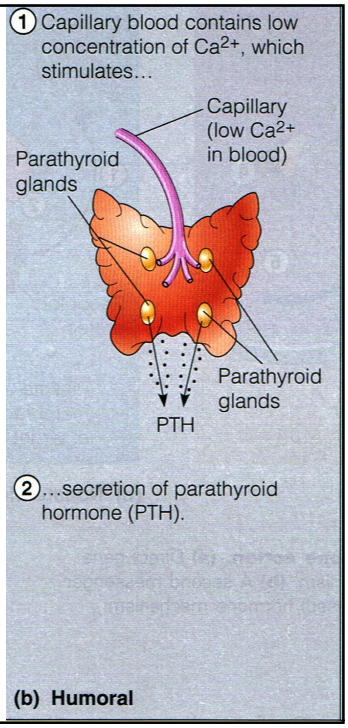
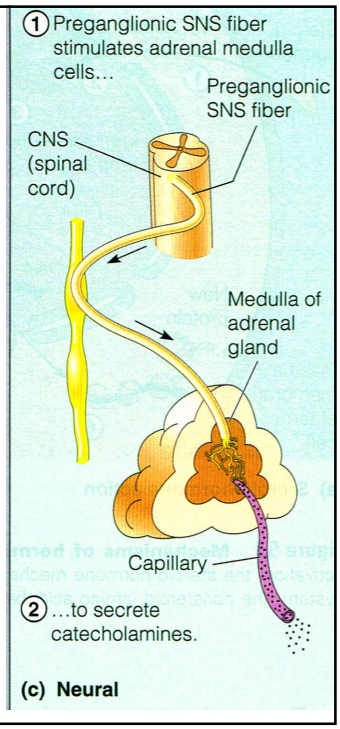
Humoral Stimuli

- Blood levels of certain ions and nutrients stimulate hormone release
- Examples
  - Decreased blood calcium levels will increase parathyroid hormone (PTH) secretion by the parathyroid glands



Neural Stimuli

- Nerve fibers stimulate hormone release
- Example
  - sympathetic nervous system stimulate the adrenal medulla to release norepinephrine and epinephrine



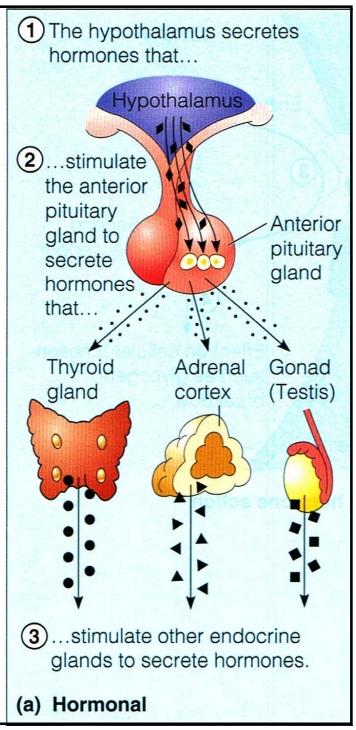
The Major Endocrine Organs

1. Pituitary
2. Thyroid
3. Parathyroid
4. Adrenal
5. Pineal
6. Thymus
7. Pancreas
8. Gonads

Pituitary Gland

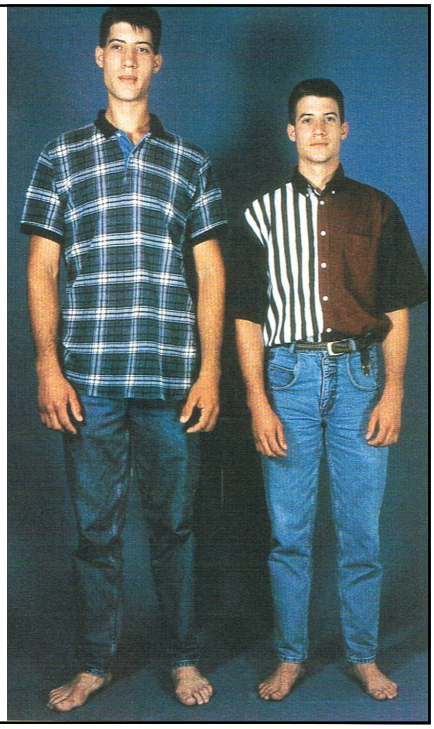
- Hangs by a stalk from the inferior surface of the hypothalamus
- Located in the sphenoid bone
- Has two lobes

1. Anterior pituitary secret 6 hormones
   - Growth hormone and prolactin affect nonendocrine targets
   - Thyrotropic, adrenocorticotropic hormone, and the two gonadotropic hormones stimulate endocrine glands, to secrete their hormones
2. Posterior pituitary:
   - Secrets ADH and Oxytocin



Growth hormone (GH)

