Endocrine System

Modified by M. Myers

The Endocrine System

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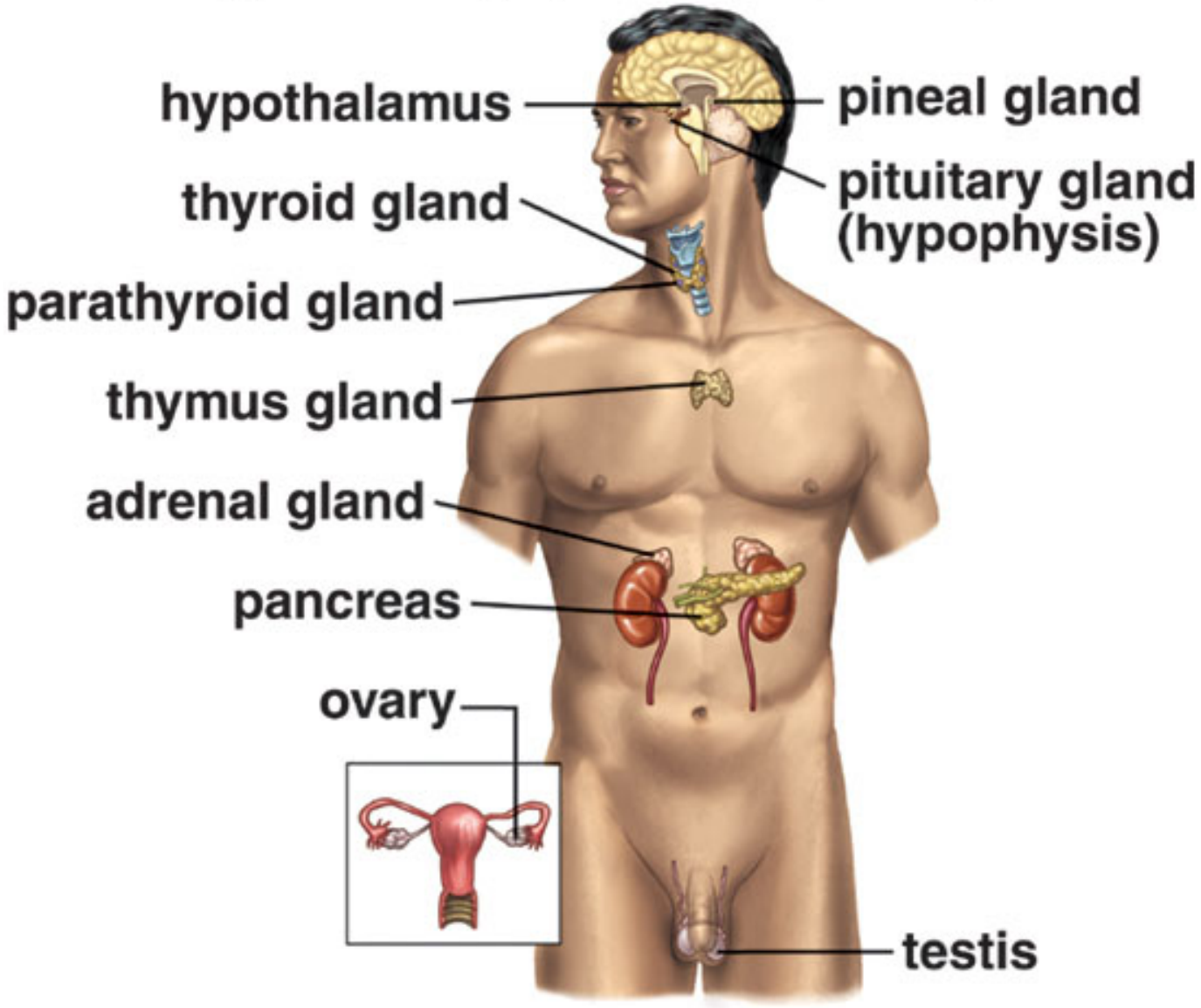


Endocrine Glands

- The *endocrine system* is made of glands & tissues that secrete hormones.

- *Hormones* are chemicals messengers influencing

a. metabolism of cells

b. growth and development

c. reproduction,

d. homeostasis.

Hormones

Hormones (*chemical messengers***)** secreted into the bloodstream and transported by blood to specific cells (**target cells)**

Hormones are classified as

1. proteins (*peptides)*

2. Steroids

Hormone Classification

- Steroid Hormones:
  - Lipid soluble
  - Diffuse through cell membranes
  - Endocrine organs
    - Adrenal cortex
    - Ovaries
    - Testes
    - placenta

Hormone Classification

- Nonsteroid Hormones:
  - Not lipid soluble
  - Received by receptors external to the cell membrane
  - Endocrine organs
    - Thyroid gland
    - Parathyroid gland
    - Adrenal medulla
    - Pituitary gland
    - pancreas

Hormone Actions

- "Lock and Key" approach: describes the interaction between the hormone and its specific receptor.
  - Receptors for nonsteroid hormones are located on the cell membrane
  - Receptors for steroid hormones are found in the cell's cytoplasm or in its nucleus

http://www.wisc-online.com/objects/index_tj.asp?objID=AP13704

Endocrine System

- There is a close assoc. b/w the endocrine & nervous systems.
- Hormone secretion is usually controlled by either ***negative feedback*** or antagonistic hormones that oppose each other's actions

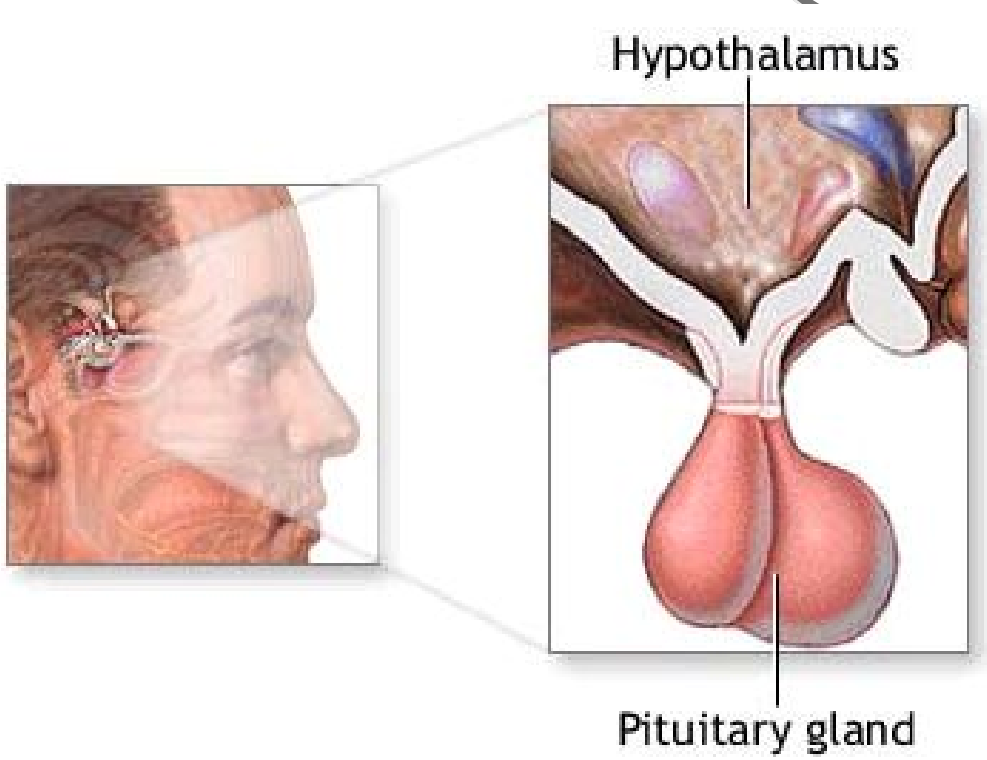
Hypothalamus

1. regulates the internal environment through the autonomic system

2. controls the secretions of the pituitary gland.

