

## Invertebrate hormones

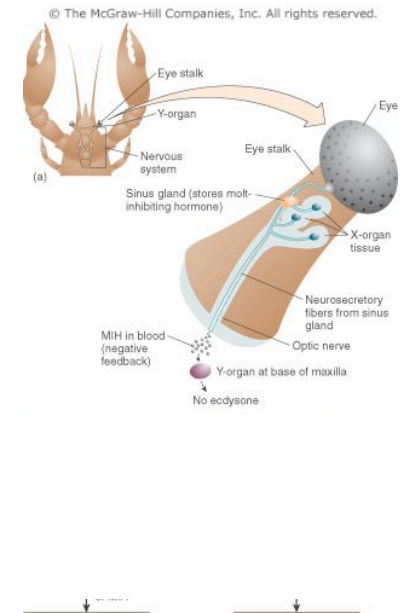
In “lower” invertebrates, ‘hormones’ consist of neuropeptides, which regulate growth, maturation and reproduction. These were probably the first signaling molecules to show up in animal evolution.

The best examples of how hormones regulate these parameters in invertebrates are seen in arthropods (crustaceans and insects):

## Ecdysis in crustaceans

The X-organ is responsible for the production of molting-inhibiting hormone; once produced, it is stored in the sinus gland.

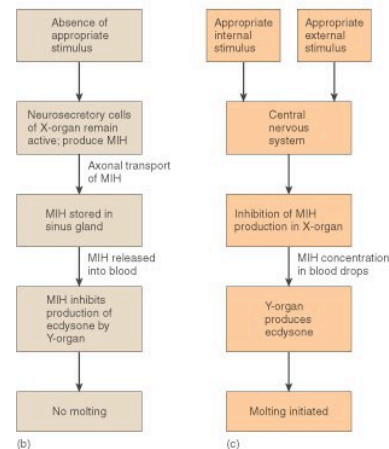
When the MIH concentration in the blood drops, the Y-organ releases Ecdysone and molting is initiated.



## Ecdysis in crustaceans

The X-organ is responsible for the production of molting-inhibiting hormone; once produced, it is stored in the sinus gland.

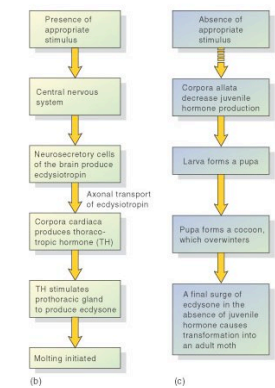
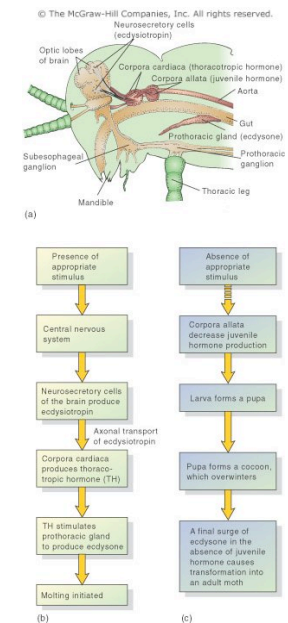
When the MIH concentration in the blood drops, the Y-organ releases Ecdysone and molting is initiated.



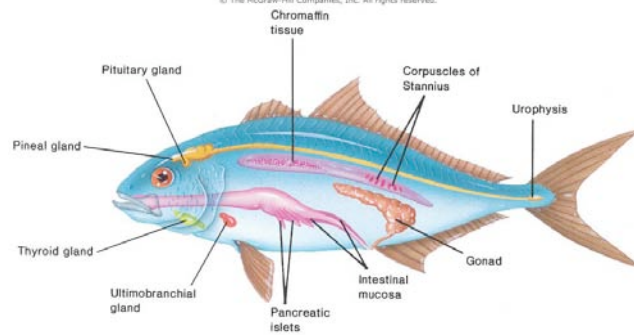
## Ecdysis in insects

The presence of a stimulus to the CNS stimulates neurosecretory cells (pars intercerebralis) in the optic lobes of the brain.