- Affect skeletal muscles and long bones
- Plays a role in determining final body size
- **Imbalance**
  - Hyposecretion during childhood result in dwarfism
  - Hypersecretion during childhood results in gigantism
  - Hypersecretion after long bone growth has ended result in acromegaly (enlargement of facial bones, feet and hands, and thickening of soft tissues)
  - Most cases of Hypersecretion result from tumor cells producing the hormones



Prolactin (PRL)

- target the breast and stimulates and maintains milk production by the mother's breasts
- Its function in males is not known

Adrenocorticotropic hormone (ACTH)

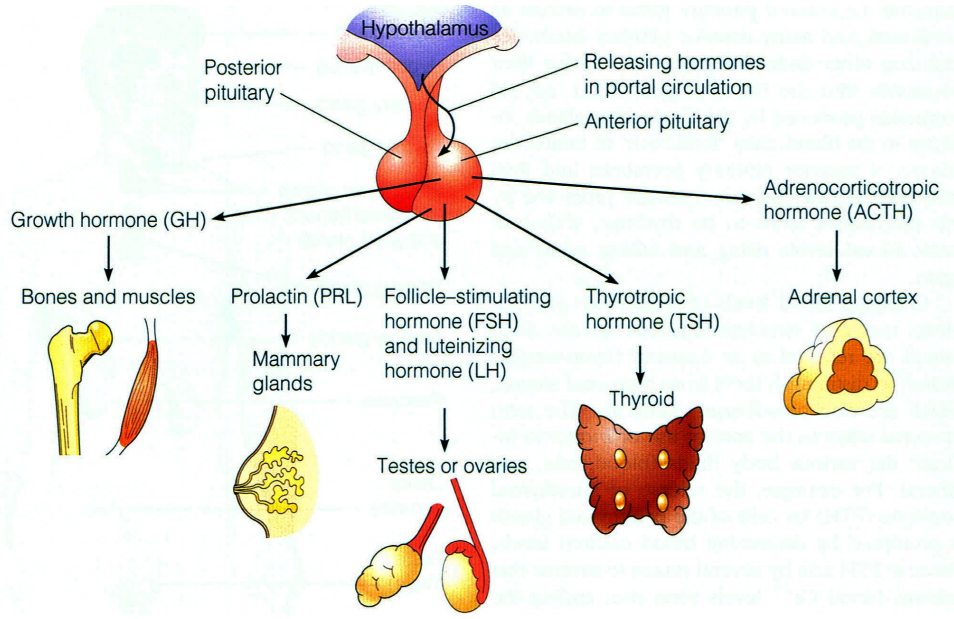
- Regulates the cortex of the adrenal gland.

Thyroid-stimulating hormone (TSH)

- Influences the activity of the thyroid gland.

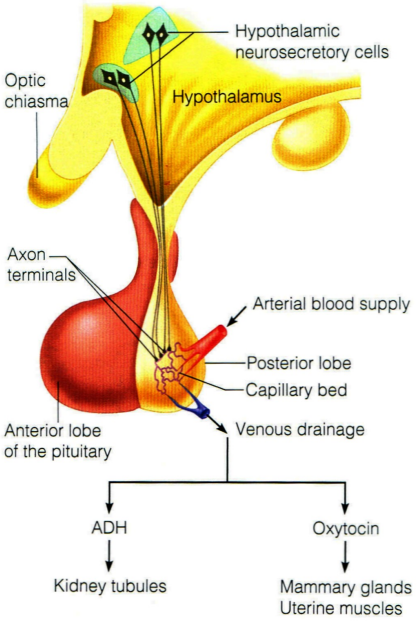
Gonadotropic Hormones

- **Follicle Stimulating Hormone (FSH)**
  - **In female**, stimulates follicle development in the ovaries.
    - As the follicles mature, they produce estrogen
  - **In male,** stimulates sperm development by the testes
- **Luteinizing Hormone (LH)**
  - **In female:**
    - triggers ovulation and causes the ruptured follicle to become a corpus luteum
    - stimulates the corpus luteum to produce progesterone and some estrogen
  - **In male**
    - stimulates testosterone production by the testes.
- **IMBALANCE**
  - Hyposecretion of FSH or LH leads to sterility in males and females



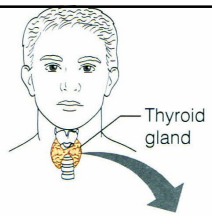
Hormones of the Posterior Pituitary

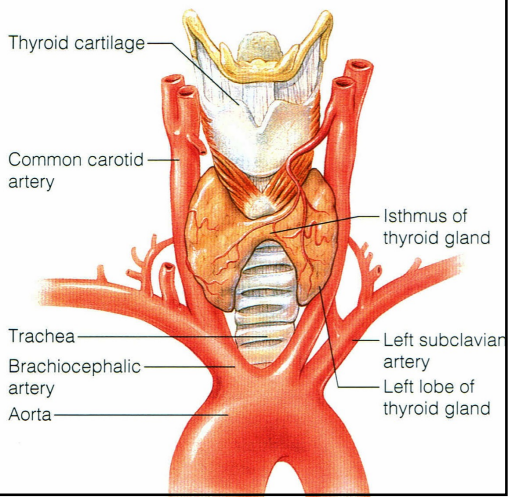
- Made in the hypothalamus; stored and secreted from posterior pituitary gland
- **Oxytocin**
  - Stimulates uterine contractions during labor
  - Causes milk letdown in a nursing woman
- **Antidiuretic hormone (ADH).**
  - causes the kidneys to reabsorb water which decrease urine volume and increase blood volume
  - In large amounts causes vasoconstriction which increases blood pressure
  - Alcohol inhibits ADH secretion
  - Hyposecretion of ADH causes *diabetes insipidus*