Hypothalamus & Pituitary Gland

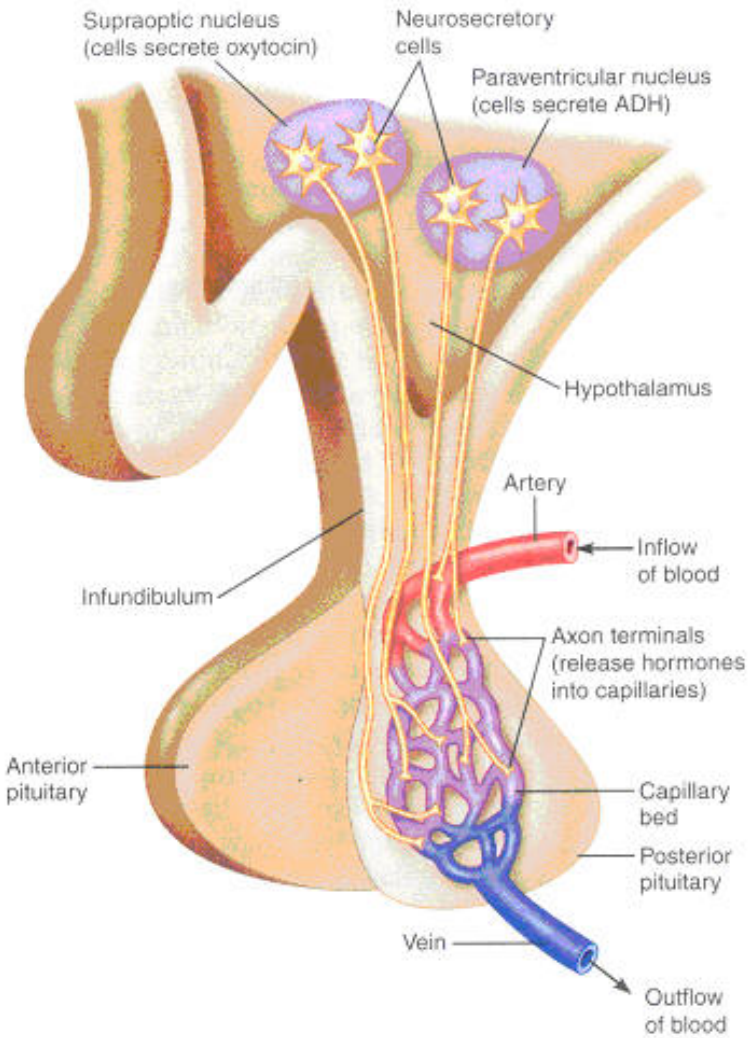
posterior pituitary/ anterior pituitary

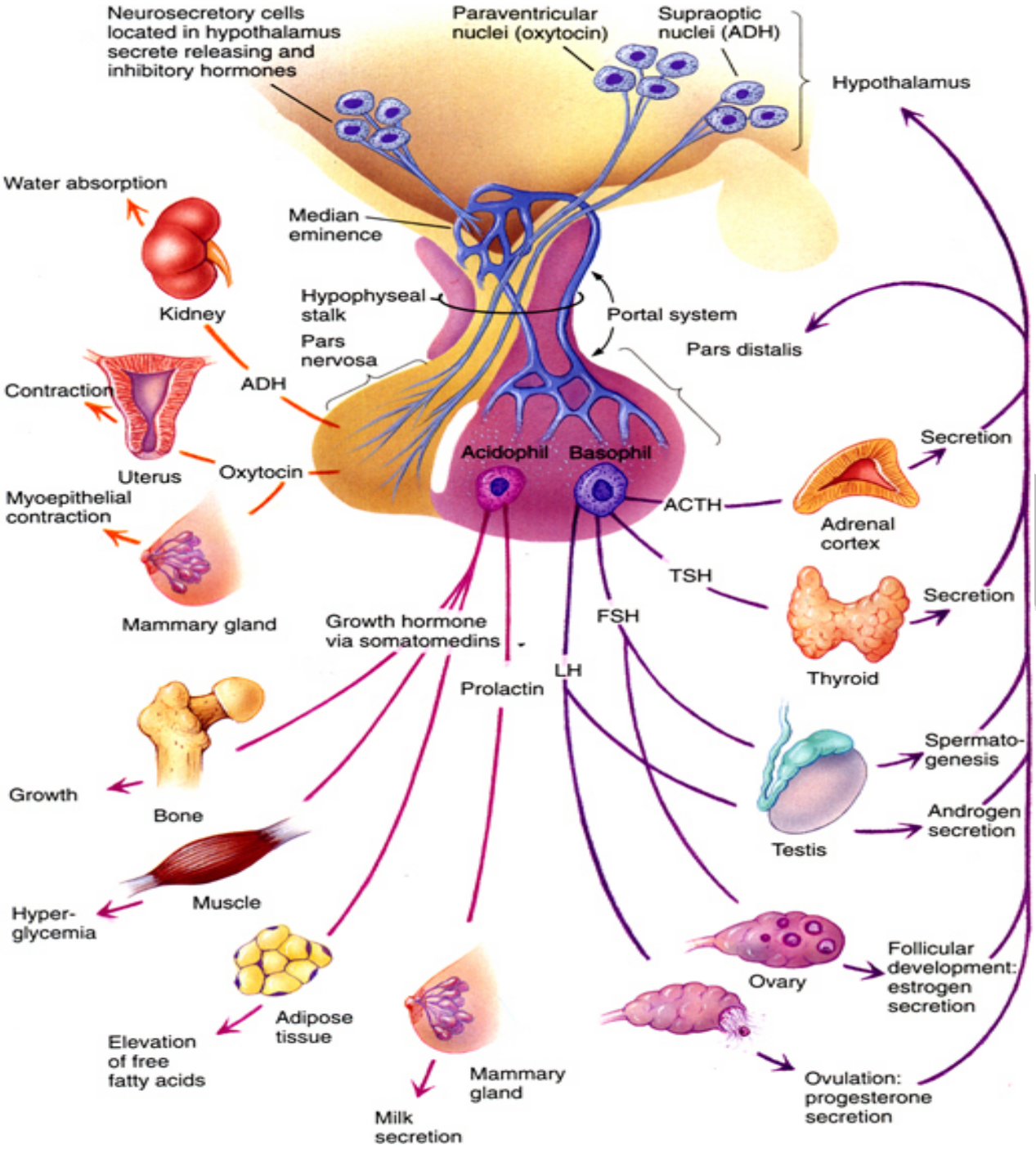


Posterior Pituitary

The *posterior pituitary* secretes

- *antidiuretic hormone* (*ADH*)
- *oxytocin*


Supraoptic nucleus
(cells secrete oxytocin)
Neurosecretory
cells
Paraventricular nucleus
(cells secrete ADH)
Hypothalamus
Artery
Inflow
of blood
Infundibulum
Axon terminals
(release hormones
into capillaries)
Anterior
pituitary
Capillary
bed
Posterior
pituitary
Vein
Outflow
of blood


Neurosecretory cells located in hypothalamus secrete releasing and inhibitory hormones
Paraventricular nuclei (oxytocin)
Supraoptic nuclei (ADH)
Hypothalamus
Water absorption
Kidney
Median eminence
Hypophyseal stalk
Portal system
Pars distalis
Pars nervosa
Contraction
ADH
Uterus
Oxytocin
Myoepithelial contraction
Mammary gland
Acidophil
Basophil
ACTH
Secretion
Adrenal cortex
TSH
Secretion
Thyroid
FSH
LH
Growth hormone via somatomedins
Prolactin
Growth
Bone
Spermato-genesis
Androgen secretion
Testis
Hyper-glycemia
Muscle
Ovary
Follicular development: estrogen secretion
Adipose tissue
Elevation of free fatty acids
Mammary gland
Milk secretion
Ovulation: progesterone secretion

Anterior pituitary gland

1. Human growth hormone (hGH) (Somatotropin)
2. Thyroid stimulating hormone (TSH)
3. Follicle-stimulating hormone (FSH)
4. Luteinizing hormone (LH)
5. Interstisal cell stimulating hormone (ICSH)
6. Prolactin (PRL): initiates milk production
7. Adrenocorticotrophic hormone (ACTH):