Ecdysiotropin is secreted, which is transported to the corpora cardiaca, which releases throacotropic hormone, which is carried to prothoracic glands, and stimulates the release of ecdysone. Molting is initiated.



## Vertebrate hormones



The major regions of hormone secretion in fish are the *pineal gland* and *preoptic nuclei*, which secrete hormones associated with growth, development, metabolism and activity (e.g. melatonin)  
The *urophysis* produces neuropeptides that help control water and ion balance, blood pressure, and smooth muscle contractions

## Hormone evolution

This forces us to consider some points:

- (1) Hormones (or neuropeptides) with the same function in different species may not be chemically identical
- (2) Certain hormones are species-specific with respect to their function; conversely, some hormones produced in one species may be completely functional in another species
- (3) A hormone from one species may elicit a different response in the same target cell or tissue of a different species

## Hormone evolution

This forces us to consider some points:

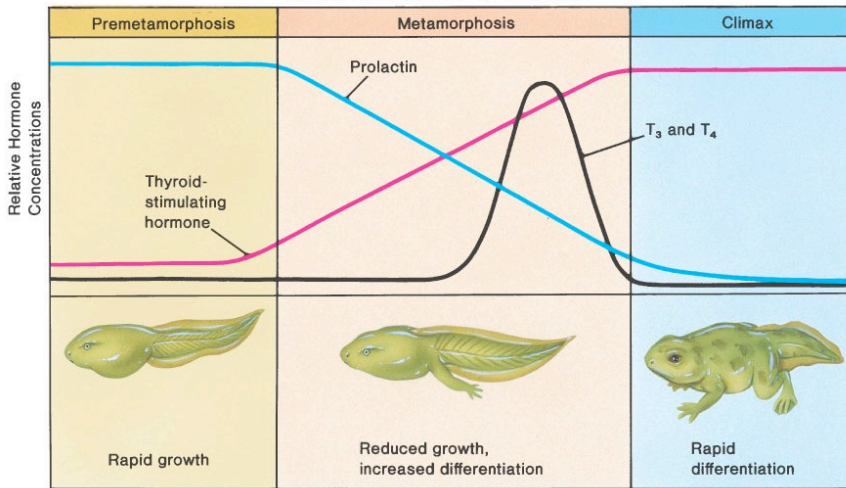
- (1) Hormones (or neuropeptides) with the same function in different species may not be chemically identical
- (2) Certain hormones are species-specific with respect to their function; conversely, some hormones produced in one species may be completely functional in another species
- (3) A hormone from one species may elicit a different response in the same target cell or tissue of a different species

## Hormone evolution

This forces us to consider some points:

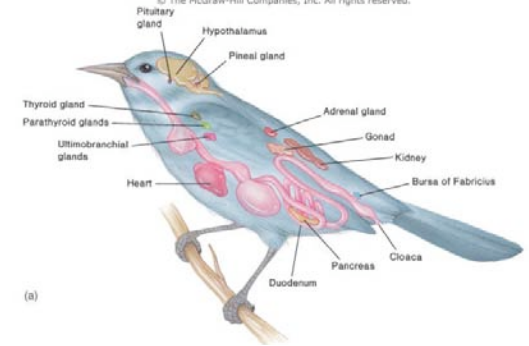
- (1) Hormones (or neuropeptides) with the same function in different species may not be chemically identical
- (2) Certain hormones are species-specific with respect to their function; conversely, some hormones produced in one species may be completely functional in another species
- (3) A hormone from one species may elicit a different response in the same target cell or tissue of a different species

© The McGraw-Hill Companies, Inc. All rights reserved.



## Birds

© The McGraw-Hill Companies, Inc. All rights reserved.