Thyroid Gland

- Located in the neck inferior to adam's apple
- Produce two hormones
- **Thyroid hormone**
  - Controls metabolism
  - Every cell in the body is a target
  - Important for normal tissue growth and development, especially the nervous systems
- **Calcitonin**
  - Decreases blood calcium levels





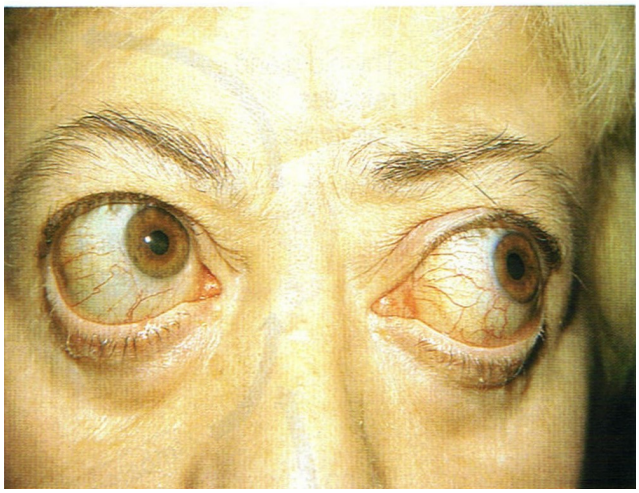
IMBALANCE

- Hypothyroidism in early childhood may cause ***cretinism*** which results in **dwarfism**
- Hypothyroidism in adults results in **myxedema:**
  - mental sluggishness, puffiness of the face, fatigue, poor muscle tone, low body temperature, obesity, and dry skin
- Hyperthyroidism results in
  - a high basal metabolic rate, intolerance of heat, rapid heartbeat, weight loss, nervous and agitated behavior and a general inability to relax.

Goiter

- enlargement of the thyroid gland due to iodine deficiency
- TSH stimulate thyroxin secretion → thyroid makes only the peptide part of the molecule which is nonfunctional hormone → Thyroid fails to provide negative feedback to inhibit TSH release → goiter

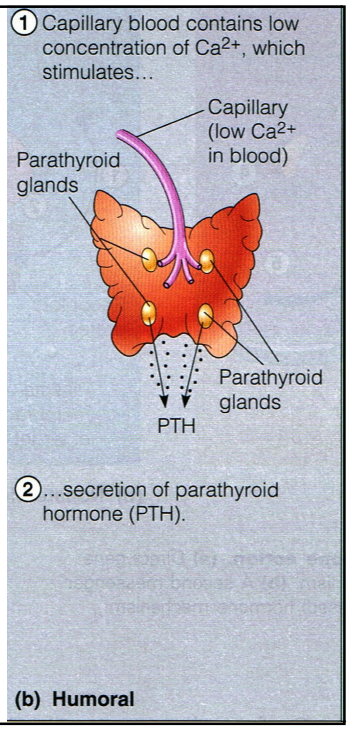
Graves' disease



- Form of hyperthyroidism
- the thyroid gland enlarges and the eyes may bulge, or protrude anteriorly

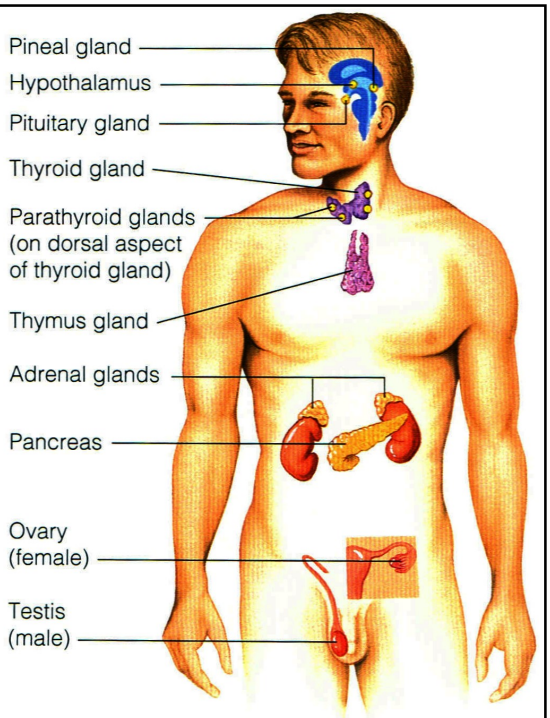
Parathyroid Glands

- Four glands on the posterior surface of the thyroid gland
- some may be in other regions of the neck.
- secrete **parathyroid hormone (PTH)**
- Decrease blood calcium levels will increase PTH which increase calcium level in the blood
- PTH also stimulates the kidneys to absorb more calcium