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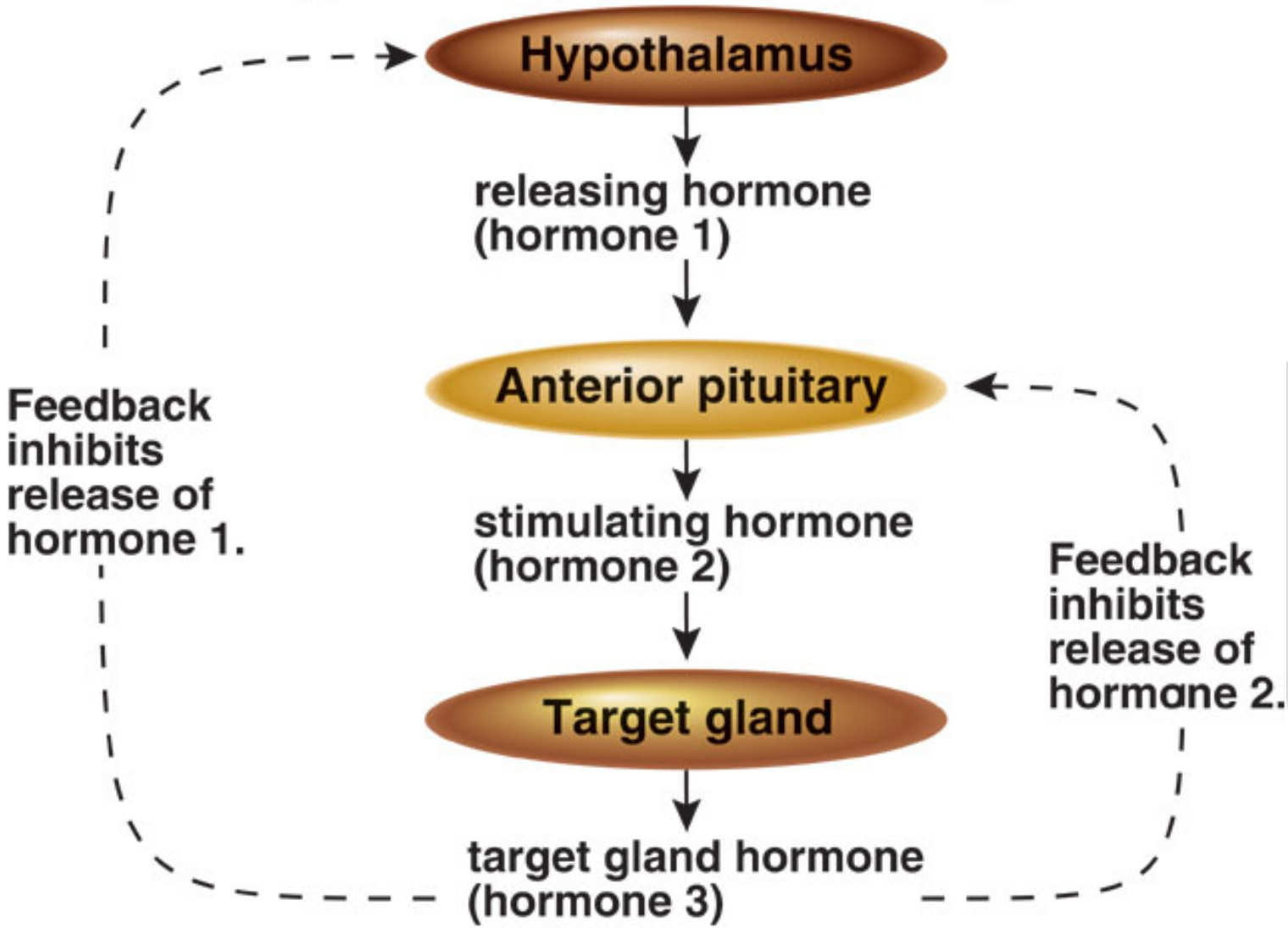
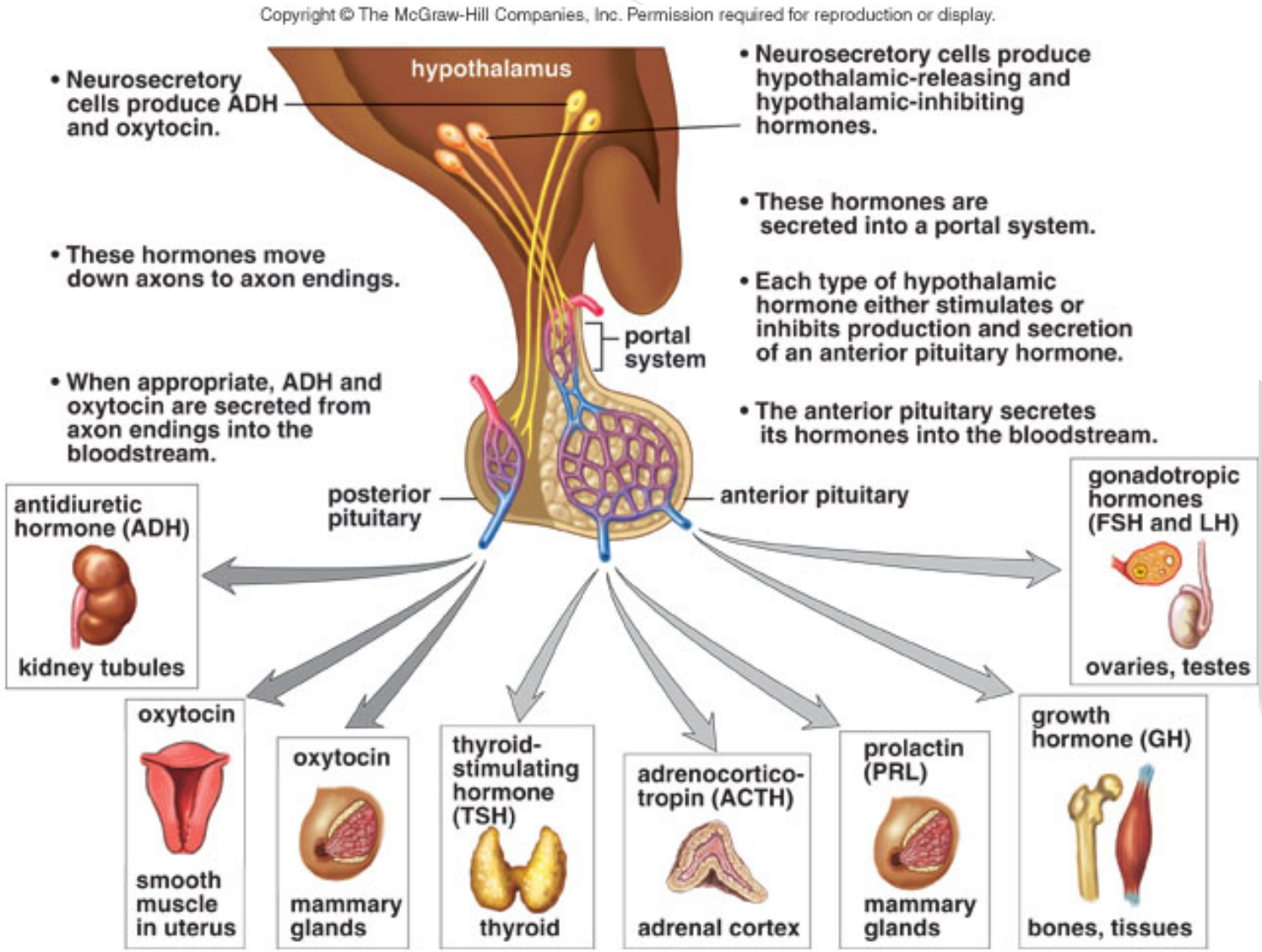


Hypothalamus and the pituitary



Effects of Growth Hormone

GH promotes bone and muscle growth.

Pituitary dwarfism results from too little GH during childhood.