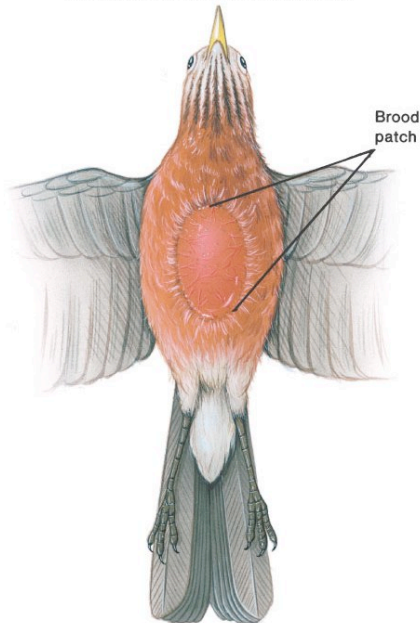


(a)

(b)

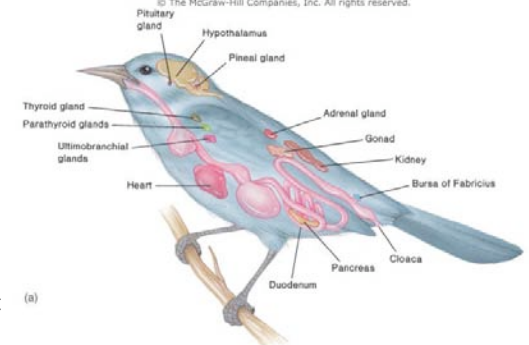
Prolactin is responsible for the production of “pigeon’s milk”, regulation of parental behavior, and with estrogen, development of the brood patch

© The McGraw-Hill Companies, Inc. All rights reserved.



## Birds

© The McGraw-Hill Companies, Inc. All rights reserved.



(a)

(b)

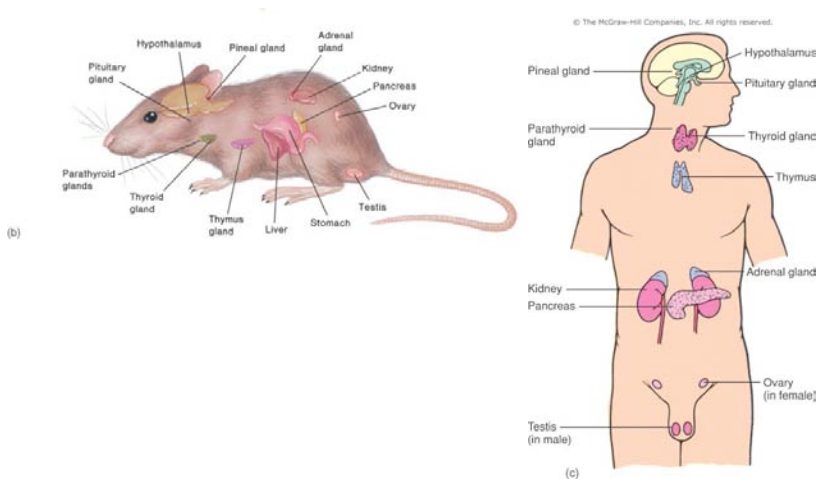
Prolactin is responsible for the production of “pigeon’s milk”, regulation of parental behavior, and with estrogen, development of the brood patch

Testosterone secreted by the testes controls secondary sexual characteristics (bright plumage, color, comb)—all of which influence behavior

Ultimobranchial glands secrete calcitonin, which is responsible for regulating blood calcium levels.

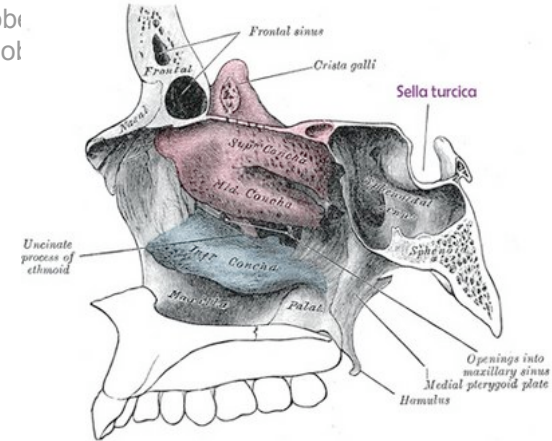
The bursa of Fabricius is well developed during embryological development, but shrinks upon hatching. It produces secretions responsible for maturation of white blood cells, which play a role in immunity.

