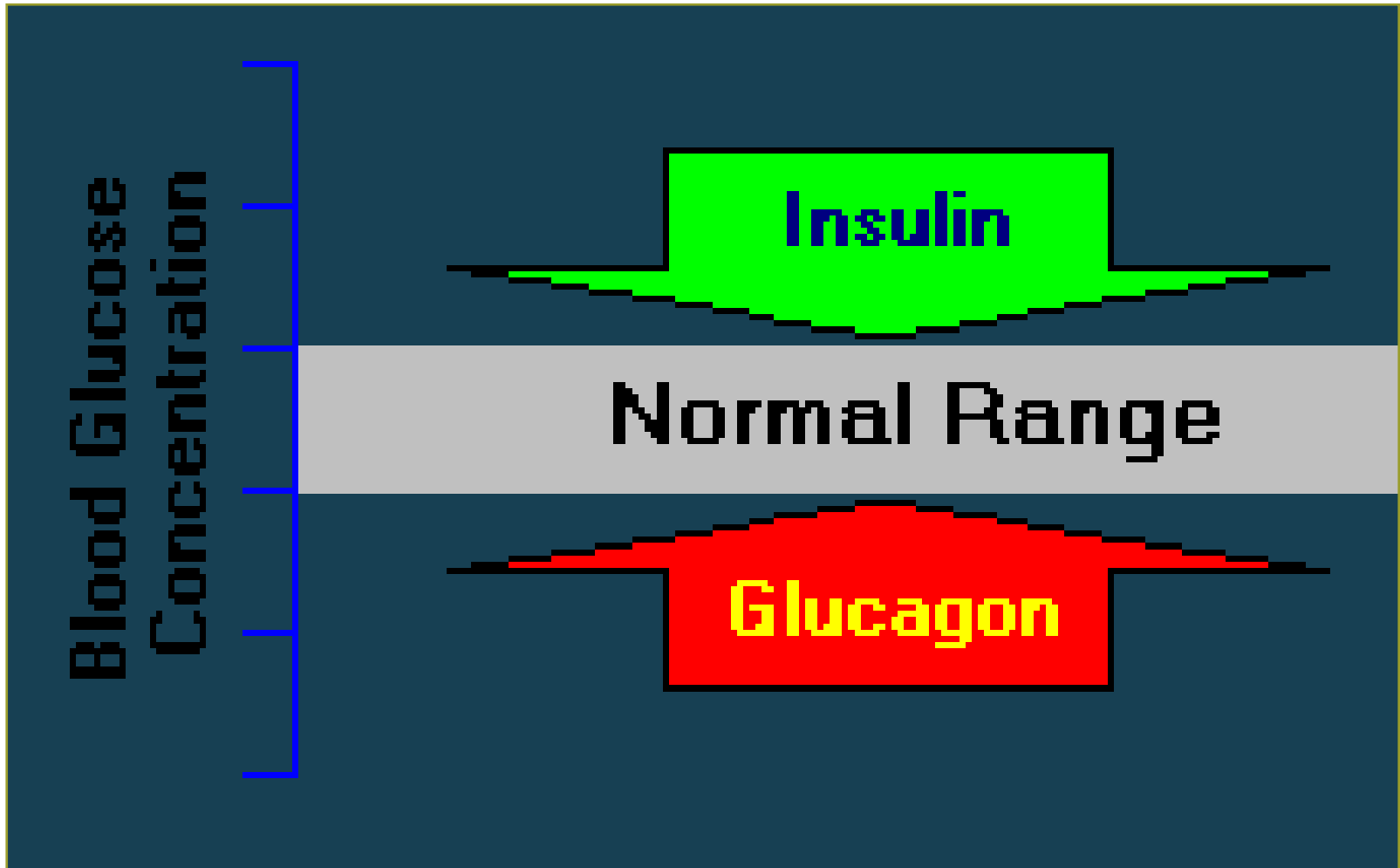
# Pancreas Hormones

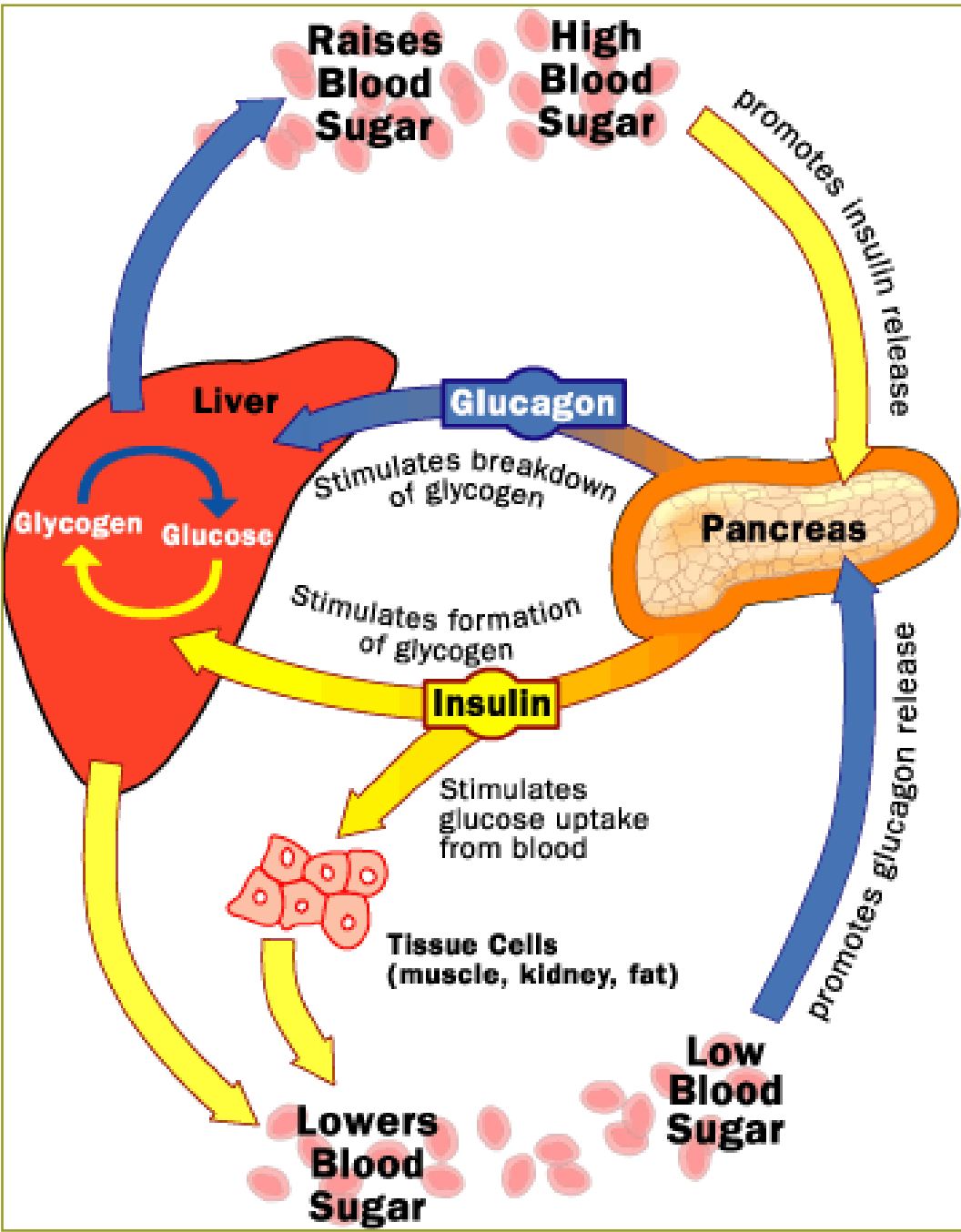
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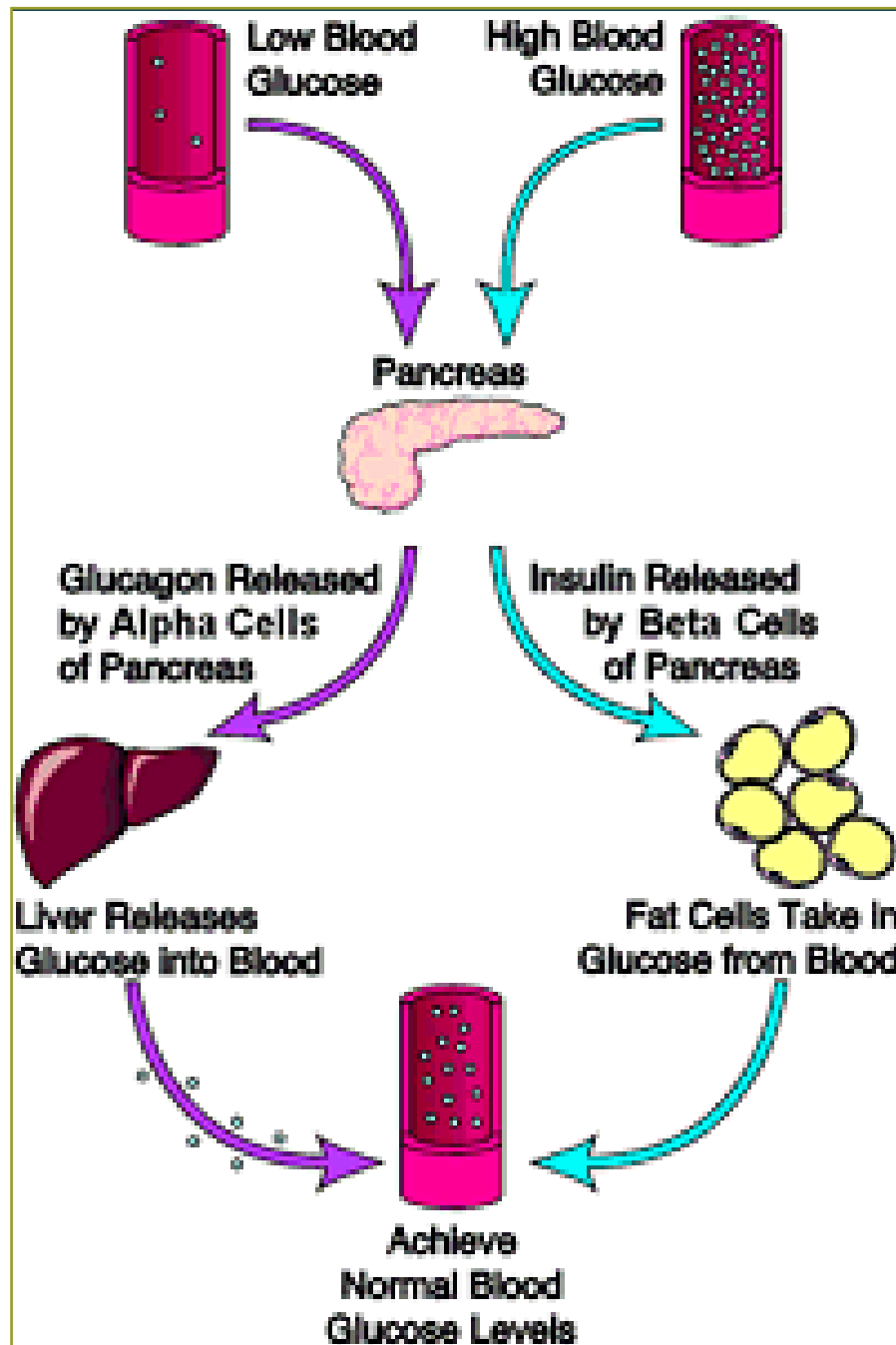
- Insulin
  - Helps glucose travel from the bloodstream to the cells in the animal's body
  - Lowers blood glucose
- Glucagon
  - Opposite effect of insulin
  - Raises blood glucose
  - Gluconeogenesis