Adrenal Glands

- Two glands over the kidneys
- Secret Glucocorticoids :
  - Mineralocorticoids
  - Glucocorticoids
  - Sex hormones.
  - EP and NE



Mineralocorticoids

- Mainly **aldosterone**.
- Regulates sodium and potassium ions concentrations
- When aldosterone rises, the kidney reclaim more sodium ions and excrete potassium ions in urine.
- Water follows sodium reabsorption; helps regulate body fluids
- Hypoaldosteronisim
  - Sodium and water are lost from the body, which leads to problems with electrolyte and water balance. This in turn, causes the muscles to become weak, and shock is a possibility
- Hyperaldosteronisim
  - More water and sodium are retained, leading to high blood pressure and edema
  - potassium loss may disrupt heart activity and nervous system

Glucocorticoids

- include cortisone and cortisol
- response to ACTH secreted from the pituitary gland
- promote normal cell metabolism and help the body to resist *long-term stressors*
  - Increase glucocorticoids level, the fats and proteins are broken down and converted to glucose, which is released to the blood
- control inflammation
- Glucocorticoids deficiency can cause
  - Hypoglycemia
  - Less ability to cope with stress
  - suppression of the immune system and increase susceptibility to infection.
  - Complete lack of glucocorticoids is incompatible with life

Cushing's syndrome

- Excessive output of glucocorticoids results in a moon face, buffalo hump of fat on the upper back, high blood pressure, hyperglycemia and possible diabetes.
- Weakening of the bones as protein is withdrawn to be converted to glucose, and severe depression of the immune system.

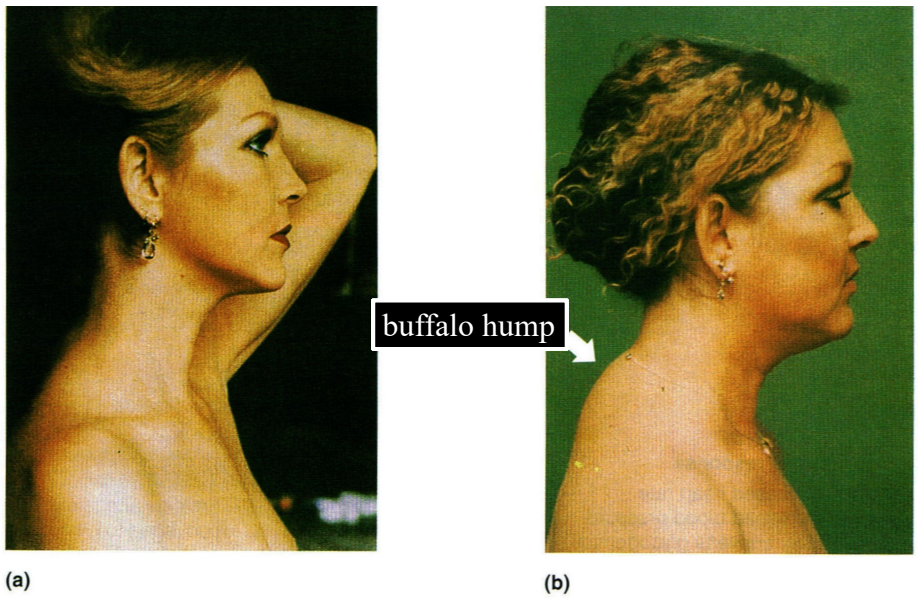


Figure 9.11 Appearance of a woman (a) before and (b) during Cushing's disease. The characteristic "buffalo hump" of fat on the woman's upper back is indicated by a white arrow.

Sex hormones

- Mainly androgens (male sex hormones), some estrogens (female sex hormones) are also formed
- **HRMONAL IMBALANCE**
  - Hypersecretion of the sex hormones leads to ***mascuilinization*** *r*egardless of sex
  - In adult males, the effect may be masked
  - In females, a beard develops, and a masculine pattern of body hair distribution occurs, among other things.