# Mammals



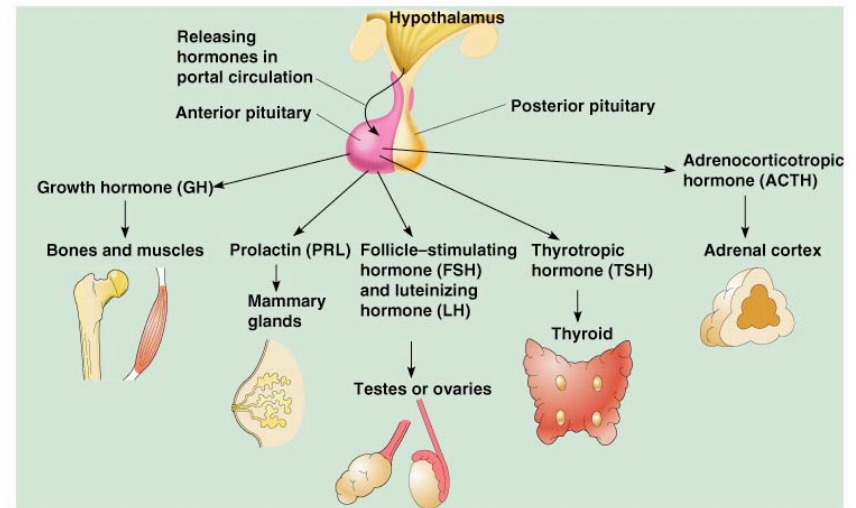
# Pituitary gland

Hangs by a stalk from the inferior surface of the *hypothalamus*  
 Nestled in the *sella turcica* (=Turkish saddle)  
 Anterior lobe  
 Posterior lobe



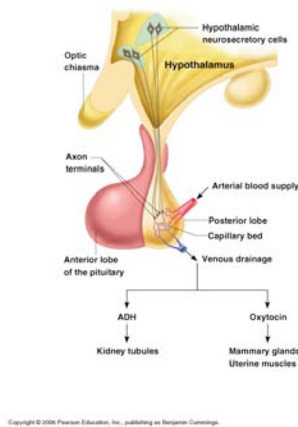
# Anterior pituitary hormones

All anterior pituitary hormones are:  
 proteins (or peptides)  
 act through second-messenger systems  
 regulated by hormonal stimulus and negative feedback  
 4 of the 6 are called *tropic* hormones (= stimulates target organs, which are also endocrine organs)

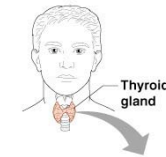


## Posterior pituitary hormones

Made by *neurosecretory* cells in the hypothalamus; pituitary is actually more of a storage organ than a production center

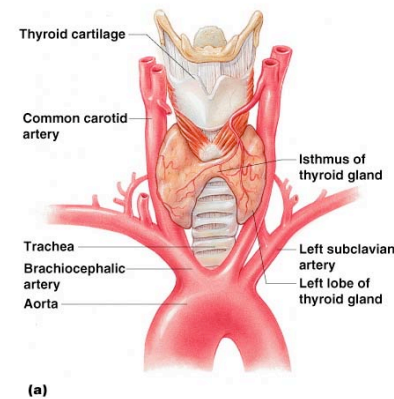


## Thyroid gland



Secretes two hormones:

- Thyroid hormone (from colloid filled follicles)
- Calcitonin (from C cells)



## Thyroid hormone

Actually two separate hormones:

*Thyroxine (T<sub>4</sub>)*

*Triiodothyronine (T<sub>3</sub>)*

T<sub>3</sub> is usually converted from T<sub>4</sub> at the target tissue

Controls rate at which glucose is metabolized and general body metabolism

Also functions in normal growth of reproductive and nervous tissue

## Perchlorate and thyroid function

Perchlorate is used in rocket fuels, pyrotechnics, and other explosives

It is also present in drinking water, and other foods

Can inhibit iodide uptake and reduce thyroid function

Can lead to metabolic disorders, but more commonly feelings of sluggishness and coldness are common

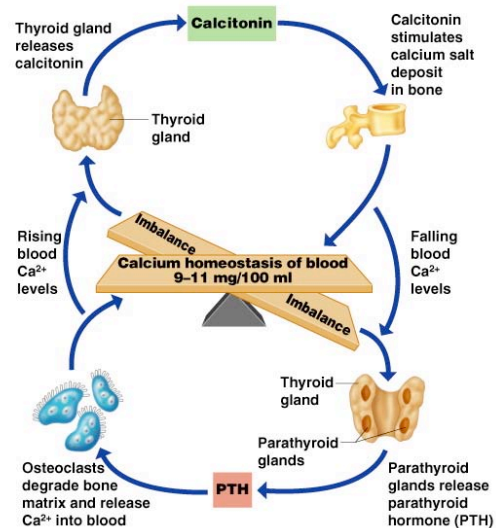
# Calcitonin

Causes blood calcium levels to be reduced by signaling the bones to absorb more  
 Acts as an *antagonist* to parathyroid hormone  
 Made in *C cells* adjacent to *thyroid follicles*  
 May not be as present in elderly adults (this may explain the progression of osteoporosis in older adults)

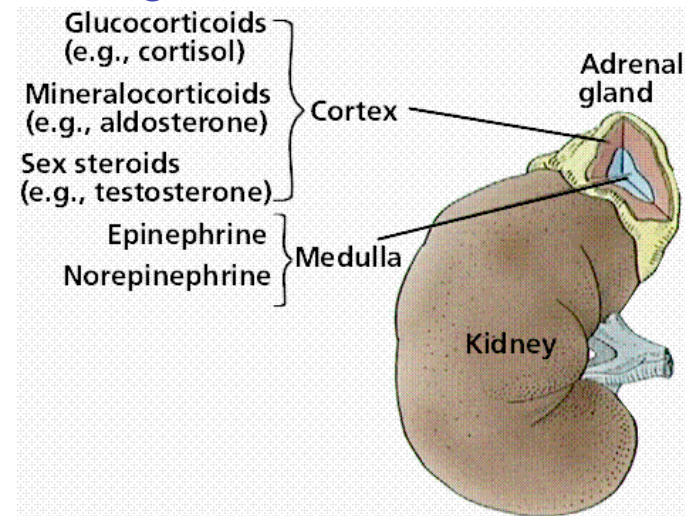
# Parathyroid glands

Usually found on the posterior of the thyroid gland (2 glands on each lobe, 4 total)  
 The major regulator of blood calcium levels  
 Stimulates *osteoclasts* to break down bone matrix and release calcium into the blood  
 Also stimulates kidneys and intestine to absorb more calcium to help increase blood calcium levels

# Calcium balance



# Adrenal glands



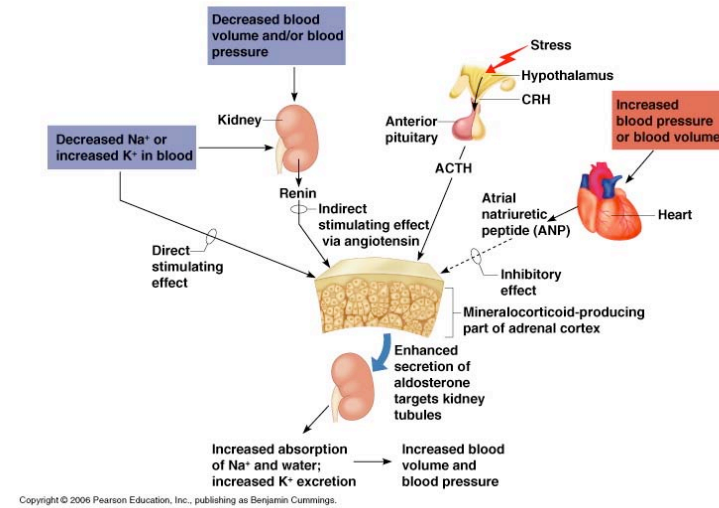
# Adrenal cortex hormones

**Mineralcorticoids** (mainly *aldosterone*)

Regulate water and electrolyte balance of the body by targeting *kidney tubules* for selective reabsorption of ions