# Regulation of Blood Glucose

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# Sex Hormones

Testicles – Testosterone

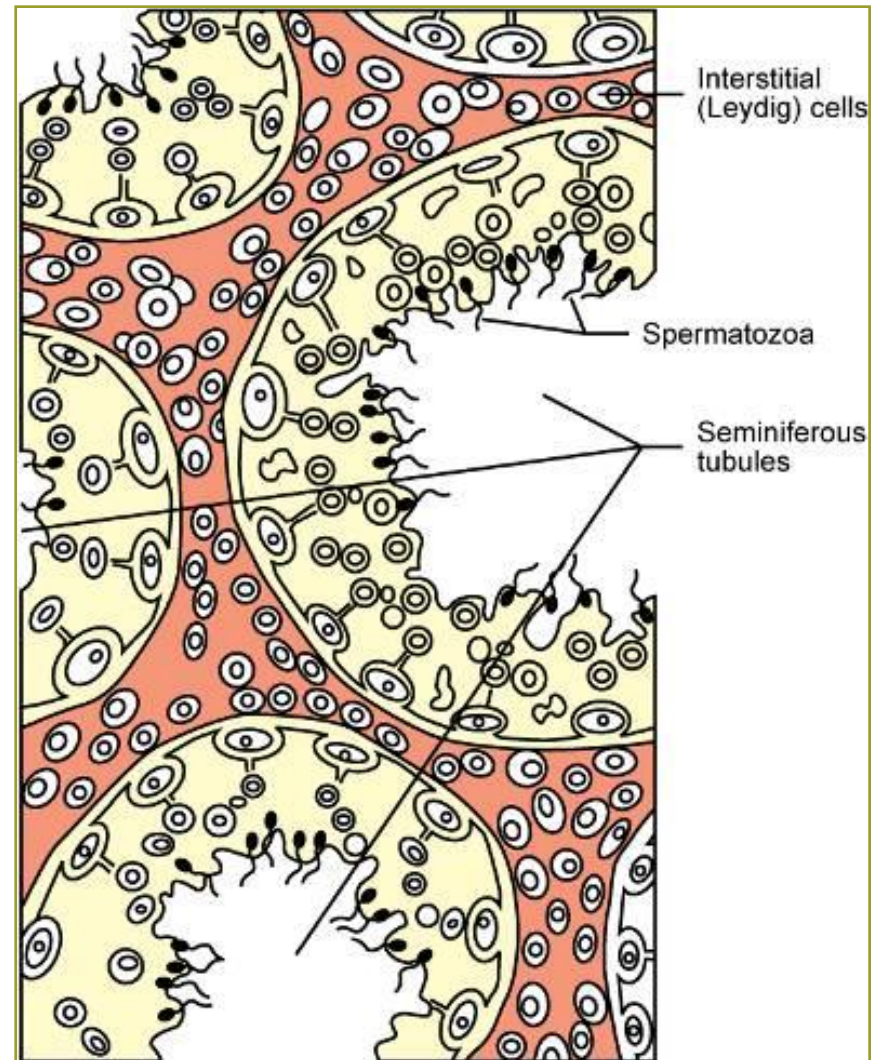
Ovaries – Estrogen, Progesterone

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# Testicles

Figure 15-7, Page 370

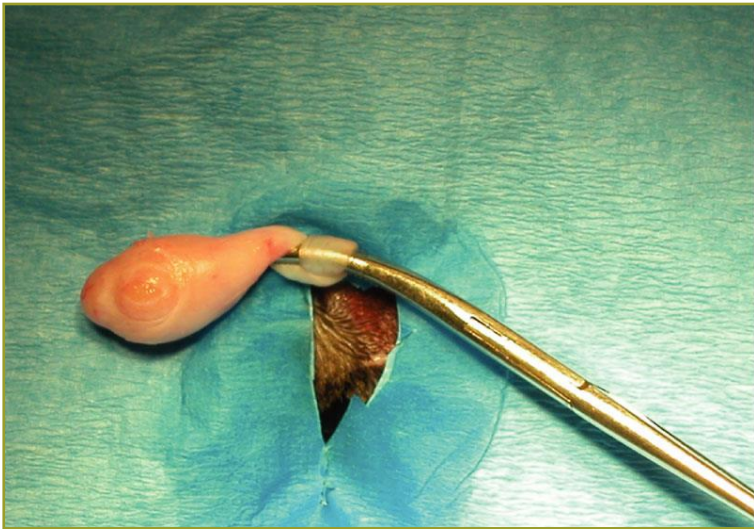
- Interstitial cells
  - Clumps of endocrine cells
  - Produce androgens when stimulated by LH
- Testosterone
  - Primary androgen
  - Provides for development of male secondary sex characteristics and accessory sex glands
  - Activates spermatogenesis