Giants result from too much GH during childhood.

If growth hormone is overproduced in an adult, it causes *acromegaly*.

Effect of growth hormone

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a.

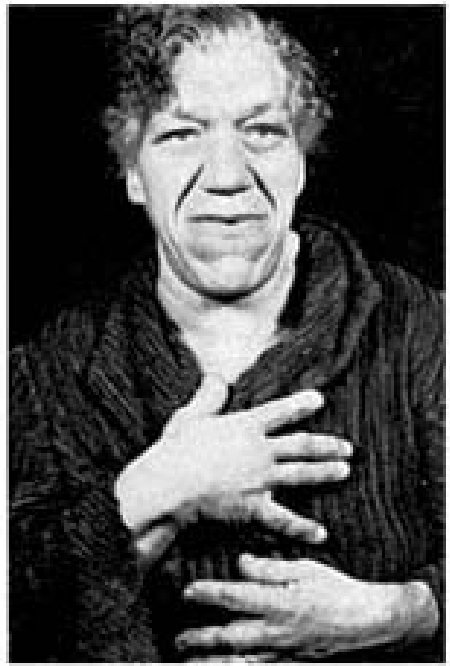
b.

Acromegaly

Age 9

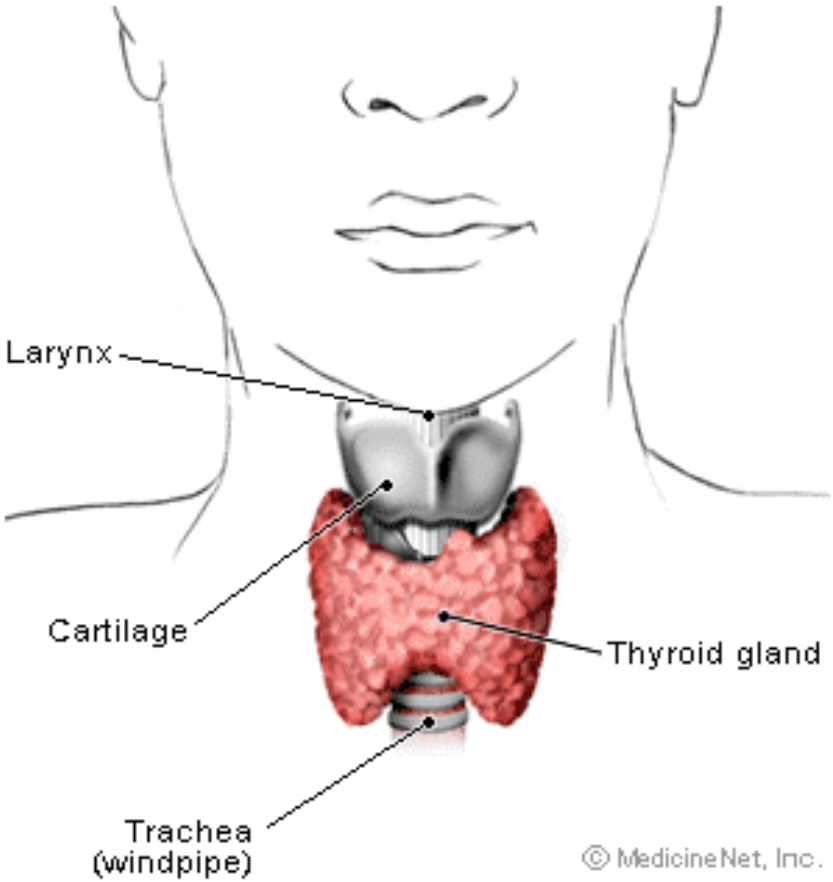
Age 16

Age 33



Age 52

Thyroid and Parathyroid Glands



- The *thyroid gland*
- The four *parathyroid glands* are embedded in the posterior surface of the thyroid gland.

Thyroid Gland

- The thyroid gland requires iodine to produce *thyroxine*
- (T_4) which contains four iodine atoms
- *triiodothyronine* (T_3) which contains three iodine atoms

- Thyroid hormones increase

1. Oxygen use
2. Cellular metabolism
3. Growth & development

Effects of Thyroid Hormones

- If *iodine* is lacking in the diet, a *simple goiter* develops.
- Use of iodized salt helps prevent simple goiters.
- *Hypothyroidism* in childhood produces *cretinism*; in adulthood it causes *myxedema*.
- If the thyroid is overactive (Grave's disease) an *exophthalmic goiter* develops.

Simple goiter

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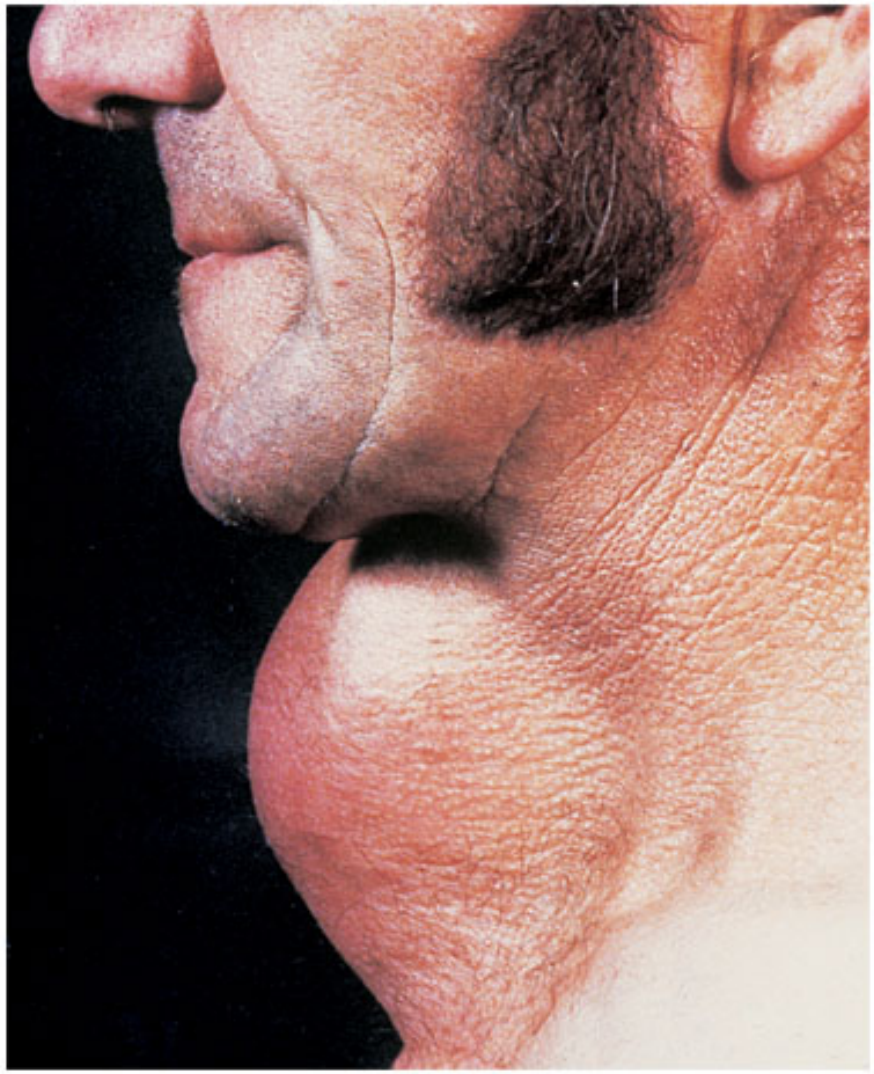