- epinephrine and norepinephrine
  - increase heart rate, blood pressure, blood glucose levels, dilate the small passageways of the lungs
- **IMBALANCE**
  - **Hypersecretion of catecholamines** leads to symptoms typical of excessive sympathetic nervous system activity
    - rapidly beating heart, high blood pressure, a tendency to perspire, very irritable

Pancreatic Islets

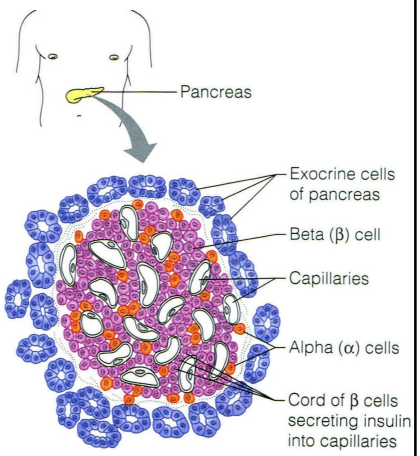
- The pancreases located behind the stomach
- Pancreatic islets scattered among exocrine cells. The islets produce two hormones

1. Insulin

- Decrease blood glucose level
- Insulin increases cell's ability to transport glucose across the cell membranes
- Decrease blood glucose level, the insulin release decreases

2. Glucagon

- Antagonist to insulin
- Increase blood glucose level
- stimulates glycogenolysis in the liver, and the release of glucose into the blood

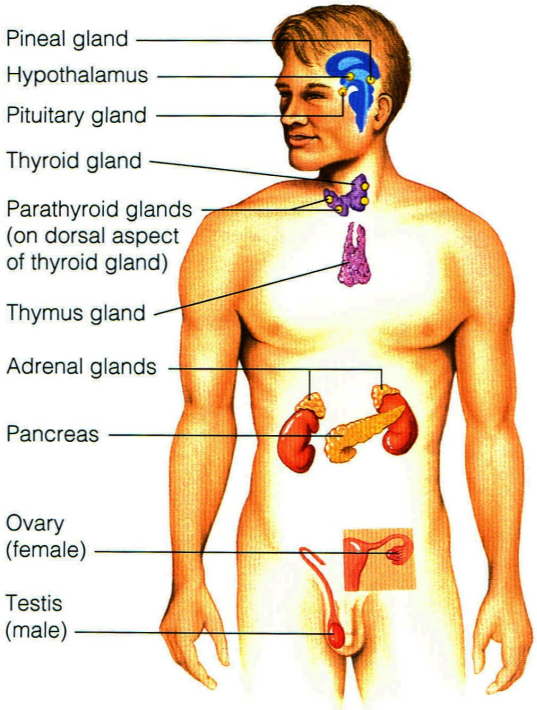


Diabetes Mellitus

- Insulin deficiency leads to increase blood levels of glucose
- Glucose appears in urine because the kidney cannot reabsorb it fast enough
- The three cardinal signs of diabetes mellitus are:
  - *Polyuria:* urination
  - *Polydipsia:* thirst resulting from water loss
  - *Polyphagia:* hunger due to inability to use sugars

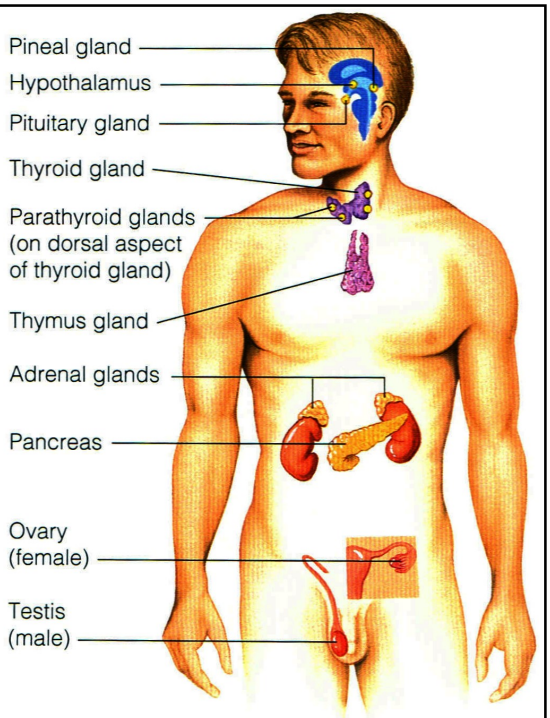
Pineal Gland

- Found on the roof of the third ventricle
- Secret melatonin
  - The levels of melatonin rise and fall during the day and night.
  - Peak levels occur at night and make us drowsy



Thymus

- Located in the upper thorax, posterior to the sternum.
- produces a hormone called **thymosin**
- during childhood the thymus involved in the maturation of T lymphocytes



Gonads

- **Ovaries**
  - paired, almond-sized located in the pelvic cavity
  - produce ova and estrogens and progesterone
  - The ovaries begin to function at puberty
- **Testes**
  - Paired, suspended in the *scrotum,* outside the pelvic cavity
  - produce *sperm and* male sex hormones, or **androgens**

Hormones of the Ovaries

- **Estrogens**
  - Stimulate development of female secondary sex characteristics
  - Estrogens work with progesterone to prepare the uterus to receive a fertilized egg. This results in cyclic changes in the uterine lining, the ***menstrual cycle.***
  - Estrogens help maintain pregnancy and prepare the breasts to produce milk (lactation)
- **Progesterone**
  - quiets the uterus so the implanted embryo will not be aborted
  - prepare breast tissue for lactation
- Hyposecretion of the ovarian hormones stop the ability of a woman to conceive