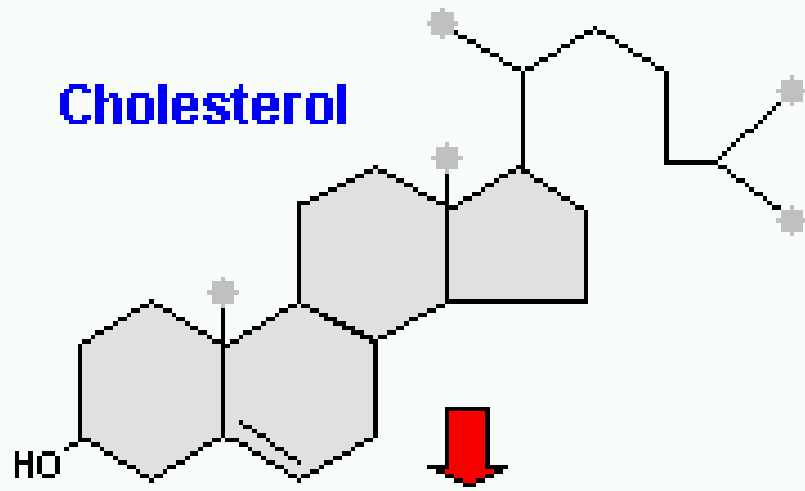
# Testosterone

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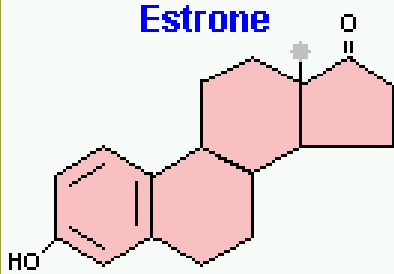
- Androgens
  - Anabolic effect