Cretinism

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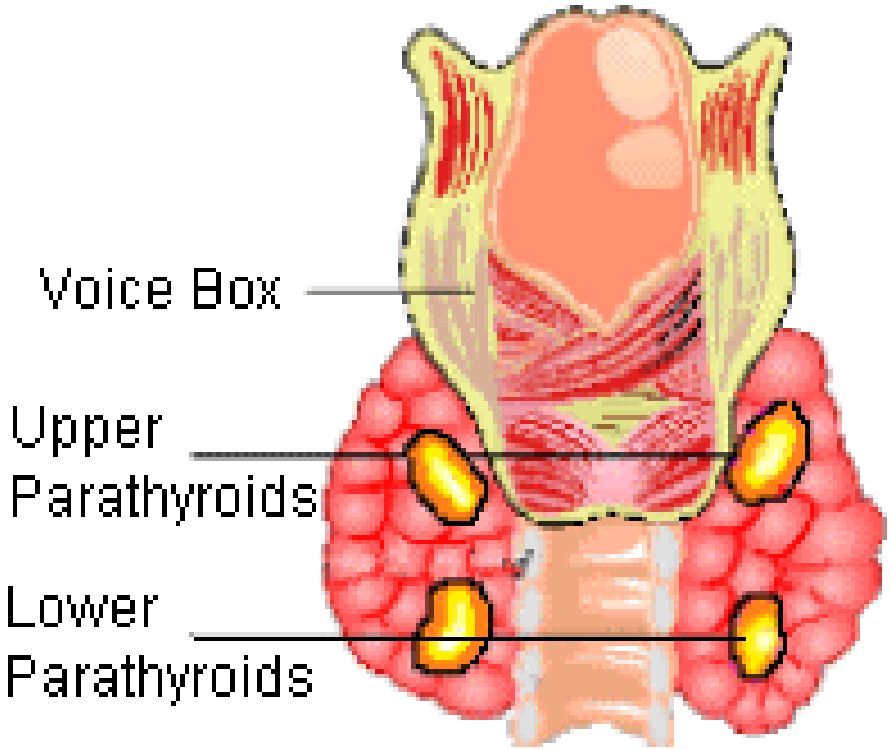
Thyroid Gland

Calcitonin

- which helps lower the blood calcium level when it is too high.
- deposits calcium in the bones
- regulates calcium homeostasis

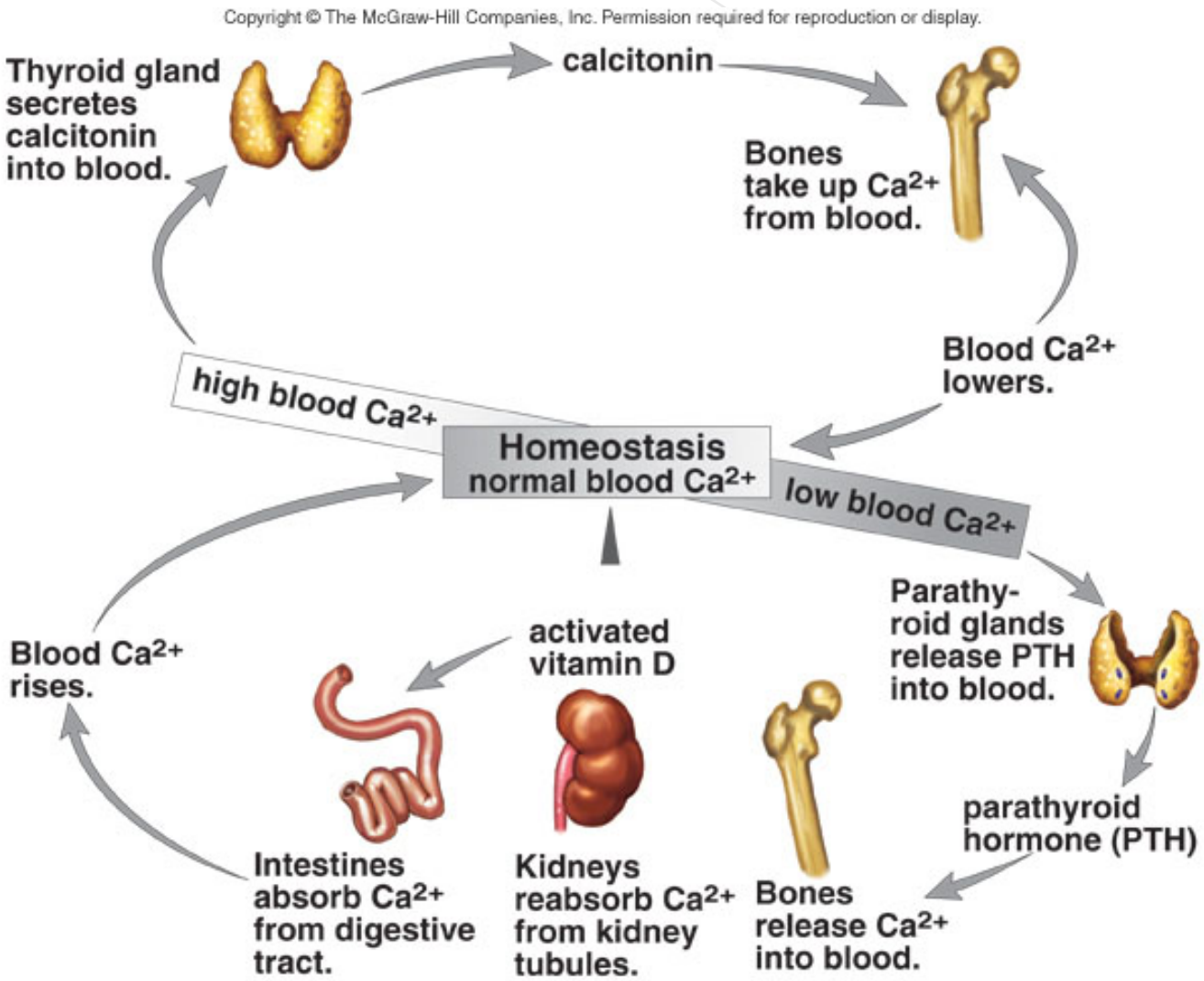
Parathyroid glands



- Parathyroid hormone (PTH

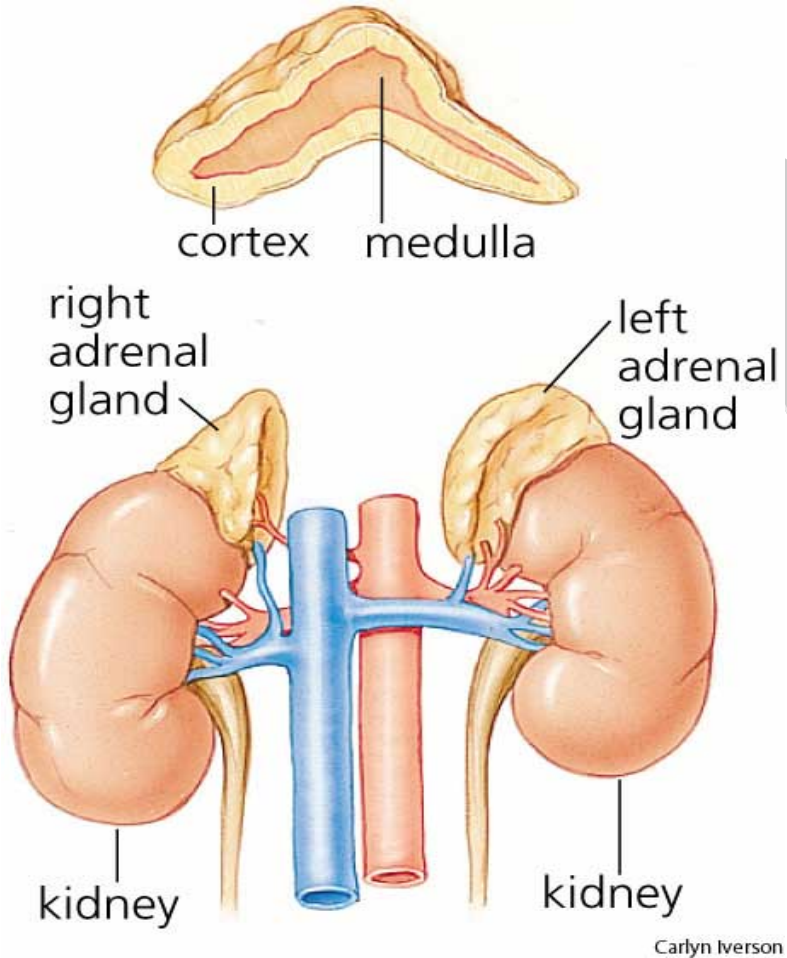
  stimulates the activity of osteoclasts, thus releasing calcium from bone, & stimulates the reabsorption of calcium by the kidneys and intestine

Regulation of blood calcium level



Adrenal Glands

- Cortex: corticosteroids- essential to life.
- Medulla: epinephrine and nor-epinephrine.