Hormones of the Testes

- Testosterone
  - promotes the growth and maturation of the reproductive system in males
  - causes development of the male's secondary sex characteristics (beard, heavy bones and muscles, voice)
  - stimulating the male sex drive
  - In adulthood, testosterone is necessary for continuous production of sperm
- Hyposecretion, the man becomes sterile.
- The function of the testes begin at puberty under the influence of the anterior pituitary gonadotropic hormones
  - Testosterone production is specifically stimulated by LH

Placenta

- Formed in the uterus of pregnant women.
- Function: respiratory and nutrition-delivery systems for the fetus and produces hormones
- **human chronic gonadotropic (hCG)**
  - in early pregnancy**,** stimulates the corpus luteum to *continue* producing estrogen and progesterone
- In the third month, placenta assumes production of ***estrogen* and *progesterone,*** and the ovaries become inactive for the rest of the pregnancy
- estrogen and progesterone maintain pregnancy and prepare the breasts for producing milk
- **Human placental lactogen (hPL**) works with estrogen and progesterone in preparing the breasts for lactation.
- **Relaxin:** relaxes the mother's pelvic ligaments and the pubic symphysis, which eases birth passage

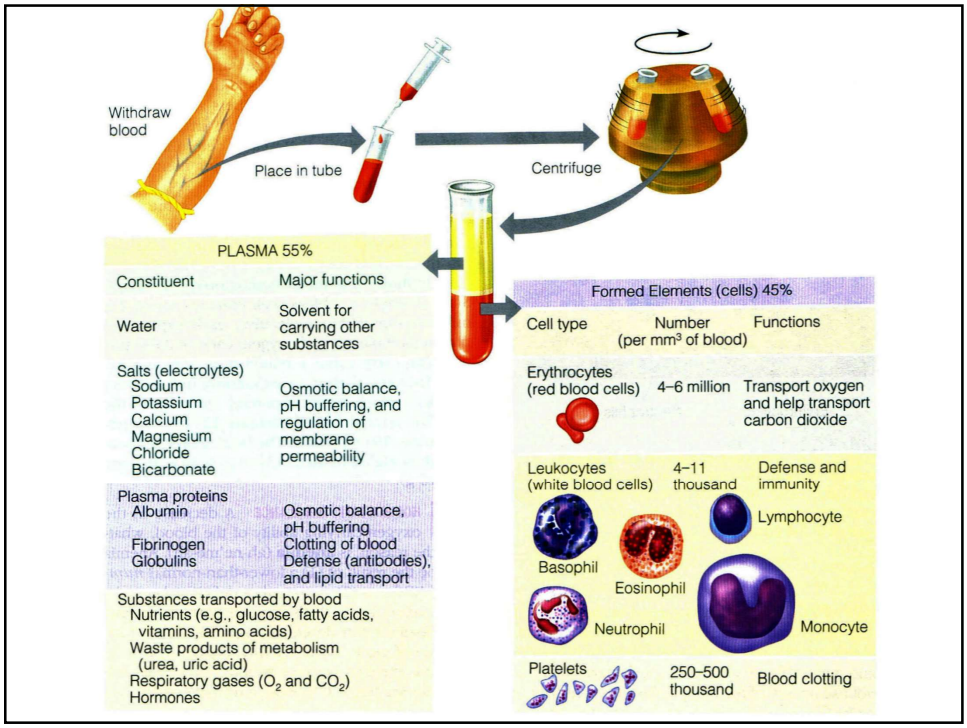
Aging, changes occur in both sexes

- The efficiency of the endocrine system gradually declines in old age
- growth hormone output declines; explains muscle atrophy in old age
- Elderly persons are less able to resist stress and infection
- adult-onset diabetes is most common in the elderly

Blood

Blood

- Blood transports nutrients, wastes, body heat …etc. through blood vessels
- Consist of blood cells (**formed elements)** suspended in fluid (plasma)
- **Hematocrit**
  - In a centrifuged blood sample, the formed elements precipitate and the plasma rises to the top
  - RBCs account about 45% of the total blood volume
  - WBCs and platelets contribute less than 1%
  - The remaining 55% is plasma



Physical Characteristics and Volume

- sticky opaque fluid
- metallic taste
- The color of blood varies from bright red (oxygen-rich) to a dull red (oxygen-poor)
- pH between 7.35 and 7.45
- Accounts for approximately 8% of body weight.
- in healthy males is 5 to 6 liters