Aldosterone regulates blood sodium levels (and thus blood pressure)

# Aldosterone regulation



# Glucocorticoids

Cortisone and cortisol

Work in the management of long-term stress by promoting glucose metabolism, release of prostaglandins, reducing swelling

# Sex hormones

Made in low amounts throughout life

Mainly androgens are made

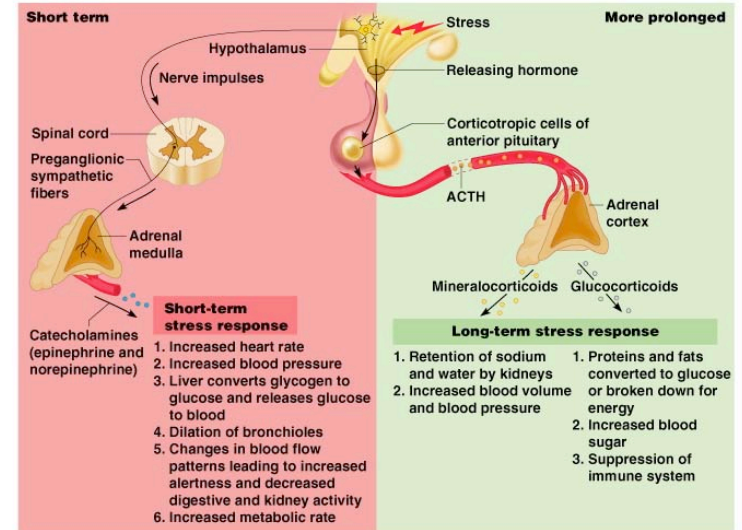
Some estrogens are also made here

## Adrenal medulla hormones

Stimulated by the **sympathetic nervous system** to secrete its hormones

**Catecholamines** (adrenaline or epinephrine) are released)

## The stress response



Copyright © 2006 Pearson Education, Inc., publishing as Benjamin Cummings.

## Pancreatic Islets

**Beta cells** secrete the hormone **insulin**, which signals cells to “take up” more circulatory glucose, reducing blood glucose levels

The hormone **glucagon** acts as an antagonist to insulin, causing glucose release from the liver during times of low blood sugar; it is secreted by **alpha cells**

## Pineal gland

Pinecone shaped gland located in the brain’s third ventricle

Melatonin is secreted

Melatonin levels are highest at night, and are lowest around noon

Believed to regulate the sleep cycle as well as regulate the timing of sexual maturity

## Thymus gland

Located in the upper thorax, posterior to the sternum

Secretes *thymosin* which helps the thymus act as an incubator for *T cells*, which help boost your immune response

## Testicular hormones

Testosterone is the most important of the androgens secreted by the testes

Causes development of male sex characteristics

Necessary for continued production of sperm

## Ovarian hormones

Produce estrogens and progesterone

Estrogens are produced by *Graafian follicles* and promote the development of secondary sexual characteristics in females

Estrogens also play a large role in the *menstrual cycle* and help the breasts to produce milk

Progesterone quiets the muscles of the uterus during pregnancy to discourage abortion

Progesterone is secreted by the *corpus luteum*

## The placenta

Has many sustaining qualities for growing babies

Human chorionic gonadotropin (hCG) is produced early in pregnancy to signal the ovaries to continue producing estrogen and progesterone so the uterine lining is not sloughed off

Later, the placenta produces its own estrogen/ progesterone

Human placental lactogen also functions to prepare the breasts for lactation

### Hormones During Pregnancy