Adrenal Glands

- *Adrenal glands* sit atop the kidneys and have an inner *adrenal medulla* and an outer *adrenal cortex*.
- The hypothalamus uses ACTH-releasing hormone to control the anterior pituitary's secretion of ACTH that stimulates the adrenal cortex.
- The hypothalamus regulates the medulla by direct nerve impulses.

- The adrenal medulla secretes *epinephrine* and *norepinephrine*, which bring about responses we associate with emergency situations.
- On a long-term basis, the adrenal cortex produces *glucocorticoids* similar to cortisone and *mineralocorticoids* to regulate salt and water balance.
- The adrenal cortex also secretes both male and female sex hormones in both sexes.

Adrenal glands

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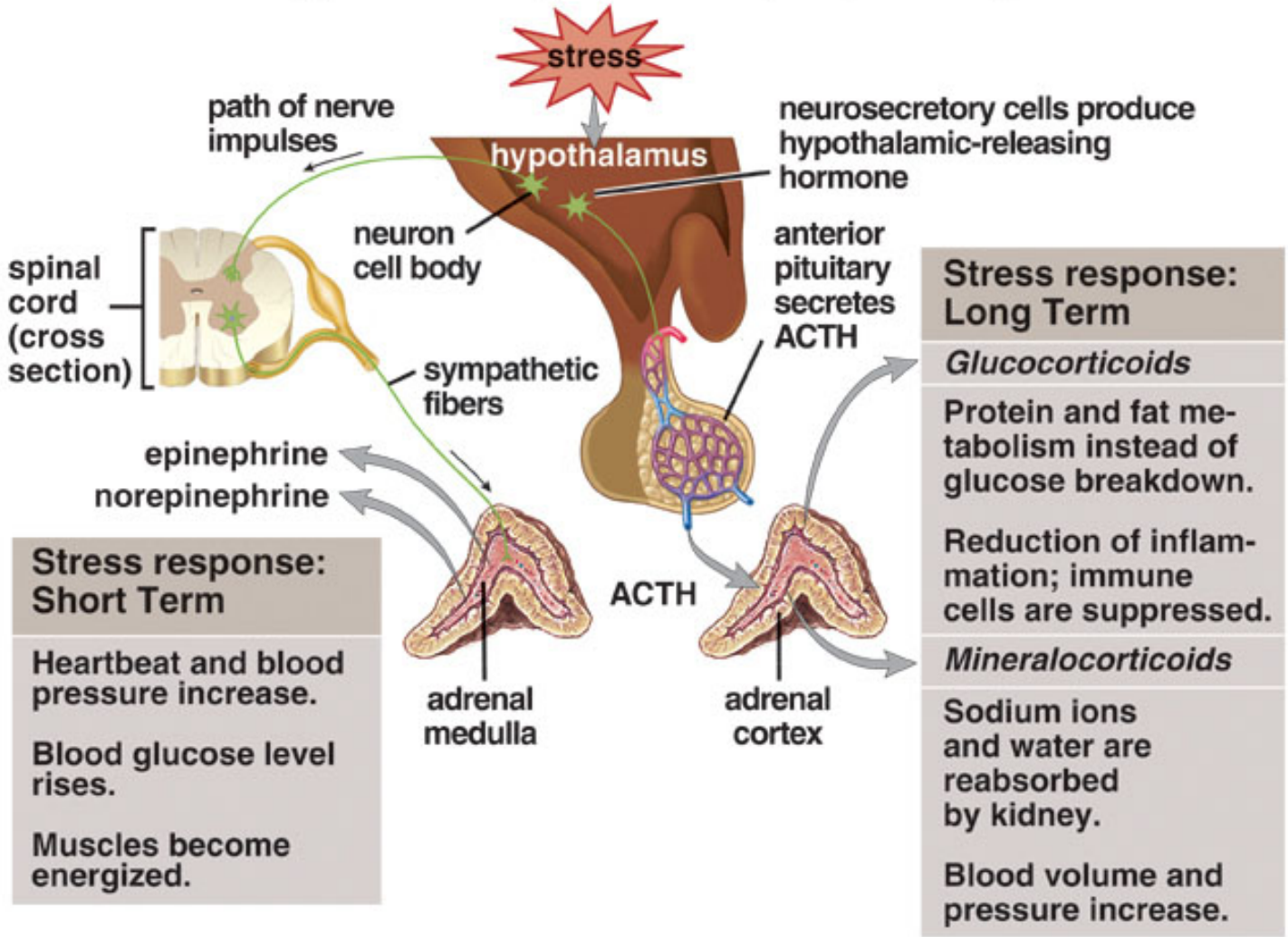


Glucocorticoids

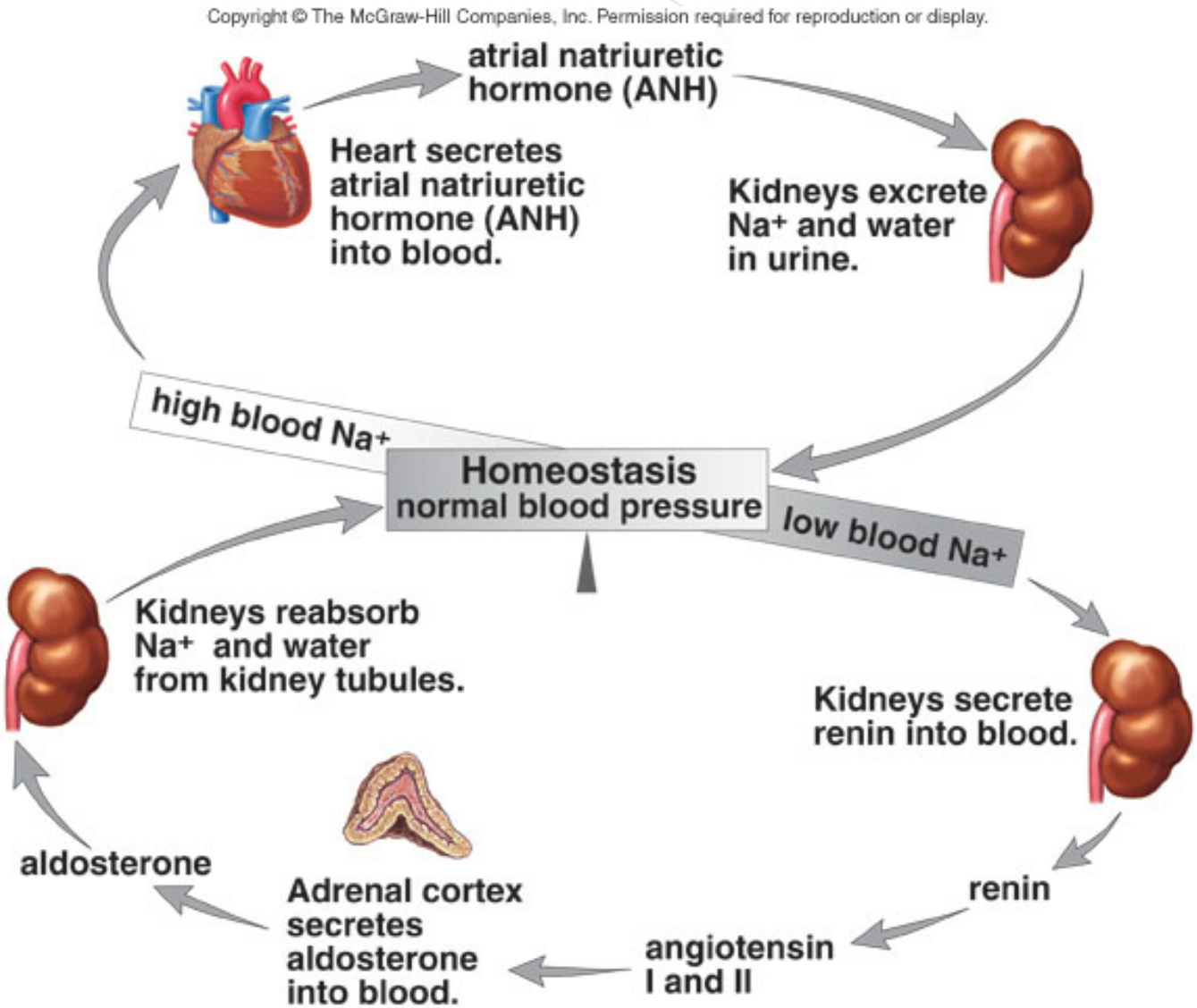
- *Cortisol* promotes breakdown of muscle proteins to amino acids; the liver then breaks the amino acids into glucose.
- Cortisol also promotes metabolism of fatty acids rather than carbohydrates, which spares glucose.
- Both actions raise the blood glucose level.
- High levels of blood glucocorticoids can suppress immune system function.