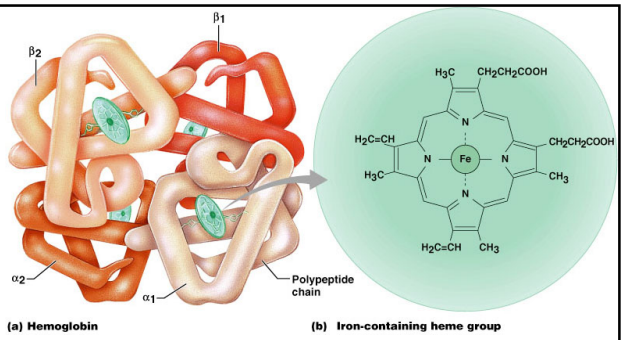
Plasma

- Consist of water and dissolved substances such as nutrients, ions, gases, hormones, proteins, and wastes products
- Plasma proteins mostly made by the liver, except for antibodies and protein hormones
- Functions:
  - albumin contributes to the osmotic pressure of blood
  - clotting proteins stop blood loss in injured vessels
  - antibodies protect the body from pathogens
- the composition of plasma is kept relatively constant

Erythrocytes

- Doughnut shape
- Contain hemoglobin
- No nucleus
- life span 100 to 120 days.
- Eliminated by the liver, spleen, and other body tissues.
- Produced in the red bone marrow.
- production is controlled by erythropoietin hormone produced by the kidneys

Hemoglobin

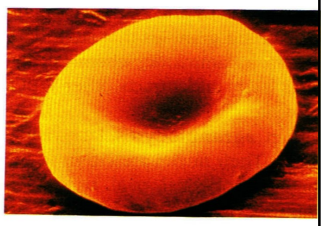


(a) Hemoglobin (b) Iron-containing heme group

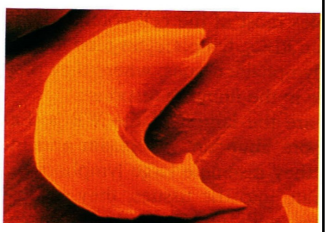
- Hemoglobin has 4 chains **two alpha and two beta**
- Each chain contains iron ion that binds to oxygen
- Alpha and beta chains bind CO2, forming carbaminohemoglobin
- Each RBC has **280 million Hb molecules.**
- Each RBC can carry more than a **billion molecule of oxygen**

IMBALANCE

- anemia is a decrease in the oxygen-carrying ability of the blood, whatever the reason.
- Iron-deficiency anemia is common in women due to monthly menses.
- Pernicious anemia is due to lack of vitamin B12
- Sickle-cell anemia is a genetic disorder due to abnormal hemoglobin formed. occurs chiefly in African descends
- Polycythemia is an excessive or abnormal increase in the number of erythrocytes



(a)



Leukocytes (WBCs)

- **Neutrophils:**
  - have multilobed nucleus
  - phagocytes at sites of acute infection
- **Eosinophils**
  - have a blue-red nucleus
  - Their number increases during allergies and infections by parasitic worms
- **Basophils**
  - Have histamine-containing granules
    - ***Histamine is an inflammatory chemical that makes blood vessels leaky and attracts other WBCs to the inflammatory site.***

Granulocytes

- Neutrophils

- Eosinophils

- Basophils

Leukocytes

- **Lymphocytes**
  - have a large dark purple nucleus that occupies most of the cell volume
  - reside in lymphatic tissues
  - play a role in the immune response.
- **Monocytes**
  - the largest of the WBCs.
  - They change into macrophages in the tissues.
    - ***Macrophages are important in fighting chronic infections, such as tuberculosis.***

Agranulocytes

- Lymphocytes

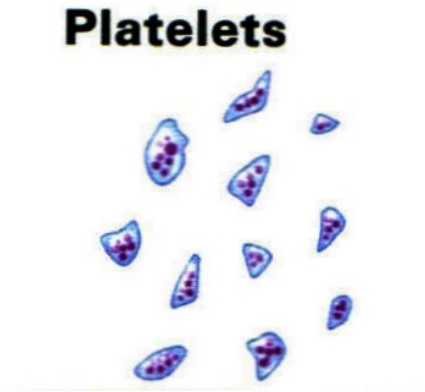
- Monocytes

Leukocytes, WBC

- less numerous than red blood cells
- crucial to body defense against diseases
- **Leukocytosis:**
  - WBC count above normal
- **Leukopenia:**
  - abnormally low WBC count.
  - commonly caused by certain drugs, such as corticosteroids and anticancer agents.

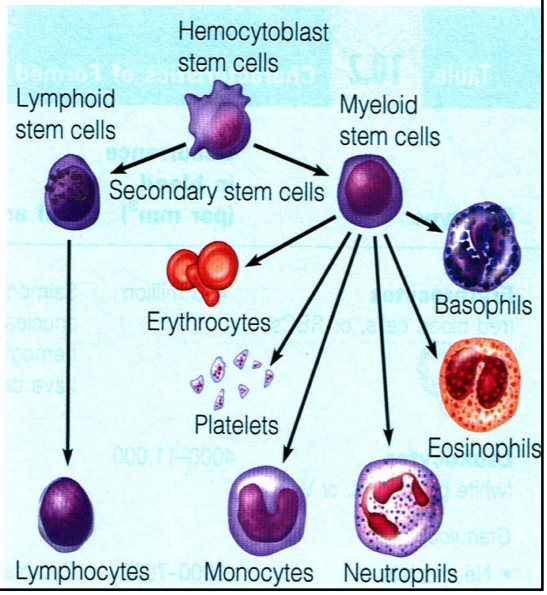
Platelets

- not cells, but fragments of **megakaryocytes**
- needed for the clotting process