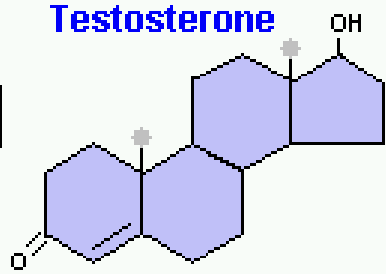
# Cholesterol



# Estrone



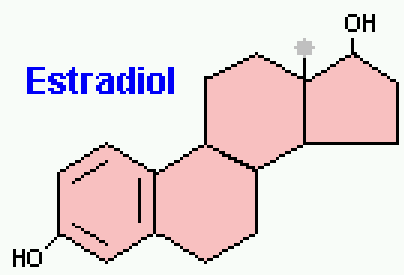
# Testosterone



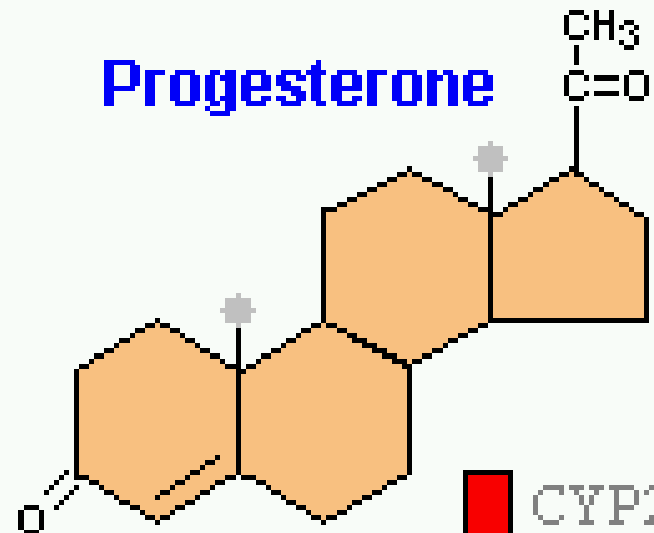
↑ 17βHSD

↓ CYP19

# Estradiol



# Progesterone



↓ CYP21

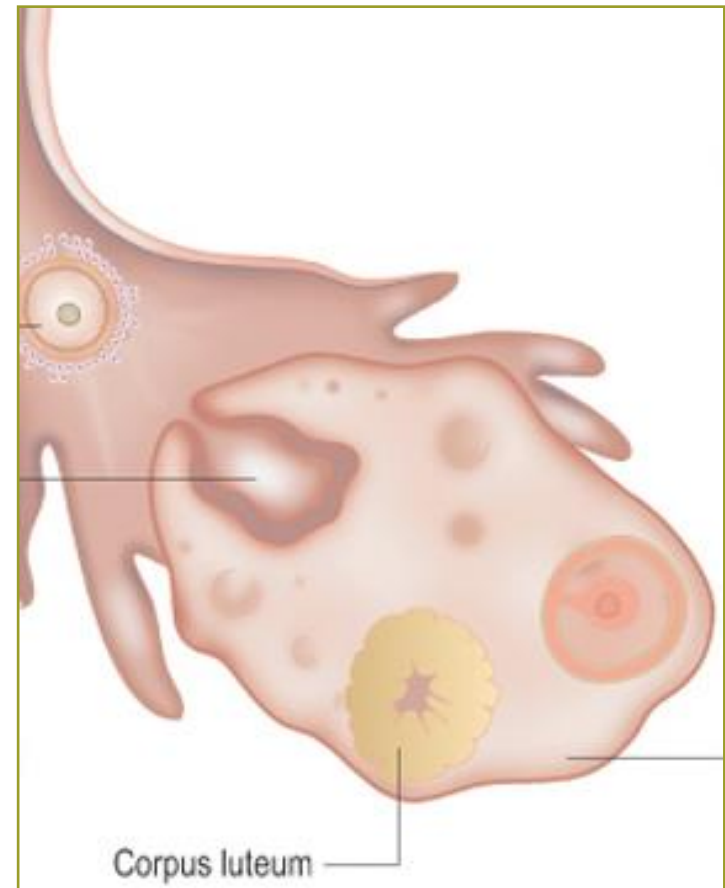
# Ovaries

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- Controlled by follicle stimulating hormone (FSH) and luteinizing hormone (LH)
- Hormone groups produced in the ovaries:
  - Estrogens
  - Progestins

# Ovaries

- Hormones produced in cycles
- Estrogens ([Estradiol](#), Estrone)
  - From ovarian follicles
- Progestins ([Progesterone](#))
  - From corpus luteum
  - Equine – used to [synchronize estrous periods in mares](#)





# Estrogens

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- FSH stimulates ovarian follicles to develop
  - Cells of follicles produce and release estrogens
  - Amount of estrogen produced increases as follicle grows
- Increasing estrogen levels accelerate physical and behavioral changes
- When follicle is fully mature, LH level peaks

# Progestins

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- Hormones produced by corpus luteum
- In pregnant female, hormone signal is sent from uterus, and corpus luteum is maintained
- If no pregnancy occurs, lack of hormone signal causes corpus luteum to shrink and disappear
- Progesterone – principal progestin
  - Helps prepare uterus to receive the fertilized ovum
  - Needed to maintain pregnancy

# Kidneys

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- Produce [erythropoietin](#) – stimulates red bone marrow to increase production of red blood cells
- As red blood cell production increases, more oxygen feeds back to kidneys and slows the production of erythropoietin

# Stomach

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- Gastrin: produced by cells in the wall of the stomach
- Secretion stimulated by presence of food in the stomach
- Stimulates gastric glands to secrete hydrochloric acid and digestive enzymes
- Encourages muscular contractions of the stomach wall

# Small Intestine

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- Secretin and cholecystokinin produced by cells in lining of small intestine