Mineralocorticoids

- *Aldosterone* causes the kidneys to reabsorb sodium ions (Na^+) and excrete potassium ions (K^+).

- When blood sodium levels and blood pressure are low, the kidneys secrete renin; the effect of the renin-angiotensin-aldosterone system is to raise blood pressure.

Regulation of BP and Fluid volume



Malfunction of the Adrenal Cortex

- *Addison disease* develops when the adrenal cortex hyposecetes hormones.

- A bronzing of the skin follows low levels of cortisol, and mild infection can lead to death; aldosterone is also hyposecreted, and dehydration can result.

Addison disease

Malfunction of the Adrenal Cortex

- *Cushing syndrome* develops when the adrenal cortex hypersecretes cortisol.

- The trunk and face become round; too much aldosterone results in fluid retention

Cushing syndrome

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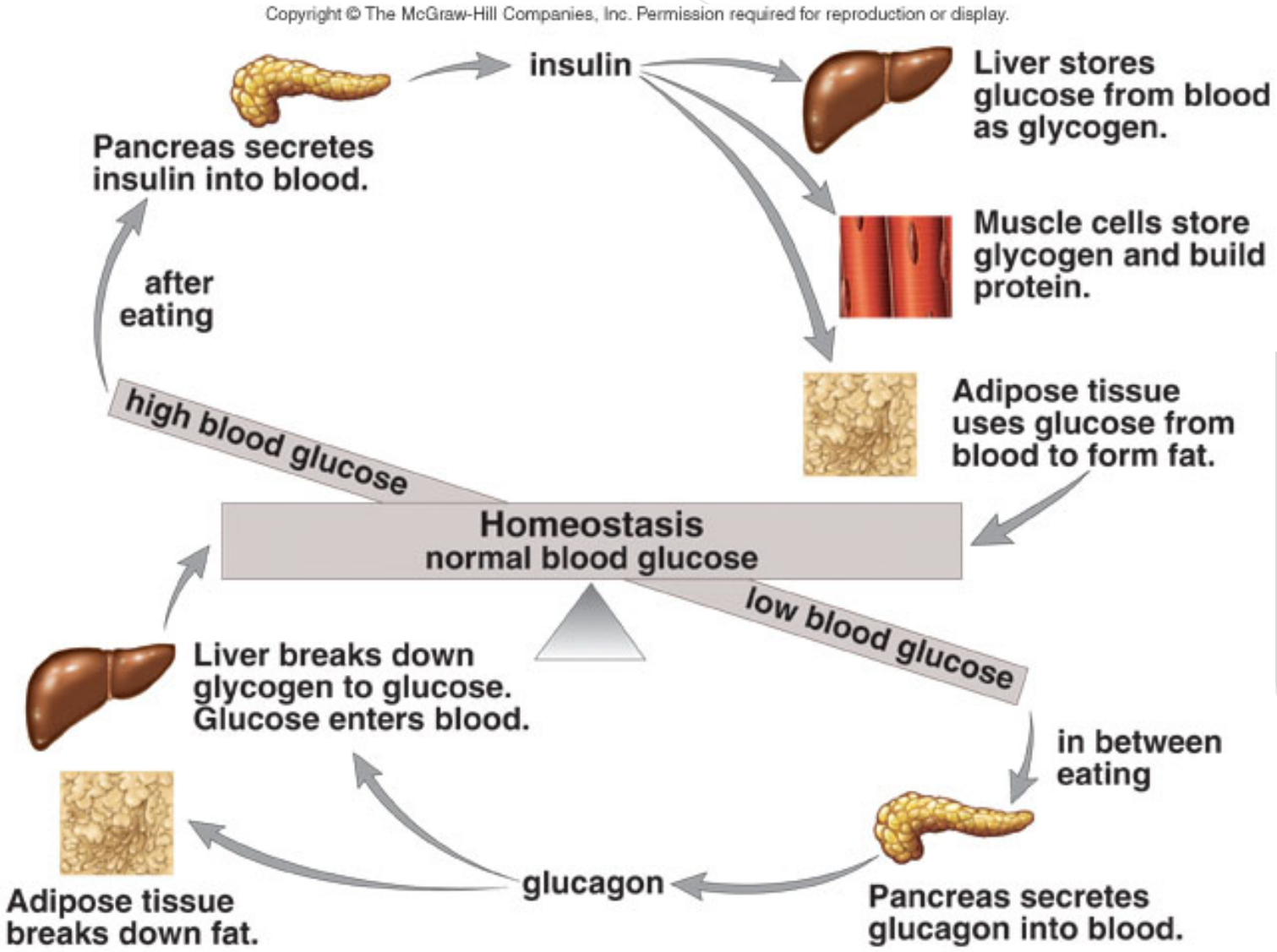
Pancreas

- The *pancreas* is between the kidneys and the duodenum and provides digestive juices and endocrine functions.

- *Pancreatic islets* secrete *insulin*, which lowers the blood glucose level, and *glucagon*, which has the opposite effect, together regulating the *glucose* level in the blood.

Regulation of blood glucose level



Diabetes Mellitus

- The most common illness due to hormonal imbalance is *diabetes mellitus*.
- Diabetes is due to the failure of the pancreas to produce insulin or the inability of the body cells to take it up.
- *Causing Hyperglycemia*

Diabetes Mellitus

- *Type I diabetes mellitus* occurs when the pancreas does not produce insulin

- *Type II diabetes mellitus* where the pancreas produces insulin but the body cells do not respond.

Testes and Ovaries

Testes, hormone *testosterone*.

Ovaries produce *estrogens* and *progesterone*.

- Secretions from the gonads are controlled by the anterior pituitary hormones.
- These sex hormones maintain the sex organs and secondary sex characteristics.