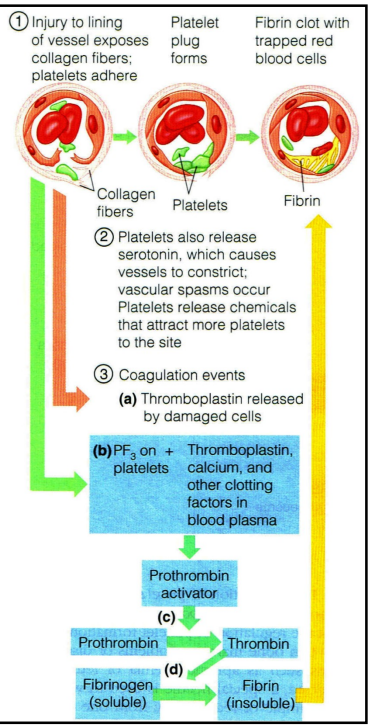
Hematopoiesis (Blood Cell Formation)

- occurs in red bone marrow (myeloid tissue)
  - In adults, found in the bones of the skull, pelvis, ribs, sternum, and proximal end of the humerus and femur.
- All formed elements arise from hemocytoblast in the red bone marrow



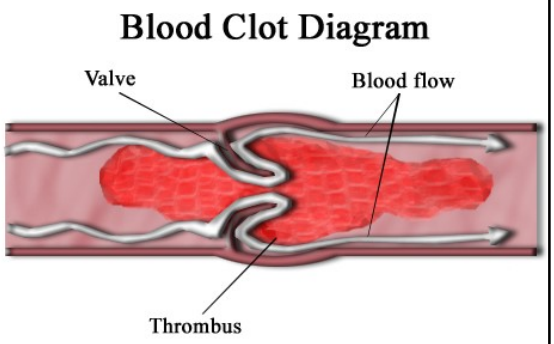
Homostasis

1. Vascular spasms
2. Platelets plug
3. Coagulation because of clotting protein. Clotting proteins mostly made in the liver. Synthesis of Some clotting protein requires vitamin K



Undesirable Clotting

- **thrombus**
  - A clot in blood vessel
  - may breaks away from the vessel and floats in the bloodstream to become an embolus
  - a cerebral **embolus** may cause a stroke



Bleeding Disorders

- platelet deficiency (thrombocytopenia)
  - cause spontaneous bleeding from small blood vessels called *petechiae* on the skin.
  - arise from conditions that suppresses bone marrow such as bone marrow cancer, radiation, or certain drugs.
- clotting factors deficiency
  - Due to deficiency of vit K, or liver disease
- Hemophilia
  - bleeding disorders result from a lack of clotting factors

ABO Blood Groups

Blood group	Frequency (% U.S. population) White	Black	Asian	RBC antigens (agglutinogens)	Illustration	Plasma antibodies (agglutinist)	Blood that can be received
AB	4	4	5	A B	A, B	None	A, B, AB, O Universal recipient
B	11	20	27	B	Anti-A, B	Anti-A	B, O
A	40	27	28	A	Anti-B, A	Anti-B	A, O
O	45	49	40	None	Anti-B, Anti-A	Anti-A Anti-B	O Universal donor

Blood Typing

- Which blood type is universal donor?
- Which blood type is universal recipient?

Blood being tested	Serum: Anti-A	Serum: Anti-B
Type AB (contains agglutinogens A and B); agglutinates with both sera	Agglutinated RBCs	Agglutinated RBCs
Type B (contains agglutinogen B); agglutinates with anti-B serum		
Type A (contains agglutinogen A); agglutinates with anti-A serum		
Type O (contains no agglutinogens); no agglutination occurs		

The Rh Blood Groups

- RBCs may carry Rh antigen on their surface
- if an Rh negative person receives Rh positive blood, the immune system begins to produce antibodies against the foreign blood type
- RBCs hemolysis does not occur with the first transfusion because it takes time to react and making antibodies. But the second time will
- Rh negative women carrying Rh positive baby
  - The first pregnancy usually results in delivery of a healthy baby
  - If the mother is sensitized, the mother will form antibodies that cross the placenta and destroy the baby's RBCs

Transfusion reactions

- The membranes of RBCs have genetically determined proteins (antigens)
- RBC proteins will be recognized as foreign if transfused into another person with different RBC antigens
- Antibodies will bind RBCs antigens causing agglutination
- foreign RBCs rupture and their hemoglobin is released into the bloodstream. The freed hemoglobin may block the kidney tubules and cause kidney failure.
- Transfusion reactions can also cause fever, chills, nausea. and vomiting.