- Secretion occurs in response to presence of chyme in duodenum
- Secretin stimulates pancreas to secrete fluid to neutralize acidic chyme after it passes out of the stomach
- Cholecystokinin stimulates pancreas to release digestive enzymes into the duodenum

# Placenta

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- Surrounds a developing fetus during pregnancy
- Acts as an interface with the maternal circulation
- Produces hormones to help support and maintain pregnancy
  - Estrogen and progesterone
  - Chorionic gonadotropin (some species)



# Thymus

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- Extends cranially from the level of the heart up into neck region along both sides of the trachea
- Large in young animals, atrophies later in life
- Function involves hormones or hormonelike chemical substances (e.g., thymosin and thymopoietin)
- Seems to cause certain cells to be transformed into T-lymphocytes

# Pineal Body

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- Located at caudal end of the cleft that separates the two cerebral hemispheres
- Influences cyclic activities in the body
- Melatonin – hormone-like substance called that seems to affect moods and wake-sleep cycles
  - May also play a role in the timing of seasonal estrous cycles in some species

# Prostaglandins

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- Hormone-like substances (“tissue hormones”) derived from unsaturated fatty acids
- Produced in a variety of body tissues (skin, intestine, brain, kidney, lungs, reproductive organs, and eyes)
- Influence blood pressure, blood clotting, inflammation, GI, respiratory, reproductive, and kidney function
- Non-steroidal anti-inflammatory drugs (NSAIDs)
  - Inhibit synthesis of certain prostaglandins
  - Side effects (Rimadyl, Deramaxx, Tramadol)

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**Test Yourself**  
**KNOW THESE IN EVERY CHAPTER!**

Pages 359, 361, 365, 367, 371, 373

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# Clinical Applications

Pages 363, 363, 366, 367, 368, 368,  
369, 371, 371

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