The effects of anabolic steroid use

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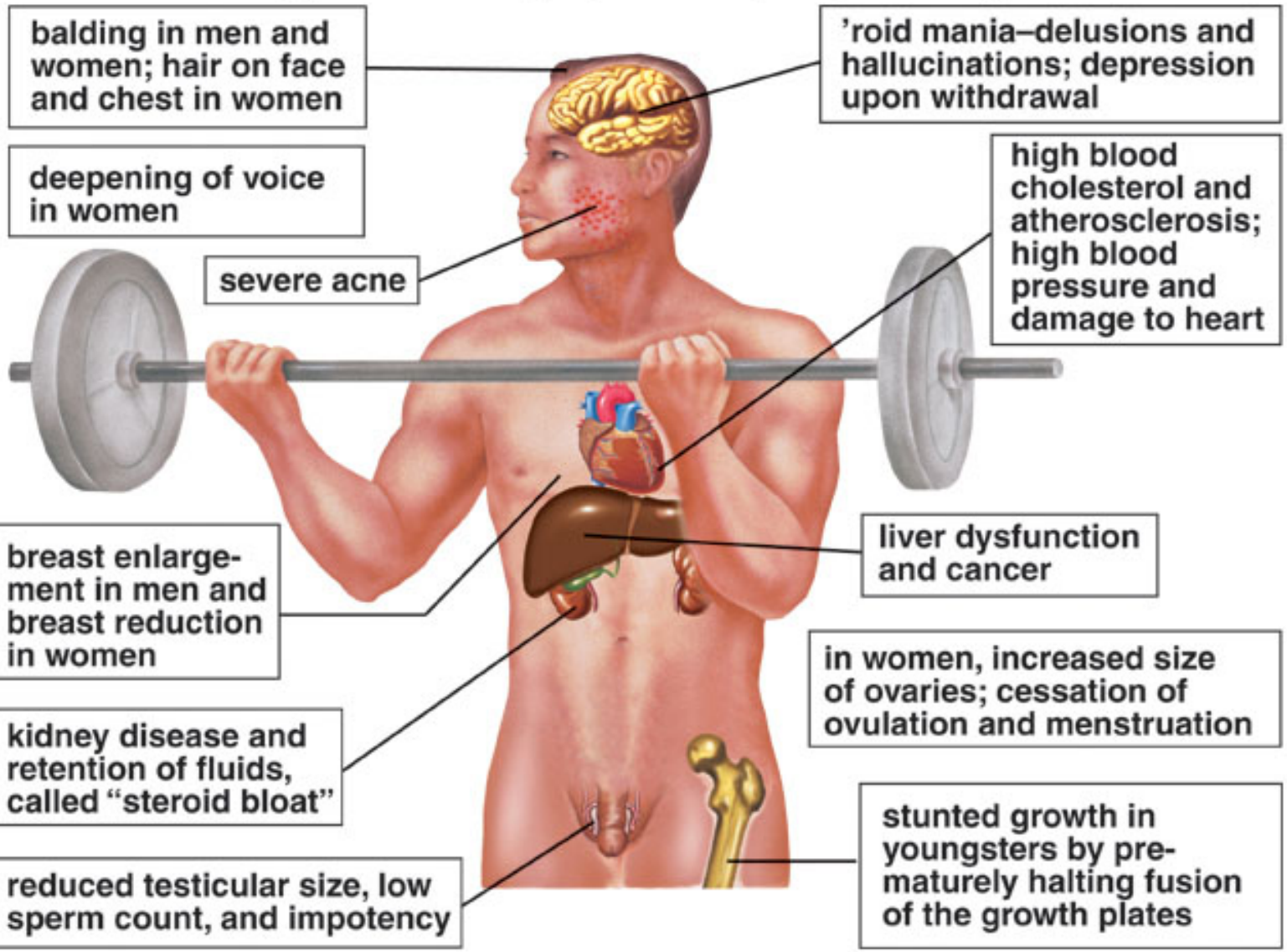
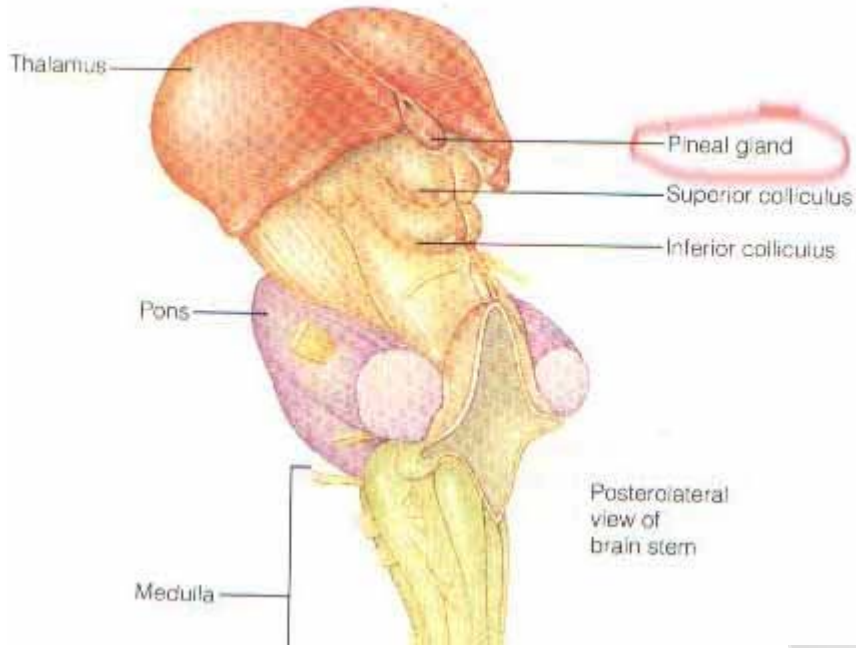


Thymus Gland

- The thymus under the sternum produces *thymosins* that stimulate T lymphocyte production and maturation.
- The thymus decreases in size with age and becomes fatty.

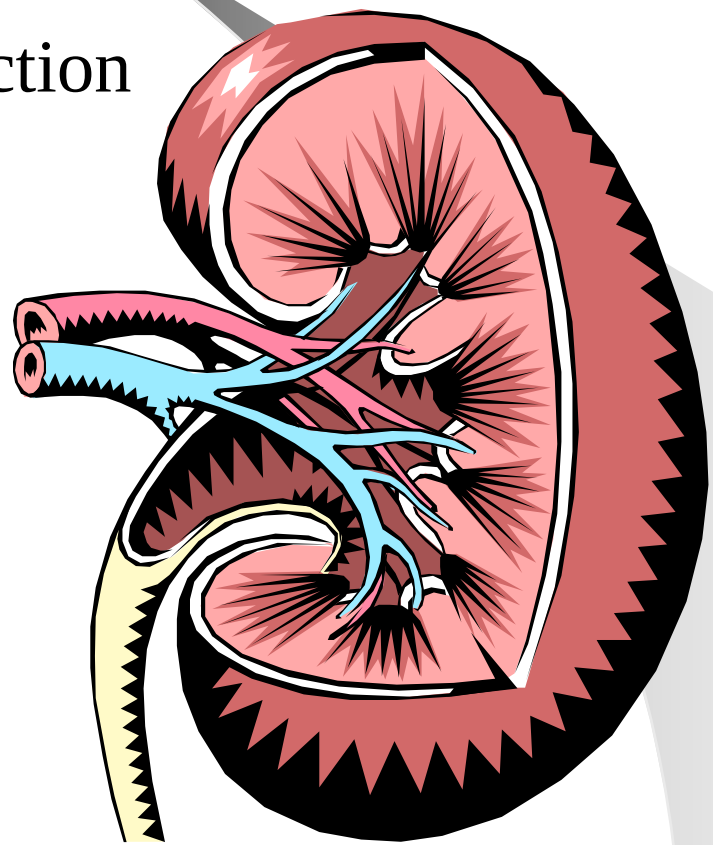
Pineal Gland

The pineal gland in the brain produces *melatonin* which is involved in circadian rhythms and the timing of development of the reproductive organs.



The Endocrine Glands

- Kidneys (erythropoietin)
  - regulates red blood cell production



Hormones from Other Tissues

Leptin

- Adipose tissue produces *leptin* that acts on the hypothalamus where it signals satiety—that the individual feels “full” and has had enough to eat.

Prostaglandins

- *Prostaglandins* a fatty acid.

- They cause uterine muscle contraction and are involved in the pain of menstrual cramps

Chemical Signals

- A *chemical signal* is any substance that affects cell metabolism or behavior of the individual.
- Chemical signals can be used between body parts, between cells, and between individual organisms (*pheromones*).
- Underarm secretions may be slightly attractive and may be involved in synchronizing the menstrual cycles of women who live together.

The Action of Hormones

- *Steroid hormones* enter the nucleus and combine with a receptor protein, and the hormone-receptor complex attaches to DNA and activates certain genes.

- *Peptide hormones* are usually received by a hormone receptor protein located in the plasma membrane.

Student Quiz

- http://www.zerobio.com/drag_oa/endo.htm